

Rouge River Water Quality – A Decade of Progress

Colleen Hughes, CDM, Ann Arbor, MI

Kelly Cave, Wayne County Department of Environment, Detroit, MI

Joe Rathbun, Michigan Department of Environment Quality, Lansing, MI

Chris Catalfo, Applied Science, Inc., Detroit, MI

Introduction and Methods

The Rouge River basin is an urban/suburban watershed of 48 communities that drains 1206 km² (466 square miles) of southeastern Michigan and discharges into the Detroit River. The Rouge suffers from typical urban watershed stressors including discharges from combined sewer overflows (CSOs), sanitary sewer overflows (SSOs), non-point sources, limited industrial discharges, contaminated sediments and high flow variability. These factors have resulted in public health advisories for fish consumption and water recreation, poor biotic communities, impoundment eutrophication, and damage to the stream channel morphology.

The Rouge River National Wet Weather Demonstration Project (Rouge Project), funded by the U.S. Environmental Protection Agency (U.S. EPA) through Wayne County's Department of Environment, was initiated in 1992 to address impairments. The project implemented an intensive monitoring program to assess existing conditions, identify primary pollution sources, and track long-term trends. Components of the program include continuous monitoring of dissolved oxygen (DO), water temperature, stream flow, rainfall (15-minute intervals), intermittent dry and wet weather water quality sampling, and periodic assessments of the trophic status of major impoundments, stream geomorphology, sediment quality, and macroinvertebrate populations.

Various projects have been undertaken to reduce pollution from CSOs (construction of retention treatment basins and sewer separation projects) and from non-point sources (reduction of the use of pesticides, herbicides and fertilizers, elimination of on-site disposal systems, illicit discharge elimination programs, etc.). Since a primary objective of the Rouge Project monitoring program is to evaluate the effectiveness of implemented watershed management activities by assessing improvements, an analysis of water quality

trends was conducted to evaluate long-term changes using data collected over the last decade (1994–2003).

Data Analysis

The analysis was performed on two important water quality constituents that were a significant problem in the Rouge Watershed, dissolved oxygen (DO) and *E. coli* bacteria. The trend tests used linear regression to quantify changes in water quality over time. Tests were run for wet and dry weather data collectively and independently, using average concentrations and the percent greater than 5 mg/L for DO and the percent less than 1,000 colony forming units/100 ml for *E. coli* (Michigan's partial body contact standard).

Dissolved oxygen trend analysis included all locations where continuously monitored data were available and included any grab DO sampling records that were available for those locations. A total of 52 sampling locations were included. Regression analysis plots and trend tests were used to detect changes in DO and *E. coli* levels over time.

A trend is defined as an increasing or decreasing change over time. Trend tests calculate an average trend statistic, indicating the magnitude of the change, and a probability statistic (P), indicating the certainty of the trend. For assessment purposes, trend analysis results were ranked as increasing, potentially increasing, none (no statistically significant trend), potentially decreasing, and decreasing based on the following criteria:

- Increasing = increasing trend with $P \leq 0.05$,
- Potentially increasing = increasing trend with $P > 0.05$ and ≤ 0.20 ,
- No statistically significant trend = $P > 0.20$,
- Potentially decreasing = decreasing trend with $P > 0.05$ and ≤ 0.20 , and
- Decreasing = decreasing trend with $P \leq 0.05$.

Improvement in water quality is indicated by increasing trends in average DO, percent DO greater than or equal to 5 mg/L, and *E. coli* less than or equal to 1,000 cfu/100ml and decreasing trends in average *E. coli*.

Several factors must be considered when interpreting the results of this study. Since all locations were not sampled all years during both dry and wet conditions, many locations have inadequate data for detecting statistically valid trends over the time period when watershed management activities were implemented. It should also be noted that the magnitude of the trend statistic is relative to the baseline condition for each site. For example, a site that had good water quality to begin with is unlikely to show much of an improving trend as water quality approaches pristine conditions. Similarly, it is important to recognize that the average trend statistic is representative of the period of available data and not necessarily a prediction that water quality will continue to change at the same rate in the future.

Results

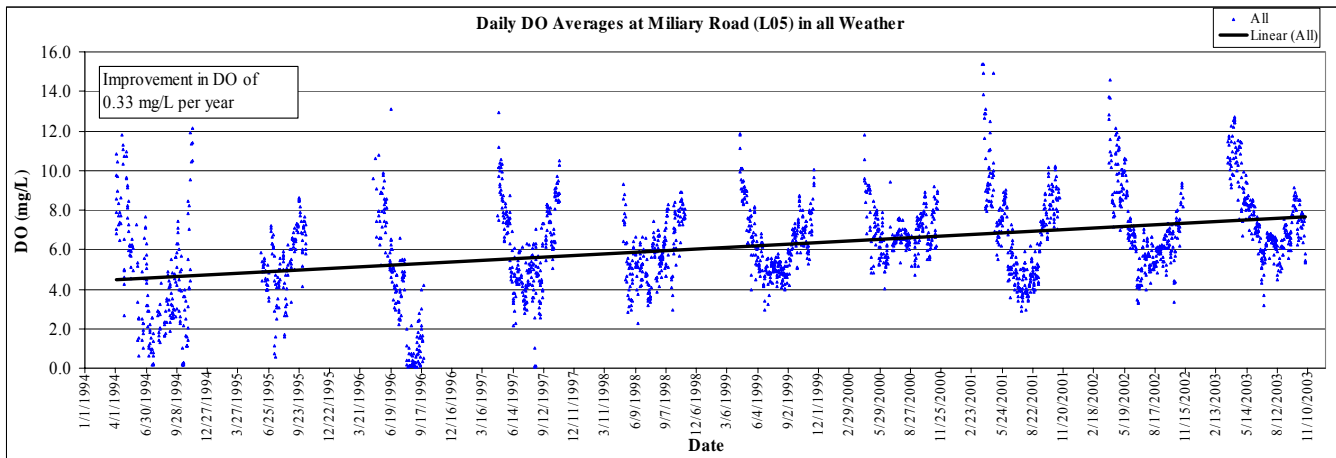


Figure 1 - Daily Average Dissolved Oxygen at Military Road (L05) - 1994-2003

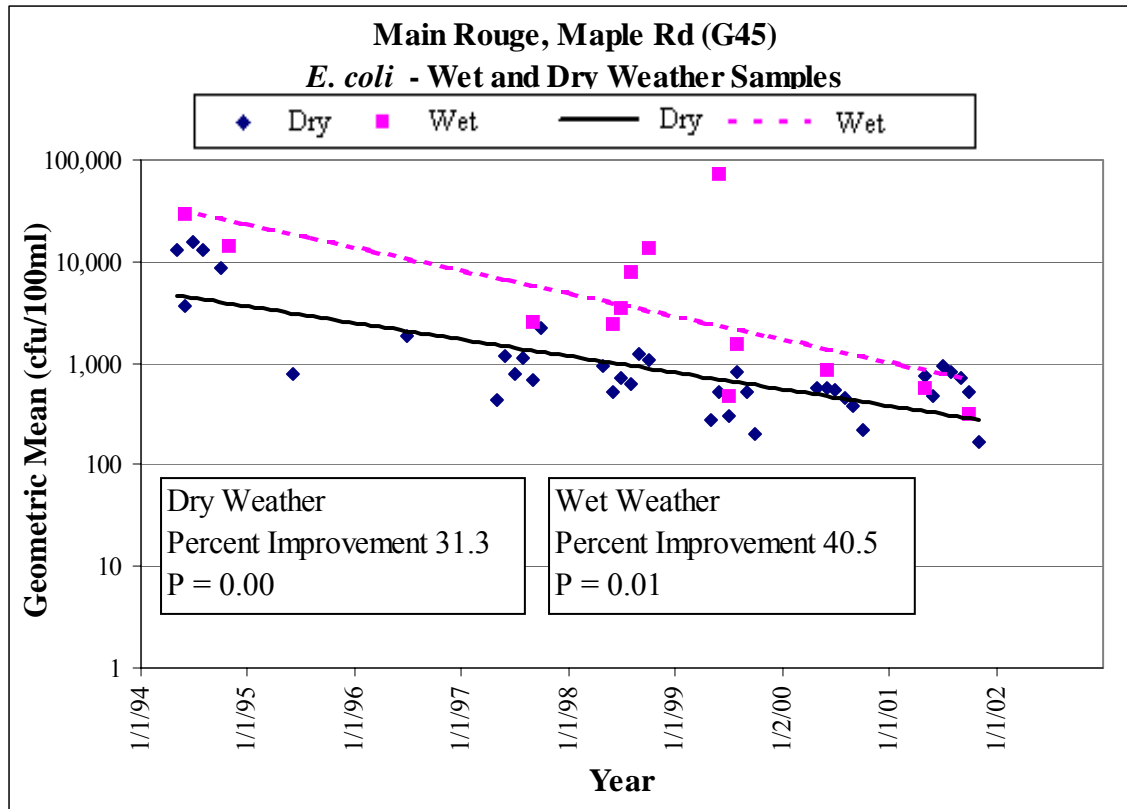


Figure 2. *E. coli* - Dry and Wet Weather Samples, 1994-2002.

Dissolved oxygen

Trend analysis results clearly demonstrate that DO concentrations are improving in the Rouge River Watershed during both wet and dry weather conditions (Figure 1). Eight of nine locations show a statistically significant improving trend for the mean DO with the average annual improvement ranging from 0.09 to 0.53 mg/L per year. The ninth location (Rotunda Drive) is the furthest downstream DO monitoring location in the watershed and is influenced by many still uncontrolled CSO outfalls. This location has been monitored for the past three years and reports no statistically significant trend.

Figure 3 compares the percent of the time the state water quality standard of 5 mg/L was met for DO at the beginning of the project and more recently. There was a dramatic improvement, with seven of the eight locations meeting the State standard over 95% of the time in 2003. Daily average DO trend results show similar improvement with all

locations showing an improvement or no trend as summarized in Figure 4. Locations with no statistically significant trend are not shown.

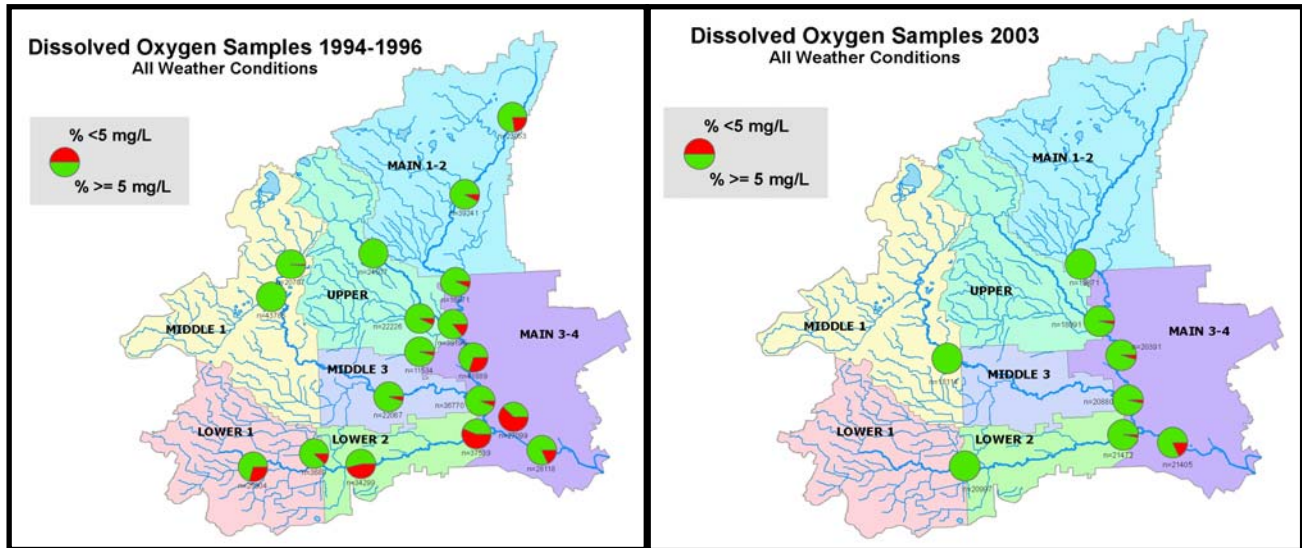


Figure 3. Achieving the state dissolved oxygen water quality standard: Comparison of dissolved oxygen levels in 1994-1996 with levels in 2003.

E. coli

E. coli trend analysis results generally showed improvement directly downstream of most watershed management activities, particularly downstream of now controlled CSO outfalls during wet weather (Fig. 2). Substantial improvement is occurring at some locations; many locations are showing little to no change; and some locations may be getting worse. Figures 5 and 6 summarize the geometric mean results spatially and in relation to the CSO control activities performed within the watershed for dry and wet weather conditions, respectively. More improvement is clearly being observed during wet weather conditions, suggesting that CSO control projects have resulted in substantial water quality improvements. Most of the potentially degrading conditions during dry weather appear to be in either the headwaters where residential and commercial development are generally expanding or in areas where CSO outfalls are still uncontrolled. Although conditions are improving, most locations are still not meeting State water quality standards for *E. coli* total or partial body contact recreation.

Summary and Conclusions

In an effort to evaluate the effectiveness of watershed management activities implemented in the Rouge River Watershed, water quality trends were evaluated using DO and *E. coli* data collected from 1994 through 2003. Results show that DO conditions have improved markedly throughout the watershed over the past decade including the percent of time the State standard of 5 mg/L is attained. In 2003, seven of the eight continuously monitored locations met the State standard more than 95 percent of the time. *E. coli* conditions generally showed improvement directly downstream of most watershed management activities, particularly downstream of now controlled CSO outfalls during wet weather; however, most locations do not meet State standards for body contact. Overall, these results clearly demonstrate that the implemented watershed management activities have been successful, but that continued diligence in addressing remaining water quality pollution sources is necessary, particularly for bacteria.

Figure 4. Daily Average Dissolved Oxygen Trends

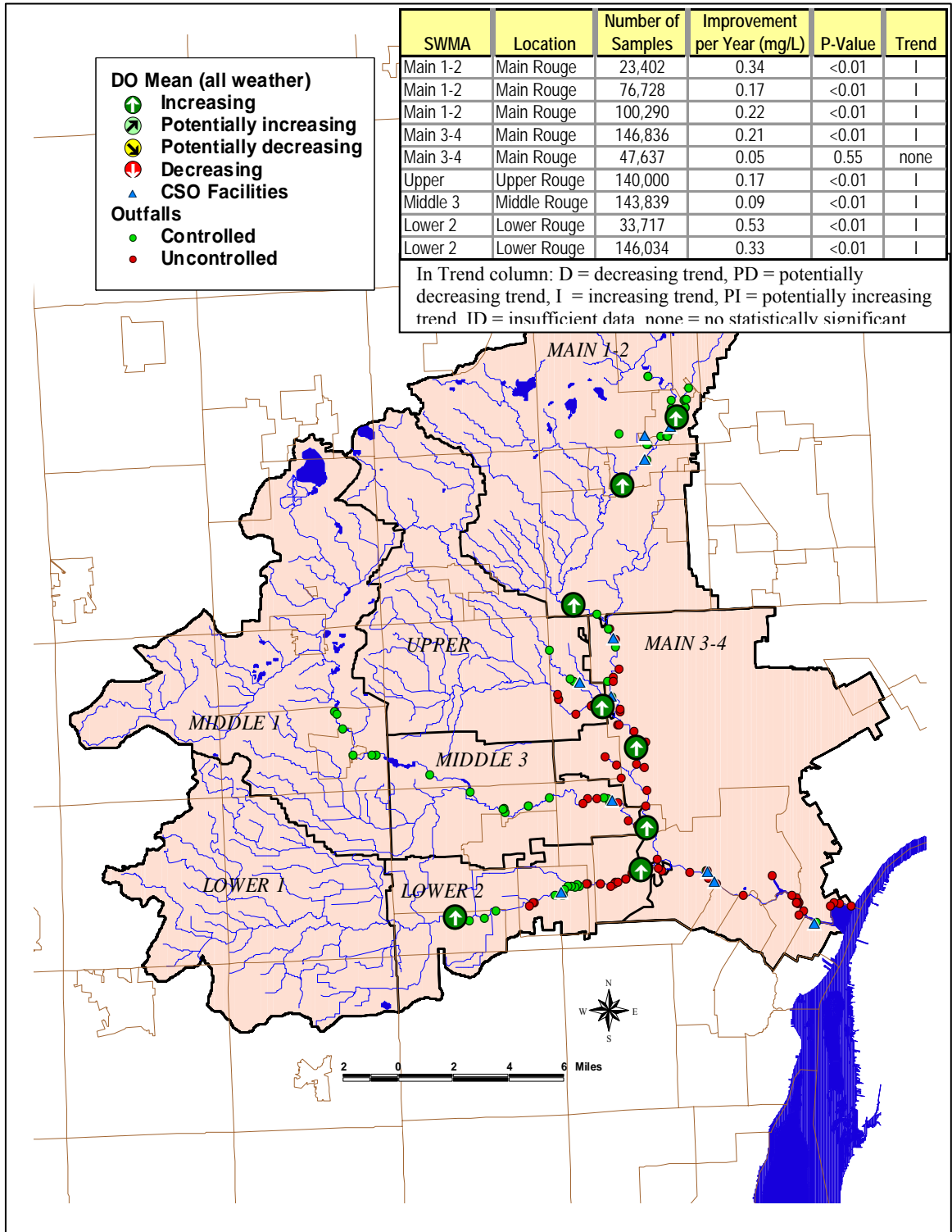


Figure 5. *E. coli* Bacteria - Dry Weather

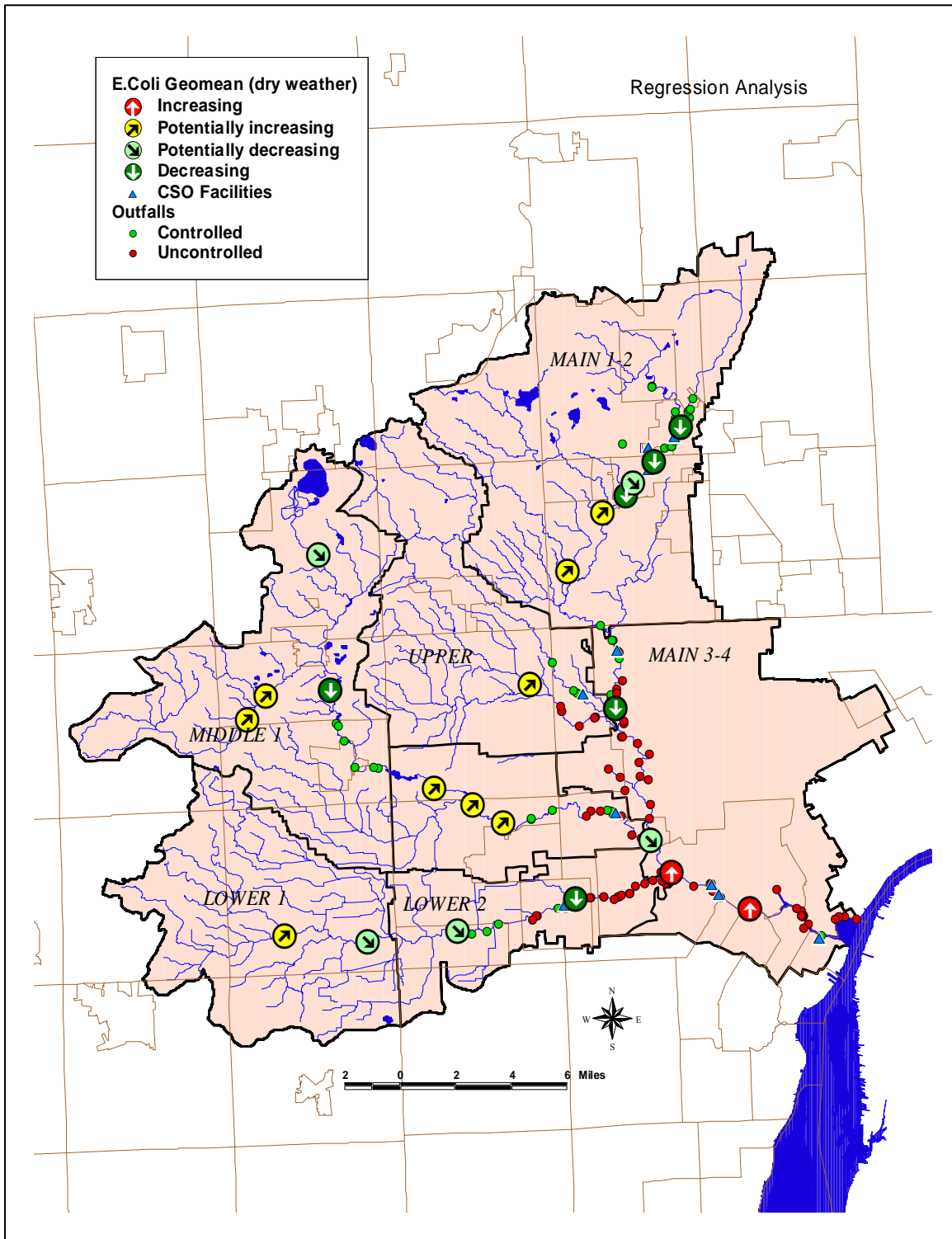


Figure 6. *E. coli* Bacteria - Wet Weather

