FARMER-LED WATERSHED COUNCIL PILOT PROJECT MAPPING ANALYSIS SUMMARY

PREPARED FOR:

WHITEWATER WATERSHED PROJECT

PREPARED BY:

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Farmer-Led Watershed Council Pilot Project
Mapping Analysis Summary

McGhie & Betts Environmental Services, Inc. (MBESI) was contracted with the Whitewater River Watershed Joint Powers Board to perform Geographic Information System (GIS) mapping and spatial analysis services under the Minnesota Pollution Control Agency (MPCA) granted Farmer-Led Watershed Council Pilot Project. The goal of the pilot project was to accelerate the restoration of water quality in the Whitewater Watershed by engaging local citizens and stakeholders in the Total Maximum Daily Load (TMDL) process through civic engagement activities.

The scope of the pilot project focused on the Logan Branch (17 sq. mi.) and the Middle Branch (54 sq. mi.) sub-watersheds of the Whitewater River Watershed (320 sq. mi.) including Viola, Quincy, Eyota and Dover Townships in Olmsted County, and Elba and St. Charles Townships in Winona County. These two sub-watersheds are dominated by an agricultural landscape in a rural environment with a low population density and little development pressure. MBESI was responsible for preparing various maps to engage and assist the Farmer-led Watershed Council members' in understanding the spatial relationship of watershed resources, water quality concerns, the TMDL process, and potential restoration solutions.

MBESI has prepared a package of deliverables that included the following items; a set of large paper maps, a database containing all GIS layers used for the project, a digital copy of each map printed on a DVD and USB flash drive, plus additional maps, and a summary report.

▪ Introduction

McGhie & Betts Environmental Services, Inc. (MBESI) was responsible for preparing various maps to engage and assist the Farmer-led Watershed Council members' in understanding the spatial relationship of watershed resources, water quality concerns, the TMDL process, and potential restoration solutions. The project focused on the Logan Branch (17 sq. mi.) and Middle Branch (54 sq. mi.) sub-watersheds of the Whitewater River (320 sq. mi.). However, for the purposes of this report both sub-watersheds will be generally referred to as a *watershed* for the remainder of the report.

To accompany each 3 by 4 foot map (prepared at a scale where 1" = 2,000') a brief synopsis discussing key information has been included in this report. The CHAPTER HEADINGS in this report can be used to reference an individual map synopsis.

▪ Aerial Map

High resolution aerial photography layers were used to orientate watershed residents to the recognizable landscape features of the Logan and Middle Branch watersheds. This map also identified MPCA registered feedlot operators, water quality monitoring stations, and estimated total human population.

Example feedlot with high-resolution aerial.

Feedlots & Animal Units

A total of 107 feedlots (28 Logan; and 79 Middle) are registered within the project area where the majority of the facilities raise beef and dairy cattle. Feedlots range in size from 2 to 999 animals per feedlot. The average number of animal units per farm in the Logan Branch and Middle Branch is 100 and 126, respectively. Combined, both watersheds' feedlot operators manage over 19,000 dairy cows, plus beef cows, turkeys, hogs, horses, deer, elk, sheep, goats or llamas.

For permitting and environmental review the number and type of animals managed within a registered feedlot facility are often calculated by comparing animal units (AU). AU calculations allow various types of animals to be compared on a standard scale that compensates for differences in animal size (i.e. weight) and manure production. Animal units are calculated by multiplying the total number of animals by their average weight and dividing by 1,000, as shown by the following equation:

$$\mathbf{AU = (w * n)/1{,}000}$$

where, AU = Animal Unit ;
w = the average weight of the animals;
n = number of animals.

Feedlot operators in the Middle Branch manage over 9,914 AU, while a smaller number of feedlot operators manage 2,804 animal units in the Logan Branch. Collectively, over 12,718 AU (19,010 individual animals) are raised within the watershed which is equivalent to 164 AU/sq. mi. (Logan), or 183 AU/sq. mi. (Middle Branch).

Other useful data included in the MPCA registered feedlot database records includes facility operator name, address, total number of animal units by specific animal type, and total number of animal units.

Population & Human Animal Unit Estimates

According to the 2010 US Census Bureau data the total human population in both watersheds is 746 people (580 people in Olmsted County; 62 people in Winona County) with a population density of 10.5 people per square mile. This represents 280 homes with 2.66 people per household.

For the purpose of comparing different types of animals (such as human animals versus agricultural animals) on a standard animal unit (AU) scale, an equivalent human AU calculation was completed to derive a "Human Animal Unit Estimate" for both watersheds. The "Human Animal Unit Estimate" was calculated by dividing the product of total population and average human weight by 1,000, where the average human weight was assumed a range between 150 and 200 pounds per person. For example, the "Human Animal Unit Estimate" was computed by the following equation: ((580)*(150))/1000 = 87 Human Animal Units.

As a result, the total number of animal units represented by the human population of both watersheds is a range between 112 to 149 Human Animal Units. Comparatively, the total number of agricultural animals within both watersheds (12,718 AU) exceeds the range of human animals (112 to 149 AU) estimated by a factor of 85. A summary of the Olmsted and Winona Counties demographic information is provided in the

It should be noted that wildlife also contribute waste, but obtaining the total wildlife population data to derive an equivalent "wildlife animal unit estimate" is

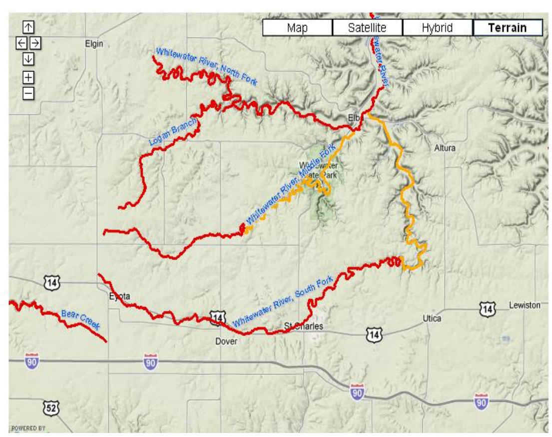
Demographics by County

	County	Olmsted	Winona	Total
Human Demographics	No. of Housing Units	218	62	280
	Estimated Population	580	166	746
	Total Human Animal Units (AU) - "Human Unit Estimate"	87 to 116	25 to 33	**112 to 149**
Agricultural Demographics	Total Number of Feedlots	91	16	107
	Total Agricultural Animal Units (AU)	10,585	2133	**12,718**

Demographic Summary by County.

not an easy task considering so many different species exists. However, based on a healthy deer population of 22 deer per square mile (DNR, 2010), we estimate that 125 "deer animal units" would be found within the watersheds.

Comparing different types of animal units to one another is useful information to analyze the possible dominant bacterial and nutrient pollutant sources that contribute to surface water impairments. The primary water quality impairments within the Logan and Middle Branch sub-watersheds are fecal coliform bacteria, nitrate-nitrogen and turbidity; parameters which all have unique pollutant sources.



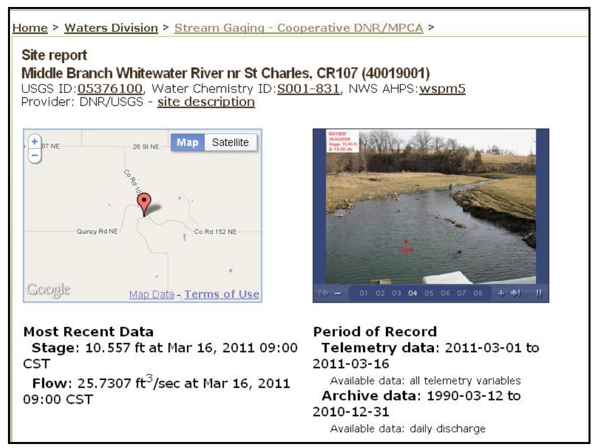
MPCA Map of Impaired Waters – 2008 Impaired Streams shown in red, DRAFT 2010 streams shown in orange.

For example, fecal coliform bacteria found in streams originate from many forms including human, pet, livestock, and wildlife waste that is transported through different pathways. Pathways include illicit septic system discharges (human), pet waste and urban stormwater runoff (urban), runoff from feedlots (livestock), manure storage facilities (livestock), runoff from agricultural fields applied with manure (livestock), or even directly from wildlife (wildlife). Identification of pollutant sources can be challenging; however, this watershed is unique compared to other watersheds throughout the state because it has no urban influence (pollutant sources) and is strictly a rural agricultural community.

Monitoring Stations

The monitoring stations are maintained by the Minnesota Pollution Control Agency (MPCA), Department of Natural Resources (DNR) or the United States Geological Survey (USGS). Depending upon the site various years of data are recorded such as stream discharge, stage, temperature, and occasionally other parameters including water chemistry data. Additionally, in 2010 individual nitrate samples were collected at various sites. The monitoring sites displayed on the aerial map include:

- MPCA (S002-073) - Middle Fork Whitewater River on CSAH-9 Bridge, 3.5 miles northwest of Dover.
- MPCA (S002-074) - Middle Fork Whitewater River at CSAH-10 Bridge, 3.5 miles north of Dover.
- 2010 Nitrate Monitoring Site - Middle Fork Whitewater River located on 10th St SE, 1.0 miles south of CR-9.
- MPCA (S001-831), DNR (40019001), USGS (05376100), and 2010 Nitrate Monitoring Site - Middle Branch of the Whitewater River nr St. Charles, CR 107.
- MPCA (S001-832) - Middle Fork Whitewater River, ½ mile north of CR-152, 5.0 miles north of St. Charles.
- USGS (05376110) and 2010 Nitrate Monitoring Site - Middle Fork Whitewater River at Street Park Road near St. Charles.
- MPCA (S001-769) - Middle Fork Whitewater River, at State Park Road, 5.0 miles north of St. Charles.
- MPCA (S001-825) - Middle Fork Whitewater River at Bridge at MN-74, at Elba.



MPCA/DNR Cooperative Stream Gauging Website

All three of these agencies maintain websites that allow access to real-time and historical stream databases. Links to these websites are listed below:

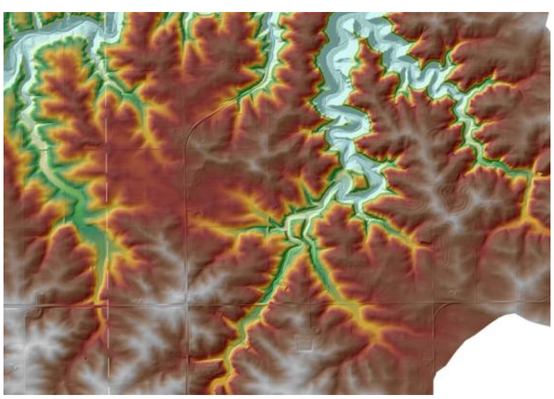
- MPCA/DNR Cooperative Stream Gauging: http://www.dnr.state.mn.us/waters/csg/index.html
- USGS: http://mn.water.usgs.gov/
- MPCA STORET Database: http://www.pca.state.mn.us/index.php/water/water-monitoring-and-reporting/storet/storet-program.html

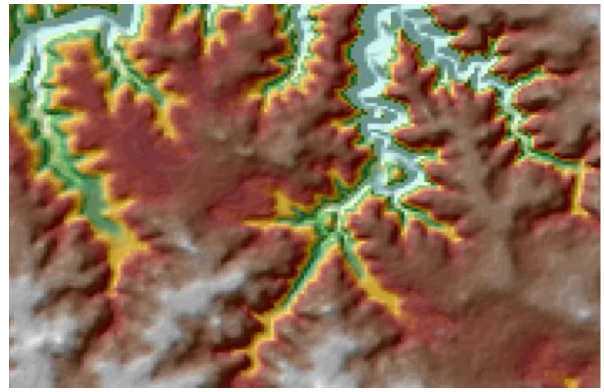
▪ LANDOWNER MAP

Parcel data from Olmsted and Winona Counties was combined with an aerial image that identified each property owner's name within the project area. This information may be useful for identifying landowner's within the same drainage area, individual tracts of land, adjacent landowner names, or landowners in other portions of the watershed. Other information such as a landowner's parcel identification number (PIN), or address can also be obtained from the parcel data information included with this project.

▪ DIGITAL ELEVATION MODEL (DEM)

Remote sensing technologies such as Light Detection And Ranging (LiDAR) utilizes laser light to detect and measure features of the earth's surface. This technology has provided efficiencies capable of generating a bare earth image of the landscape at a higher quality resolution than 30-meter digital elevation models (DEM) can provide.


3-Meter DEM (2008) – Fine Resolution


30-Meter DEM (2001) – Course Resolution

The elevation change displayed on this map ranges from 1,350 feet in the west at the headwaters of both watersheds to 950 feet and 900 feet at the confluence for the Logan and Middle Branches, respectively. It is important to understand variability in watershed topography since if affects many watershed attributes such as slope, slope steepness and even soil erosion potential. This map displays the differences in slope as the watershed elevation drops roughly 24 ft/mi from the headwaters of the Middle Branch to the confluence at Elba, MN (450 foot elevation distance over 18.2 miles of stream).

▪ SURFACE WATER MAP

Various surface water characteristics were depicted on this map including protected waters, 50-foot shoreland buffers, impaired waters, monitoring stations, and trout streams.

PROTECTED WATERS

Protected Waters were interpreted and then digitized from the Minnesota Department of Natural Resources (DNR) Public Waters Inventory (PWI) Maps. These maps were authorized by Minnesota Statues, Section 103G.201. For stream reaches identified in the Protected (i.e. Public) Waters and Wetlands final inventory the regulatory "boundary" of all waters is called the ordinary high water level (OHWL). The OHWL is typically the point where the natural vegetation changes from aquatic to terrestrial plant species or for watercourses the top of the bank channel. The OHWL is also the point that defines the DNR's regulatory authority over development projects that have the potential to affect Protected Waters.

Shoreland Management

The shore impact zone is 300 feet wide which requires a 50-foot (from the OHWL) vegetative grass buffer strip to be maintained along agricultural land in shoreland areas adjacent to designated public waters. This rule is authorized under Minnesota State Rule 6120.3300 and is enforced at the county level. The buffer is intended to slow down runoff from adjacent fields that may carry excess sediment and nutrients. A properly installed 50-foot buffer can reduce sediment by 75 percent, or nutrients and pesticides by 50 percent (MDA, 2011).

Impaired Water Monitoring

MPCA monitoring data from inventoried streams (only protected waters) suggests that 40 percent of Minnesota's lakes and streams are impaired for conventional pollutants (MPCA). Roughly 60 percent of the protected waters have been inventoried across the state. Every two years under the Clean Water Act states are required to list impaired streams on the Section 303(d) list; once listed a sequence of events is triggered.

First, a TMDL study is required to determine the allowable amount of pollutants a water body can receive, while still maintaining designated uses such as drinking water, fishing, swimming, irrigation or industrial use classifications. In urban watersheds a load allocation is usually given to specific industries regulating the total amount of pollutants they can discharge. Once these limits have been determined for the watershed as a whole, within one to two years an implementation plan is required.

The implementation plan identifies pollutant sources and possible restoration strategies or activities that will aid in the de-listing of an impaired stream reach. Once approved by the US Environmental Protection Agency and the MPCA, funding for restoration activities will be available through Clean Water Fund dollars appropriated to the Board of Soil and Water Resources.

Monitoring Stations

Monitoring stations identified on this map shows where agencies have collected stream data to support the forthcoming TMDL allocations.

Trout Streams

Designated trout streams provide trophy quality trout fishing. Some streams have public fishing access which allows anglers permission to access trout stream through Aquatic Management Area easements (AMAs).

AMAs are permanent conservation easements that provide monetary compensation to willing landowners for installing buffers (minimum 66-foot wide) adjacent to streams. Landowner's retain the legal rights to the land, but land use alterations are restricted. AMAs protect high quality trout habitat through corridor protection and allows the DNR to conduct habitat improvements if needed.

Middle Branch of the Whitewater River depicting a side-hill seep and a pool and riffle.

The geology of southeastern Minnesota and groundwater input from natural springs or seeps creates a unique environment that supports trout habitat and fishing opportunities. When excessive sediment is deposited in trout streams it has the potential to fill in gravel runs or riffles which reduces spawning beds they rely on for reproduction.

STREAM EDITING

The DNR 1:24,000 stream layer was edited (re-digitized) to reflect the current flow path of the two streams. Data was digitized using the 2008 LiDAR generated hydro-breakline data when a water signature was present, otherwise hillshade, profile curvature, or 10-foot contour data was used to assist interpretations. The edited stream layer is provided as a deliverable.

▪ LAND USE MAP

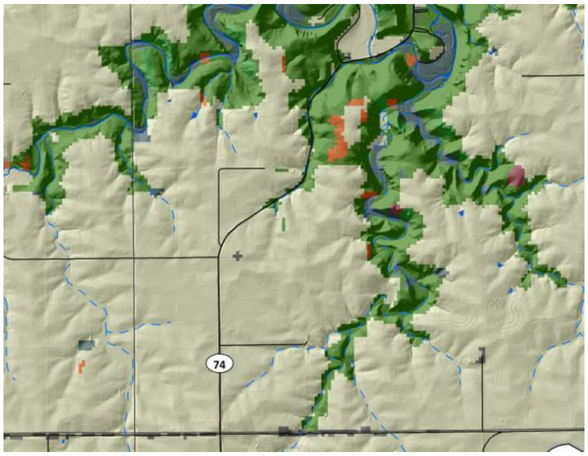
The land use in both watersheds is dominated by agricultural row crops with little development pressure and no urban influence. The closest cities of Elba, Eyota, Dover and St. Charles are located just outside the watershed boundaries. The land cover classifications for each watershed are summarized in the Land Cover Classification Summary table.

Land Use Type	Logan Branch	Middle Branch	Totals (acres)	%
Cropland	7,620.26	24,027.71	**31,647.97**	**69.95**
Grassland	2,303.68	6,555.08	**8,858.76**	**19.58**
Upland Deciduous Forest	797.52	2,635.59	**3,433.10**	**7.59**
Lowland Deciduous Forest	242.15	484.82	**726.97**	**1.61**
Non-Vegetated	22.70	190.66	**213.35**	**0.47**
Upland Conifer-Deciduous Forest Mix	20.10	128.10	**148.20**	**0.33**
Shrubland	8.90	110.19	**119.09**	**0.26**
Upland Conifer Forest	66.00	12.90	**78.90**	**0.17**
Aquatic Habitats	0.89	10.23	**11.12**	**0.02**
Total	**11,082.21**	**34,155.27**	**45,237.48**	**99.99**

Land Cover Classification Summary (Values reported in acres).

Almost 90 percent of the project area is cropland or pasture, with the second largest land use being upland deciduous forest (7.5%). A majority of the non-agricultural land that remains is either protected as a State Park, or is too steep to farm with conventional agricultural equipment. Conventional farming practices harvest nearly all of the previous year's crop residue leaving the soil unprotected and at risk for potential soil loss.

According the MDA, agricultural land that is managed by conservation tillage practices such as no-till, ridge-till, mulch-till or strip-till can leave up to 70 percent of the previous years crop residue on the soil from November – May. These practices reduce the amount of soil exposed to rain or snow which can detach soil particles and transport sediment and other pollutants to streams. Other benefits of conservation tillage include a reduction in soil erosion by 60-80 percent, improved soil and water quality from increased organic matter, conservation of energy (less passes with machinery), a reduction in air pollution, and food reserves, or cover for wildlife.



Example Land Cover Map. Beige areas are agriculture.

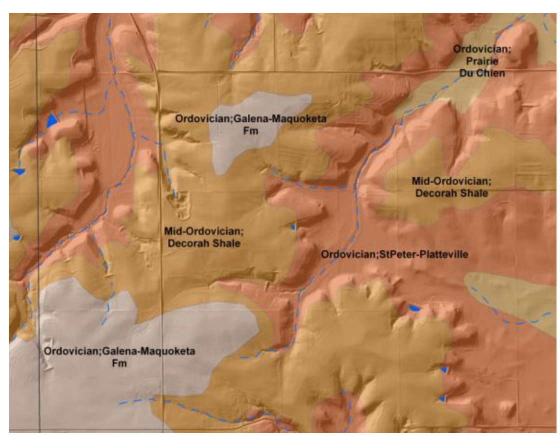
▪ Geology Map

The Logan Branch and Middle Branch watersheds of the Whitewater River lie within the "Driftless Area" of southeast Minnesota; the area not covered by the continental ice sheet during the last glaciation. The land is dominated by a bedrock controlled topography eroded into deep valleys and flat-topped ridges. The geology map shows the bedrock formations and identifies the recorded karst features such as sinkholes and springs.

The bedrock map displays the first encountered bedrock. The terrain in the western uplands is dominated by limestone karst of the Galena-Maquoketa formations, collectively known as the Upper Carbonate aquifer. The bedrock in the east is dominated by the St. Peter/Platteville/Prairie du Chien/Jordan or Lower Carbonate aquifer. Both aquifers have karst; fractured solution dissolved bedrock that yields high volumes of groundwater. However, the water is highly susceptible to contamination from fertilizer and farm chemicals and the Upper Carbonate aquifer cannot be used as a safe drinking water supply.

The two aquifers are separated by 60 to 90-foot thick, impervious, clay-rich bedrock, known as the Decorah Shale that outcrops in a band across the middle of both watersheds. In the subsurface this formation separates the Upper Carbonate aquifer from the underlying St. Peter/Platteville/Prairie du Chien/Jordan aquifer allowing groundwater to be stored in the Upper Carbonate. The stored water creates a Decorah Edge effect where groundwater discharge along the outcrop area creates springs and groundwater supported side-hill wetland seeps that are known to naturally remove nitrates from groundwater.

The bedrock of the lower aquifer is also highly fractured and permeable karst, capable of producing large yields of water; however, the groundwater is susceptible to contamination to a great depth. In these areas maps generated by the Minnesota Geological Survey and the Minnesota Department of Health Nitrate Susceptibility Maps indicate that contaminates can rapidly leach through the thin soils and reach the groundwater in days to weeks. With thin highly productive soils covering the bedrock the entire landscape of the Whitewater Watershed is susceptible to contaminant.



Example Geology Map.

▪ Highly Erodible Soils Map

Highly Erodible Land (HEL) is a classification assigned to soil units recognized as susceptible to sheet and rill erosion. HEL is based on the physical properties of the soil unit, slope length, precipitation and soil erodibility. The erodibility index of a soil map unit is calculated by dividing the potential erodibility for each soil by the calculated soil loss tolerance (T) value. The soil loss tolerance or T value represents the maximum annual rate of soil erosion that could take place, per acre, per year, without causing a decline in sustainable agricultural. Each soil map unit has a calculated T value. The erodibility index of a soil map unit was calculated by the following equation:

$$A = \frac{R * K * LS}{T}$$

where, A is the long-term average annual soil loss (T/ac/yr)
R is the rainfall factor;
K is the soil erodibility factor, which measures the susceptibility of soil particles to detach and be transported during rainfall;
LS is the slope length-gradient factor, and
T is the tolerable soil loss (T/ac/yr).

A soil map unit with an erodibility index of 8 or more is considered a highly erodible soil map unit. HEL designations have been calculated for all soil map units by the NRCS and all factors in the equation above are included in the soils data provided as part of this project. HEL soils depicted on the HEL map are listed below.

Highly Erodible Soils (MUSYM)			
103C	388E	401C	592E
103D	388E	401D	815F
11D	401C	457G	826C
173F	401D	476C	829C
174D	457G	476D	830D
285C	476C	501C	831F
322E2	476D	501D	832F
322F	501C	584F	832G
369C	501D	587C	95C
388D	584F	587D	99C

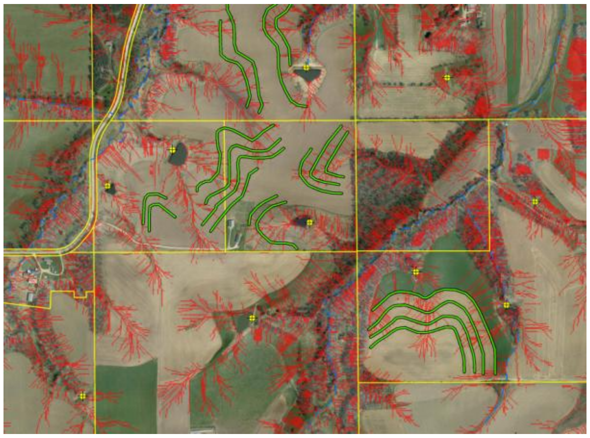
Olmsted and Winona Counties HEL.

HEL has the potential to contribute sediment to nearby water bodies if agricultural lands are not properly managed. Practices such as contour farming, installation of erosion and sediment control basins, buffer strips, and terraces can help slow water down allowing infiltration to occur before pollutants runoff and enter streams. Even proper manure application can prevent unnecessary pollution to water bodies.

Information describing other soil classification such as hydric soils, or floodplain soils can be explained in detail online at the NRCS Web Soil Survey http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm.

▪ Map Of Stream Power Index Signatures Paired with Existing Conservation Structures

Spatial analysis extensions were used in ArcGIS Software to generate 10-foot contour topography maps, calculate the Stream Power Index (SPI) and to perform other operations that assisted in identify existing soil and water conservation practices.



Example of SPI Signatures/Erosion Potential (red) with Existing Conservation Practices (yellow and green).

STREAM POWER INDEX

Stream Power Index (SPI) is a compound terrain attribute that measures the erosive power of overland runoff using flow accumulation and slope as inputs. SPI has been used extensively in studies of erosion, sediment transport, and geomorphology (I.D. Moore et al. 1991). SPI is calculated as follows:

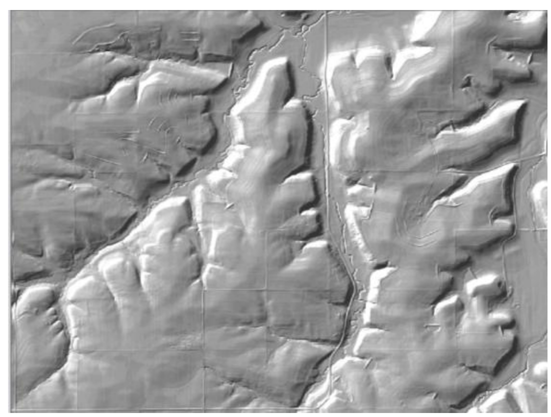
SPI = Ln(FA) * (Slope)
Where, FA is Flow Accumulation.

Stream network lines can be derived from this layer by applying a threshold from which a cell value must meet to be included. The index is useful for conceptually identifying areas of a landscape where erosion potential is high from overland water flow.

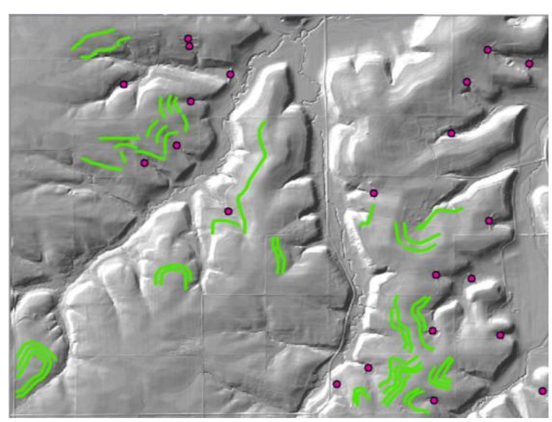
For example, a farmer may utilize this data in conjunction with local knowledge to determine where the modeled erosion potential is applicable on their farm. As shown in the example SPI image above the modeled erosion potential (red lines) depicted in the lower left hand corner may be a logical location for installing new terraces, or sediment basin, compared to the farm located in the lower right hand corner that already has terraces (green lines) installed. Analyzing the data at the field-scale level can promote efficiencies in selecting and designing conservation practices that are tailored to each farm.

IDENTIFICATION OF EXISTING CONSERVATION STRUCTURES

Existing conservation structures included the following; ponds (NRCS Conservation Practice Standard No.378), dams (No.402), sediment basins (No.350), and terraces (No.600). These structures were identified throughout the Logan Branch and Middle Branch watersheds using a 3-meter digital elevation model (DEM) derived from LiDAR. Structures were identified at the section scale (1 sq. mile) with a point shapefile for ponds, sediment basins and dams, and a polyline shapefile for terraces.



3-meter DEM (2008)



3-meter DEM (2008) with Identified Structures

Ancillary data layers, including historical aerials, curvature, and LiDAR generated contour lines were used when necessary to further aid in the identification process. As a result of this mapping effort a total of 450 structures were mapped, as summarized in the table below.

Practice	Logan Branch	Middle Branch	Total
Ponds, Dams, Sediment Basins	71	77	**148**
Terraces	92	210	**302**
Total	**163**	**287**	**450**

Summary of Existing Conservation Structures Identified.

This information can now be utilized by the NRCS/SWCD technicians to populate an existing structure database with sensitive, non-public landowner information such as type of structure, year installed, maintenance notes, landowner name, address, or any other pertinent information can be included.

Since most of this information is private, McGhie & Betts was not able to include this information in the database. However, once utilized by conservation professionals spatial mapping of existing conservation practices can be used as a screening tool at the watershed-scale for prioritizing conservation efforts, or at the field-scale for creating efficiencies in individual management decisions.

Using Terrain Attributes to Identify Areas for New Conservation Structures

Primary terrain attributes such as hillshade, slope, aspect, flow accumulation, profile curvature, and the secondary attribute called the stream power index are useful tools that can assist in the identification of areas where new conservation structures are needed. Each of the terrain attributes is briefly discussed below.

Hillshade

Hillshading a DEM adds depth to a surface by conceptual illuminating the surface by assuming a specified direction of the sun. This attribute takes into account the azimuth and altitude of the sun's angle for creating hillshaded relief. The azimuth determines the angular direction of the sun, as it is measured from north in a clockwise direction from 0 to 360 degrees. Altitude or the slope/angle of the sun above the horizon is also considered in generating a hillshade.

Slope

Slope is calculated by determining the maximum rate of change in value from one cell to another. It identifies the steepest downhill slope for a location on a land surface. The lower the slope value the flatter the terrain. Essentially, slope is the rise (height) of the land surface over the total distance, or run.

Aspect

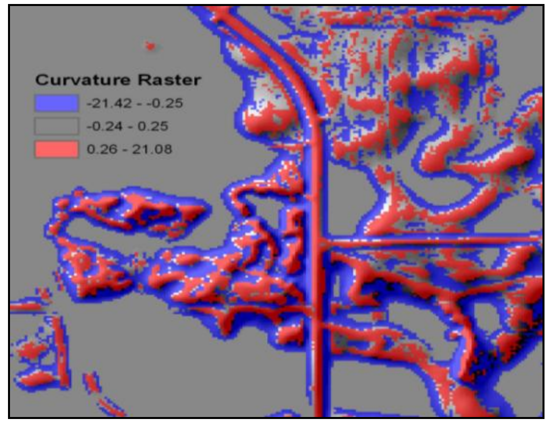
Aspect measures the direction a slope faces and is calculated beginning in a clockwise direction beginning at zero degrees north until it turns full circle ending at 360 degrees. This measurement can be interpreted as the compass direction the hill faces. Manipulating slope in this manner allows identification of all north-facing slopes on a landscape. Flat slopes have no direction.

Flow Accumulation

The flow accumulation attribute calculates accumulated flow in the downslope direction of each cell. Cells with high flow accumulation can be considered areas of concentrated flow and are helpful to identify stream channels or areas where grade control or other best management practices would be effective. Areas with a flow accumulation value of zero represent ridges or divides that receive no accumulation.

Profile Curvature

A quantified curvature surface can be classified as concave, convex, or flat, with values of negative, positive, or neutral, respectively. Curvature can be further described in terms of either a plan and profile curve. Plan curvature measures perpendicular to the direction of maximum slope revealing the ridges and valleys. Profile curvature measures parallel to the direction of maximum slope and is used for distinguishing between upper (convex) slopes and lower (concave) slopes. As shown in figure below, areas of positive versus negative curvature can be classified.



Curvature Example. Red areas have a positive curve, blue areas have a negative curve, and grey areas are mostly flat.

Conclusion

The capacity to adjust the scale of a desktop GIS analysis from field-scale to watershed-scale can streamline conservation assessments, and save time and money. Nevertheless, field visits, or ground-truthing modeled results, combined with ancillary data, or on-site knowledge should always be used in conjunction with GIS modeling and assessments.

Identification of areas most sensitive to erosion, infiltration, or areas best suited for certain BMPs is a task that cannot be performed using just air photos or paper maps alone. Now with the availability of sub-meter LiDAR data, terrain attribute databases can be statistically packaged, ranked and prioritized to identify potential watershed restoration BMP locations at field-scale levels.

Once the data is sorted, field visits or ground-truthing is required. Ground-truthing provides confidence that the desktop model is calibrated to the most appropriate scale or threshold and ensures the model is a true representation of physical on-the-ground landscape features. Proper calibration will allow specialist to begin identifying areas where new conservation structures or best management practices (BMPs) are needed.

However, the real utility of this tool is the ability of any individual to define their ultimate goal, and ask the right questions so that the appropriate data can be displayed for the appropriate scale. For example, if an individual is trying to determine where stream bank erosion is occurring multiple data layers, including highly erodible lands, slope, flow accumulation, SPI, or curvature data layers may all be used to derive the desired result.

Conversely, if an individual wants to determine what fields should be planted in alfalfa in the current growing season an entirely different set of data layers would be referenced. In this situation the highly erodible land data layer may provide all of the necessary information.

Depending upon individual goals relative to time, and space, the utility of this tool is using the data in a way that supplements local field knowledge to promote conservation efficiencies. Efficiencies on different scales can be realized at the watershed-scale as a screening tool, or to develop policies or programs; or at the field-scale level as a design tool.

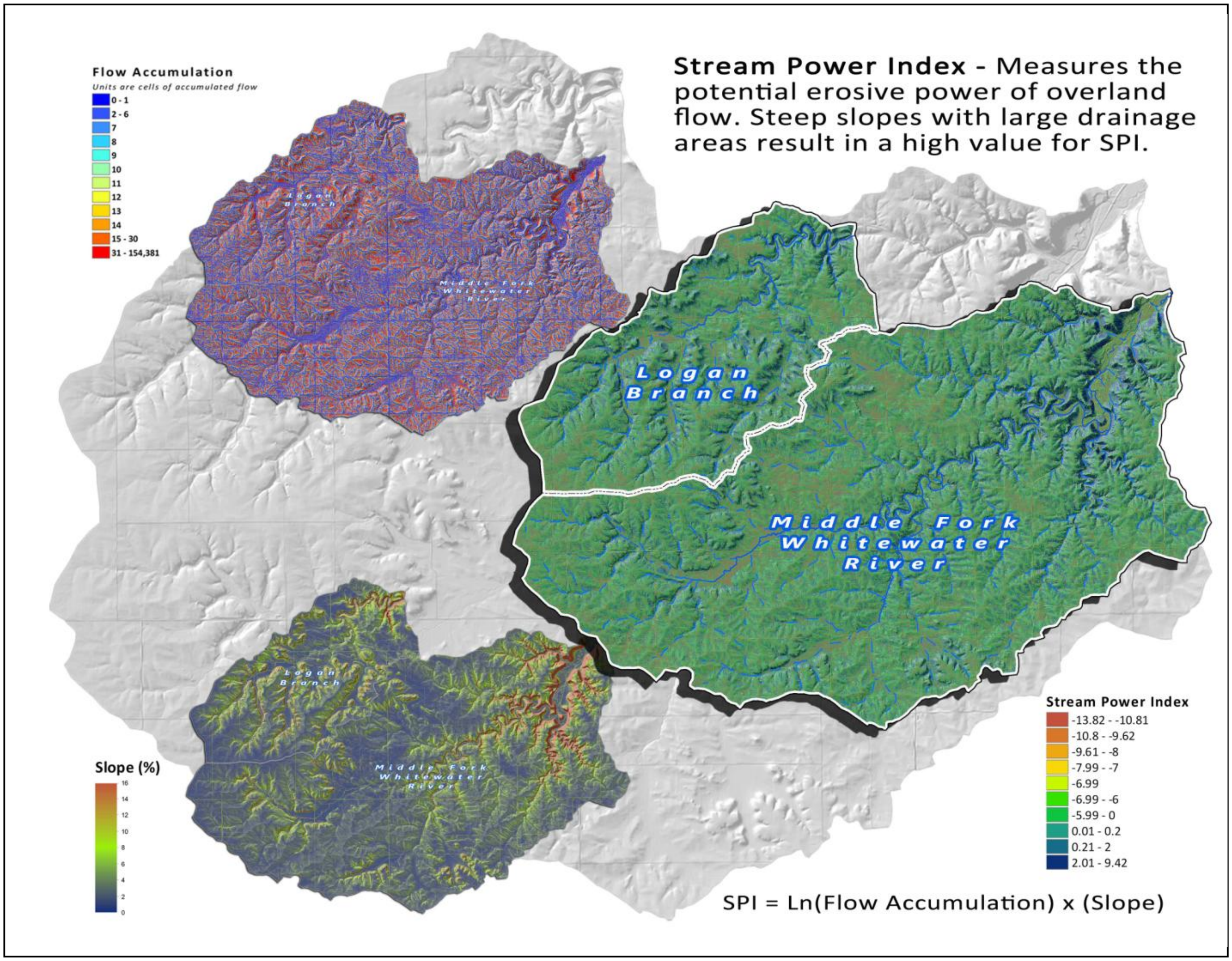
It should be recognized that training on the usage of new GIS data is needed. Specifically, conservation technicians and other individuals who work directly with landowners or deliver conservation should understand the power of this tool. Budgeting specialized training in future watershed projects is recommended. Training will provide the skills necessary for a qualified individual to correctly interpret modify or re-classify the data to fit different watershed or field scales.

ArcReader

MBESI has provided an additional deliverable that will allow any Farmer-led Council member or any other individual access to these data layers through a free, easy-to-use desktop mapping application provided by Environmental Systems Research Institute (ESRI) called ArcReader. ArcReader allows users to view, explore, and print maps that were generated as a deliverable for this project. We have included a copy of the ArcReader set-up file that can be installed on most PC desktop computers.

Data layers that have been provided as a result of this project include:

- **Standard Base Map Layers** – major County Roads, Township names, Section number, County and sub-watershed boundaries, municipal boundaries.
- **DEMs and Aerial Photographs** – 3-meter LiDAR and high-resolution aerial photographs.
- **Demographic Layers** – feedlots, land cover and parcel information.
- **Hydrolayer** – Perennial and intermittent streams (edited), 2010 Impaired Streams, MPCA Water Quality Monitoring Stations, County Well Index, Protected Waters, and 50-foot Protected Waters Setbacks.
- **Geology and Soils** – Bedrock geology, geomorphology, and highly erodible soils.
- **Terrain Attributes** – Hillshade, slope, aspect, flow accumulation, flow direction, profile curvature, and stream power index.
- **Other Data** - Existing conservation practices including ponds, dams, sediment basins and terraces.



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