Appendix F. Water Chemistry

F.1 Background

Since 1964, watercourses in Oxford County have been monitored for water quality as part of the Provincial Water Quality Monitoring Network (PWQMN) of the Ontario Ministry of the Environment (MOE). While there have been numerous other short term studies in Oxford that have involved site specific watercourse monitoring, this report focuses on the more comprehensive PWQMN data. The objectives of this monitoring program are to assess broad scale water quality trends, determine the general location and causes of water quality problems, and measure the effectiveness of broad pollution control water management programs

The long term nature of this data gives a valuable assessment of trends in Oxford County water quality over the past 40 years. There are currently 12 sites monitored in Oxford County which fall within the watersheds of the Upper Thames River, Grand River and Long Point Region Conservation Authorities (see Figure F.1).

This chapter summarizes water quality results for the PWQMN data as well as current bacteria monitoring data collected as a partnership with the Ministry of Health at sites in the Upper Thames River watershed. These programs are not funded by the County.

F.2 Sampling Methods and Analysis

Under the PWQMN, eight samples per year are taken at each site in the ice-free months. An attempt is made to sample during a variety of stream conditions including storm events when most pollutant delivery occurs. PWQMN samples are analysed for 37 parameters at the Ontario Ministry of the Environment lab in Etobicoke. The bacteria samples are analysed at the Regional Health Lab in London, Ontario.

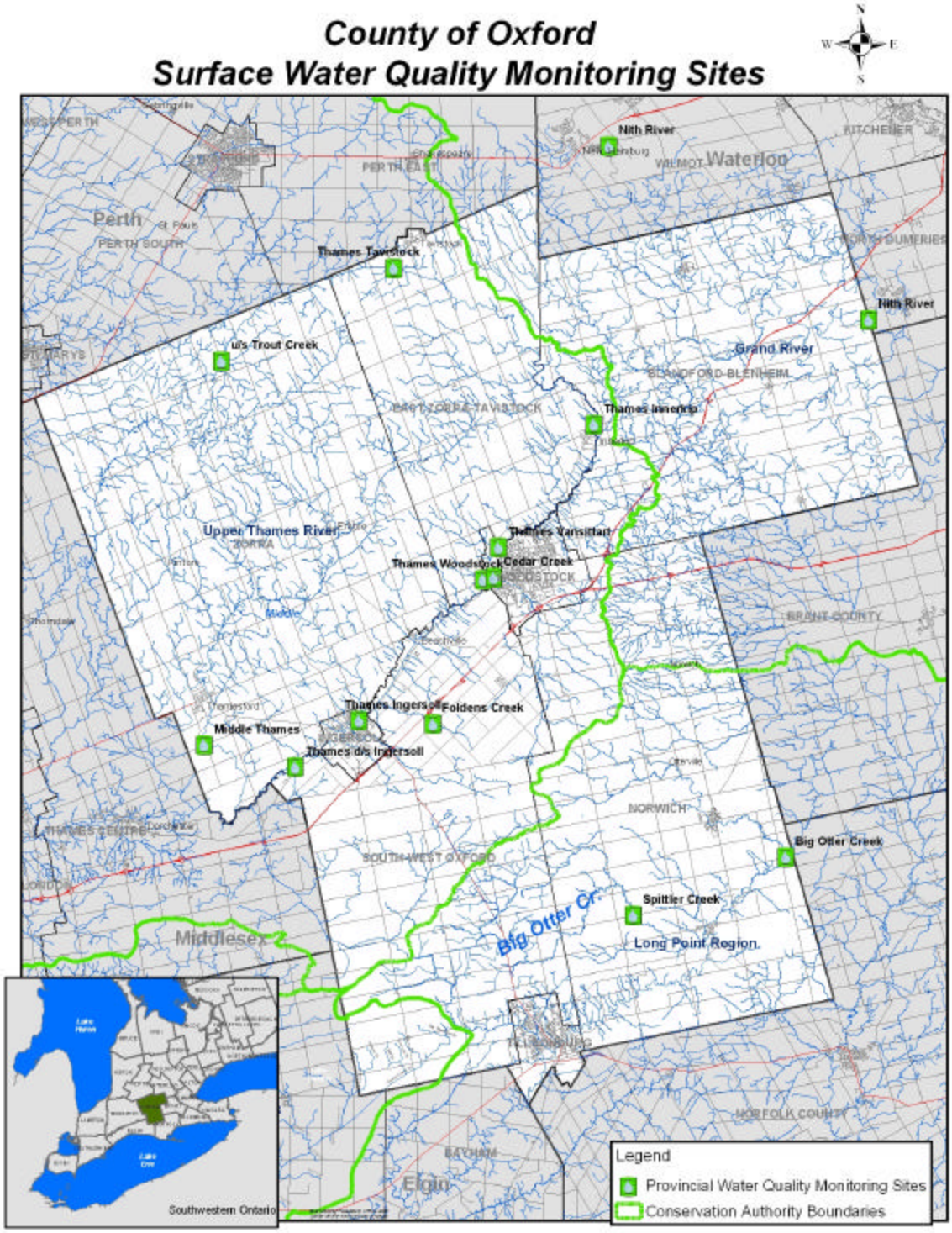
F.3 Findings

The results of six key parameters that reflect land use activities and relate to aquatic health are summarized in the sections below. The six parameters include: total phosphorus, nitrate, chloride suspended solids, bacteria and copper.

Figures F.1 through F.6 show the 75^{th} percentile for each five-year block of data for the years sampled. Figure F.7 shows the geometric mean for each five year block of bacteria data. Sampling data tends to be dry weather biased and using 75^{th} percentiles (i.e. 75% of sample results are less than this value and 25% are higher) more accurately reflects true contaminant concentrations than by using average value. Results for current sites as well as several discontinued long-term sites are summarized below.

The nature of pollutant levels in water samples tends to be quite variable year to year, often as a result of weather conditions and changing activities on the land. This variability is seen in the data as shown in the graphs that follow.

Figure F.1. Location of the 12 monitoring sites in Oxford County.



F.4 Total Phosphorus

***Fate and Behavior**:* While phosphorus is an essential nutrient for plant and animal life, excess phosphorus loading can result in significant increases in plant growth. Phosphorus is not directly toxic to aquatic life but elevated concentrations can lead to undesirable changes in a watercourse including reduced oxygen levels, reduced biodiversity, and toxic algae blooms which can be a health risk in recreational water and drinking water sources.

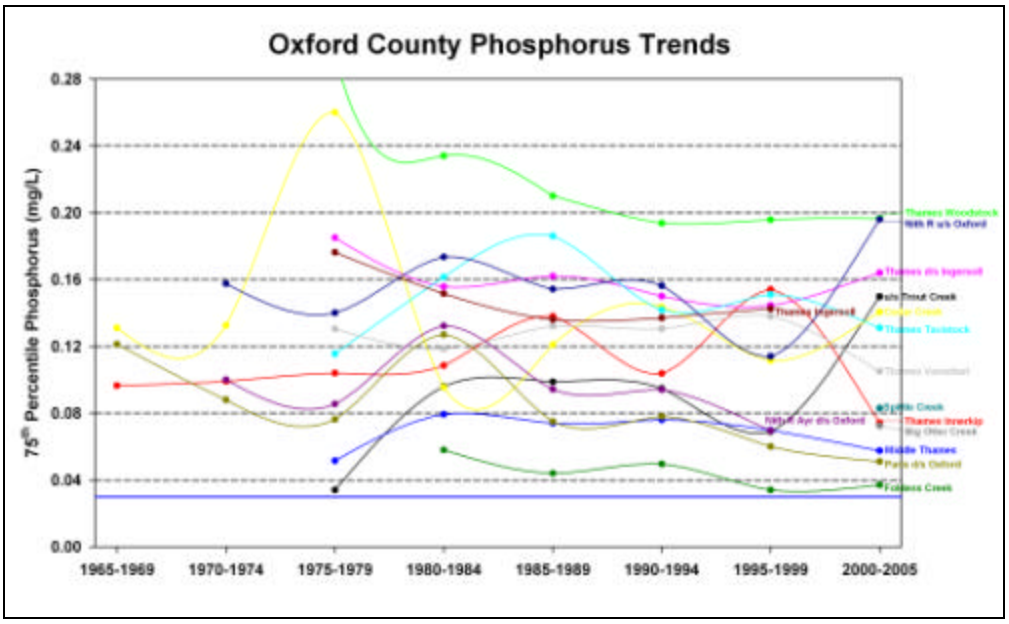
Sources: Phosphorus sources include commercial fertilizers, animal waste, domestic and industrial wastewater, including soaps and cleaning products. Phosphorus binds to soil and is readily transported to streams with eroding soil.

***Standards**:* Ontario's interim Provincial Water Quality Objective is 30 micrograms/L total phosphorus to prevent the nuisance growth of algae. There is no Ontario Drinking Water Standard.

Monitoring Results: Concentrations of total phosphorus routinely exceed the Provincial Objective for the protection of aquatic life at all sites in Oxford County

- Graph below shows, top to bottom: Thames Woodsotck, Nith R upstream of Oxford, Thames downstream of Ingersoll, upstream of Trout Cr., Thames Ingersoll, Cedar Cr., Thames Tavistock, Thames Vansittart, Spittler Creek, Thames Innerkip, Big Otter Cr, Middle Thames, Paris downstream of Oxford, Foldens Cr
- For many sites, phosphorus concentrations have shown little change since the 1970's. The exception is the Thames at Woodstock and Cedar Creek where large reductions in phosphorus occurred in the 1970's.
- Highest current levels of phosphorus (4 to 6 times the Provincial Objective) are at the following sites: Thames at Woodstock, Nith River upstream of Oxford, Thames downstream of Ingersoll, Trout Creek, Cedar Creek and Thames at Tavistock.
- Recent changes seen at the Nith R upstream of Oxford and Trout Cr with phosphorus levels doubling in recent years while the Thames at Innerkip has decreased by half.

Figure F.2. Phosphorus Trends

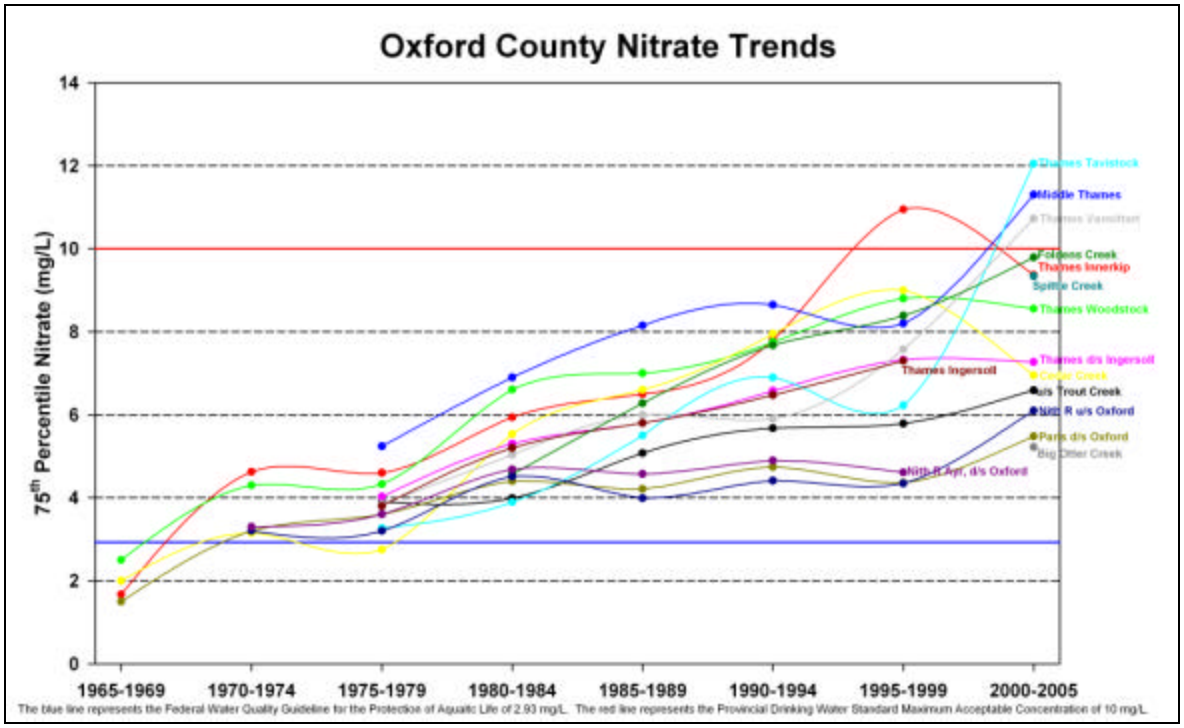


F.5 Nitrate

Fate and Behaviour: Nitrate is a nutrient that does not adsorb to sediment and moves readily through surface runoff to streams and through soil into groundwater. Elevated levels in a watercourse can be toxic to aquatic organisms, especially amphibians. A condition called blue baby syndrome can result from young children drinking water with elevated nitrates.
Sources: Nitrate sources include animal waste, commercial fertilizers, municipal waste water and septic systems, and atmospheric deposition.
Standards: The Ontario Drinking Water Standard for nitrate is a maximum acceptable concentration of 10 mg/L. The Province does not have an objective for aquatic life but the Canadian Environmental Quality Guideline to protect aquatic life from direct toxicity is 2.93 mg/L.
Monitoring Results: Since the 1960's nitrate levels at all long-term monitoring sites in Oxford County have shown a continual increase. This is a trend seen province-wide. Only the Thames at Innerkip and Cedar Creek have shown improvements in recent years.

- Graph below shows, top to bottom: Thames Tavistock, Middle Thames, Thames Vansittart, Foldens Cr, Thames Innerkip, Spittler Creek, Thames Woodstock, Thames downstream Ingersoll, Cedar Cr, Thames Ingersoll, upstream Trout Cr, Nith upstream Oxford, Paris downstream Oxford, Big Otter Cr, Nith R Ayr downstream Oxford
- Concentrations of nitrate routinely exceed the Canadian Guideline (CCME) for the protection of aquatic life at all sites in Oxford County. The majority of sites have nitrate levels below the Ontario Drinking Water Standard.
- Highest current levels of nitrate (3 to 4 times the federal aquatic life guideline) are at the following sites: Thames at Tavistock, Middle Thames, Thames at Vansittart in Woodstock, Foldens Creek, Thames at Innerkip and Spittler Creek.

Figure F.3. Nitrate Trends



F.6 Chloride

Fate and Behaviour: Chloride moves easily with water and persists in the river system. Nearly all chloride added to the environment will eventually migrate to surface or groundwater. Chloride can be toxic to aquatic organisms at high concentrations, and affects growth and reproduction at lower concentrations.

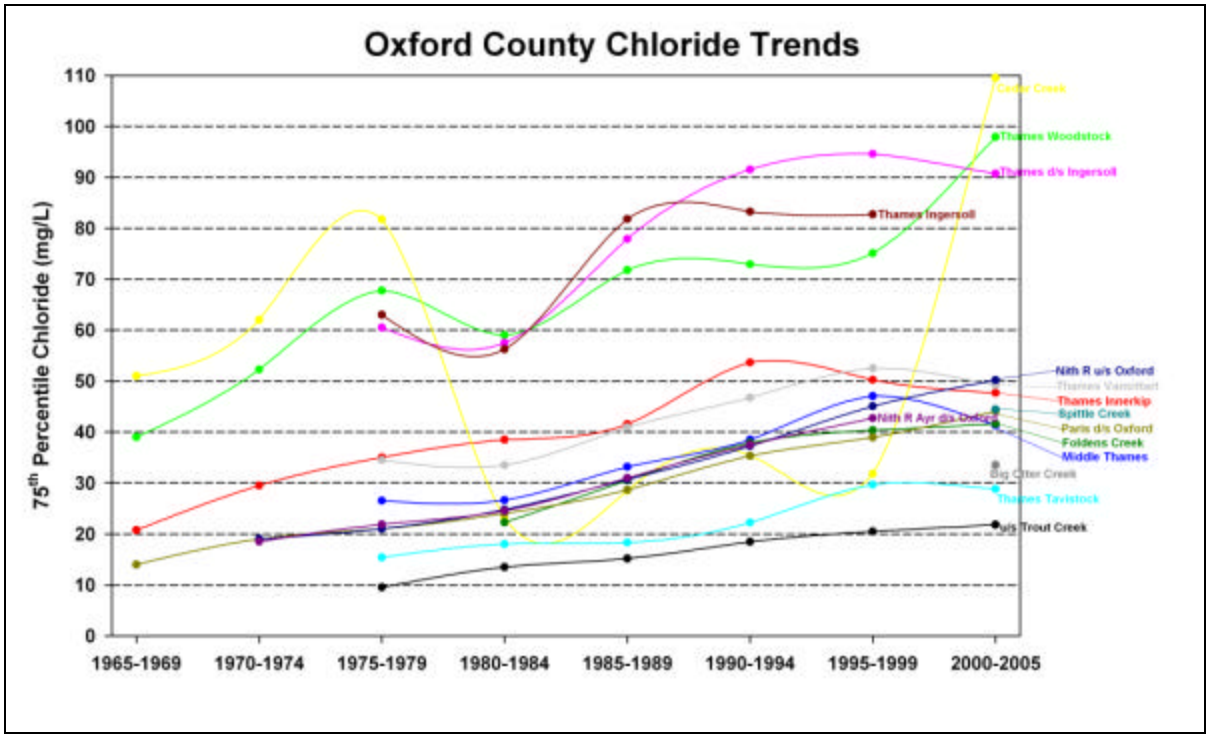
Sources: The highest loadings of chloride are typically associated with the application and storage of road salt (e.g. calcium chloride). Urban streams tend to have the highest chloride concentrations.

Standards: The Ontario Drinking Water Standard (aesthetic objective) is 250 mg/L. Ontario does not have a Provincial Water Quality Objective for aquatic life. An Environment Canada/Health Canada assessment report (2001) documents toxicity for sensitive aquatic species at 210 mg/L. British Columbia recommends a guideline of 600 mg/L for acute exposure and 150 mg/L (30 day average) for chronic exposure to protect sensitive aquatic species.

Monitoring Results: Since the 1960's and 1970's chloride levels at all long-term monitoring sites in Oxford County have shown a continual increase but concentrations remain below drinking water and aquatic health toxicity levels. This increasing trend is occurring across the Province. Most Oxford sites have doubled their concentration of chloride over this time period.

- Graph below show, top to bottom: Cedar Cr, Thames Woodstock, Thames d/s Ingersoll, Thames Ingersoll, Nith u/s Oxford, Thames Vansittart, Spittler Creek, Nith R Ayr, Paris d/s Oxford, Foldens Cr, Middle Thames, Big Otter Cr, Thames Tavistock, us Trout Cr
- Highest current levels of chloride are at Cedar Creek, Thames at Woodstock, and Thames downstream of Ingersoll. In recent years Cedar Creek has had a major increase in chloride levels.

Figure F.4. Chloride Trends

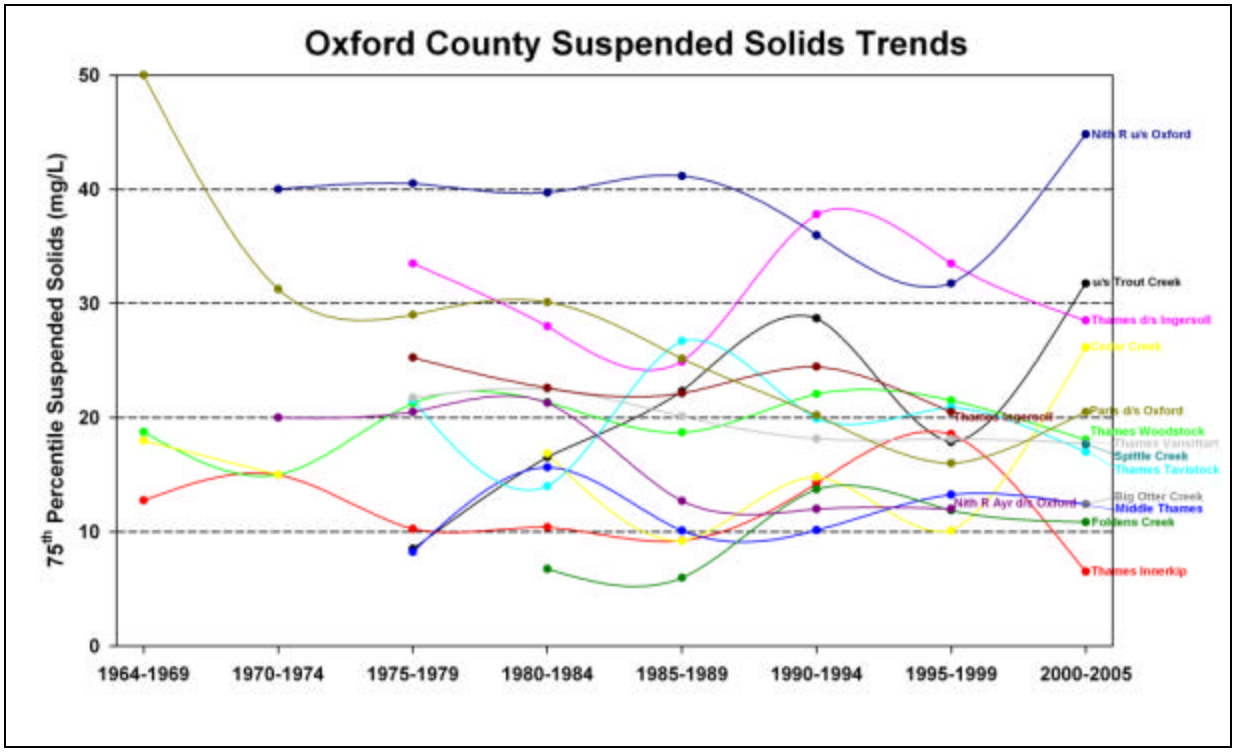


F.7 Suspended Solids

Fate and Behaviour: Suspended solids consist of silt, clay, and fine particles of organic and inorganic matter. These particles are significant carriers of phosphorus, metals, and other hazardous contaminants. Suspended solids can be detrimental to aquatic organisms including fish (spawning beds, damage gills, etc). Oxygen levels in the stream can be impaired by organic solids from sources such as wastewater treatment plants and storm sewers.
Sources: Soil erosion is the most common source of suspended solids to a watercourse. Suspended solids from urban sources appear in storm water and combined sewer runoff during storm events. Erosion of soil from cultivated land, construction/development sites and eroded stream banks all contribute sediment to surface water. Natural erosion of streambeds and banks are also sources.
Standards: There are no established standards for suspended solids. Turbid water is undesirable for water supplies, healthy aquatic life, recreation and aesthetics. Suspended solids can also transport quantities of trace contaminants.
Monitoring Results:

- Graph below shows, top to bottom: Nith R upstream Oxford, upstream Trout Cr, Cedar Cr, Paris downstream of Oxford, Thames Ingersoll, Thames Woodstock, Thames Vansittart, Spittler Creek, Thames Tavistock, Big Otter Cr, Nith R Ayr, Middle Thames, Foldens Cr, Thames Innerkip
- While there is fluctuation in concentrations, overall levels of suspended solids at most sites in the County have remained consistent over the long term.
- The site at Paris downstream of Oxford has shown decreasing levels of suspended solids since 1960's. Sediment levels in upstream Trout Creek have increased over the sampling period. Wildwood Reservoir acts as a sediment and nutrient settling basin, decreasing suspended solids in downstream Trout creek.

Figure F.5. Suspended Solids Trends



F.8 Copper

Fate and Behaviour: Copper is an essential element that can be toxic to aquatic life at elevated levels. Metals including copper, lead, and zinc can bio-accumulate in fish, wildlife, and humans causing long-term health effects. Metals are long lasting in the environment where they tend to accumulate in streambed sediments.

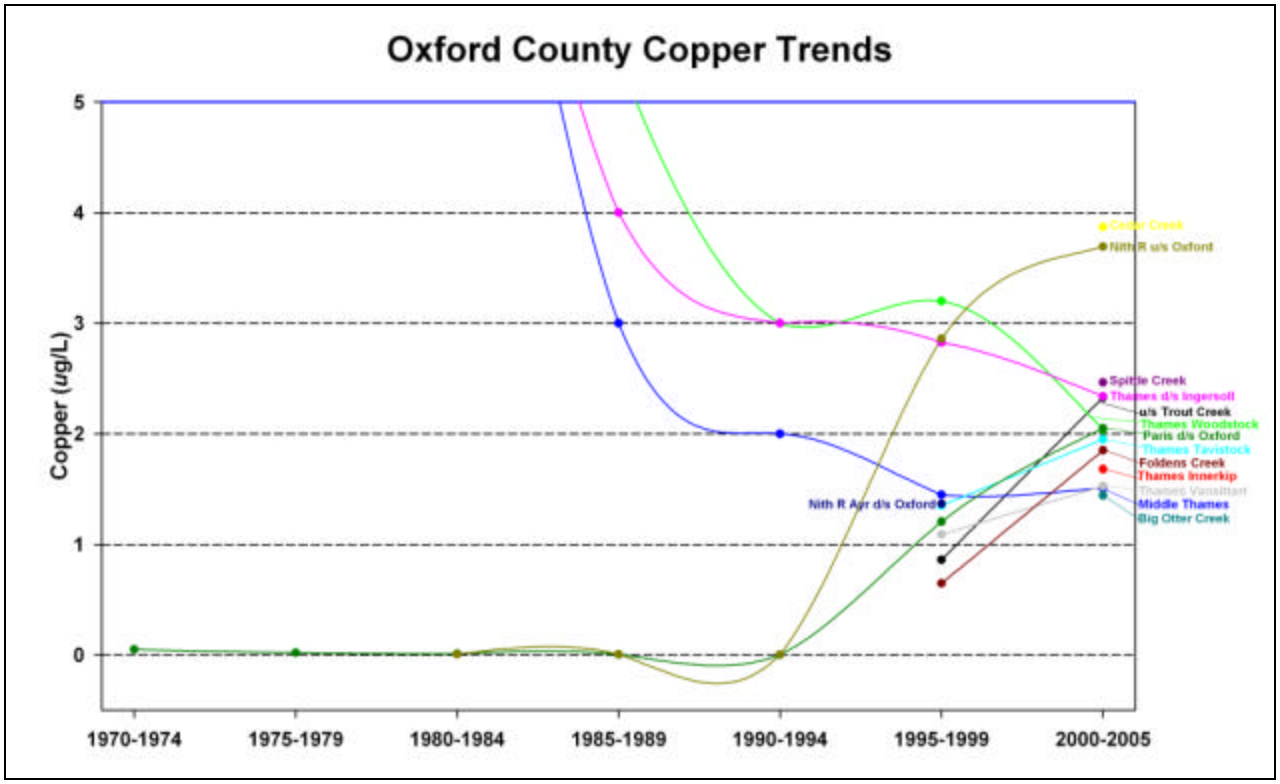
Sources: Anthropogenic sources which can impact on water quality include plumbing fixtures and pipes, textile manufacturing, paints, electrical conductors, wood preservatives, pesticides, fungicides, and sewage treatment plant effluent.

Standards: The Provincial Water Quality Objective for copper is 5 ug/L for healthy aquatic life. The Ontario Drinking Water Standard is 1 mg/L (aesthetic objective).

Monitoring Results:

- Graph below shows, top to bottom: Cedar Cr, Nith upstream of Oxford, Spittler Creek, Thames downstream of Ingersoll, upstream of Trout Cr, Thames Woostock, Paris downstream of Oxford, Thames Tavistock, Foldens Cr, Thames Innerkip, Thames Vansittart, Middle Thames, Big Otter Cr
- Current concentrations of copper fall well below the Ontario Drinking Water Standard (aesthetic objective) and the Provincial Water Quality Objective for the protection of aquatic life at all Oxford County sites.
- Since the 1980's, there has been a significant decrease in copper concentrations at the Thames downstream of Ingersoll, the Thames at Woodstock, and the Middle Thames. These sites dropped from above the guideline for aquatic life to well below the guideline.
- In recent years copper in the Nith River upstream of Oxford and at Paris has been increasing but remains below guide line levels.

Figure F.6. Copper Trends



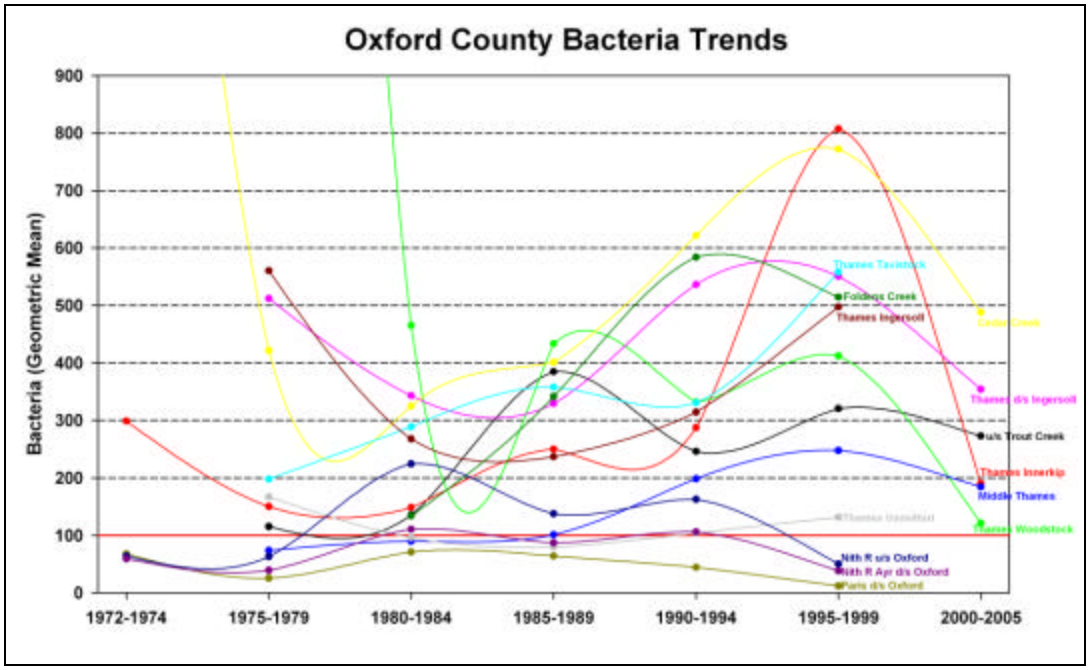
F.9 Bacteria

Fate and Behaviour: Escherichia coli (E.coli) is a type of fecal bacteria that is monitored as an indicator of other pathogens present in human and animal waste. Many of these pathogens such as Giardia and Cryptospiridium are more difficult to detect. Bacteria in surface water can also contaminate groundwater, putting drinking water sources at risk. Bacteria can enter a watercourse and survive for many months, especially in nutrient-rich sediments.
Sources: E. coli and other fecal bacteria are found in the feces of humans and animals. Potential sources of fecal bacteria include runoff from biosolids/sewage or livestock waste application, faulty private septic systems, inadequate manure storage, and urban storm water runoff.
Standards: The Provincial Water Quality Objective for recreational waters is 100 *E. coli*/ 100mL. The Ontario Drinking Water Standard for bacteria is that there should be no bacteria present in a drinking water supply.
Monitoring Results:

- Graph below shows, top to bottom: Thames Tavistock, Foldens Cr, Thames Ingersoll, Cedar Cr, Thames downstream of Ingersoll, upstream of Trout Cr, Thames Innerkip, Middle Thames, Thames Vansittart, Thames Woodstock, Nith R upstream of Oxford, Nith R Ayr, Paris downstream Oxford
- Concentrations of *E. coli* bacteria are routinely above the Provincial recreational guideline for all Oxford sites, except the Nith sites which are frequently low and below the guideline.
- Highest levels of *E. coli* are at Cedar Creek and Thames downstream of Ingersoll. These sites have 25% of samples over 3 times the recreational guideline.
- In recent years all sites have shown improvement.

The PWQMN discontinued bacteria monitoring in 1999 and only six long-term sites are currently monitored through a partnership with the Ministry of Health. Before 1995, the parameter monitored was fecal coliforms; then starting in 1995 the bacteria indicator became *E.coli*. Since the data is comparable, the data was pooled together to form a longer time series.

Figure F.7. Bacteria Trends



F.10 Technical Guidance

Continue to collect long-term monitoring data through the PWQMN at current sites to assess environmental change in Oxford County's rivers over time.

Implement programs that address point and non-point source pollution to reduce sediments, nutrients, chloride, and bacteria in watercourses in Oxford County.

References

Canadian Council of Ministries of the Environment. 2002. *Canadian water quality guidelines for the protection of aquatic life.*