



Vermillion River Monitoring Network 2010 Report

Prepared for:
Vermillion River Watershed Joint Powers Organization

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Executive Summary:

The Vermillion River Monitoring Network was created to collect water quality and quantity information from throughout the Vermillion River Watershed. Water quality samples are analyzed for a variety of parameters including nutrients, bacteria, and sediment. Continuous temperature monitoring is conducted to ensure stream temperatures remain conducive to supporting a healthy trout fishery. Macroinvertebrate populations and habitat are assessed to provide insights into the health of biological communities living in the waters of the Vermillion River.

All results are used to establish long-term water quality and quantity data, provide trend analysis, and determine pollutant loading values. Results are compared against current state water quality standards, proposed state water quality standards (2012), or minimally impacted stream eco-region means, developed by the Minnesota Pollution Control Agency (MPCA) (Table 1). Results in red text exceed state water quality standards or eco-region means.

In general, water quality monitoring results for 2010 were below or near state standards or minimally impacted stream eco-region means, although several endpoints appear problematic (Table 1). Wastewater treatment plant discharge may have contributed to elevated conductivity results for those sites nearest to the Elko/New Market waste water treatment plant (VR24, VR809). Since numerous reaches of the Vermillion River have been listed as impaired for bacteria, it is not surprising that 2010 *E. coli* bacteria results continued to exceed the state standard at most monitoring stations. A region-wide Total Maximum Daily Load (TMDL) study has been completed to help address elevated bacteria concentrations (MPCA 2006). After several years of increasing nitrate results on the south branch of the Vermillion River, the 2009 and 2010 results were slightly lower than what has been observed in the past. Nitrate results from 2010 are meeting the existing state standard. Mean turbidity (cloudiness) results at all sites were below the state standard, but individual measurements exceed state water quality standards.

Nitrate and total suspended solids (TSS) pollutant yields (pollutant load per acre) were calculated for all monitoring stations and associated tributaries within the Vermillion River Watershed. Nitrate pollutant yields continue to be extremely high in the South Branch of the Vermillion River. Agricultural runoff is a likely source of high nitrate yields in this watershed. Total suspended solids pollutant yields were surprisingly high in the South Creek sub-watershed. This may be due to urban and agricultural runoff, as well as a highly mobile bed load in this watershed. Total suspended solids pollutant yields were highest in the South Branch sub-watershed and at the Goodwin Ave. site. These yields are also likely due to agricultural runoff and a mobile stream bed.

Temperature monitoring results from 2010 were near or slightly above the brown trout chronic exposure limit of 64°F for the warmer summer months (June-August). During periods where temperatures are approaching the chronic exposure limit, it is assumed that trout seek refuge in nearby cool and deeper pools. Temperatures appear to be supportive of maintaining a healthy trout fishery.

Macroinvertebrate and habitat monitoring, sponsored by the Vermillion River Joint Powers Board, began in 2009. Macroinvertebrate results from 2010 monitoring are inconclusive since an appropriate index of biological integrity (IBI) for this region does not currently exist. An IBI simply incorporates several measures, called metrics, of a biological community into a summary score. IBIs from various water resources can then be compared. Although an index appropriate for the Vermillion River is not currently available, the widely used Hilsenhoff Family Biotic Index (FBI) and several simple metrics were used to evaluate 2010 results. In general, sites A06 and A05 produced the best index and metric scores, while sites A15 and A02 produced the worst scores. Most sites scored “fair” or better using the FBI index. Habitat assessments were completed using the MPCA’s Multi-Stream Habitat Assessment Protocol. These assessments revealed that site A10 had the least desirable aquatic habitat, primarily due to excessive silt and poor fish cover amounts.

Table 1. 2010 Water Quality Data Summary

Parameter (state standard or eco-region mean)	Monitoring Sites								2010 Notes
	Vermillion River and Cty. 46 (Scott Co.) (VR24)	Vermillion River and 235 th St. (VR809)	Vermillion River and 220 th St. (SC804)	Vermillion River and Denmark Ave. (VR807)	North Creek and Hwy. 3 (NC808)	Middle Creek and Hwy. 3 (MC801)	South Branch Vermillion River and Cty. 66 (SB802)	Vermillion River and Goodwin Ave. (VR803)	
Mean Conductivity (698 mMHOs)	1142 mMHOs	715 mMHOs	611 mMHOs	628 mMHOs	638 mMHOs	667 mMHOs	519 mMHOs	648 mMHOs	Above eco-region mean near Elko/New Market WWTP
Mean Dissolved Oxygen (*7.0 mg/L)(**5.0 mg/L)	10.26 mg/L	7.49 mg/L	8.40 mg/L	8.30 mg/L	7.24 mg/L	7.15 mg/L	8.63 mg/L	9.10 mg/L	Adequate for trout fishery
Geometric Mean E. coli (126 MPN/100ml)	249 MPN/100ml	69 MPN/100ml	152 MPN/100ml	170 MPN/100ml	171 MPN/100ml	192 MPN/100ml	188 MPN/100ml	120 MPN/100ml	Exceeding state standard at most sites
Mean Nitrate (10 mg/L)	1.87 mg/L	0.57 mg/L	1.80 mg/L	2.14 mg/L	0.77 mg/L	0.85 mg/L	5.25 mg/L	3.06 mg/L	In compliance with state standard
Un-ionized Nitrogen Ammonia (*16 µg/L)(**40 µg/L)	1.63 µg/L	1.30 µg/L	0.65 µg/L	0.45 µg/L	0.89 µg/L	0.82 µg/L	0.51 µg/L	0.66 µg/L	In compliance with state standard
Mean Total Phosphorus (0.28 mg/L)	0.21 mg/L	0.14 mg/L	0.11 mg/L	0.10 mg/L	0.14 mg/L	0.11 mg/L	0.09 mg/L	0.12 mg/L	Below ecoregion mean
Mean pH (*8.5)(**9.0)	7.71	7.83	7.95	7.87	7.63	7.67	7.89	8.08	Individual sample at SC804 exceeded state standard
Mean Total Suspended Solids (45.3 mg/L)	3.80 mg/L	3.75 mg/L	7.87 mg/L	10.17 mg/L	5.65 mg/L	7.57 mg/L	10.79 mg/L	17.12 mg/L	Below ecoregion mean
Mean Summer Temperature (64 °F)	66.8 °F	67.3 °F	66.6 °F	64.2 °F	67.1 °F	67.0 °F	63.9 °F	na	Slightly elevated for trout fishery
Mean Turbidity (*10 NTU)(**25NTU)	3.45 NTRU	2.85 NTRU	8.87 NTRU	8.43 NTRU	6.92 NTRU	7.35 NTRU	8.72 NTRU	7.65 NTRU	Individual samples exceed state standard
mg/L = milligrams per liter or parts per million (ppm) mMHO = micromhos or microseimens MPN = most probable number °F = degrees Fahrenheit		NTU= nephelometric turbidity unit NTRU = nephelometric turbidity ratio unit *applies only to monitoring locations located within 2A waters (SC804, VR807, MC801, NC808, SB802) **applies only to monitoring locations located within 2B waters (VR24, VR809, VR803)							

Results in red text are exceeding state water quality standards or eco-region means.

Introduction:

The Vermillion River Watershed is one of the largest watersheds located within the Minneapolis/St. Paul metropolitan area. More importantly, the watershed is home to a robust and thriving trout population located within two rapidly growing counties in Minnesota. As a result, numerous water quality monitoring programs are actively assessing the health of this watershed. The purpose of this report is to concisely summarize the results of the surface water quality monitoring activities sponsored by the Vermillion River Watershed Joint Powers Organization (VRWJPO) and completed by the Dakota County Soil and Water Conservation District (DCSWCD) and the Scott Soil and Water Conservation District (SSWCD).

In addition to describing results from 2010, this report includes historical water quality monitoring results from as early as 2000. The historical results presented here are intended to provide perspective with regards to long-term water quality trends in the watershed.

Vermillion River Monitoring Network:

The Vermillion River Monitoring Network (VRMN) was created in the late 1990's to obtain water quality and quantity data from the Vermillion River Watershed and initially consisted of six monitoring stations located in Dakota County. Since then, the network has grown to include a total of eight permanent monitoring stations (Figure 2) and includes an automated weather station designed to assist with water quality/quantity analysis in the Vermillion River Watershed. Data from the Metropolitan Council's Watershed Outlet Monitoring Program (WOMP) site is included for comparison purposes. All stations are equipped with a continuous water level logger and temperature logging equipment. Water quality grab samples are collected during large rain events and on a scheduled, bi-weekly basis. Flow is typically measured five to seven times per season, at every site. Staff attempt to measure flow during a variety of flow regimes, to ensure that the mathematical relationship between stage and volume is well understood under most climatic conditions.

Temperature Monitoring

Since the Vermillion River is home to a thriving brown trout population, there is great interest in maintaining cold water temperatures, suitable for a healthy trout fishery. In addition to water quality and quantity monitoring stations, the VRMN also includes 32 temperature monitoring sites, designed to help identify areas where the fishery could be stressed due to high temperatures (Figure 1). Results presented in this report only include temperature data collected at the eight permanent water quality and quantity monitoring stations (Figure 2).

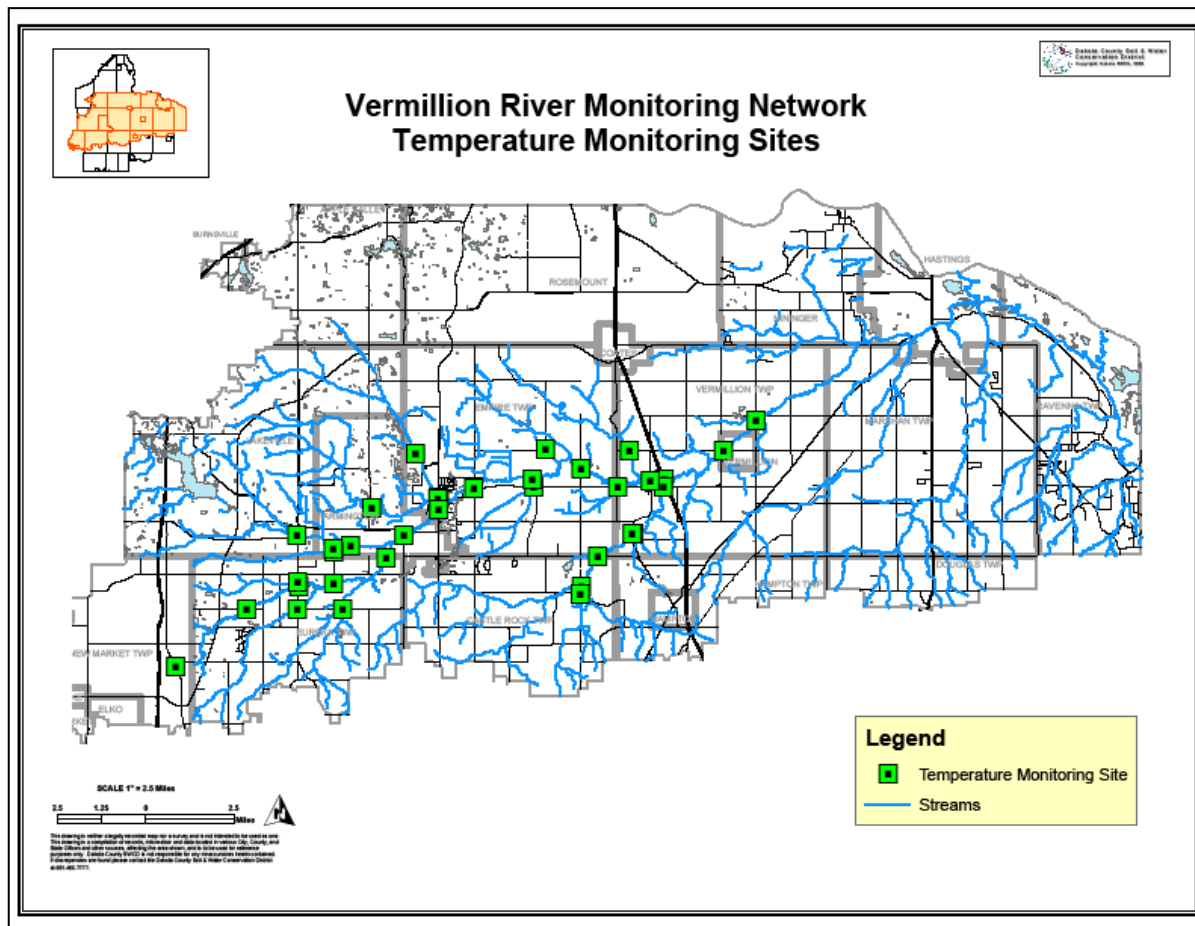


Figure 1. 2010 VRMN Temperature Monitoring Sites

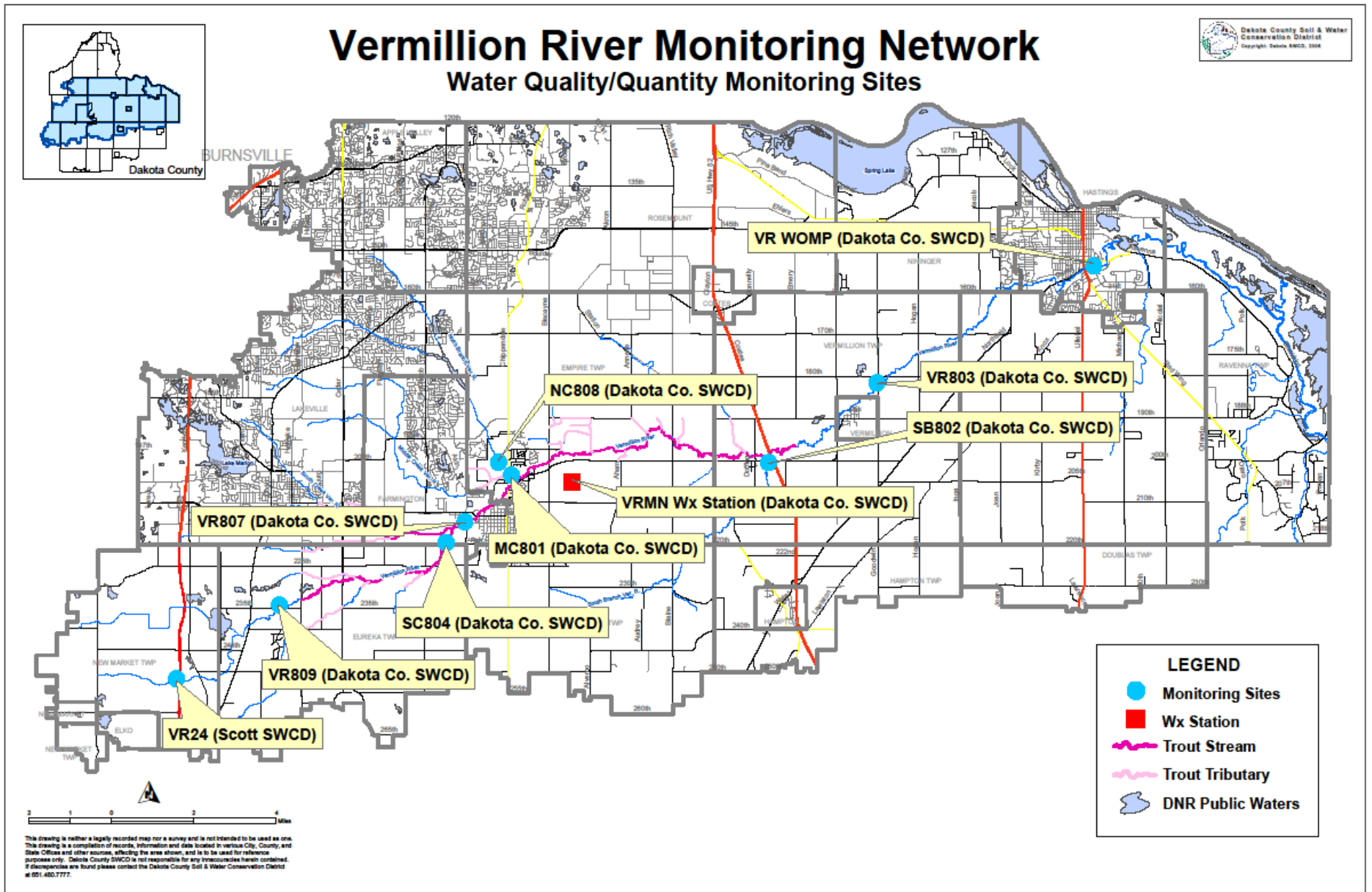


Figure 2. Vermillion River Monitoring Network and WOMP Station Locations

Turbidity Monitoring

In 2008, the Minnesota Pollution Control Agency (MPCA) listed the Vermillion River as impaired for turbidity. In anticipation of the forthcoming turbidity TMDL study, the VRWJPO added two automated turbidity probes to the VRMN in an attempt to supplement existing turbidity data for the impaired reach (Figure 3). This new equipment allows for an improved understanding of conditions contributing to turbidity exceedences of state water quality standards and will aid in future TMDL load calculations.

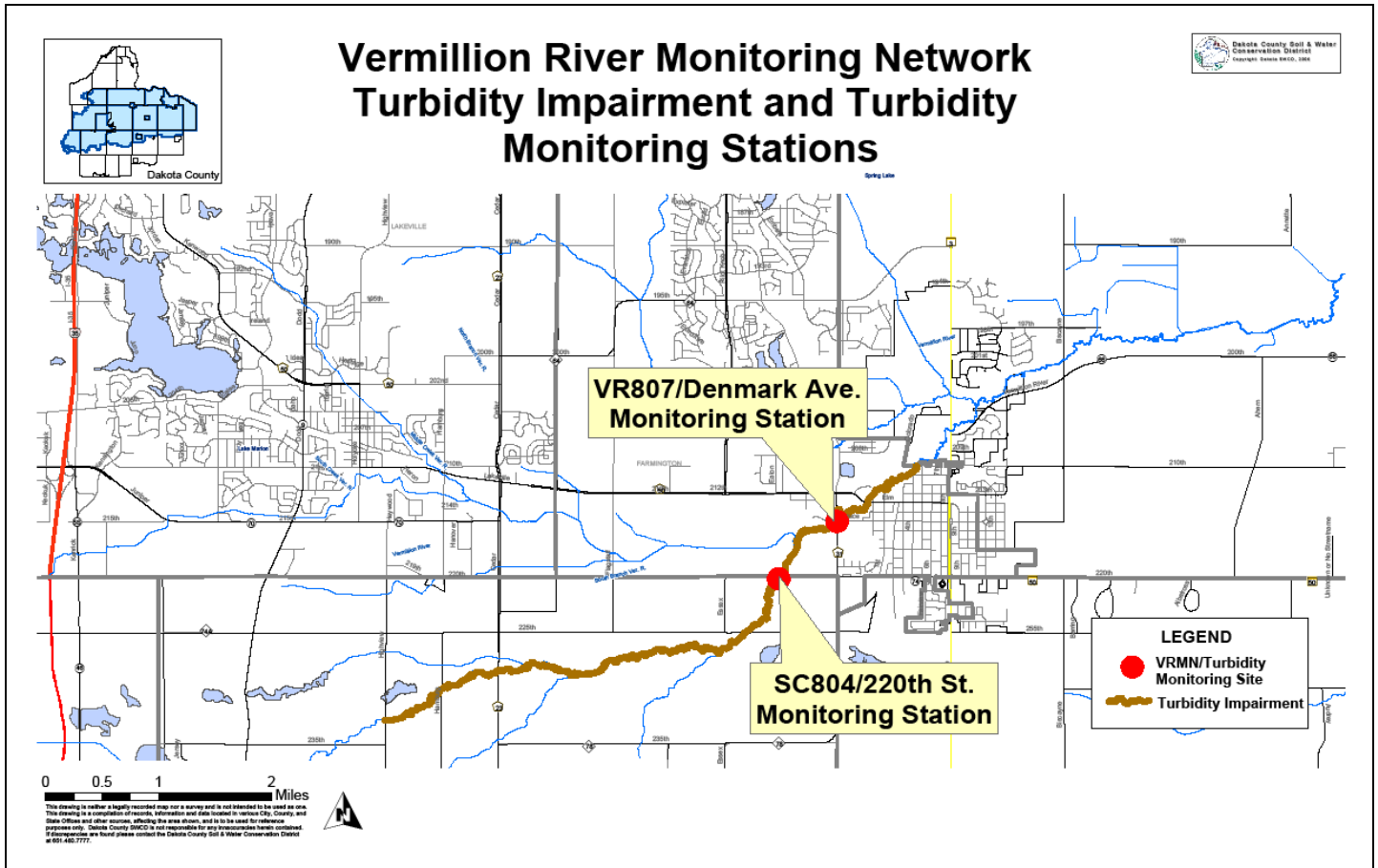


Figure 3. Vermillion River (upper) Turbidity Impairments and Turbidity Monitoring Stations.

Supplemental Flow Monitoring and Data Analysis

The Vermillion River Joint Powers Board continues to contract with the Minnesota Department of Natural Resources (MNDNR) to assist in refining flow measurements and the data analysis necessary to convert VRMN 15-minute stage data into 15-min flow data, which is used by various water resource management organizations. By using some of the most modern technology and techniques available, this process ensures that the VRMN produces the highest quality flow data possible for the watershed. These water quantity data are available on the Minnesota Cooperative Stream Gaging Program website (<http://www.dnr.state.mn.us/waters/csg/index.html>).

Vermillion River Biomonitoring

Monitoring biological communities is becoming a widely accepted method for assessing the health of an aquatic environment. Using this strategy, a direct measurement of the quality of the biological community can be described, rather than attempting to infer the health of the community through the assessment of chemical parameters. Biological monitoring may also be more sensitive at identifying the cumulative effects of numerous, simultaneous stressors on the biological community.

In 2009, the VRWJPO began implementing the Vermillion River Biomonitoring Plan to assist in assessing the health of waters within the Vermillion River (Vermillion River Watershed Joint Powers Organization, 2008). This program includes whole fish community monitoring, geomorphic assessments, macroinvertebrate monitoring, and habitat assessments. This monitoring strategy supplements pre-existing monitoring efforts by increasing



Figure 4. DCSWCD Staff Collecting Macroinvertebrate Samples in 2010

the number of sites, frequency, and parameters of biological communities monitored within the watershed (Figure 5). This program has also been carefully designed to seamlessly integrate with other biomonitoring efforts to ensure that adequate biological monitoring data is being obtained, while minimizing monitoring expenses.

Whole fish community monitoring and geomorphic assessment work was completed by the MNDNR and private consultants hired by the VRWJPO, while macroinvertebrate sampling and habitat assessments were completed by the DCSWCD.

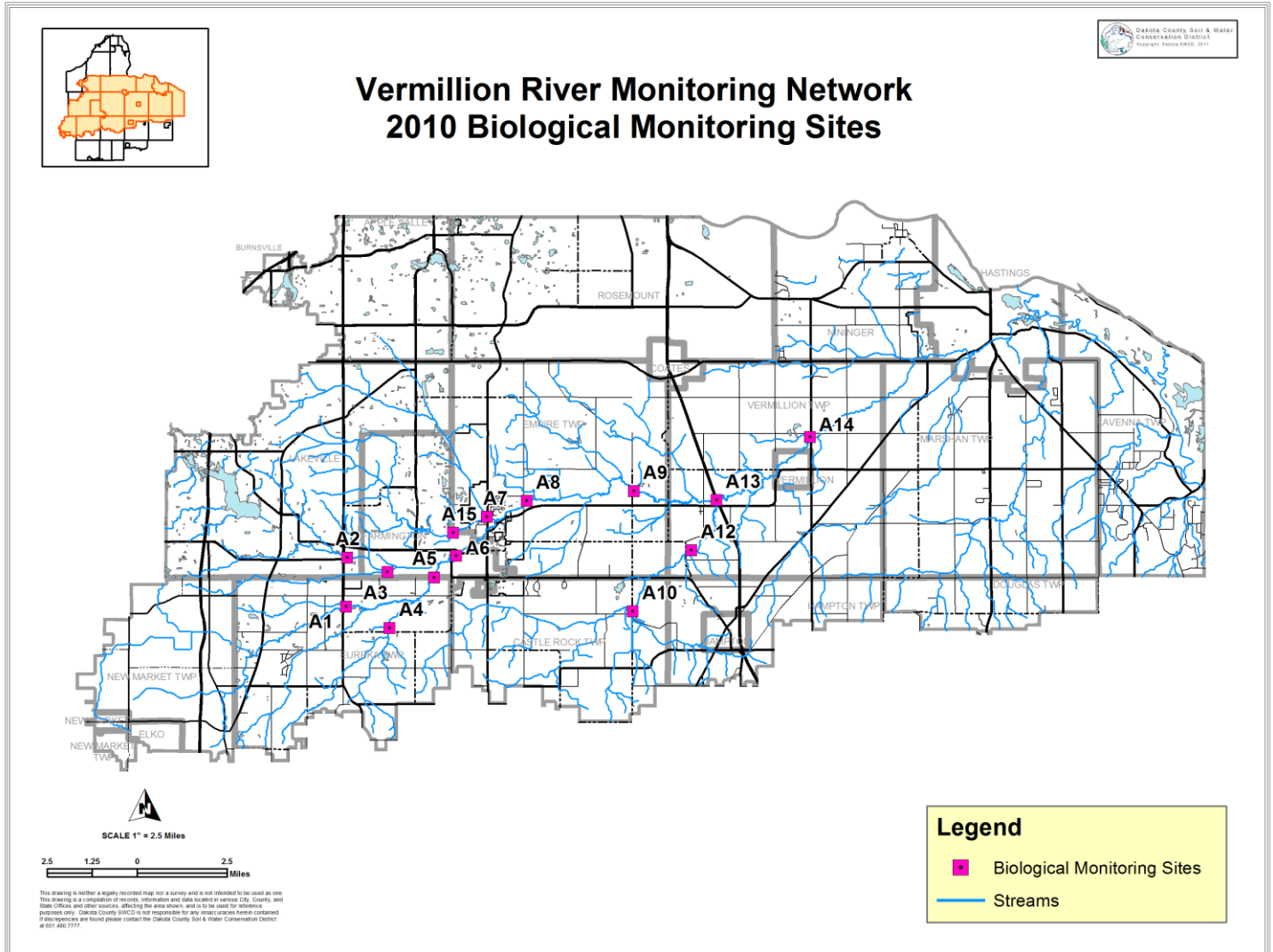


Figure 5. Vermillion River Monitoring Network Biological Monitoring Sites

Methods:

Vermillion River Monitoring Network

Scheduled samples were collected every two weeks from all VRMN sites. Event flow grab samples were collected from sites SC804, VR807, NC808, MC801, and SB802 whenever river stage responded strongly to precipitation events. Event flow samples were collected from these sites to ensure that pollutant loads could be calculated for the major tributaries in the watershed. Event flow samples were not collected from VR24, VR809, and VR803 since load calculations for these locations has been deemed unnecessary. However, it should be mentioned that prior to 2009, monthly base flow and event flow grab samples were collected from all sites. Historical results presented below include data from both of these separate monitoring strategies.

Water quality samples were collected from the Vermillion River Monitoring Network utilizing standardized procedures established by the Metropolitan Council Environmental Services (Metropolitan Council, 2003). At each station, automated equipment records stage every fifteen minutes, which is then converted to flow values through the use of MNDNR developed rating tables. A temperature logger is also located at each station to continuously record temperature throughout the warm summer months.

All samples are transported to the Metropolitan Council Environmental Services laboratory and are analyzed according to Environmental Protection Agency (EPA) specified protocols for various endpoints. These endpoints include standard bacterial and chemical parameters. Quality assurance and quality control samples are reviewed annually using MPCA established data quality objectives. At the end of every sampling season, all chemistry data are entered into the MPCA's Environmental Data Access system (<http://www.pca.state.mn.us/data/edaWater/index.cfm>) and the EPA's STORET database (<http://www.epa.gov/storet/dbtop.html>), where they are available for use by the MPCA for water quality assessments.

Recognizing that accurate flow data is an essential, but often overlooked, component of load calculations and future TMDL modeling efforts, great care is taken to ensure that VRMN flow measurements are producing the highest quality data possible. Staff carefully follow United States Geological Survey (USGS) established protocols for measuring flow (Buchanan, 1969). Additionally, staff have received field training from both USGS and MNDNR hydrologists to improve flow measurement techniques.

Macroinvertebrate and Habitat Monitoring

Prior to macroinvertebrate sampling or habitat assessments, a site visit was completed for each monitoring location. The primary purpose of each site visit was to ensure that sites were suitable for sampling and to identify sample reach lengths. Macroinvertebrate habitat was also documented during site reconnaissance so that all appropriate habitats were sampled when staff returned for macroinvertebrate sample collection, approximately one month later. Protocols for site reconnaissance were adopted from those specified by the MPCA (MPCA, 2009).

Dakota County Soil and Water Conservation District staff have been trained by the MPCA to ensure that procedures are being followed correctly and to make certain that macroinvertebrate data collected from this program can be used by the MPCA for future assessment purposes. Macroinvertebrate samples were collected following the MPCA Qualitative Multi-Habitat Sample (QMH) protocol (MPCA, EMAP-SOP4). All samples were collected during the MPCA specified macroinvertebrate index period (August 1st-September 30th).

The habitat assessments were completed by following the MPCA's Stream Habitat Assessment (MSHA) protocol (MPCA, 2007). Dakota County Soil and Water Conservation District staff have been trained by the MPCA to ensure that protocols are being used by DCSWCD staff appropriately.

Results and Discussion:

In addition to results from the Vermillion River Monitoring Network, data from the Metropolitan Council's Watershed Outlet Monitoring Program (WOMP) site, located on the Vermillion River in Hastings, are included to provide water quality data from the extreme eastern portion of the watershed. This site is labeled as VR WOMP in Figure 2. Dakota County Soil and Water Conservation District staff collected monthly low flow samples and event flow samples from this location, for the Metropolitan Council's monitoring program.

Results presented in the following graphs follow similar formats in that the graphs are generally constructed, reading left to right, in a west (upstream) to east (downstream) format. The western most site is located in Scott County, and the eastern most site is the Metropolitan Council's WOMP site, located in Hastings. Results include flow, precipitation, nutrient concentrations, pollutant yields, turbidity, *E. coli* (bacteria) concentrations, temperature, macroinvertebrate, and habitat monitoring data.

Water quality results are presented as an arithmetic or geometric mean and are compared against mean values for minimally impacted streams of the Western Corn Belt Plains ecoregion, published by the Minnesota Pollution Control Agency (MPCA) (McCollor and Heiskary, 1993). The Western Corn Belt Plains ecoregion was selected since the majority of the Vermillion River Watershed is

located within this ecoregion. Results are also compared against State Water Quality Standards (Minnesota Statute 7050) where appropriate. Stream temperature data are compared against optimal temperatures for adult brown trout (Bell, 2006).

Comparisons with ecoregion means and state standards are simple and are only intended to be used as a coarse method to identify water quality values exceeding normal regional ranges or water quality standards. These analyses are not intended to be the definitive determination of water quality impairments. Water quality assessments are completed routinely by the MPCA using more comprehensive processes and methods.

Flow and Precipitation:

Mean daily flow and precipitation data for the 2010 monitoring season are presented in Figure 6. Total April through October precipitation data from the VRMN weather station was 29.43 inches. According to National Weather Service (NWS) data, the 50 year average (1959-2009) for the same April-October period is 22.75 inches. As a result, flow values for 2010 far exceeded those observed in recent years. For comparison purposes, 2009 flow data for station VR803 are also included in Figure 6. Peak flow volumes for this station in 2010 were nearly an order of magnitude greater than peak volumes in 2009, and roughly twice as large as those observed in recent years.

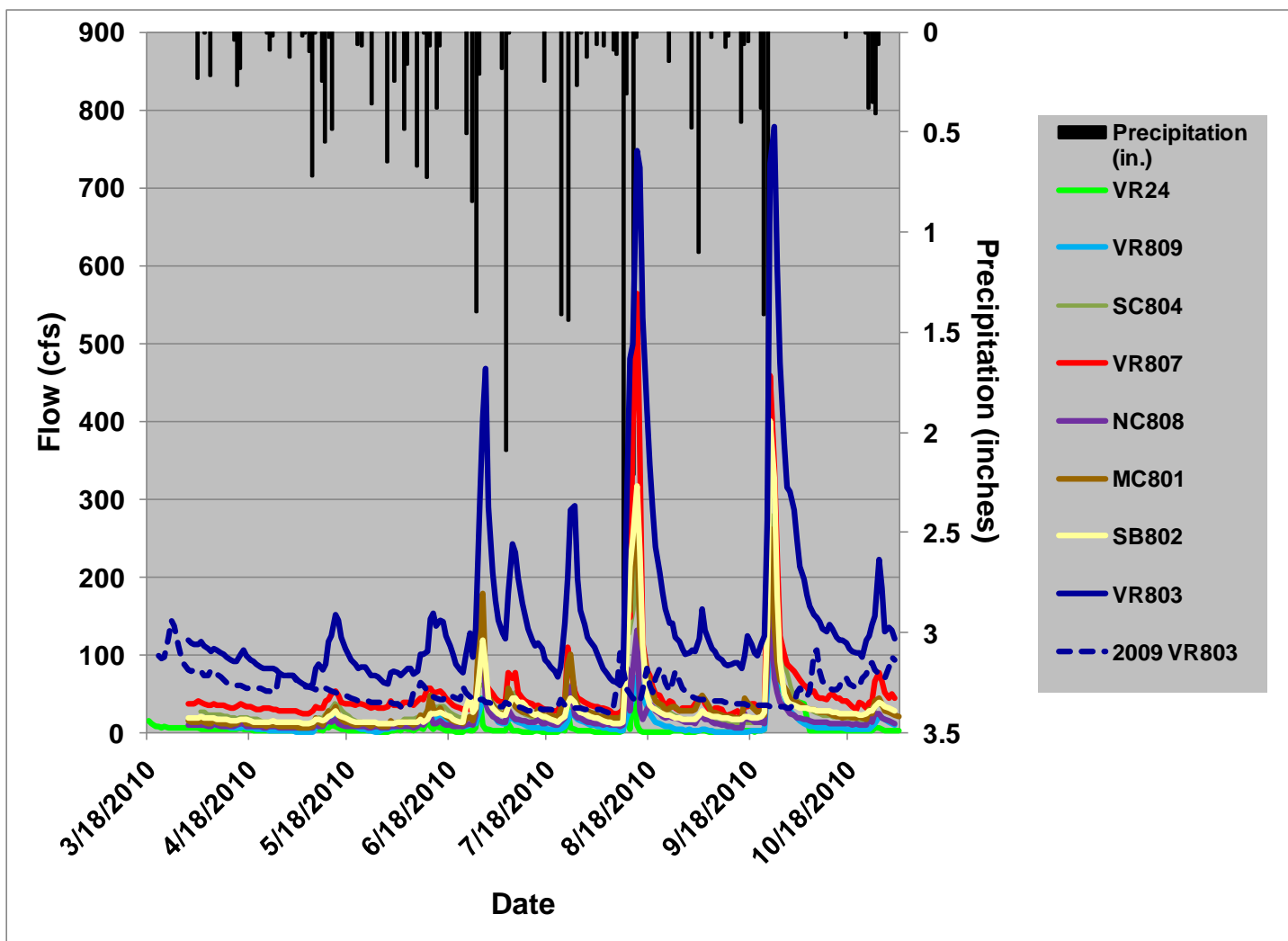


Figure 6. 2010 Vermillion River Monitoring Network Flow and Precipitation Results

Total Phosphorus

Total phosphorus is a commonly used indicator of overall water quality for surface waters and is included here for a similar purpose. Total phosphorus concentrations in 2010 (Figure 7) were generally low, but occasional event samples exceeded the Western Corn Belt Plains eco-region mean. Sites located closer to the Elko/New Market wastewater treatment plant (VR24, VR809) frequently had higher total phosphorus results than other monitoring locations. Site VR803, located in agriculturally dominated subwatershed, also had higher total phosphorus concentrations. Exceedences of water quality eco-region means at VR803 is likely the result of increased runoff in 2010.

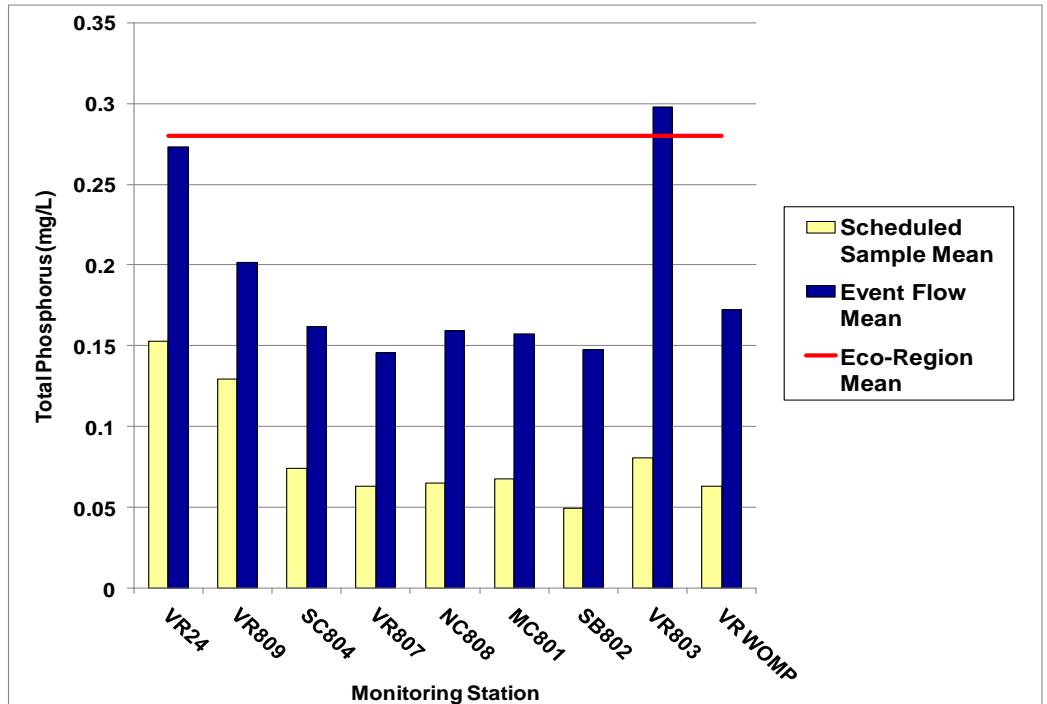


Figure 7. 2010 Mean Total Phosphorus Results

Historical total phosphorus results are presented in Figure 8. Empire wastewater treatment plant (located upstream from site VR803) upgrades and effluent re-routes appear to have dramatically reduced total phosphorus concentrations at the VR803 site. Higher concentrations at sites VR24 and VR809 may be due to their proximity to the Elko-New Market wastewater treatment plant. Discharge from this plant is expected to be re-routed to the Mississippi in the near future. In general, 2010 total phosphorus concentrations are similar to what has been observed in the historical record.

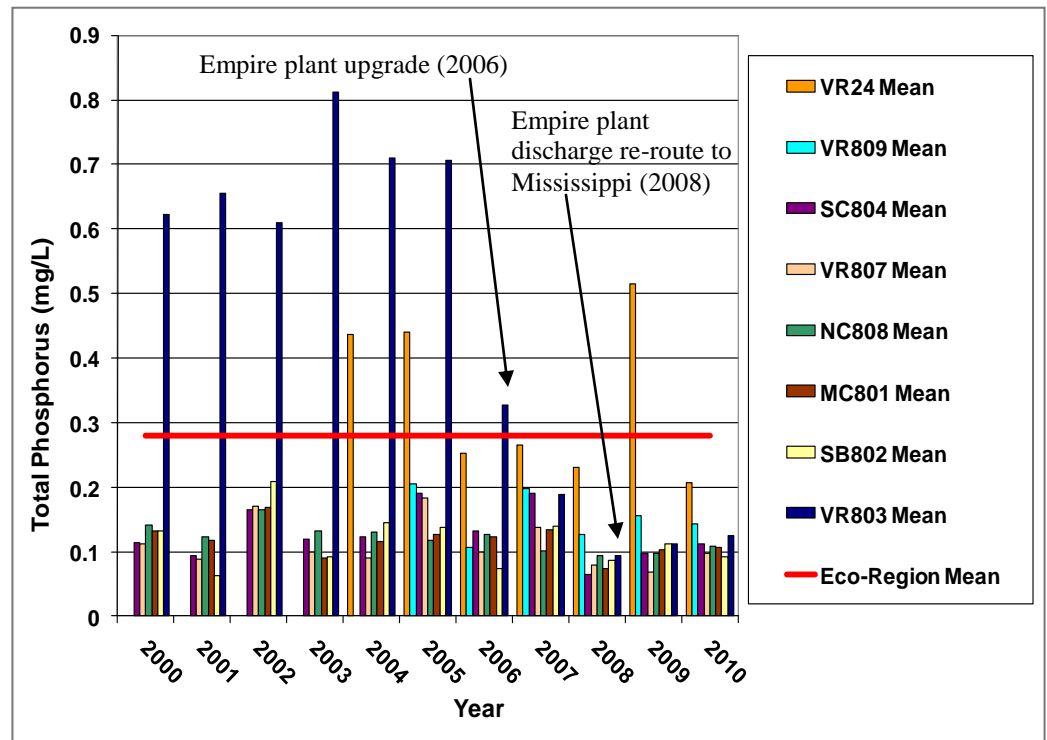


Figure 8. Historical VRMN Total Phosphorus Results

Nitrates

Mean nitrate concentrations in 2010 were well below the cold water nitrate standard of 10 mg/L. However, scheduled sample or low flow concentrations at site SB802 frequently exceeded the eco-region mean. Higher concentrations at the SB802 site may be the result of a combination of nitrate sources including agricultural runoff and various groundwater inputs.

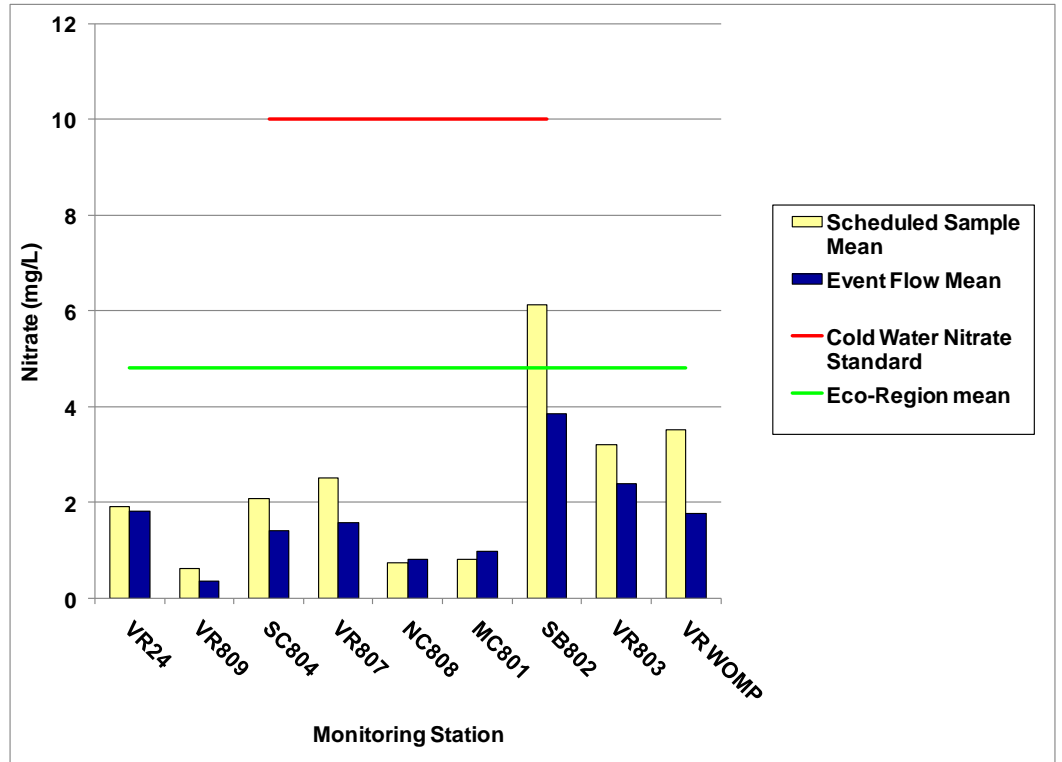


Figure 9. 2010 Mean Nitrate Results (Cold water nitrate standards apply only to stations on the trout stream portion of the Vermillion River-SC804, VR807, NC808, MC801, SB802)

When 2010 nitrate concentrations are plotted against historical annual mean concentrations, a few general trends begins to emerge. Since 2006, mean nitrate concentrations have consistently been highest at the SB802 monitoring site (Figure 10). This is likely the result of a chronic source of nitrates in the South Branch sub-watershed. Since 2010 was a relatively wet year, it is somewhat surprising that mean nitrate concentrations at the SB802 site are not lower than those observed in drier years (2009). Concentrations at the VR803 site have continued to decrease since a peak in 2003. Wastewater treatment plant improvements and the eventual re-routing of the Empire wastewater treatment plant discharge are most likely responsible for the observed reduction in nitrate concentrations here.

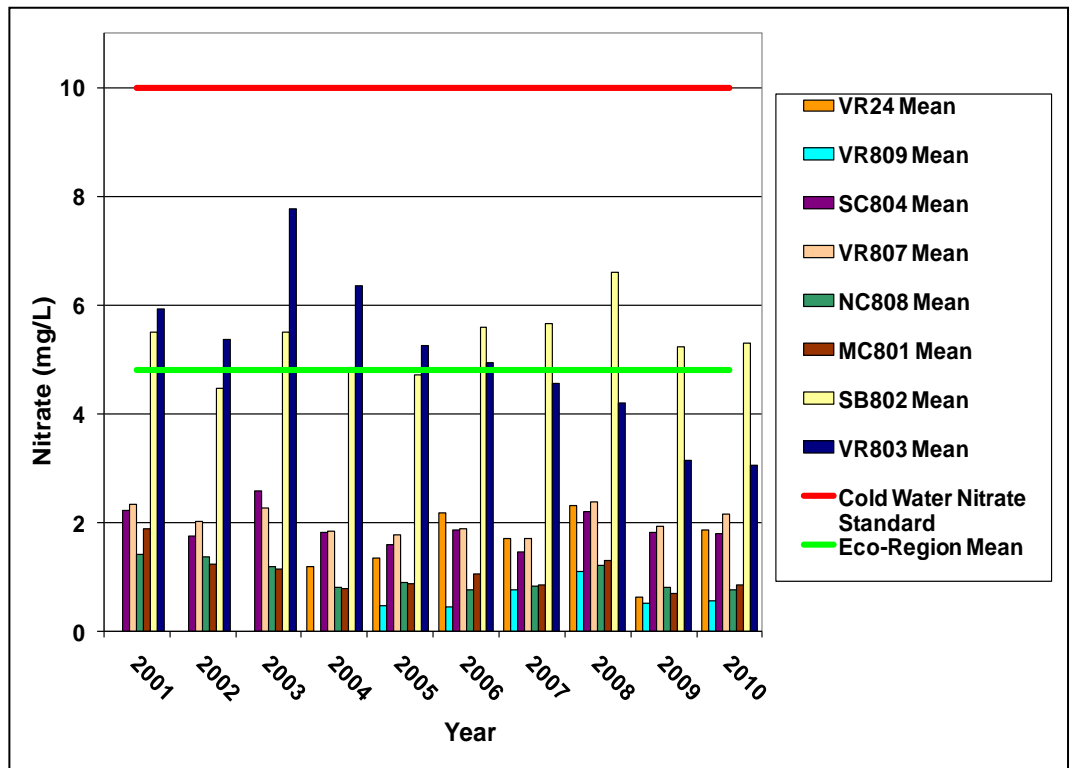


Figure 10. Historical VRMN Nitrate Results (Cold water nitrate standards apply only to stations on the trout stream portion of the Vermillion River-SC804, VR807, NC808, MC801, SB802)

Turbidity

Turbidity results in 2010 were mixed throughout the watershed (Figure 11). Mean event flow conditions at stations located within the trout stream designated portion of the river often exceeded the state turbidity standard. Furthermore, individual sample results for sites SC804, VR807, MC801, and SB802 exceed the state standard and may constitute an expansion of the current turbidity impairment into these reaches. Precipitation amounts in 2010 were well above the 50 year average and are likely the cause for this apparent increase in turbidity within the watershed.

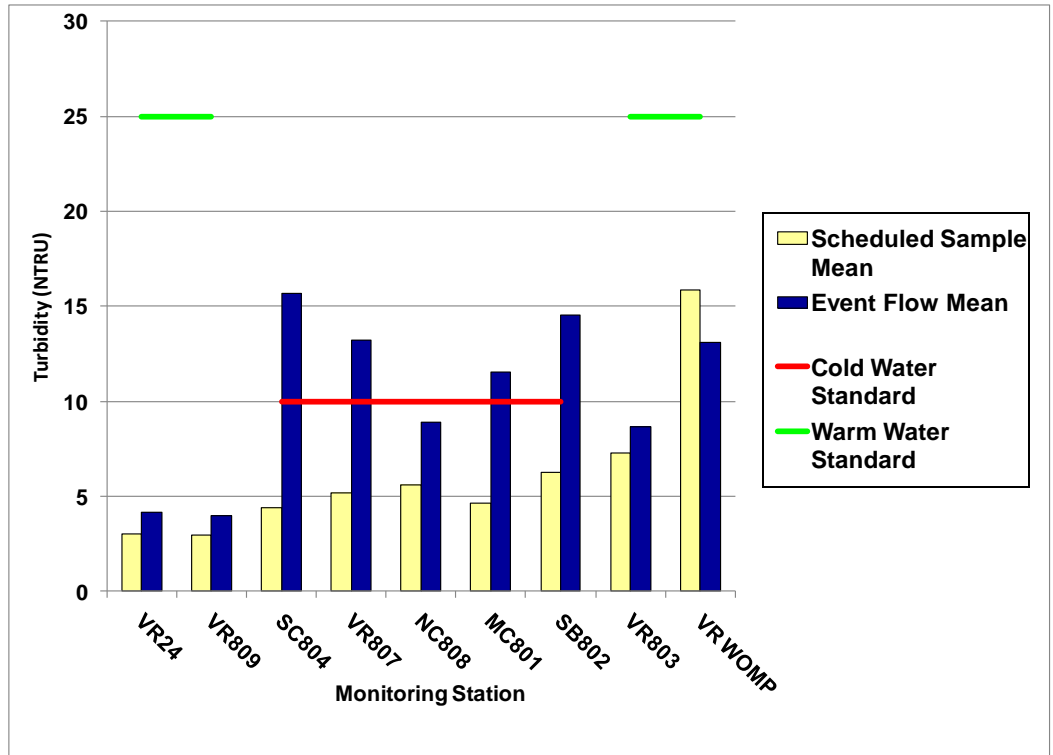


Figure 11. 2010 Mean VRMN Turbidity Results (Cold water turbidity standards apply only to stations on the trout stream portion of the Vermillion River- SC804, VR807, NC808, MC801, SB802)

Mean turbidity results are variable over the period of record (Figure 12). Despite increased precipitation amounts, the 2010 results appear to suggest that turbidity conditions were similar to what has been observed in recent years. However, it should be mentioned that an important change to the VRMN sampling strategy was implemented in 2009. Since then, efforts have been made to collect samples from more typical water quality conditions and less focused on event samples. In general, this has resulted in lower mean turbidity results since 2009. However several individual results from 2010 greatly exceeded state standards, due in part to large rain events in 2010.

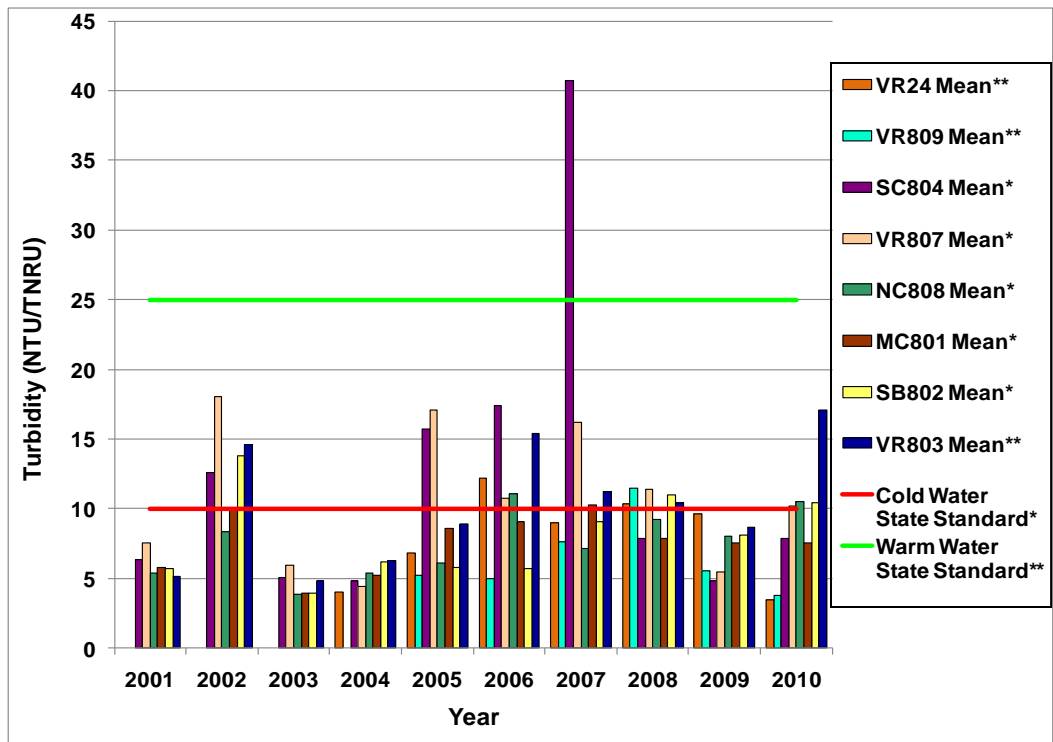


Figure 12. Historical Mean Turbidity Results

Escherichia coli

Geometric mean *Escherichia coli* concentrations for 2010 within the Vermillion River Watershed continue to exceed the state standard (Figure 13). Precipitation event samples produced the highest results. This is expected, since heavy precipitation tends to carry bacteria off of the landscape and into the river. Possible explanations for elevated *E. coli* results include septic system discharge, agricultural runoff, livestock in streams, urban runoff, and re-suspension of bacteria in the sediment.

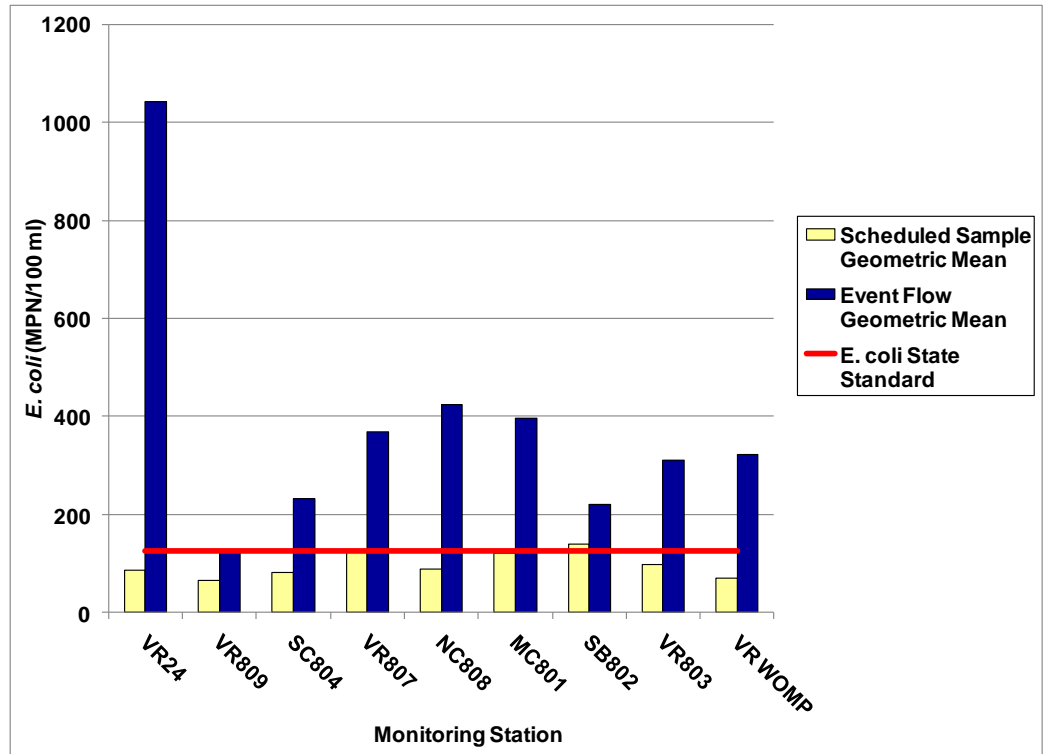


Figure 13. 2010 Geometric Mean *E. coli* Results

Pollutant Yields

Nitrate and total suspended solids (TSS) pollutant loads were calculated using the FLUX stream load computation tool (Walker, 1999) for the 2010 monitoring season (March-November), for each monitoring station and/or associated tributary (Figure 14). A pollutant load is the total mass of a particular pollutant that flows through a monitoring station over a given period of time. Calculated loads are then divided by the area of the associated sub-watershed for each monitoring station/tributary to provide a pollutant load per acre or a pollutant yield. This type of analysis allows for a comparison of pollutants produced per unit area, regardless of total watershed size, among various sub-watersheds.

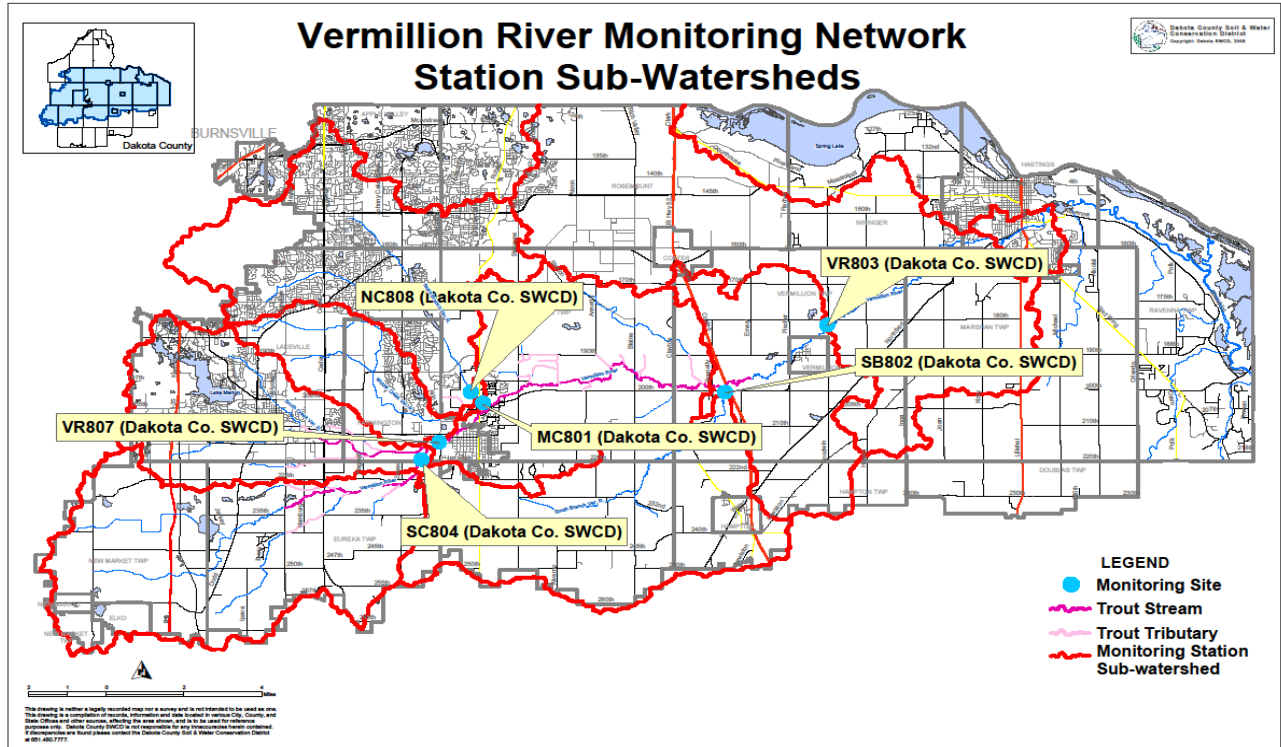


Figure 14. Monitoring Site Sub-Watersheds

Nitrate yields for 2010 were highest for the South Branch Vermillion River sub-watershed. Actual values are listed in Figure 15. The South Branch sub-watershed, which is of similar size and similar land use as the sub-watershed monitored at 220th Street (SC804), produced pollutant yields roughly four times larger than the yield at 220th Street.

Surprisingly, the South Creek sub-watershed produced the second highest nitrate yields within the watershed. Expanded monitoring may be needed to help identify sources of nitrates within this sub-watershed.

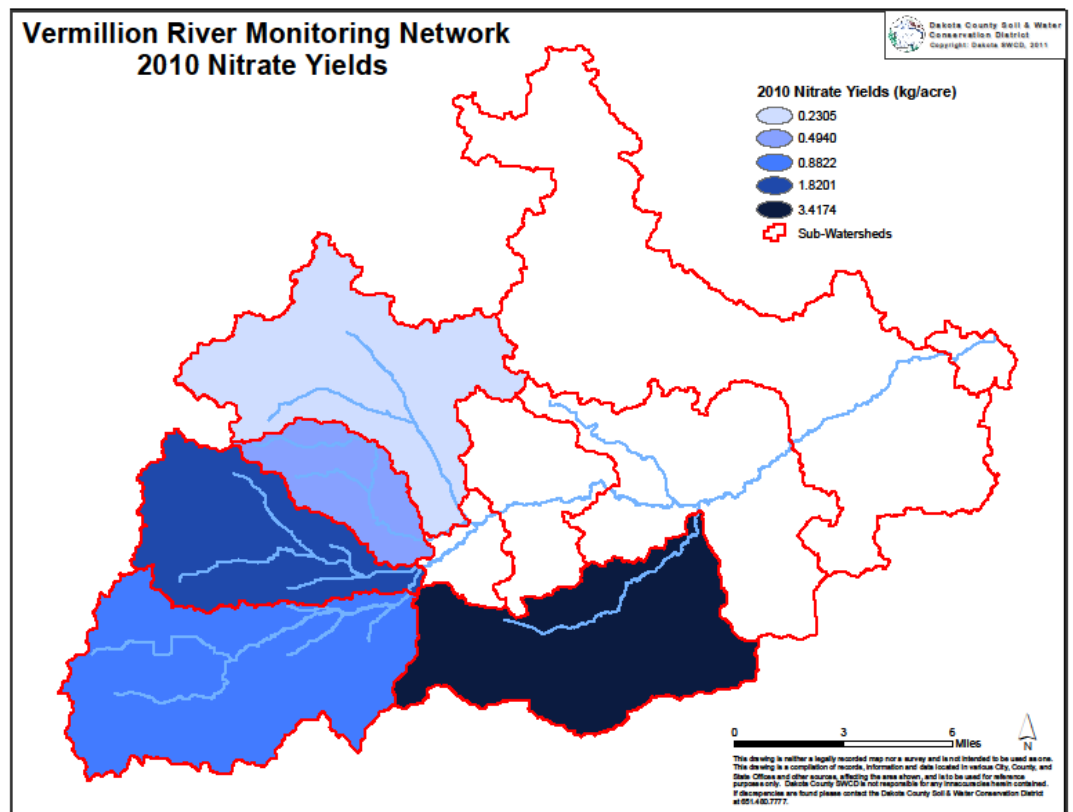


Figure 15. 2010 Nitrate Yields

Total suspended solids (TSS) yields for 2010 were highest in the South Creek sub-watershed, followed closely by results from the South Branch sub-watershed. Actual values for all sub-watersheds are listed in Figure 16. The results from South Creek are somewhat surprising, since much of this watershed is developed and stable. Additional monitoring may help describe sources of TSS in this watershed. Potential TSS sources include urban development, agricultural runoff, and bed load.

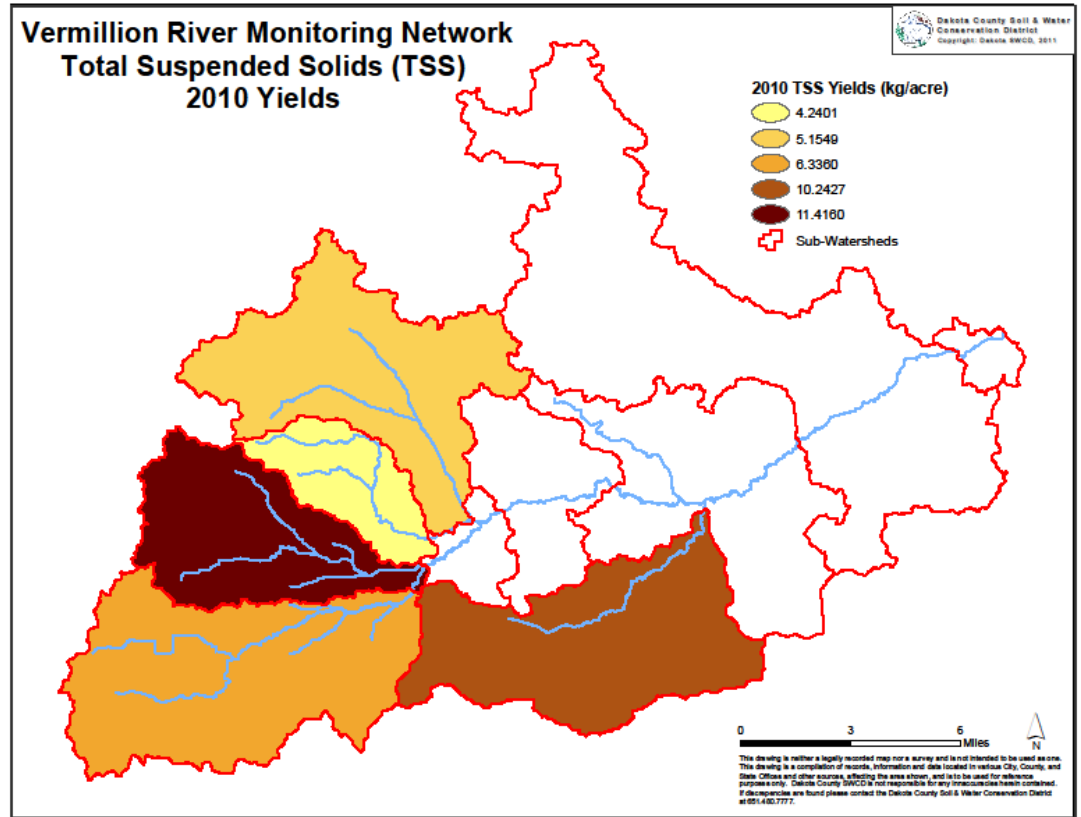


Figure 16. 2010 TSS Yields

Temperature

The Minnesota Department of Natural Resources (MNDNR) has been very active in monitoring stream temperatures in the Vermillion River Watershed. Since 2005, the DCSWCD has been assisting the MNDNR with temperature monitoring to help delineate the trout stream designation on the Vermillion River. In addition, the VRWJPO was awarded an EPA Targeted Watershed Grant in 2005 to identify and describe the way in which groundwater and anthropogenic inputs are influencing the temperatures of the Vermillion River. The current stream temperature monitoring network has been developed and expanded from these initial temperature monitoring studies to comprehensively monitor temperature throughout the watershed. The limited results presented here are only from temperature monitoring sites immediately adjacent to VRMN permanent water quality/quantity monitoring stations.

Automated temperature loggers were placed at each of the VRMN stations, and water temperature was recorded at 15-minute intervals. Mean temperatures for the period of June 2nd through September 2nd were plotted and are shown in Figure 17. Results from 2010 are plotted adjacent to 2005, 2006, 2007, 2008, and 2009 temperatures for the same reference period. According to a recent literature review, the adult brown trout chronic (long-term) exposure temperature limit is approximately 64° F (Bell, 2006). Mean temperatures at most monitoring stations in 2010 were near or slightly above this threshold. However, mean temperatures at sites NC808 and MC801 were higher in 2010 than in any other time within the period of record. This is likely a reflection of increased precipitation in the watershed. As precipitation increases, the temperature “signal” of cold groundwater in the watershed is reduced.

Mean temperatures generally appear lower in 2005, 2007, and 2008. This is likely the result of numerous large construction de-watering projects in the Middle and North Creek area. De-watering projects remove cool groundwater and discharge those waters to area streams. In addition, low precipitation amounts in 2009 increased the apparent effect of cold groundwater on stream temperatures and likely accounts for cooler mean temperatures in 2009. It should also be noted that the temperature logger at site VR809 is frequently out of the water during summer months, and as a result, the reported mean temperature is based on a smaller dataset than at other sites. This site appears to be located very near the surface water/ground water interface and frequently runs dry during a typical monitoring season.

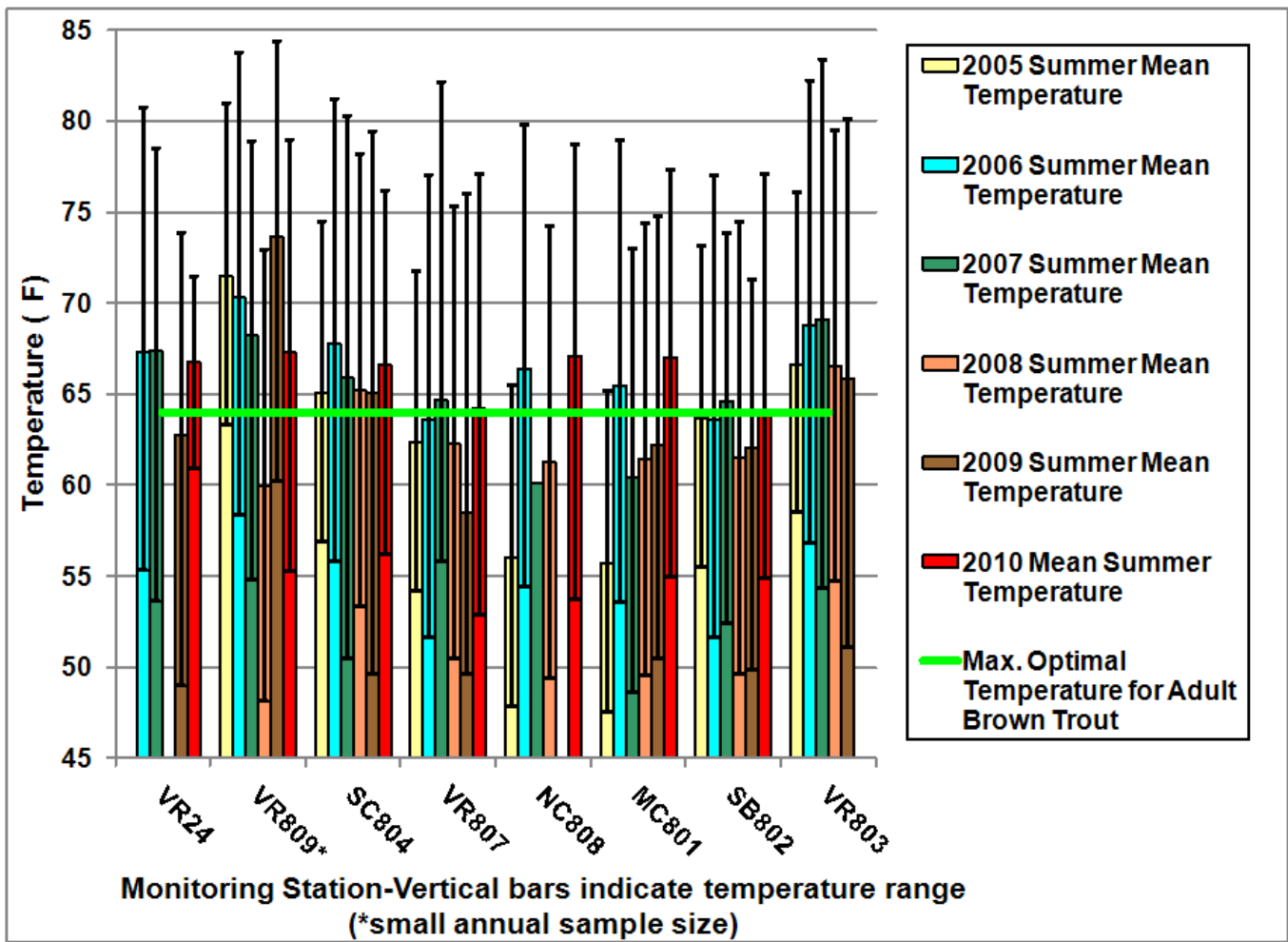


Figure 17. Historical Temperature Monitoring Results

Macroinvertebrate/Habitat Monitoring

Although biological stream monitoring is becoming a widely accepted method for assessing stream health, analysis of these results can be challenging. Typically, biological results are described using a well established and validated summary called an index of biological integrity (IBI), where individual components of the biological community, or metrics, are counted and summarized to provide an index score. Using indices specific to certain types of water resources located in similar geographical areas allows for direct comparisons of biological communities from different water resources.

In recent years, the MPCA has begun creating indices for various portions of the state. However, a macroinvertebrate/habitat index has not yet been created for the portion of the state where the Vermillion River Watershed is located. Therefore, using best professional judgment, we have selected several widely utilized metrics and indices used for measuring biological health throughout the state. Unfortunately, results from these metrics cannot be compared to other watersheds and are likely only useful for comparing biomonitoring sites within the Vermillion River Watershed. Sites monitored for macroinvertebrates and habitat can be found on Figure 5. Site A15 is a new warm water monitoring location that was added in 2010.

Family Biotic Index

A commonly used index for measuring macroinvertebrate community biological health is the Family Biotic Index (FBI) (Hilsenhoff, 1987). This index assigns an organic pollution tolerance value to each macroinvertebrate taxa and quantifies the number of each taxa present in a sample to provide an index score. This index may also be sensitive to thermal pollution (Hilsenhoff, 1998). A lower FBI index score is indicative of more organic/thermal pollution intolerant taxa, and higher water quality.

Sites with the lowest 2010 FBI scores were A06 and A05 respectively (Figure 18). These sites fall within the “Very Good” water quality category of the Hilsenhoff Water Quality Classification table (Table 3). The site with the highest FBI scores was site A15. This site falls within the “Poor” range of the water quality classification table.

The 2010 FBI scores reflect a similar pattern of monitoring results when compared against 2009 data. This early data suggests that sites are relatively static and should be appropriate for obtaining long-term macroinvertebrate data. However, FBI results for sites A02, A03, A05, A10, and A12 were substantially improved for 2010 monitoring efforts. It is possible the increased precipitation amounts in 2010 reduced the frequency of stagnant water conditions developing within the watershed. Faster moving flow through the watershed may have increased dissolved oxygen concentrations. In addition, an increase in water quantity likely increased the amount of wetted area along stream banks and increase the availability of habitat for macroinvertebrates. Changes to these factors may account for the observed improvement in certain FBI scores.

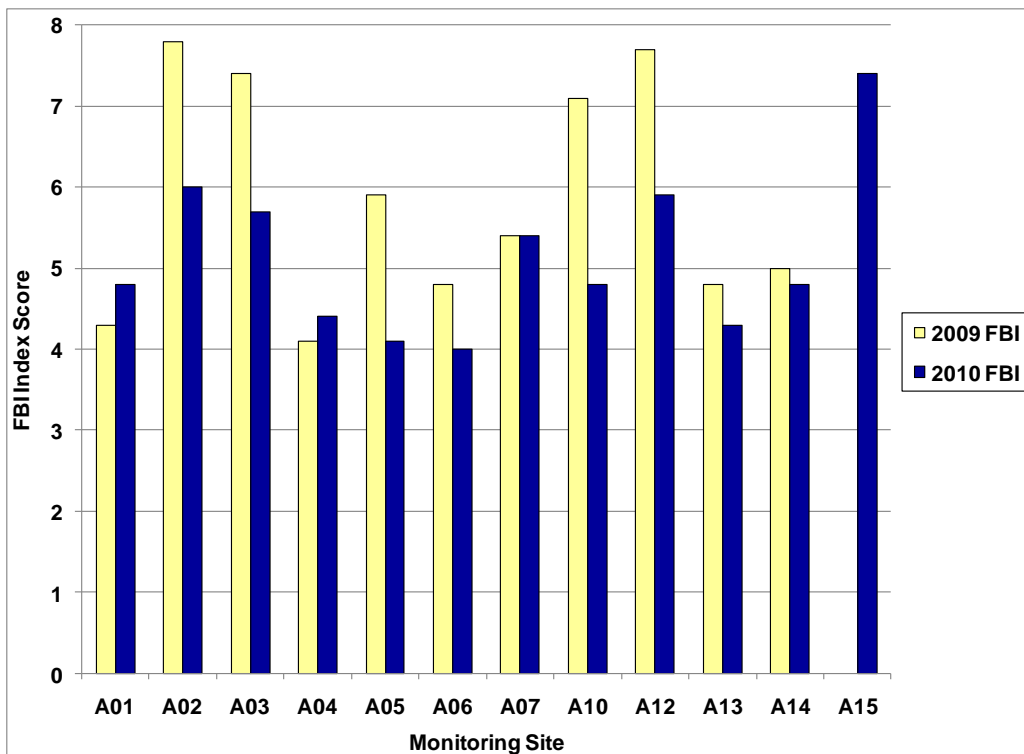


Figure 18. 2010 VRMN Family Biotic Index Scores

FBI Score	Water Quality	Degree of Organic Pollution
0.00-3.50	Excellent	No apparent organic pollution
3.51-4.50	Very Good	Slight organic pollution
4.51-5.50	Good	Some organic pollution
5.51-6.50	Fair	Fairly significant organic pollution
6.51-7.50	Fairly Poor	Significant organic pollution
7.51-8.50	Poor	Very significant organic pollution
8.51-10.00	Very Poor	Severe organic pollution

Table 3. Hilsenhoff Water Quality Classification Table

Percent Tolerant Macroinvertebrate Taxa

Using tolerance values developed for use with the FBI, directly quantifying pollution tolerant and intolerant taxa is another method for evaluating macroinvertebrate community health. A low percent tolerance score is indicative of less organic pollution and higher water quality.

Sites with the smallest percentage of pollution tolerant taxa were A05 and A13 respectively (Figure 19). Sites with the highest percentage of pollution tolerant taxa were A15 and A2.

Lower percentages of pollution tolerant taxa in 2010 may be due to increased volume and fewer occurrences of stagnant conditions and an increase in available habitat for macroinvertebrates.

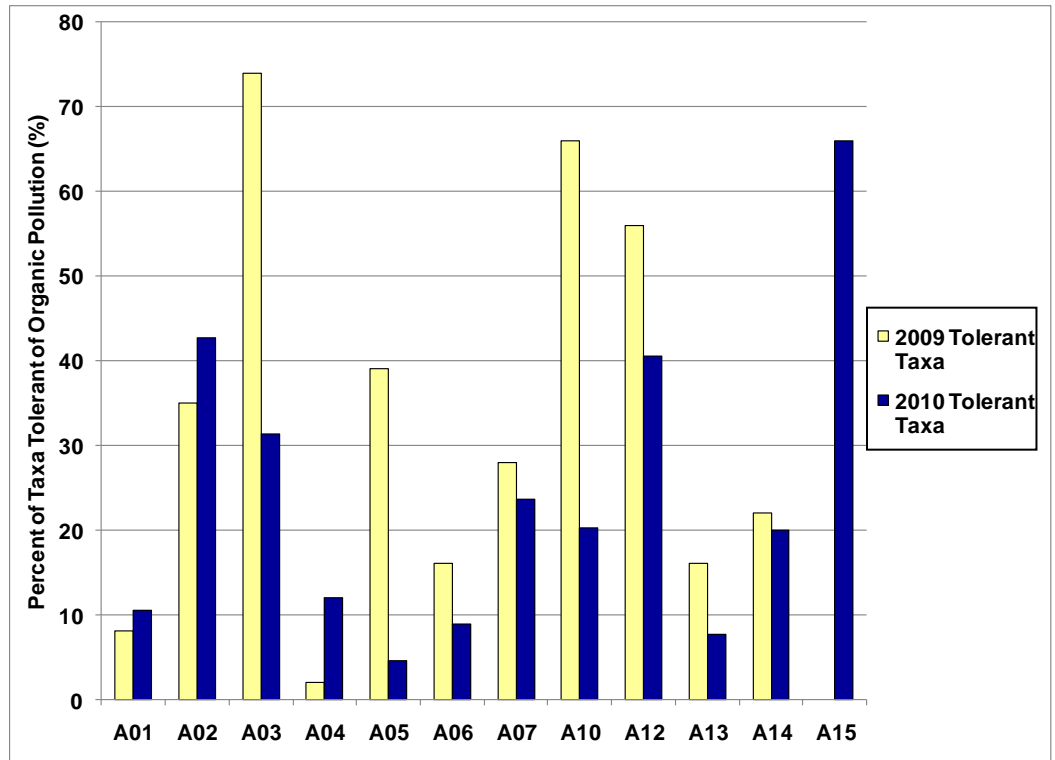


Figure 19. 2010 VRMN Percent Tolerant Macroinvertebrate Taxa

Macroinvertebrate Taxa Richness

Diversity of macroinvertebrate taxa is often considered a simple measurement of high water quality and desirable macroinvertebrate habitat. Samples with more macroinvertebrate diversity may have higher water quality and/or habitat more suitable to support a diverse population of macroinvertebrates.

Sites with the highest taxa diversity were A12 and A07 respectively (Figure 20). Sites with the lowest taxa diversity were sites A01 and A10.

In general, taxa diversity in 2010 was lower than observed in 2009. This may be the result of increased flow which could remove certain macroinvertebrate groups less well adapted to higher flow streams (“swimmer” and/or “sprawler” taxa).

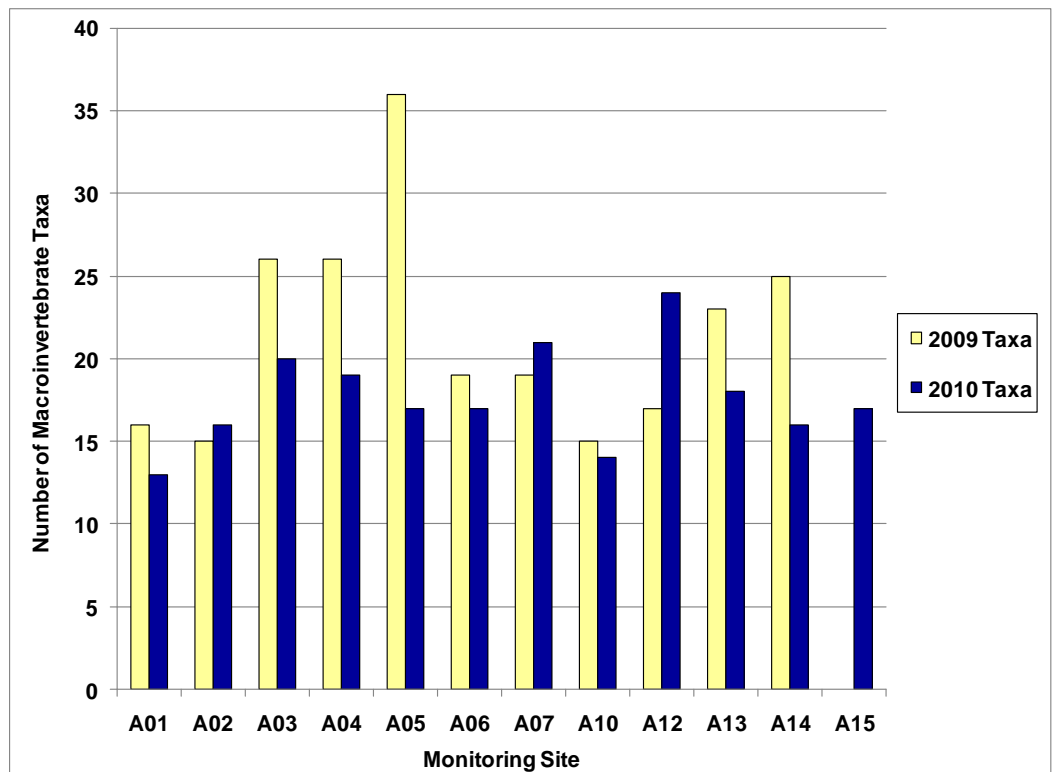


Figure 20. 2010 VRMN Macroinvertebrate Taxa Richness

Macroinvertebrate EPT Taxa

The number of Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa in a macroinvertebrate sample is another common macroinvertebrate metric used in many indices. These taxa are sensitive to low dissolved oxygen levels, and high concentrations of organic pollution. Sites with the highest EPT scores are thought to have the highest water quality or habitat characteristics (Figure 21).

The sites with the highest number of EPT taxa were sites A14 and A13 respectively. Sites with the lowest and equal numbers of EPT taxa were A01 and A15.

Surprisingly, the number of taxa was somewhat reduced in 2010 from 2009. This may be the result of increased organic pollution entering the waterways or may have removed macroinvertebrate groups less adapted to high flow conditions.

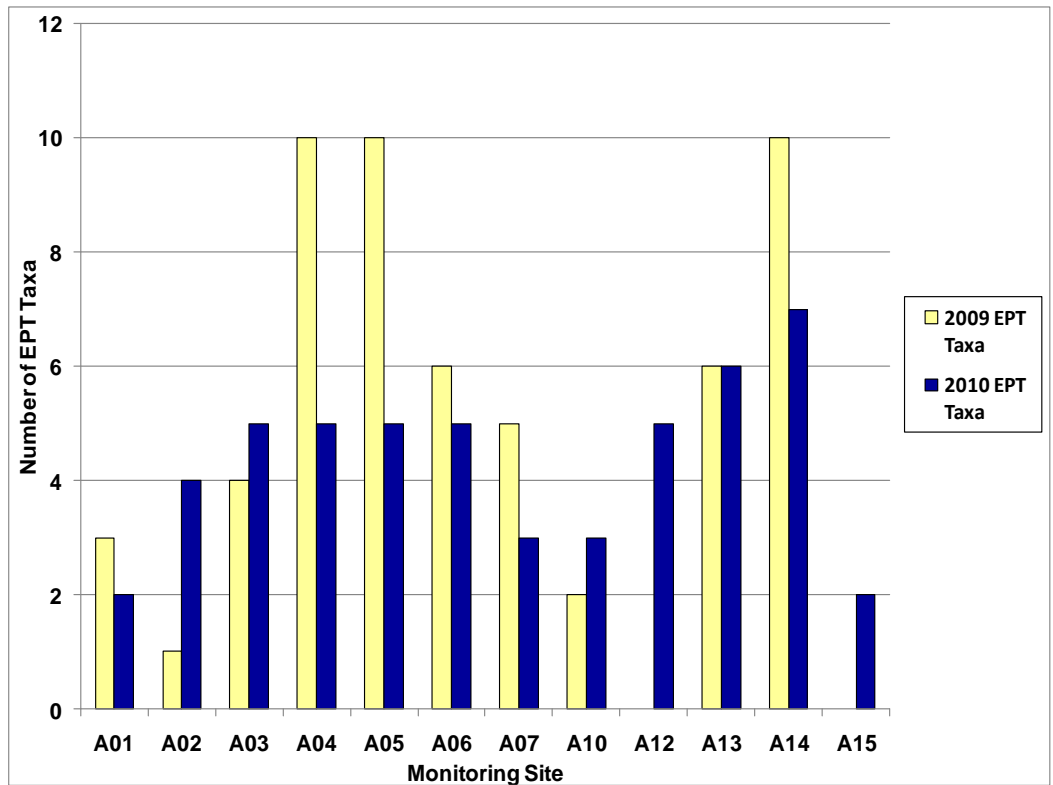


Figure 21. 2010 VRMN Macroinvertebrate EPT Taxa

Habitat Assessments

Habitat assessments were completed for each biological monitoring location using the MPCA’s Stream Habitat Assessment (MSHA). Total scores for the MSHA assessments are shown in Figure 22, which can be interpreted using the MPCA’s scoring table shown in Table 4.

Sites with the highest MSHA habitat scores, or the best habitat conditions, were A08 and A07 respectively. According to the MPCA’s scoring table, most sites received good habitat quality scores. Sites with the lowest MSHA scores were sites A10 and A09 respectively. The site A10 score suggests that habitat conditions are only fair. This is primarily due to excessive silt and poor fish cover observed in this reach.

Comparisons between the 2009 and 2010 MSHA results are somewhat concerning (Figure 22). Although 2010 was a high precipitation/volume year, it seems unlikely that habitat changed dramatically between the two years, as indicated by the results (A01, A04, A09, A10, A13, A14). This is likely a consequence of the somewhat arbitrary nature of the MSHA scoring protocol. It may be more useful to consider changes dramatic enough to shift a site’s score from one category to another (Table 4). Using this strategy, only sites A04, A10, and A13 seem to have changed substantially between monitoring seasons. Site A04 had much more volume in 2010, which resulted in many more riffles observed in previous years and a much higher habitat score. Site A10 was relocated slightly downstream in 2010 where the character of the habitat in this reach is dramatically different than observed in 2009. Site A13 indicated a significant improvement in conditions, but upon reviewing individual MSHA metrics, this may be the result of inconsistent scoring by the habitat evaluator.

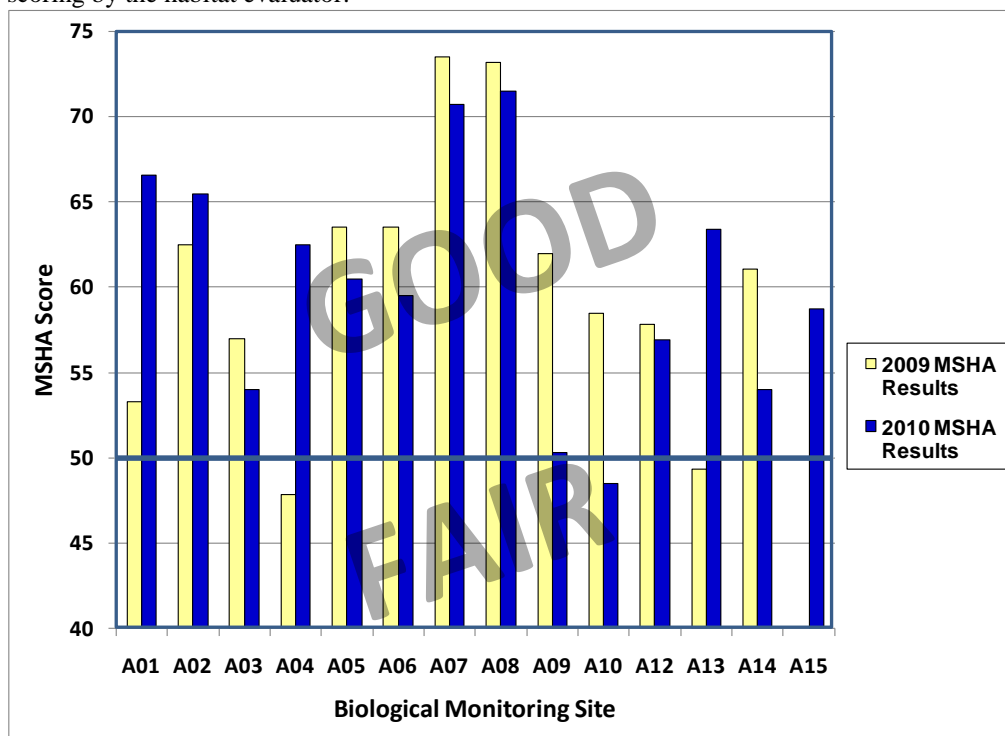


Table 4. MPCA MSHA Scoring Table

MPCA MSHA Habitat Score	Habitat Quality
75-100	Excellent
50-74	Good
25-49	Fair
0-24	Poor

Figure 22. 2009-10 VRMN MPCA Stream Habitat Assessment Results

Conclusions:

Chemistry

The 2009 monitoring strategy included a new emphasis on regularly scheduled grab samples, in addition to event grab samples, in an attempt to collect water quality data that most accurately reflects actual conditions in the Vermillion River Watershed. The 2009 results appeared to have captured this change in strategy, which also evident in the 2010 results. Many individual samples still exceeded state standards or eco-region means, but mean 2010 values were generally lower than historical averages.

Nitrate concentrations within the South Branch of the Vermillion River continue to be problematic. Nitrate concentrations at site SB802 remain substantially higher than anywhere else in the watershed. The source of these elevated levels still remains largely unknown. The VRWJPO may want to consider developing a strategy (increased incentives for conservation practices) to minimizing nitrate concentrations in the South Branch sub-watershed.

Pollutant Yields

Pollutant yields continue to reveal valuable information regarding the health of the watershed. The 2010 nitrate yields were highest in the South Branch of the Vermillion River. In fact, nitrate yields for the South Branch sub-watershed are roughly four times larger than nitrate yields for a sub-watershed of similar size and land use (SC804-220th St.) in the area. Further study to identify nitrate sources in South Branch of the Vermillion River sub-watershed may be warranted. Nitrate yields were surprisingly high in the South Creek sub-watershed as well. This may help explain poorer macroinvertebrate scores observed here (Figure 15/16). Additional chemistry data from this sub-watershed would be helpful in identifying nitrate sources within this watershed.

Total suspended solids pollutant yields were also unexpectedly high in the South Creek sub-watershed when compared against sub-watersheds of similar size and land use (SC804-220th St. and NC808-North Creek). Staff have observed that sediment substrates in sub-watersheds with higher TSS yields are predominately sand, while sediments in similar sub-watersheds, with lower TSS yields, appear to consist of more cobble and gravel materials. Although extensive sediment surveys have not been completed for the entire Vermillion River Watershed, it is possible that higher TSS yields are a consequence of sediment substrates dominated by sandy materials which may be re-suspended under higher flow conditions and captured in event samples. However, evidence for this explanation is anecdotal at best. Additional chemistry monitoring on South Creek may help identify TSS sources in this sub-watershed.

Macroinvertebrate Monitoring

Since the VRWJPO biological monitoring program has only been operating for two field seasons, it is very difficult to draw conclusions from 2010 results. However, results from the two years this program has been in operation are promising. Several interesting results can be observed in these results.

Despite the fact that 2009 was a relatively dry year and 2010 was a wetter year, the macroinvertebrate monitoring results are surprisingly consistent. Although the exact results vary between years, the general pattern seems to be approximately the same during the period of record. At a minimum, this suggests that conditions are not dramatically changing from year to year, despite large fluctuations in water level.

Sites A05 and A06 produced some of the best metric/index scores for macroinvertebrate monitoring sites for 2010. Other sites, which scored well in 2009, may have scored better had water levels been lower in 2010. It is possible that some of the monitoring sites were effectively “scraped clean” of more desirable macroinvertebrate taxa. However, the combined results of this monitoring effort suggest that the Vermillion River remains conducive to maintaining a healthy and relatively consistent macroinvertebrate community.

Sites A02 and A15 scored poorly for several of the metrics/indices used. This is the second consecutive year that site A02 has scored poorly, and may indicate that a macroinvertebrate stressor is present at this location. Pollutant yields also suggest that this location may be receiving higher nitrate and total suspended solids concentrations than expected. Site A15 also scored poorly, but this is likely a reflection of the surrounding landscape rather than a water quality/habitat issue. This portion of the watershed is flat and poorly drained. It is possible that this wide reach functions more as a wetland rather than a stream. These wetland characteristics likely account for poor macroinvertebrate results here.

Habitat Monitoring

Similar to what was observed for the macroinvertebrate results, the habitat results follow a similar pattern between 2009 and 2010. This suggests that evaluation techniques are consistent from year to year and that habitat is not changing substantially in this timeframe. Most sites scored in the “good” range, and only site A10 scored within the “fair” range. Based on these results, habitat within the Vermillion River Watershed should be considered good with only minor changes taking place between these two monitoring years.

2011 Monitoring Suggestions:

- Continue with 2010 monitoring strategy; bi-weekly grab samples and storm event grab samples.
- Make minor modifications to the Vermillion River Monitoring Network by moving stations VR807 and SC804 to more stable monitoring locations, as per recommendations made by the MNDNR (L. Pearson, personal communication-5/6/10).
- Discontinue monitoring at VR809, due to ephemeral flow, and relocate this station to South Creek.
- Continue turbidity monitoring at VR807 and SC804, in preparation for the upcoming Vermillion River turbidity TMDL.
- Utilize new MPCA macroinvertebrate indices to evaluate macroinvertebrate results, as they become available.
- Consider funding a more detailed and rigorous trend analysis of VRMN data.

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