MARTIN COUNTY MULTIPURPOSE DRAINAGE MANAGEMENT PLAN

MARTIN COUNTY

MARTIN COUNTY, MINNESOTA

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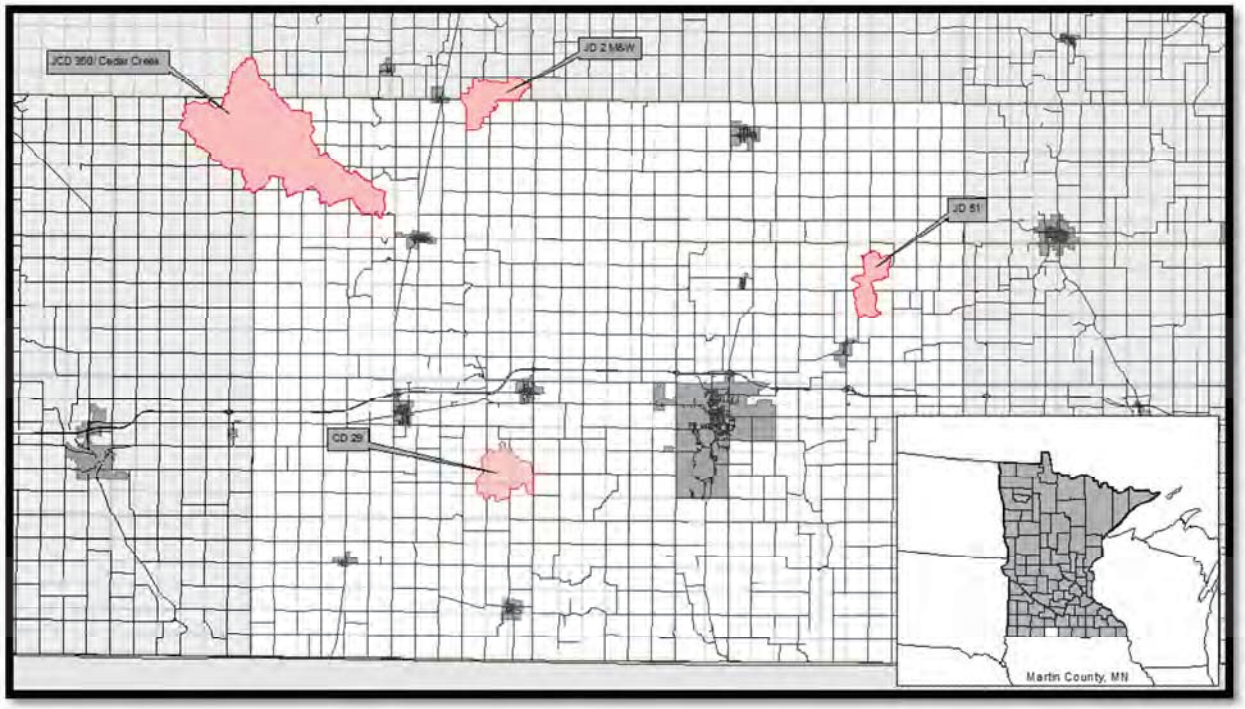
TABLE OF CONTENTS

A. OVERVIEW

The Martin County Multipurpose Drainage Management Plan was developed to supplement drainage projects with methods aimed at reducing peak flows and erosion, trapping sediment, reducing nutrient loading, and improving water quality throughout four watersheds located in Martin County. These four watersheds include **Judicial Ditch 51**, **Joint County Ditch 350**, **County Ditch 29**, and **Judicial Ditch 2 M&W** (as shown in Appendix A). This report is to be used to identify water quality improvements on a watershed scale, as a guide to landowners to explore improvements available, and as an attachment for future drainage improvement plans.



Source: I&S Group

This document identifies an analysis of multi-purpose drainage management scenarios throughout each individual watershed. These scenarios are aimed at water quality improvements that will benefit the entire watershed and identifies practices that can be incorporated by individual landowners. Scenarios include conservation practices and drainage needs, the benefits of each, and areas or requirements to make the practice successful. The best management practices (BMPs) used to supplement the multi-purpose drainage management are divided into three areas: preventative measures, control measures, and treatment measures. BMPs used in this analysis will first be defined followed by an individual watershed analysis with a detailed plan in how each BMP can be utilized to better water quality.

Preventative Measures

Preventative Measures are practices that can be applied towards the existing land without dramatically changing the layout of the land. These practices can be used by any of the owners through proper decisions in regards to the crops and the land area in which they are planted. Such measures will contribute towards higher water quality through erosion control, soil stability, and nutrient management.

Residue Management

Crop residues are materials left from harvest including stems, leaves, stalks, and seed pods. These residues can be properly managed through reduced tillage, strip tillage, and no till farming. Reduced tillage is any method of cultivation that leaves 15 to 30 percent of the previous year's crop residue on fields before and after planting the next crop. Strip tillage is a conservative tillage practice where rather than plowing the entire field; strips are tilled, exposing a small strip of topsoil for the seed bed while leaving some residue on the surface from the past year's harvest. No till farming is a practice where crops are planted each year without disturbing the soil from the previous year's harvest. Benefits to residue management are less erosion, increased irrigation efficiency, increased water infiltration, and increased organic matter in the soil creating higher soil stability. Funding is available through the Environmental Quality Incentives Program (EQIP) at $23 per acre for no till and strip agricultural practices.

Source: University of Minnesota, Minnesota Crop News

Nutrient Management

Nutrient Management is a system used by farmers to manage the amount, form, placement, and timing of the application of nutrients to crops. The purpose is to provide crops enough nutrients for optimum yields while minimizing the nutrient runoff, groundwater contamination, and by maintaining healthy soil conditions. Nutrient Management consists of proper quantity selection in the fertilizers used as well as the type of fertilizers being used. Other practices include the timing and method of manure application where it is less susceptible to runoff, erosion, and leaching. EQIP funding is available at $16 per acre for enhanced nutrient management practices.

Crop Rotation

Crop rotation is defined as a system for growing several different crops in a planned succession on the same field. At least one soil conserving crop rotation such as perianal hay or other small grain must be included in the rotation. This practice typically consists of a corn-soybean-hay or corn-soybean-small grain rotation. Crop rotation benefits include reduced soil erosion, improved soil quality and fertility, and improved wildlife habitat. Additional benefits include more nitrogen credits to the soil and reducing fertilizer inputs therefore reducing nitrate leaching and nutrient runoff. Funding is available through the EQIP payment program at $40 per acre for annual crops to two years of cover.

Cover Crops

Cover crops refer the use of grasses, forbs, or legumes planted to provide seasonal soil cover on cropland when the soil would otherwise be bare and unseeded. Typical vegetation includes winter rye, oats, barley, alfalfa, and buckwheat planted near the end of a crop cycle or after harvest to utilize the short growing season to provide winter topsoil cover. Cover crops are planted to reduce soil erosion, nutrient leaching, and to outcompete weeds. They reduce soil erosion by providing a cover for precipitation impact and wind erosion, uptake nitrogen for plant growth which limits nutrient losses in the soil, and increase soil infiltration. EQIP payments are available at $40 per acre for legumes of mixed covers and $16 per acre for small grain seeding.

Source: Agricultural BMP Handbook for Minnesota

Control Measures

Structures For Water Control

A structure for water control is a structure in a drainage management system that either conveys water, controls flow direction and rate, or maintains a desired water elevation. They include a variety of weirs, drop inlets, culverts, or baffles. These structures are normally installed in open channels; however they can be used to control water elevations in restored wetlands. Water quality benefits associated with structures for water control include sedimentation, reducing flow volumes, and providing wildlife habitat.

Source: Blue Earth County Ditch 57, I&S Group

Two Stage Ditch

A two stage ditch can be described as a channel inside a channel. The inner (or low flow) channel is smaller and designed to carry water during perennial flows or low flows. The benches of the larger outer channel act as the floodplain to the inner channel. The benches have the capacity for the high flow events while also providing an area for sedimentation to occur. A two stage ditch can minimize and prevent sediments and nutrients from traveling further downstream. The low flow channel can help reduce high flow channel bank erosion.

Source: Blue Earth County Ditch 57, I&S Group

Tile Downsizing

The purpose of tile downsizing is to reduce or prevent flood damage by utilizing temporary storage within the tiling system. The goal is to reduce the peak flow as much as possible without causing significant flooding throughout the drainage system. This is achieved by providing short term storage within tile networks to the drainage system. A common practice is to undersize the tile outlet into the adjacent channel. Typically 20 to 50 feet of the adjacent tile from the ditch is undersized, allowing water to be stored in the nearby tiling system. This causes

a steadier and lower flow rate to enter into the channel. By controlling the entering flow, sediment transport in streams is reduced, causing less sloughing and erosion.

Alternative Tile Intake Structures

Source: Agricultural BMP Handbook for Minnesota

Alternative tile intake structures are a variation of standard isolate surface intakes that are flush with the exiting ground intakes. They include perforated risers, gravel inlets, dense pattern tile within the isolated region, and any other variation of the above. They increase sediment trapping efficiency through an increased settling time and filtering of the sediment runoff. This prevents sediments from further entering drainage systems and also controls flow volumes of surface runoff which reduces sloughing and erosion in nearby waterways.

Grassed Waterways

Grassed waterways are vegetative channels through agricultural land which provides a means for concentrated flows to drain from the surface while minimizing erosion. They are installed on fields with steeper slopes to prevent gully erosion. They are also used to convey runoff from terraces and diversion to nearby drainage channels. Grassed waterways also control flow volumes and act as a filter for nutrients. EQIP funding ranges from $1.25 per linear foot of a 12 foot wide strip to $3.65 per linear foot for a 35 foot wide strip.

Riparian Channel Vegetation

Riparian vegetation is a mix of grasses, forbs, sedges, and other vegetation that serves as an intermediate zone between upland and aquatic environments. It can be used to stabilize banks by anchoring soil through its root system. Riparian vegetation provides enhanced water quality benefits through sedimentation, uptake in nutrients, energy dissipation of high streamflows while providing additional habitat for aquatic species.

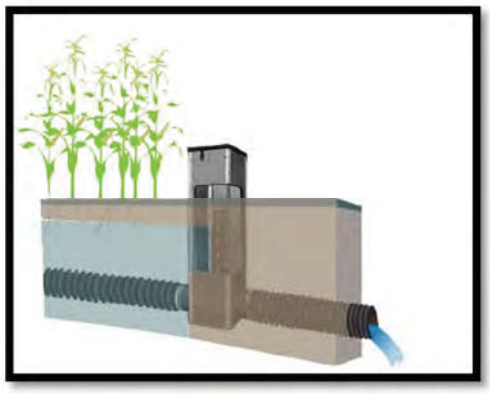
Source: Big Woods Stream Restoration

Typically, riparian vegetation is installed in or along streambanks where during high flow periods, surface water makes contact with the vegetation, providing benefits to surface water quality and aquatic species. It is also installed between upland vegetation such as filter strips and buffers, and the in stream channel to act as an additional filter of

surface runoff. Although EQIP does not provide funding specifically for riparian vegetation, some riparian vegetation may qualify for funding similar to filter strips and streambank and shoreline protection.

Controlled Subsurface Drainage

Controlled subsurface drainage is a practice used to manipulate the ground water elevation in an agricultural field that contains a tiling system. It is similar to a traditional drainage system; however the outflow is intercepted by a water control structure which controls the water table elevation. This structure contains an inlet and outlet tile with stoplogs placed between them to effectively control the water table elevation.



Source: Farm Progress

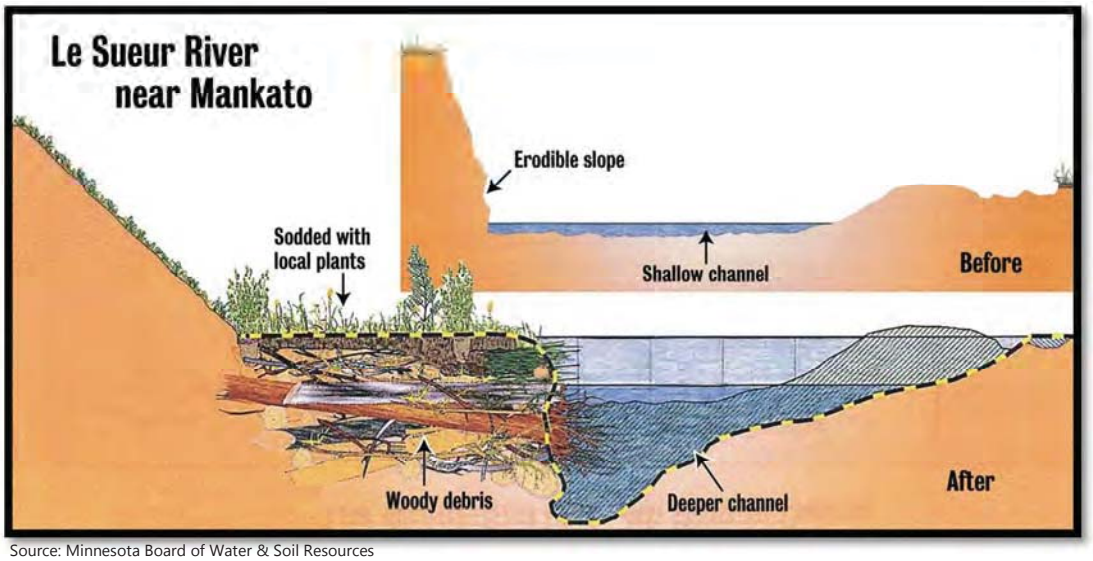
Typically the control structure is adjusted to allow the water to drain during the planting and harvesting months while during the growing season, the water table is held higher in the ground to allow for better crop growth. In this system, field tile is placed 3-4 feet below the ground surface. The control structures allow water to either remain high in the ground or to be drained when necessary. A control structure can manage the water in the ground for a difference of 1-2 feet of elevation change. For areas where greater elevation changes occur, additional control structures are needed. Adequate areas for controlled subsurface drainage include areas that contain an average of 10 acres over an elevation change of 1-2 feet. Water quality benefits associated with controlled subsurface drainage include overall volume reduction of subsurface drainage, an increase in soil moisture which allows for more plant growth and higher yield potential, and it minimizes the amount of nutrients that infiltrate through the soil with the shallower placement of tile laterals.

Funding for controlled subsurface drainage is available through the Soil and Water Conservation Districts (SWCD) or the Natural Resources Conservation Services (NRCS)

Toe Wood Sod Mat

This is a form of erosion control that uses vegetation to stabilize the shoreline of a stream or river bank. Toe Wood Sod Mats reduce water velocity, trap sediments, hold bank soil in place, and maintain a low width to depth ratio. They are typically placed in areas where soil erosion occurs with no other vegetation along the banks. Woody debris such as logs or branches are placed on top of the existing river bed along the eroding bank. They are stacked to fill the portion of the river below the baseline water elevation. Placed on top of the woody debris are

sod mats. Theses sod mats fill the top of the woody debris and create a new top of bank. Once the sod mats are installed, woody species such as dogwoods, cedars, or willows are planted in the sod layer for extra soil stabilization. This method ties vegetation into the eroding bank and provides additional support while providing a more natural habitat for fish and other animals.



Source: Minnesota Board of Water & Soil Resources

Block Ramps

Block ramps are a hydraulic structure designed to stabilize, minimize erosion, and dissipate energy of flow in river beds. They are typically designed in portions of rivers where the bed slope is steep and susceptible to erosion. There are two designs of block ramps. The first design is a block carpet which consists of blocks tightly packed together allowing the flow to smoothly pass while slightly interrupting the constant flow. The second type of block ramps are block clusters. Block clusters contain random placement of blocks throughout the channel bed which causes the flow to be disrupted upon making contact. Block clusters are designed for large streams or rivers with a high flow volume. Both forms of block ramps provide erosion control and control flow volumes by dissipating energy from the water.

Treatment Measures

Filter Strips

Filter strips are an area of vegetation planted between fields and surface waters to minimize organics, nutrients, and sediments in runoff from entering nearby surface waters. They also effectively reduce runoff volume and erosion near surface waters by developing sheet flow throughout the strip. They are typically installed on field edges, property lines, or along any waterway at the top of the bank. Strip widths must be at least 1 rod (16.5 feet) along a public drainage ditch and 50 feet where adjacent to public waters. Typical plant species in filter strips include stiff, upright stemmed vegetation such as Big Bluestem, Canada Wildrye, Switchgrass, and other native prairie grasses. EQIP offers a payment schedule of $222 per acre of filter strips installed and $282 per acre if they are installed with shaping.

Source: Minnesota Pollution Control Agency, Willmar

Wetland Restoration

A Wetland Restoration is the reestablishment of the hydrology, plants, and soils of a former or degraded wetland that has been drained, farmed or otherwise modified. The goal is to approximate the original wetland as closely as possible. Restored wetland plants usually include a mix of native water-loving grasses, sedges, rushes and forbs in the basin or ponded area. Mixtures of native grasses are also incorporated in the upland areas. There are many benefits to wetland restoration including:

a. Improvement of surface and ground water quality by filtering sediments, pesticides, nutrients, and bacteria
b. Reducing soil erosion by slowing the overland flow
c. Providing storage of water during heavy rainfall events
d. Preventing nutrients from traveling further downstream by plant uptake

In addition to improved water quality, wetlands are often restored to provide breeding grounds for ducks, geese, and migratory waterfowl whose habitat has been reduced. They also provide habitat for small game and other species in the upland area. Recently, many wetlands have been restored by private land owners to sell as wetland mitigation credits. An individual land owner is responsible for up front construction costs, but can sell the credits through the wetland banking program. An example vegetation establishment, management, and monitoring plan is provided in Appendix F.

Source: Agricultural BMP Handbook for Minnesota

Sediment Basins

A sediment basin is an excavated or ponded area with an engineered outlet designed to provide water storage in a rain event. The basin functions by detaining sediment or nutrient laden water for a sufficient time, allowing the particles to drop out of suspension and allow for nutrient uptake in vegetative areas. They may be used in agricultural or urban settings and primary are designed to treat water from disturbed areas. Water quality benefits associated with sediment basins include nitrogen and phosphorous removal, sediment removal, and reduced flow volumes preventing erosion in downstream waterways.

Woodchip Bioreactor

Source: Conservation Technology Information Center

The use of a woodchip bioreactor is a primary method of removing nitrogen from subsurface drainage waters. Carbon from the woodchips is used by bacteria to break down nitrates through the process of denitrification. Typical designs of a woodchip bioreactor include excavating a trench in line with the drainage system, filling the trench with non-treated chips between ¼ and 1 inch, and installing a structure for water control to properly manage the amount of water entering the bioreactor. The structure is aligned such that in a heavy rain event, water can bypass the bioreactor and allow for proper drainage

throughout the system. Drainage areas associated with a bioreactor range from 40 to 100 acres and are generally site specific in design. Advantages of woodchip bioreactors include a high rate of nitrate removal, small footprint, minimal maintenance during the design life, and low installation costs. Life expectancy for a woodchip bioreactor ranges from 15 to 20 years. Funding for woodchip bioreactors is available through the SWCD or the NRCS.

Saturated Buffer

A saturated buffer or vegetative subsurface outlet is an alternative outlet scheme in which subsurface drainage travels through areas of trees, shrubs, or other vegetation via a subsurface distribution pipe prior to entering a drainage ditch. The purpose of a saturated buffer is to reduce nitrate loading from subsurface drain outlets, to enhance or restore saturated soil conditions in riverine, lacustrine fringe, or slope landscape classes, and to reduce peak flows associated with typical tile drainage outlets. The design of a saturated buffer includes installing a structure for water control and subsurface distribution piping capable of diverting drainage system discharge to create an elevated zone of soil saturation near the end of the tile system. The structure diverts water to the vegetative buffer strip via perforated tiling during normal flows while allowing peak flows to travel directly to the system discharge through a non-perforated drain tile. This practice is applicable to agricultural lands with subsurface drainage where the soils and topography are capable of maintaining a raised water table near the outlet of the system without adverse effects to channel banks and adjacent land. Funding for saturated buffers is available through the SWCD or the NRCS.

B. MARTIN COUNTY JUDICIAL DITCH 51

Martin County Judicial Ditch 51's (JD 51) watershed is located east of the city of Northrop and northeast of the City of Granada. It is located in Sections 4, 5, 8, 9, 16, 17, 20, and 21 of Center Creek Township (T-103-N, R-29-W) in Martin County. This drainage system drains 1,585 acres of land. The area is primarily made up of agricultural land cover. The majority of the watershed is relatively flat with an overall variation of elevations of only 30 feet. JD 51 flows into Elm Creek which is on the impaired waters list for fish bioassessment, turbidity, and fecal coliform impacting aquatic life and aquatic recreation.

Source: Judicial Ditch 51 Outlet To Elm Creek, I&S Group

Drainage in this watershed is currently comprised of only tiling. Current best management practices include a 9 acre CRP field located in the southwest quarter of Section 16. There are several additional BMPs that could be applied to this watershed to improve water quality of Elm Creek, as discussed below and as shown in Appendix B.

Preventative Measures

The major preventative measures that could be applied to JD 51's watershed include crop rotation, cover crops, residue management, and nutrient management. Since the watershed is primarily comprised of tillable agricultural land, all of these practices could be applied throughout the entire watershed to improve water quality by controlling sediments, minimizing erosion, minimizing nutrient runoff, and by sustaining the soils health. These BMPs could be applied either as one practice to a field, or a combination of practices to different fields within the watershed.

Control Measures

Since the watershed consists of only underground tiling and no open channels, the only control measure that could be applied to this watershed is controlled subsurface drainage. There are several locations within this watershed where controlled subsurface drainage is feasible and would have beneficial impacts towards water quality. These locations have ideal characteristics such as low elevation variance through an average of 10 acres in agricultural fields. Table 1 below summarizes the location, owner associated with the area, and the number of acres controlled.

Table 1. JD 51 Controlled Subsurface Drainage

DRAINAGE AREA	OWNER	LOCATION	NUMBER OF ACRES
1	Larson, Sandra K	N ½ of SW ¼, Section 4	25.5
2	Larson, Sandra K	SW ¼ of SE ¼, Section 5	13.0
3	Palmer, GW	W ½ of NW ¼, Section 16	80.0
4	Becker, Lonny A & Lynn J	W ½ of SW ¼, Section 16	70.0
5	Mortensen, Frances V	NW ¼ of NW ¼ Section 21	40.0
6	Snyder, Jr, Ronald R	SW ¼ of SE ¼ Section 17	25.0

Controlled subsurface drainage areas would contain tiling placed between 3 and 4 feet below the ground surface. The tiling would be placed parallel with the contours rather than perpendicular like traditional tiling. A water elevation control structure would be placed on the field tile mainline and would be spaced at every 1 to 2 foot elevation difference. The structure would contain adjustable stop logs which hold water in the tile during the growing season while allowing drainage during the spring plant and fall harvest. Design considerations such as control structure size and placement, tile size, and tile locations would be incorporated to each individual controlled drainage area as necessary.

Since this watershed is entirely drained by a tiling system, one major benefit to improve water quality is a sediment basin. The sediment basin can provide additional storage to the system, reducing peak flows entering Elm Creek while maintaining adequate drainage throughout the watershed. The sediment basin would provide additional water quality benefits to the impaired Elm Creek by allowing sediments to drop out of suspension and minimizing the amount of nutrients entering the creek. A good location for the sediment basin is on the property of Randy Kroon, located in the southeast quarter of Section 5. This location was chosen based on the topography of the area, the current drainage system, and the land use. Currently this location is at the intersection of 180th Street and 270th Avenue. There are no row crops planted in this area and it is located just upstream from the outlet of the system. At this location, roughly 1,100 acres drains from the watershed, providing treatment for nearly three quarters of the tile water for sediments and nutrients.

A woodchip bioreactor can provide treatment for nitrates in this watershed at four different locations. These locations were selected based on the current tile drainage system, total area drained to each bioreactor, and land use proximity based on property lines and roadways. The current tile system is made up of one main line with several branches. Since bioreactors cannot treat a large drainage area, the locations were aimed at treating the branch lines with smaller drainage areas rather than the tile mainlines.

The first woodchip bioreactor could be located in the southeast quarter of Section 5 on the field edge, just west 270th avenue. Darwin and Saundra Roberts are the landowners of the parcel. This bioreactor would be on the downstream end of a branch line which drains roughly 110 acres of agricultural land. Since this branch does not flow through the proposed detention pond, this location would provide water quality improvements to the system by preventing nutrients from directly entering Elm Creek.

The second bioreactor location could be on the property of Arlen Larson in the northeast quarter of Section 9. It would be located on the west side of the existing driveway on the ditch line. At this location, the branch line drains roughly 80 acres of agricultural land. This location was chosen since no other locations along this branch were feasible due to land use and access.

Another location for a woodchip bioreactor could be in Section 17 just south of CSAH 38. The landowner of this parcel is GW Palmer. This would be a good location because it is located on a branch of the mainline near a roadway, allowing it to have minimal impacts to the surrounding agricultural land. At this location of the branch, the tiling system drains roughly 100 acres and is feasible for a bioreactor.

The last location for a woodchip bioreactor could be on the property of Lonny and Lynn Becker in the west half of Section 16. This location was chosen since it is at the end of a branch line, draining approximately 120 acres. It is suggested that the bioreactor be placed along the property line for ease of farming practices. Although this location is not ideal since it is in the middle of an agricultural field, the area drained is suitable for a bioreactor and this would provide nitrogen treatment to every branch of the drainage system.

There is one potential wetland restoration area in JD 51. It is located in the southeast quarter of Section 17 on the property of Donald Snyder. This agricultural field contains a low area which has past records of flooding. Three branches of the tiling system drain through this area which then connects to the tile mainline. This location is good for a wetland restoration due to the hydrology benefits. The two north branch lines would be removed and be replaced with new tile at a shallower depth below surface. This allows both tiles to daylight into the proposed wetland area. Riprap and geotextile material would be placed around the daylight section to provide erosion control. A berm would be built to prevent the water in the wetland from flooding nearby fields. A structure for water control would be installed at the southeast end of the wetland, returning the water to existing branch line. From here, the tile would connect to the mainline tile. The overall wetland boundary is 22.4 acres while the total project area consists of 49.0 acres with the potential of 29.0 wetland mitigation credits. A wetland restoration in this area would provide nitrate treatment to each branch of the drainage system in addition to the woodchip bioreactors.

A saturated buffer could be incorporated at the outlet of the JD 51 system at Elm Creek. Adjacent to the banks of Elm Creek is an area of dense tress, spanning nearly 200 feet. Currently the outlet of the system drains directly to the creek. By modifying the outlet with a diversion structure at the beginning of the tree line, a saturated buffer system could be installed to use the dense woody area as a filter. Since the saturated buffer will incorporate the entire mainline system, it is likely that it would only operate during base flow conditions. During rain events, the majority of the drainage water will bypass the saturated buffer to provide adequate drainage throughout the system. By utilizing a saturated buffer at the outlet of the system, the entire watershed has the potential to be diverted from the primary outlet, providing the drainage water with a filter, reduce peak flows, and minimize erosion in Elm Creek.

Prioritizing

The following table prioritizes the above BMPs taking into consideration the current land use, potential funding to land owners, and the most beneficial water quality improvement options.

Table 2. JD 51 BMP Prioritizing				
Best Management Practice	**Water Quality Benefits**	**Number of Acres Treated**	**Potential Funding Options**	**Estimated Construction Cost**
Sediment Basin	Storage, Sedimentation, Nutrient Uptake, Reduced Peak Flows	1,100	Contact NRCS Or SWCD	$8,375/ acre-ft of storage
Woodchip Bioreactor	Nitrogen Reduction, Reduced Peak Flows	410	Contact NRCS Or SWCD	$12,500
Saturated Buffer	Nutrient Uptake, Reduced Peak Flows	1,585	Contact NRCS Or SWCD	$2.5/ l.f. $2,500/ control structure
Wetland Restoration	Nutrient Uptake, Reduced Soil Erosion, Reduced Peak Flows	49	$20,000 to $30,000/acre-Wetland Banking	$4000/ acre
Cover Crops	Reduced Soil Erosion, Reduced Nutrient Leaching, Healthier Soil Conditions	Throughout Entire Watershed	$40/acre-EQIP	$30/acre *Dependent on crop seeded
Crop Rotation	Reduced Soil Erosion, Healthier Soil Conditions	Throughout Entire Watershed	$40/acre-EQIP	No direct construction costs
Controlled Subsurface Drainage	Reduced Peak Flows, Reduced Erosion, Healthier Soil Conditions	254	Contact NRCS Or SWCD	$2.5/ l.f. tile $2,500/ control structure
Residue Management	Reduced Soil Erosion, Reduced Nutrient Leaching, Healthier Soil Conditions	Throughout Entire Watershed	$23/acre-EQIP	No direct construction costs
Nutrient Management	Reduced Soil Erosion, Reduced Nutrient Runoff, Healthier Soil Conditions	Throughout Entire Watershed	$16/acre-EQIP	No direct construction costs

Recommendations

Based on the best management practices described above, the following are recommendations to improve water quality throughout the watershed and in Elm Creek:

1. Construct a sediment basin near the end of the drainage system for storage, sedimentation, and flow reduction
2. Install woodchip bioreactors on branch lines to minimize the amount of nutrients discharging from the drainage system
3. Restore a wetland on the property of Donald Snyder to provide nutrient uptake and to grant the landowner with wetland mitigation potentials
4. Apply preventative measures such as cover crops, crop rotation, residue management, and nutrient management throughout the watershed as desired by individual land owners to provide sustainability to the soil and grant landowners with funding for their conservative practices

By implementing these BMPs, water quality would be improved throughout the watershed while maintaining adequate drainage and desired yield potential, upholding tillable acres, and providing additional funding benefits to landowners.

These recommendations are not requirements, but shall be discussed among land owners or whenever any work is done on the system to provide water quality benefits throughout the watershed and in downstream waterways.

C. JOINT COUNTY DITCH 350

Joint County Ditch 350's (JCD 350) watershed is located northwest of the City of Trimont and west of the Cities Ormsby and Odin. JCD 350 lies in the counties of Martin, Cottonwood, Jackson, and Watonwan. It is located in Sections 4, 5, 6, 7, 8, 9, 16, 17, 18, 19, 20, 21, 22, 28, 29, and 30 of Cedar Township (T-104-N, R-33-W) in Martin County and Sections 1, 2, 3, 4, 9, 10, 11, 12, 13, 14, 15, 23, 24, and 25 of Kimball Township (T-104-N, R-34-W) in Jackson County. Furthermore, the watershed is located in Sections 30, 31, and 32 of Odin Township (T-105-N, R-33-W) in Watonwan County and Sections 25, 35, and 36 of Mountain Lake Township (T-105-N, R-34-W) in Cottonwood County. The watershed drains to Cedar Lake through Cedar Creek which contains a watershed of 15,143 acres. JCD's watershed contains 12,840 acres including the existing 3,033 acre Judicial Ditch 75 in Jackson County and the existing 1,897 Judicial Ditch 91 in Jackson and Martin Counties. Furthermore, the Cedar Creek Watershed is located within the Elm Creek Watershed, which is on the impaired waters list for fish bioassessment, turbidity, and fecal coliform. The area within the Cedar Creek Watershed is primarily made up of agricultural land cover in gently rolling terrain with an overall elevation variation of 100 feet.

Source: Eroding Bank Of Joint County Ditch 350, I&S Group

Drainage in this watershed is currently comprised of open channel ditches and two tile drainage systems. The drainage ditches connect and drain into Cedar Creek, as shown in Appendix C. Minimal water quality measures are incorporated in this watershed to improve downstream conditions of Cedar Creek and Cedar Lake. Current BMPs include vegetation buffers along the ditch system, several grassed waterways draining adjacent to the ditch, and areas of CRP along portions of the ditch. Several additional BMPs could be applied to this watershed to improve water quality of Cedar Creek and Cedar Lake, as discussed below and as shown in Appendix C.

Preventative Measures

The major preventative measures that could be applied to JCD 350's watershed include crop rotation, cover crops, residue management, and nutrient management. Since the majority of the watershed is comprised of agricultural land, all of these practices could be applied throughout the entire watershed to improve water quality by controlling sediments, minimizing erosion, minimizing nutrient runoff, and by sustaining the soils health. These BMPs can be applied either as one practice to a field, or a combination of practices to different fields within the watershed.

Control Measures

There are several control measures that could effectively be applied to areas inside the watershed. Tile downsizing could be utilized at tile inlets larger than 12 inches in diameter to lower flow volumes entering the ditch, minimizing sloughing and erosion. Alternative tile intakes could be used at applicable surface inlets adjacent to the ditch. Additionally, at all tile inlets geofabric and riprap could be installed to protect the ditch bank from erosion. Filter strips could be placed along the ditch to trap sediments prior to entering the ditch, provide nutrient uptake in plants, and slow surface flow velocities. 50 foot filter strips could be installed along the public ditch while 16.5 foot filter strips could be installed along private ditch portions of the watershed (as identified in Appendix C).

Grassed waterways could further be implemented in the watershed to minimize the amount of sediments entering the ditch. Although there are no specific locations where grassed waterways would have a major impact to the watershed, they are most beneficial in areas near the existing ditch and areas with steep land slopes, susceptible to erosion. These areas include the downstream end of the watershed where the slopes are much steeper with higher surface flow rates.

A two stage ditch could also be incorporated into this watershed as a control measure in two areas. The first location would be at the end of the watershed of Judicial Ditch 75 (JD 75). JD 75 is comprised of 3,033 acres which is drained through a tiling system. This tiling system drains into an open channel at the upstream end of JCD 350, located in Section 1 of Kimball Township.

A two stage ditch could be established in this area allowing low flows to enter into JCD 350 while providing additional storage to the system during rain events. Placing a two stage ditch at this location would have beneficial water quality effects to the system by preventing sediments and nutrients from entering the JCD 350 drainage system.

The second two stage ditch could be constructed in the existing open ditch for a stretch of 8,500 feet located in Sections 4, 5, and 6 of Cedar Township. The main objective of this ditch is to provide in-stream treatment. By creating a two stage ditch in this location, storage would be provided to the system reducing peak flows and allowing sediments to drop out of suspension in the banks of the ditch. Nearly 6,000 acres of the watershed will pass through this two stage ditch further improving water quality to nearly one third of the overall watershed.

Just downstream of this location, a riparian channel could be constructed in Sections 9 and 16 of Cedar Township. Currently the area is flat, wide, and comprised of upland grasses and areas of CRP. This area could be modified by excavating 30 foot benches on each side of the channel and lining it with riparian vegetation such as sedges, forbs, and other water loving grasses. This vegetation would provide nutrient uptake, and protect the banks of the ditch from erosion. In addition to the riparian vegetation, filter strips could be installed for 16.5 feet on each side of the bank to provide treatment of surface runoff. The length of the riparian channel is 8,500 feet and would treat approximately 12,000 acres of the Cedar Creek watershed.

The installation of Toe Wood Sod Mats is a new method to stabilize existing weak bank slopes. This method consists of placing logs or branches topped by sod mats and vegetation into the existing channel bed. Vegetation is planted into the top layer and consists of willows, dogwoods, or cedars providing additional support and erosion control to the banks. This method is typically installed in areas along banks with minimal vegetation growth and areas that are susceptible to erosion. Cedar Creek contains a large area of unprotected bank slope in the southwest quarter of Section 25 in Cedar Township. This area contains no bank vegetation and two sharp corners of Cedar Creek which have eroding banks. Placing toe wood sod mats in this area would help protect Cedar Creek from erosion and prevent sediments from depositing into Cedar Lake.

Block ramps are designed to dissipate energy in a drainage system which prevents erosion and scouring of a river bank. With the large watershed of JCD 350, Cedar Creek experiences high flow volumes at the end of the creek prior to entering Cedar Lake. These high flow volumes are responsible for erosion and sediment deposits in Cedar Lake. By placing block ramps in Cedar Creek, high energy in the flow would be interrupted and dissipated. A good location for the block clusters is in a stretch of 3,500 feet of Cedar Creek located in the east half of Section 26 of

Cedar Township. Design considerations such as block sizes, spacing, and placement locations would be incorporated to the stretch as needed.

Most agricultural fields within this watershed contain elevation differences more than ten feet across the parcel. Therefore controlled subsurface drainage is not feasible to the majority of the watershed. However, ten areas within the watershed have characteristics that support controlled subsurface drainage. These areas contain agricultural fields between 38.5 and 160.0 acres with an elevation variation between 4 and 8 feet. Table 3 below summarizes the location, owner associated with the area, and the number of acres drained.

Table 3. JCD 350 Controlled Subsurface Drainage

DRAINAGE AREA	OWNER	LOCATION	NUMBER OF ACRES
1	Rahn, Noel & Angelina	EW ¼ of Section 30, Odin Township	160.0
2	Wilson, Gary & Linda	W ½ of NW ¼, Section 7, Cedar Township	83.5
3	Rahn, Noel P & Angelina	N ½ of NE ¼, Section 7, Cedar Township	80.0
4	Sandbo, Irene J Etal	W ½ of NW ¼, Section 8, Cedar Township	38.5
5	Scholl, Roxanne	W ½ of SE ¼, Section 7, Cedar Township	70.0
6	Scholl, Roxanne	E ½ of SE ¼, Section 7, Cedar Township	113.0
7	Hockel, Myra	S ½ of SW ¼, Section 8, Cedar Township	80.0
8	Bernhardt, Viola A Etal	W ½ of NE ¼ Section 22, Cedar Township	80.0
9	Crevier, Sandra J	NW ¼ of NE ¼ Section 27, Cedar Township	40.0
10	Sjogren, Dennis & Roxanne	E ½ of NE ¼ Section 27, Cedar Township	80.0

Controlled subsurface drainage areas would contain tiling placed between 3 and 4 feet below the ground surface. The tiling would be placed parallel with the contours rather than perpendicular like traditional tiling. A water elevation control structure would be placed on the field tile mainline and would be spaced at every 1 to 2 foot elevation difference. The structure contains adjustable stop logs which hold water in the tile during the growing season while allowing drainage during the spring plant and fall harvest. Design considerations such as

control structure size and placement, tile size, and tile locations would be incorporated to each individual controlled drainage area as necessary.

Treatment Measures

There are two areas within this watershed where a wetland restoration is feasible. The first location is on the property of Ray Wilson and Stanley Johanek in the southeast quarter of Section 1 of Kimball Township. At this location, the wetland would treat roughly 175 acres of surface runoff prior to entering the existing ditch. Two berms would be created to pond water in the low area and a structure for water control would be installed in one berm. This structure would outlet to a proposed grassed waterway connecting to an existing grassed waterway adjacent to the existing ditch. The total area of the wetland is 45.5 acres would have the potential of 30.5 wetland mitigation credits

The second wetland area is on the property of Thomas Mayberry located in the northwest quarter of Section 9 of Cedar Township. At this location, the wetland would treat approximately 150 acres of surface runoff. There is also an existing private tile line that has the potential to be realigned and day lighted into the wetland. There are two different scenarios for this wetland restoration. The first would require an installation of a large berm on the south side of the property with a structure for water control to pond water in the area. This option has the potential for 19.3 wetland mitigation credits. The second option would require the installation of two large berms and a water control structure to pond water in the area. This option is larger than the first and has the potential for 40.0 wetland mitigation credits.

Saturated buffers could be incorporated into the end of the watershed in Sections 25 and 26 of Cedar Township. Currently there are several areas with thick vegetation including trees and shrubs adjacent to Cedar Creek. Tile drainage systems could be rerouted through a diversion structure to percolate the water through the trees and shrubs. This would provide the drainage water with a filter, reduce peak flows, and minimize erosion in the creek. Up to 500 acres of tile water could be treated throughout this location.

Prioritizing

The following table prioritizes the above BMPs taking into consideration the current land use, potential funding to land owners, and the most beneficial water quality improvement options.

Table 4. JCD 350 BMP Prioritizing				
Best Management Practice	**Water Quality Benefits**	**Number of Acres Treated**	**Potential Funding Options**	**Estimated Construction Cost**
Riparian Vegetation	Nutrient Uptake, Reduced Erosion, Sedimentation, Storage, Bank Protection	12,000	$222/acre-EQIP	$1,000/ acre-seeded
Two Stage Ditch	Storage, Sedimentation, Reduced Peak Flows	Up to 6,000	Contact NRCS Or SWCD	$3/ l.f. $800/ acre seeded
Tile Downsizing and Inlet Protection	Reduced Erosion and Peak Flows	Throughout Entire Watershed	Contact NRCS Or SWCD	$20/ l.f. $25/ CY riprap
Block Ramps	Reduced Peak Flows, Reduced Erosion, Energy Dissipation	14,500	Contact NRCS Or SWCD	$20/ l.f.
Toe Wood Sod Mat	Reduced Water Velocity, Trap Sediments, Bank Stabilization	15,000	Contact NRCS Or SWCD	$110/ l.f.
Filter Strips	Reduced Soil Erosion, Nutrient Uptake, Reduced Peak Flows	Adjacent To Existing Ditch	$222/acre-EQIP	$500/ acre seeded *Dependent on crop seeded
Cover Crops	Reduced Soil Erosion, Reduced Nutrient Leaching, Healthier Soil Conditions	Throughout Entire Watershed	$40/acre-EQIP	$30/acre *Dependent on crop seeded
Crop Rotation	Reduced Soil Erosion, Healthier Soil Conditions	Throughout Entire Watershed	$40/acre-EQIP	No direct construction costs
Wetland Restoration	Nutrient Uptake, Reduced Soil Erosion, Reduced Peak Flows	114	$20,000 to $30,000/acre-Wetland Banking	$4000/ acre
Controlled Subsurface Drainage	Reduced Peak Flows, Reduced Erosion, Healthier Soil Conditions	825	Contact NRCS Or SWCD	$2.5/ l.f. tile $2,500/ control structure

Saturated Buffer	Nutrient Uptake, Reduced Peak Flows	500	Contact NRCS Or SWCD	$2.5/ l.f. $2,500/ control structure
Residue Management	Reduced Soil Erosion, Reduced Nutrient Leaching, Healthier Soil Conditions	Throughout Entire Watershed	$23/acre-EQIP	No direct construction costs
Nutrient Management	Reduced Soil Erosion, Reduced Nutrient Runoff, Healthier Soil Conditions	Throughout Entire Watershed	$16/acre-EQIP	No direct construction costs
Grassed Waterways	Reduced Soil Erosion, Sedimentation	Throughout Entire Watershed	Up to $3.65/ Linear Foot	$50/ acre seeded

Recommendations

Based on the best management practices described above, the following are recommendations to improve water quality throughout the watershed and in Cedar Creek:

1. Construct a two stage ditch for a stretch of 8,500 feet located in Sections 4, 5, and 6 of Cedar Township to provide storage and in-stream treatment of sediments and nutrients
2. Provide inlet protection and downsize tile inlets where applicable in the ditch and as desired by land owners
3. Plant filter strips adjacent to the ditch throughout the entirety of the system to provide a buffer to surface runoff and to provide landowners with funding for the practice
4. Apply preventative measures such as cover crops, crop rotation, residue management, and nutrient management throughout the watershed as desired by individual land owners to provide sustainability to the soil and grant landowners with funding for their conservative practices

By implementing these BMPs, water quality would be improved throughout the watershed while maintaining adequate drainage and desired yield potential, upholding tillable acres, and providing additional funding benefits to landowners.

These recommendations are not requirements, but shall be discussed among land owners or whenever any work is done on the system to provide water quality benefits throughout the watershed and in downstream waterways.

D. MARTIN COUNTY DITCH 29

County Ditch 29's (CD 29) watershed is located north of the City of Ceylon and south of the City of Welcome in Martin County. It is located in Sections 13, 14, 22, 23, 24, 25, 26, 27, 34, and 35 of Manyaska Township (T-102-N, R32-W). The watershed drains to the southeast and discharges into Judicial Ditch 367 (JD 367). The overall area of the watershed is 2,538 acres which is primarily made up of agricultural land cover. It consists of gently rolling terrain with an overall elevation variation of 30 feet.

Source: Farmed Wetland Area In County Ditch 29, I&S Group

Drainage in this watershed is currently comprised of only tiling. Minimal water quality measures are incorporated in this watershed to improve downstream conditions. Current best management practices include 30 acres of CRP located in the southwest quarter of Section 24 and 32 acres of a wetland area located in the northwest quarter of Section 23. There are several additional BMPs that can contribute to improved water quality throughout the watershed, as discussed below and as shown in Appendix D.

Preventative Measures

The major preventative measures that could be applied to CD 29's watershed include crop rotation, cover crops, residue management, and nutrient management. Since the majority of the watershed is comprised of tillable agricultural land, all of these practices could be applied throughout the entire watershed to improve water quality by controlling sediments, minimizing erosion, minimizing nutrient runoff, and by sustaining the soils health. These BMPs could be applied either as one practice to a field, or a combination of practices to different fields within the watershed.

Control Measures

Since the watershed consists of only underground tiling and no open channels, the only control measure that could be applied to this watershed is controlled subsurface drainage. There are several locations within this watershed where controlled subsurface drainage is feasible and would have beneficial impacts towards water quality. Table 5 below summarizes the location, owner associated with the area, and the number of acres of controlled subsurface drainage.

Table 5. CD 29 Controlled Drainage

DRAINAGE AREA	OWNER	LOCATION	NUMBER OF ACRES
1	Hartwig, Peter D	W ¼ of NW ¼, Section 23	48.0
2	Kramer, Inc.	SW ¼ NE ¼, Section 23	40.0
3	Degaard, Deloris L Le Etal	S ½ of SW ¼, Section 23	98.0
4	Simmering, Howard D	E ½ of NE ¼, Section 26	80.0
5	Meyer, Carl H Irrev Trust	SE ¼ of Section 26	140.0

Controlled subsurface drainage areas would contain tiling placed between 3 and 4 feet below the ground surface. The tiling would be placed parallel with the contours rather than perpendicular like traditional tiling. A water elevation control structure would be placed on the field tile mainline and would be spaced at every 1 to 2 foot elevation difference. The structure would contain adjustable stop logs which hold water in the tile during the growing season while allowing drainage during the spring plant and fall harvest. Design considerations such as control structure size and placement, tile size, and tile locations would be incorporated to each individual controlled drainage area as necessary.

Since this watershed is entirely drained by a tiling system, one major benefit to improve water quality is a sediment basin. The sediment basin would provide additional storage to the system, reducing peak flows entering the downstream JD 367, and allow sediments to drop out of suspension while maintaining adequate drainage throughout the watershed. A good location for the sediment basin is on the property of Robert and Doris Gerhardt, located in the northeast quarter of Section 25. This location was chosen based on the topography of the area, the current drainage system, and the proximity to the downstream JD 367. Additionally, this location is in a low area and is also on the National Wetland Inventory list. Currently this location is in the middle of an agricultural field with row crops planted and it is located just upstream from the end of the system. At this location, roughly 2,300 acres drains from the watershed, providing treatment for nearly the entire tile drainage water for sediments and nutrients.

There are three potential wetland restoration areas in the CD 29 watershed. These areas are low basins in the watershed with a history of past flooding. Due to the extreme flatness of the watershed, these wetlands would only collect surface water runoff since existing tile lines cannot be day lighted without a large amount of excavation and earthwork. Each wetland area would contain a structure for water control which would be connected into the existing drainage tile. The wetlands would provide the watershed with nutrient uptake, temporary water storage, and sedimentation of soil particles. Detailed layouts for each wetland option are included in Appendix E.

The first area is a large basin located in the in the north half of Section 23. Due to the size of the basin, there are four land owners including Douglas and Dawn Willner, Krahmer Inc., Jeffrey Alan Miller, and Tenhassen Farms Inc. At this location, the wetland would treat roughly 400 acres of surface runoff prior to entering the drainage tile. A large berm on the south side of the wetland would be constructed to pond water in the basin and prevent the land to the south from being flooded. The total area of this wetland is 160 acres and has the potential for 99.6 wetland mitigation credits.

The second potential wetland restoration area is located in the southwest quarter of Section 24. Laverne and Mildred Miller are the land owners of this property. Currently the land cover is grassland with areas CRP. Since this area does not consist of row crops and already contains upland grasses, it is an ideal location for a wetland. At this location, the wetland would treat roughly 200 acres of surface water runoff. The total area of this wetland option is 78 acres and has the potential for 50.4 wetland mitigation credits.

The third potential wetland restoration is located in the south half of Section 26. Land owners include Carl H and Patricia Ann Meyer. This area is a low basin which has past records of flooding. There are two options for the outlet of this wetland, both of which would collect surface water from approximately 350 acres. The first is to outlet the wetland to the south through a proposed tile to a future DNR wetland, located 3,700 feet south of the wetland. The second option is to place a drop intake at the north side of the wetland, allowing the water to enter the existing drainage tile. Both options have the same overall wetland layout with a total project area of 106.9 acres and the potential for 64.9 wetland mitigation credits.

One woodchip bioreactor could be placed in Section 24 along a branch line just east of 120th Avenue. This location is also in an upland buffer region of a potential wetland near the ditch line. At this location of the branch, the tiling system drains roughly 120 acres and is feasible for a bioreactor. Placing a woodchip bioreactor at this location would provide the watershed with water quality improvements by absorbing more nitrates and preventing them from entering downstream waterways.

Prioritizing

The following table prioritizes the above BMPs taking into consideration the current land use, potential funding to land owners, and the most beneficial water quality improvement options.

Table 6. CD 29 BMP Prioritizing

Best Management Practice	Water Quality Benefits	Number of Acres Treated	Potential Funding Options	Estimated Construction Cost
Sediment Basin	Storage, Sedimentation, Nutrient Uptake, Reduced Peak Flows	2,300	Contact NRCS Or SWCD	$5,892/ acre-ft of storage
Wetland Restoration	Nutrient Uptake, Reduced Soil Erosion, Reduced Peak Flows	950	$20,000 to $30,000/acre-Wetland Banking	$4000/ acre
Woodchip Bioreactor	Nitrogen Reduction, Reduced Peak Flows	120	Contact NRCS Or SWCD	$12,500
Controlled Subsurface Drainage	Reduced Peak Flows, Reduced Erosion, Healthier Soil Conditions	406	Contact NRCS Or SWCD	$2.5/ l.f. tile $2,500/ control structure
Cover Crops	Reduced Soil Erosion, Reduced Nutrient Leaching, Healthier Soil Conditions	Throughout Entire Watershed	$40/acre-EQIP	$30/acre *Dependent on crop seeded

Crop Rotation	Reduced Soil Erosion, Healthier Soil Conditions	Throughout Entire Watershed	$40/acre-EQIP	No direct construction costs
Residue Management	Reduced Soil Erosion, Reduced Nutrient Leaching, Healthier Soil Conditions	Throughout Entire Watershed	$23/acre-EQIP	No direct construction costs
Nutrient Management	Reduced Soil Erosion, Reduced Nutrient Runoff, Healthier Soil Conditions	Throughout Entire Watershed	$16/acre-EQIP	No direct construction costs

Recommendations

Based on the best management practices described above, the following are recommendations to improve water quality throughout the watershed and in the nearby waterways:

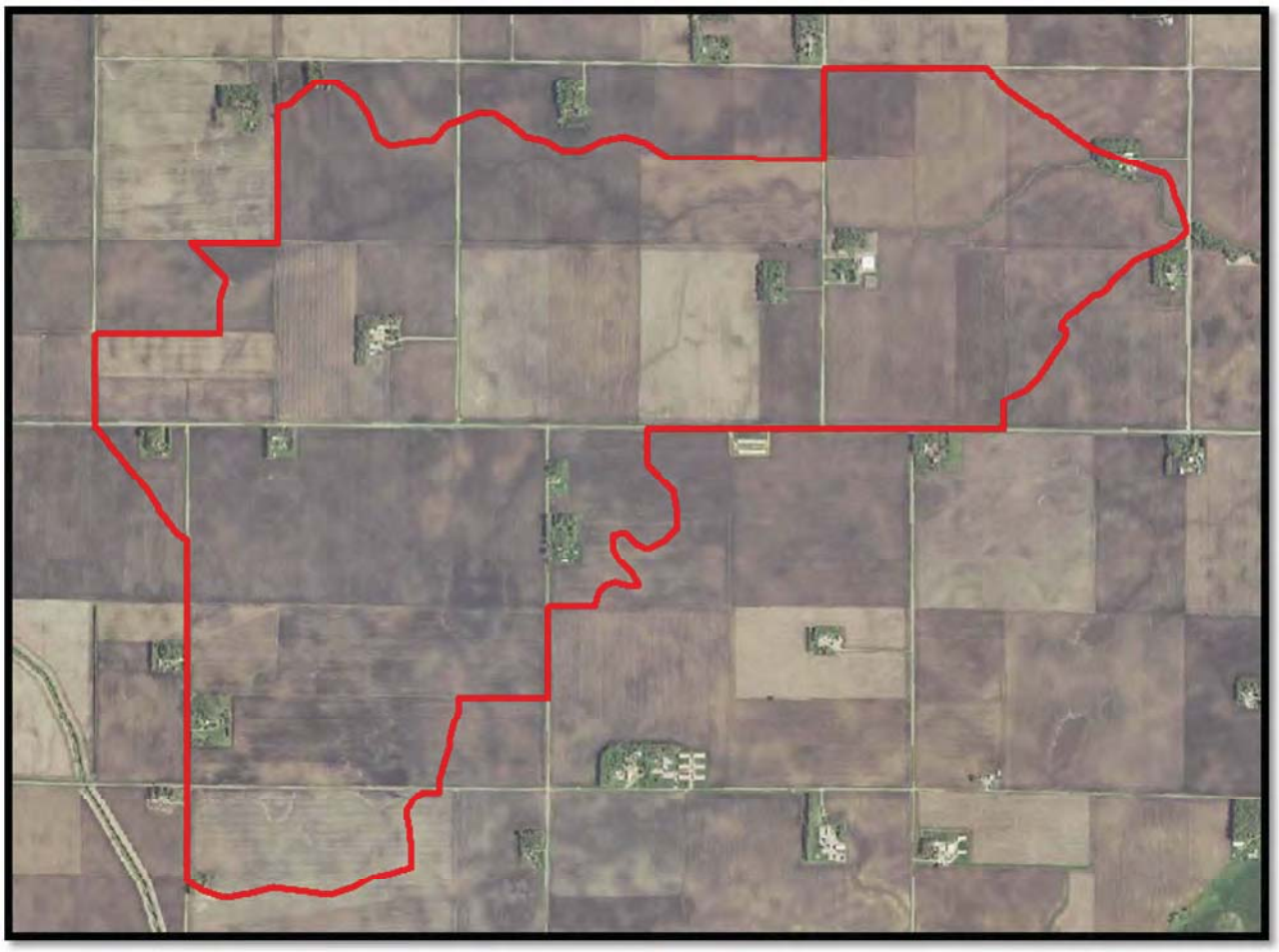
1. Restore wetlands on one or more properties as identified previously to provide nutrient uptake and to grant the owner with wetland mitigation potentials
2. Construct a sediment basin near the end of the drainage system for storage, sedimentation, and flow reduction
3. Install controlled subsurface drainage systems as applicable to the watershed to reduce peak flows and provide the potential of higher yields to landowners
4. Apply preventative measures such as cover crops, crop rotation, residue management, and nutrient management throughout the watershed as desired by individual land owners to provide sustainability to the soil and grant landowners with funding for their conservative practices

By implementing these BMPs, water quality would be improved throughout the watershed while maintaining adequate drainage and desired yield potential, upholding tillable acres, and providing additional funding benefits to landowners.

These recommendations are not requirements, but shall be discussed among land owners or whenever any work is done on the system to provide water quality benefits throughout the watershed and in downstream waterways.

E. JUDICIAL DITCH 2 M&W

Martin and Watonwan County Judicial Ditch 2's (JD 2 M&W) watershed is located east of the City of Ormsby. It is located in Sections 34, 35, and 36 of Long Lake Township (T-105-N, R-32-W) in Watonwan County and Sections 2, 3, and 10 of Galena Township (T-104-N, R-32-W) in Martin County. The watershed drains to the northeast and discharges into a ravine leading to Willow Creek. The overall area of the watershed is 2,046 acres which is primarily made up of agricultural land cover. The terrain is gently rolling with an overall elevation variation of 50 feet.



Source: Aerial Photo Of Judicial Ditch 2 M&W Watershed, I&S Group

Drainage in this watershed is currently comprised of only a tiling system. Currently the only BMP that is practiced in the watershed is a grassed waterway located in Section 36 of Long Lake Township at the end of the watershed. There are several additional BMPs that can contribute to improved water quality throughout the watershed, as discussed below and as shown in Appendix E.

Preventative Measures

The major preventative measures that could be applied to JD 2 M&W's watershed include crop rotation, cover crops, residue management, and nutrient management. Since the entire watershed is comprised of tillable agricultural land, all of these practices could be applied throughout the entire watershed to improve water quality by controlling sediments, minimizing erosion, minimizing nutrient runoff, and by sustaining the soils health. These BMPs could be applied either as one practice to a field, or a combination of practices to different fields within the watershed.

Control Measures

A two stage ditch could be incorporated into this watershed at the end of system where the tile daylights into an open ditch. It could be placed in northeast quarter of Section 36, on the property of Warren Winkelman. This location was chosen since it is at the end of the drainage system and it is in an open area containing only wide buffers along the ditch. By placing a two stage ditch at this location, storage is provided to the system reducing peak flows and allowing sediments to drop out of suspension in the banks of the ditch further improving water quality to the entire watershed.

Another control measure for this watershed is controlled subsurface drainage. There are thirteen locations, combining over 1,000 acres within this watershed where controlled subsurface drainage is feasible. This would have beneficial impacts towards water quality by providing temporary in-tile storage and reducing peak tile flows, minimizing downstream erosion. Table 7 below summarizes the location, owner associated with the area, and the number of acres of controlled subsurface drainage.

Table 7. JD 2 M&W Controlled Drainage

DRAINAGE AREA	OWNER	LOCATION	NUMBER OF ACRES
1	Erickson, Dianna	NE ¼ of Section 34, Long Lake Township	151.5
2	Stroschein, Amy J Etal	S ½ of SW ¼ of Section 34, Long Lake Township	80.0
3	Kuehl, David F	W ½ of SW ¼, Section 35, Long Lake Township	40.0
4	Saxen, Jon & Jennifer	S ½ of NE ¼ of Section 35, Long Lake Township	80.0
5	Warren Winkelman Etal Trust	NW ¼ of NW ¼ of Section 36, Long Lake Township	40.0

6	Mars Invest LTD Partnership	E ½ of NE ¼, Section 3, Galena Township	80.0
7	Winkelman, Donald R & Velma Eta	N ½ of NW ¼ of Section 2, Galena Township	70.0
8	Stroschein, Sylvan	NW ¼ of SW ¼ of Section 3, Galena Township	40.0
9	Sandberg, Dianne & Marvin	NE ¼ of SW ¼ of Section 3, Galena Township	40.0
10	Petersen, James G	SW ¼ of SW ¼ Section 3, Galena Township	28.5
11	Petersen, James G	SE ¼ of SW ¼ of Section 3, Galena Township	40.0
12	Putrino, J W & D M Rev Liv TST	S ½ of SE ¼ of Section 3, Galena Township	80.0
13	Miller, Joyce E	N ½ of Section 10, Galena Township	240

Controlled subsurface drainage areas would contain tiling placed between 3 and 4 feet below the ground surface. The tiling would be placed parallel with the contours rather than perpendicular like traditional tiling. A water elevation control structure would be placed on the field tile mainline and would be spaced at every 1 to 2 foot elevation difference. The structure would contain adjustable stop logs which hold water in the tile during the growing season while allowing drainage during the spring plant and fall harvest. Design considerations such as control structure size and placement, tile size, and tile locations would be incorporated to each individual controlled drainage area as necessary.

Treatment Measures

The outlet of JD 2 M&W is a ravine that travels east to Willow Creek. This ravine travels through a low valley with steep banks. By utilizing the layout of the ravine, two sediment basins could be created by installing a berm with a water elevation control structure. The sediment basins would be created in the current ravine without any excavation required. These basins would be created at two different elevations along the ravine, providing storage, sedimentation, and would reduce peak flows entering Willow Creek. The basins are located on the property of Janet Etal Saxen, in the south half of Section 31 of South Branch Township in Watonwan County and would provide treatment for the entire watershed.

Due to the majority of the tiling system traveling directly through the middle of agricultural fields; there is only one location where a woodchip bioreactor is feasible. This location is in Section 3 along a branch line just east of the Terry Hanson and Carol Peirson farm. This location

was chosen because it is located on a branch of the mainline near the edge of the field, allowing it to have minimal impacts to the surrounding agricultural land. At this location of the branch, the tiling system drains roughly 150 acres and is feasible for a bioreactor. Placing a woodchip bioreactor at this location would provide the watershed with water quality improvements by absorbing more nutrients and preventing them from entering the mainline.

Prioritizing

The following table prioritizes the above BMPs taking into consideration the current land use, potential funding to land owners, and the most beneficial water quality improvement options.

Table 8. JD 2 M&W BMP Prioritizing

Best Management Practice	Water Quality Benefits	Number of Acres Treated	Potential Funding Options	Estimated Construction Costs
Two Stage Ditch	Storage, Sedimentation, Reduced Peak Flows	2,141	Contact NRCS Or SWCD	$3/ l.f. $800/ acre seeded
Sediment Basin (At Ravine Outlet)	Storage, Sedimentation, Nutrient Uptake, Reduced Peak Flows	2,141	Contact NRCS Or SWCD	$6,000/ acre-ft of storage
Controlled Subsurface Drainage	Reduced Peak Flows, Reduced Erosion, Healthier Soil Conditions	1,010	Contact NRCS Or SWCD	$2.5/ l.f. tile $2,500/ control structure
Cover Crops	Reduced Soil Erosion, Reduced Nutrient Leaching, Healthier Soil Conditions	Throughout Entire Watershed	$40/acre-EQIP	$30/acre *Dependent on crop seeded
Crop Rotation	Reduced Soil Erosion, Healthier Soil Conditions	Throughout Entire Watershed	$40/acre-EQIP	No direct construction costs
Woodchip Bioreactor	Nitrogen Reduction, Reduced Peak Flows	150	Contact NRCS Or SWCD	$12,500

Residue Management	Reduced Soil Erosion, Reduced Nutrient Leaching, Healthier Soil Conditions	Throughout Entire Watershed	$23/acre-EQIP	No direct construction costs
Nutrient Management	Reduced Soil Erosion, Reduced Nutrient Runoff, Healthier Soil Conditions	Throughout Entire Watershed	$16/acre-EQIP	No direct construction costs

Recommendations

Based on the best management practices described above, the following are recommendations to improve water quality throughout the watershed and in the nearby waterways:

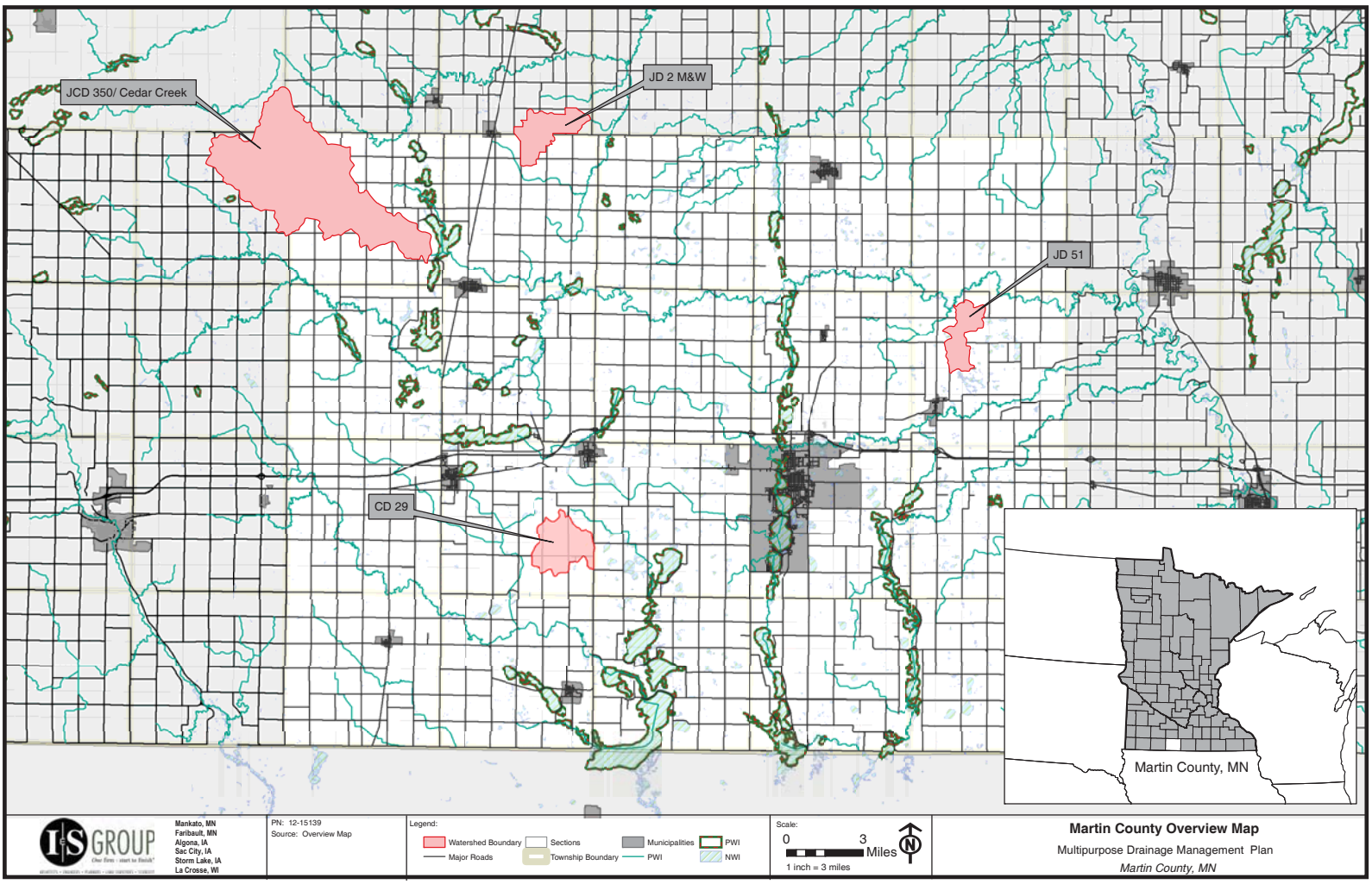
1. Install controlled subsurface drainage systems as applicable to the watershed to reduce peak flows and provide the potential of higher yields to landowners
2. Construct a two stage ditch at the end of the system to provide storage and in-stream treatment of sediments and nutrients
3. Construct a sediment basin in the ravine just upstream of Willow Creek for storage, sedimentation, and flow reduction
4. Apply preventative measures such as cover crops, crop rotation, residue management, and nutrient management throughout the watershed as desired by individual land owners to provide sustainability to the soil and grant landowners with funding for their conservative practices

By implementing these BMPs, water quality would be improved throughout the watershed while maintaining adequate drainage and desired yield potential, upholding tillable acres, and providing additional funding benefits to landowners.

These recommendations are not requirements, but shall be discussed among land owners or whenever any work is done on the system to provide water quality benefits throughout the watershed and in downstream waterways.

APPENDIX A

Martin County Overview Map



Mankato, MN
Faribault, MN
Algona, IA
Sac City, IA
Storm Lake, IA
La Crosse, WI

PN: 12-15139
Source: Overview Map

Legend:
Watershed Boundary
Sections
Municipalities
PWI
Major Roads
Township Boundary
PWI
NWI

Scale:
0 3 Miles
1 inch = 3 miles

N

Martin County Overview Map

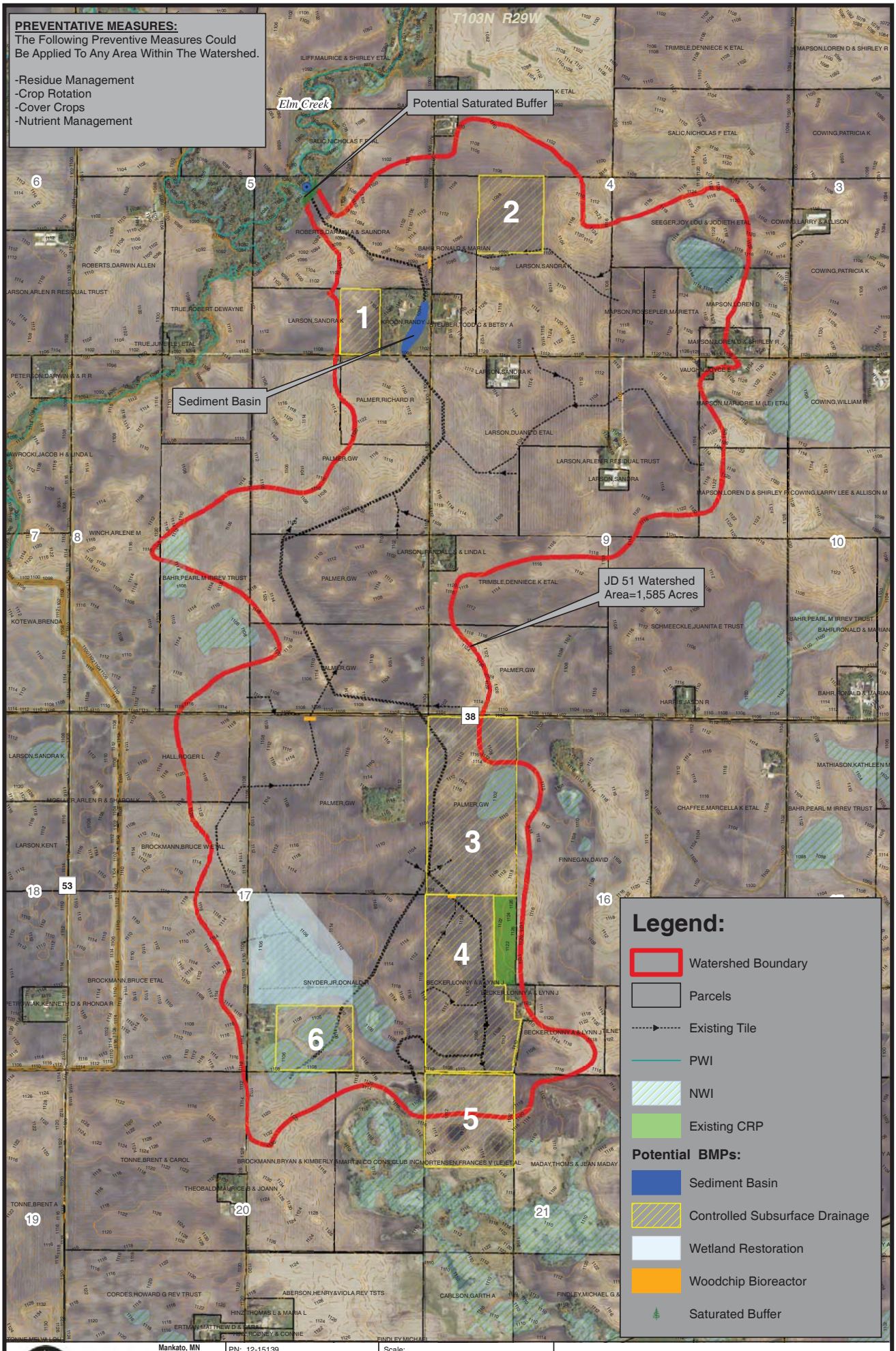
Multipurpose Drainage Management Plan

Martin County, MN

APPENDIX B

Judicial Ditch 51 Overview Map

Snyder Wetland Option Details



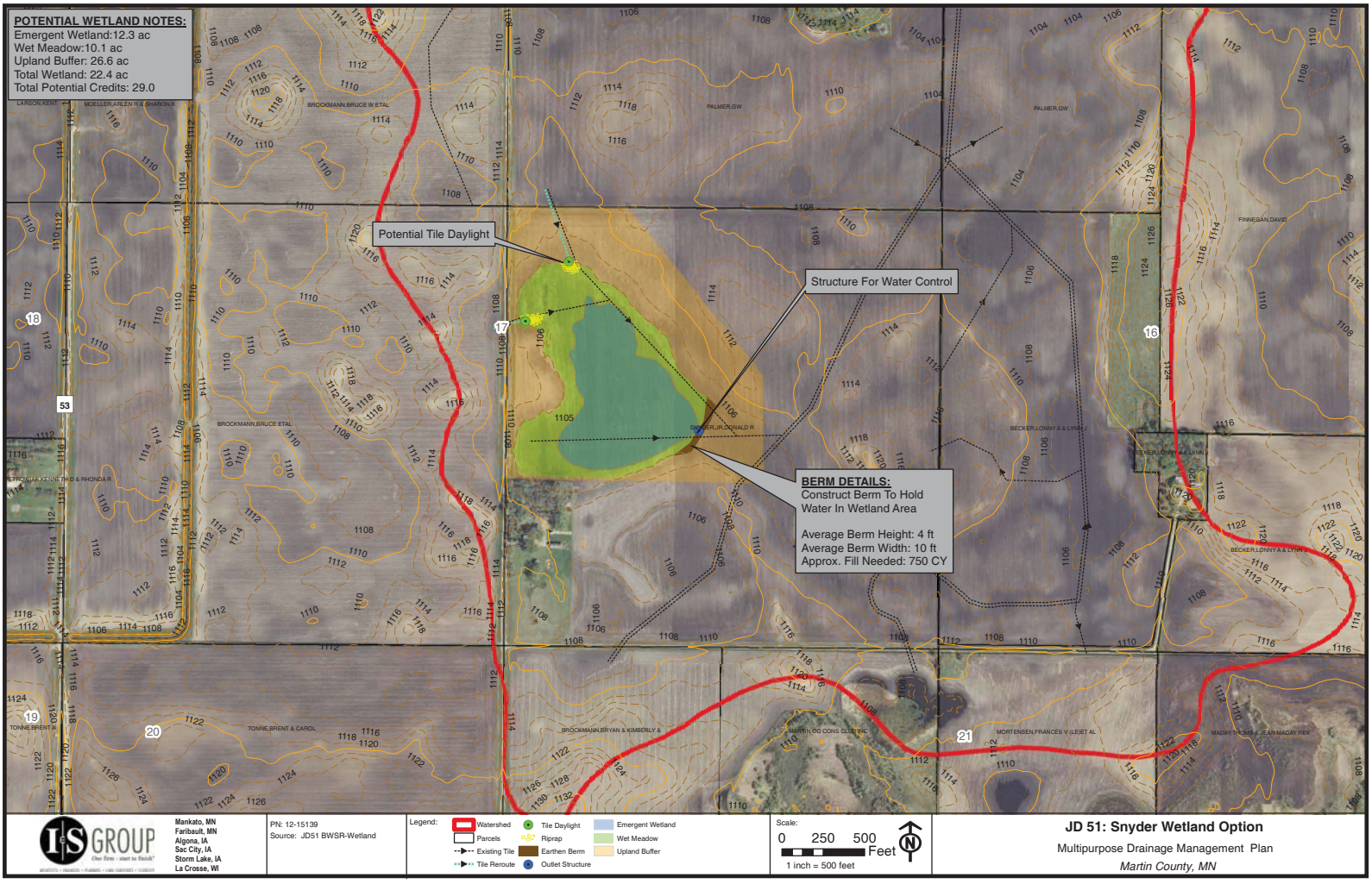
IS GROUP One firm - start to finish

Mankato, MN
Faribault, MN
Algona, IA
Sac City, IA
Storm Lake, IA
La Crosse, WI

PN: 12-15139
Source: JD51 BWSR

Scale:
0 1,250 Feet
1 inch = 1,250 feet

Judicial Ditch 51 Watershed
Multipurpose Drainage Management Plan
Martin County, MN



IS GROUP
One Firm · Total Resources

Mankato, MN
Faribault, MN
Algona, IA
Sac City, IA
Storm Lake, IA
La Crosse, WI

PN: 12-15139
Source: JD51 BWSR-Wetland

Legend:
Watershed
Parcels
Existing Tile
Tile Reroute
Tile Daylight
Riprap
Earthen Berm
Outlet Structure
Emergent Wetland
Wet Meadow
Upland Buffer

Scale:
0 250 500 Feet
1 inch = 500 feet

JD 51: Snyder Wetland Option

Multipurpose Drainage Management Plan

Martin County, MN

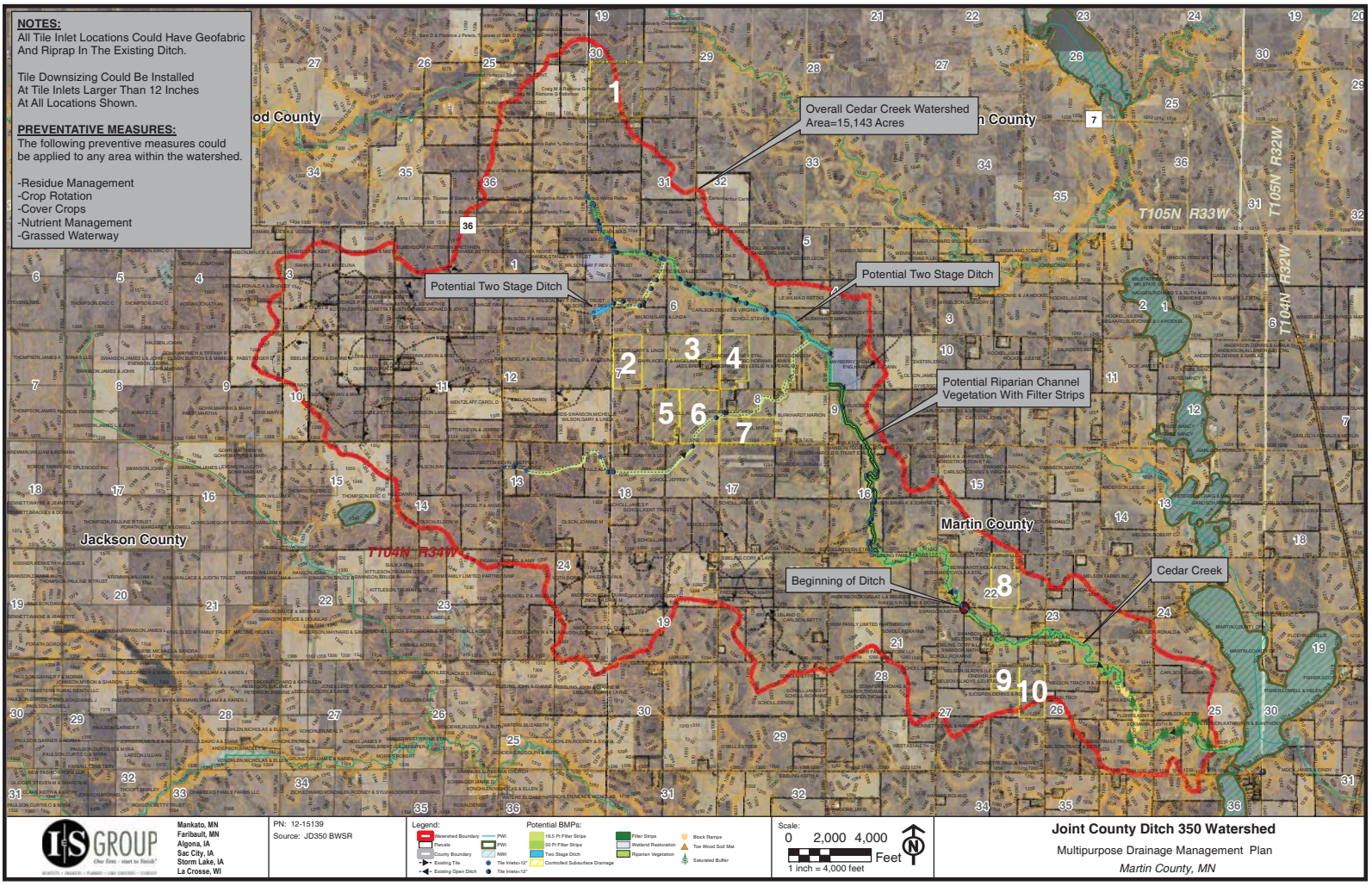
APPENDIX C

Joint County Ditch 350 Overview Map

Wilson Wetland Option Details

Mayberry Wetland Option Details

Mayberry Wetland Option 2 Details



IS GROUP
One firm - start to finish

Mankato, MN
Faribault, MN
Algona, IA
Sac City, IA
Storm Lake, IA
La Crosse, WI

PN: 12-15139
Source: JD350 BWSR

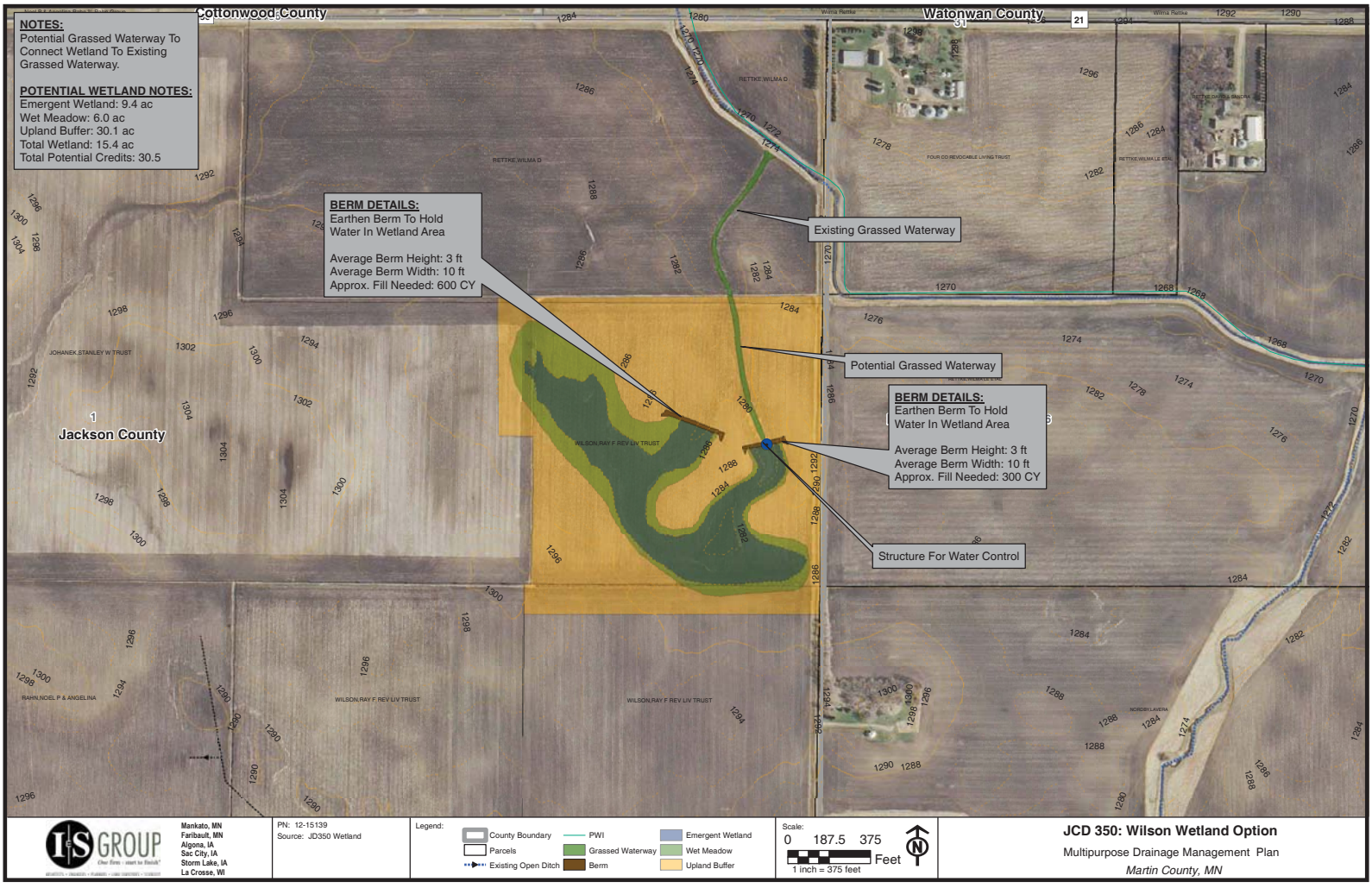
Legend:
Watershed Boundary
Parcels
County Boundary
Existing Tile
Existing Open Ditch
PWI
PWI
NWI
Tile Inlets<12"
Tile Inlets>12"

Potential BMPs:
16.5 Ft Filter Strips
50 Ft Filter Strips
Two Stage Ditch
Controlled Subsurface Drainage
Filter Strips
Wetland Restoration
Riparian Vegetation
Block Ramps
Toe Wood Sod Mat
Saturated Buffer

Scale:
0 2,000 4,000 Feet
1 inch = 4,000 feet

N

Joint County Ditch 350 Watershed
Multipurpose Drainage Management Plan
Martin County, MN



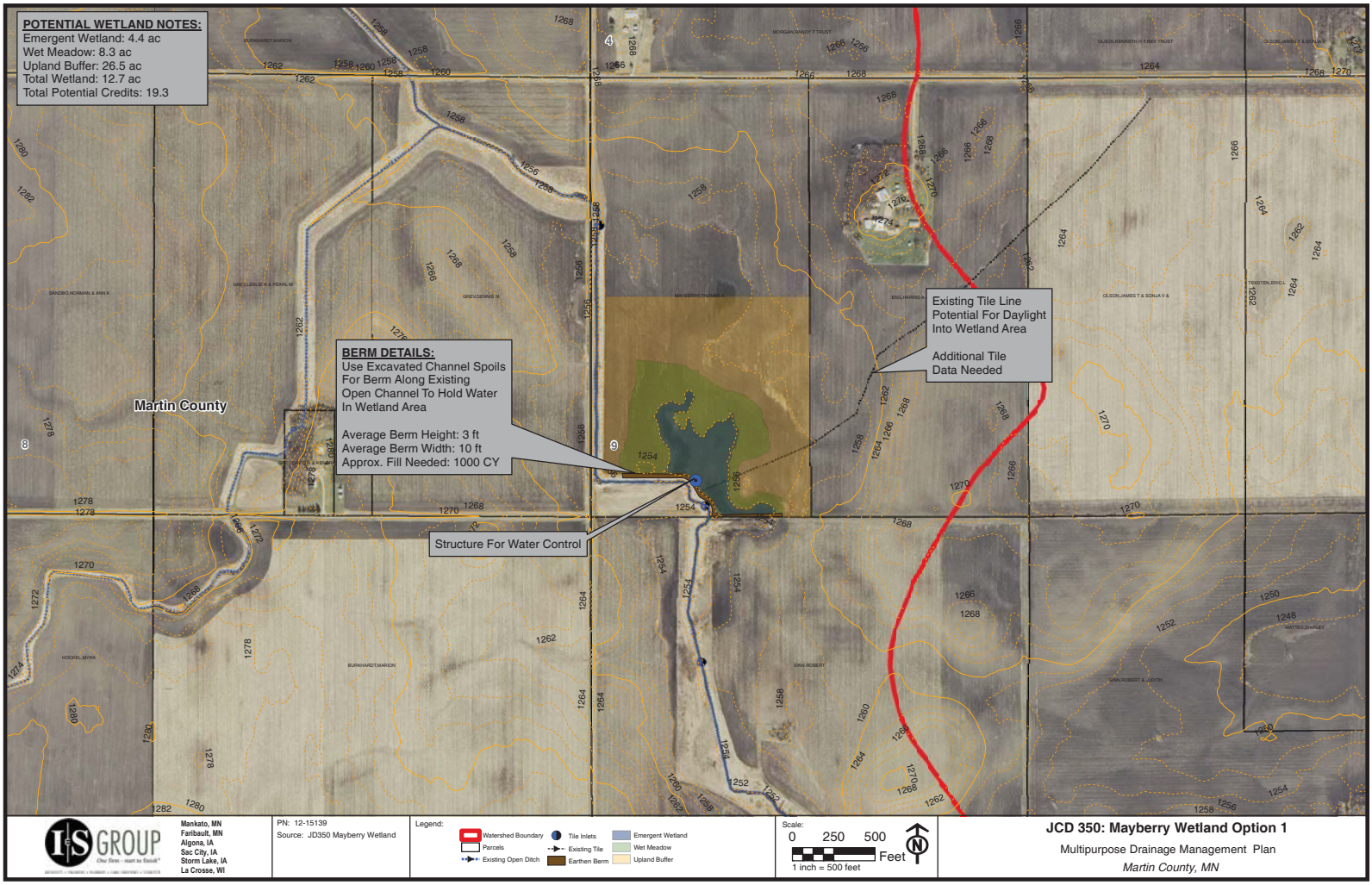
IS GROUP
Mankato, MN
Faribault, MN
Algona, IA
Sac City, IA
Storm Lake, IA
La Crosse, WI

PN: 12-15139
Source: JD350 Wetland

Legend:
County Boundary
Parcels
Existing Open Ditch
PWI
Grassed Waterway
Berm
Emergent Wetland
Wet Meadow
Upland Buffer

Scale:
0 187.5 375
Feet
1 inch = 375 feet

JCD 350: Wilson Wetland Option
Multipurpose Drainage Management Plan
Martin County, MN



IS GROUP
One firm - start to finish

Mankato, MN
Faribault, MN
Algona, IA
Sac City, IA
Storm Lake, IA
La Crosse, WI

PN: 12-15139
Source: JD350 Mayberry Wetland

Legend:
Watershed Boundary
Parcels
Existing Open Ditch
Tile Inlets
Existing Tile
Earthen Berm
Emergent Wetland
Wet Meadow
Upland Buffer

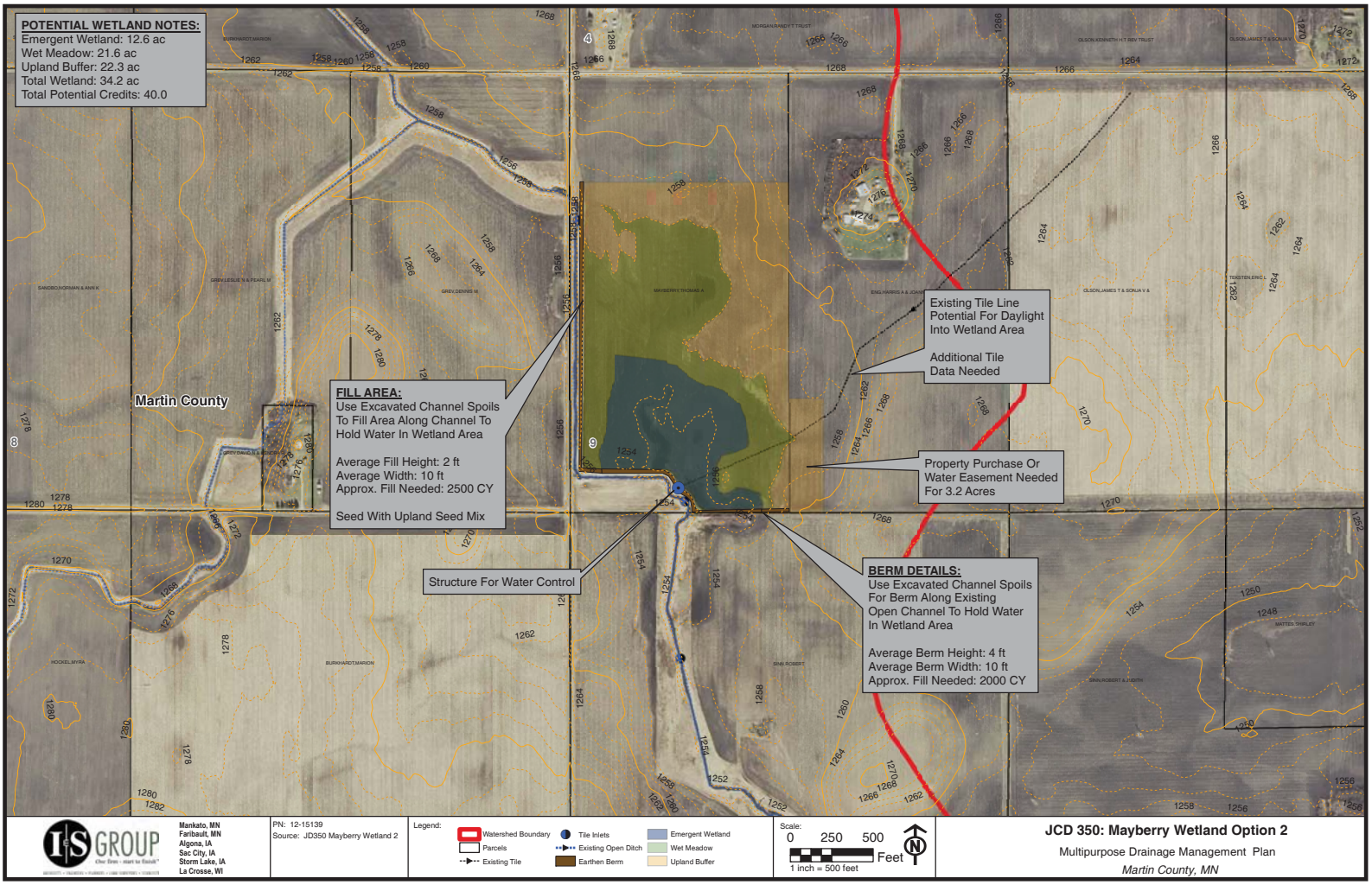
Scale:
0 250 500 Feet
1 inch = 500 feet

N

JCD 350: Mayberry Wetland Option 1

Multipurpose Drainage Management Plan

Martin County, MN



IS GROUP
One firm - start to finish®

Mankato, MN
Faribault, MN
Algona, IA
Sac City, IA
Storm Lake, IA
La Crosse, WI

PN: 12-15139
Source: JD350 Mayberry Wetland 2

Legend:
Watershed Boundary
Parcels
Existing Tile
Tile Inlets
Existing Open Ditch
Earthen Berm
Emergent Wetland
Wet Meadow
Upland Buffer

Scale:
0 250 500 Feet
1 inch = 500 feet

JCD 350: Mayberry Wetland Option 2

Multipurpose Drainage Management Plan

Martin County, MN

APPENDIX D

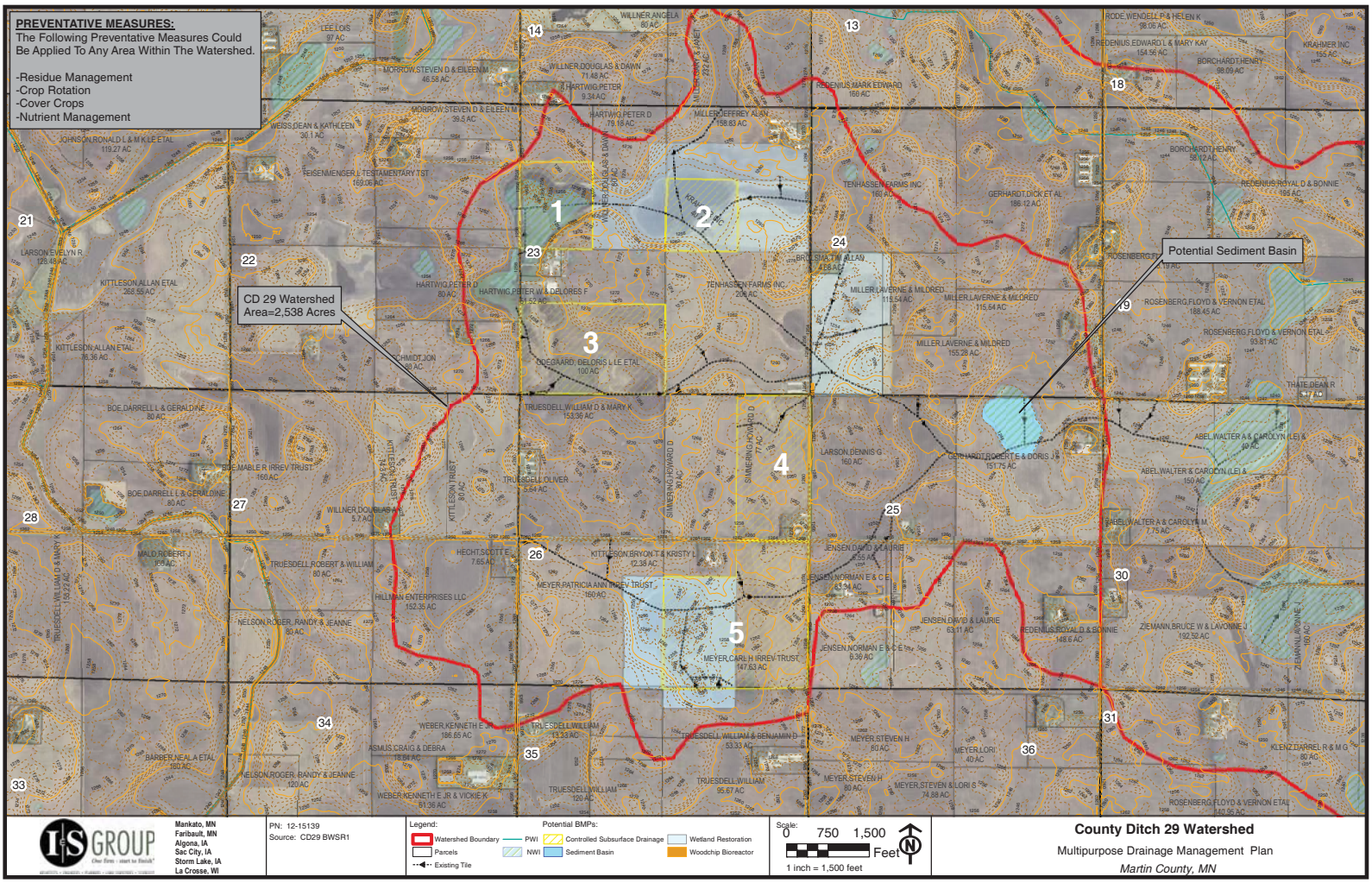
County Ditch 29 Overview Map

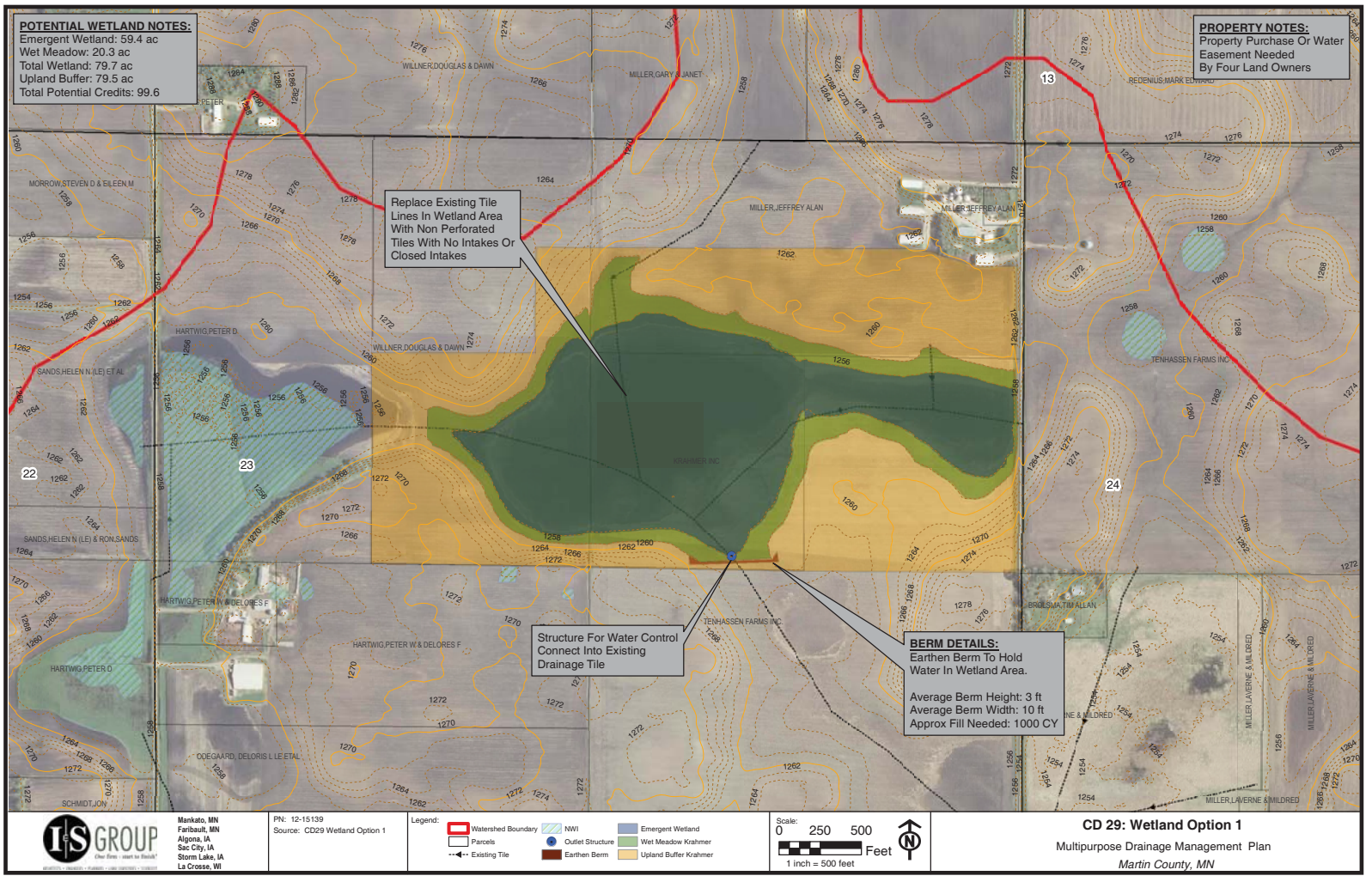
Wetland Option 1 Details

Miller Wetland Option Details

Meyer Wetland Option 1 Details

Meyer Wetland Option 2 Details


PREVENTATIVE MEASURES:
The Following Preventative Measures Could Be Applied To Any Area Within The Watershed.
-Residue Management
-Crop Rotation
-Cover Crops
-Nutrient Management
CD 29 Watershed Area=2,538 Acres
Potential Sediment Basin
1
2
3
4
5
Mankato, MN
Faribault, MN
Algona, IA
Sac City, IA
Storm Lake, IA
La Crosse, WI
PN: 12-15139
Source: CD29 BWSR1
Legend:
Watershed Boundary
Parcels
Existing Tile
Potential BMPs:
PWI
NWI
Controlled Subsurface Drainage
Sediment Basin
Wetland Restoration
Woodchip Bioreactor
Scale:
0 750 1,500 Feet
1 inch = 1,500 feet
N
County Ditch 29 Watershed
Multipurpose Drainage Management Plan
Martin County, MN



IS GROUP
One firm - start to finish

Mankato, MN
Faribault, MN
Algona, IA
Sac City, IA
Storm Lake, IA
La Crosse, WI

PN: 12-15139
Source: CD29 Wetland Option 1

Legend:
Watershed Boundary
Parcels
Existing Tile
NWI
Outlet Structure
Earthen Berm
Emergent Wetland
Wet Meadow Krahmer
Upland Buffer Krahmer

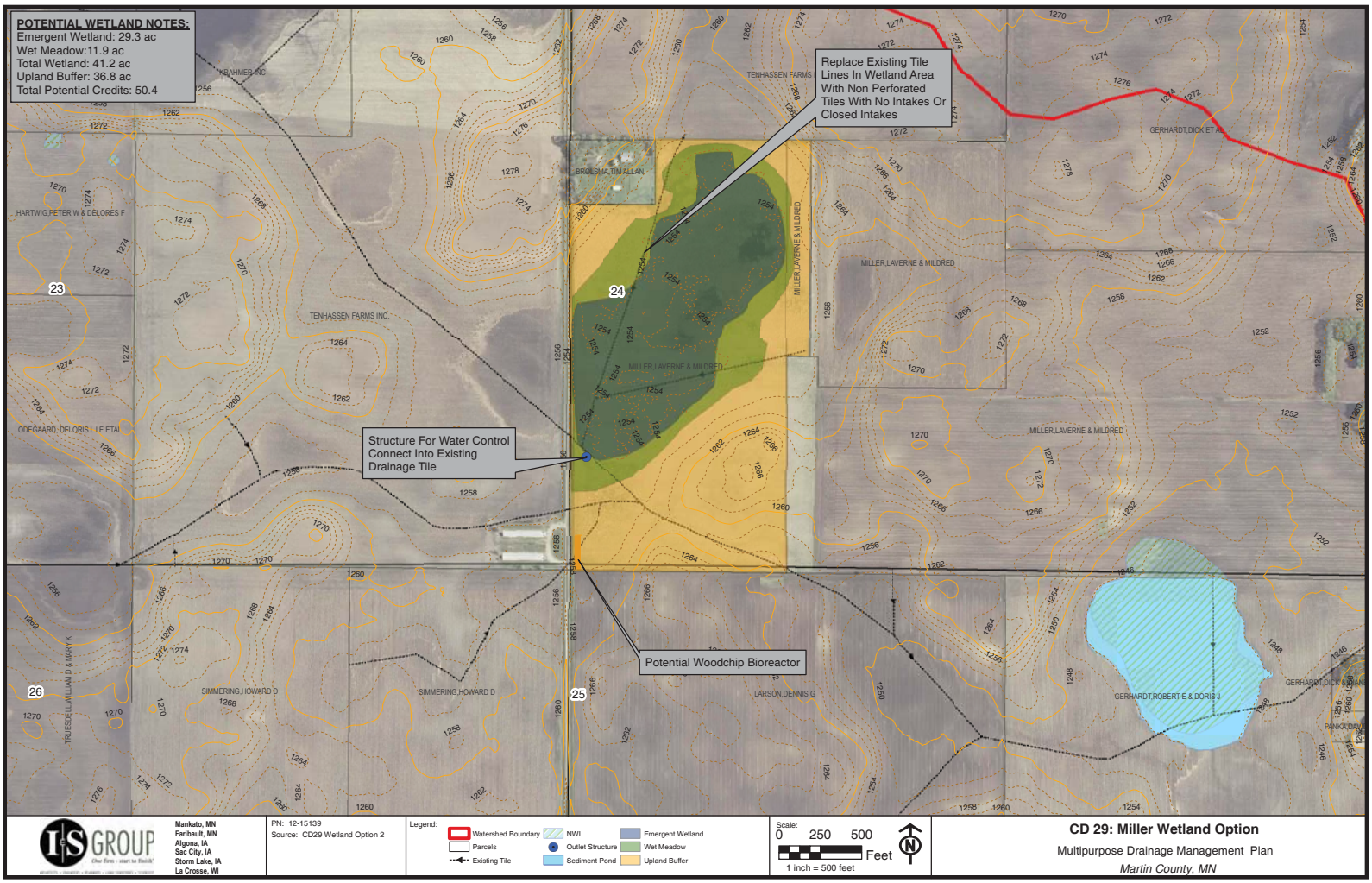
Scale:
0 250 500 Feet
1 inch = 500 feet

N

CD 29: Wetland Option 1

Multipurpose Drainage Management Plan

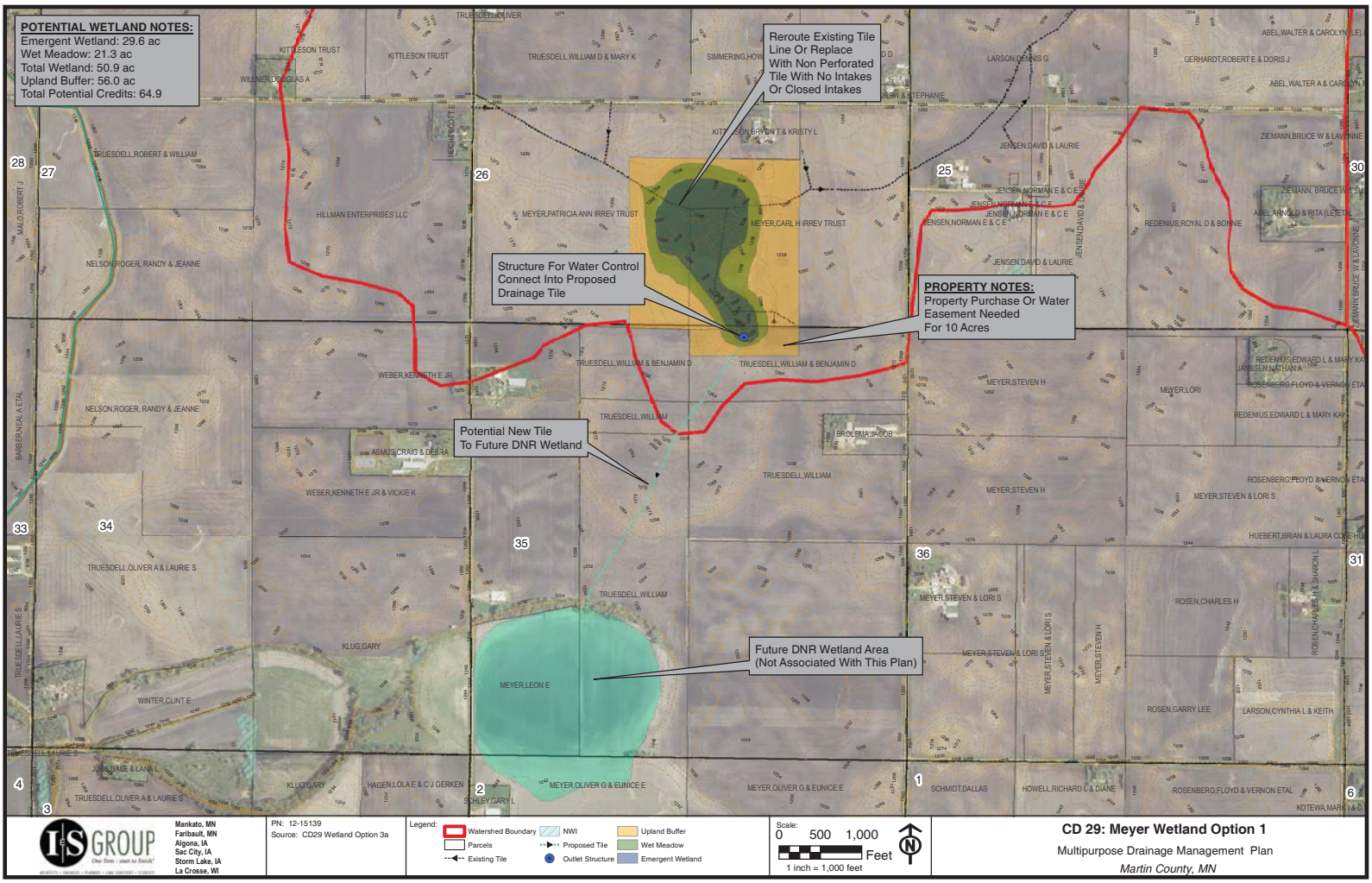
Martin County, MN

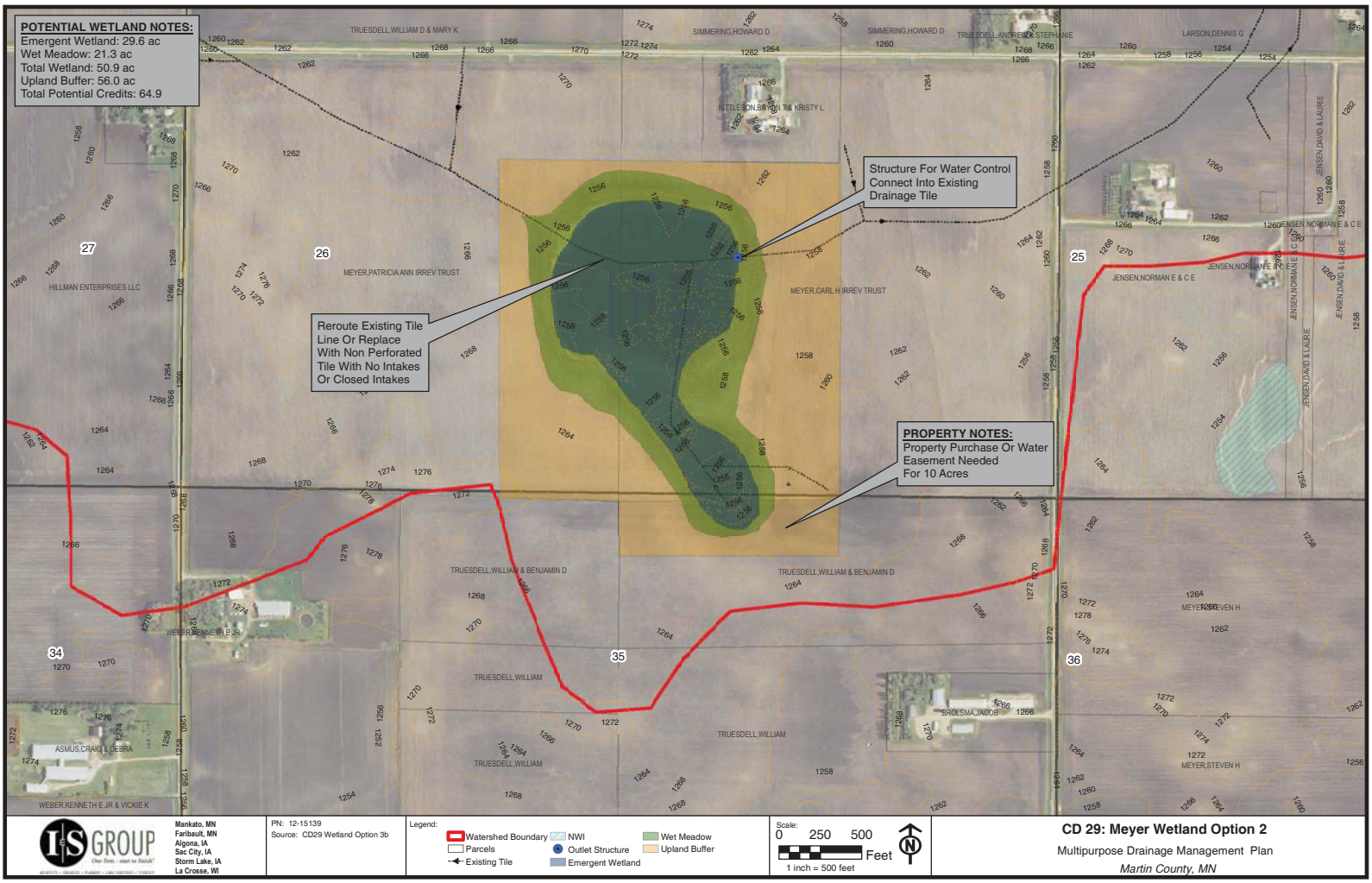


CD 29: Miller Wetland Option

Multipurpose Drainage Management Plan

Martin County, MN


POTENTIAL WETLAND NOTES:
Emergent Wetland: 29.6 ac
Wet Meadow: 21.3 ac
Total Wetland: 50.9 ac
Upland Buffer: 56.0 ac
Total Potential Credits: 64.9
Reroute Existing Tile Line Or Replace With Non Perforated Tile With No Intakes Or Closed Intakes
Structure For Water Control Connect Into Proposed Drainage Tile
PROPERTY NOTES:
Property Purchase Or Water Easement Needed For 10 Acres
Potential New Tile To Future DNR Wetland
Future DNR Wetland Area (Not Associated With This Plan)
KITTLESON TRUST
TRUESDELL,WILLIAM D & MARY K
TRUESDELL,ROBERT & WILLIAM
HILLMAN ENTERPRISES LLC
MEYER,PATRICIA ANN IRREV TRUST
MEYER,CARL H IRREV TRUST
NELSON,ROGER, RANDY & JEANNE
WEBER,KENNETH E JR
TRUESDELL,WILLIAM & BENJAMIN D
ASMUS,CRAIG & DEBRA
WEBER,KENNETH E JR & VICKIE K
TRUESDELL,OLIVER A & LAURIE S
TRUESDELL,WILLIAM
KLUG,GARY
WINTER,CLINT E
MEYER,LEON E
JENSEN,DAVID & LAURIE
MEYER,STEVEN H
MEYER,STEVEN & LORI S
ROSEN,CHARLES H
ROSEN,GARRY LEE
LARSON,CYNTHIA L & KEITH
SCHMIDT,DALLAS
HOWELL,RICHARD L & DIANE
ROSENBERG,FLOYD & VERNON ETAL
MEYER,OLIVER G & EUNICE E
SCHLEY,GARY L
HAGEN,LOLA E & C J GERKEN
JUHS,DALE & LANA L
REDENIUS,ROYAL D & BONNIE
REDENIUS,EDWARD L & MARY KAY
ZIEMANN,BRUCE W & LAVONNE
GERHARDT,ROBERT E & DORIS J
ABEL,WALTER & CAROLYN
BROLSMA,JACOB
MEYER,LORI
JANSSEN,NATHAN A
HUEBERT,BRIAN & LAURA
KOTEWA,MARK I & D
28
27
26
25
30
33
34
35
36
31
4
3
2
1
6
Mankato, MN
Faribault, MN
Algona, IA
Sac City, IA
Storm Lake, IA
La Crosse, WI
PN: 12-15139
Source: CD29 Wetland Option 3a
Legend:
Watershed Boundary
Parcels
Existing Tile
NWI
Proposed Tile
Outlet Structure
Upland Buffer
Wet Meadow
Emergent Wetland
Scale:
0 500 1,000
Feet
1 inch = 1,000 feet
N
CD 29: Meyer Wetland Option 1
Multipurpose Drainage Management Plan
Martin County, MN



IES GROUP
Mankato, MN
Faribault, MN
Algona, IA
Sac City, IA
Storm Lake, IA
La Crosse, WI

PN: 12-15139
Source: CD29 Wetland Option 3b

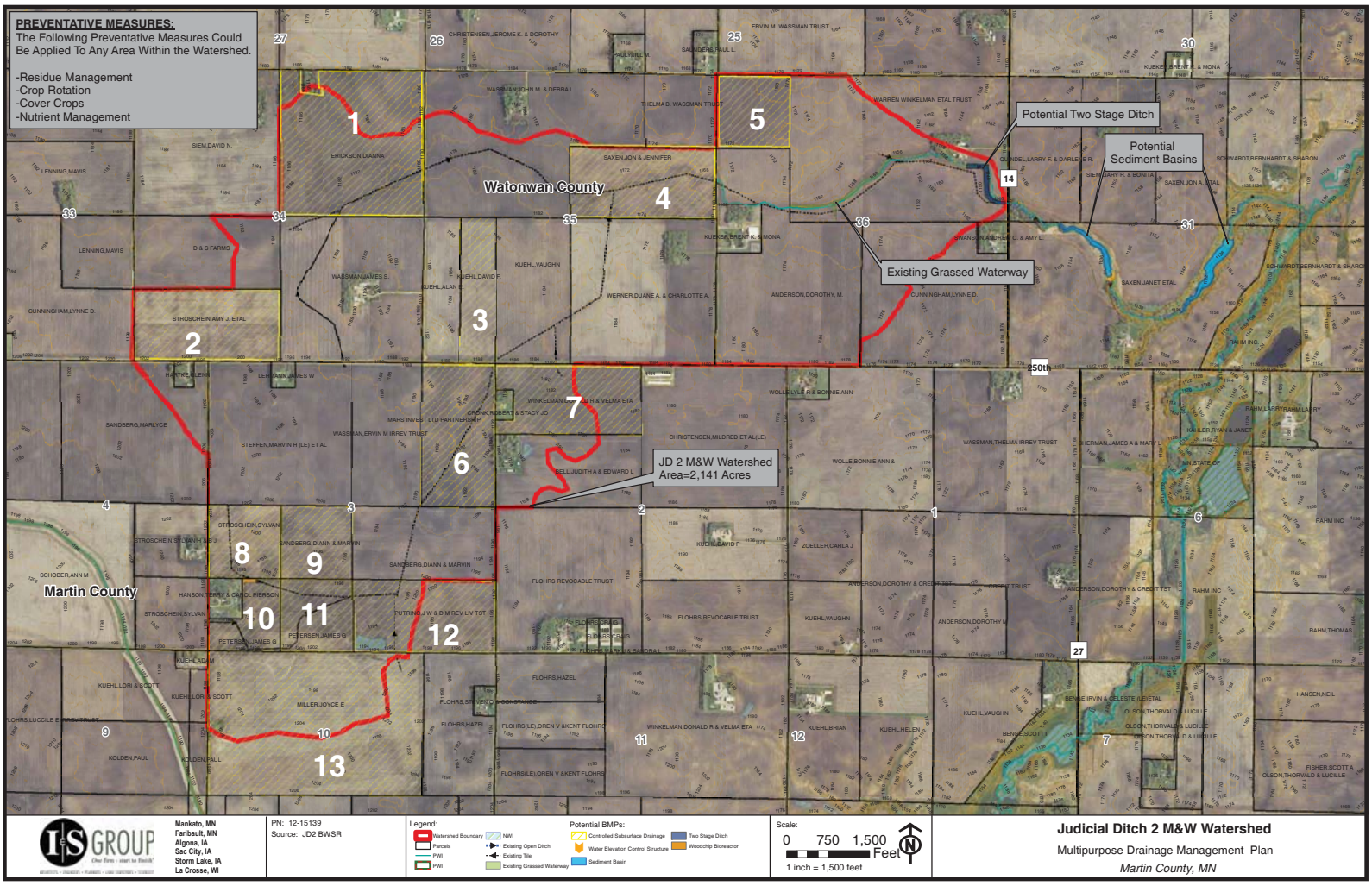
Legend:
Watershed Boundary
Parcels
Existing Tile
NWI
Outlet Structure
Emergent Wetland
Wet Meadow
Upland Buffer

Scale:
0 250 500
Feet
1 inch = 500 feet

CD 29: Meyer Wetland Option 2
Multipurpose Drainage Management Plan
Martin County, MN

APPENDIX E

Judicial Ditch 2 M&W Overview Map


PREVENTATIVE MEASURES:
The Following Preventative Measures Could Be Applied To Any Area Within the Watershed.
-Residue Management
-Crop Rotation
-Cover Crops
-Nutrient Management
Potential Two Stage Ditch
Potential Sediment Basins
Existing Grassed Waterway
JD 2 M&W Watershed Area=2,141 Acres
Watonwan County
Martin County
1
2
3
4
5
6
7
8
9
10
11
12
13
14
250th
27
Mankato, MN
Faribault, MN
Algona, IA
Sac City, IA
Storm Lake, IA
La Crosse, WI
PN: 12-15139
Source: JD2 BWSR
Legend:
Watershed Boundary
Parcels
PWI
NWI
Existing Open Ditch
Existing Tile
Existing Grassed Waterway
Potential BMPs:
Controlled Subsurface Drainage
Water Elevation Control Structure
Sediment Basin
Two Stage Ditch
Woodchip Bioreactor
Scale:
0 750 1,500 Feet
1 inch = 1,500 feet
N
Judicial Ditch 2 M&W Watershed
Multipurpose Drainage Management Plan
Martin County, MN

APPENDIX F

Example Vegetation Establishment, Management, and Monitoring Plan

VEGETATION ESTABLISHMENT, MANAGEMENT AND MONITORING PLAN

Vegetation Establishment (Spring):

1) Site preparation including invasive species control/topsoil stripping where needed.
2) Plow and disk the site prior to seeding with typical equipment. (Mid to Late April)
3) Broadcast Seed within one week of the final disking. (Early May to Mid June)
4) Cultipack or harrow the seeded areas to improve the seed to soil contact.
5) Vegetation will be established in accordance with the BWSR Native Vegetation Establishment and Enhancement Guidelines[1].

Seed Mix Details

The seed mixes to be used are Minnesota State Seed Mixes 34-181 (Emergent Wetland), 34-271 (Wet Meadow South & West), and 35-541 (Mesic Prairie Southwest). Seed mix details are given in Tables 1-3. Seeding zones are shown on the Seeding/Planting Zone Map (Sheet 22) in the construction plan set.

Table 1. Emergent Wetland Seed Mix 34-181

Common Name	Scientific Name	Rate (kg/ha)	Rate (lb/ac)	% of Mix (% by wt)	Seeds/ sq ft
American slough grass	*Beckmannia syzigachne*	0.78	0.70	14.07%	12.92
tall manna grass	*Glyceria grandis*	0.28	0.25	4.98%	6.40
rice cut grass	*Leersia oryzoides*	0.34	0.30	5.93%	3.70
	Total Grasses	**1.40**	**1.25**	**24.98%**	**23.02**
river bulrush	*Bolboschoenus fluviatilis*	0.85	0.76	15.20%	1.20
bristly sedge	*Carex comosa*	0.20	0.18	3.63%	2.00
lake sedge	*Carex lacustris*	0.07	0.06	1.19%	0.24
tussock sedge	*Carex stricta*	0.04	0.04	0.77%	0.75
least spikerush	*Eleocharis acicularis*	0.11	0.10	1.94%	2.50
marsh spikerush	*Eleocharis palustris*	0.11	0.10	2.03%	1.90
Torrey's rush	*Juncus torreyi*	0.04	0.04	0.85%	25.00
Three-square bulrush	*Schoenoplectus pungens*	0.26	0.23	4.54%	1.00
soft stem bulrush	*Schoenoplectus tabernaemontani*	0.49	0.44	8.78%	5.00
woolgrass	*Scirpus cyperinus*	0.06	0.05	1.02%	32.00
	Total Sedges and Rushes	**2.24**	**2.00**	**39.95%**	**71.59**
Sweet flag	*Acorus americanus*	0.31	0.28	5.53%	0.67
common water plantain	*Alisma triviale*	0.45	0.40	8.00%	9.70
marsh milkweed	*Asclepias incarnata*	0.31	0.28	5.67%	0.50
broad-leaved arrowhead	*Sagittaria latifolia*	0.34	0.30	6.07%	6.80
giant bur reed	*Sparganium eurycarpum*	0.55	0.49	9.80%	0.09
	Total Forbs	**1.96**	**1.75**	**35.07%**	**17.76**
	Totals:	**5.60**	**5.00**	**100.00%**	**112.37**

[1] *MN BWSR, Native Vegetation Establishment and Enhancement Guidelines, May 2012. Available online: http://www.bwsr.state.mn.us/native_vegetation/*

Table 2. Wet Meadow Seed Mix 34-271

Common Name	Scientific Name	Rate (kg/ha)	Rate (lb/ac)	% of Mix (% by wt)	Seeds/ sq ft
fringed brome	*Bromus ciliatus*	1.23	1.10	9.18%	4.45
bluejoint	*Calamagrostis canadensis*	0.06	0.05	0.41%	5.00
Virginia wild rye	*Elymus virginicus*	1.12	1.00	8.37%	1.55
rice cut grass	*Leersia oryzoides*	0.28	0.25	2.07%	3.10
tall manna grass	*Glyceria grandis*	0.17	0.15	1.26%	3.90
fowl manna grass	*Glyceria striata*	0.11	0.10	0.83%	3.30
fowl bluegrass	*Poa palustris*	0.39	0.35	2.88%	16.50
	Total Grasses	3.36	3.00	25.00%	37.80
bristly sedge	*Carex comosa*	0.24	0.21	1.78%	2.36
pointed broom sedge	*Carex scoparia*	0.06	0.05	0.43%	1.60
awl-fruited sedge	*Carex stipata*	0.19	0.17	1.40%	2.10
tussock sedge	*Carex stricta*	0.03	0.03	0.21%	0.50
fox sedge	*Carex vulpinoidea*	0.16	0.14	1.13%	5.00
path rush	*Juncus tenuis*	0.04	0.04	0.34%	15.00
dark green bulrush	*Scirpus atrovirens*	0.20	0.18	1.48%	30.00
woolgrass	*Scirpus cyperinus*	0.09	0.08	0.67%	50.00
	Total Sedges and Rushes	1.01	0.90	7.44%	106.56
marsh milkweed	*Asclepias incarnata*	0.27	0.24	2.03%	0.43
common boneset	*Eupatorium perfoliatum*	0.02	0.02	0.18%	1.30
grass-leaved goldenrod	*Euthamia graminifolia*	0.01	0.01	0.06%	1.00
spotted Joe pye weed	*Eutrochium maculatum*	0.02	0.02	0.18%	0.75
autumn sneezeweed	*Helenium autumnale*	0.03	0.03	0.23%	1.30
sawtooth sunflower	*Helianthus grosseserratus*	0.04	0.04	0.30%	0.20
great lobelia	*Lobelia siphilitica*	0.02	0.02	0.13%	2.90
blue monkey flower	*Mimulus ringens*	0.01	0.01	0.07%	6.80
Virginia mountain mint	*Pycnanthemum virginianum*	0.07	0.06	0.53%	5.10
giant goldenrod	*Solidago gigantea*	0.02	0.02	0.14%	1.50
eastern panicled aster	*Symphyotrichum lanceolatum*	0.03	0.03	0.22%	1.50
red-stemmed aster	*Symphyotrichum puniceum*	0.19	0.17	1.42%	5.00
tall meadow-rue	*Thalictrum dasycarpum*	0.01	0.01	0.12%	0.11
blue vervain	*Verbena hastata*	0.15	0.13	1.12%	4.61
bunched ironweed	*Vernonia fasciculata*	0.03	0.03	0.28%	0.30
Culver's root	*Veronicastrum virginicum*	0.01	0.01	0.12%	4.20
golden alexanders	*Zizia aurea*	0.28	0.25	2.06%	1.00
	Total Forbs	1.23	1.10	9.19%	38.00
Oats or winter wheat (see note at beginning of list for recommended dates)		7.85	7.00	58.37%	3.12
	Total Cover Crop	7.85	7.00	58.37%	3.12
	Totals:	13.45	12.00	100.00%	185.48

Table 3. Mesic Prairie Seed Mix 35-541 (Upland Buffer)

Common Name	Scientific Name	Rate (kg/ha)	Rate (lb/ac)	% of Mix (% by wt)	Seeds/ sq ft
big bluestem	*Andropogon gerardii*	1.01	0.90	7.49%	3.30
side-oats grama	*Bouteloua curtipendula*	1.01	0.90	7.49%	1.98
nodding wild rye	*Elymus canadensis*	1.01	0.90	7.46%	1.71
slender wheatgrass	*Elymus trachycaulus*	1.01	0.90	7.46%	2.27
green needle grass	*Nassella viridula*	0.49	0.44	3.67%	1.70
switchgrass	*Panicum virgatum*	0.18	0.16	1.30%	0.80
western wheatgrass	*Pascopyrum smithii*	0.56	0.50	4.15%	1.30
little bluestem	*Schizachyrium scoparium*	1.68	1.50	12.50%	8.27
Indian grass	*Sorghastrum nutans*	1.68	1.50	12.54%	6.63
	Total Grasses	8.63	7.70	64.06%	27.96
Canada milk vetch	*Astragalus canadensis*	0.07	0.06	0.53%	0.40
partridge pea	*Chamaecrista fasciculata*	0.11	0.10	0.84%	0.10
white prairie clover	*Dalea candida*	0.03	0.03	0.24%	0.20
purple prairie clover	*Dalea purpurea*	0.08	0.07	0.61%	0.40
Canada tick trefoil	*Desmodium canadense*	0.06	0.05	0.45%	0.11
narrow-leaved purple coneflower	*Echinacea angustifolia*	0.09	0.08	0.65%	0.20
ox-eye	*Heliopsis helianthoides*	0.07	0.06	0.50%	0.14
rough blazing star	*Liatris aspera*	0.03	0.03	0.28%	0.20
great blazing star	*Liatris pycnostachya*	0.02	0.02	0.21%	0.10
wild bergamot	*Monarda fistulosa*	0.04	0.04	0.29%	0.90
stiff goldenrod	*Oligoneuron rigidum*	0.03	0.03	0.28%	0.50
gray-headed coneflower	*Ratibida pinnata*	0.08	0.07	0.61%	0.80
black-eyed susan	*Rudbeckia hirta*	0.07	0.06	0.49%	2.00
smooth aster	*Symphyotrichum laeve*	0.03	0.03	0.25%	0.60
blue vervain	*Verbena hastata*	0.08	0.07	0.61%	2.50
hoary vervain	*Verbena stricta*	0.06	0.05	0.41%	0.50
golden alexanders	*Zizia aurea*	0.28	0.25	2.06%	1.00
	Total Forbs	1.23	1.10	9.31%	10.65
Oats or winter wheat (see note at beginning of list for recommended dates)		3.59	3.20	26.63%	1.42
	Total Cover Crop	3.59	3.20	26.63%	1.42
	Totals:	13.45	12.00	100.00%	40.03

Recommended Maintenance & Monitoring Schedule

Management activities will be conducted by the Applicant as necessary to successfully restore the areas by utilizing the Minnesota Wetland Restoration Guide[2].

Year 1 (Growing Season)

Maintenance:

1) Mow (6-10 inches) – June through September as needed to control annual weeds.

2) Spot spray aggressive perennial weeds such as; Canada thistle, reed canary grass, purple loosestrife, European buckthorn, smooth brome, etc.

[2] *MN BWSR, Minnesota Wetland Restoration Guide, December 2008. Available online: http://www.bwsr.state.mn.us/publications/restoration_guide.html*

-Chemical selection will be based upon the plant species to be treated and the current hydrologic conditions of the treatment area.

Evaluation and Monitoring:
1) Native grass seedlings may only be 4-6 inches tall.
2) Random sampling plots will be evaluated to characterize the success of the seedings.
3) Weed species and densities will be evaluated, and additional mowing and/or spraying practices will be recommended as needed for control.
4) Annual monitoring reports will be submitted to the Martin SWCD and USACE for review and approval.

Year 2 (Growing Season)
Maintenance:
1) Mow (6-10 inches) – June through September as needed to control annual weeds.
2) Spot spray aggressive perennial weeds such as; Canada thistle, reed canary grass, purple loosestrife, European buckthorn, smooth brome, etc.
-Chemical selection will be based upon the plant species to be treated and the current hydrologic conditions of the treatment area.

Evaluation and Monitoring:
1) Plant communities should be showing signs of establishment.
2) Annual weeds will begin to thin out due to maintenance practices, and competition from the native plant species.
3) Random sampling plots will be evaluated to characterize the success of the seedings.
4) Weed species and densities will be evaluated, and additional mowing and/or spraying practices will be recommended as needed for control.
6) Annual monitoring reports will be submitted to the Martin SWCD, BWSR, and USACOE for review and approval.

Year 3 (Growing Season)
Maintenance:
1) Spot Mow (6-10 inches) – June through September as needed for annual weed control.
2) Spot spray aggressive perennial weeds such as; Canada thistle, reed canary grass, purple loosestrife, European buckthorn, smooth brome, etc.
-Chemical selection will be based upon the plant species to be treated and the current hydrologic conditions of the treatment area.
3) Sites generally do not require much maintenance after the third year.

Evaluation and Monitoring:
1) Site should begin to fill in and resemble a native prairie and wetland plant community.
2) Random sampling plots will be evaluated to characterize the success of the seedings.
3) Weed species and densities will be evaluated, and additional mowing and/or spraying practices will be recommended as needed for control.

4) Annual monitoring reports will be submitted to the Martin SWCD, BWSR, and USACOE for review and approval.

Year 4 (Growing Season)

Maintenance:

1) Prescribed burn of the entire bank site – late April to mid May as weather allows. If weather does not allow for a prescribed burn; the burn will be completed in year 5 or haying the site may be used as an alternative.

- The prescribed burn will follow a Prescribed Burn Plan, which is written in accordance with the Natural Resources Conservation Service (NRCS) Field Office Technical Guide.

2) Spot spray aggressive perennial weeds such as; Canada thistle, reed canary grass, purple loosestrife, European buckthorn, smooth brome, etc.

-Chemical selection will be based upon the plant species to be treated and the current hydrologic conditions of the treatment area.

Evaluation and Monitoring:

1) Site will resemble a native prairie and wetland plant community.

2) Random sampling plots will be evaluated to characterize the success of the seedings and evaluate the effectiveness of the prescribed burn.

3) Weed species and densities will be evaluated, and determined if mowing and/or spraying practices will be needed for control.

4) Annual monitoring reports will be submitted to the Martin SWCD, BWSR, and USACOE for review and approval.

Year 5 (Growing Season)

Maintenance:

1) Prescribed burn of the entire bank site – late April to mid May as weather allows. If the weather did not allow for a prescribed burn in year 4, or haying the site may be used as an alternative.

- The prescribed burn will follow a Prescribed Burn Plan, which is written in accordance with the Natural Resources Conservation Service (NRCS) Field Office Technical Guide.

2) Spot spray aggressive perennial weeds such as; Canada thistle, reed canary grass, purple loosestrife, European buckthorn, smooth brome, etc.

-Chemical selection will be based upon the plant species to be treated and the current hydrologic conditions of the treatment area.

Evaluation and Monitoring:

1) Site will resemble a native prairie and wetland plant community.

2) Random sampling plots will be evaluated to characterize the success of the seedings and evaluate the effectiveness of the prescribed burn, if completed in Year 5.

3) Weed species and densities will be evaluated, and additional mowing and/or spraying practices will be recommended as needed for control.

4) Annual monitoring reports will be submitted to the county SWCD, BWSR, and USACOE for review and approval.

Performance Standards

The following hydrology performance standards shall be met prior to the end of the five year monitoring period:

- Fresh (Wet) Meadow - Hydrology shall consist of saturation at or within 12 inches of the surface for a minimum of 14 consecutive days, or two periods of 7 consecutive days, during the growing season under normal to wetter than normal conditions (70 percent of years based on most recent 30-year record of precipitation). Inundation during the growing season shall not occur except following the 10-year frequency or greater storm/flood event. The depth of inundation shall be 6 inches or less and the duration of any inundation event shall be less than 15 days. An exception can be made for sites with hummocky microtopography -- hollows between hummocks can have standing water depths of up to 6 inches for extended duration.
- Shallow Marsh - Hydrology shall consist of saturation to the surface, to inundation by up to 6 inches of water, for a minimum of 60 consecutive days or two periods of 30 consecutive days or four periods of 15 consecutive days, during the growing season under normal to wetter than normal conditions (70 percent of years based on most recent 30-year record of precipitation). During the growing season, inundation by up to 18 inches of water following the 2-year or greater storm/flood event is permissible provided that the duration does not exceed 30 days (e.g., water depth drops from 18 inches to 6 inches within the 30 days).
- Deep Marsh - Hydrology shall consist of inundation by 6 to 36 inches of water throughout the growing season, except in drought years (driest 10 percent of most recent 30-year period of precipitation record).

The following vegetation performance standards shall be met prior to the end of the five year monitoring period:

- Herbaceous communities shall be dominated by 10 or more species of native grasses, sedges, rushes, forbs and/or ferns and achieve approximately 90 or greater areal coverage of the total mitigation site by year five.
- More than 50% of all plant species within the wetland communities of the mitigation site shall be facultative (FAC) or wetter (FACW or OBL).
- Control of invasive and/or non-native plant species shall be carried out for five full growing seasons. Control shall consist of mowing, burning, disking, mulching, biocontrol and/or herbicide treatments. By the third growing season, any areas one-quarter acre in size or larger that have greater than 50 percent areal cover of invasive and/or non-native species shall be treated (e.g., herbicide) and/or cleared (e.g., disked) and then reseeded. Follow-up control of invasive and/or non-native species shall be implemented as stated above. At the end of the fifth growing season, the vegetative community shall not contain greater than 5 percent areal cover of invasive and/or non-native species including but not limited to: reed canary grass *(Phalaris arundinacea),* Canada thistle *(Cirsium arvense),* bull thistle *(Cirsium vulgare),* smooth brome grass *(Bromus inermis),* giant ragweed *(Ambrosia trifida),* common ragweed *(Ambrosia artemisiifolia),* quack grass *(Elytrigia repens),* black locust *(Robinia pseudoacacia),* sweet clovers *(Melilotus alba* and *M. officinalis),* non-native honeysuckles (e.g., *Lonicera* x *bella),* and non-native buckthorns *(Rhamnus cathartica* and *R. frangula).* The mitigation site shall have no purple loosestrife *(Lythrum salicaria)* present at the end of the monitoring period. Failure to meet any of the above criteria shall extend the

permittee's responsibility for monitoring and control of invasive/non-native species within the compensation site.

Monitoring Requirements

An as-built report will be submitted within one month of the completion of construction. This report will summarize the construction activities, describe any changes to the original plan, describe any corrective actions needed, and provide an as-built survey showing 1 foot elevation contours or spot elevations. This survey will be prepared by a licensed surveyor and certified by a registered professional engineer that it conforms to the design plans and specifications.

Annual mitigation monitoring reports shall be submitted on the status of the mitigation. The reports shall be submitted by December 31 following each of the first five growing seasons. The reports shall, at a minimum, include the following information:

- All plant species along with their percent cover, identified using standard plots and/or transects, with at least one representative plot/transect in each plant community within the mitigation site including upland buffers. In addition, the presence, location and percent cover of invasive and/or non-native species, such as purple loosestrife and common buckthorn, in any of plant communities shall be noted.
- Vegetation cover maps at an appropriate scale shall be submitted for each reported growing season.
- Photographs showing all representative areas of the mitigation site taken at least once each reported growing season during the period of July 1 to September 30. Photographs shall be taken from a height of approximately five to six feet from at least one location per acre. Photos shall be taken from the same reference point and direction of view each reporting year.
- Surface water and groundwater elevations in representative areas (e.g., at least one sample point in each plant community) recorded at least once each week for the first 10 weeks of each growing season, thereafter taken monthly for the remainder of each growing season. The location of each monitoring site shall be shown on a plan view of the site.

At the close of the monitoring period, a wetland delineation of the site applying the 1987 Corps of Engineers Wetlands Delineation Manual and Midwest Regional supplement shall be submitted. This delineation will be prepared by a wetland professional.

Long Term Management Plan

After performance standards are achieved, the Wetland site will be managed to ensure that the site remains a viable wetland to ensure the long-term sustainability of the resource. The site will be inspected periodically to ensure the outlet structure is intact and functioning properly and that there are no large-scale changes to the vegetative communities or hydrologic regimes of the wetland.