Appendix C

Fullarton Pond Water Quality Assessment

Prepared By:

Karla Young

December 9, 2016

Contents

List of Figures

Purpose and Background

Fullarton Pond is located just south of the community of Fullarton, has an upstream drainage area of 408 hectares, and is within the larger Glengowan subwatershed located along the North Thames River. The headwaters flow into the pond through the Neil Drain. The purpose of this study was to initiate monitoring in 2015 to give a general assessment of water quality conditions in the pond and immediately upstream and downstream. **This monitoring gives us a very narrow snapshot of water quality and is limited to the conditions of 3 sampling occasions from June to September in 2015 and with one year of past monitoring data in 1986 being evaluated as well.**

As part of an evaluation of water quality in Fullarton Pond, 3 samples were taken in 2015 at 3 locations, one upstream, one in pond, and one downstream (see Figure 1).

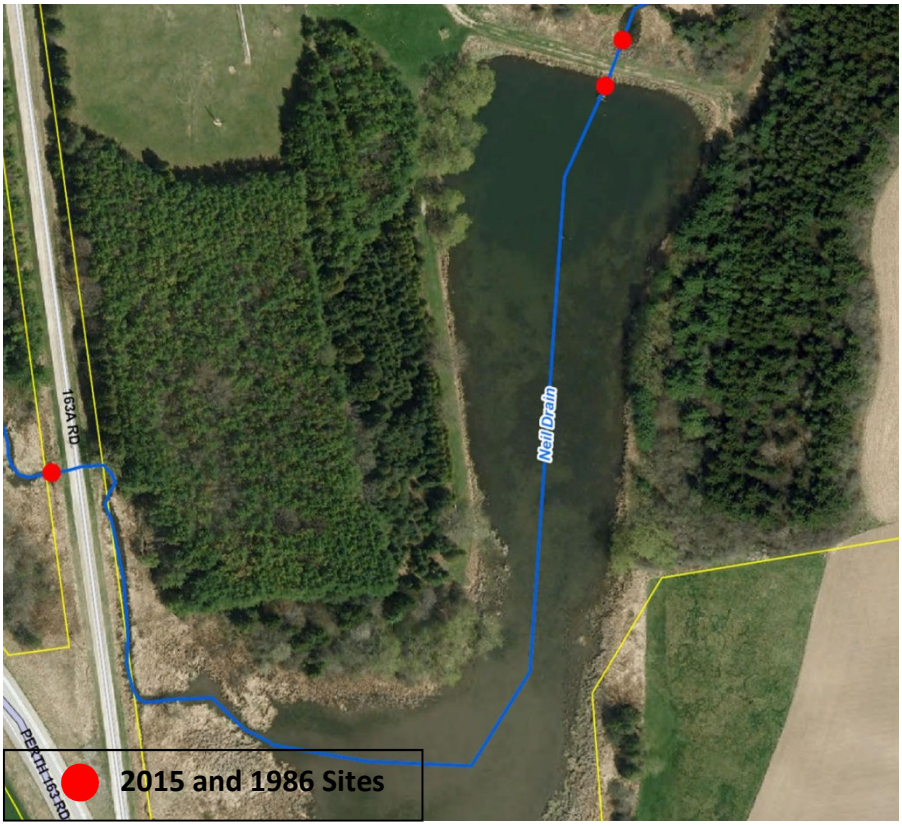

Figure 1: Fullarton Pond water quality sampling sites

Fullarton Pond also had one year of historical data (1986) and this was included in the evaluation of the results. Two of the three samples were taken during low flow conditions. The dry conditions in the summer and fall of 2015 resulted in minimal opportunity to monitor runoff conditions. Only one date had rain with full runoff conditions (June 1). Samples were analysed at ALS Laboratories in London.

Samples were analyzed for Nitrate, Nitrite, Total Kjeldahl Nitrogen, Total Phosphorus, Orthophosphate, *E. coli*, Chloride, and Suspended Solids. Field measurements were taken with a YSI multi-parameter meter for Dissolved Oxygen, pH, Conductivity, and Temperature. Continuous temperature measurements were taken from June 1 to September 23 in 2015 and from June 1 to July 20 in 2016 using a datalogger recording in half hour intervals.

Results: Water Chemistry and Bacteria

Results are provided for seven parameters related to land use activities.

Temperature

Fate and Behaviour: Water temperature in the river system varies with seasonal changes and also throughout the day, warming in the daytime and cooling in the evening and overnight. Water temperature can have an effect on water quality and the water's ability to hold dissolved oxygen. As water warms, it has a reduced ability to retain oxygen. Optimizing cooler temperatures is desired to maintain oxygen levels and reduce excess algae growth. This can help to support diverse and healthy fish communities.

Sources: Water temperatures can be cooled by groundwater inputs, stream shading, and natural deeper channel flow. Water temperatures can be warmed by widened channelized streams, ponding, and reduced shading and tree cover.

Standards: There is no standard for temperature but the Ministry of Environment and Climate Change states that the natural thermal regime of any body of water shall not be altered so as to impair the quality of the natural environment. In particular, the diversity, distribution and abundance of plant and animal life shall not be significantly changed.

Monitoring Results:

- The temperatures upstream in 2016 are consistently cooler than downstream temperatures indicating the pond has a warming effect.
- The difference in temperature in 2015 from upstream to downstream ranges from 0 to 2.3C, with an average difference of only 0.5C change.
- The difference in temperature in 2016 from upstream to downstream ranges from 4 to over 7C, with an average difference of almost 6C change and the difference becoming greater as the summer progresses.
- 2016 was a very dry summer with little precipitation which could account for the vast difference from 2015. There is a groundwater source upstream which could also explain why the upstream is so much cooler with the water warming in the pond before it reaches downstream.
- For both upstream and downstream, the stream temperature shows a diurnal pattern with day time highs and night time lows.

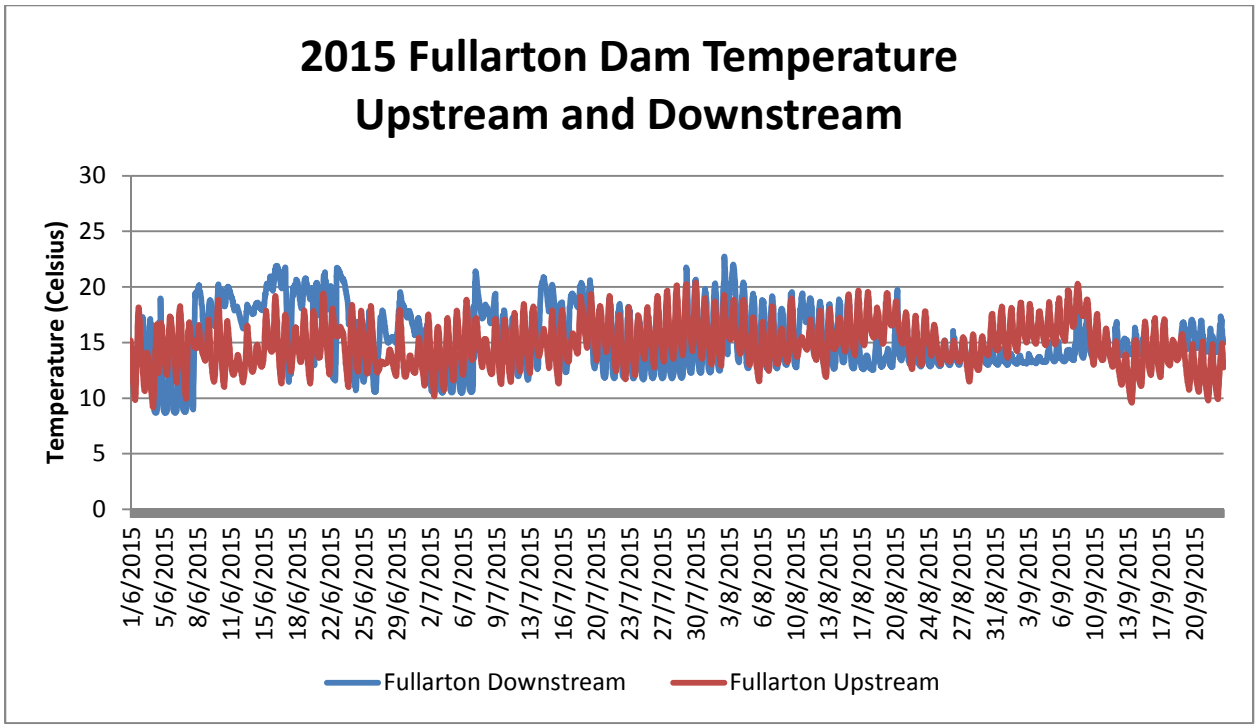

Figure 2: 2015 Fullarton Pond continuous temperature upstream and downstream

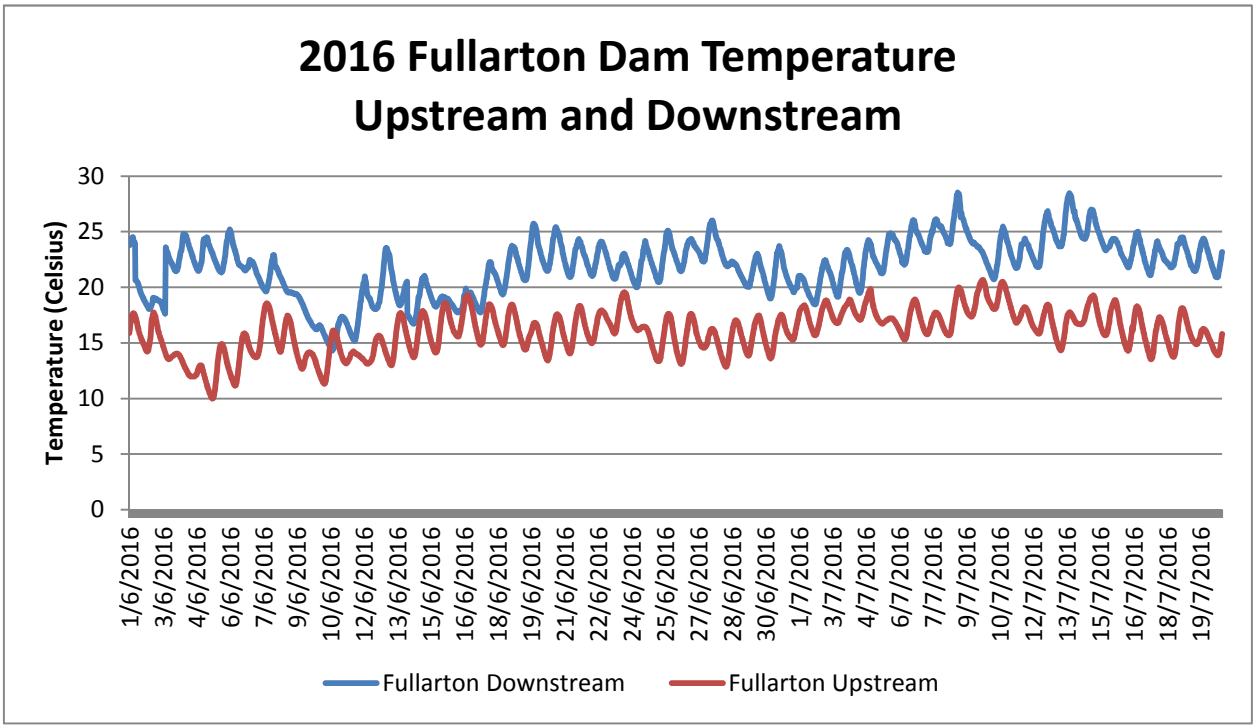

Figure 3: 2016 Fullarton Pond continuous temperature upstream and downstream

E. coli Bacteria

Fate and Behavior: *Escherichia coli* (*E. coli*) are a type of fecal bacteria found in human and animal waste. Their presence in water indicates fecal contamination. *E. coli* are a strong indicator for the presence of other pathogens found in human and animal waste.

Sources: Potential sources of fecal bacteria in a watershed include upstream runoff from biosolids/sewage, livestock or wildlife waste, faulty private septic systems, and other stormwater runoff.

Standards: The Provincial Water Quality Objective (PWQO) for recreational waters is 100 *E. coli*/100 mL. This guideline is used as a target for comparison, recognizing that Fullarton Pond is not monitored as recreational water.

Monitoring Results:

- Concentrations of *E. coli* bacteria for upstream samples are all above the provincial recreational guideline and the pond and downstream samples are below or near the guideline.
- 2015 *E. coli* levels are varied at samples upstream, in the pond and downstream with results in range of the Thames River watershed. On June 15 the pond levels were higher than upstream and downstream and the September 1 upstream levels were higher than in pond and downstream.
- In the 1986 samples, the upstream levels are consistently higher than in the pond and downstream.

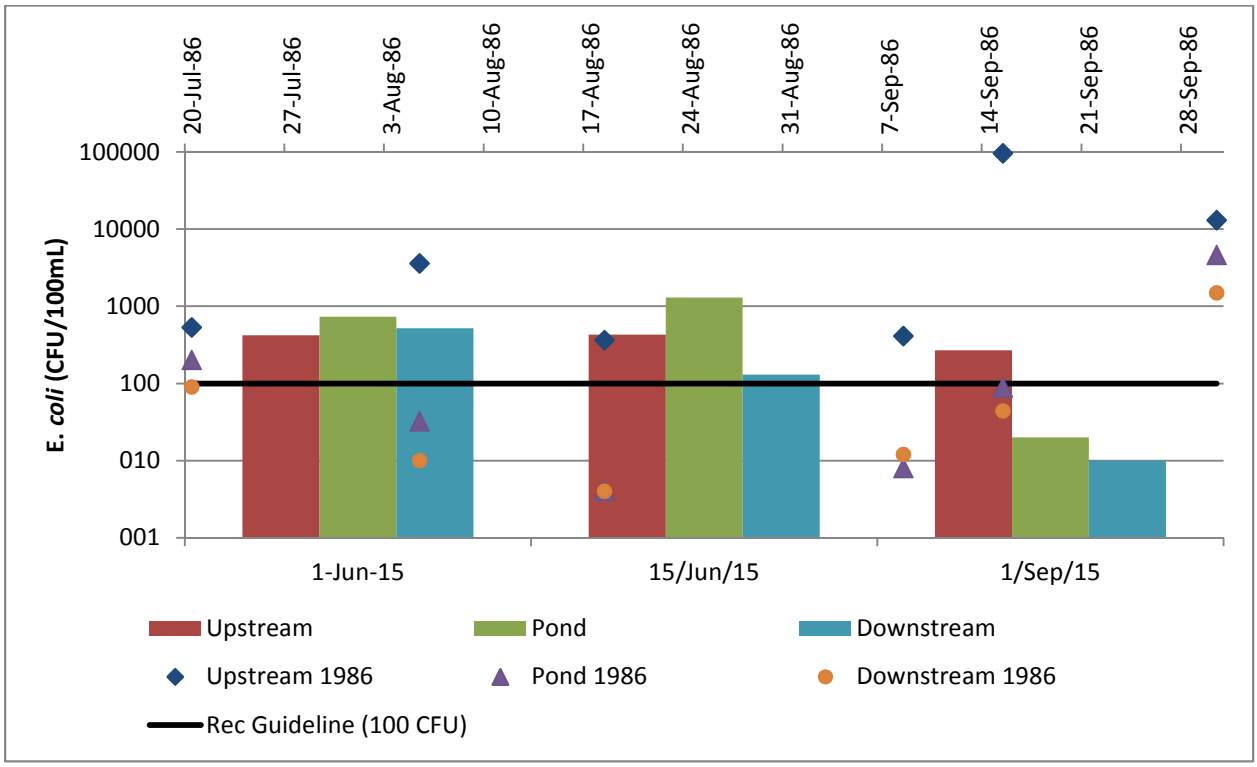

Figure 4: E. coli bacteria 1986 and 2015 (Log Scale)

Total Phosphorus and Orthophosphate

Fate and Behavior: Phosphorus is not directly toxic to aquatic life, but elevated concentrations can lead to undesirable changes in a watercourse including excess plant growth, reduced oxygen levels, reduced biodiversity, and harmful algae blooms. Orthophosphate, which is a form of phosphorus most biologically available to plants, was also measured.

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

Standards: Ontario has an interim Provincial Water Quality Objective (PWQO) of 30 *u*g/L of total phosphorus to prevent the nuisance growth of algae.

Monitoring Results:

- In 2015 concentrations of total phosphorus were low and close to the Provincial Objective except for the pond site which was elevated on June 15 and September 1.
- The 1986 levels were varied with more than half above the Provincial Objective. The upstream site was generally higher than the pond and downstream levels.
- Orthophosphate levels are low. The lowest numbers are in the mid to late summer and early fall when plant uptake of this more biologically available form of phosphorus is at its peak. The 1986 levels were also low except for the September levels on the 15th and 30th when the levels became elevated.

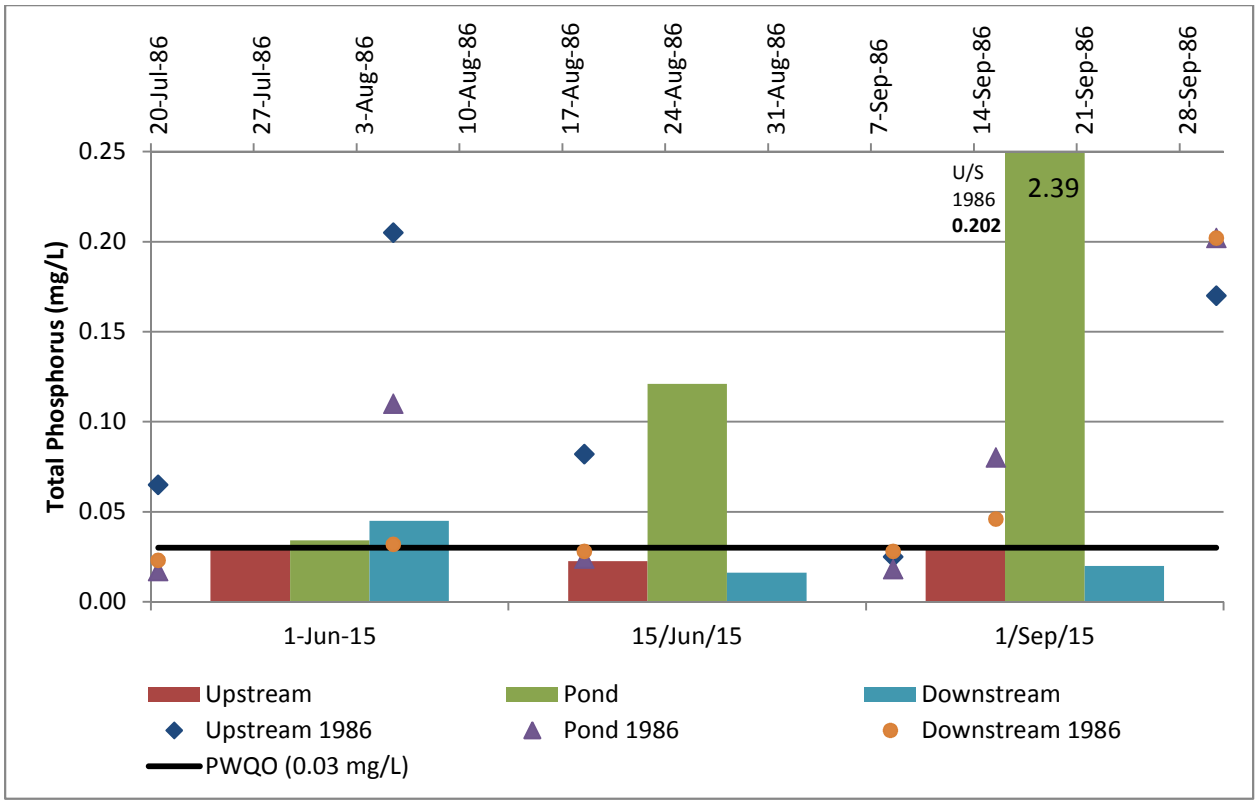

Figure 5: Total Phosphorus 1986 and 2015

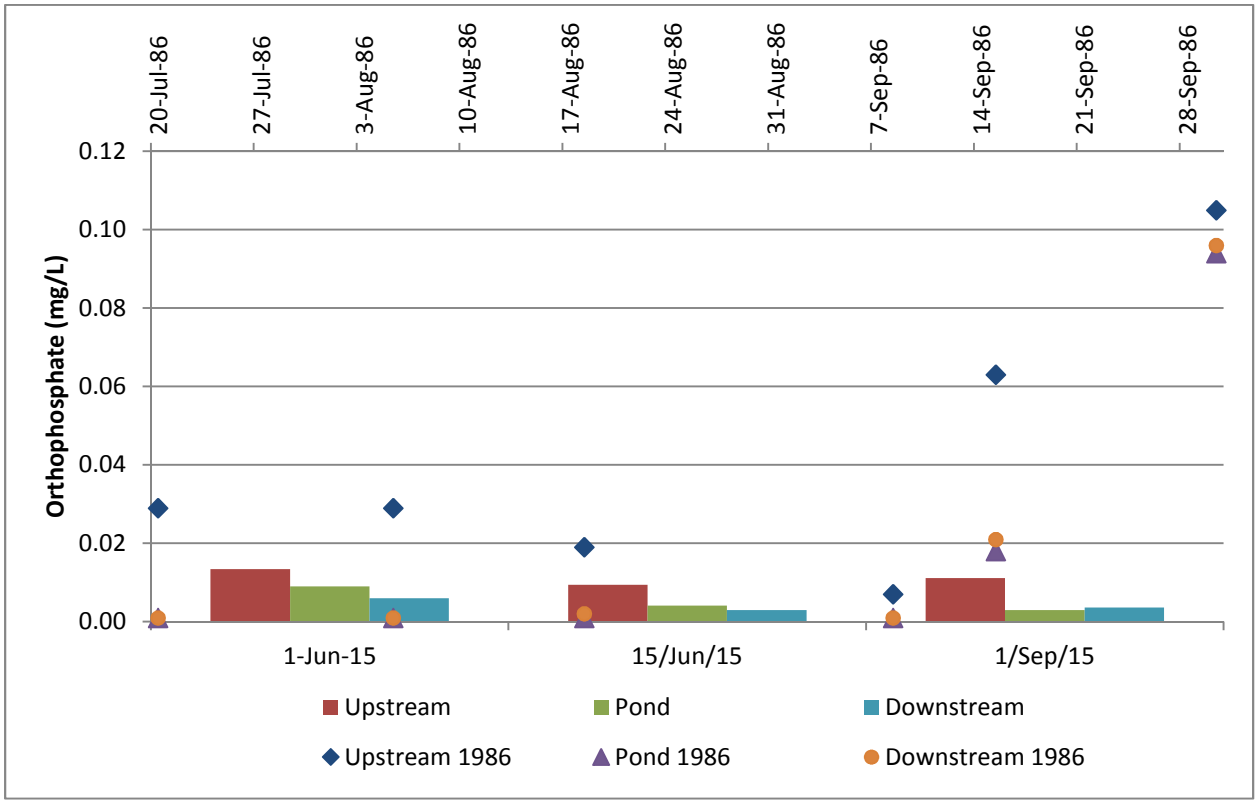

Figure 6: Orthophosphate 1986 and 2015

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.

Sources: Nitrate sources can include sewage/animal waste, commercial fertilizers, septic systems, atmospheric deposition and natural decomposition of organic wastes.

Standards: Ontario does not have a Provincial Water Quality Objective for aquatic life but the Canadian Environmental Quality Guideline (CEQG) to protect aquatic life from direct toxicity to nitrate is 2.93 mg/L.

Monitoring Results:

- For 2015 the nitrate levels are consistently above the aquatic life guideline but within range of typical levels for the Thames River watershed. On the June 1 sample the levels were all similar but the June 15 and September 1 upstream levels were higher than in the pond and downstream.
- Nitrates in the 1986 samples were also consistently above the guideline and the upstream levels were always higher than the pond and downstream levels.

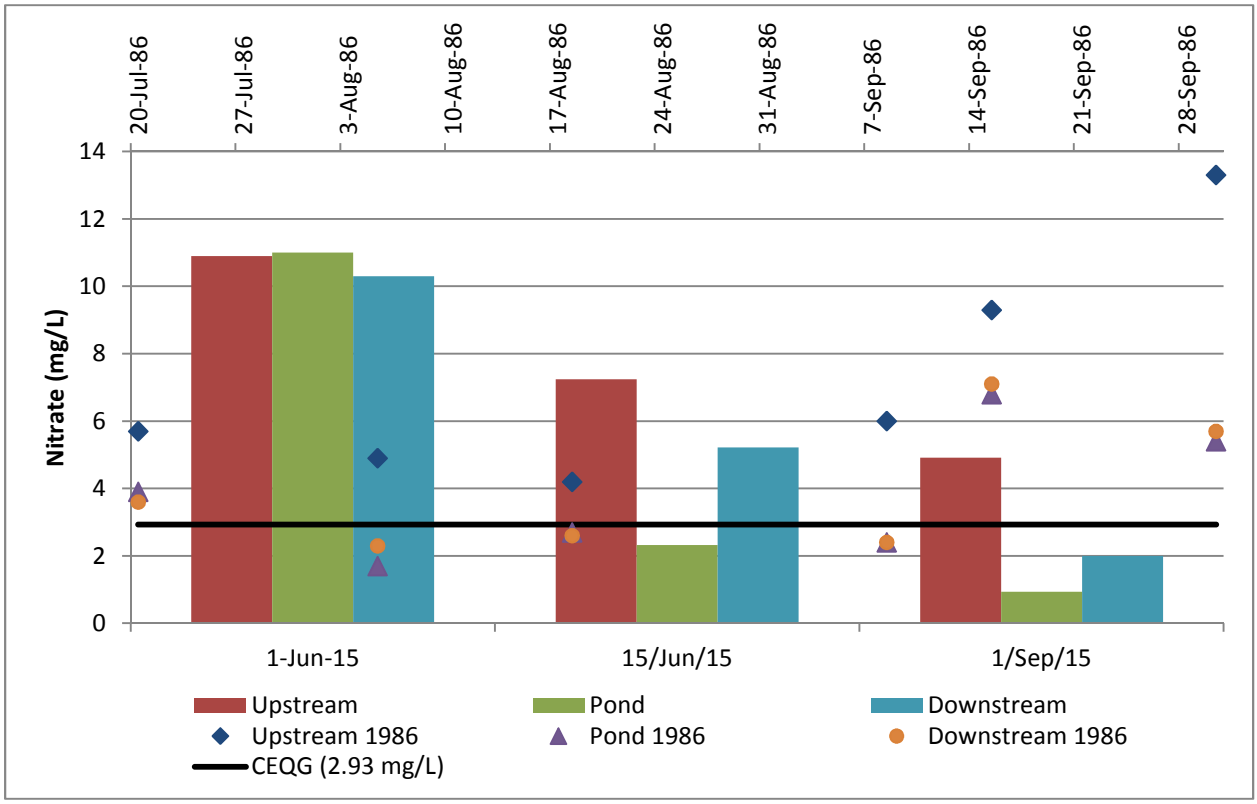

Figure 7: Nitrate 1986 and 2015

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 water 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: Ontario does not have a Provincial Water Quality Objective for aquatic life. A Canadian Environmental Quality Guideline (CEQG) for the long-term exposure of toxicity for sensitive aquatic species is 120 mg/L.

Monitoring Results:

- All samples were well below the guideline for chloride for both 2015 and 1986 which is expected in a rural area.
- The timing of sampling for this study did not provide data for winter or early spring runoff when chloride levels would be expected to be higher as a result of road salt runoff.

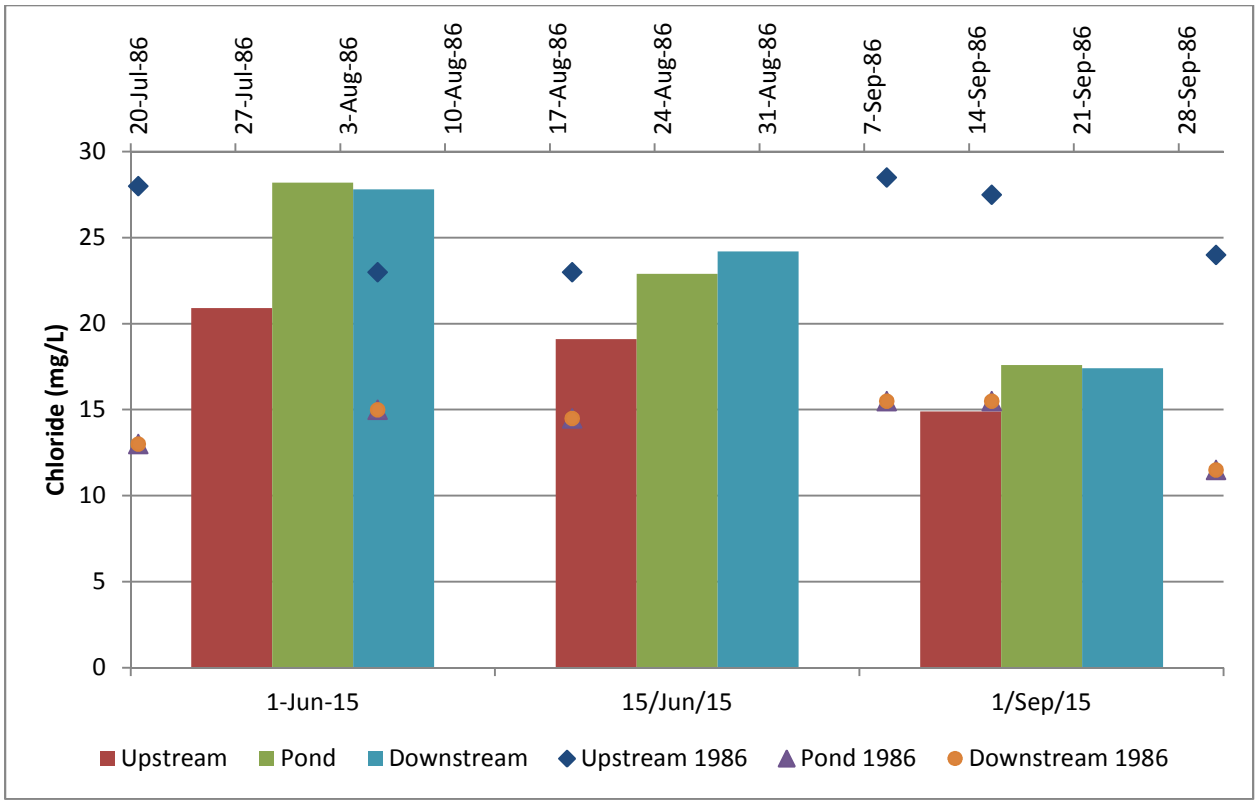

Figure 8: Chloride 1986 and 2015

Suspended Solids

Fate and Behaviour: Suspended solids consist of silt, clay, and fine particles of organic and inorganic matter. These particles can be carriers of phosphorus, metals, and other contaminants. Suspended solids can be detrimental to aquatic organisms including fish.

Sources: Soil erosion is the most common source of suspended solids to a watercourse. This can be from cultivated land, construction, development, eroded stream banks or natural erosion of stream beds.

Standards: There is no established standard for suspended solids. However, turbid water is undesirable for healthy aquatic life, recreation, and aesthetics.

Monitoring Results:

- Suspended solid levels are fairly low compared to other sites across the Upper Thames watershed.
- Samples in the pond for 2015 were higher than the upstream and downstream samples.
- The upstream samples for 1986 were always higher than the downstream and pond samples except on September 30.

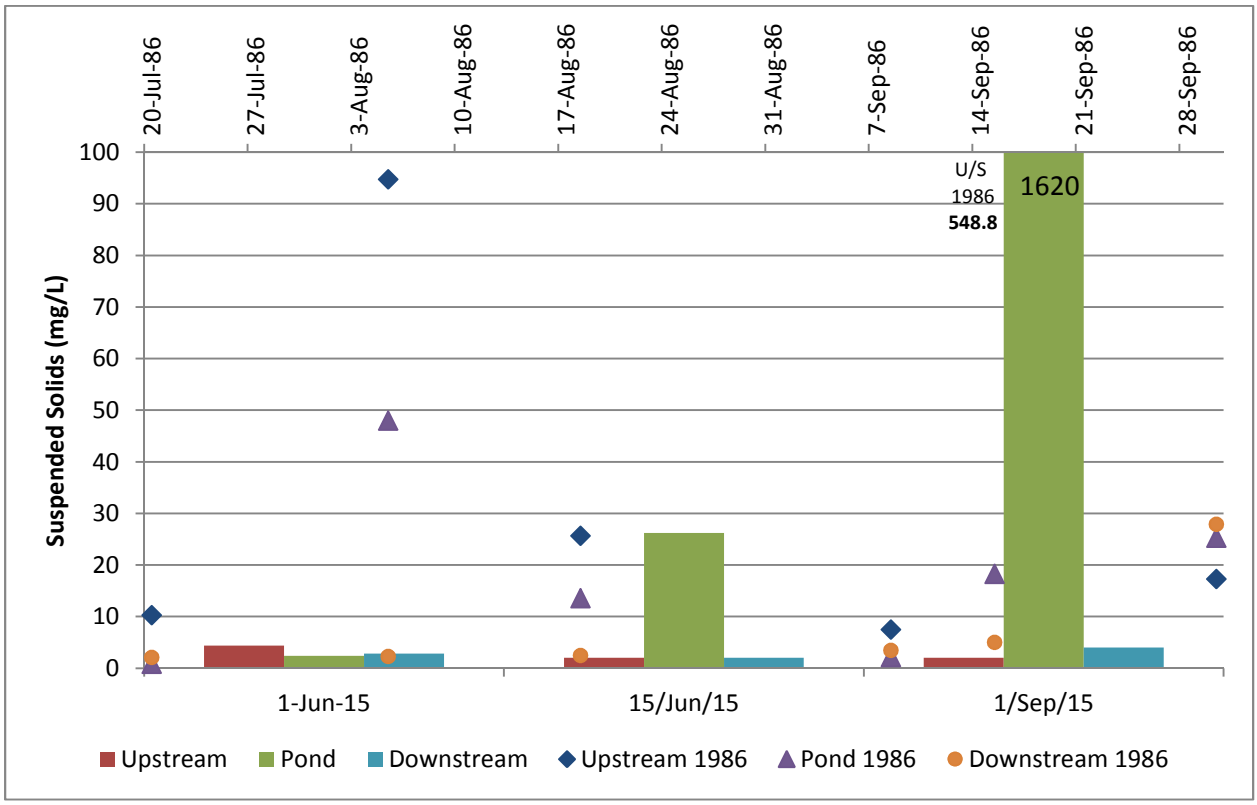

Figure 9: Suspended Solids 1986 and 2015

Dissolved Oxygen

Dissolved oxygen is important for fish and other aquatic life. Dissolved oxygen levels below 4 mg/L can have an adverse effect on fish communities. Cooler water temperatures help to retain dissolved oxygen in water. Water flowing through natural stream channels with rock/riffles improves oxygen levels. Stagnant areas and decaying vegetation reduce oxygen levels.

Results: Spot field measurements were taken for dissolved oxygen using the YSI meter. This limited data gives a general indication of oxygen conditions at the time of sampling recognizing dissolved oxygen levels vary throughout the day. Readings showed good oxygen levels ranging from 6 mg/l to 12 mg/l and upstream and downstream readings similar.

Discussion

- In general, the water quality in the Neil Drain, where it was sampled upstream, downstream and in Fullarton Pond, showed levels typical of water quality seen in Upper Thames watershed streams for the parameters measured in 2015.
- On June 15 and September 1 of 2015 the pond levels of total phosphorus and suspended solids were elevated which could be a result of capturing sediment in the sampling process.
- Nitrate and E. *coli* levels were varied through the sampling time but within range of typical levels in the Thames River watershed. Chloride levels were quite low. This can be due to sampling timing, flow conditions, and this being a rural stream.
- 2016 was a very dry summer with little precipitation while 2015 had more normal precipitation so there was large difference in the temperature of the upstream and downstream. There are groundwater inputs in this area which explain why the 2016 temperatures are so much cooler upstream than downstream with the pond warming the water before it reaches downstream.
- Ponds can act as a settling basin for sediment and associated contaminants such as phosphorus, and these can accumulate in the bottom sediments. These contaminants can be resuspended when disturbed such as during more extreme flow conditions. They can also be discharged downstream through the outlet. Sampling of the bottom sediments would give an indication of any accumulation.