Chapter 4 Watershed Assessments and Techniques

Watershed Assessments

Several different approaches were used to analyze the watershed. Analysis of the watershed included:

- Pollutant load estimations using water quality and hydrology monitoring.
- Current research applicable to this watershed. Red Top Farms, St Peter Wellhead protection FANMAP survey and nutrient management demonstrations, and University of MN and Extension Service research.
- Nutrient and Sediment Transport (Advanced RUSLE Modeling) and Mass Balance (chapter 6).
- Tillage Transect Survey.
- Stream Bank Erosion Inventory for lower riparian corridor in minor shed 2.
- SWCD/NRCS. Local, state, federal agencies and watershed resident knowledge.
- Field Surveys. TISWA, stream bank erosion, tile and intake inventories.
- Producer practice surveys.

Spatial Analysis

- GIS modeling using USGS DEMs and Hydro-Tools
    - Flow Accumulation–Used in hydro-analysis. Can help identify sighting of waterways and intermittent streams.
    - Wetness Index–Used to identify locations of tile intakes and wetland restoration sites.
    - Sediment Transport Index–Used to identify potential areas of high stream bank and in stream erosion locations based on topography.

All of this information is integrated to obtain load reduction goals and BMP targeting locations.

Minnesota's Tillage Transect Survey for Monitoring Trends in Crop Residue Management

Minnesota Board of Water and Soil Resources

Every spring since 1995, local government staff in Minnesota's agricultural counties have driven along a designated route to build an annual record of crops grown, tillage type, and surface residue remaining after planting. For each participating county, the route is designed as a grid that equally represents all cultivated areas. Local staff from the SWCD, NRCS and other conservation organizations cooperate to cover the route, stopping every half mile to record field conditions to the left and right of the road. With 450-500 field observations in each county, the data represents a statistical average of the entire cropland area. This tillage transect survey procedure was developed by the Department of Agronomy at Purdue University.

The results are entered on forms that are scanned into a computer program that aids in summarizing the data. Each data point is associated with its county, major watershed, slope length and steepness and other RUSLE based erosion information. A methodology has been developed to conduct the survey in minor watersheds, and participating watersheds will be able to compare crop residue trends with stream monitoring data.

Counties facing growing expectations for water and soil resource conservation are finding the data useful for demonstrating the importance of promoting conservation tillage, and prioritizing where those efforts should be targeted. The data also enables conservation staff to monitor outcomes from tillage programs, and recognize the success (or failure) of agricultural producers in meeting crop residue targets. When it is used to demonstrate needs, prioritize efforts, track progress and recognize success, the Tillage Transect Program's data enables a county to secure funding and achieve conservation objectives.

Trends in crop residue management are summarized using a method that calculates the percent of fields in the corn-soybean rotation that meet crop residue targets. **It is computed as the average of the percent of corn acres planted into >15% residue, and the percent of soybean acres planted into >30% residue.** From 1995 to 1999, the number of Minnesota counties conducting the survey has been 37, 37, 27, 39, and 43, respectively. During those years, the percent of cropland meeting residue targets has been 31%, 41%, 50%, 39% and 37%, respectively. There is large variation in surface residue management from county-to-county, and year-to-year. The amount of residue left on the surface depends on many factors, most importantly opportunity to till (based on weather conditions) and intent to maintain residue.

A summary of the conservation tillage results for counties within the watershed is shown in table 16

Seven Mile Creek Watershed Tillage Transect Survey

On May 30, 2001 Kevin Ostermann of Nicollet County SWCD and Kevin Kuehner of BNC Water Board conducted a tillage survey of the watershed. The tillage survey followed BWSR tillage transect survey protocol. 161 fields were sampled within the watershed with survey locations taken every ¼ to ½ mile. Of the 161 locations, 156 were actually utilized for the survey. Some points had to be emitted due to some fields not being planted or other factors affecting the visibility of the fields. To maximize equal representation of the watershed, a travel route using air photos and GIS was used to aid in the process. In addition to documenting the residue for individual fields, present crop level, tolerable soils loss, previous crop, K factor, tillage system, percent slope, slope length, P factor, drainage outlet, and ephemeral erosion were surveyed. Where possible, open tile intakes and highly erodible areas were inventoried and mapped. The results of the survey can be found below in table 14. Approximately 60% of the cultivated acres within the watershed were surveyed. 96% of the fields surveyed were found to have a corn/soybean rotation. Results of the survey indicated that a majority of the watershed fields (65%) were meeting conservation tillage requirements while the remaining 35% of the fields were left with little or no residue after spring planting. The majority of fields with little or no residue were corn planted into soybeans.

C Factor

The C factor represents the condition of the cover found in the landscape. The results of the tillage transect survey were then used to obtain a more accurate C factor for use in the Revised Universal Soil Loss Equation. C values specific to the fields surveyed were taken from a USDA publication technical guide[1]. Corn and soybean yield was considered high for the cultivated acres, and assumed fall and spring mulch till. The area weighted factor for the watershed was 0.13.

[1] **Predicting Rainfall Erosion Losses, USDA-NRCS Technical Publication, January 1997.**

Table 16. Tillage Transect Survey results for Seven Mile Watershed.

Seven Mile Creek Watershed, Nicollet County, Tillage Transect Survey Results
Completed by: Kevin Kuehner and Kevin Osterman, May 30, 2001

Number of Sample Points	168
Number of Sample Points Utilized	156

Estimated cultivated acres surveyed in watershed(based on parcels)	11974
Estimated acres of cultivated land in watershed	20181
% of area surveyed	59

Residue	Fields	%
0-15%	37	23.72
16-30%	64	41.03
31-50%	44	28.21
51-75%	11	7.05

	%
% of fields surveyed **out** of conservation tillage*	35
% of fields surveyed **in** conservation tillage*	65

2001 Crop	Fields	%	2000 Crop	Fields	%
Beans	85	52.80	Beans	76	48.72
Corn	74	45.96	Corn	82	52.56
Hay	2	1.24	Other	3	1.92

Number of fields following corn soybean rotation	149
% of fields following corn/soybean rotation	95.51

C Factor

Corn Year (Previous Crop=Soybeans)

% of fields in conservation tillage: 71.23

	Residue	*Fields*	*% Area*	*Area*	*C Factor*	*Area Weighted*
	0-15%	21	29	0.29	0.21	0.060410959
	16-30%	46	63	0.63	0.14	0.088219178
	>30%	6	8	0.08	0.13	0.010684932
Total		73	100			0.159315068
					C Factor	0.16

Bean Year (Previous Crop=Corn)

% of fields in conservation tillage: 59.04

	Residue	*Fields*	*% Area*	*Area*	*C Factor*	*Area Weighted*
	0-15%	16	19	0.19	0.15	0.028915663
	16-30%	18	22	0.22	0.11	0.023855422
	>30%	49	59	0.59	0.07	0.041325301
Total		83	100			0.094096386
					C Factor	0.09

**Average C factor for cultivated land in Seven Mile Watershed (.09+.16/2) 0.13

*"in conservation tillage"=computed as the average of the percent of corn acres planted into >15% residue, and the percent of soybean acres planted into >30% residue.
**C factor values taken from RUSLE 1.5 and 1997 USDA-NRCS-MN Technical Guide, Sec. I-C
Assumed yield level High, corn/soybean rotation, fall and spring mulch till, Table 4H

Watershed Modeling Techniques

Geographic Information System

Minnesota State University Water Resources Center, Mankato (MSUWRC) has provided technical assistance with the creation of a Geographic Information System (GIS) database for much of the MN River basin including that of the Seven Mile Creek watershed. An extensive database of existing and newly gathered information through inventories of feedlots, land use, drained wetlands, etc. has been obtained. The information provided by MSUWRC is an important tool to assist in the selection of priority management areas, watershed modeling, on land water quality improvements, and general communication of projects through maps.

Data used for this study was created by the MSUWRC, which employs strict quality control assurance procedures. Some data layers however were not created by MSUWRC and were created by BNC Water Board staff and Nicollet County Environmental Services. Examples of those coverages include: feedlots, septics, spreading acres and spatial analysis. Similar control procedures however were also used to ensure reliable, accurate and up to date information. All GIS analysis for the project was conducted by BNC staff.

Predicting Rainfall Erosion Losses—Revised Universal Soil Loss Equation (RUSLE)

Soil erosion is frequently associated with sediment and phosphorus transport to surface water bodies. Identifying the extent and location of high erosion areas within a watershed can help managers pinpoint vulnerable areas and what kind of best management practices should be implemented such as filter strips, or conservation tillage. Maps 16 and 17 of chapter 2 depict modeled soil erosion in Seven Mile Creek Watershed.

RUSLE is a soil erosion potential model developed by the United States Department of Agriculture. RUSLE is an erosion prediction model that enables conservation planners to predict the long-term average annual rate of interill (sheet) and rill soil erosion on a landscape as described by the factor values for site-specific conditions. RUSLE computes soil erosion rates to guide planning conservation systems for individual fields by evaluating the impact of present or planned land use management.

RUSLE is the rate of soil erosion from the landscape, not the amount of sediment leaving a field or watershed via a waterway. The calculated soil loss is an average erosion rate for the landscape profile.

The soil erosion potential model was calculated using RUSLE for sheet and rill erosion predications. The RUSLE equation is:

A= R Factor * K Factor * LS Factor * C Factor * P Factor

Methodology

The clipped land use and soils for the watershed were unioned in ArcView to produce a coverage that combined attributes of all three. Once the coverage was cleaned for "ghost" polygons, the RUSLE equation was used to calculate erosion rates for each unioned polygon. The values were then classified into four soil loss categories. The P factor or conservation factor was given a value of 0.875. It was assumed special conservation practices such as conservation tillage, strip cropping, or other practices represented half the watershed while the other half had little conservation being practiced. Although there are many areas where conservation is incorporated on cultivated land, P factor was given a default value of 0.75 based on NRCS staff information. Below is a short description of each factor and the values used for the watershed.

- Soils and land use unioned
- Wetlands and sinks deleted from new unioned coverage
- Cleaned up ghost polygons as a result of union process
- R, K, LS, C, and P factors added to soils attribute table, C factor adjusted as a result of 2001 tillage transect survey
- RUSLE reclassified into four categories

To quantify the number of acres within each category by minor shed, the five reclassified RUSLE categories were queried and converted to shape files. The minor5 field was selected and a summary of the acres was produced for each minor shed per five RUSLE categories.

R Factor (Rainfall and Runoff)

- Incorporates the rainfall frequencies of geographic areas. RUSLE contains expanded and more precise information for locations across the United States. R factor has the ability to calculate the effect that ponded or puddled water has on raindrop erosion.
- Values used for analysis:

  Nicollet County=115

K Factor (Soil Erodibility)

- More significant erodibility data from around the world such as the soil type, the diameter of soil particles, and the presence of rock fragments. Adjusted to account for soils in South-Central Minnesota.
- K values assigned by specified soil unit and adjusted for RUSLE zone 100B/C:

0.28 adjusted to 0.26	0.20 adjusted to 0.17
0.32 adjusted to 0.30	0.24 adjusted to 0.22

-9.00 were not included in analysis-represents wetlands and lakes

LS Factor (Slope Length and Steepness)

- Known value found in the soil survey
- Possesses the ability to predict soil loss on complex slopes

- Can apply different functions based on the relative amounts of rill and inter-rill erosion

C Factor (Cover and Management)

0.13 cultivated land (based on 2001 tillage transect survey)

0.02 grassland/CRP/shrubs

0.003 deciduous forest

0.26 Urban and industrial

0.45 exposed soil, sandbars, dunes

0.0 shallow or seasonal wetlands (types 1, 2, 3)=0.003

0.45 gravel pits and open mines

0.15 farmsteads and other rural developments

0.0 lakes and deeper water wetlands

P Factor (Support Practice)

A P factor value of 0.875 assumed some special practices such as contour farming, buffer strips, and waterways on half the acres and the other half with no conservation practices.

Advanced Sediment and Phosphorus Transport Modeling using RUSLE and Loading Rates

See Chapter 6

Slopes, Elevations, Hill shading

All coverages were created using USGS 30 meter resolution Digital Elevation Models (DEM). DEMs were obtained from MDNR as GRIDS. The GRIDS were transformed using ArcInfo Import 7 to allow for ArcView Spatial Analyst readability. DEMS were then added to the view as GRIDS. DEMs from Cottonwood, Brown and Cottonwood Counties were clipped to the watershed boundary using USGS Spatial Analysis extension. X tools extension was then used to convert the shape file boundary into a graphic before clipping the DEM. The merge command in the USGS spatial analysis extension was used to combine the three individual clipped DEMS into one DEM.

Spatial Analyst Extension within ArcView 3.2 was then used to perform calculations, reclassifications and analysis to construct slope as percentage and hill shading within the watershed.

Biological

Historical Fishery Assessment- MN DNR

Seven Mile Creek ecological classification is a 1-D Marginal Trout Waters. Below is an excerpt taken from the 1993 fisheries survey by Todd Kolander.

Length of Stream: 12.2 miles

Average width: 3.4 m

Mouth Location: T109N R27W Section 12

Initial source of sustained flow: ditch at T110 R27 S17

Gradient: 18.9 feet/mile

Sinuosity: 2.1

(MN DNR Todd Kolander 1993 Stream Survey)

Comparisons with past investigations and surveys:

Fingerling brown trout were first introduced into Seven Mile Creek in 1986. Prior to this introduction, the stream supported a fish community dominated by cyprinid species. Fish species such as northern pike, yellow perch and walleye typically use the stream in the summer, migrating up from the Minnesota River.

The initial stream survey was completed in 1985. Data on the physical and biological make up of the stream indicated it could support a marginal trout fishery. Stream population checks were completed in 1986, 1987 and 1991. Population checks confirmed that the brown trout stockings were providing a trout population in marginal trout water.

History of fishing conditions

Prior to and following the introduction of brown trout, most fishing occurs at the confluence of the Seven Mile Creek and the Minnesota River. The cool water coming from Seven Mile Creek attracts game fish during warm summer months. During peak runoff periods, fish in the Minnesota River will migrate up Seven Mile Creek. Other times fish will become stranded in shallow pools as flows decrease.

Discussion of Fishery

The initial survey of Seven Mile Creek was in 1985. Population checks were done in 1986, 1987 and 1991. Results indicate that brown trout fingerlings have successfully provided a fishable trout population. Stocked fingerlings have survived in sections of stream both above and below the low-head dam (mile 4.7).

Seven Mile Creek is not without watershed problems. Lost riparian vegetation, increased tiling, and intense row-crop agriculture in the upper watershed (miles 5-12.3) are destabilizing the stream hydrograph and increasing summer water temperatures and stream loading. Currently, extreme high and low flows occur in a very short time period. This type of flow regime is stressful for most aquatic organisms. High flows create elevated velocities that pick up loose bottom material (silt, sand and gravel) that scour the stream bottom, disrupting its inhabitants. Conversely, low flows restrict the available habitat to any remaining pools. Increased competition and predation in these pools adds to the stress on surviving organisms. Removal of the wooded riparian zone in the upper watershed (miles 5-12.3) and replacement with open drainage ditch has increased summer stream temperatures. Elevated stream temperature (>70 F) is stressful for brown trout and can affect other species of fish and invertebrates. Increased sediment loading from row-crop agricultural practices has inundated pools and created turbid water conditions.

The variable that most limits adult brown trout survival in Seven Mile Creek is the lack of deep pools having overhead cover. Literature addressing factors limiting large brown trout in streams show a strong positive relationship between this habitat type and the presence of large brown trout. Seven Mile Creek contains only a few deep pools, and these lack any associated overhead bank cover. Some log jams that may provide overhead cover exist; however these lack deep water adjacent to them.

The fish community present in Seven Mile Creek is diverse, reflecting the different habitat types. A total of 19 species were identified from all the investigations. Of the species sampled, two were darter species, the presence of which suggests good water quality. Darters were only sampled in the lower reach (mile 0-4.7), while the upper reach favored more tolerant species such as fathead minnows, creek chubs, and black bullheads. Investigators sampled some young-of-the-year game fish (walleye, northern pike, and yellow perch). These species may be using the stream as a nursery area because of the available food and suitable environmental conditions.

Summary

At present, the only active management on Seven Mile Creek is annual stocking of 7500 brown trout fingerlings. This had produced an adequate and fishable trout population. As with other marginal trout streams in this area, no data exist on harvest rates or the fishing pressure that occur on Seven Mile Creek. All available information suggests that both fingerlings pressure and harvest occur at low levels. Fishing access along the lower reach (mile 0-1.8) is good, with the county park providing a scenic setting for a variety of outdoor activities. Good access and good survival of fingerlings make trout management an attractive and justifiable expenditure of time and money.

The need to improve habitat for adult brown trout is a future management need. Installation of inexpensive habitat structures should be done in the lower reach of Seven Mile Creek. Structures will be evaluated for fish use and how they improve the carrying capacity of a marginal trout population. Future stream management should also include establishing good riparian buffers in the upper reach of the stream. This should improve the stream hydrologic cycle, while lowering water temperatures and sedimentation rates.

Summary of 1996 Survey (Craig Berberich)

At present the only active management on Seven Mile Creek is annual stocking of 2,500 brown trout fingerlings. Good survival of fingerlings to age three has produced an adequate and fishable trout population. No harvest estimates or fishing pressure data were available, but indications are that both have been low. The county park is an attractive setting for outdoor activities. With some effort in improving pool depth and creating cover, the carrying capacity of large trout could be improved in the lower reach.

Summary 1987 Survey (Duane Williams)

The estimated size of the brown trout population in the 0-4.7 mile reach of Seven Mile Creek was 421 plus or minus 552 (95% CI). This represents 6% survival of the 7,000 brown trout fry planted in 1986. The population should be assessed in 1988 to determine the survival of the 1986 plant and also the 7,000 brown trout planted in 1987.

Summary 1986 (Duane Williams)

The upper reach of SMC (above dam at mi. 4.7) is nearly all open drainage ditch intensively farmed right to the banks. Gradient is relatively low, bottom types mostly sand and silt, and cover for game fish poor. Only three species of fish were sampled—fathead minnow, creek chub, and brook stickback.

The lower reach (below dam at mi. 4.7) is an entirely different type of stream. It flows through a heavily wooded valley to the MN River. Gradient is very high and bottom type is mostly boulder, rubble, and gravel. Cover for game fish is good. Fish species present are the various minnows, suckers, and darters common to most Southern MN streams. No game fish are present. This reach is the one being proposed for trout stocking.

Aquatic and Biological management problems discussed in surveys

- Low flows are the major management problem on Seven Mile Creek. If brown trout stocking is successful, the lack of cover could limit the abundance of adult fish (1988).

- Unstable flows are a problem on Seven Mile Creek. Lack of pools and suitable cover limits the carrying capacity of trout in the lower reach (1997).

- Low flows are the biggest management problem on Seven Mile Creek. If trout management takes place, as proposed, lack of cover for adult fish would also be a problem (1986).

Comments from DNR Fisheries Staff regarding the management of trout and other aquatic Fishery

- Extreme flow conditions pose the single greatest threat and challenge for fisheries management within the creek. Water storage is considered the most important management strategy for attempting an ecosystem-based restoration. The scope of the water quality concerns in the watershed requires solutions on a scale commensurate with the magnitude of the problems. Over the past century the watershed has changed dramatically. About 95% of the watershed has been converted from prairie and wetland to cultivated land and artificial drainage structures. The net effect of the extreme flow conditions includes massive stream bank failures, and high sediment and nutrient loads. A best management practice, which would help address the issue of water quantity, is water storage.

    - An example of a management strategy would be to store 10,000 acre-feet through the use of wetlands. In 2001, about 32,500 acre-feet came through the system. If wetlands were installed at recommended levels, a 30% reduction in flows would be obtained.

- Water quality and water quantity are directly correlated. The volume of water entering seven mile has the largest impact on the trout fishery of Seven Mile.

- Adopt a **"no-net increase"** in drainage within the watershed. If drainage improvements are made, encourage and work with engineers to design features within the construction that will mitigate the cumulative affects of the additional water downstream. If this is not feasible, restore, construct or augment existing wetlands within the minor shed.

- Need for in-stream restoration efforts. Create additional habitat through the use of bank hide structures and rock crossvane structures.

- Create diverse habitats, which in turn encourage diverse fish, amphibian, mussel, invertebrate, and plant communities.

- Increase water quality. Maintain or improve dissolved oxygen levels. Maintain temperatures below 70 ^{o}F.

- Maintain natural and sustainable flow regimes.
- Stabilize stream banks and streambed substrates