# Burnt Bridge Creek
# Water Quality Monitoring Report
## 1991 to 1993

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by
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Water Quality Division

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Storm and Surface Water Utility,
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# BURNT BRIDGE CREEK WATER QUALITY MONITORING REPORT 1991-1993

## EXECUTIVE SUMMARY

The water quality of Burnt Bridge Creek has been continuously monitored since 1972. Monitoring was increased with the establishment of the Burnt Bridge Creek Stormwater Utility in 1980. The resulting monitoring data was summarized annually from 1981-1990. The present report summarizes data from 1991-1993. The report evaluates the data for exceedences of those parameters for which surface water standards have been set and analyzes for significant differences in these and other parameters between sample sites and between years. Three parameters, turbidity, total suspended solids, and total phosphorus, are analyzed over the previous 20 years.

Burnt Bridge Creek is placed in Class A by the Washington Department of Ecology, but is listed as "partially supporting" the characteristic uses designated for that category. The "partially supporting" designation is due to exceedences of standards for pH, temperature, dissolved oxygen, turbidity, and fecal coliform bacteria (a state standard has not been set for phosphorus).

Exceedences were found for all parameters for which state standards or EPA criteria have been set. Exceedences were also observed in total phosphorus concentrations. Temperature and dissolved oxygen exceeded standard regularly during summer months due to lack of shading by riparian vegetation and high nutrient concentrations. Total phosphorus concentrations frequently exceeded the EPA criterion for lake tributaries. Virtually all of the samples from the downstream sample site were in exceedence. Concentrations were sufficiently high to degrade water quality in Vancouver Lake as well as in Burnt Bridge Creek itself. The predominant source of phosphorus as well as nitrogen, fecal coliform bacteria, and other pollutants to the creek appears to be contaminated ground water. Fecal coliform bacteria were also regularly above standard, indicating that septic systems are likely to be a major source of ground water pollution. Turbidity also regularly exceeded standard due primarily to uncontrolled runoff. Turbidity values appear to have declined but still present a serious water quality problem.

In order to reduce these impacts we recommend the following measures:

1. Restoration of riparian habitat in order to shade stream and bring summer temperatures down.
2. Creation of riffle habitats and other instream habitat structure where possible in order to increase concentrations of dissolved oxygen.
3. Rigorous implementation of stream buffer setback regulations in order to preserve existing riparian habitat.
4. Rigorous enforcement of new County stormwater ordinance and adoption of the ordinance by the City of Vancouver in order to reduce turbidity and suspended solids.
5. Construction of more regional stormwater facilities like Meadowbrook in order to provide increased water quality treatment.
6. Expansion of program for conversion of septic systems to sewer.
7. Continue water quality monitoring program in order to document status and changes.
8. Investigate sources of phosphorus pollution and study possible remedies.

# BURNT BRIDGE CREEK
## WATER QUALITY MONITORING REPORT
## 1991-1993

CLARK COUNTY WATER QUALITY DIVISION

Water quality studies in the Burnt Bridge Creek basin began with limited sampling in 1972-3 by the Washington Department of Ecology and in 1974 by the Southwest Washington Health District. A more extensive study was conducted in 1976 by the consulting firm of Kramer Chin Mayo (KCM) under contract to Clark County. The KCM study included an assessment of the biological communities of the stream, including benthic invertebrates, periphyton, and macrophytes. KCM's report (1976) summarized all water quality data for the stream up to 1976 and pointed out violations of surface water standards in terms of temperature, dissolved oxygen, sediment, and bacteria, as well as problems with high levels of nutrients and metals. The Washington Department of Ecology has classified Burnt Bridge Creek as a Class A stream and listed it as "partially supporting" the Characteristic Uses for that category, citing exceedences in temperature, pH, turbidity, dissolved oxygen, and fecal coliforms (nutrients were not mentioned since state surface water standards have not been written for these pollutants).

Based on abundances of biological organisms rated according to pollution tolerance, KCM concluded that the stream showed progressive degradation from headwaters to Vancouver Lake at its downstream end. These violations and degradation were attributed to agricultural and construction-related runoff, street runoff, lack of stream-side shading, and failing septic systems.

Based on KCM's findings and recommendations, the BBC Storm and Surface Water Utility was established in 1980. The Utility began a water quality monitoring program and contracted with the SW Washington Health District to conduct the sampling and analysis. The program was reorganized in May, 1991 to include an additional sample site. Sampling was changed from biweekly to monthly, and some sample parameters were changed at that time.

The water quality monitoring program seeks to characterize and document the water quality status of Burnt Bridge Creek watershed in terms of its physical, chemical, and biological components. In order to meet this objective, the program has established an ambient water quality monitoring network which will provide information suitable for long-term trend analysis as well as for short-term indications of problem areas requiring more specific studies. Detection of impacts due to agricultural practices, runoff from construction sites, and failing septic systems are emphasized.

The water quality data from the monitoring program was summarized yearly from 1981 to 1990, but no cumulative summaries or analyses based on these reports have been prepared. The present report summarizes the monitoring results for calendar years 1991-1993. Three parameters, turbidity, total suspended solids, and total phosphorus, were chosen for comparison with earlier data at one of the sample sites (BBC1, NW 2nd Ave.).

## METHODS

### Sample Sites

Four sites on Burnt Bridge Creek had been sampled since 1974 (Figure 1). With reorganization of the program in May, 1991, sampling at the Royal Oaks site was discontinued and replaced by the site at Burton Rd. (BBC4) approximately 2,000 ft downstream (River Mile 7.2). An additional site was also established at NE 86th Ave. (BBC3, RM 7.5) These two sample sites enabled monitoring immediately above and below the recently constructed Meadowbrook stormwater facility. BBC4 is at the bottom of approximately 50 ft of artificially constructed riffle habitat. Upstream of this, the channel is a slow moving, sediment filled ditch.

The other three original sample sites were retained. These are described below:

BBC1, NW 2nd Ave. (RM 1.2), is situated approximately 500 ft downstream of the confluence of Cold Creek and approximately 1000 ft downstream of I-5. The site is shaded on the south bank and runs through approximately 100 ft of riffle habitat upstream of the sample site.

BBC2, NE 18th St. (RM 5.2), is located at the head of the natural channel of Burnt Bridge Creek. Upstream of this site, the creek flows in a man-made channel with very little shade or diversified shoreline habitat. The bottom structure consists predominantly of silt and sand above this site.

BBC5, NE 112th Ave. (RM 9.5), marks the approximate limit of the original watershed. The watershed upstream of this site was originally a large marshy lake that was drained into Burnt Bridge Creek probably around 1910. The creek immediately upstream of this site consists of a deep ditch with very limited stream-side vegetation and a bed of loose silt. Further upstream, above approximately NE 115th Ave., the ditch flows through a deep bed of nearly pure organic peat and muck soils.

### Sample Collection Schedule

Samples were collected biweekly between January, 1980, and May, 1991, and monthly before and after that period. Samples were collected during the first week of the month. The sites were sampled in the same order in each sampling run (beginning at the upstream site and working downstream) in order to keep the daily time of sampling for each site as consistent as possible and thus minimize bias due to diurnal variability of the parameters analyzed.

"Diurnal runs" were also conducted. These consisted of up to four rounds of sampling during a single day in order to determine the extent of diurnal variability in temperature, dissolved oxygen, and pH. The time of year for sampling was set to optimize high temperature and long daylength in order to sample during the most adverse conditions for temperature, dissolved oxygen, and pH.

Table 2. Exceedences of state or EPA (phosphorus) water quality criteria , expressed as number of samples exceeding standard over number of samples.

| Parameter | BBC1 | BBC2 | BBC3 | BBC4 | BBC5 | Total |
|---|---|---|---|---|---|---|
| Temperature * | + | + | + | + | + | + |
| Dissolved Oxygen * | 0 | + | + | + | + | + |
| pH | 0 | 2/36 | 0 | 0 | 4/36 | 6/172, 3.5% |
| Turbidity | 14/36 | 9/36 | 6/32 | 5/32 | 14/36 | 48/172, 27.9% |
| Total Phosphorus | 35/36 | 30/36 | 30/32 | 31/32 | 29/36 | 155/172, 90.1% |
| Dissolved Phosphorus** | 24/36 | 9/32 | 16/30 | 19/32 | 15/32 | 83/172, 48.3% |
| Fecal Coliform Bacteria | 33/36 | 23/36 | 18/32 | 15/32 | 17/36 | 106/172, 61.6% |

* Exceedences were observed whenever measured under conditions of high air temperature.
** Expressed as exceedence of EPA total phosphorus lake tributary criterion.

Temperature

Stream temperature in Burnt Bridge Creek exceeded the state standard of 18.0°C whenever measured under conditions of high air temperature. Since ambient monthly samples were typically taken in the morning or early afternoon before air temperatures had reached their peak, measurements of stream temperature did not necessarily show the full extent of exceedence. However, during the diurnal (24 hr) sample runs in July and August, stream temperatures regularly exceeded standard during mid to late afternoon. Exceedences were observed at all sample sites including BBC5, the upstream site.

Dissolved Oxygen

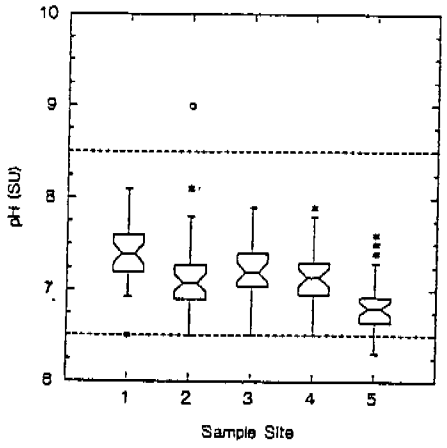
Like stream temperature, dissolved oxygen showed strong diurnal variability, and exceedences were most clearly shown by the results of the diurnal sample runs. Exceedences were observed at all sites but BBC1. They were also regularly observed during the diurnal runs.

pH

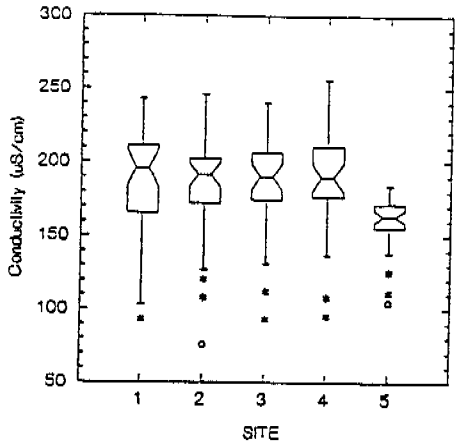
Exceedences of pH were observed at two sites, BBC2 and BBC5 (Figure 2a). Of the 6 exceedences observed, 5 were due to low pH; one was due to high pH. All of the 4 exceedences observed at BBC5 were below the 6.5 SU standard. The median pH at BBC5 was significantly lower than at the other sites at the 95% confidence level. The pH values at BBC1 were significantly higher than those of the other sites. Although pH typically varies diurnally due to variations in DO and $CO_2$, maximum observed diurnal variation was 0.3 SU.

Figure 2. Ambient pH (a.) and conductivity (b.) by sample site in Burnt Bridge Creek

a.




b.




Conductivity

Conductivity (an indication of total dissolved solids) showed relatively consistent values between years and between sites, with the exception of BBC5 which was significantly lower than the others (Figure 2b). The interquartile ranges of all sites together varied between approximately 150 and 210 µS/cm, which is below the range expected for shallow ground water (Turney 1990). The steep increase at BBC4 indicates a potential pollutant input between NE 112th Ave. and NE Burton Rd. Conductivity values showed slight seasonal variability in a range of approximately 20 µS/cm, with higher values occurring during summer.

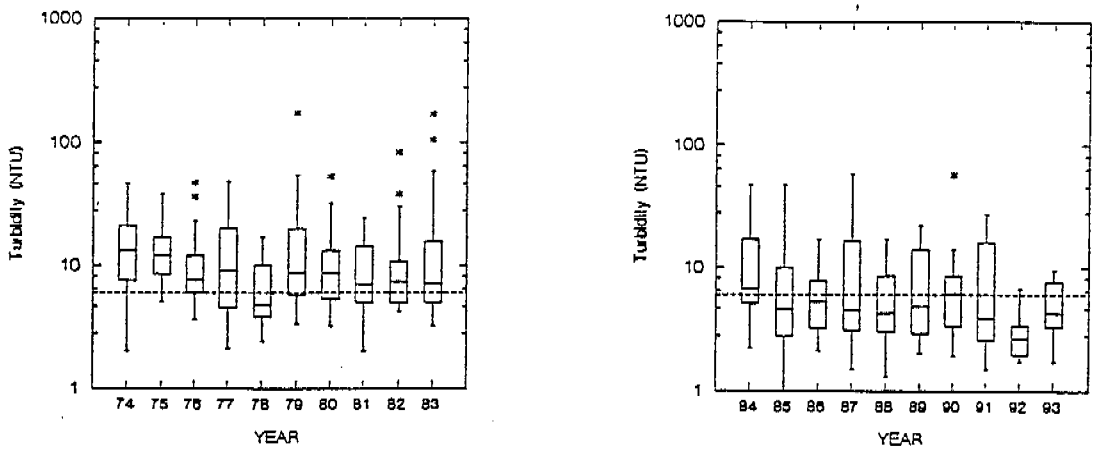
Total Suspended Solids

Total suspended solids showed a relatively consistent pattern with no significant differences between years or between sites. Values tended to vary seasonally with the highest values in the winter months. Median values varied from approximately 4-6 mg/l. Several values at much higher levels were observed during storm events, with the highest recorded value at 212 mg/l (BBC1 on 3/1/91). No significant differences were observed between the values measured in 1991-1993 and those measured in 1982-1983.

Turbidity

A total of 48 exceedences of the turbidity standard (6 NTU) were observed, representing 27.9% of the samples. Exceedences occurred at all sites but were fewest, and median values lowest, at BBC3 and BBC4. No exceedences were observed at these sites in 1992. As with total suspended solids, turbidity tended to vary seasonally with the highest values observed in the winter months. Over the past 20 years turbidity appears to have declined significantly at BBC1 (Figure 3). Values were significantly lower in 1992 and 1993 than they were in 1974 and 1975, with intermediate values in the interim.

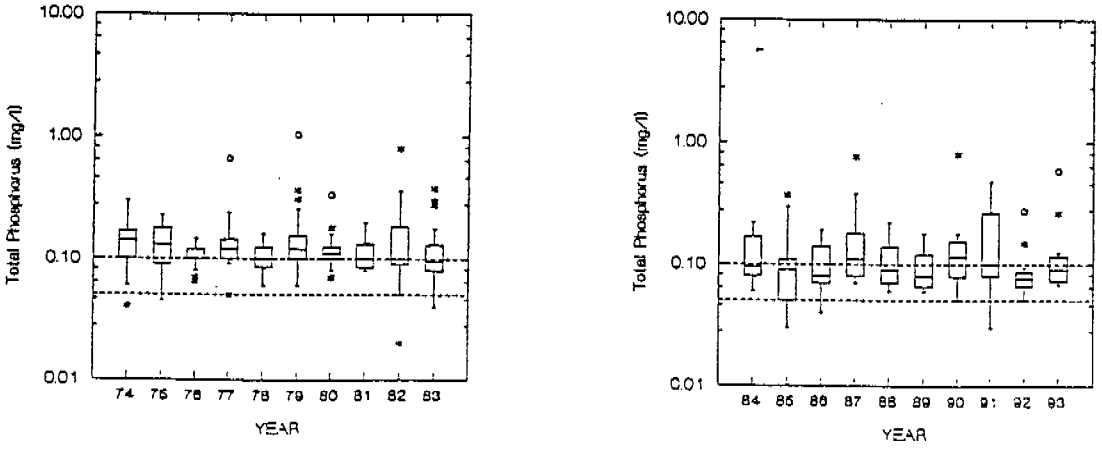
Figure 3. Turbidity at sample site BBC1, NW2nd Ave., for 1974-1993




Total Phosphorus

Total phosphorus concentrations in Burnt Bridge Creek regularly exceeded the EPA criterion for lake tributaries, with 35 of the 36 samples (97.2%) from the downstream site, BBC1, above the exceedence level. Over 90% of all measurements made in 1991-1993 were above the lake tributary criterion of 0.05 mg/l, with no significant differences between sites. This level of phosphorus input to Vancouver Lake is sufficient to cause significant eutrophication, with resulting algae blooms and excessive macrophyte growth. In terms of the impact of phosphorus pollution on Burnt Bridge Creek itself, 21.5% of all samples were above the instream criterion of 0.1 mg/l, sufficient to seriously compromise aquatic life. These high levels of phosphorus extend consistently back to 1984 at BBC1 without significant change (Figure 4). Extremely high values were recorded at all sites during January, February, and March of 1991, with values as high as 0.6 mg/l, well over 10 times the EPA lake tributary criterion.

Figure 4. Total Phosphorus concentrations in Burnt Bridge Creek, 1974-1993. Dotted lines at 0.05 and 0.1 mg/l indicate EPA criteria for lake tributaries and other streams respectively.



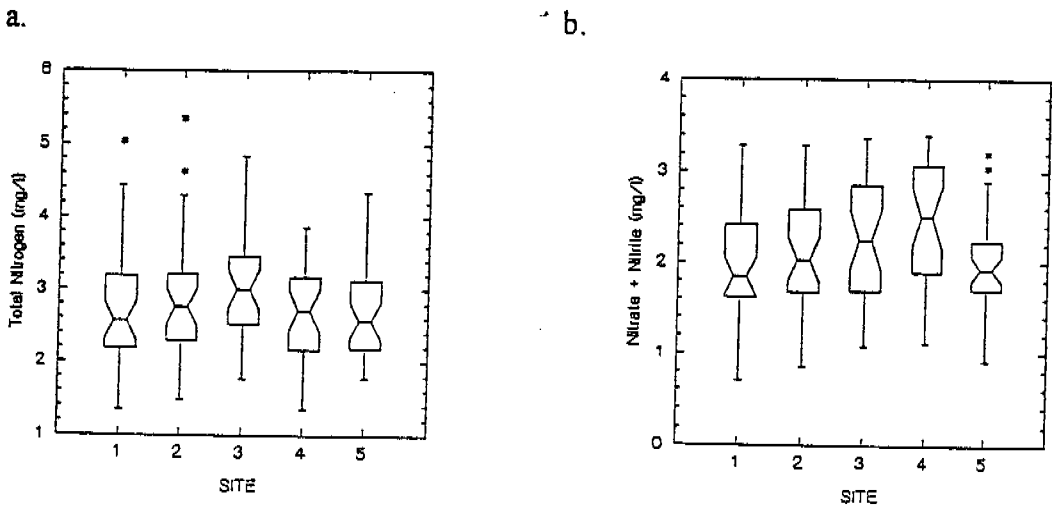
Dissolved Phosphorus

The dissolved fraction (ortho-phosphate) of total phosphorus was also at very high concentrations. Median values were over half of the total phosphorus medians. Nearly half (48.3%) of the samples exceeded the criterion for total phosphorus.

Total Nitrogen

Median values for combined 1991-1993 data for total nitrogen showed no significant differences between sites. However, significant differences did occur between sites within 1991 and between years at all sites, indicating significant variability in the sources of nitrogen pollution. In 1991, values were significantly higher at BBC3 and BBC4 than at the other sites, with median values at approximately 3.2 mg/l compared to median values at approximately 2.4-2.6 mg/l at the other sites. Values were significantly lower in 1993 than in 1992 at all sites, but the difference between 1993 and 1991 was significant only at BBC3 and BBC4. This result may be due to unusually high concentrations in 1992 throughout the watershed and at BBC3 and BBC4 in 1991 rather than a significant decline in pollutant input to the creek.

Figure 5. Total nitrogen (a.) and nitrate + nitrite (b.) by sample site in Burnt Bridge Creek.




Nitrate + Nitrite

Values for nitrate + nitrite were significantly higher in 1991 than 1992 or 1993 at both BBC3 and BBC4. The highest values measured, however, were nevertheless within acceptable limits (EPA criterion for drinking water = 10.0 mg/l). The other sites showed no significant differences between years or between sites. Median values for all sites ranged from approximately 1.8-3.1 mg/l, with the highest value of 3.4 mg/l recorded on 3 occasions at BBC4.

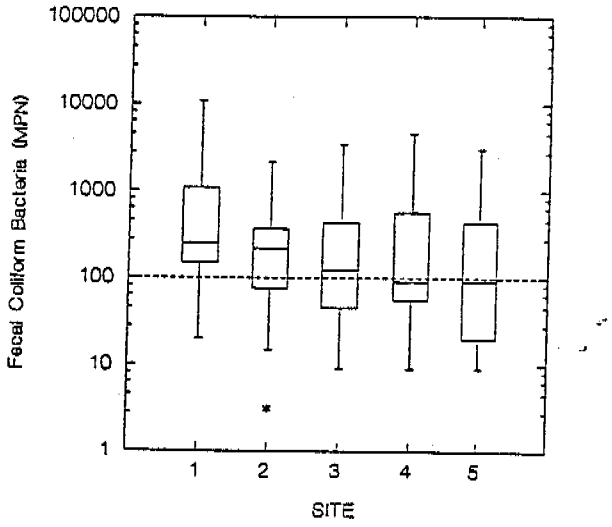
Ammonia

Ammonia concentrations for the 3 years combined were significantly higher at BBC5 than at BBC1, with intermittent values at the other 3 sites. No significant differences were detected between years at any of the sites. All observed values were far below calculated standards and

Fecal Coliform Bacteria

Exceedences of the fecal coliform bacteria standard were most numerous and the median value highest at BBC1, where 91.7% of the samples were in exceedence (Figure 6). Overall, 61.6% of the samples exceeded standard. Values tended to follow a seasonal trend with the highest during summer. Values did not differ significantly between sample sites.

Figure 6. Fecal coliform bacteria by sample site in Burnt Bridge Creek.




## DISCUSSION

High stream temperatures appear to be related to lack of shading of the stream channel as noted by KCM (1976). In combination with high phosphorus and nitrate concentrations, the exposed reaches of the stream provide a favorable environment for the production of algae and submerged plants. These produce high levels of dissolved oxygen during the day, but then consume great quantities during the night, driving oxygen concentrations down below acceptable levels. The diurnal sampling runs were designed to determine the extent of dissolved oxygen deficiencies by sampling during the early morning as well as throughout the day during the hottest days of the year. Whenever sampled under such conditions, the creek regularly showed severe deficiencies. The lack of exceedence of the dissolved oxygen standard during ambient or diurnal sampling at BBC1 was probably due to its position below over 100 ft of riffle habitat which effectively reoxygenated the water. BBC4 is also downstream of riffle habitat, although a much shorter stretch of it, and shows less severe oxygen deficiencies. Riffle habitat is rare in Burnt Bridge Creek, but many opportunities exist for restoring it.

The low pH values in the headwaters of Burnt Bridge Creek can be expected from the nature of the soil types in this region, which are predominantly pure organic muck and peat. These soil types release considerable acidity as a result of weathering and breakdown of the organic

material. The rise in pH below BBC5 is coincident with a rise in conductivity, possibly indicating that dissolved substances entering the stream below BBC5 are contributing to the stream's buffering capacity.

The high levels of phosphorus in Burnt Bridge Creek represent a serious pollution problem. Potential sources of input for phosphorus, as well as for the various forms of nitrogen, are 1) fertilizers used in agriculture, lawns, and gardens, 2) septic systems, 3) livestock waste, 4) detergents and cleaning solutions, and 5) weathering of geologic formations containing phosphate-bearing minerals. Shallow groundwater in the vicinity contains nutrient concentrations that are similar to those found in Burnt Bridge Creek (Turney 1990), indicating that these sources are acting on the ground water before it reaches the creek. Runoff from agriculture and other developed areas undoubtedly deliver significant amounts of a wide range of polluting substances, and aggressive measures must be undertaken to control them. But these must be combined with measures such as converting septic systems to sewers in order to control the pollution of ground water.

## CONCLUSIONS AND RECOMMENDATIONS

1. Temperature and dissolved oxygen continue to exceed standards and impair water quality. Restoration of riparian habitat will provide cover to the stream. Existing riparian habitat should be protected through rigorous enforcement of buffer setback regulations. Creation of riffle habitat and other in-stream structure will increase dissolved oxygen. In addition to improving temperature and dissolved oxygen conditions, these measures will greatly improve opportunities for the conservation of fisheries and other aquatic life .

2. Total phosphorus concentrations are very high and consistently exceed the EPA lake tributary criterion. The concentrations do not appear to have changed significantly over the last 20 years. Accelerated efforts with containment of animal waste and conversion of septic to sewer systems are needed to bring phosphorus and other nutrients under control.

3. Sediment pollution, as indicated by turbidity, appears to have declined over the last 20 years, but frequent violations of the state standard occur throughout the watershed. Rigorous enforcement of the new stormwater and erosion control ordinances and their adoption by the City of Vancouver should result in further improvements. The creation of additional stormwater facilities will provide sedimentation as well as uptake of nutrients by wetland vegetation.

## REFERENCES CITED

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