WATER QUALITY OF TURTLE CREEK NEAR BELOIT, WISCONSIN

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INTRODUCTION

Two of water's unique qualities are that it is an exceptionally good solvent because of its strong dipolar nature and it has a strong dielectric constant or ability to keep ions in solution. In other words solutes are not only easily dissolved but their resulting ions' electric attraction is reduced drastically, making it difficult for ions to precipitate (Berner and Berner, 1987). Unfortunately these unique properties make it easier for water to carry pollution.

Pollution of surface water can take place in several different ways with pollutants being found in solution, suspension, or in bedload sediments. From the high number of water quality parameters, seven tests were chosen to characterize the water quality along the fifteen mile stretch of Turtle Creek from State Highway 140 to the confluence with the Rock River, south of Beloit. Parameters measured include: temperature, dissolved oxygen, pH, conductivity, turbidity, Total Coliform, Fecal Coliform, Fecal Streptococci, and dissolved trace heavy metals (Cu, Zn, Pb, Cd, and Ni).

This preliminary study includes only part of the information necessary to obtain a complete picture of the water quality at Turtle Creek, WI. However, these results are indicators of the overall water quality and provide an initial base for further study.

METHODS

Sampling techniques for on site measurements, bacteria, and heavy metals, followed those outlined by *Standard Methods For the Examination of Water and Wastewater*, 1985. To determine variation in measurements across the Creek, I took ten samples at equal increments at site C, six at site P, and three at site L (see Map). I found three samples per site was adequate. At sites B, H, and K, only one sample could be taken because the water was too deep across the remainder of the Creek.

Measurements of temperature, dissolved oxygen, pH, conductivity, and turbidity were performed using portable meters at sixteen different sites using the Equal Width Increment (EWI) method. Heavy metal samples were also obtained at these sites, as well as one extra site, site N, using depth integrated sampling and the EWI method. The high number of sites was intended to determine whether contamination was of the point source or diffuse source type. Also, more sites were established near the industrial area along the last mile of the Creek to pinpoint any potential polluters. At sites C, F, N, and P, I took one sample at the centroid of flow intending to use the samples for another test. Instead of disregarding them, these samples were also analyzed for heavy metals and are denoted by C', F', N', and P'. Dissolved heavy metal concentrations were then measured using the Inductively Coupled Argon Plasma Spectrometer (ICAP). At sites A and B, bacteriological testing was performed using the membrane filtration method. Site A was upstream of suspected septic system contamination and site B was downstream.

RESULTS

Given the limited scope of this report, I have chosen to give only dissolved oxygen, bacteriological, and dissolved heavy metals results.

Dissolved oxygen results can be seen in Figure 1, along with corresponding temperature and dissolved oxygen saturation levels. Levels of dissolved oxygen were not measured at sites A and B due to equipment malfunction.

Total Coliform counts were approximately 190 count/100 ml at sites A and B. Fecal Coliform results show 24 count/100ml at site A and approximately 112 count/100ml at site B. Fecal strep at each site was approximately > 2000 count/100 ml. Fecal coliform/fecal strep ratios were .012 upstream and .041 downstream.

were sufficiently well mixed, and therefore were representative of the inflow into the City of Beloit. The average pH at this sight was 9.27, indicating a poor environment for heavy metal mobility.

The downstream cross-section showed elevated concentration levels across the board. The average Ca reading was 6 ppm higher, and the average for the sodium concentration was nearly 25 ppm higher. These jumps in concentration were due to the City of Beloit's waste water treatment facility. The outflow for the facility was located approximately 50 meters upstream from the Shirland Avenue bridge sampling sight. The water they were discharging was much higher in sodium and calcium than the river water.

The downstream cross-section also showed higher concentrations of the heavy metals. With the exception of cobalt and chromium, all the heavy metals showed up in concentrations of at least 1/100th of a part per million with some as high as1/2 a part per million. Lead showed up in the highest concentration, 1.258 parts per million at a single interval. Lead concentrations were also recorded at two of the other four remaining intervals. Initially such a high lead reading was attributed to an error in analysis or perhaps contaminated equipment. An additional cross-section was done the next day. Again the lead concentration was found to be quite high in a single interval, 1.753 ppm. This time however the interval wasn't the same. The lead plume appeared to have shifted to an adjacent interval. A third set of samples was taken the following day. This time, samples were taken every 5 meters. However, the lead was now below detectable limits and did not show up in the third analysis. pH taken at this sight was very similar to the upstream pH. The average pH reading taken here was 8.74, slightly more acidic but still an alkaline solution.

The analysis of the two suites of storm water outflow samples were informative. The analysis of the samples taken after a light sporadic rain on the 7th of August, showed very high concentrations of the heavy metals. Potassium, iron, cadmium, and lead were all seen in much higher concentrations than in the river. A lead concentration at one sight was 1.970 ppm. Iron was seen in concentrations as high as 1.406 ppm. A fairly high concentration of cadmium was seen, .0690. The analysis of samples taken on August 8th, after a heavy early morning rainfall, showed drastically reduced concentrations across the board. Nearly all the elements tested for were found to be below detection limits, or very in minute quantities. This trend in the data seems to indicate that most trace elements are washed out with the initial runoff or are more highly diluted by the greater amount of rainfall.

CONCLUSIONS

The data support the conclusion that, at least in the initial stages of a storm event, high concentrations of trace elements, especially lead, are washed into the Rock River by means of storm sewer runoff. Storm sewer runoff is a possible explanation for the high lead anomaly seen in the downstream cross-section. It is difficult to speculate on the exact amount of contribution by storm sewers. Concentrations could be contributed from any number of non-point sources. An in-depth study of the problem could prove enlightening. If several storm sewer outfalls could be monitored throughout an entire precipitation event, and then if several such events could be compared, a much more precise study could be developed. In addition, analysing the upper and lower cross-section after a storm event would determine whether or not the storm events produce a definite spike in the concentrations. Storm sewer runoff in highly industrialized areas makes a definite contribution to surface water pollution. The next step is to determine the exact extent of the problem.

Concentrations of heavy metals in most samples was on the order of μg/L, falling below ICAP minimum detectable limits. This was indicated by relative standard deviations of greater than 15 %. Results for samples with concentrations with relative standard deviation less than 5% can be seen in Figures 2-6.

DISCUSSION / CONCLUSIONS

Dissolved Oxygen-

Dissolved oxygen values, when adjusted for temperature variation, show levels of saturation or near saturation (see Figure 1). The values also surpass minimum acceptable levels of 4.0 - 5.0 mg/L (Black, 1977). It appears that water quality along Turtle Creek is not threatened by dissolved oxygen levels.

Bacteria-

Fecal Coliform bacteria are most often found in association with human feces whereas Fecal Streptococci are more prevalent in animal feces. Total Coliform includes many non-fecal bacteria and is used to give a broader picture of water quality with respect to bacteria. Results indicate that bacteria levels at sampling sites A and B are safe for all activities but drinking which requires Fecal and Total Coliform counts of 0 per 100 ml. The Fecal Coliform to Fecal Strepococci ratio indicates the contamination is most likely from livestock which tends to give ratios of approximately 0.04 or less (Millipore, 1983). Therefore, the suspect septic system is most likely not contributing to the majority of the fecal waste in this section of the Creek. Further study would include sampling sites further upstream and downstream to pinpoint pollution sites and would re-evaluate Total Coliform at sites A and B, and Fecal Coliform at site B to obtain ideal colony ranges.

Dissolved Heavy Metals-

The toxic effect of heavy metals varies widely and is dependent upon several variables, including biological species, organism density, degree of mixing, suspended solids, redox conditions, and other elements or compounds in solution (Moore and Ramamoorthy, 1984). Toxicity ranges for aquatic plants and fish in Figures 2-6 take into account each of these variables. At concentrations higher than the upper boundary, other conditions (density, mixing, etc...) do not affect toxicity. Concentrations below the lower boundary are not toxic, regardless of other conditions.

All sample concentrations for Zn fall within the given toxicity ranges for aquatic plants. However, concentrations at C1-C10, C', D1, and N', are out of range for fish and borderline for aquatic plants. Sample concentrations at F' and P' are more likely to be toxic for fish than plants given their proximity to the upper toxicity boundary for fish. Concentrations of Cu at C7 and F' approach toxicity levels for aquatic plants. These concentrations at C7 and F' are less likely to affect fish given the upper toxicity boundary of 1.0 mg/L. Sample K1 shows toxic levels of Ni for aquatic plants. These samples seem to indicate a sporadic point source pollution because other values of samples at the same sites do not contain these high concentrations. Toxic levels for Cd and Pb may be reached in Turtle Creek, but the toxic ranges are so wide that the present concentrations are likely insignificant. In future study special attention should be paid to Zn levels with respect to fish and Cu and Ni levels with respect to aquatic plants.

References Cited

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Black, John A. 1977. *Water Pollution Technology.* Prentice-Hall, New Jersey.

Field Procedures in Water Microbiology. 1983. Millipore Corporation, New York.

Moore, James W., and S. Ramamoorthy. 1984. *Heavy Metals in Natural Waters.* Springer-Verlag, New York.

Standard Methods for the Examination of Water and Wastewater. 1985. American Public Health Association. Port City Press, Baltimore.

MAP: Study area and field sites along Turtle Creek.

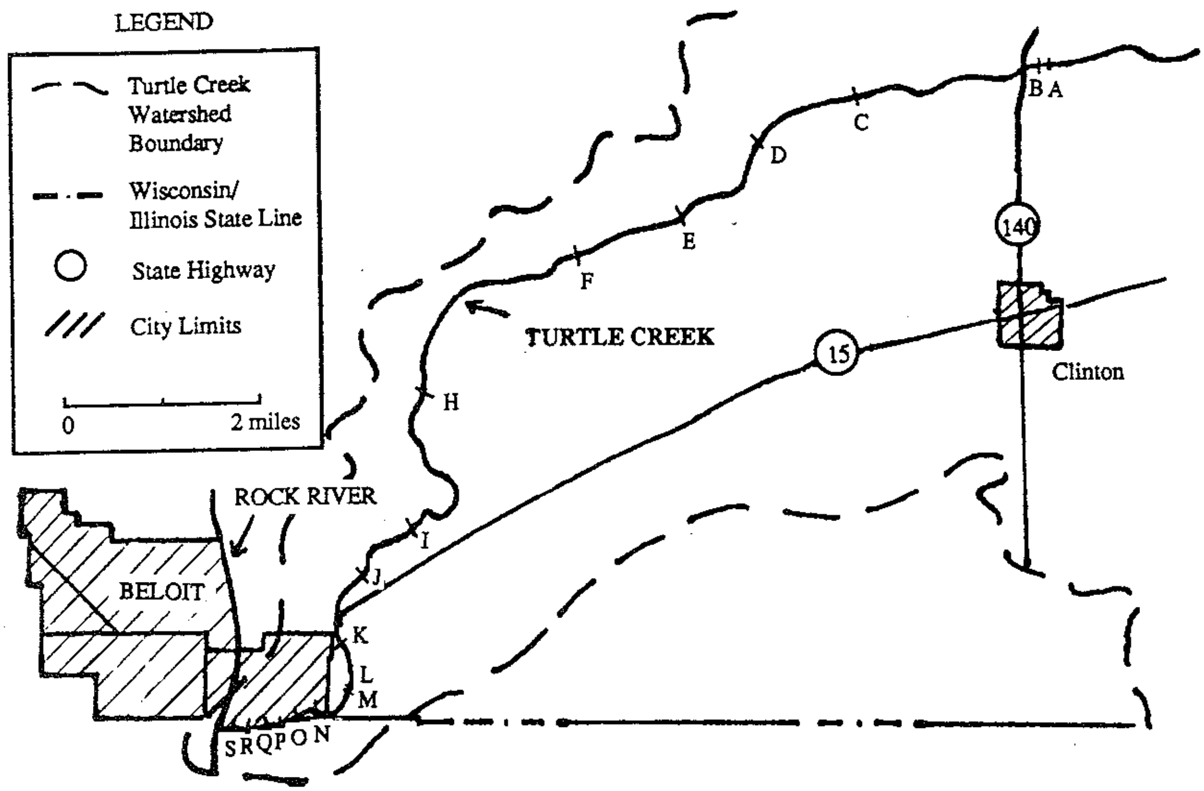
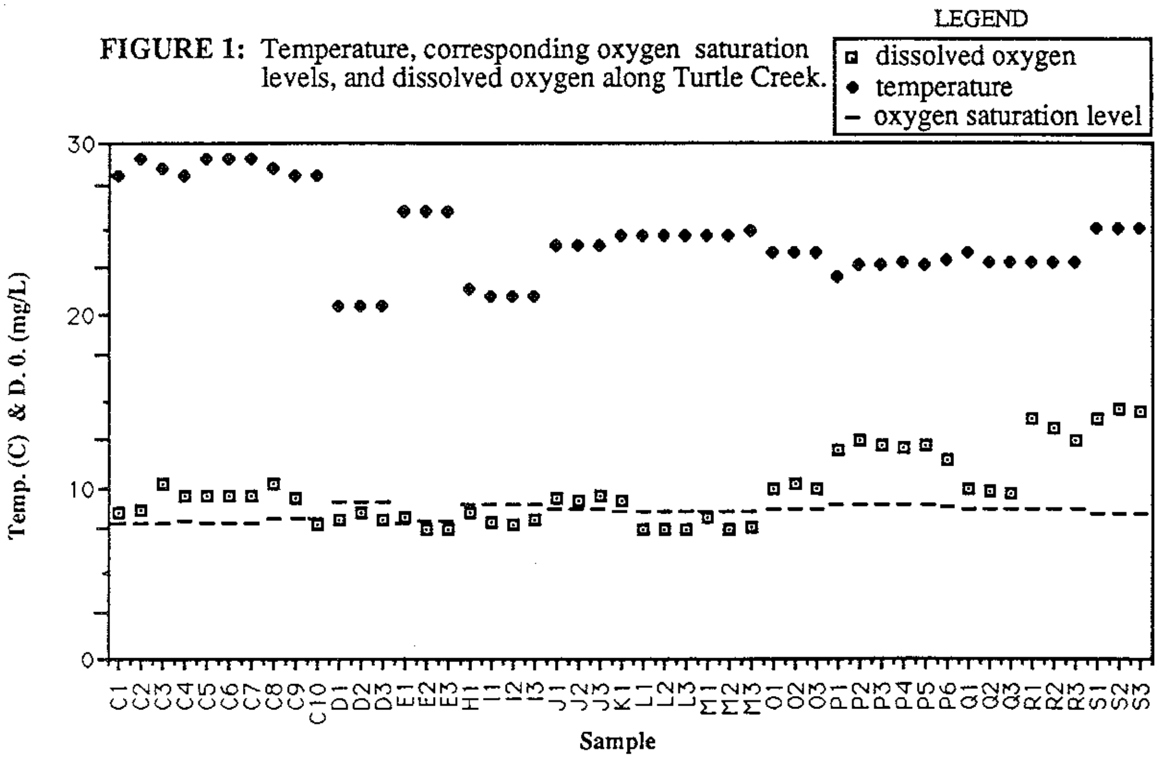


FIGURE 1: Temperature, corresponding oxygen saturation levels, and dissolved oxygen along Turtle Creek.



FIGURES 2-6: Dissolved Heavy Metals Concentrations and Corresponding Toxicity Ranges for Aquatic Plants and Fish.

LEGEND *

- - - fish toxicity bounds

—— aquatic plant toxicity bounds

*Values from Moore and Ramamoorthy, 1984.

FIGURE 2: ZINC

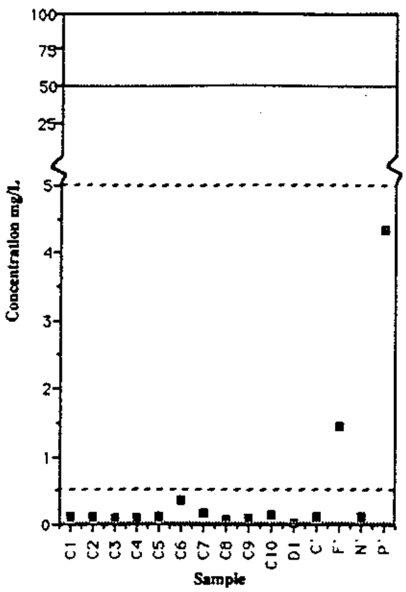
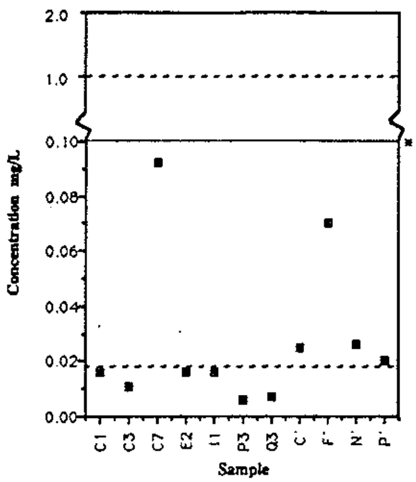


FIGURE 3: COPPER



* Conc. > 0.1 mg/L is toxic regardless of conditions or species.

FIGURE 4: NICKEL

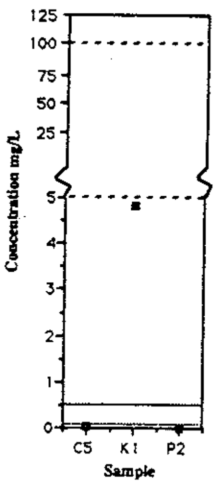


FIGURE 5: LEAD

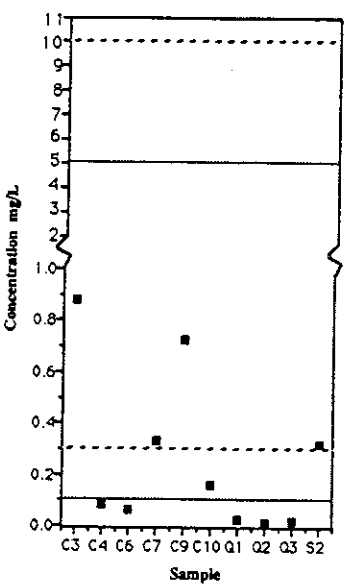
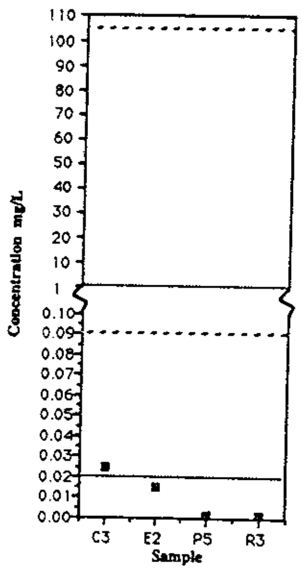


FIGURE 6: CADMIUM



An Analysis of the Discharges of Geo. A. Hormel & Co. Into Spring Brook

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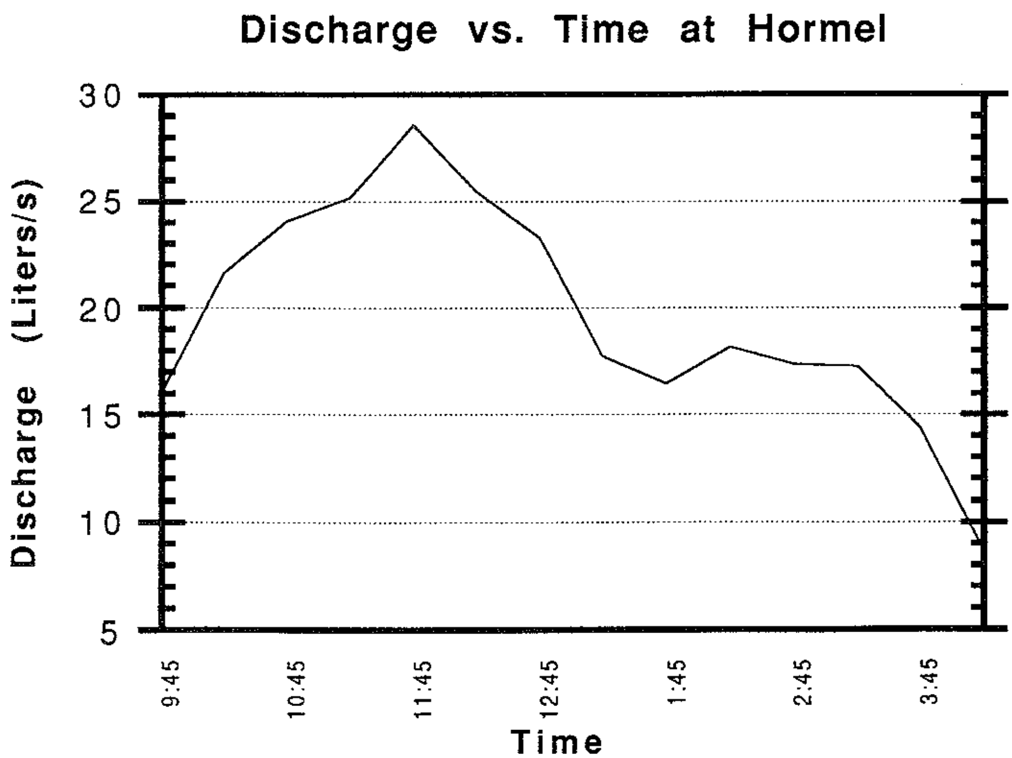
This study analyzed the chemical, biological and physical aspects of discharge by Geo. A. Hormel and Co. into Spring Brook as they relate to the Clean Water Act and the health of the stream. Stream gages have been operating on Spring Brook at the Wisconsin Power and Light Station (WPL) and the Halverson Station (HAL) for several years. Hormel's discharge pipe is a half a mile downstream from HAL and three miles upstream from WPL. Hydrographs have operated at these stations during the summer for several years and discharge peaks have consistently shown up on the hydrographs at WPL that have not been observed at HAL, but the source of these peaks and their effect on the stream have not been investigated previously.

After cleaning out the stilling wells at WPL and HAL and installing the gages, daily peaks in discharge were noted immediately. Discharge rose sharply at 3:30 to 4:00 pm in the afternoon and usually stayed high, with some fluctuation, until 8:00 or 9:00 the next morning. These peaks were observed on every weekday during the observation period, but not on any weekends. The consistency in the timing of the flow peaks and their uniform nature suggested that we were dealing with an industrial source that discharged the same amount daily. There was only one precipitation event during the study period, providing us with a near constant background.

We located the discharger by examining the city storm sewer maps to see where storm sewers emptied into the stream and by walking along it. Three 54" pipes draining the Beloit Industrial Park appeared the most likely sources of the discharge. Further investigation yielded the location of a large cooling pond behind the Hormel plant, only 200 feet from one of the large storm sewers. There was a discernable flow coming out of this pipe, but little flow was evident from the other two pipes..

We determined when effluent flowed from the Hormel plant by measuring discharge from the storm sewer every half hour for a day. We observed that the Hormel discharge peaked at 11:45 am, and when we compared this to the hydrograph for that day, we found a lag time of three and a half hours. In storm events a lag time of two and a half to three hours can be seen between HAL and WPL.



Once we had isolated the major discharger, we took water samples at WPL, HAL, the drain pipe behind Hormel, 50 feet upstream of the pipe, and 50 feet downstream of the pipe. We ran tests in the field for conductivity, pH, temperature, color, turbidity, and dissolved oxygen. Back in the lab we analyzed for coliform bacteria, fecal coliform bacteria, fecal streptococcus bacteria, and Biochemical Oxygen Demand (BOD). We also ran these samples