Fullarton Dam and Conservation Area

Existing Environmental Conditions

March 2017 Draft

UPPER THAMES RIVER
CONSERVATION AUTHORITY

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1.0 Introduction to Fullarton Conservation Area

This report describes much of the existing natural environment conditions for the Fullarton Dam and Conservation Area (Fullarton CA). This report includes measurement, inventory, analysis, and observations undertaken by Upper Thames River Conservation Authority (UTRCA) staff during 2015 and 2016 of sedimentation, water quality, aquatic environment, natural heritage, cultural setting, hydrotechnical and geotechnical, and limited hydrogeological background information. Similar information is gathered and interpreted routinely by the Authority in support of watershed focused environmental efforts.

This information will help with the assessment of the environmental conditions and how they may play a role in deciding the future of the dam.

1.1 History of Fullarton Conservation Area

As written in the "*Twenty Five years of Conservation on the Upper Thames Watershed 1947-1973",* the UTRCA purchased 77 acres of land, which contained a "good trout stream" (known as Neil Drain) in 1953, for recreational purposes. Development of the conservation area started in September, 1955; an earthen dam nine feet high and 300 feet long was completed that November, and the five-acre pond was created in the spring of 1958. Fish habitat was enhanced in the pond when a large quantity of silt was removed and the pond deepened during the winter of 1966-67. In the spring of 1967, the pond was restocked with trout.

1.2 Current Uses of Fullarton Conservation Area

In 1964, UTRCA turned over four acres of land to the Township of Fullarton to create the "Fullarton Centennial Ball Park" (Upper Thames River Conservation Authority, 1973). The recreation centre currently consists of two baseball fields, a batting cage, playground, and a pavilion.

During the mid to late 1990s, two trails were constructed in the conservation area: a 500 m trail through the 1980 plantation, and an 800 m trail through the 1960 plantation. The trails, which are accessed from the conservation area parking lot, off Road 163A, are maintained in cooperation between the Upper Thames River Conservation Authority and the local Scouts group.

1.3 Management of Fullarton Conservation Area

Fullarton CA is currently under a five year renewable management agreement with the Municipality of West Perth. The Management Committee is comprised of one UTRCA staff, one West Perth staff, a West Perth councilperson, and a few interested local citizens. The agricultural land within the Fullarton CA boundary is leased with revenue generated from this lease being used for projects specifically benefitting Fullarton CA (B. Mackie, personal communications, 2016).

1.4 Description of the Neil Drain Catchment and Fullarton Conservation Area

Fullarton Dam and Conservation Area, which is part of the Glengowan watershed, is on Neil Drain, a tributary of the North Thames River. The Glengowan watershed drains an area of approximately 114 km^2, and includes portions of the Municipalities of West Perth (68%) and Perth South (32%). Land use within the Glengowan watershed is primarily agriculture (87%) with other land use including natural vegetation (12%), urban (1%), and water (<1%).

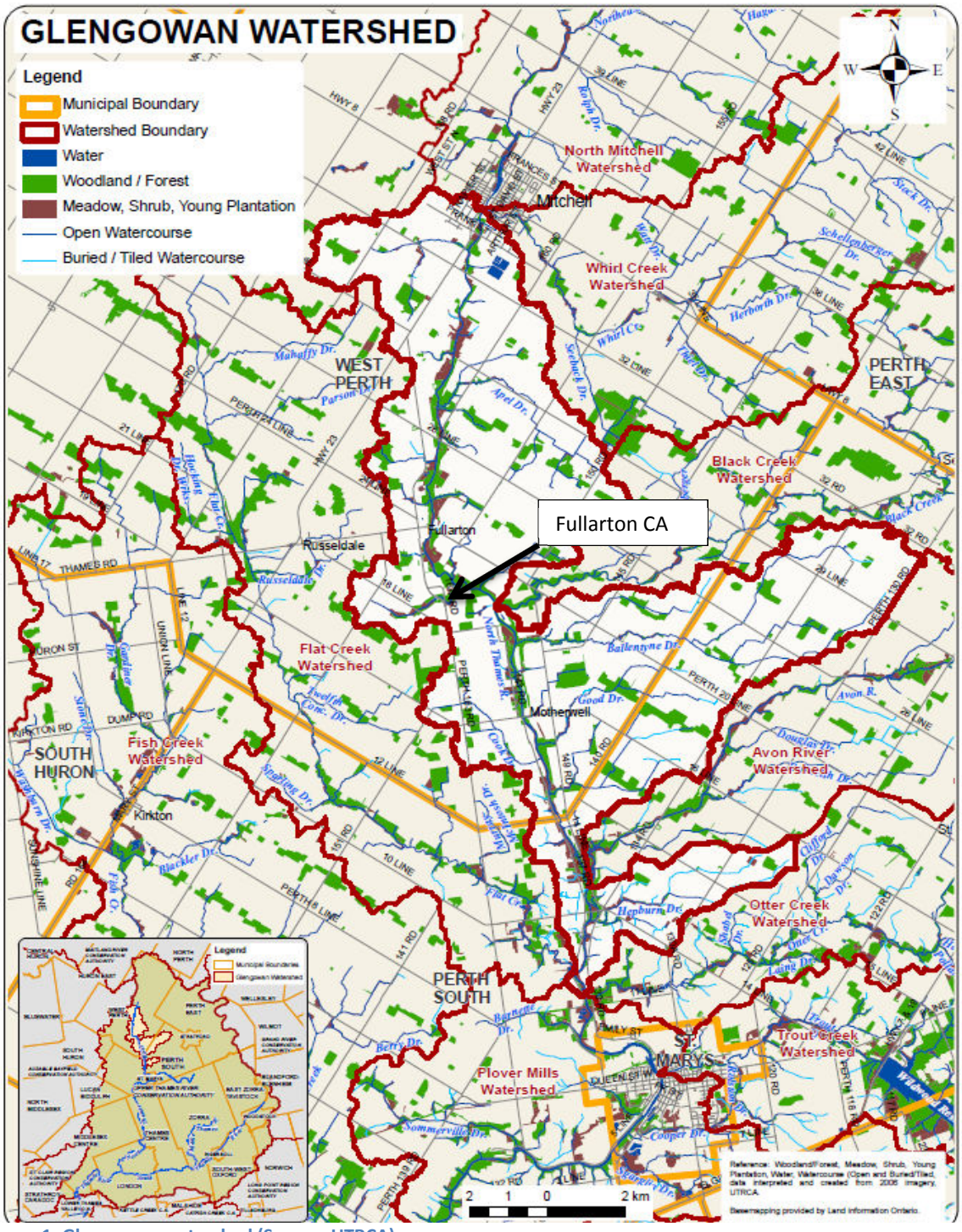

Figure 1: Glengowan watershed (Source: UTRCA)

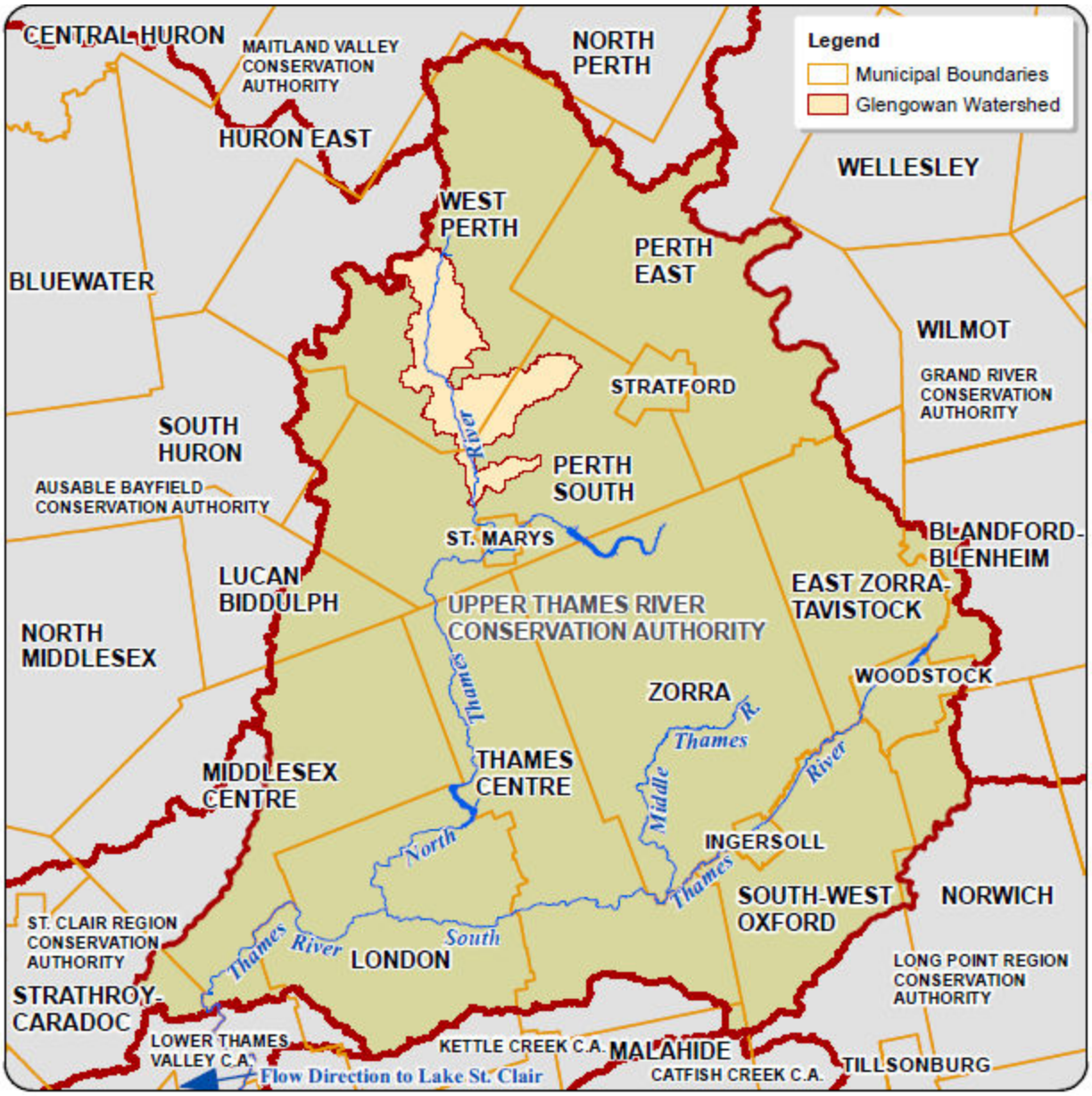

Figure 2: Glengowan watershed in relation to the Upper Thames watershed (Source: UTRCA)

The study area for the Fullarton Dam will include the lands within the Fullarton CA and adjacent lands as necessary. Fullarton CA is at 2999 Perth Road 163A in Perth County, Municipality of West Perth, Lot 15, Concession Mitchell Road East Side.

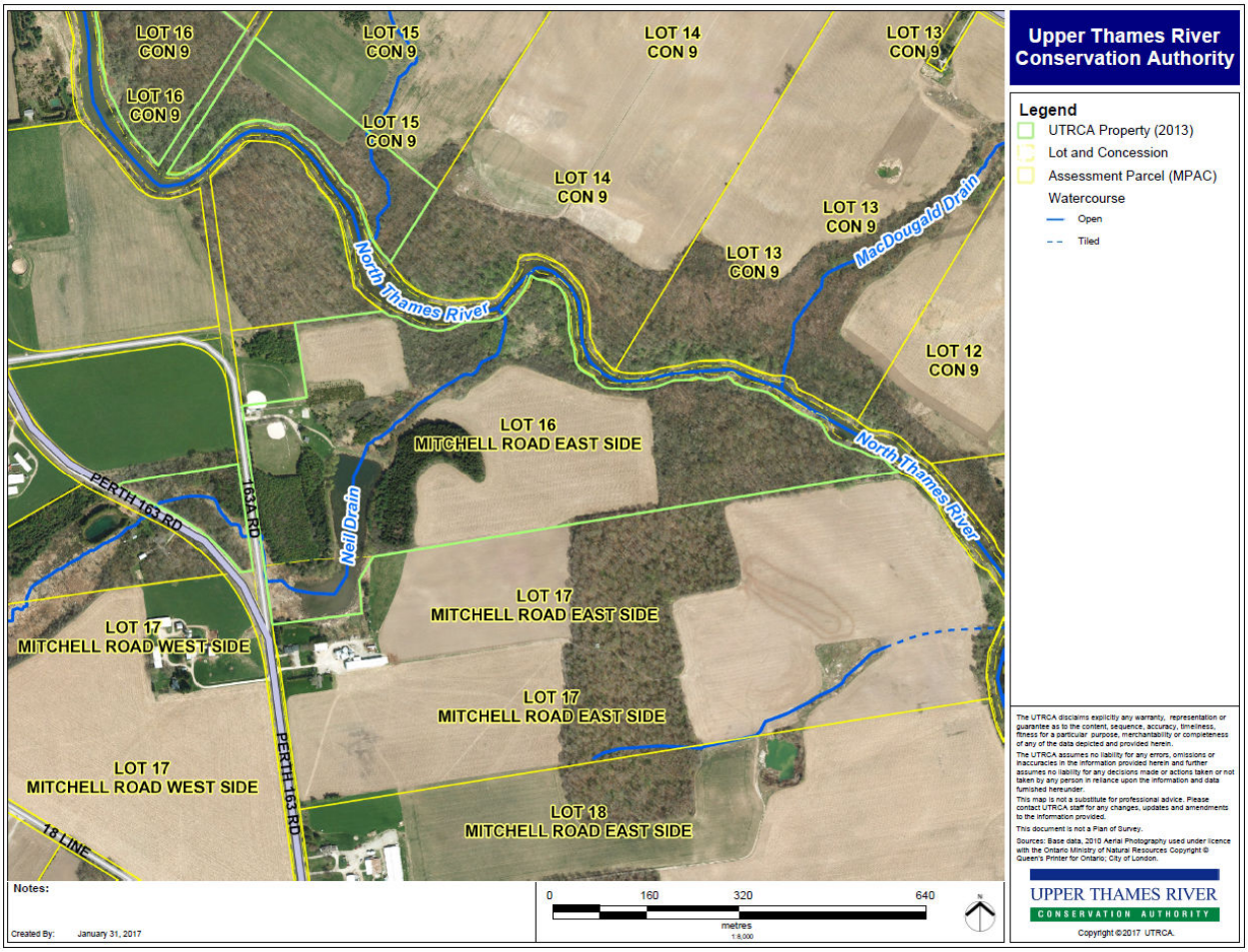

Figure 3: Fullarton Conservation Area (Source: UTRCA)

Fullarton CA is about 83 acres in area with 11 acres of plantation, 45 acres of natural woodland, and 27 acres of agricultural land. The reservoir/pond area is approximately five acres. UTRCA has planted conifers on two different occasions within the CA: on the east side of the pond in 1960, and on the west side of the pond in 1980. In 2015, 962 trees and shrubs were planted in an agricultural area at the north tip of the 1960 coniferous planting, as well as along the southern edge of the treed buffer along the North Thames River. The agricultural field north of the reservoir was planted with 3094 trees and shrubs in 2016 (see Figure 4). The east side of this former agricultural field was not planted with trees as it was under water due to beaver activity just downstream of the dam.

The conservation area has community involvement with two baseball fields, a volleyball court, a picnic shelter and two walking trails (600 and 800 m).

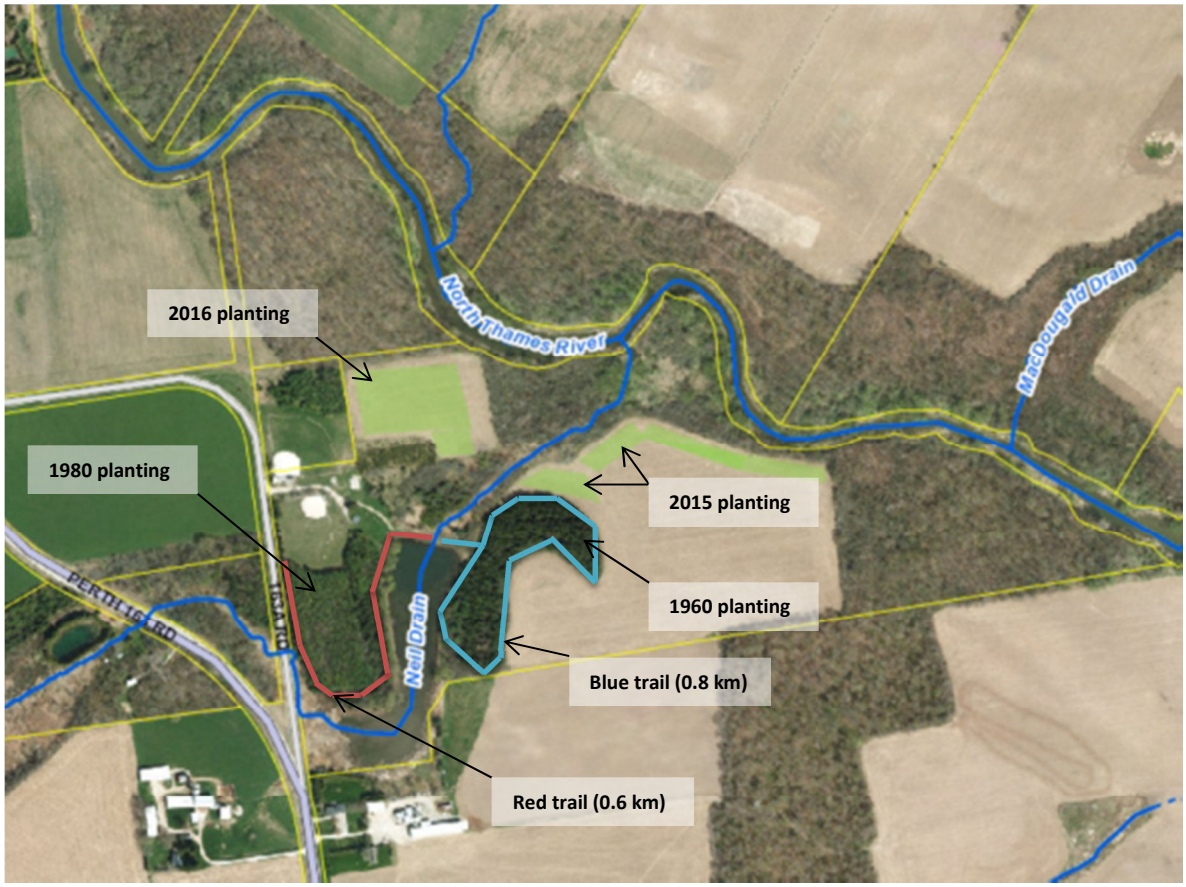

Figure 4: Planting sites and trail systems within Fullarton CA (Source: UTRCA)

More detailed information about various physical and biological features of the Fullarton Dam study area are discussed in the following.

2.0 Fullarton Dam Hydrotechnical and Geotechnical Review

The discharge facilities at the dam consist of a concrete drop inlet structure with a set of stop logs at the upstream face and an inverted V-shaped trash rack anchored to the top of the inlet. There is an emergency spillway located on the right (when facing downstream) or east bank. This is a lower section at the end of the embankment dam which is covered with cable-connected concrete blocks. The mouth of the spillway measured 9.5 m in length and appeared to be in good condition. The emergency spillway has a grassed discharge channel that runs parallel to the creek before joining it.

There are no permanent dwellings or development in the immediate downstream reach of the discharge channel. Overall, no potential incremental loss of life under flood conditions is expected. Incremental economic, social and environmental losses are not expected to exceed the VERY LOW category. The dam was designated as a VERY LOW Incremental Hazard Potential (IHP) structure. The Ministry of Natural Resources and Forestry (MNRF) updated the methodology for classifying the Hazard Potential associated with Dams after Fullarton Dam was previously assessed. Fullarton Dam has not been assessed using this updated methodology, but it is estimated that if assessed, it would continue to be assigned the lowest possible hazard classification. The embankment dam is approximately 3.4 m high and impounds a total estimated storage volume of 20 x 10^3 m^3. Based on the draft Ontario Dam Safety Guidelines, the dam has been designated as a SMALL dam.

Deterministic modeling results established that the 50-year return period, 3 day summer storm (peak of 17.7 m^3/s) is the Inflow Design Flood event and that the current dam does not have sufficient freeboard or capacity to pass this flood without the crest overtopping (Acres International, 2007).

The calculated factors of safety from the stability analysis performed by Naylor Engineering Associates determined that the embankment maintains high stability under steady state, rapid draw down, and seismic conditions (Naylor Engineering Associates, 2006).Both the Dam Safety Assessment by Acres International and the Geotechnical Investigation by Naylor Engineering Associates produced recommendations to maintain or improve the stability of the dam. These recommendations are listed in section 7.2 Retaining the Dam this document. The total cost to complete all of the dam stability recommendations is estimated at approximately $93,000 in 2010 dollars (R.J. Burnside, 2010).

The bottom of Fullarton reservoir was surveyed in late spring, 2016. Upstream of the reservoir was surveyed in February, 2017. Measurements were taken at the top of the sediment and below the sediment. The elevation below the sediment was determined by pushing the GPS rod through the sediment until a significant increase in resistance was felt which indicated the native reservoir bottom had been reached.

The Fullarton reservoir was previously surveyed on August 22, 2006, using a slightly different methodology. In the 2006 survey a GPS unit used to determine the horizontal position in the pond and a large rod was used to manually measure the vertical depth to the top of the sediment and the vertical

depth to the native bottom. The location position accuracy was less accurate in 2006 compared to the 2016 -17 accuracy.

The effect of Fullarton Dam on sediment transport is most evident at the upstream section of the pond between Station 150 and Station 250 (Figures 5 and 6), where the depth of sediment was on average approximately 0.6 m thick. For context the water depth (i.e. water surface to top of sediment) in this reach is less than 0.3 m, in other words less than half of the depth of sediment. At Fullarton Dam, the water flow rate below the elevation of the drop inlet to the discharge pipe is relatively low, which results in sediment that would normally be suspended in the watercourse to instead settle out. As the sediment accumulates in the reservoir, over time the open water surface area will decrease and the pond will take on wetland characteristics.

Figure 5: Stations of surveyed streambed (Source: UTRCA)

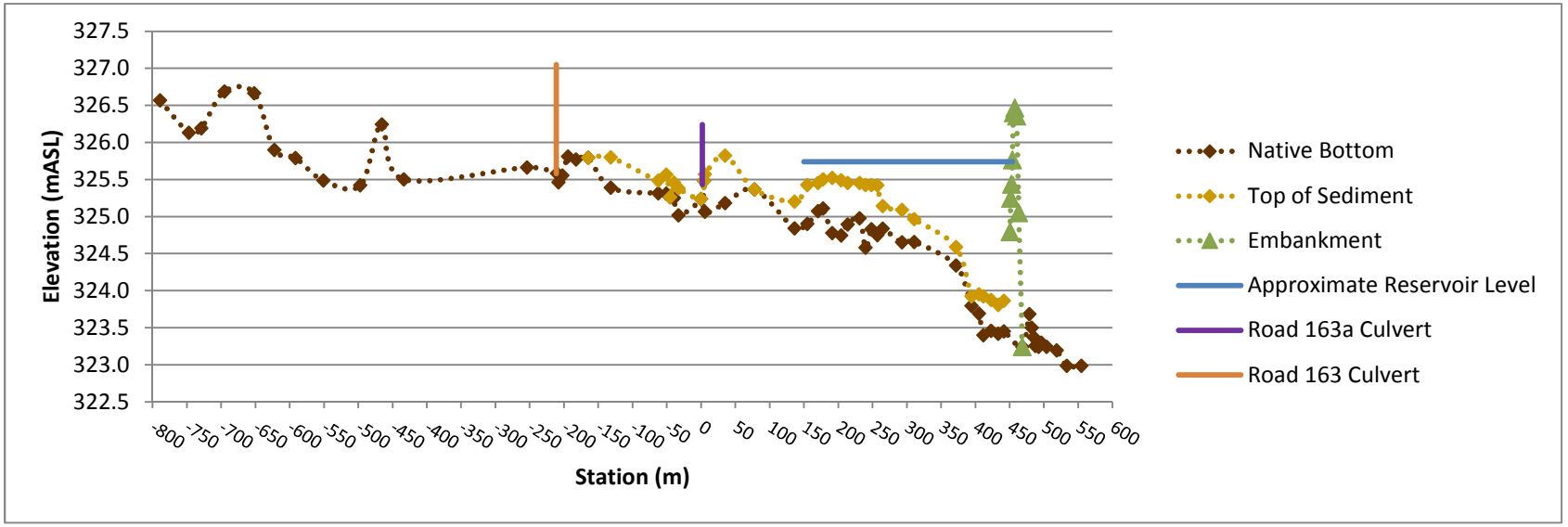

Figure 6: Profiles of streambed and top of sediment (Source: UTRCA)

There is some uncertainty in estimating the loading rate at Fullarton Pond. Records indicate that a large quantity of silt was removed and the pond was deepened in the winter of 1966/1967 (estimated as Jan 15, 1967), it was assumed that at this date there was no sediment in the pond. From the 2016 survey it was determined that in the pond there was approximately 6015 m^3 of sediment, this equates to a sediment accumulation rate of ~ 119 m^3 of sediment/year. From the 2006 survey it was determined that in the pond there was approximately 6400 m^3 of sediment, this equates to a sediment accumulation rate of ~ 158 m^3 of sediment/year. A number of factors that can be used to estimate soil loss and sediment accumulation (e.g. slope, land-use, and barriers), one important factor is the size of the catchment area. From the recent sediment accumulation/km^2 of catchment area per year calculated for Harrington and Embro the expected sediment accumulation rate would be ~ 95 m^3 of sediment accumulation per year. Taking all of this information in to account, a reasonable estimate of the sediment accumulation rate at Fullarton dam would be between 90 – 160 m^3 of sediment per year.

More information on the hydrotechnical assessment of Neil Drain and the geotechnical assessment of Fullarton Dam can be found in Appendix A: Fullarton Dam Hydrotechnical and Geotechnical Review.

3.0 Hydrogeology Assessment

A desktop evaluation of the hydrogeology at the Fullarton Conservation Area was completed using Ministry of the Environment and Climate Change (MOECC) well logs, surficial and bedrock geology mapping available from the Ontario Geological Survey. Figure 7 is a marked-up copy of the Surficial Geology and includes direction of groundwater flow, surface water catchment and physiography. In the Fullarton CA area, there is a shallow overburden aquifer and a deep bedrock aquifer. The bedrock aquifer is continuous across the regional area but likely is only relevant as a drinking water source. The shallow aquifer recharges the bedrock aquifer in the area.

The shallow aquifer occurs where the shallow porous media reaches a thickness to support a saturated zone known as a water table and parallels Neil Drain. A shallow water table map was constructed based on surface water elevations and well information (see Appendix B). The shallow aquifer is interpreted to be in direct communication with Neil Drain and the Thames River. The shallow aquifer is limited in lateral extent and is relatively thin reaching up to 5 m in thickness and less than 15 m depth along the drain. The shallow aquifer receives recharge from the entire surface water catchment but only reaches a thickness to accommodate a water table along the drain. Contribution from groundwater outside the surface water catchment area is from a buried geological feature known as an esker which extends westward of the catchment (Figure 7). The esker provides additional baseflow from outside the catchment area. In these hydrogeological settings, it is common to have groundwater dependent ecosystems such as wetlands and seeps.

The baseflow has not been measured in the area however, contribution from groundwater would be similar to other areas of the watershed which is in the range of 50-70% of flow in the drain is contributed from groundwater discharge. Due to the surficial geology and hydrogeology of the catchment, the contribution by groundwater (baseflow) to Fullarton dam and Neil drain is likely the higher end of the range. Groundwater transfers nutrients such as nitrate and other contaminants such

as road salt from the catchment to the drain. Nutrient contribution from groundwater has not been measured in the catchment. Groundwater discharge is greatest in the winter and spring but also maintains flow during the summer periods of low flow. Parts of the drain may dry out during the summer if the water table falls below the level of the base of the drain or river.

The surface water catchment area of the Fullarton Conservation Area is approximately 4.1 square kilometres. Discharge areas (drains, ponds and seeps and likely represent about 1% of catchment). The remaining catchment area is recharge areas for the shallow groundwater watershed. Groundwater recharge (or infiltration) (see Appendix B) varies across the catchment between 55-445 mm/year with the highest recharge of 445 mm/year occurring along the drain. High infiltration probably accounts for 10-15 percent of the surface water catchment area, while 80% of the area has an infiltration of 110 mm/year. Thus groundwater contribution (cold baseflow) in the catchment to Neil drain is significant which is reflected in the surface water temperature upstream of the dam.

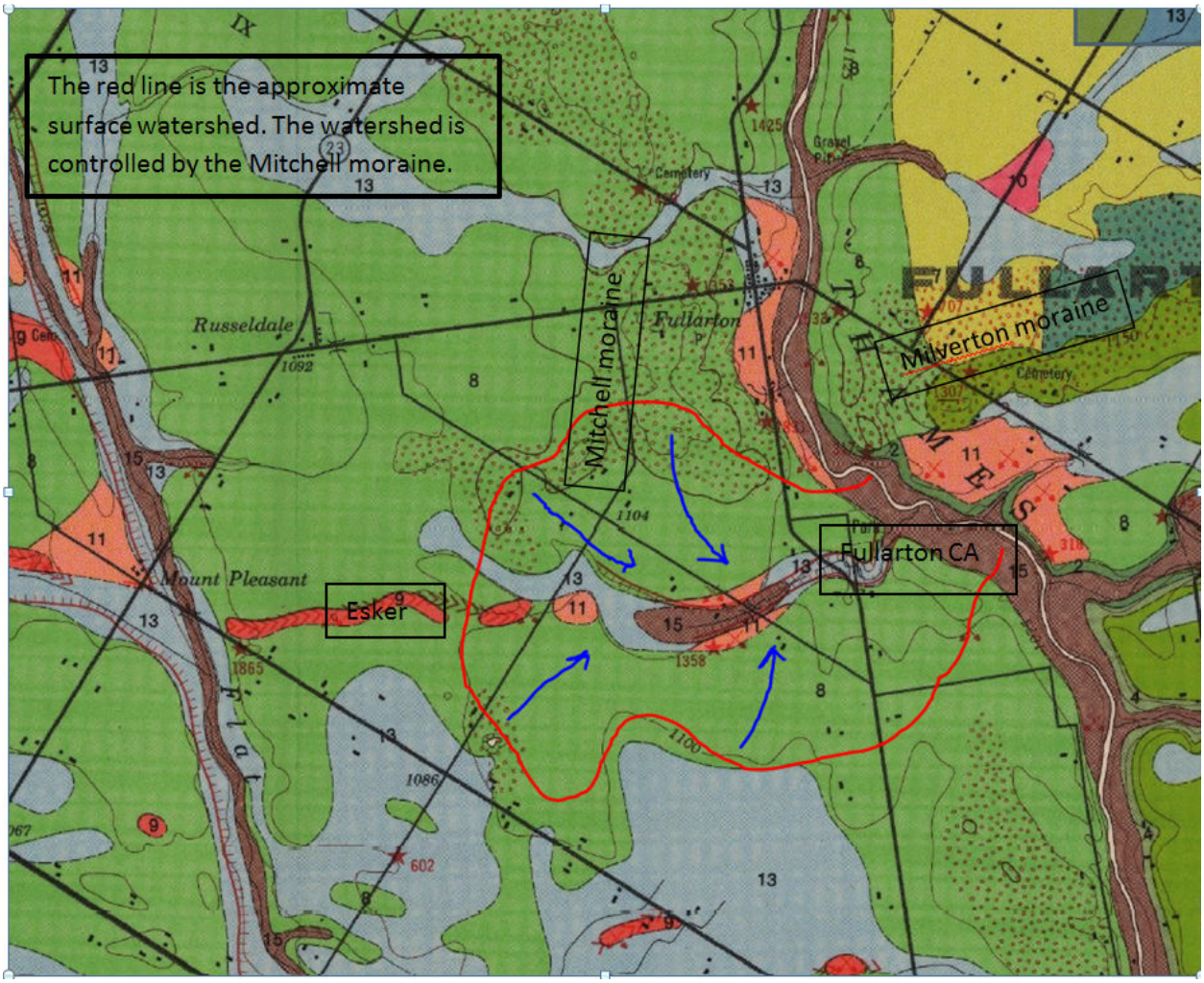

Figure 7: Surficial Geology of St. Marys area. The catchment is indicated in red. Blue lines indicate shallow groundwater recharge direction. The highest recharge is along areas designated as 9 and 11 (see Appendix B). The Mitchell moraine provides indirect recharge to the shallow aquifer. The esker represented by 9 conveys groundwater from outside area. The Fullarton CA is an area of increased recharge due to the confluence of the Milverton and Mitchell moraines.

3.0 Surface Water Quality

The Neil Drain was sampled three times during the summer of 2015 at three locations: upstream of Fullarton Pond, in Fullarton Pond upstream of the dam, and downstream of the dam (Figure 8). This monitoring provides a snapshot of water quality, limited to the conditions of three sampling occasions from June to September in 2015 along with one year of past monitoring data in 1986. Two of the three 2015 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 the June 1 sample had rain with full runoff conditions. Samples were sent to ALS Laboratories for analysis of nitrate, nitrite, Total Kjeldahl Nitrogen, total phosphorous, orthophosphate, *E. coli*, chloride, and suspended solids. Field measurements were taken with a YSI multi-parameter meter for dissolved oxygen, pH, conductivity, and temperature. For more detailed surface water quality information of the Neil Drain and Fullarton Pond, see Appendix C: Fullarton Pond Water Quality Assessment.

In general, the water quality in the Neil Drain where it was sampled showed levels typical of water quality seen in the Upper Thames watershed streams for the parameters measured in 2015. On June 15 and September 1, 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 throughout the sampling time, but within range of typical levels in the Thames River watershed. Chloride levels were quite low; this could be due to sampling timing, flow conditions, and rural location of the Neil Drain.

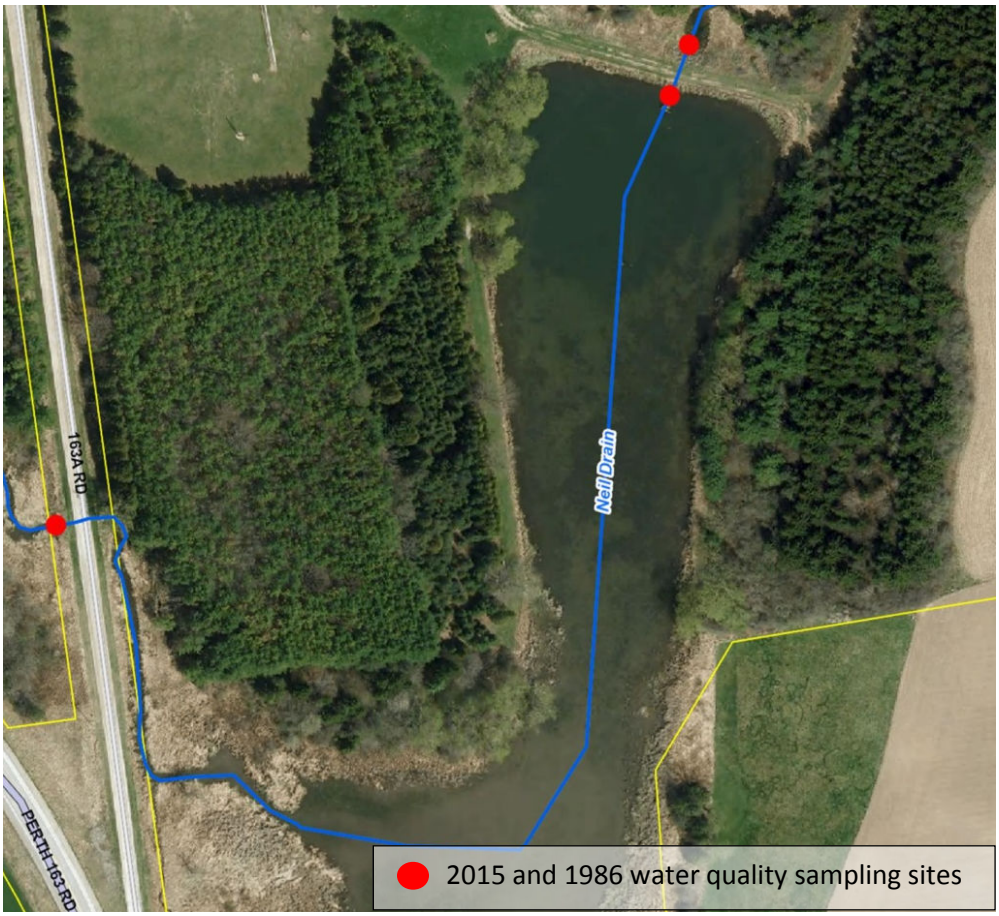

Figure 8: Water quality sampling sites (Source: UTRCA)

Continuous temperature measurements were taken from June 1 to July 20 in 2016 (Figure 9) using a datalogger recording in half hour intervals.

The temperatures upstream in 2016 are consistently cooler than downstream temperatures (Figure 9), with the difference in temperature ranging from 4 to over 7C, with an average difference of almost 6C and the difference becoming greater as the summer progresses. There is a groundwater source upstream which could explain why the upstream is so much cooler with the water warming in the pond before it reaches downstream.

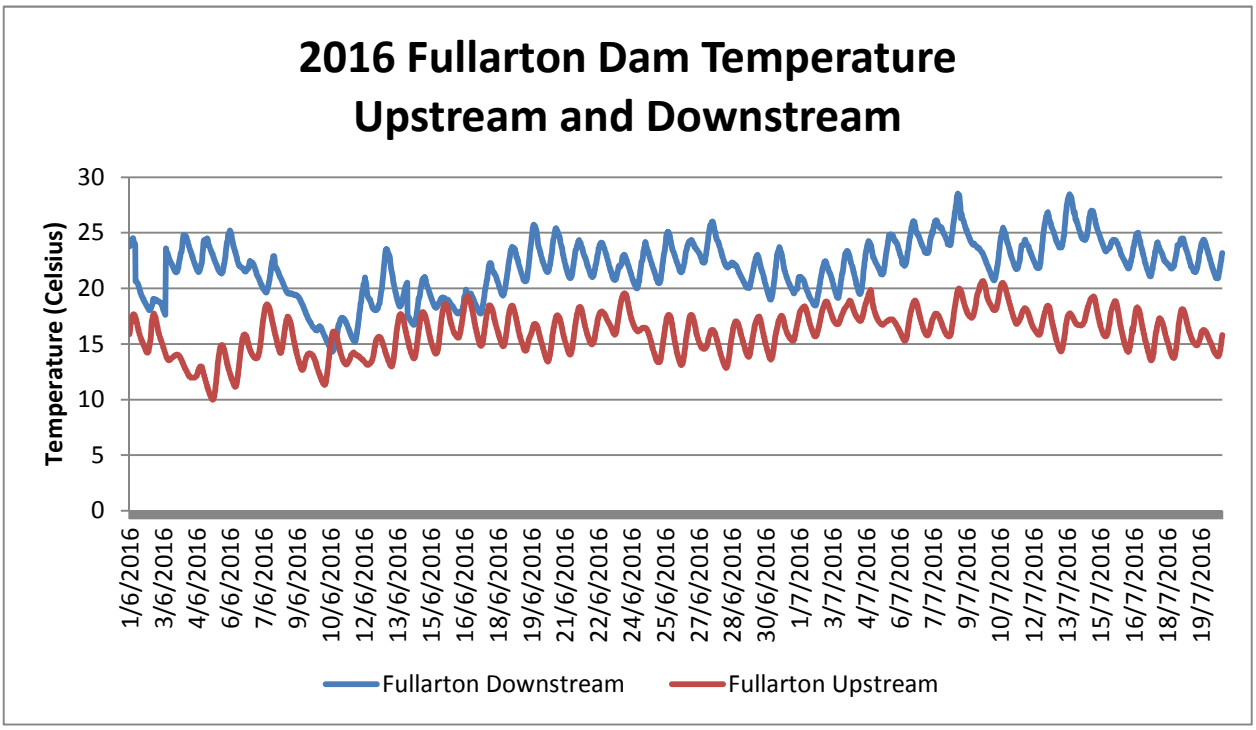

Figure 9: Continuous temperature upstream and downstream of Fullarton Pond June-July 2016 (Source: UTRCA)

4.0 Aquatic Ecology

Electrofishing and benthic surveys were carried out during 2015 and 2016. The map in Figure 10 shows the different sampling sites. A list of recorded fish and benthic species, separated into sampling location, is provided in Appendix D: Fullarton CA Fish and Benthic Records.

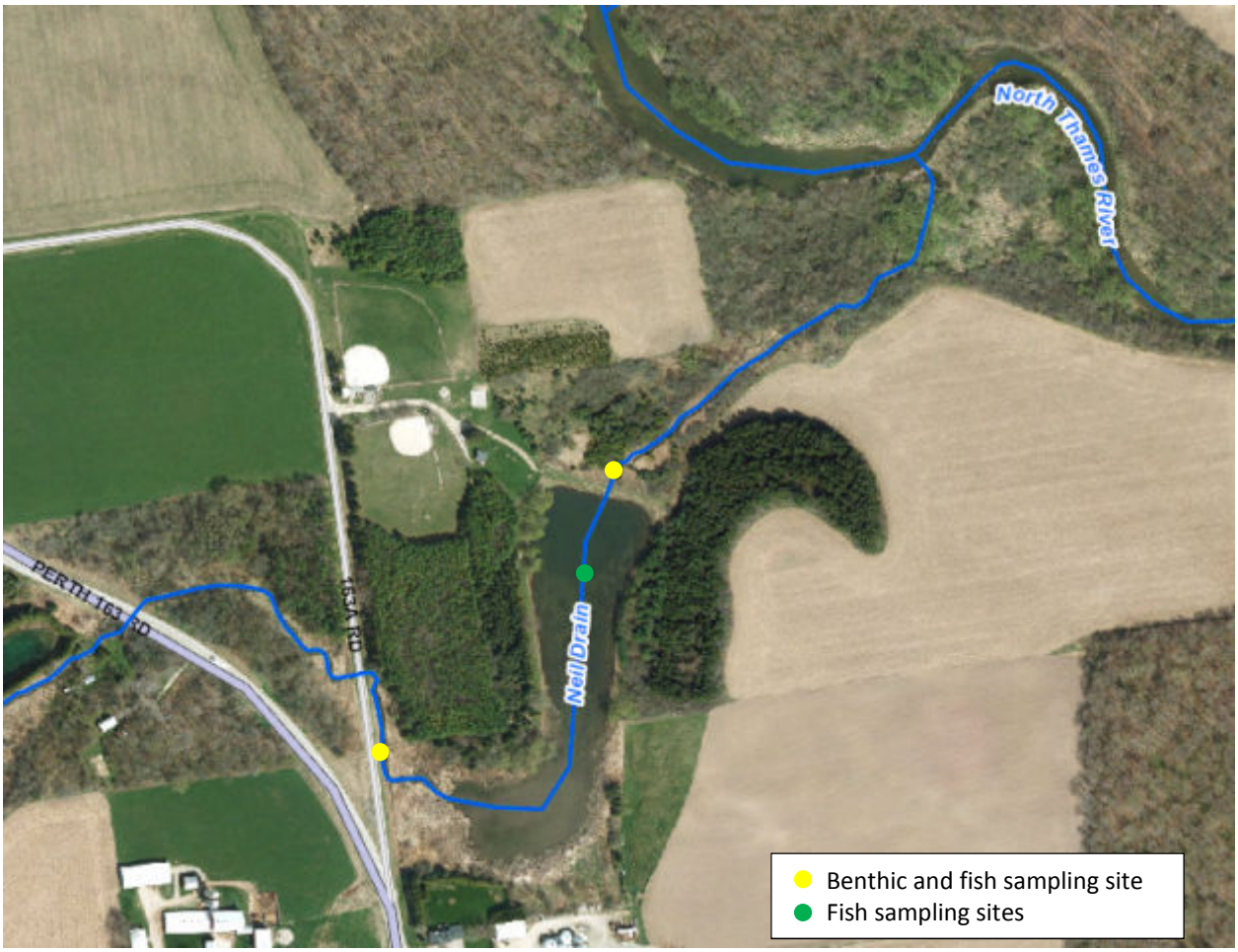

Figure 10: Fullarton Dam area benthic and fish sampling sites (Source: UTRCA)

4.1 Fisheries Resources

Neil Drain in the vicinity of Road 163A upstream of Fullarton Pond was sampled in 1995, 2008, and the summer and fall of 2015. A total of nine species were identified including three minnow species, two darter species, along with brook stickleback, white sucker, green sunfish, and mottled sculpin. The presence of mottled sculpin is a good indicator that cold water conditions exist. Mottled sculpin often share their habitat with brook trout, although no brook trout were found in these and other upstream samples.

Fullarton Pond was sampled twice in the fall of 2015. A total of seven species were encountered including three sunfish species, two minnow species, brook stickleback, and least darter. All of the species sampled are typically found in pond and quiet, weedy stream habitats. The only species of occasional interest for recreational angling was pumpkinseed (sunfish). The other species rarely reach a size suitable for angling.

Downstream of Fullarton Pond, Neil Drain was sampled six times since 2002, most recently in the summer and fall of 2015. A remarkable 34 species were sampled including 13 minnow species, two sucker and catfish species, six sunfish species, including smallmouth and largemouth bass, and northern

pike. Two of the sunfish, bluegill and pumpkinseed, along with the bass and the pike, are all sought after recreational gamefish. They are all more typically found in river habitat like that of the nearby North Thames but their presence indicates Neil Drain likely serves as important spawning and nursery habitat for these species. Mottled sculpin sampled in Neil Drain downstream of Fullarton Pond probably passed over and got trapped below the Fullarton dam where they persist in unsuitable warm water habitat.

4.2 Benthic Resources

Benthic invertebrate sampling was conducted in the spring and fall of 2015 and 2016 immediately above and below Fullarton Pond. A site above the pond was also sampled in the summer of 2008. Sample records (including historic records) with calculated Family Biotic Index (FBI) are provided in Appendix D: Fullarton CA Fish and Benthic Records.

Results indicate moderately impaired conditions that are stable over time and very similar both up and downstream of the pond. This is likely due at least in part to the location of the upstream sample; as a result of site access limitations, these benthic invertebrate samples were conducted in a stream reach where water levels were impacted by elevated water levels due to the Fullarton dam. The benthic community therefore responded to both pond influences and inflowing stream influences and may not have accurately reflected stream health. The results could also indicate that Fullarton Pond does not have major impacts on stream health as measured by benthic invertebrate sampling.

Table 1 below compares the FBI values of the 2015 Neil Drain samples to values of Glengowan and Upper Thames watersheds. The 2015 Neil Drain values indicate slightly poorer water quality than the average value for all samples of the Upper Thames watershed processed for 2015 (FBI = 5.68), and is slightly better than the long term UTRCA average of FBI = 5.99. It is slightly worse than the value utilized for the most recent (2012) Glengowan Watershed Report Card (FBI = 5.62). All values are within the same water quality range of “fair” to “fairly poor”, which is below the provincial guideline target of “good” water quality (FBI < 5.00).

Benthic Sample Location	Spring 2015 FBI	Fall 2015 FBI	Average FBI	Water Quality
Neil Drain upstream of Fullarton Pond	5.82	6.06	5.94	Fairly poor
Neil Drain downstream of Fullarton Dam	5.84	6.37	6.12	Fairly poor
Glengowan watershed 2012	N/A	N/A	5.62	Fair
UTRCA watershed 2015	N/A	N/A	5.68	Fair
Provincial Guideline (target only)	N/A	N/A	< 5.00	Good

Table 1: Comparison of FBI values for Fullarton CA, Glengowan, and UTRCA watersheds (Source: UTRCA)

5.0 Vegetation and Wildlife Inventory

This study examined the vegetation and bird and wildlife of Fullarton CA to determine habitat quality and to flag any rare or sensitive species that might be impacted if the Fullarton Dam and reservoir are decommissioned and the creek restored.

A three-season botanical inventory was completed in 2015 of a 9 ha study area that included lands up to 100 m of the pond's edge. There were nine inventory days from June 1 to September 2. Incidental sightings of wildlife were recorded on each day.

A detailed report of the vegetation, bird, and other wildlife inventory can be found in Appendix E: Fullarton CA Vegetation and Bird Inventory 2015.

5.1 Vegetation

The study area consisted of five terrestrial vegetation communities (cultural woodland, coniferous plantations, shallow marsh and cultural meadow) and the pond. Of the 228 plant species found, 36% are non-native, a moderate number. The overall quality of the vegetation was moderate as well. Only the shallow marsh (Community 4) at the upstream end of the pond will be affected by the potential removal of the dam however, wetland plants are likely to re-establish along the restored creek, especially since this is an area of groundwater discharge.

The Fullarton Pond was not surveyed specifically for aquatic plants. A common native plant, White Water Buttercup, was present in large numbers in 2016. If the dam was removed and the creek restored, pond plants such as the White Water Buttercup would not remain, but these pond plants are not uncommon, and a diversity of riverine plants as seen in the cultural woodland (Community 1) would soon establish.

No plant species at risk were found in the study area or within 2 km of the study area. No plants with a high Coefficient of Conservatism score were found, indicating most plants are generalist species found in a wide variety of habitats, including disturbed or young sites. Hispid Buttercup was the only plant found with an SRANK of S3 (rare to uncommon), though it is relatively common in the Upper Thames watershed.

5.2 Birds and Wildlife

Incidental bird and wildlife observations were made over the six field days (spring, summer, and fall) of 2015. Some 43 bird species, all native, were recorded. Most were common breeding species and/or permanent residents. Two uncommon breeding species (Bald Eagle and Green Heron) were seen but not breeding and one uncommon breeding species or common winter resident (Red-breasted Nuthatch) was seen. The Great Egret and Trumpeter Swan, both uncommon visitors, were seen also.

None of the 43 bird species seen are exclusively pond dwellers. Species such as Canada Goose, Mallard, Belted Kingfisher, Bald Eagle, and Killdeer feed in or by standing water but these species utilize rivers and streams as well. Use of the pond by native waterfowl seemed to be on an occasional basis for feeding and resting, only occasionally for nesting and rearing young. Most of the songbirds seen use the wooded habitats and nearby fields.

Eight herptiles (reptiles and amphibians), seven Lepidoptera (butterflies) and five mammals were seen. All species are common to our area. The Green Frog, American Bullfrog, Red-spotted Newt and Snapping Turtle are the only animals with a strong affiliation to permanent water bodies/ponds. Their overwintering habitat in pond sediment will be lost if the dam/reservoir is removed.

5.3 Rare or Sensitive Wildlife Species

One threatened species, the Barn Swallow, was seen in the study area. There was no breeding evidence at Fullarton CA. Since it nests in old buildings, its nesting habitat will be unaffected by changes to the dam.

Three Special Concern species were seen: Bald Eagle, Snapping Turtle, and Monarch. Special concern species do not receive provincial species or habitat protection, but they are important to recognize.

Bald Eagles were not breeding at the Fullarton CA and they likely forage throughout the North Thames River corridor for fish. Thus, there is no action that is needed for this species.

Snapping Turtles were seen in the Fullarton Reservoir and there are records of this species within the nearby Thames River as well. Habitat will be lost if the reservoir is drained and restored since cold water creeks are only occasionally used by Snapping Turtles due to the lower temperature. Harm to individual turtles can be avoided during dam deconstruction by slowly releasing water in the summer period, allowing enough time for the turtles to find new hibernation areas.

The Monarch butterfly was seen and while it is a commonly seen summer species, the Monarch populations have fallen drastically over the last decade or so, likely due to the elimination of milkweeds along its migration route in the USA and Canada (e.g., herbicide use) and threats to its overwintering areas in Mexico. There is no specific action at Fullarton CA that is required. Establishment of more riparian vegetation, including its host plant milkweeds, and other nectar plants, will help support this butterfly locally.

5.4 Significant Woodlands, Wetlands, and Areas of Natural Scientific Interest (ANSIs)

The woodland communities within Fullarton CA are deemed Significant Woodlands in Perth County as they are over 1 ha in size. They will not be altered by the possible removal of the dam and pond. In time, the pond will likely fill in with herbaceous and then woody plant communities, thus providing an enlarged area of significant woodland cover.

Fullarton CA is part of an unevaluated wetland that extends along the Neil Drain up to the pond. Most of this wetland will be unaffected by any changes to dam/reservoir. Hydrogeological information indicates this is a groundwater-dependent wetland and not influenced to any great degree by backwater from the reservoir. The shallow marsh at the upstream end of the Fullarton Reservoir may decrease or increase in size if the dam is removed, depending on topography. The wetland vegetation is very likely to colonize the area around the restored creek as in the upstream sections of this unevaluated wetland.

The North Thames Valley Earth Science ANSI and candidate Fullarton Moraine ANSI that occur in the Fullarton CA area would be unaffected by changes to the dam/reservoir as no major changes to the topography will be made.

6.0 Discussion

The discussion of the future of Fullarton Dam should consider the following points:

As sediment continues to build in the reservoir, open water surface area will decrease and the pond will take on wetland characteristics. Should the dam be removed, costs to stabilize the sediment and form a natural stream will increase over time as sediment continues to accumulate. If the dam is to be retained an optimum level of retention should be decided on and reserve funds may need to be accumulated to pay for periodic maintenance removal and disposal.

The baseflow has not been measured in the area; however, contribution from groundwater would be similar to other areas of the watershed which is in the range of 50-70% of flow in the drain that is contributed from groundwater discharge. Due to the surficial geology and hydrogeology of the catchment, the contribution by groundwater (baseflow) to Fullarton dam and Neil drain is likely at the higher end of the range.

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 re-suspended when disturbed such as during more extreme flow conditions, and can be discharged downstream through the outlet. Sampling of the bottom sediments would give an indication of any accumulation of contaminants. Results of this sampling would guide the use or disposal of sediments in any possible future reshaping of the pond and or stream.

The presence of 22 additional different species below Fullarton Pond than were found in the pond and upstream dramatically illustrates the impact of the dam as a barrier to fish movement, limiting species diversity upstream. Neil Drain has been considered a possible target for brook trout reintroduction as it maintains cold water conditions as proven by the presence of sculpin and by water temperature logging. Unfortunately, the dam would trap brook trout moving downstream as has happened with the sculpin. The dam also separates habitat types that would likely be necessary for the trout to complete their life cycle.

No plant species at risk were found during the study and most plants observed are generalist species found in a variety of habitats. Should the dam be removed, the shallow marsh at the upstream end of the pond would be affected, though the wetland plants would likely re-establish in this area of the restored creek. The White Water Buttercup (a common native plant) that was observed in large numbers in the pond in 2016 would be lost if the dam is removed, but would be replaced by a diversity of riverine plants.

None of the bird species observed in Fullarton CA are exclusive pond dwellers, and the waterfowl that were seen seemed to use the pond only on an occasional basis for feeding and resting, though a nesting family may occasionally occur. If the dam was removed and reservoir drained, overwintering habitat for four herptiles would be lost.

Of the four wildlife species at risk found in Fullarton CA, specific action to reduce potential harm to the species is only required for the Snapping Turtle, should the dam be removed. Releasing the water from the reservoir slowly during the summer would allow time for any turtles to find new hibernation areas.

7.0 Recommendations

Going forward with the process of deciding the future of Fullarton Dam, the following actions are recommended:

- Sediment surveys should be repeated to monitor sediment rate.
- Streamflow should be monitored and characterized that can assist with future stream naturalization design.
- Costs should be investigated for the permanent or maintenance removal and disposal of sediment, including sediment chemistry testing.
- Costs should be estimated for the removal of the dam and restoration of the stream.

The following subsections include recommendations that have been proposed should the dam be removed, should the dam be retained, as well as other non-dam related recommendations to enhance Fullarton CA.

7.1 Removal of the Dam

If the dam is to be decommissioned, the following actions are recommended to minimize possible impacts to the vegetation and bird and wildlife that were observed in the Fullarton Conservation Area:

- Survey the aquatic plants in the pond to ensure no rare species are impacted.
- The drawdown of the reservoir should be done very slowly over summer providing time for Snapping Turtles and other amphibians to find new sites prior to hibernation.
- Examine the benefits, costs, and feasibility of constructing an off-line pond to accommodate snapping turtles and other aquatic wildlife species.
- Examine the road culverts along the Neil Drain after drawdown to see if any are perched as a result of the water level changes. Correcting perched culvert problems will allow the creek to flow unobstructed.
- Monitor the plant species that colonize the former pond bed and augment with seed/plants of native wetland species if needed.
- If the creek restored, maintain the trail where it is currently, away from the sensitive creek edges and the unconsolidated sediments from the pond bottom. Consider providing viewing points to the creek that elevates the visitor above the shoreline vegetation height (e.g., a mound or a wooden viewing platform).

7.2 Retaining the Dam

If the dam is retained, recommendations have been made to maintain or improve the stability of the dam. The main recommendations are to:

- Raise the crest height of the dam so that the dam can pass the Inflow Design Flood without the crest overtopping

- Install rip-rap on the upstream face of the dam and on the downstream side from the outlet to 10 m downstream to prevent erosion.
- Install a toe drain at the base of the embankment that runs perpendicular to the outlet pipe (50 m in either both directions) to prevent piping erosion from seepage

The total cost to complete to retain the dam based on technical recommendations is estimated at approximately $100,000 in 2016 dollars (based on R.J. Burnside estimates, 2010). This does not include sediment removal.

Retention of the dam will require that a decision on maintaining of optimum sediment levels. On water recreation is already being compromised by aquatic vegetation and boating will be further be compromised where depths become too shallow over time.

7.3 Other Site Recommendations

An opportunity to further enhance the Fullarton Conservation Area may be to consider the closure and decommissioning of the 163A Road as the second entry into the Conservation Area from the south. The road was likely part of the main road through the area before it was diverted to the west and replaced by Perth 163 Road. The Conservation area may be adequately serviced by the driveway entrance further north along the Perth 163 Road. If retired, the southerly access (163A Road) would have considerable gravel reserves to recover for other road projects. The retiring of the road would also provide the opportunity to fully vegetate and connect the stream and forest corridor through the Fullarton CA lands on either side of 163A Road. Public trails could also be further enhanced with the connections.

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Naylor Engineering Associates, 2008

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Upper Thames River Conservation Authority. 1973. *Twenty Five years of Conservation on the Upper Thames Watershed 1947-1973.*

See the following reference documents:

Fullarton Dam Safety Review, Acres, 2007

R.J. Burnside repair estimates, 2010

Glengowan Watershed Report Card, 2012. Retrieve from http://thamesriver.on.ca/wp-content/uploads//WatershedReportCards/RC_Glengowan.pdf

Appendix A - Fullarton Dam Hydrotechnical and Geotechnical Review

Appendix B - Hydrogeology Assessment of Fullarton Conservation Area

Appendix C - Fullarton Pond Water Quality Assessment

Appendix D - Fullarton Dam Area Fish and Benthic Records

Appendix E - Fullarton Dam and Conservation Area Vegetation and Bird Inventory

Appendix F - Fullarton Power Point Presentation - March 2016

Appendix A

Fullarton Dam

Hydrotechnical and Geotechnical

Review

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January 17, 2017

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Introduction

The dam controls a very small drainage area of 4 km^2 comprising mostly agricultural land. The conservation reservoir surface area is small and is impounded by a low earth-fill embankment dam located at the northern end of the reservoir. Flow releases from the dam outlet enter a narrow channel, and flow in a northeasterly direction for approximately 0.45 km before entering the main stem of the North Thames River.

The discharge facilities at the dam consist of a concrete drop inlet structure with a set of stop logs at the upstream face and an inverted V-shaped trashrack anchored to the top of the inlet. There is an emergency spillway located on the right or east bank. This is a lower section at the end of the embankment dam which is covered with cable-connected concrete blocks. The mouth of the spillway measured 9.5 m in length and appeared to be in good condition. The emergency spillway has a grassed discharge channel that runs parallel to the creek before joining it.

A review of previous investigations, mainly the 2007 Dam Safety Assessment Report for Fullarton Dam by Acres International and the 2008 Geotechnical Investigation Fullarton Dam Embankment Stability Assessment by Naylor Engineering Associates, was completed in order to summarize and highlight key information that can be used for future analysis and decision-making regarding Fullarton Dam.

Geotechnical Review

In order to assess the stability of the dam, the soil properties of the dam needed to be determined. To accomplish this, boreholes were taken. The two boreholes were taken by Acres International between November 24 to November 26, 2003, and four additional boreholes were taken by Naylor Engineering Associates on November 11, 2005. The locations of the boreholes are indicated on Figure 1.

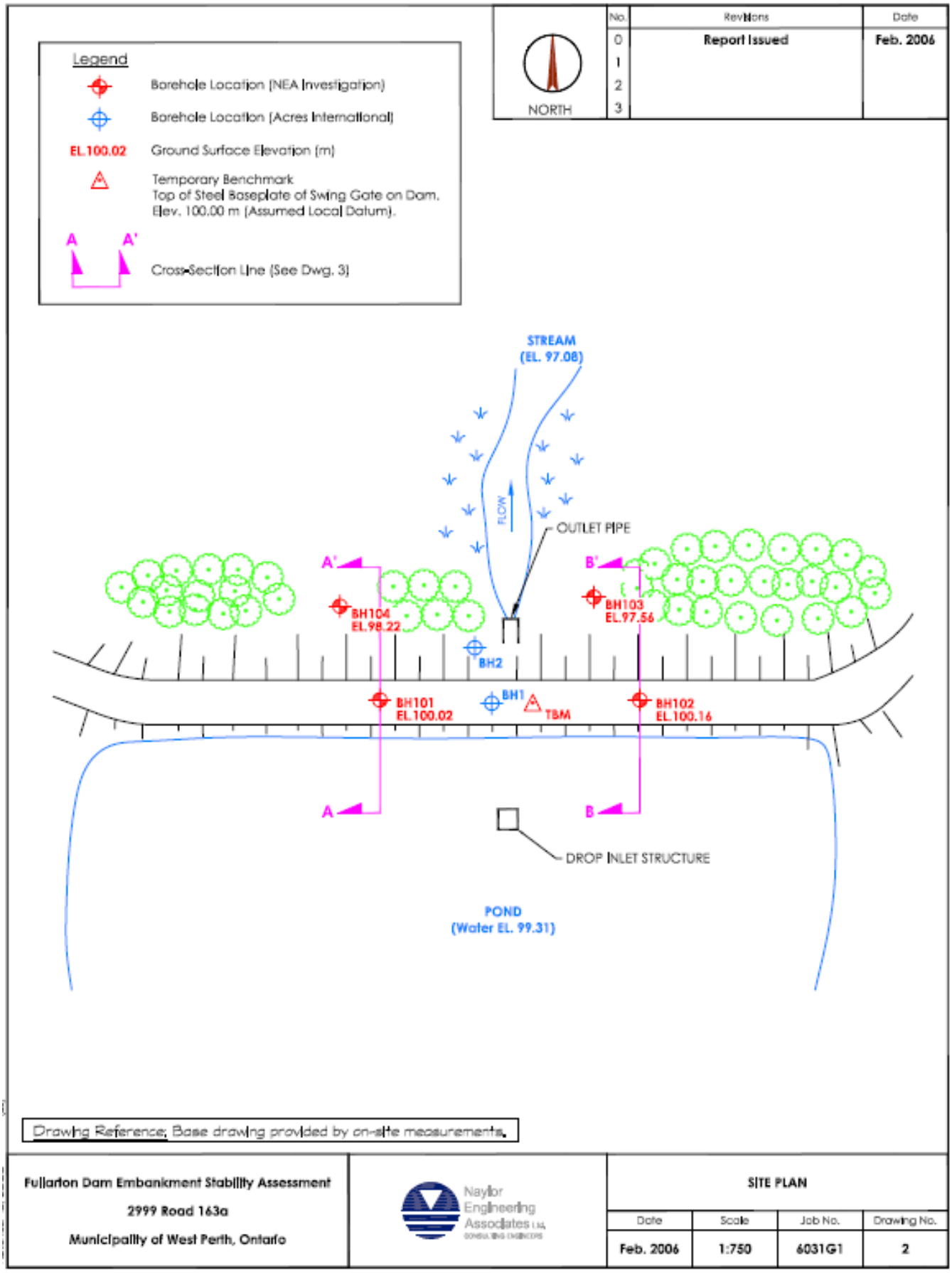

Figure 1: Location of Boreholes at Fullarton Dam

Acres International Stability Assessment

To be designated as stable, a dam must meet or exceed the requirements set by the Canadian Dam Safety Association and the Ontario Ministry of Natural Resources and Forestry. In the Dam Safety Assessment Report, the stability of the dam was calculated using the limit equilibrium method of slope analysis utilizing SLOPE/W and the Morgenstern-Price method of slices with half-sine function. Table 1 summarizes the soil properties used for the stability analysis as well as the results of the safety analysis.

Table 1: Stability Analysis of Earth Embankments by Acres International

Item	Criteria	Calculated	Comments
General			
IHP		Very Low	
Flood Conditions			
IDF		50-yr flood	
Materials			
Embankment			
- embankment fill (CL)			
cohesion (kPa)		0	
ϕ (deg)		32	
moist unit weight (kN/m^3)		17.8	
saturated unit weight (kN/m^3)		19.0	
Foundation			
- SP - SM			
cohesion (kPa)		0	
ϕ (deg)		32	
moist unit weight (kN/m^3)		18.5	
saturated unit weight (kN/m^3)		21.0	
- glacial till			
cohesion (kPa)		0	
ϕ (deg)		38	
moist unit weight (kN/m^3)		18.5	
saturated unit weight (kN/m^3)		20.3	
Loads			
Normal water level (NWL)		99.28	
IDF water level		100.05	
Seismic, horizontal (S_h) PGA (g)		0.020*	* 2/3, i.e., 0.013g, was used in pseudostatic analyses
Load Combinations			
Upstream Slope			
Normal (NWL)	1.50	1.32	Does not meet the criteria
Extreme (NWL, S_h)	1.10	1.26	
Extreme (IDF)	1.30	1.35	
Rapid Drawdown	1.20	N/A	
Downstream Slope			
Normal (NWL)	1.50	1.41	Does not meet the criteria
Extreme (NWL, S_h)	1.10	1.36	
Extreme (IDF)	1.30	1.41	
Rapid Drawdown	N/A	N/A	

As seen from Table 1, under normal water level conditions the upstream and the downstream slopes did not meet the criteria required to be classified as stable. The cross section of the dam and the areas of predicted failure from the Dam Safety Report are provided in Figure 2 and Figure 3.

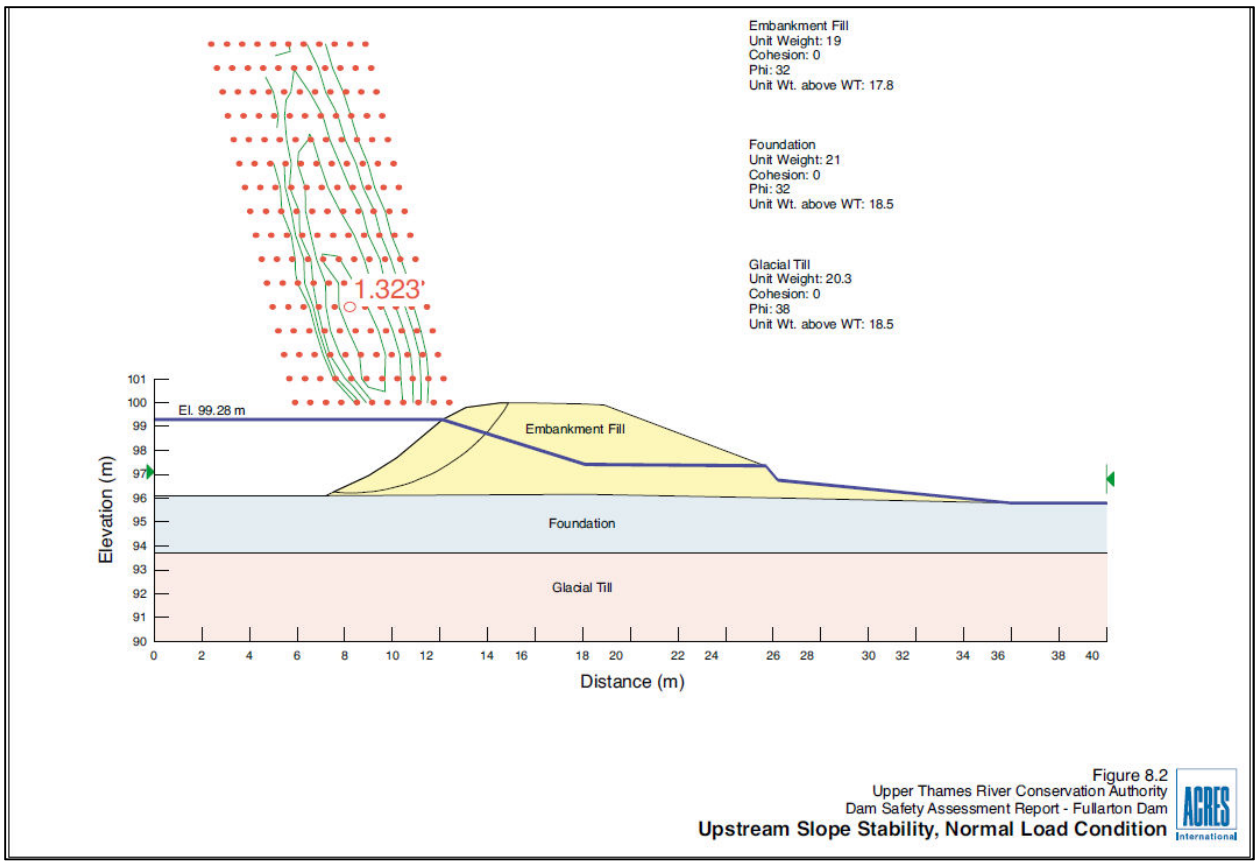

Figure 2: Upstream Slope Stability Under Normal Load Conditions

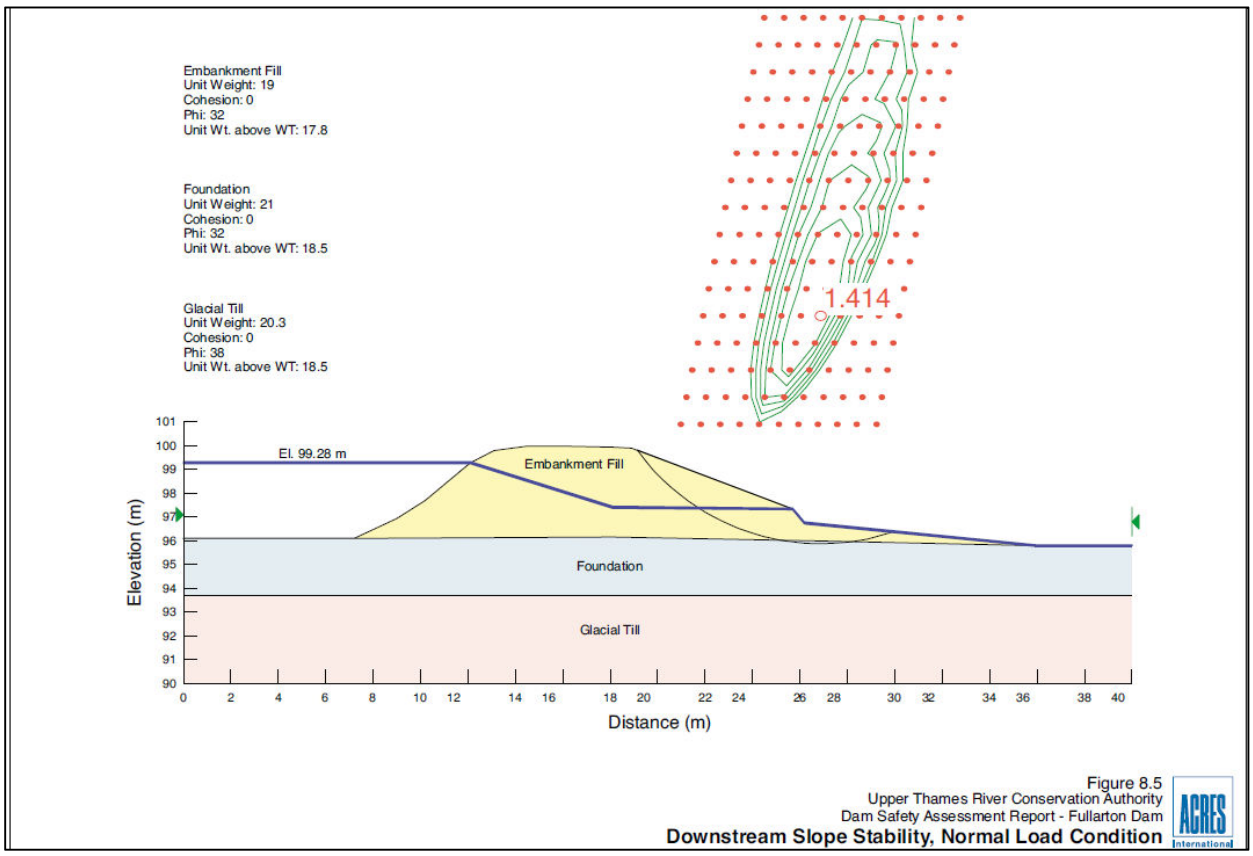

Figure 3: Downstream Slope Stability Under Normal Load Conditions

Naylor Engineering Associates Stability Assessment

As the calculations resulted in the dam not meeting the criteria by a very small amount it was recommended that the internal angle of friction assumed for the calculations be confirmed through shear strength tests.

Laboratory testing was completed on the soil samples from the four additional boreholes taken by Naylor Engineering Associates. From the samples taken from the boreholes it was determined that the internal angle of friction was 34 degrees. The calculated factors of safety from the stability analysis performed by Naylor Engineering Associates are provided in Table 2, below. These indicate that embankment maintains high stability under steady state, rapid draw down, and seismic conditions.

Table 2: Stability Analysis of Earthen Embankments by Naylor Engineering and Associates

Loading Conditions	Slope	Minimum Factor of Safety	Calculated Factor of Safety
Steady State Seepage with maximum storage pool	Downstream	1.5	2.7 to 3.2
Full or partial rapid drawdown	Upstream	1.3	1.5 to 1.7
Horizontal seismic load	Downstream and Upstream	1.3	1.3 to 2.6

Hydrotechnical Review

Hazard Potential Classification

There are no permanent dwellings or development in the immediate downstream reach of the discharge channel. Overall, no potential incremental loss of life under flood conditions is expected. Incremental economic, social and environmental losses are not expected to exceed the VERY LOW category. The dam has, therefore, been designated as a VERY LOW Incremental Hazard Potential (IHP) structure. See Table 3 below for detailed breakdown of Incremental Hazard Potential classifications from draft Ontario Dam Safety Guidelines 1999.

Table 3: Incremental Hazard Potential of Dams (MNR 1999)

Hazard Potential	Loss of Life	Economic and Social Losses	Environmental Losses
Very Low	Potential for LOL: None.	Damage to dam only. Little damage to other property. Estimated losses do not exceed $100,000.	Environmental Consequences: Short-term: Minimal Long-term: None
Low	Potential for LOL: None. The inundation area (the area that could be flooded if the dam fails) is typically undeveloped.	Minimal damage to agriculture, other dams or structures not for human habitation. No damage to residential, commercial, industrial or land to be developed within 20 years. Estimated losses do not exceed $1 million.	No significant loss or deterioration of fish and/or wildlife habitat. Loss of marginal habitat only. Feasibility and/or practicality of restoration or compensating in kind is high, and/or good capability of channel to maintain or restore itself.
Significant	Potential for LOL: None expected. Development within inundation area is predominantly rural or agricultural, or is managed so that the land usage is for transient activities such as with day-use facilities. There must be a reliable element of warning if larger development exists.	Appreciable damage to agricultural operations, other dams or residential, commercial, industrial development, or land to be developed within 20 years. Estimated losses do not exceed $10 million.	Loss or significant deterioration of important fish and/or wildlife habitat. Feasibility and/or practicality of restoration and/or compensating in kind is high, and/or good capability of channel to maintain or restore itself.
High	Potential for LOL: One or more. Development within inundation area typically includes communities, extensive commercial and industrial areas, main highways, public utilities and other infrastructure.	Extensive damage to communities, agricultural operations, other dams and infrastructure. Typically includes destruction of or extensive damage to large residential areas, concentrated commercial and industrial land uses, highways, railways, power lines, pipelines and other utilities. Estimated losses exceed $10 million.	Loss or significant deterioration of critical fish and/or wildlife habitat. Feasibility and/or practicality of restoration and/or compensating in kind is low, and/or poor capability of channel to maintain or restore itself.

* Supporting References: MNR Guidelines for Approval Under the Lakes and River Improvement Act, 1977
MNR Fisheries Section, 1999
US Army Corps of Engineers, Dam Safety Assurance Program, 1995
Dam Structure Assessment Program, Ontario Hydro, 1990

Notes:

1. Consideration should be given to the cascade effect of dam failures in situations where several dams are situated along the same watercourse. If failure of an upstream dam could contribute to failure of a downstream dam(s), the minimum hazard potential classification of the upstream dam should be the same as or greater than the highest downstream hazard potential classification of the downstream dam(s).
2. Economic losses refer to all direct and indirect losses to third parties; they do not include losses to owner, such as loss of the dam, associated facilities and appurtenances, loss of revenue, etc.
3. Estimated losses refer to incremental losses resulting from failure of the dam or misoperation of the dam and appurtenant facilities.
4. For Hazard Potential Classification and Safety Criteria for tailings dams, refer to "Guidelines for Proponents, Rehabilitation of Mines", issued by Ontario Ministry of Northern Development and Mines, 1995.

Updates to the Dam Hazard classification methodology were made after Fullarton dam was assessed using the MNR's Dam Safety Guidelines (Table 3). This updated methodology has been provided in Table 4, below.

Table 4: Incremental Hazard Classification of Dams (MNR 2011)

	Hazard Categories – Incremental Losses[1]			
Hazard Potential	**Life Safety[2]**	**Property Losses[3]**	**Environmental Losses**	**Cultural – Built Heritage Losses**
Low	No potential loss of life.	Minimal damage to property with estimated losses not to exceed $300,000.	Minimal loss of fish and/or wildlife habitat with high capability of natural restoration resulting in a very low likelihood of negatively affecting the status of the population.	Reversible damage to municipally designated cultural heritage sites under the Ontario Heritage Act.
Moderate	No potential loss of life.	Moderate damage with estimated losses not to exceed $3 million, to agricultural, forestry, mineral aggregate and mining, and petroleum resource operations, other dams or structures not for human habitation, infrastructure and services including local roads and railway lines. The inundation zone is typically undeveloped or predominantly rural or agricultural, or it is managed so that the land usage is for transient activities such as with day-use facilities Minimal damage to residential, commercial, and industrial areas, or land identified as designated growth areas as shown in official plans.	Moderate loss or deterioration of fish and/or wildlife habitat with moderate capability of natural restoration resulting in a low likelihood of negatively affecting the status of the population	Irreversible damage to municipally designated cultural heritage sites under the Ontario Heritage Act. Reversible damage to provincially designated cultural heritage sites under the Ontario Heritage Act or nationally recognized heritage sites.
High	Potential loss of life of 1-10 persons	Appreciable damage with estimated losses not to exceed $30 million, to agricultural, forestry, mineral aggregate and mining, and petroleum resource operations, other dams or residential, commercial, industrial areas, infrastructure and services, or land identified as designated growth areas as shown in official plans Infrastructure and services includes regional roads, railway lines, or municipal water and wastewater treatment facilities and publicly-owned utilities.	Appreciable loss of fish and/ or wildlife habitat or significant deterioration of critical fish and/or wildlife habitat with reasonable likelihood of being able to apply natural or assisted recovery activities to promote species recovery to viable population levels. Loss of a portion of the population of a species classified under the Ontario Endangered Species Act as Extirpated, Threatened or Endangered, or reversible damage to the habitat of that species.	Irreversible damage to provincially designated cultural heritage sites under the Ontario Heritage Act or damage to nationally recognized heritage sites.
Very High	Potential loss of life of 11 or more persons.	Extensive damage, estimated losses in excess of $30 million, to buildings, agricultural, forestry, mineral aggregate and mining, and petroleum resource operations, infrastructure and services. Typically includes destruction of, or extensive damage to, large residential, institutional, concentrated commercial and industrial areas and major infrastructure and services, or land identified as designated growth areas as shown in official plans. Infrastructure and services includes highways, railway lines or municipal water and wastewater treatment facilities and publicly-owned utilities.	Extensive loss of fish and/ or wildlife habitat or significant deterioration of critical fish and/or wildlife habitat with very little or no feasibility of being able to apply natural or assisted recovery activities to promote species recovery to viable population levels. Loss of a viable portion of the population of a species classified under the Ontario Endangered Species Act as Extirpated, Threatened or Endangered or irreversible damage to the habitat of that species.	

Notes
1. Incremental losses are those losses resulting from dam failure above those which would occur under the same conditions (flood, earthquake or other event) with the dam in place but without failure of the dam.
2. Life safety. Refer to Technical Guide – River and Streams Systems: Flooding Hazard Limits, Ontario Ministry of Natural Resources,

2002, for definition of 2 x 2 rule. The 2 x 2 rule defines that people would be at risk if the product of the velocity and the depth exceeded 0.37 square metres per second or if velocity exceeds 1.7 metres per second or if depth of water exceeds 0.8 metres. For dam failures under normal (sunny day) conditions the potential for loss of life is assessed based on both permanent dwellings (including habitable dwellings, trailer parks and seasonal campgrounds) and transient persons.
3. Property losses refer to all direct losses to third parties; they do not include losses to the owner, such as loss of the dam, or revenue. The dollar losses, where identified, are indexed of Statistics Canada values Year 2000.
4. An HPC must be developed under both flood and normal (sunny day) conditions.
5. Evaluation of the hazard potential is based on both present land use and on anticipated development as outlined in the pertinent official planning documents (e.g. Official Plan). In the absence of an approved Official Plan the HPC should be based on expected development within the foreseeable future. Under the Provincial Policy Statement, '*designated growth areas*' means lands within *settlement areas* designated in an official plan for growth over the long-term planning horizon (specifies normal time horizon of up to 20 years), but which have not yet been fully developed. *Designated growth areas* include lands which are *designated and available* for residential growth in accordance with the policy, as well as lands required for employment and other uses (Italicized terms as defined in the PPS, 2005).
6. Where several dams are situated along the same watercourse, consideration must be given to the cascade effect of failures when classifying the structures, such that if failure of an upstream dam could contribute of failure of a downstream dam, then the HPC of the upstream dam must be the same as or greater than that of the downstream structure.
7. The HPC is determined by the highest potential consequences, whether life safety, property losses, environmental losses, or cultural built heritage losses.

In these updates the classification methodology was updated to be more descriptive and to consider cultural and heritage losses. Fullarton Dam has not been assessed using these updated methodologies, but it is estimated that if it was assessed it would still be assigned the lowest possible hazard classification and as such would not affect the design criteria.

Dam Size Classification and Minimum Inflow Design Flood Return Period

The embankment dam is approximately 3.4 m high and impounds a total estimated storage volume of 20 x 10^3 m^3. The dam has, therefore, been designated as a SMALL dam, based on the Ontario Dam Safety Guidelines. Due to the IHP classification of VERY LOW and the dam being classified as a SMALL dam, the inflow design flood is the 50 year flood. See Table 5 below for detailed breakdown of the determination of Minimum Inflow Design Flood return periods.

Table 5: Minimum Inflow Design Floods from Ontario Dam Safety Guidelines

Hazard Potential	Size of Dam and Inflow Design Floods					
	Small		Medium		Large	
	Height < 7.5 m	Storage < 100 x 10^3 m^3	Height 7.5 to 15 m	Storage 100 x 10^3 to 1000 x 10^3 m^3	Height > 15 m	Storage > 1000 x 10^3 m^3
Very Low	25-year flood to 50-year flood		50-year flood to 100-year flood		100-year flood to RF	
Low	25-year flood to 100-year flood		100-year flood to RF		RF to PMF	
Significant	100-year flood to RF		RF to PMF		PMF	
					Policy for existing dams is under consideration	
High	RF to PMF		PMF		PMF	
	Policy for existing dams is under consideration					

Legend: RF – regulatory flood
PMF – probable maximum flood

Notes:

1. For Minimum Inflow Design Floods for Mine Tailings dams, refer to "Guidelines for Proponents, Rehabilitation of Mines", issued by Ontario Ministry of Northern Development and Mines, 1995.
2. Existing dams refer to those structures built prior to 1978.

Deterministic Modelling

At Fullarton Dam, stream gauging and water level recording was not undertaken, rather the information presented is from past studies listed in the references section that estimated peak flows using deterministic modeling of the watershed on an event basis. The input data included:

- Physical parameters or the river basin such as, drainage area, stream course length and slope, and average slopes from topographic maps.
- Lag time was determined from the US Soil Conservation Service (SCS) method and then a conversion factor was applied based on the difference between the observed results and SCS results at the watershed used for calibration (Waubuno Creek watershed).
- The curve number of the watershed was based on land-use conditions, soil mapping units with physical soil characteristics (texture and infiltration rates).
- Precipitation data from the Stratford (Station 6148105) was used as it was determined to be the most representative of the storm events expected for the Fullarton basin.
- Intensity-duration-frequency (IDF) curves from Meteorological Service Canada/Environment Canada were used to determine the design storm(s) which would produce the maximum flow.
- Lake area and estimates of live storage.

The input data for the HEC-HMS model is summarized in the Table 6 below

Table 6: Summary of HEC-HMS Input Data for Fullarton Dam

Watershed	Local Drainage Area (km^2)	Total Drainage Area (km^2)	Pond Area (km^2)	Basin Lag (hrs)	Curve Numbers (CN)		Stream Length (km)	Average Slope (m/m)	Storm Event	Base Flow (m^3/s)	Initial Water Levels (m)
					II	III					
Neil Drain Catchment	4.0	4.0	0.016	2.6	79	91	2.8	0.0039	Spring Fall	0.12 0.01	99.40 99.34

Note: All elevations referred to a local datum of 100.00m based of a field survey of a steel marker at the dam surface.

Deterministic rainfall/runoff modeling results have established that the 50-yr, 3-day summer storm event is the governing flood for this site. During passage of the 50-yr, 3-day summer storm Inflow Design Flood event, approximately 84.2% of the discharge would be conveyed through the emergency overflow spillway with the remainder going through the drop inlet and over the embankment section. The inflow design flood for this frequency was estimated to be 17.7 m^3/s while the peak outflow was also 17.7 m^3/s due to negligible attenuation by the pond. Without considering wind and wave effects, the dam discharge facilities would be unable to pass this flood without slightly overtopping the main embankment dam by 0.05 m due to the upstream water level of 100.05 m (Acres International, 2007).

Minimum freeboard requirements were assessed in accordance with MNR guidelines and determined that under the inflow design flood conditions and the 1 in 100 year wind condition, the Wind Set-up and

Wave Run-Up would result in an additional height of 0.02 cm and 0.24 cm, respectively (Acres International, 2007).

Therefore, the dam does not have adequate spillway capacity or adequate freeboard to pass the inflow design flood.

Sedimentation

The Fullarton reservoir was surveyed on May 30, May 31, June 1, and June 2, 2016. The survey was completed using a Trimble GPS Geo7x unit with the minimum vertical accuracy set to 5 cm. Measurements were taken at the top of the sediment and below the sediment. The elevation below the sediment was determined by pushing the GPS rod through the sediment until a significant increase in resistance was felt which indicated the native reservoir bottom had been reached.

Upstream of the reservoir was surveyed on February 10, 2017, using the same techniques and equipment as described above.

The Fullarton reservoir was previously surveyed on August 22, 2006, using a slightly different methodology. In the 2006 survey a GPS unit accurate to ~ 1 m was used to determine the horizontal position in the pond and a large rod was used to manually measure the vertical depth to the top of the sediment and the vertical depth to the native bottom.

The effect of Fullarton Dam on sediment transport is most evident between Station 150 and Station 250 (See Figure 4 and Figure 5), where the depth of sediment was on average approximately 0.6 m thick. For context the water depth (i.e. water surface to top of sediment) in this reach is less than 0.3 m, in other words less than half of the depth of sediment. At Fullarton Dam, all of the water below the elevation of the drop inlet is slowed, which results in sediment that would normally be suspended in the watercourse to instead settle out. As the sediment accumulates in the reservoir, over time the open water surface area will decrease and the pond will take on wetland characteristics.

Typically the length of watercourse impacted by backwater effects of a dam can be identified by changes in substrate size. Smaller diameter substrates (silts, and fine sand) are found in lengths impacted by backwater effects and larger diameter substrates (gravels and pebbles) are visible further upstream in lengths not impacted by backwater effects. It is estimated that the extent of the backwater effect concludes at approximately Station -165, about 50 m downstream of the culvert at Road 163. There is some added uncertainty to this location due to the fact that at the date of the survey there were 3 beaver dams located further upstream between 18 Line and Road 163. Beaver dams have an impact on sediment transport that is similar to the impact from man-made dams in that water is slowed which allows sediments to settle out.

There is some uncertainty in estimating the loading rate at Fullarton Pond. Records indicate that a large quantity of silt was removed and the pond was deepened in the winter of 1966/1967 (estimated as Jan 15, 1967), it was assumed that at this date there was no sediment in the pond. From the 2016 survey it was determined that in the pond there was approximately 6015 m^3 of sediment, this equates to a sediment accumulation rate of ~ 119 m^3 of sediment/year. From the 2006 survey it was determined that in the pond there was approximately 6400 m^3 of sediment, this equates to a sediment accumulation rate of ~ 158 m^3 of sediment/year. There are a number of factors that can be used to estimate soil loss and sediment accumulation (e.g. slope, land-use, barriers), one of these factors is the size of the

catchment area. From the recent Environmental Assessments completed for Harrington Dam and Embro Dam, the sediment accumulation rate was 24.3 and 23.0 m^3 of sediment/km^2 of catchment area per year, respectively. If this average sediment accumulation rate per catchment area was applied to Fullarton Dam, the expected sediment accumulation rate would be ~ 95 m^3 of sediment accumulation per year. A reasonable estimate of the sediment accumulation rate at Fullarton dam would be between 90 – 160 m^3 of sediment per year.

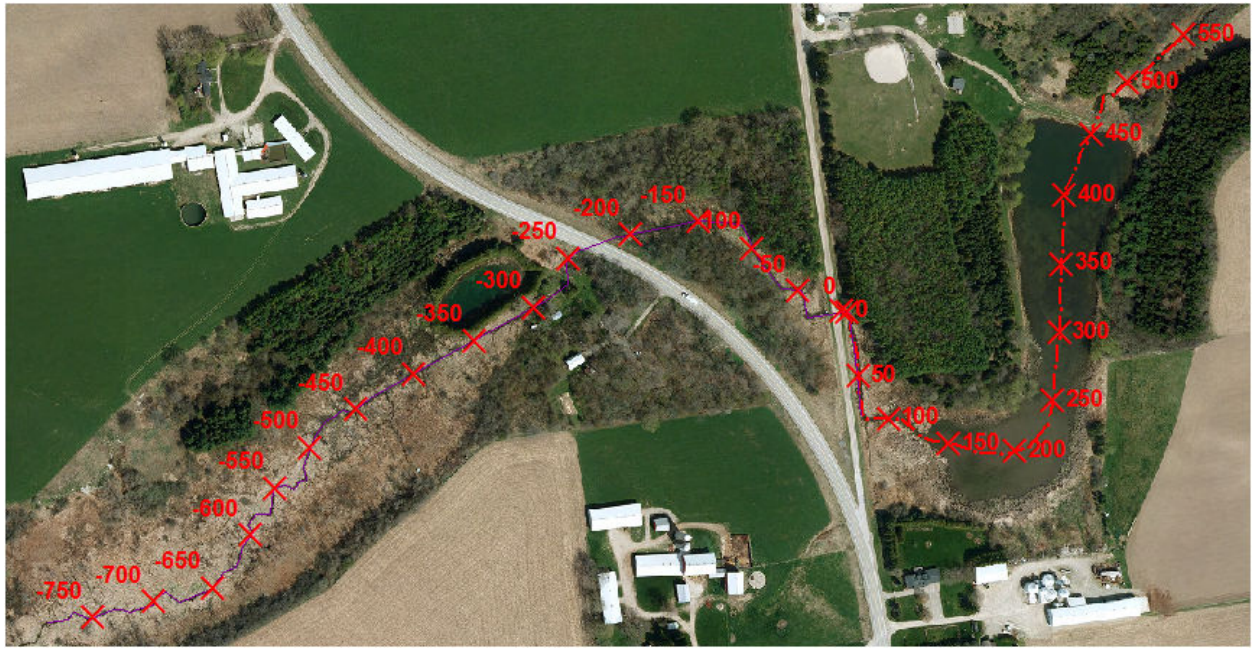

Figure 4: Stations of Surveyed Streambed

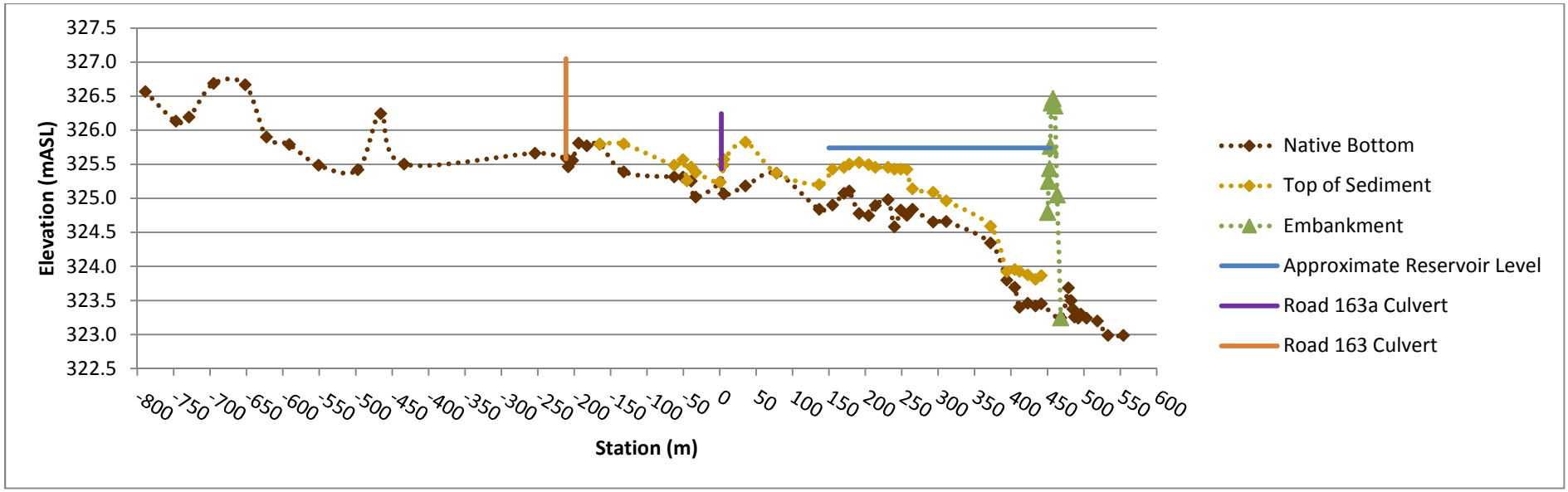

Figure 5: Profiles of Streambed and Top of Sediment

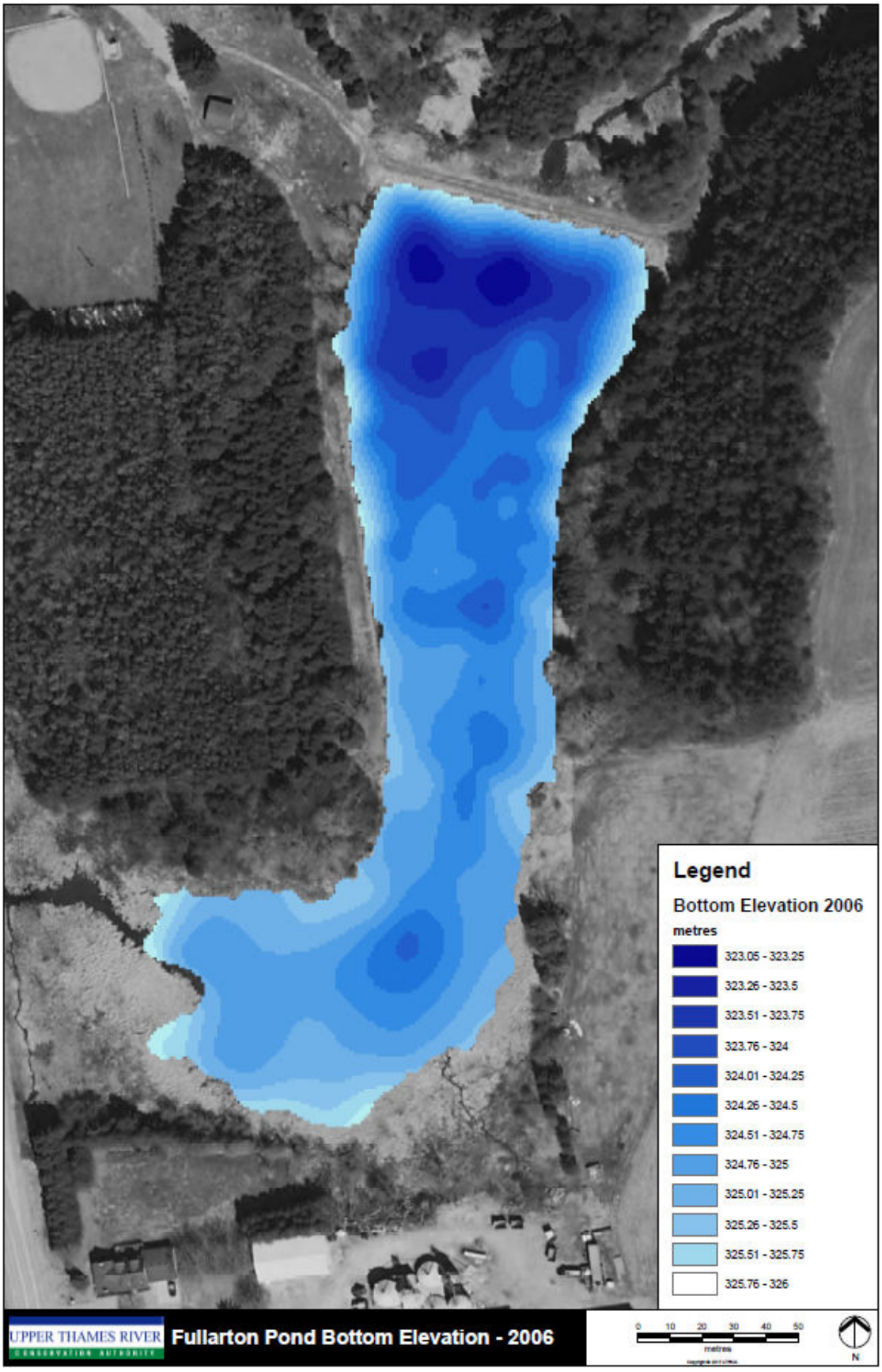

Figure 6: Fullarton Pond Bottom from 2006 Survey

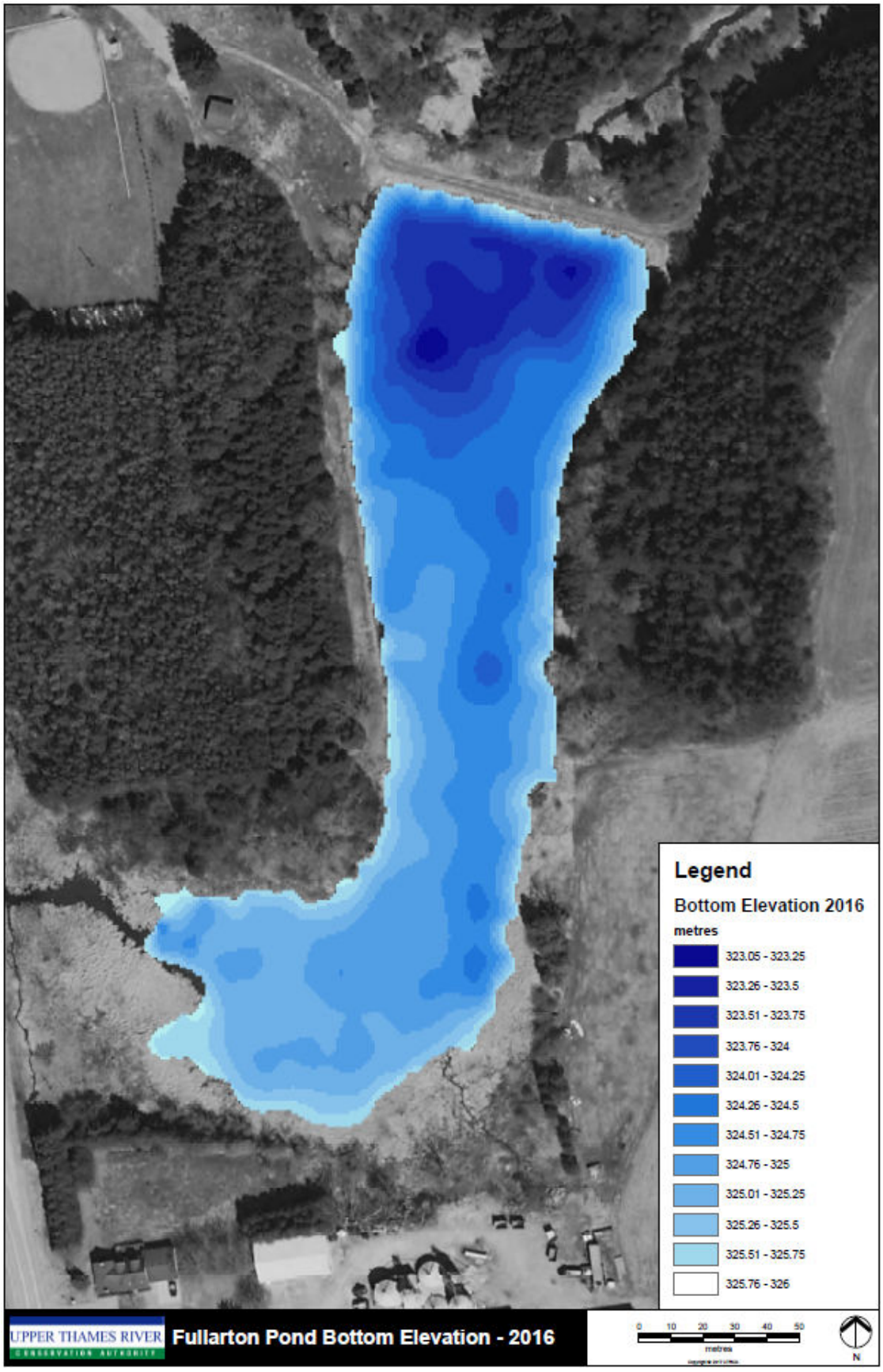

Figure 7: Fullarton Pond Bottom from 2016 Survey

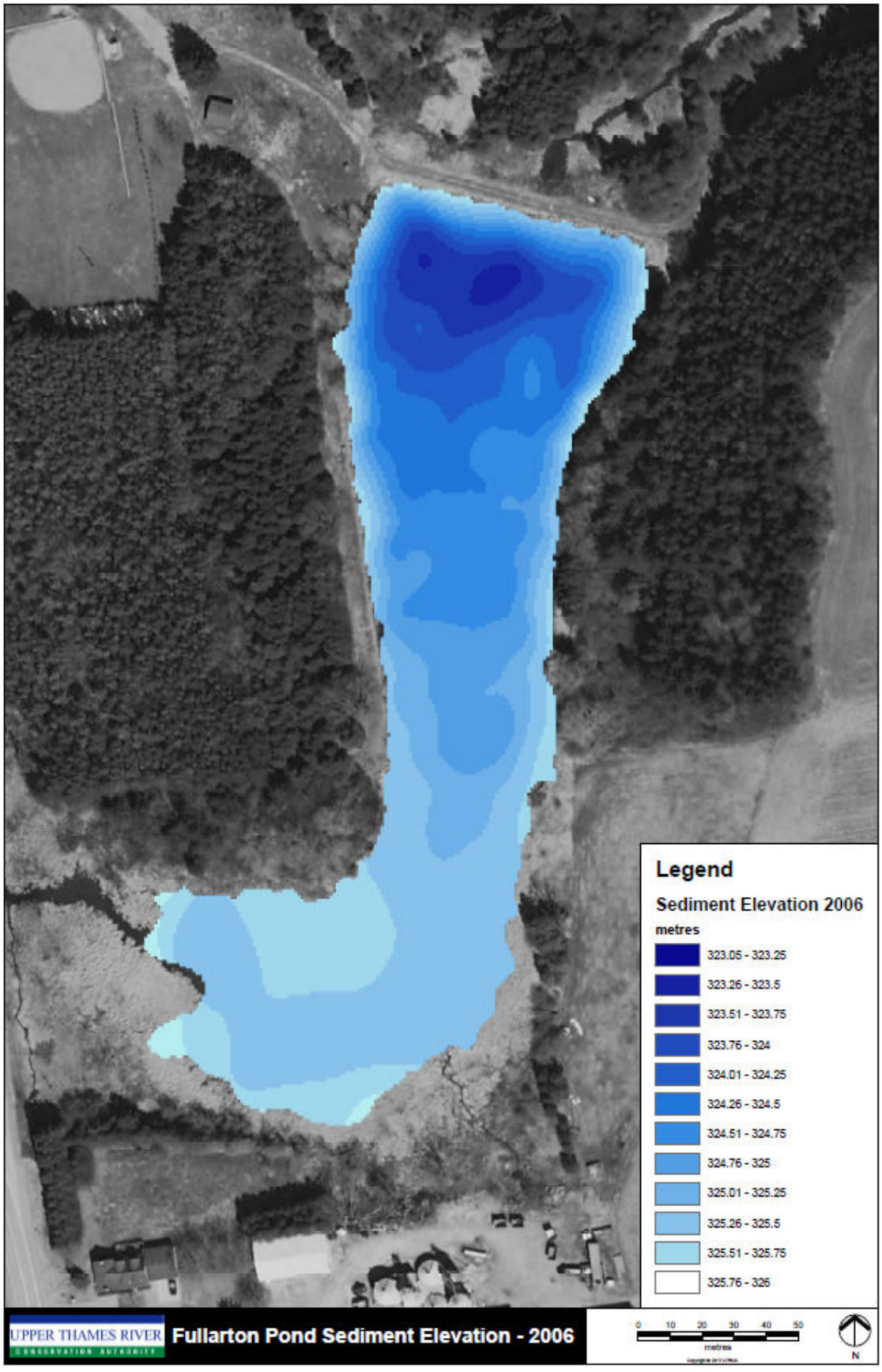

Figure 8: Fullarton Top of Sediment from 2006 Survey

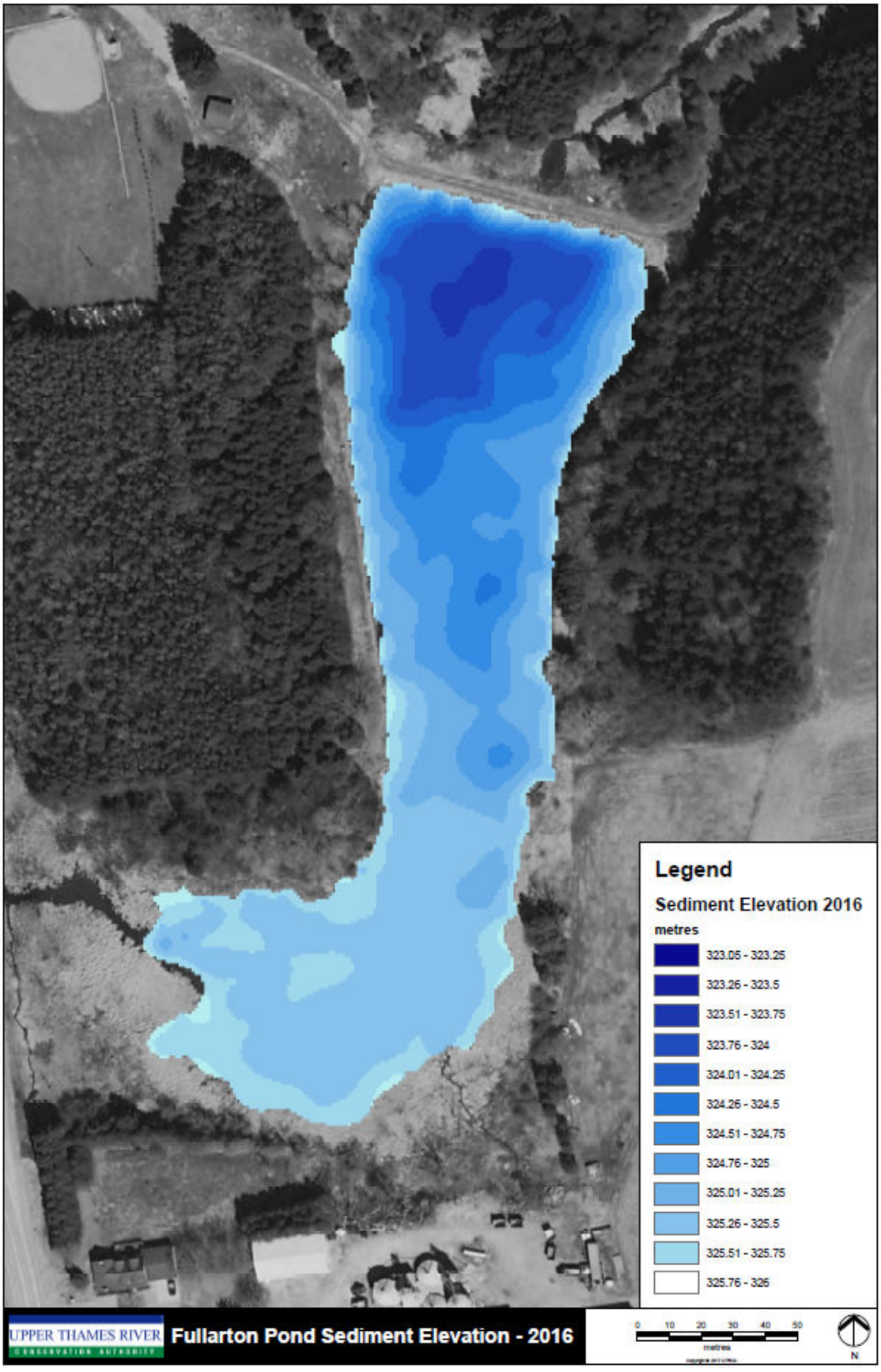

Figure 9: Fullarton Top of Sediment from 2016 Survey

Recommendations

Both the Dam Safety Assessment by Acres International and the Geotechnical Investigation by Naylor Engineering Associates produced recommendations to maintain or improve the stability of the dam. These recommendations and the cost estimates to complete them (updated to 2016 dollars) are detailed in Table 7. Estimated UTRCA costs for project management have also been included.

The total cost to complete all of the recommendations from Acres International and Naylor Engineering Associates is estimated at approximately $101,000.

It is recommended that the following work be completed in order to assist with decision making on future options regarding Fullarton Dam:

- a repeat of sediment surveys in order to allow sediment loading rates to be monitored
- investigate unit costs for sediment removal, testing, stabilization, and appropriate disposal
- investigate costs for dam removal and stream restoration

Table 7: Recommendations and Costs

Item	Contract Quantity	Unit	Unit Price ($)	Contract Total
UTRCA Project Management	1	LS	9000	9000
Design, Tender, and Admin @ 30%	1	LS	18170	18170
Contingency @ 15%	1	LS	9090	9090
Mobilization and Demobilization	1	LS	3030	3030
Bonding and Insurance	1	LS	1820	1820
Sediment Control (Silt Fencing)	1	LS	1640	1640
Clear and Grub Dam Embankments -to allow crest to be raised and to maintain the capacity of the emergency spillway	1	LS	2740	2740
Raise Crest Height -place and compact clay fill to prevent the dam crest from being overtopped during the inflow design flood	150	cu.m	110	16420
Supply and Install 100-300mm diameter Rip-Rap over filter cloth and sand and Granular “A” gravel base -required on upstream face of embankment and 10m downstream of dam outlet	380	sq.m	50	18720
Supply and Install 150 mm diameter Toe Drain with filter sand and sock that runs perpendicular to the outlet pipe 50 m on either side of the pipe -required to prevent seepage piping erosion	110	m	190	21070
Total Cost				101,700

References

Acres International Inc. (2007). *Dam Safety Assessment for Fullarton Dam.*

Naylor Engineering Associates Inc., Kelly, Dennis. (2006). *Geotechnical Investigation Fullarton Dam Embankment Stability Assessment Municipality of West Perth, Ontario for Upper Thames River Conservation Authority*

R.J. Burnside & Associates Ltd., MacIntyre, Paul. (2010). *Dam Rehabilitation* (p. 8).

Appendix B

Hydrogeology Assessment of Fullarton Conservation Area

Prepared By:

Linda Nicks

January 17, 2017

Contents

The hydrogeology assessment was a desk top exercise based on existing mapping and public information in the vicinity of the Fullarton Conservation Area.

Physiography and Surficial Geology

The Physiography was mapped by Chapman and Putnam (1966) and the Surficial Geology was mapped by Karrow (1977) (Figure 1). The Fullarton CA is located at a portion of the North Thames River where the river bisects two moraines: the Milverton and Mitchell moraines. The North Thames occupies the eastern margin of the Mitchell moraine which controls the river and Black Creek (southeast of the CA) borders the southern margin of the Milverton moraine. The CA is dominated by late glacial Rannoch till (diamicton/till) (Figure 3) which was deposited by the Huron Lobe (Mitchell moraine) as it retreated westward and outwash sand and gravel deposited associated with the esker to the west. The Rannoch till is a clayey silt till. In the low areas silt was deposited later on top of the till, through alluvial processes following deglaciation.

Topography

In general the topography is characterized by low relief with the steepest slopes adjacent to the river. The topography of Fullarton CA varies between 325-335 metres above sea level (MASL). Low areas are along Neil Drain and the North Thames River.

Monitoring wells, boreholes and private wells

There are no monitoring wells located on the CA site. The only subsurface information is from the Ministry of Environment, Energy and Climate Change (MOECC) that are well records from wells completed for domestic purposes (Figure 2). No additional well surveys were completed. There are no documented permit to take water sites nearby (https://www.ontario.ca/environment-and-energy/map-permits-take-water).

Hydrogeology

In the vicinity of Fullarton Conservation Area, drinking water wells are sourced in the shallow overburden or the deep bedrock. The shallow aquifer is limited in lateral extent and is relatively thin reaching up to 5 m in thickness and less than 15 m depth. The bedrock aquifer would be continuous across the regional area.

The shallow aquifer is limited in extent (see Figure 3) and if a well is located outside the extent of the shallow aquifer (e.g. 5002359), the only source of water is the deep bedrock aquifer. A sample of a few MOECC wells in the immediate area of the site (Figure 4) demonstrates the elevation of the ground and the shallow aquifer. The elevation of the shallow aquifer mimics the topography which is common in shallow aquifers. The shallow aquifer is in direct communication with the surface water in Neil Drain (parts of Neil drain are cold water which indicates groundwater discharge), the pond, marsh and wetland fringe and the North Thames River. Some of the ecosystems would be groundwater dependent

ecosystems. Thus, groundwater in the CA has potential to impact the surface water in terms of water quantity and quality.

The bedrock aquifer exists across the entire area. Based on MOECC well records, the water levels vary between 250-265 masl. The elevation of the bedrock surface is much shallower between 290 and 310 m elevation (Figure 6). This indicates that there is more than 40-50 m of dry bedrock above the bedrock water level (potentiometric surface) and the bedrock aquifer. This indicates a significant downward groundwater gradient between the overburden and the bedrock. Tens of metres of dry bedrock generally indicate a significant weathered bedrock (karst) environment. Wells completed in this aquifer can have fluctuating water levels, varying pressure changes and have potential to be influenced or impacted by surface water. However, this deep aquifer is below the depth of the surface water bodies and would not contribute to surface water quality or quantity.

Groundwater Quality and Quantity

No groundwater quality or quantity monitoring has occurred at the Conservation Area. The nearest Provincial Groundwater Monitoring Network (PGMN) site operated by the UTRCA is Well 54 which is a bedrock groundwater monitor. Well 54 is approximately 6 kilometres downstream of Conservation area and on the western bank of the North Thames River. The average water level is 303 m which is significantly higher than the bedrock aquifer located at the CA and likely is a different aquifer than present at the CA. The groundwater in PGMN well 54 varies up to 4 m since 2001 when the monitoring program was initiated. The quality of the water in the bedrock aquifer at Well 54 is excellent.

References

Chapman, L.J. and Putnam, D.F. 1966. The Physiography of southern Ontario; University of Toronto Press, Toronto 2nd ed. 386 p.

Karrow, P.F. Quaternary Geology of the St. Marys Area, Southern Ontario, 1977. Geoscience Report 148

Figures

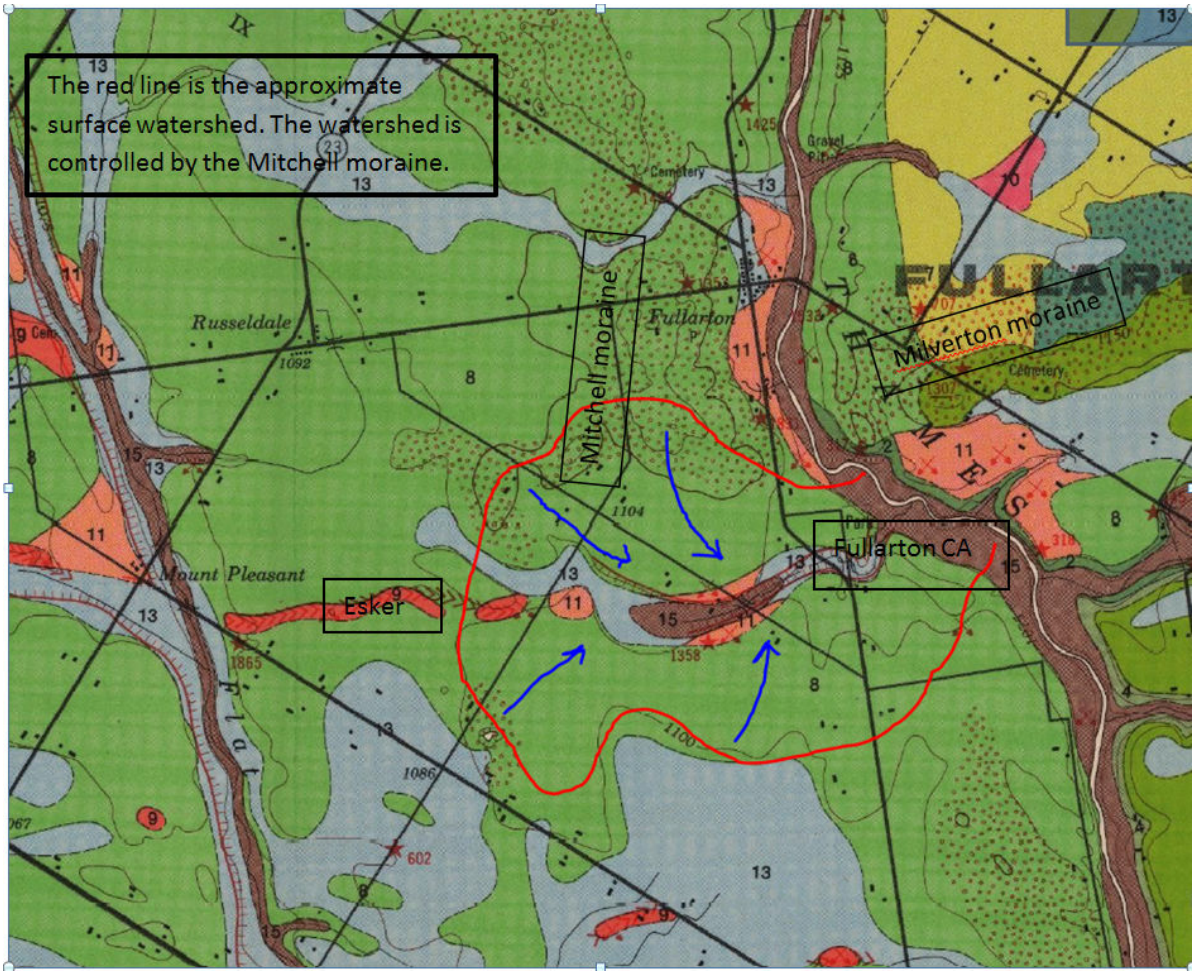

Figure 1: A portion of Ontario Geological Survey Map 2366 Quaternary Geology of the St. Marys area which illustrates the physiography of the Fullarton CA. Figure 3 is based on this mapping and more clearly represents catchment and legend. The Conservation Area is located at the confluence of the Mitchell moraine (stippled area north south orientation) and the Milverton moraine (stippled east- northeast). Black Creek runs parallel and south of the Milverton moraine and the North Thames runs adjacent to the Mitchell moraine. See Figure 3 for surficial geology and legend of the CA. An esker (9) west of the CA would contribute to groundwater at the CA.

Figure 2: Location of wells in the area and the nature of the aquifers at depth. There are both shallow overburden wells (less than 15 m depth) and deep bedrock wells tapping water between 70 and 120 m depth. The graphic superimposed on the aerial photography is a representation of the materials encountered at depth as described by the well driller. The colour indicates material and the aquifers are represented by gravel and limestone, depth of the well is indicated in meters. (http://analysis.gw-info.net/gin/publicgin.aspx)

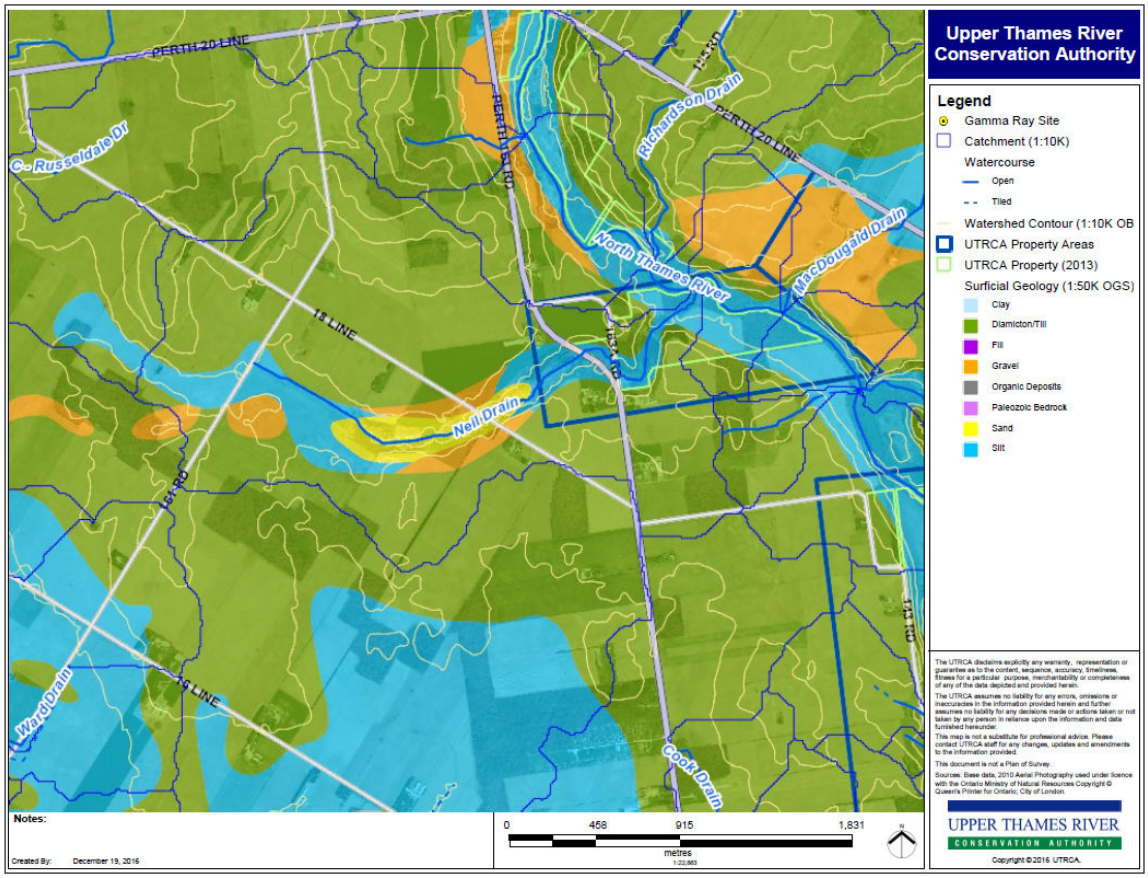

Figure 3: Surficial geology with legend and elevation contours (masl), based on Ontario Geological Survey Map 2366: St Mary's, Southern Ontario, 1974 by P. F, Karrow and assistants. Mapping is the same as Figure 1.

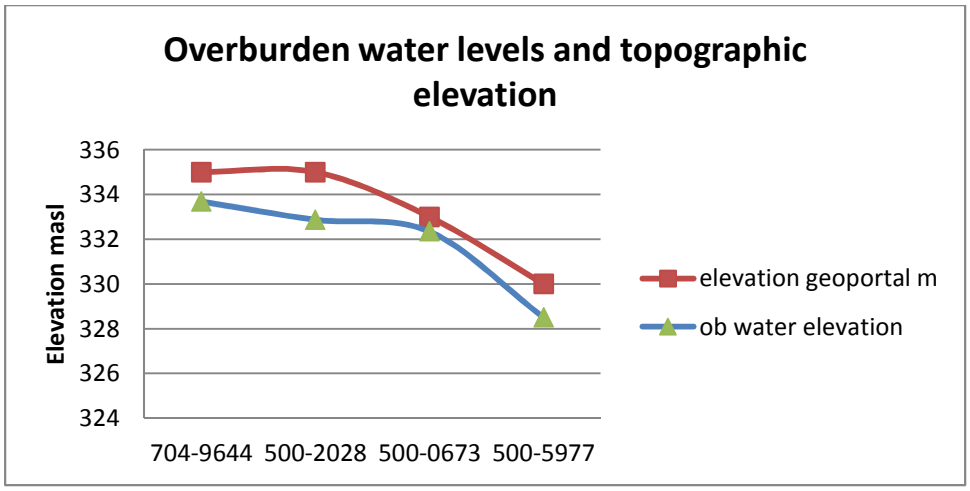

Figure 4: Ground elevation versus shallow water table based on MOECC well logs.

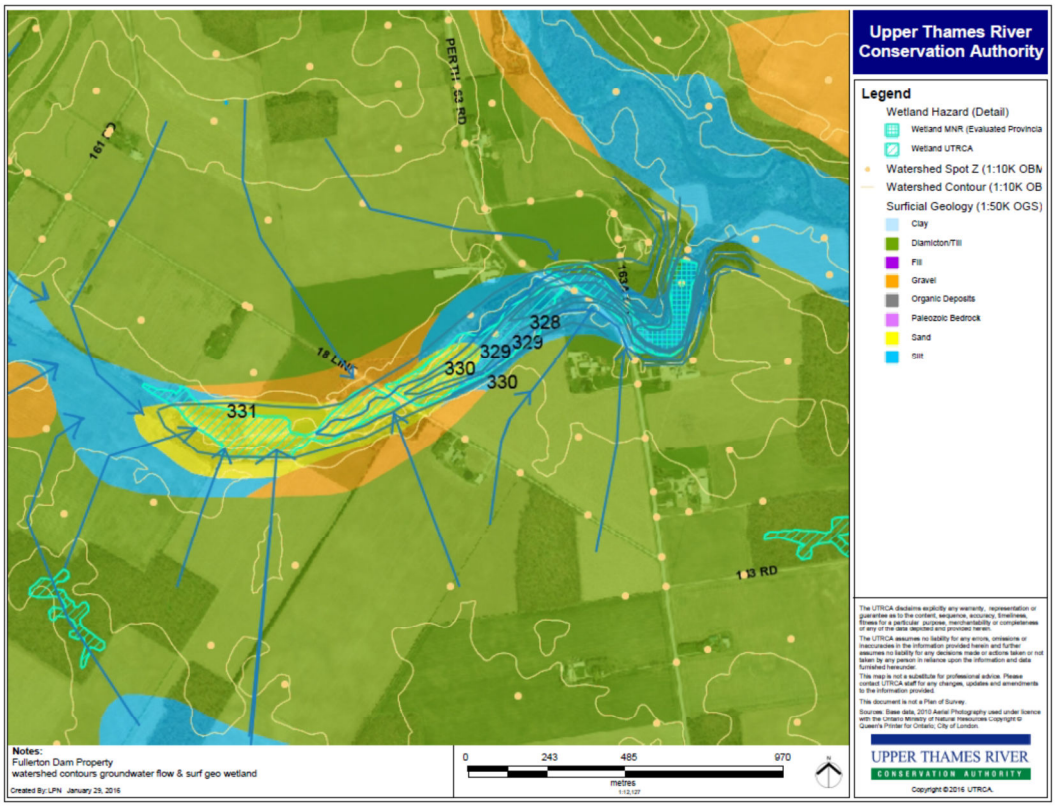

Figure 5: The arrows represent shallow recharge to the shallow groundwater aquifer and flow direction from the high areas to the low areas. The contours represent the approximate groundwater levels and are schematic based on MOECC water well records.

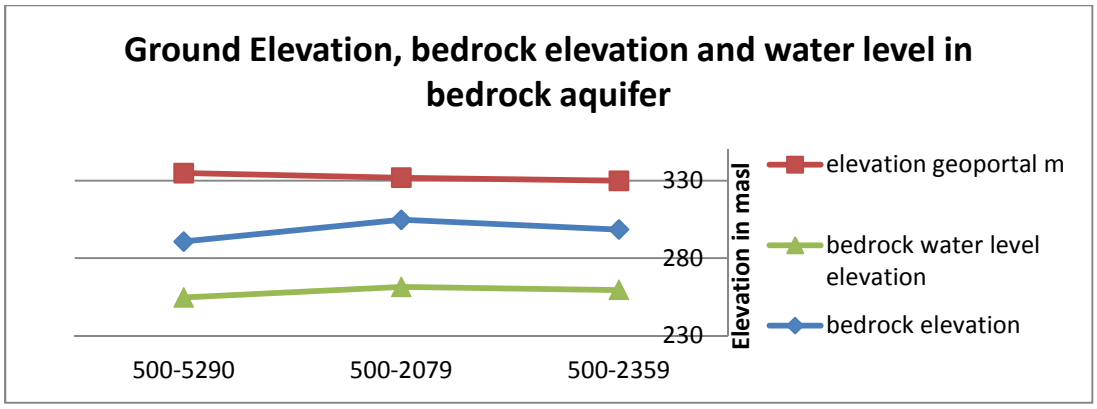

Figure 6: A representation of MOECC bedrock well logs in the Fullarton CA area. The bedrock aquifer water levels and flow direction are regional and generally do not show a correlation to the topography of the site.

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).

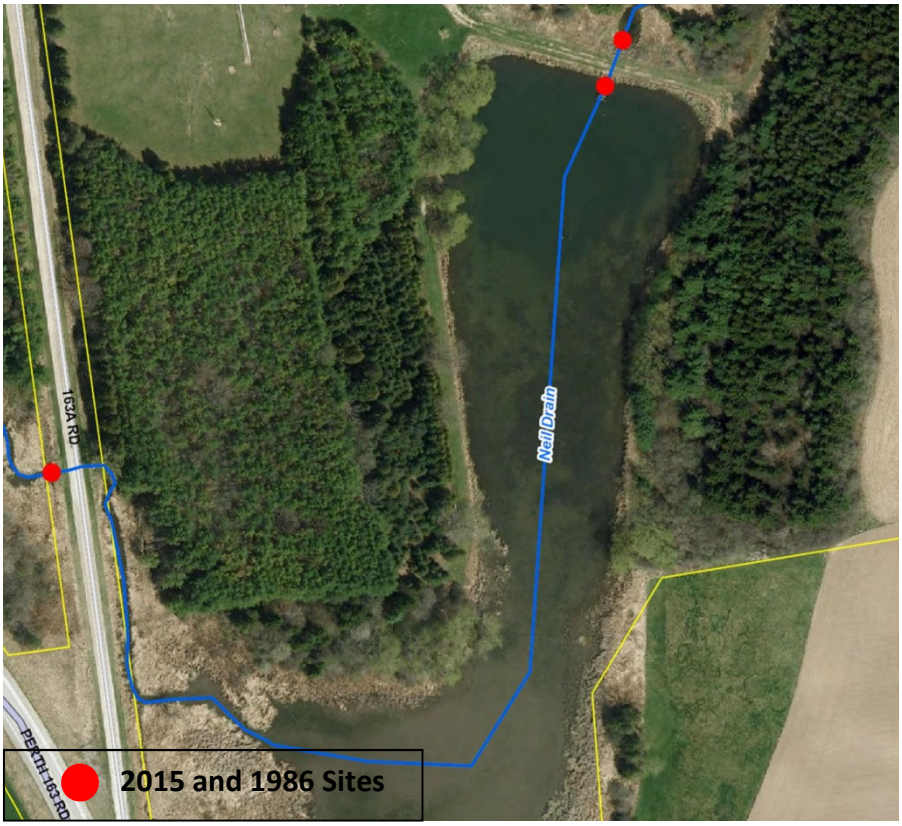

Figure 1: Fullarton Pond water quality sampling sites

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.

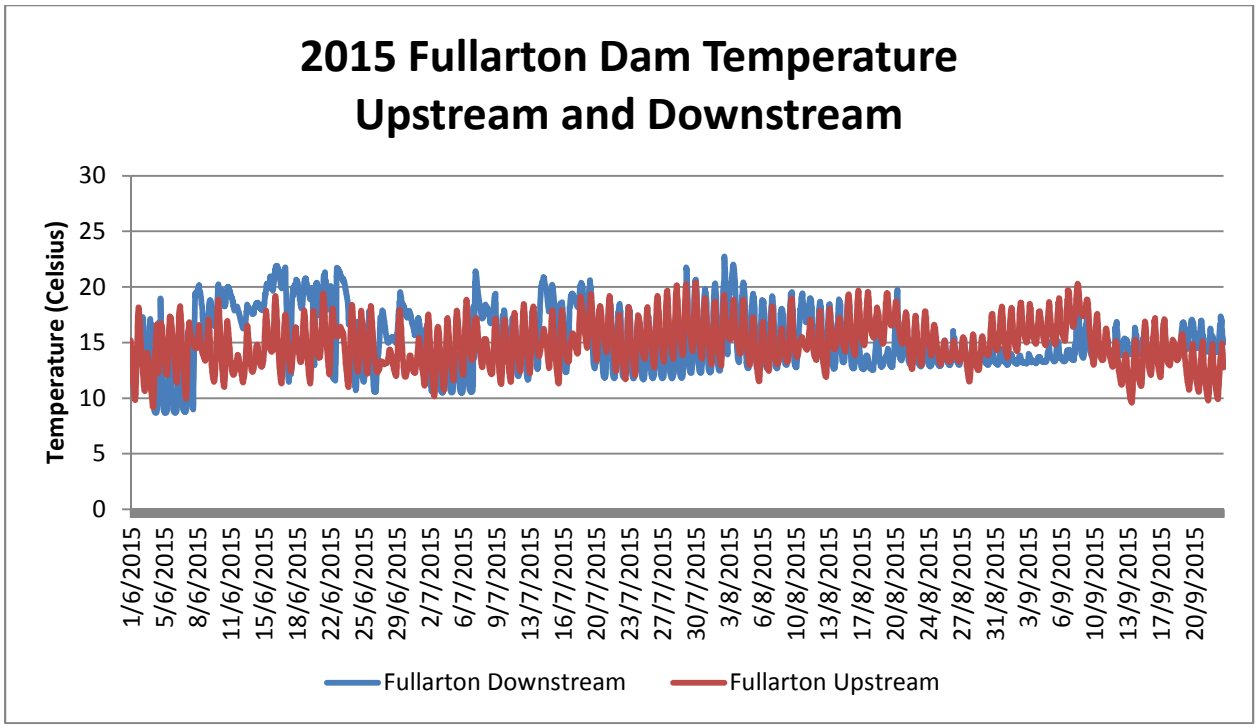

Figure 2: 2015 Fullarton Pond continuous temperature upstream and downstream

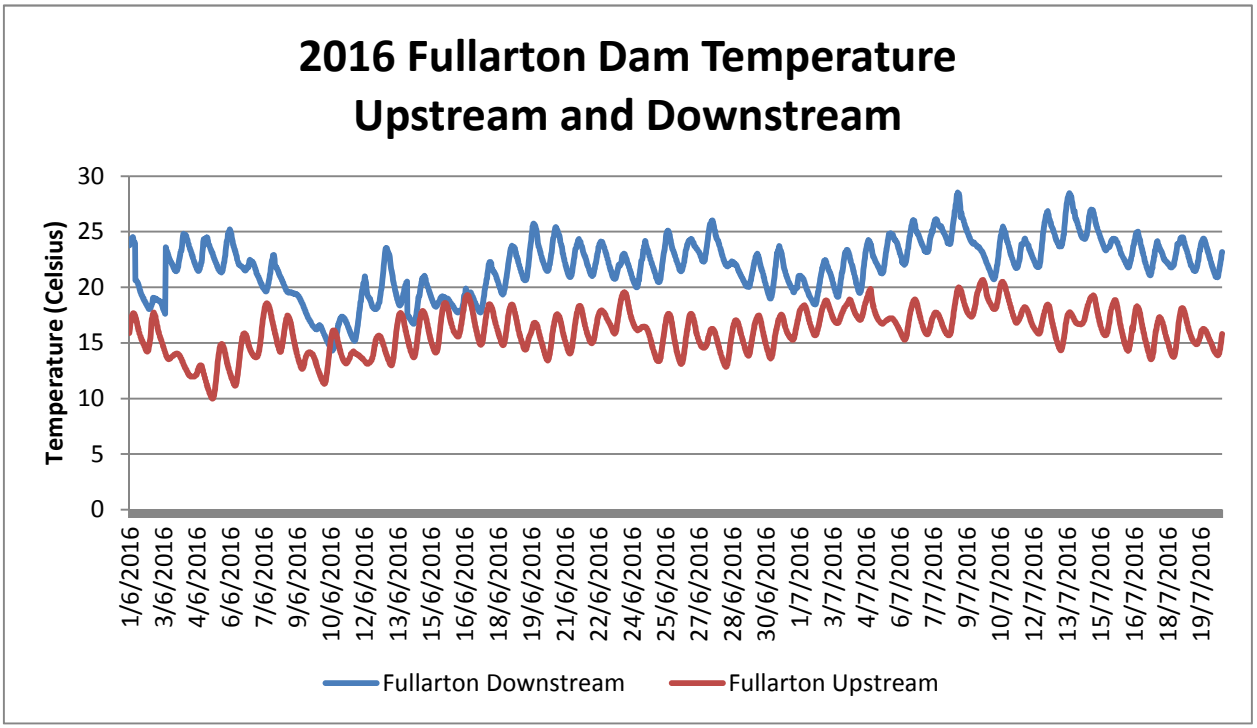

Figure 3: 2016 Fullarton Pond continuous temperature upstream and downstream

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.

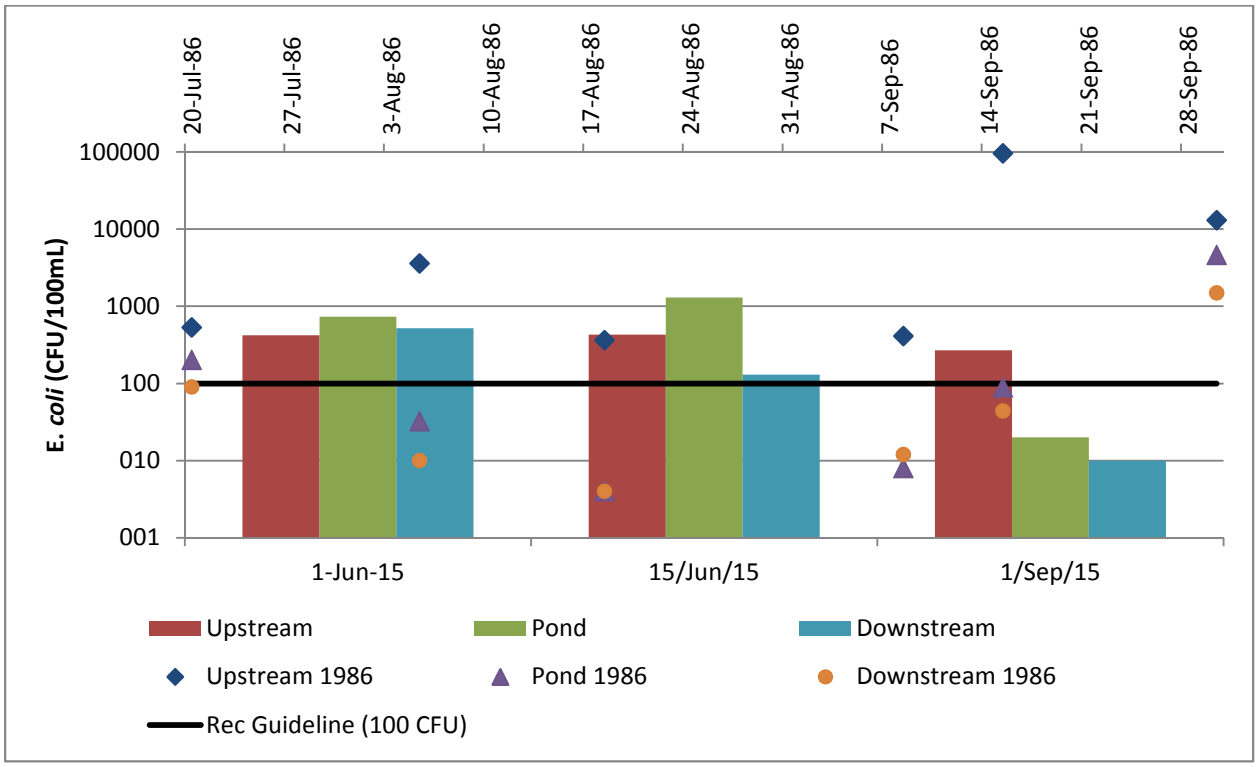

Figure 4: E. coli bacteria 1986 and 2015 (Log Scale)

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.

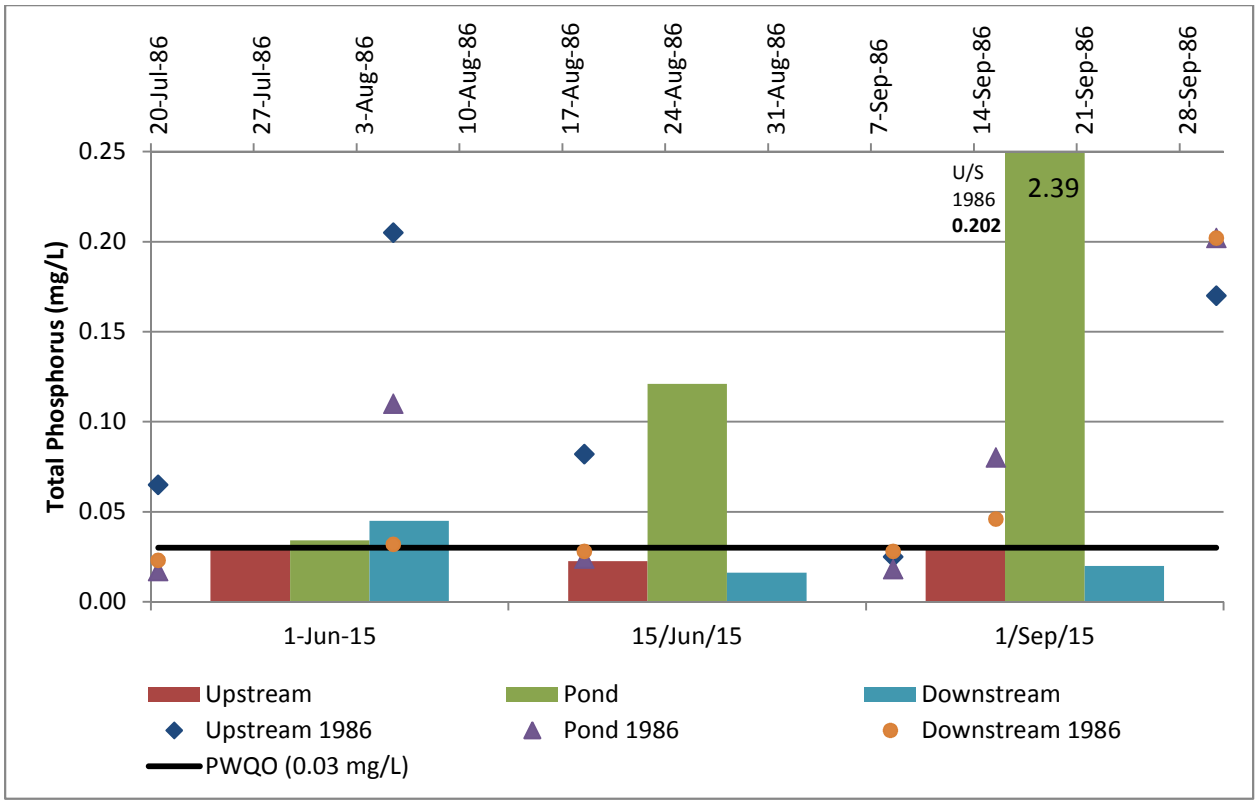

Figure 5: Total Phosphorus 1986 and 2015

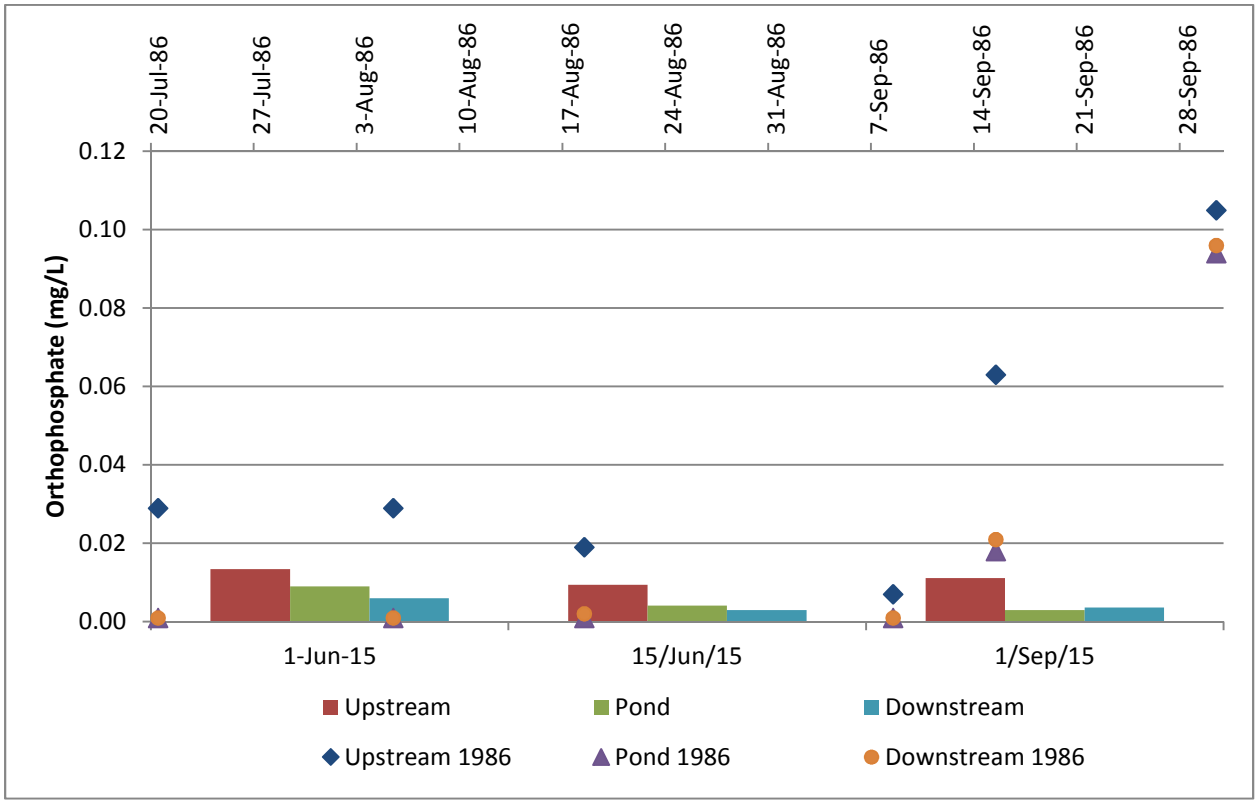

Figure 6: Orthophosphate 1986 and 2015

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.

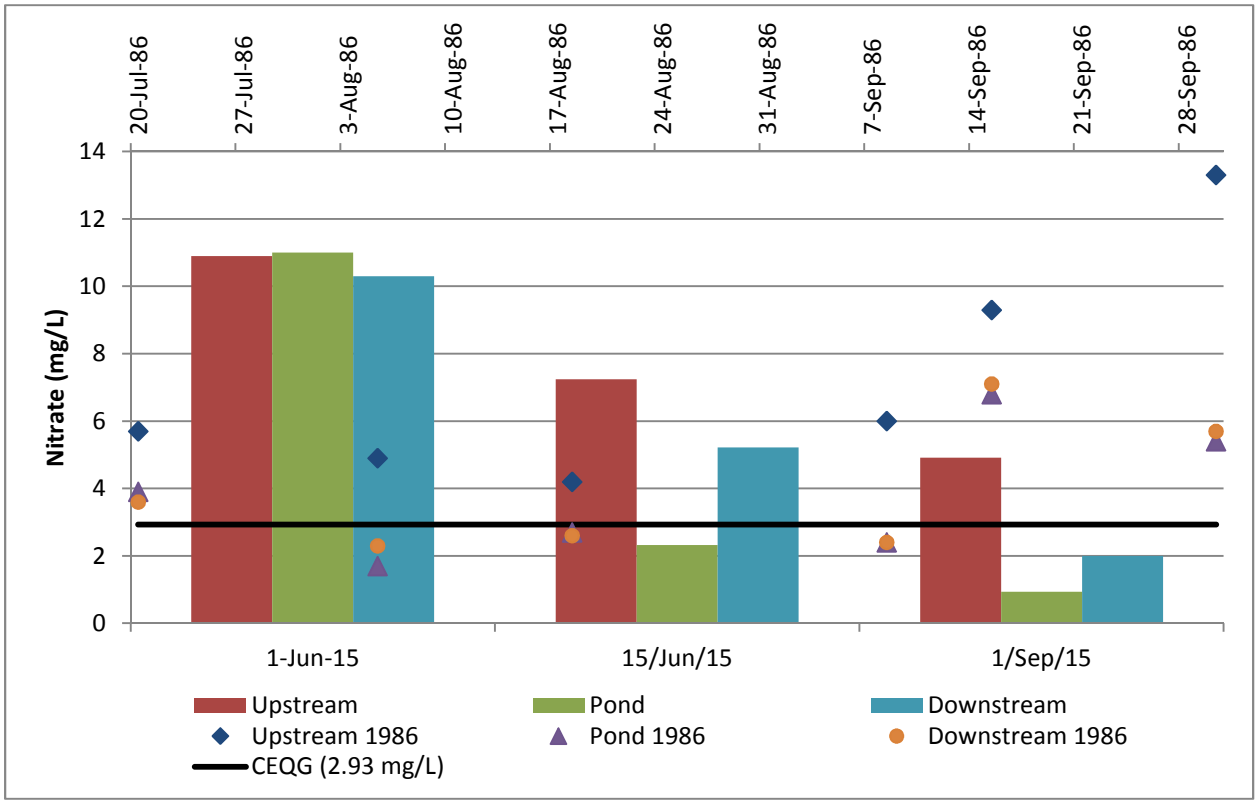

Figure 7: Nitrate 1986 and 2015

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.

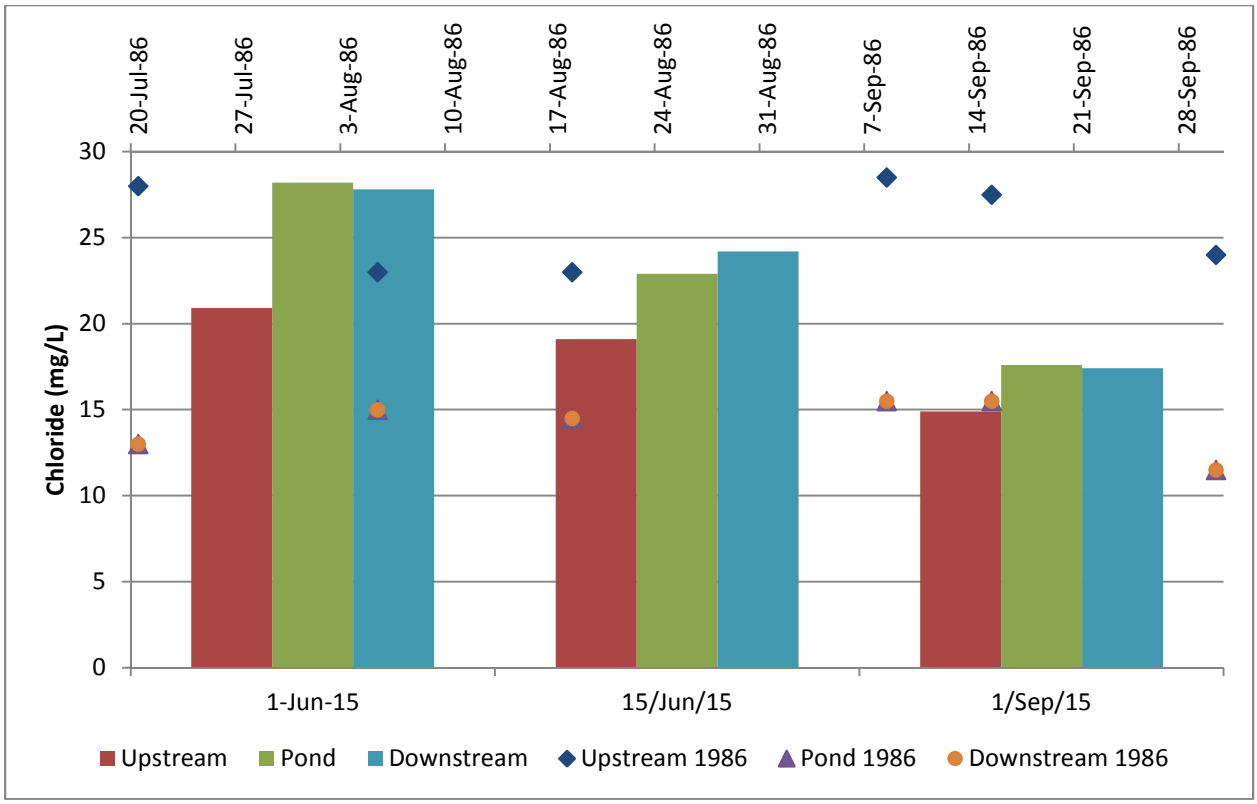

Figure 8: Chloride 1986 and 2015

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.

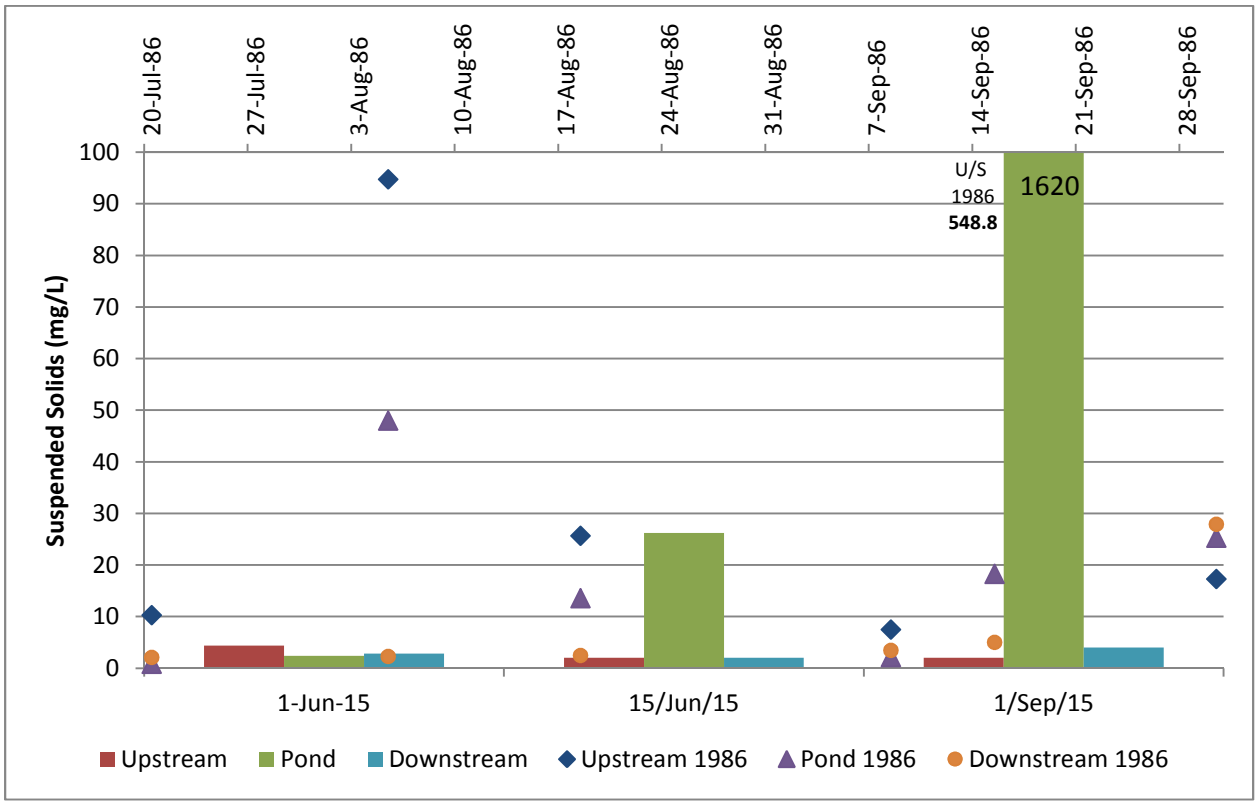

Figure 9: Suspended Solids 1986 and 2015

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.

Appendix D

Fullarton Dam Area
Fish and Benthic Records

Records provided by:
John Schwindt

January 17, 2017

Contents

Fish Resources

Records are presented for sampling conducted above and in Fullarton Pond, and in Neil Drain downstream of the dam. With the exception of one sample in the pond where minnow traps were employed, backpack electrofishers were utilized to provide representative samples. All fish were identified to species and released at the sampling site. In some cases photo vouchers were taken.

Fish diversity upstream of Fullarton Pond (Neil Drain)

Species	Status – Global	Can	Ont.	Thames	Thames Distribution	Times Sampled
Brook Stickleback	G5		S5	Abundant	Throughout	4
Creek Chub	G5		S5	Abundant	Throughout	1
Fathead Minnow	G5		S5	Common	Throughout	1
Green Sunfish	G5		S4	Uncommon	Widespread	2
Iowa Darter	G5		S5	Uncommon	Widespread	1
Least Darter	G5		S4	Uncommon	Throughout	1
Mottled Sculpin	G5		S5	Uncommon	Localized	4
Northern Redbelly Dace	G5		S5	Common	Throughout	4
White Sucker	G5		S5	Abundant	Throughout	3

Fish diversity downstream of Fullarton Dam (Neil Drain)

Species	Status – Global	Can	Ont.	Thames	Thames Distribution	Times Sampled
Black Bullhead	G5		S4	Uncommon	Throughout	2
Blacknose Dace	G5		S5	Abundant	Throughout	6
Blacknose Shiner	G4		S5	Rare	Localized	3
Bluegill	G5		S5	Uncommon	Widespread	1
Bluntnose Minnow	G5		S5	Abundant	Throughout	2
Brook Stickleback	G5		S5	Abundant	Throughout	2
Central Mudminnow	G5		S5	Uncommon	Throughout	1
Central Stoneroller	G5		S4	Abundant	Throughout	6
Common Carp	G5		SNA	Common	Throughout	1
Common Shiner	G5		S5	Abundant	Throughout	3
Creek Chub	G5		S5	Abundant	Throughout	6
Fantail Darter	G5		S4	Abundant	Throughout	2
Fathead Minnow	G5		S5	Common	Throughout	5
Golden Shiner	G5		S5	Uncommon	Widespread	4
Green Sunfish	G5		S4	Uncommon	Widespread	6
Greenside Darter	G5		S4	Abundant	Throughout	6
Hornyhead Chub	G5		S4	Common	Throughout	3
Iowa Darter	G5		S5	Uncommon	Widespread	4
Johnny Darter	G5		S5	Abundant	Throughout	3
Largemouth Bass	G5		S5	Common	Throughout	5
Least Darter	G5		S4	Uncommon	Throughout	1
Mottled Sculpin	G5		S5	Uncommon	localized	2
Northern Hog Sucker	G5		S4	Common	Throughout	2
Northern Pike	G5		S5	Uncommon	Throughout	1
Northern Redbelly Dace	G5		S5	Common	Throughout	2
Northern Sunfish	G5		S3	Uncommon	Throughout	6
Pumpkinseed	G5		S5	Common	Throughout	5
Rainbow Darter	G5		S4	Uncommon	Throughout	5
Rock Bass	G5		S5	Abundant	Throughout	6
Rosyface Shiner	G5		S4	Common	Throughout	1
Smallmouth Bass	G5		S5	Common	Throughout	3
Striped Shiner	G5		S4	Common	Throughout	2
White Sucker	G5		S5	Abundant	Throughout	6
Yellow Bullhead	G5		S4	Uncommon	Localized	1

Fish diversity in Fullarton Pond

Species	Status – Global	Can	Ont.	Thames	Thames Distribution	Times Sampled
Brook Stickleback	G5		S5	Abundant	Throughout	2
Golden Shiner	G5		S5	Uncommon	Widespread	1
Green Sunfish	G5		S4	Uncommon	Widespread	2
Least Darter	G5		S4	Uncommon	Throughout	1
Northern Redbelly Dace	G5		S5	Common	Throughout	1
Northern Sunfish	G5		S3	Uncommon	Throughout	1
Pumpkinseed	G5		S5	Common	Throughout	1

Fullarton Dam area fish sampling records

Species Common Name	Scientific Name	COSEWIC	SARA	ESA 2007	SRank	Abundance	Distribution
Neil Drain Upstream of Fullarton Pond (1995-2015)							
Neil Drain, Road 163a (upstream of Fullarton Pond)		UTM x: 482738		UTM y: 4802225			11/7/1995
Brook Stickleback	Culaea inconstans				S5	Abundant	Throughout
Green Sunfish	*Lepomis cyanellus*				S4	Uncommon	Widespread
Mottled Sculpin	*Cottus bairdi*				S5	Uncommon	Localized
Northern Redbelly Dace	*Phoxinus eos*				S5	Common	Throughout
White Sucker	*Catostomus commersoni*				S5	Abundant	Throughout
Neil Drain, Road 163a (upstream of Fullarton Pond)		UTM x: 482738		UTM y: 4802225			8/22/2008
Brook Stickleback	*Culaea inconstans*				S5	Abundant	Throughout
Creek Chub	*Semotilus atromaculatus*				S5	Abundant	Throughout
Green Sunfish	*Lepomis cyanellus*				S4	Uncommon	Widespread
Mottled Sculpin	*Cottus bairdi*				S5	Uncommon	Localized
Northern Redbelly Dace	*Phoxinus eos*				S5	Common	Throughout
White Sucker	*Catostomus commersoni*				S5	Abundant	Throughout
Neil Drain, Road 163a (upstream of Fullarton Pond)		UTM x: 482738		UTM y: 4802225			6/3/2015
Brook Stickleback	*Culaea inconstans*				S5	Abundant	Throughout
Iowa Darter	*Etheostoma exile*				S5	Uncommon	Widespread
Least Darter	*Ethostoma microperca*				S4	Uncommon	Throughout
Mottled Sculpin	*Cottus bairdi*				S5	Uncommon	Localized
Northern Redbelly Dace	*Phoxinus eos*				S5	Common	Throughout
White Sucker	*Catostomus commersoni*				S5	Abundant	Throughout
Neil Drain, Road 163a (upstream of Fullarton Pond)		UTM x: 482738		UTM y: 4802225			10/23/2015
Brook Stickleback	*Culaea inconstans*				S5	Abundant	Throughout
Fathead Minnow	*Pimephales promeals*				S5	Common	Throughout
Mottled Sculpin	*Cottus bairdi*				S5	Uncommon	Localized
Northern Redbelly Dace	*Phoxinus eos*				S5	Common	Throughout
Fullarton Pond (2015)							
Fullarton CA		UTM x: 482863		UTM y: 4802336			10/23/2015
Brook Stickleback	*Culaea inconstans*				S5	Abundant	Throughout
Green Sunfish	*Lepomis cyanellus*				S4	Uncommon	Widespread
Least Darter	*Etheostoma microperca*				S4	Uncommon	Throughout
Fullarton CA		UTM x: 482863		UTM y: 4802336			11/4/2015
Brook Stickleback	*Culaea inconstans*				S5	Abundant	Throughout
Golden Shiner	*Notemigonus crysoleucas*				S5	Uncommon	Widespread
Green Sunfish	*Lepomis cyanellus*				S4	Uncommon	Widespread
Northern Redbelly Dace	*Phoxinus eos*				S5	Common	Throughout
Northern Sunfish	*Lepomis peltastes*				S3	Uncommon	Throughout
Pumpkinseed	*Lepomis gibbosus*				S5	Common	Throughout

Species (Common Name)	Scientific Name	COSEWIC	SARA	ESA 2007	SRank	Abundance	Distribution
Neil Drain Downstream of Fullarton Pond (2002 – 2015)							
Downstream of Fullarton Pond		UTM x: 482913		UTM y:	4802387		11/28/2002
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	Throughout
Bluntnose Minnow	*Pimephales notatus*				S5	Abundant	Throughout
Central Stoneroller	*Campostoma anomalum*				S4	Abundant	Throughout
Common Shiner	*Luxilus comutus*				S5	Abundant	Throughout
Creek Chub	*Semotilus atromaculatus*				S5	Abundant	Throughout
Fathead Minnow	*Pimephales promelas*				S5	Common	Throughout
Golden Shiner	*Notemigonus crysoleucas*				S5	Uncommon	Widespread
Green Sunfish	*Lepomis cyanellus*				S4	Uncommon	Widespread
Greenside Darter	*Etheostoma blennioides*				S4	Abundant	Throughout
Johnny Darter	*Etheostoma nigrum*				S5	Abundant	Throughout
Least Darter	*Etheostoma microperca*				S4	Uncommon	Throughout
Northern Hog Sucker	*Hypentelium nigricans*				S4	Common	Throughout
Northern Sunfish	*Lepomis peltastes*				S3	Uncommon	Throughout
Pumpkinseed	*Lepomis gibbosus*				S5	Common	Throughout
Rock Bass	*Ambloplites rupestris*				S5	Abundant	Throughout
Smallmounth Bass	*Micropterus dolomieu*				S5	Common	Throughout
Striped Shiner	*Luxilus chrysocephalus*				S4	Common	Throughout
White Sucker	*Catostomus commersoni*				S5	Abundant	Throughout
Downstream of Fullarton Pond		UTM x: 482913		UTM y: 4802387			8/27/2009
Black Bullhead	*Ameiurus melas*				S4	Uncommon	Throughout
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	Throughout
Blacknose Shiner	*Notropis neterolepis*				S5	Rare	Localized
Bluntnose Minnow	*Pimephales notatus*				S5	Abundant	Throughout
Brook Stickleback	*Culaea inconstans*				S5	Abundant	Throughout
Central Stoneroller	*Campostoma anomalum*				S4	Abundant	Throughout
Common Carp	*Cyprinus carpio*				SNA	Common	Throughout
Common Shiner	*Luxilus comutus*				S5	Abundant	Throughout
Creek Chub	*Semotilus atromaculatus*				S5	Abundant	Throughout
Fantail Darter	*Etheostoma flabellare*				S4	Abundant	Throughout
Fathead Minnow	*Pimephales promelas*				S5	Common	Throughout
Golden Shiner	*Notemigonus crysoleucas*				S5	Uncommon	Widespread
Green Sunfish	*Lepomis cyanellus*				S4	Uncommon	Widespread
Greenside Darter	*Etheostoma blennioides*				S4	Abundant	Throughout
Hornyhead Chub	*Nocomis biguttatus*				S4	Common	Throughout
Iowa Darter	*Etheostoma exile*				S5	Uncommon	Widespread
Johnny Darter	*Etheostoma nigrum*				S5	Abundant	Throughout
Northern Hog Sucker	*Hypentelium nigricans*				S4	Common	Throughout
Northern Redbelly Dace	*Phoxinus eos*				S5	Common	Throughout
Northern Sunfish	*Lepomis peltastes*				S3	Uncommon	Throughout
Pumpkinseed	*Lepomis gibbosus*				S5	Common	Throughout
Rainbow Darter	*Etheostoma caeruleum*				S4	Uncommon	Throughout
Rock Bass	*Ambloplites rupestris*				S5	Abundant	Throughout
Smallmouth Bass	*Micropterus dolomieu*				S5	Common	Throughout
White Sucker	*Catostomus commersoni*				S5	Abundant	Throughout

Species (Common Name)	Scientific Name	COSEWIC	SARA	ESA 2007	SRANK	Abundance	Distribution
Downstream of Fullarton Pond			UTM x: 482913	UTM y: 4802387			8/15/2013
Black Bullhead	*Ameiurus melas*				S4	Uncommon	Throughout
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	Throughout
Bluegill	*Lepomis macrochirus*				S5	Uncommon	Widespread
Central Mudminnow	*Umbra limi*				S5	Uncommon	Throughout
Central Stoneroller	*Campostoma anomalum*				S4	Abundant	Throughout
Creek Chub	*Semotilus atromaculatus*				S5	Abundant	Throughout
Green Sunfish	*Lepomis cyanellus*				S4	Uncommon	Widespread
Greenside Darter	*Etheostoma blennioides*				S4	Abundant	Throughout
Northern Pike	*Esox Lucius*				S5	Uncommon	Throughout
Northern Sunfish	*Lepomis peltastes*				S3	Uncommon	Throughout
Pumpkinseed	*Lepomis gibbosus*				S5	Common	Throughout
Rainbow Darter	*Etheostoma caeruleum*				S4	Uncommon	Throughout
Rock Bass	*Ambloplites rupestris*				S5	Abundant	Throughout
White Sucker	*Catostomus commersoni*				S5	Abundant	Throughout
Downstream of Fullarton Pond			UTM x: 482913	UTM y: 4802387			6/3/2015
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	Throughout
Blacknose Shiner	*Notropis heterolepis*				S5	Rare	Localized
Central Stoneroller	*Campostoma anomalum*				S4	Abundant	Throughout
Common Shiner	*Luxilus cornutus*				S5	Abundant	Throughout
Creek Chub	*Semotilus atromaculatus*				S5	Abundant	Throughout
Fathead Minnow	*Pimpephales promelas*				S5	Common	Throughout
Golden Shiner	*Notemigonus crysoleucas*				S5	Uncommon	Widespread
Green Sunfish	*Lepomis cyanellus*				S4	Uncommon	Widespread
Greenside Darter	*Etheostoma blennioides*				S4	Abundant	Throughout
Hornyhead Chub	*Nocomis biguttatus*				S4	Common	Throughout
Iowa Darter	*Etheostoma exile*				S5	Uncommon	Widespread
Mottled Sculpin	*Cottus bairdi*				S5	Uncommon	Localized
Northern Sunfish	*Lepomis peltastes*				S3	Uncommon	Throughout
Rainbow Darter	*Etheostoma caeruleum*				S4	Uncommon	Throughout
Rock Bass	*Ambloplites rupestris*				S5	Abundant	Throughout
Rosyface Shiner	*Notropis rubellus*				S4	Common	Throughout
White Sucker	*Catostomus commersoni*				S5	Abundant	Throughout
Downstream of Fullarton Pond			UTM x: 482913	UTM y: 4802387			10/5/2015
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	Throughout
Blacknose Shiner	*Notropis heterolepis*				S5	Rare	Localized
Central Stoneroller	*Campostoma anomalum*				S4	Abundant	Throughout
Creek Chub	*Semotilus atromaculatus*				S5	Abundant	Throughout
Fantail Darter	*Etheostoma flabellare*				S4	Abundant	Throughout
Fathead Minnow	*Pimpephales promelas*				S5	Common	Throughout
Golden Shiner	*Notemigonus crysoleucas*				S5	Uncommon	Widespread
Green Sunfish	*Lepomis cyanellus*				S4	Uncommon	Widespread
Greenside Darter	*Etheostoma blennioides*				S4	Abundant	Throughout
Hornyhead Chub	*Nocomis biguttatus*				S4	Common	Throughout
Iowa Darter	*Etheostoma exile*				S5	Uncommon	Widespread
Largemouth Bass	*Micropterus salmoides*				S5	Common	Throughout
Northern Sunfish	*Lepomis peltastes*				S3	Uncommon	Throughout
Pumpkinseed	*Lepomis gibbosus*				S5	Common	Throughout

Species (Common Name)	Scientific Name	COSEWIC	SARA	ESA 2007	SRANK	Abundance	Distribution
Rainbow Darter	*Etheostoma caeruleum*				S4	Uncommon	Throughout
Rock Bass	*Ambloplites rupestris*				S5	Abundant	Throughout
Smallmouth Bass	*Micropterus dolomieu*				S5	Common	Throughout
Striped Shiner	*Luxilus chrysocephalus*				S4	Common	Throughout
White Sucker	*Catostomus commersoni*				S5	Abundant	Throughout
Downstream of Fullarton Pond		UTM x: 482913		UTM y: 4802387			10/23/2015
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	Throughout
Brook Stickleback	*Culaea inconstans*				S5	Abundant	Throughout
Central Stoneroller	*Campostoma anomalum*				S4	Abundant	Throughout
Creek Chub	*Semotilus atromaculatus*				S5	Abundant	Throughout
Fathead Minnow	*Pimephales promelas*				S5	Common	Throughout
Green Sunfish	*Lepomis cyanellus*				S4	Uncommon	Widespread
Greenside Darter	*Etheostoma blennioides*				S4	Abundant	Throughout
Iowa Darter	*Etheostoma exile*				S5	Uncommon	Widespread
Johnny Darter	*Etheostoma nigrum*				S5	Abundant	Throughout
Mottled Sculpin	*Cottus bairdi*				S5	Uncommon	Localized
Northern Redbelly Dace	*Phoxinus eos*				S5	Common	Throughout
Northern Sunfish	*Lepomis peltastes*				S3	Uncommon	Throughout
Pumpkinseed	*Lepomis gibbosus*				S5	Common	Throughout
Rainbow Darter	*Etheostoma caeruleum*				S4	Uncommon	Throughout
Rock Bass	*Ambloplites rupestris*				S5	Abundant	Throughout
Smallmouth Bass	*Micropterus dolomieu*				S5	Common	Throughout
White Sucker	*Catostomus commersoni*				S5	Abundant	Throughout
Yellow Bullhead	*Ameiurus natalis*				S4	Uncommon	Localized

COSEWIC Status: The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses species for their consideration for legal protection and recovery (or management) under the Species at Risk Act (SARA).

Extinct: A wildlife species that no longer exists.
Extirpated: A wildlife species no longer existing in the wild in Canada, but exists elsewhere.
Endangered: A wildlife species facing imminent extirpation or extinction.
Threatened: A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern: A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk: A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient: A category that applies when the available information is insufficient (a) to resolve a wildlife species' eligibility for assessment or (b) to permit an assessment of the wildlife species' risk of extinction.

Reference: www.cosewic.gc.ca (current to November 2011)

SARA Status: The federal at risk designation for species under the Species at Risk Act (SARA)
Reference: www.sararegistry.gc.ca (current to December 2011)

ESA 2007 / SARO Status: Species at Risk in Ontario (SARO) are designated by the Ontario Ministry of Natural Resources (OMNR) in accordance with the provincial Endangered Species Act (ESA) through the Committee on the Status of Species at Risk in Ontario (COSSARO).

Extirpated: A native species that no longer exists in the wild in Ontario but still occurs elsewhere.
Endangered: A native species facing imminent extinction or extirpation in Ontario.
Threatened: A native species that is at risk of becoming endangered in Ontario.
Special Concern: A native species that is sensitive to human activities or natural events which may cause it to become endangered or threatened.

Reference: www.ontario.ca/speciesatrisk (current to January 2012)

Provincial Rank (SRANK): Provincial (or Subnational) ranks are used by the Natural Heritage Information Centre (NHIC) to set protection priorities for rare species and natural communities. These ranks are assigned to consider only those factors within the political boundaries of Ontario.

SX Presumed Extirpated: Species or community is believed to be extirpated from the nation or state/province. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.
SH Possibly Extirpated (Historical): Species or community occurred historically in the nation or state/province, and there is some possibility that it may be rediscovered. Its presence may not have been verified in the past 20-40 years. A species or community could become NH or SH without such a 20-40 year delay if the only known occurrences in a nation or state/province were destroyed or if it had been extensively and unsuccessfully looked for. The NH or SH rank is reserved for species or communities for which some effort has been made to relocate occurrences, rather than simply using this status for all elements not known from verified extant occurrences.
S1 Critically Imperiled: Critically imperiled in the nation or state/province because of extreme rarity (often 5 or fewer occurrences) or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state/province.
S2 Imperiled: Imperiled in the nation or state/province because of rarity due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors making it very vulnerable to extirpation from the nation or state/province.
S3 Vulnerable: Vulnerable in the nation or state/province due to a restricted range, relatively few populations (often 80 or fewer), recent and widespread declines, or other factors making it vulnerable to extirpation.
S4 Apparently Secure: Uncommon but not rare; some cause for long-term concern due to declines or other factors.
S5 Secure: Common, widespread, and abundant in the nation or state/province.
SNR Unranked: Nation or state/province conservation status not yet assessed.
SU Unrankable: Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.
SNA Not Applicable: A conservation status rank is not applicable because the species is not a suitable target for conservation activities.
S#S# Range Rank: A numeric range rank (e.g., S2S3) is used to indicate any range of uncertainty about the status of the species or community. Ranges cannot skip more than one rank (e.g., SU is used rather than S1S4).

Reference: http://nhic.mnr.gov.on.ca/MNR/nhic/nhic.cfm (current to March 2012)

Abundance: Refers to the relative abundance of the species found within the waters of the Upper Thames River watershed based on sampling results. Some species may be underrepresented as they are difficult to capture with commonly used sampling methods.
Abundant: Occurred in >25% of the sampling records
Common: Occurred in 10-25% of the samples
Uncommon: Occurred in <10% of the samples

Distribution: Based on the number of Upper Thames Watershed Report Card subwatersheds in which a species has been recorded.
Throughout: Recorded in >20 subwatersheds
Widespread: Recorded in 10-20 subwatersheds
Localized: Recorded in <10 subwatersheds

Prepared - Thursday, September 22, 2016

Benthic Resources

Benthic invertebrates are organisms that live on the bottom or in the sediment of a water body. Because they are diverse, generally sedentary, and responsive to environmental alterations, benthic invertebrates are often sampled to study water quality (Jones, N.E. 2011).

To determine water quality, a value from 0 to 10, called a biotic index, is assigned to benthic invertebrate taxa. This value indicates their sensitivity and tolerance to pollution. Lower numbers indicate pollution sensitivity and high numbers indicate tolerance. A weighted average of the biotic index and the number of invertebrates in each taxa in the sample gives a value called a Family Biotic Index (FBI). The water quality ranges for the FBI values can be seen in the following table:

FBI Value	Water Quality
< 4.25	Excellent
4.25 – 5.00	Good
5.00 – 5.75	Fair
5.75 – 6.50	Fairly Poor
6.50 – 7.25	Poor
> 7.25	Very Poor

Sampling was conducted using a traveling kick and sweep method, and samples handled and analyzed using methods consistent with Provincial (OBBN) and Federal (CABIN) protocols. Samples were preserved in the field, randomly subsampled in the lab and identified to the Family taxonomic level. Resulting data was entered into, and analyzed, using an MS Access database.

Fullarton Dam area benthic water quality sampling summary

Neil Drain upstream of Fullarton dam

Perth Road 163A South of Fullarton

				DATE	FBI	QUALITY
Site code:	GL20	UTM X Coordinate:	482738	UTM Y Coordinate: 4802225		
				7/2/1998	5.79	Fairly Poor
				5/19/2015	5.95	Fairly Poor
				9/24/2015	5.80	Fairly Poor
				5/5/2016	6.10	Fairly Poor
				9/21/2016	5.84	Fairly Poor

Neil Drain downstream of Fullarton dam

Site code:	GL23	UTM X Coordinate:	482913	UTM Y Coordinate 4802387		
				5/19/2015	6.27	Fairly Poor
				9/24/2015	5.84	Fairly Poor
				5/5/2016	6.17	Fairly Poor
				9/21/2016	6.09	Fairly Poor

Biotic indices are values assigned to benthic invertebrate taxa indicating their pollution sensitivity and tolerance on a scale from 0 to 10. Lower numbers indicate pollution sensitivity and high numbers tolerance. The Family Biotic Index (FBI) is the weighted average of the biotic index and number of bugs in each taxa in the sample. The water quality ranges for the FBI values are as follows: < 4.25 = Excellent; 4.25 - 5.00 = Good; 5.00 - 5.75 = Fair; 5.75 - 6.50 = Fairly Poor; 6.50 - 7.25 = Poor; and > 7.25 = Very Poor.

Fullarton Dam area Benthic Sampling Data

Neil Drain

Perth Road 163A South of Fullarton

Site code: GL20 UTM X: 482738 UTM Y: 4802225

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Sampled – 7/2/1998	**REP: 1**			
Ceratopogonidae	Biting Midge	L	6	6
Chironomidae	Midge	L	19	6
Chironomidae	Midge	P	1	6
Elmidae	Riffle Beetle	L	2	5
Lymnaeidae	Pond Snail	A	2	6
Nematoda	Thread Worm	A	6	5
Oligochaeta	Aquatic Worm	A	1	8
Pisidiidae	Fingernail Clam	A	17	6
Tabanidae	Horse Fly	L	7	5
	Stream Health = Fairly Poor		**Family Biotic Index =**	**5.79**
Sampled - 5/19/2015	**REP: 1**			
Acariformes	Water Mite	A	66	6
Asellidae	Sow Bug	A	4	8
Caenidae	Crawling Mayfly	N	1	6
Chironomidae	Midge	P	2	6
Chironomidae	Midge	L	171	6
Corixidae	Water Boatmen	A	10	5
Elmidae	Riffle Beetle	L	21	5
Elmidae	Riffle Beetle	A	3	5
Ephydridae	Shore Fly	L	1	7
Hyalellidae	Sideswimmer	A	2	8
Lepidostomatidae	Lepistomatid Caddisfly	L	4	1
Nematoda	Thread Worm	A	3	5
Oligochaeta	Aquatic Worm	A	15	8
Perlodidae	Stonefly	N	1	2
Physidae	Pouch Snail	A	1	8
Pisidiidae	Fingernail Clam	A	5	6
Tabanidae	Horse Fly	L	2	5
Valvatidae	Round-mouthed Snail	A	1	8
Veliidae	Ripple Bug	A	1	-1
	Stream Health = Fairly Poor		**Family Biotic Index =**	**5.95**
Sampled - 9/24/2015	**REP: 1**			
Acariformes	Water Mite	A	73	6
Asellidae	Sow Bug	A	6	8
Chironomidae	Midge	L	17	6
Corixidae	Water Boatmen	A	118	5
Elmidae	Riffle Beetle	L	20	5
Elmidae	Riffle Beetle	A	1	5
Gammaridae	Sideswimmer	A	1	6
Hydropsychidae	Net-spinning Caddisfly	L	3	5
Lymnaeidae	Pond Snail	A	4	6
Nematoda	Thread Worm	A	1	5
Oligochaeta	Aquatic Worm	A	34	8
Philopotamidae	Finger-net Caddisfly	L	1	4
Pisidiidae	Fingernail Clam	A	10	6
Planorbidae	Orb Snail	A	5	6
Tabanidae	Horse Fly	A	13	5
Valvatidae	Round-mouthed Snail	A	7	8
	Stream Health = Fairly Poor		**Family Biotic Index =**	**5.80**

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Sampled 5/5/2016	**Rep : 1**			
Acariformes	Water Mite	A	28	6
Asellidae	Sow Bug	A	2	8
Baetidae	Small Mayfly	N	1	6
Ceratopogonidae	Biting Midge	L	1	6
Chironomidae	Midge	P	5	6
Chironomidae	Midge	L	194	6
Corixidae	Water Boatman	A	6	5
Elmidae	Riffle Beetle	L	9	5
Lepidostomatidae	Lepistomatid Caddisfly	L	3	1
Limnephilidae	Northern Caddisfly	L	2	4
Lymnaeidae	Pond Snail	A	1	6
Nematoda	Thread Worm	A	4	5
Oligochaeta	Aquatic Worm	A	31	8
Perlodidae	Stonefly	N	1	2
Pisidiidae	Fingernail Clam	A	4	6
Planorbidae	Orb Snail	A	2	6
Tabanidae	Horse Fly	A	2	5
Valvatidae	Round-mouthed Snail	A	4	8
	Stream Health = Fairly Poor		**Family Biotic Index = 6.10**	
Sampled 9/21/2016	**Rep : 1**			
Acariformes	Water Mite	A	18	6
Aeshnidae	Dragonfly	N	1	5
Asellidae	Sow Bug	A	8	8
Ceratopogonidae	Biting Midge	L	1	6
Chironomidae	Midge	P	1	6
Chironomidae	Midge	L	20	6
Corixidae	Water Boatman	A	75	5
Elmidae	Riffle Beetle	L	28	5
Elmidae	Riffle Beetle	A	6	5
Haliplidae	Crawling Water Beetle	A	1	5
Hyalellidae	Sideswimmer	A	1	8
Leptoceridae	Long-horned Caddisfly	L	1	4
Limnephilidae	Northern Caddisfly	L	1	4
Lymnaeidae	Pond Snail	A	26	6
Oligochaeta	Aquatic Worm	A	6	8
Pisidiidae	Fingernail Clam	A	9	6
Planorbidae	Orb Snail	A	74	6
Valvatidae	Round-mouthed Snail	A	12	8
	Stream Health = Fairly Poor		**Family Biotic Index = 5.84**	

Neil Drain

Below Fullarton Pond

Site code: GL23 UTM X: 482913 UTM Y: 4802387

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Sampled – 5/19/2015	**REP: 1**			
Asellidae	Sow Bug	A	71	8
Ceratopogonidae	Biting Midge	L	9	6
Chironomidae	Midge	L	160	6
Chironomidae	Midge	P	4	6
Elmidae	Riffle Beetle	A	9	5
Elmidae	Riffle Beetle	L	89	5
Empididae	Dance Fly	L	4	6
Empididae	Dance Fly	P	2	6
Helicopsychidae	Snail-case Caddisfly	L	1	3
Hydropsychidae	Net-spinning Caddisfly	L	3	5
Leptoceridae	Long-horned Caddisfly	L	2	4
Nematoda	Thread Worm	A	10	5
Oligochaeta	Aquatic Worm	A	55	8
Perlodidae	Stonefly	N	1	2
Pisidiidae	Fingernail Clam	A	12	6
Simuliidae	Black Fly	L	8	5
Tipulidae	Crane Fly	L	1	4
Turbellaria	Flatworm	A	5	6
	Stream Health = Fairly Poor		**Family Biotic Index =**	**6.27**
Taxonomic Name	**Common Name**	**Life Stage**	**# in Subsample**	**Biotic Index**
Sampled – 9/24/2015	**REP: 1**			
Acariformes	Water Mite	A	2	6
Asellidae	Sow Bug	A	21	8
Caenidae	Crawling Mayfly	N	3	6
Calopterygidae	Broad-winged Damselfly	N	6	6
Ceratopogonidae	Biting Midge	L	5	6
Chironomidae	Midge	P	4	6
Chironomidae	Midge	L	69	6
Coenagrionidae	Narrow-winged Damselfly	N	6	8
Elmidae	Riffle Beetle	A	2	5
Elmidae	Riffle Beetle	L	30	5
Empididae	Dance Fly	L	7	6
Erpobdellidae	Leech	A	1	8
Helicopsychidae	Snail-case Caddisfly	L	7	3
Hyalellidae	Sideswimmer	A	8	8
Hydropsychidae	Net-spinning Caddisfly	L	71	5
Leptoceridae	Long-horned Caddisfly	L	5	4
Oligochaeta	Aquatic Worm	A	23	8
Philopotamidae	Finger-net Caddisfly	L	16	4

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Pisidiidae	Fingernail Clam	A	1	6
Planorbidae	Orb Snail	A	1	6
Scirtidae	Marsh Beetle	L	1	5
Simuliidae	Black Fly	L	1	5
Turbellaria	Flatworm	A	17	6
	Stream Health = Fairly Poor		**Family Biotic Index = 5.84**	
Sampled – 5/5/2016	**REP: 1**			
Acariformes	Water Mite	A	4	6
Asellidae	Sow Bug	A	3	8
Ceratopogonidae	Biting Midge	L	1	6
Chironomidae	Midge	L	149	6
Chironomidae	Midge	P	9	6
Elmidae	Riffle Beetle	A	7	5
Elmidae	Riffle Beetle	L	39	5
Empididae	Dance Fly	L	4	6
Helicopsychidae	Snail-case Caddisfly	L	6	3
Hydropsychidae	Net-spinning Caddisfly	L	6	5
Leptoceridae	Long-horned Caddisfly	L	3	4
Nematoda	Thread Worm	A	2	5
Oligochaeta	Aquatic Worm	A	63	8
Pisidiidae	Fingernail Clam	A	6	6
Planorbidae	Orb Snail	A	2	6
Tipulidae	Crane Fly	L	1	4
	Stream Health = Fairly Poor		**Family Biotic Index = 6.17**	
Sampled – 9/21/2016				
Acariformes	Water Mite	A	4	6
Asellidae	Sow Bug	A	3	8
Brachycentridae	Brachycentrid Caddisfly	L	1	2
Caenidae	Crawling Mayfly	N	15	6
Calopterygidae	Broad-winged Damselfly	N	2	6
Chironomidae	Midge	P	1	6
Chironomidae	Midge	L	31	6
Dryopidae	Long-toed Water Beetle	L	1	5
Dytiscidae	Predacious Diving Beetle	L	1	5
Elmidae	Riffle Beetle	L	103	5
Elmidae	Riffle Beetle	A	5	5
Helicopsychidae	Snail-case Caddisfly	L	1	3
Hyalellidae	Sideswimmer	A	7	8
Hydropsychidae	Net-spinning Caddisfly	L	14	5
Leptoceridae	Long-horned Caddisfly	L	1	4
Oligochaeta	Aquatic Worm	A	63	8
Pisidiidae	Fingernail Clam	A	38	6
Planorbidae	Orb Snail	A	2	6

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Simuliidae	Black Fly	L	1	5
Turbellaria	Flatworm	A	3	6
Valvatidae	Round-mouthed Snail	A	1	8
	Stream Health = Fairly Poor		**Family Biotic Index = 6.09**	

Benthic Samples were obtained using a Rapid Bioassessment Protocol developed by the United States Environmental Protection Agency and modified by Dr. Robert Bailey of the University of Western Ontario Zoology Department. A representative section of stream is selected, incorporating a riffle if present and sampled by moving upstream along a diagonal transect, dislodging and capturing invertebrates with a .5 mm mesh "D"- frame net. Samples are preserved in the field and analyzed in the lab to randomly select a 100 bug subsample which is identified to the Family taxonomic level.

The biotic index is a value assigned to benthic invertebrate taxa indicating their pollution sensitivity and tolerance on a scale from 0 to 10. Lower numbers indicate pollution sensitivity and high numbers tolerance. A value of -1 indicates that no biotic index value has been assigned to these taxa.

The Family Biotic Index is the weighted average of the biotic index and number of bugs in each taxa in the sample. The water quality ranges for the FBI values are as follows: < 4.25 = Excellent; 4.25 - 5.00 = Good; 5.00 - 5.75 = Fair; 5.75 - 6.50 = Fairly Poor; 6.50 - 7.25 = Poor; and > 7.25 = Very Poor.

Report prepared - Tuesday, January 10, 2017

Appendix E

Fullarton Conservation Area
Vegetation and Bird Inventory 2015

Sept 29, 2016 DRAFT

Inventory by: Brenda Gallagher, Vegetation Specialist and Forestry Technician
Report by: Cathy Quinlan, Terrestrial Biologist

UPPER THAMES RIVER
CONSERVATION AUTHORITY

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Cover Photos

Fullarton Pond in the summer of 2015. Photo by Cathy Quinlan.
Canada Goose. Photo by Brenda Gallagher

Cite as:

Upper Thames River Conservation Authority. 2016. *Fullarton CA Vegetation and Bird Inventory 2015.*

Executive Summary

This study examined the vegetation and bird and wildlife of Fullarton CA to flag any rare or sensitive species that might be impacted if the Fullarton Dam and reservoir are decommissioned and the creek restored. It is part of the Fullarton Dam Class Environmental Assessment report.

A three-season botanical inventory was completed in 2015 of a 9 ha study area, that included lands up to 100 m of the pond's edge. There were nine inventory days from June 1st to September 2nd. Incidental sightings of wildlife were recorded on each day.

Vegetation

The study area consisted of five terrestrial vegetation communities (cultural woodland, coniferous plantations, shallow marsh and cultural meadow) and the pond. Of the 228 plant species found, 36% are non-native, a moderate number. The overall quality of the vegetation was moderate as well. Only the shallow marsh (Community 4) at the upstream end of the pond/reservoir will be affected by the potential removal of the dam/reservoir. However, wetland plants are likely to re-establish along the restored creek, especially since this is an area of groundwater discharge.

The Fullarton Pond/Reservoir was not surveyed specifically for aquatic plants. A common native plant, White Water Buttercup, was present in large numbers in 2016. If the dam was removed and the creek restored, pond plants such as the White Water Buttercup would not remain. However, these plants are not uncommon and a diversity of riverine plants as seen in Community 1 would soon establish.

No plant species at- risk were found in the study area or within 2 km of the study area. No plants with a high Coefficient of Conservatism score were found, indicating most plants are generalist species found in a wide variety of habitats, including disturbed or young sites. Hispid Buttercup was the only plant found with an SRANK of S3 (rare to uncommon), however, it is relatively common in the Upper Thames watershed.

Birds and Wildlife

Incidental bird and wildlife observations were made over the six field days (spring, summer and fall) of 2015. Some 43 bird species, all native, were recorded. Most were common breeding species and/or permanent residents. Two uncommon breeding species (Bald Eagle and Green Heron) were seen but not breeding and one uncommon breeding species or common winter resident (Red-breasted Nuthatch) was seen. The Great Egret and Trumpeter Swan, both uncommon visitors, were seen also.

None of the 43 bird species seen are exclusively pond dwellers. Species such as Canada Goose, Mallard, Belted Kingfisher, Bald Eagle, and Killdeer feed in or by standing water but these species utilize rivers and streams as well. Use of the pond/reservoir by native waterfowl seemed to be on an occasional basis for feeding and resting, only occasionally for nesting and rearing young. Most of the songbirds seen use the wooded habitats and nearby fields.

Eight herptiles (reptiles and amphibians), seven Lepidoptera (butterflies) and five mammals were seen. All species are common to our area. The Green Frog, American Bullfrog, Red-spotted Newt and Snapping Turtle are the only animals with a strong affiliation to permanent water bodies/ponds. Their overwintering habitat in pond sediment will be lost if the dam/reservoir is removed.

Rare or Sensitive Wildlife Species

One threatened species, the Barn Swallow, was seen in the study area. There was no breeding evidence at Fullarton CA. Since it nests in old buildings, its nesting habitat will be unaffected by changes to the dam/reservoir.

Three Special Concern species were seen: Bald Eagle, Snapping Turtle and Monarch. Special concern species do not receive provincial species or habitat protection, but they are important to recognize.

Bald Eagles were not breeding at the Fullarton CA and they likely forage throughout the North Thames River corridor for fish. Thus, there is no action that is needed for this species.

Snapping Turtles were seen in the Fullarton Reservoir and there are records of this species within the nearby Thames River as well. Habitat will be lost if the reservoir is drained and restored since cold water creeks are only occasionally used by Snapping Turtles due to the lower temperature. Harm to individual turtles can be avoided during dam deconstruction by slowly releasing water in the summer period, allowing enough time for the turtles to find new hibernation areas.

The Monarch butterfly was seen and while it is a commonly seen summer species, the Monarch populations have fallen drastically over the last decade or so, likely due to the elimination of milkweeds along its migration route in the USA and Canada (e.g., herbicide use) and threats to its overwintering areas in Mexico. There is no specific action at Fullarton CA that is required. Establishment of more riparian vegetation, including its host plant milkweeds, and other nectar plants, will help support this butterfly locally.

Significant Woodlands, Wetlands and ANSIs

The woodland communities within Fullarton CA are deemed Significant Woodlands in Perth County as they are over 1 ha in size. They will not be altered by the possible removal of the dam and reservoir. In time, the former pond will likely fill in with herbaceous and then woody plant communities, thus providing an enlarged area of significant woodland cover.

Fullarton CA is part of an unevaluated wetland that extends along the Neil Drain up to the reservoir. Most of this wetland will be unaffected by any changes to dam/reservoir. Hydrogeological information indicates this is a groundwater-dependent wetland and not influenced to any great degree by backwater from the reservoir. The shallow marsh at the upstream end of the Fullarton Reservoir may decrease or increase in size if the dam is removed, depending on topography. The wetland vegetation is very likely to colonize the area around the restored creek as in the upstream sections of this unevaluated wetland.

The North Thames Valley Earth Science ANSI and candidate Fullarton Moraine ANSI that occur in the Fullarton CA area would be unaffected by changes to the dam/reservoir as no major changes to the topography will be made.

Recommendations

1: Survey the aquatic plants in the pond to ensure no rare species are impacted.

2: If the dam is decommissioned, the drawdown of the reservoir should be done very slowly over summer providing time for Snapping Turtles and other amphibians to find new sites prior to hibernation.

3. If the dam/reservoir is decommissioned, examine the benefits and feasibility of constructing an off-line pond to accommodate snapping turtles and other aquatic wildlife species.

4: If the dam/reservoir is decommissioned, examine the road culverts along the Neil Drain after drawdown to see if any are perched as a result of the water level changes. Correcting perched culvert problems will allow the creek to flow unobstructed.

5: If the dam is decommissioned, monitor the plant species that colonize the former pond bed and augment with seed/plants of native wetland species if needed.

6. If the dam is decommissioned and the creek restored, maintain the trail where it is currently, away from the sensitive creek edges and the unconsolidated sediments from the pond

bottom. Consider providing viewing points to the creek that elevates the visitor above the shoreline vegetation height (e.g., a mound or a wooden viewing platform).

Photo of the creek and Cultural Woodland habitat below the Fullarton Dam

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1.0 Purpose of the Vegetation and Bird Study

This study is a component of a larger Environmental Assessment study on the Fullarton Dam and Reservoir. The purposes of this study are to:

- document the vegetation communities within approximately 100 m of the Fullarton Pond/Reservoir to establish baseline conditions and to flag any unique or rare species that need protection or consideration prior to any potential changes to the Conservation Area, dam and reservoir; and

- record the bird and wildlife species (incidental observations) that use the aquatic and terrestrial habitats of Fullarton Conservation Area (CA), either year round, seasonally or infrequently, to establish baseline conditions and to flag any unique or rare species that need protection or consideration prior to any potential changes to the CA (i.e., the dam and reservoir).

2.0 Vegetation Inventory

2.1 Methodology

A study area was delineated that included an area up to 100 m from the pond's edge or the edge of the property or natural vegetation (i.e., farm fields were not included). The study area is 9 ha in size.

A three-season vegetation inventory was carried out in study area in 2015 by Brenda Gallagher, Vegetation Specialist and Forestry Technician with the Upper Thames River Conservation Authority (UTRCA). The area was inventoried in June, again in July and lastly in August. Each season's inventory spanned three field days. Table 1 summarizes the survey effort.

Table 1. Vegetation Survey Dates in 2015

Dates Inventoried	No. Days
June 1, 2, 3	3
July 13, 15, 16	3
August 31, September 1, 2	3
Total days	**9**

After walking the entire site once, the ELC (Ecological Land Classification) vegetation communities were mapped onto 2010 colour orthoimagery. Vascular plant species in each vegetation community were recorded on field sheets. At the end of the study, the plant lists were entered into the UTRCA plant database to produce a full checklist of vascular plants by community. Statistics on vegetation/habitat quality were generated also.

While undertaking the vegetation inventories, Brenda Gallagher recorded incidental wildlife sightings, especially of birds, amphibians, reptiles and mammals.

No aquatic plants in the pond/reservoir were sampled.

2.2 Results and Discussion

Figure 1 shows the ELC vegetation communities with the Fullarton CA study area. Table 2 shows the area of each community. ELC communities less than 0.5 ha in size are usually merged with neighbouring vegetation communities, as per Lee *et al*. 1998. A full annotated checklist of vascular plants found in the five terrestrial communities (excluding Community 6) is provided in Appendix A.

Table 2. Area of Ecological Land Classification (ELC) Vegetation Communities

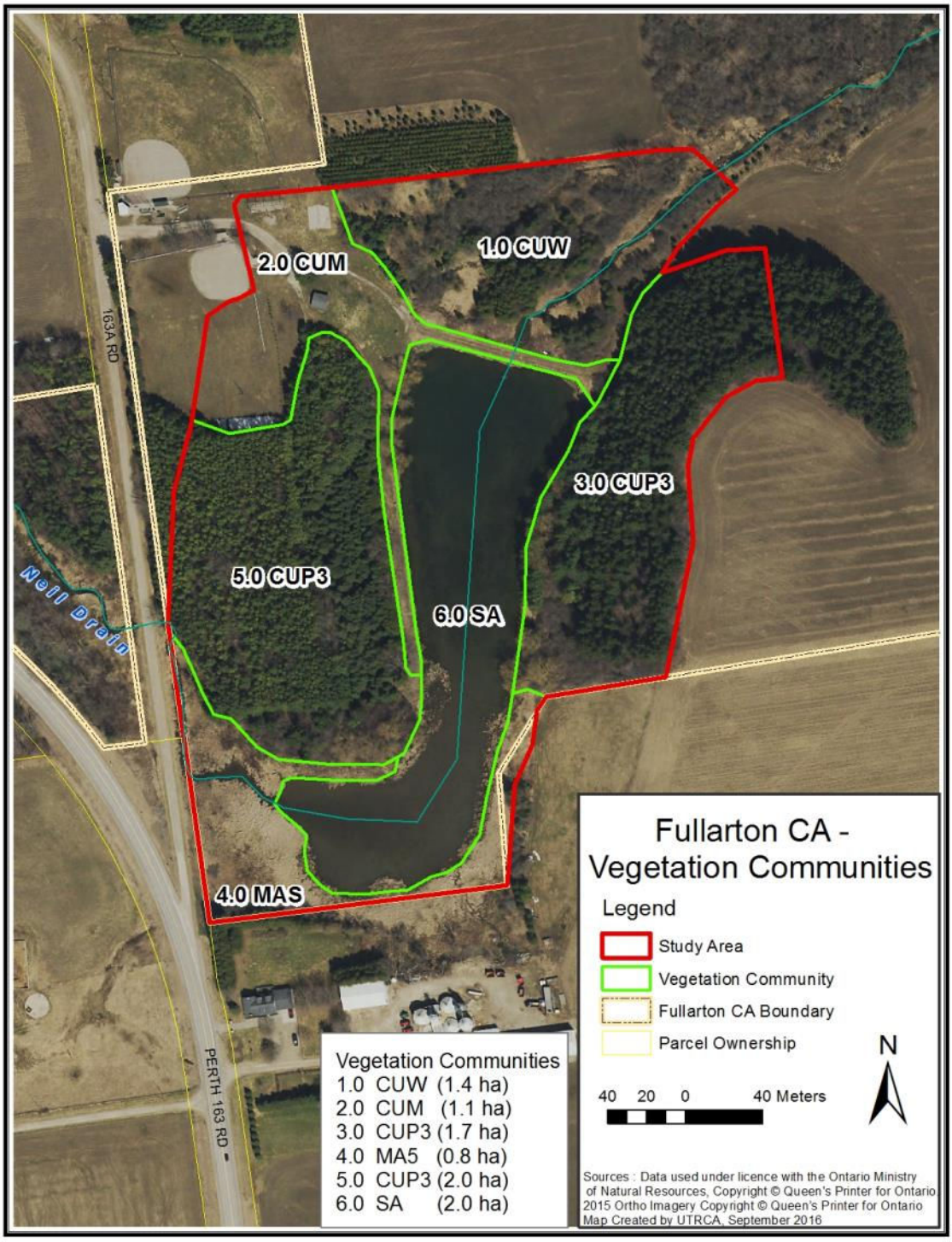
Community	ELC Code	Community Description	Area
1.0	CUW	Cultural Woodland	1.4 ha
2.0	CUM	Cultural Meadow (Lawn)	1.1 ha
3.0	CUP3	Coniferous Plantation	1.7 ha
4.0	MAS	Shallow Marsh	0.8 ha
5.0	CUP3	Coniferous Plantation	2.0 ha
6.0	SA	Shallow Water/Aquatic	2.0 ha
	Total		**9.0 ha**

Table 3 summarizes the number of species, both native and non-native, as well as MCC (Mean Coefficient of Conservatism) and Average Wetness for each plant community (except the pond) and overall. Descriptions of these parameters are provided in Appendix B. While the number of species found (228 species) is high for such a small site, the overall quality of the vegetation is moderate. The overall wetness score is negative, meaning there are more wetland plants than upland. The sections that follow describe the conditions in greater detail for each of the communities.

Table 3. Summary of Plant Statistics

Community Number and ELC		# Species	# Native Species	# Non-native Species	% Non-native Species	MCC	# Species with CC 8-10	Overall Quality	Average Wet-ness
1	CUW	161	104	57	35%	3.36	0	Mod to Mod Poor	-0.9
2	CUM	84	39	45	54%	2.23	0	Poor	0.5
3	CUP3	132	89	43	33%	3.46	0	Moderately Poor	-0.2
4	MAS	133	88	46	35%	3.35	0	Mod to Mod Poor	-2.0
5	CUP3	126	77	49	39%	3.36	0	Mod to Mod Poor	0.1
Overall		**228**	**144**	**84**	**37%**	**3.60**	**0**	**Moderate**	**-0.8 More wet than dry**

Figure 1. ELC Vegetation Communities within the Study Area



CUW – Cultural Woodland, CUM – Cultural Meadow (lawn), CUP3 – Coniferous Plantation, MAS – Shallow Marsh, SA – Shallow Aquatic

2.2.1 Community 1, Cultural Woodland (CUW)

The Cultural Woodland of Community 1 is 1.4 ha in size and encompasses the northern part of the study area downstream of the pond/reservoir. Cultural woodlands are treed areas characterized by canopy coverage between 35 - 60%. These communities often represent the stage of natural succession between cultural thicket and forest. Cultural communities result from, or are maintained by, cultural or anthropogenic-based disturbances. In this case, the trees were planted in the early 1980s.

Community 1 has the largest diversity of plant species of any of the communities in the study area. There is a wide mix of native and non-native plant species that have been either planted or that have self-naturalized over the years. A total of 161 plant species were recorded: 101 native and 57 non-native or adventive species. The number of plant species is relatively large for such a small area, owing to the diversity of micro-habitats within it: creek edge (wetland emergent plants), naturally succeeding thickets and woods and planted conifers. The percentage of non-native plants is 35%, which is about average or moderate for sites like this in the Upper Thames watershed.

The MCC (Mean Coefficient of Conservatism) is 3.36, a moderate to moderately poor score. There is a predominance of wetland plants in this community (average Wetness score is -0.9).

Mature trees include White Cedar, ash, Black Walnut, spruce and pines. There are a variety of shrubs including dogwoods, nannyberry and highbush cranberry. In the sunnier areas along the creek there was a wide range of wildflowers, both native and non-native, including asters, goldenrods, Spotted Joe Pye-Weed, touch-me-nots, Field Mint and a variety of grass species.

Photo 1. Community 1 ─ View looking downstream from the dam crossing, with goldenrods and Joe Pye-weed in bloom.

2.2.2 Community 2, Cultural Meadow (CUM) or Lawn

Community 2 is made up of mown lawn areas (day-use, trail) that include a scattering of trees and the narrow community along the edge of the pond. It is 1.1 ha in size. Cultural meadows are communities that have a sparse or no canopy cover of trees or shrubs. They result from, or are maintained by, cultural or anthropogenic-based disturbances.

Some 84 species were recorded in Community 2, the least diverse of the communities (unsurprisingly). The understory is mostly manicured lawn grass with plantings of drying ash, Norway Spruce, Red Oak. It also includes a narrow fringe of tree willows (White Willow) between the pond's edge and the trail.

Of the 84 species, 39 were native and 45 were non-native. The percentage of non-native species (54%) is high and reflects the human disturbance and manicured nature of the site. The MCC is 2.23, a poor score.

Pond shore plants include Swamp Milkweed, Field Mint, Peppermint, cattails, Joe-Pye-Weed, beggarticks, jewelweeds and the non-native Yellow-Flag (iris). These wetland plants are also represented in the shallow marsh of Community 4.

Photo 2. Community 2 ─ Cultural meadow (lawn) along the edge of the reservoir.

Photo 3. Community 2 ─ Grass and goldenrods grow along the mowed trail over the dam (often very wet).

2.2.3 Community 3, Coniferous Plantation (CUP3)

The Coniferous Cultural Plantation in Community 3 is located on the east side of the Fullarton reservoir and is 1.7 ha in size. According to the ELC, cultural plantations have tree cover > 60%, resulting from, or maintained by cultural or anthropogenic-based disturbances. In this case the trees were planted. The coniferous tree species make up > 75% of the canopy cover.

A total of 132 species were recorded from Community 3, 89 native species and 43 non-native species. The percent of non-native plants (33%) is considered moderate and typical of areas such as this. The MCC score of 3.46 indicates the habitat is of moderately poor quality.

Dominant tree species include Norway Spruce and White Pine. There is a sparse understory of shrubs and herbaceous plants, typical of dark, shaded plantations. Species included hawthorns, apple, dogwoods, Red Elderberry, currants and raspberries. At the southwest end of this community is a low-lying forest consisting of apples, Manitoba Maple, ash, buckthorn, Silver Maple and willow.

Communities 3 and 5, both cultural plantations, are similar. However, Community 3 was planted in the 1960s, and Community 5 in the 1980s.

Photo 4. Community 3 – The large 50-year old pines create a lot of shade, limiting understory plants.

Photo 5. Community 3 – Apple trees dominate the southwest parts of Community 3, likely spread from the former homestead.

2.2.4 Community 4, Shallow Marsh (MAS)

Community 4 is a shallow marsh located at the upstream end of the Fullarton reservoir. According to the ELC, shallow marshes are communities with standing or flowing water up to 2 m deep for much of or all of the growing season, tree and shrub cover ≤ 25% and hydrophytic emergent macrophyte cover (non-woody wetland plants) ≥ 25%.

Some 133 species were recorded in Community 4, quite diverse for a small area. Of the 133 species, 88 were native and 46 were non-native. The percentage of non-native species (35%) is moderate or average. The MCC is 3.46, a moderately poor score.

Dominant plants include cattails, sedges, Purple stem Aster, and jewelweed. There is a scattering of shrubs and trees including nannyberry, willows and dogwoods.

This community has developed along the upstream end of the reservoir where the water is shallow enough to support these emergent plants. As the creek (Neil Drain) enters the pond, it slows down and silt settles out. The pond has been filling up with sediment over the years, especially the lower end.

Photo 6. Community 4 -- Brenda Gallagher in the shallow marsh with asters in bloom

Photo 7. Community 4 – The shallow marsh grows along the inflowing Neil Drain

2.2.6 Community 5, Coniferous Cultural Plantation (CUP3)

The Coniferous Cultural Plantation of Community 5 is located on the west side of the Fullarton reservoir. According to the ELC, cultural plantations have tree cover > 60%, resulting from, or maintained by cultural or anthropogenic-based disturbances (i.e., the trees were planted). The coniferous tree species make up > 75% of the canopy cover.

A total of 125 species were recorded, 76 native species and 49 non-native species. The percent of non-native plants (39%) is considered moderate and typical of areas such as this. The MCC score of 3.36 indicates the habitat is of moderately poor quality.

The trees here were planted in the early 1980s and are 10-20 years younger than the trees in Community 3. However, the vegetation is similar between communities 3 and 5, sharing 100 species in common.

Dominant tree species include White Pine, White Spruce, Norway Spruce with some Eastern White Cedar. A sparse shrub component consisted of dogwoods, young ash, Red Elderberry, and raspberries. The herbaceous layer was very sparse in the centre of the plantation, thickening up towards the edges where there is more sunlight.

Photo 8. Community 5 is dominated by 35 year old White Pines.

Photo 9. Community 5 -- White Cedars were planted along edge of the creek/drain.

2.2.6 Community 6 - Shallow Water (SA)

The Fullarton Pond/Reservoir is classified as a Shallow Water/Aquatic community. These communities have water up to 2 m depth, with standing water always present. There may be submerged or floating-leaved plants associated with it.

The submerged and rooted pond plants were not surveyed. However, a native, rooted aquatic plant called White Water Buttercup (*Ranunculus aquatilis (*formerly *R. trichophyllus*) was seen on June 9th of 2016, the flowers blanketing the pond. This flower was not seen in 2015.

Any shoreline vegetation is included in Communities 1 to 5. Aside from the shallow marsh at the south end of the pond/reservoir, there is only a narrow fringe of wetland emergent plants growing along the pond shore. The pond is steep sided and the water level permanent, so this does not permit the establishment of many wetland plants as they often require seasonal mudflats to germinate.

Photo 10. Community 6 – White Water-Buttercups blanket the Fullarton pond, June 9th, 2016.

Photo 11. Community 6 ─ Floating algae is visible on the Fullarton pond/reservoir surface (2015). A narrow fringe of cattails line the bank. Asters and Common Milkweed grow adjacent to the pond on the drier ground in late summer.

2.2.7 Plants with High Coefficient of Conservatism (CC) Scores

No plants with CC scores of 8 to 10 were found. Plants with a CC score of 8, 9 or 10 are considered more specialized in habitat or condition and conserve themselves to very specific environments, usually unaltered communities. Plants with low CC scores are considered generalist species that are found in a wide variety of habitats, including disturbed sites.

2.2.8 Plants with Species At Risk (SAR) Designations

No plant species with at-risk designations were found in the study area. Appendix B lists the various species-at-risk categories.

2.2.9 Plants with Provincial Ranking (SRANK) of S1, S2 or S3

One plant species had a SRANK of S3 (rare to uncommon), Hispid Buttercup (*Ranunculus hispidus* var. *hispidus*). It was found in Community 1 (Cultural Woodland) and Community 4 (Shallow Marsh) in sunny, wet areas. It is relatively common in the Upper Thames watershed. SRANKS do not afford legal protection to species; they are used by the MNRF's Natural Heritage Information Centre to track the population status of Ontario's species and set protection priorities.

3.0 Incidental Wildlife

3.1 Methodology

Incidental bird and animal observations were made by Brenda Gallagher while she was undertaking the botanical inventories. Brenda is also an experienced birder. Table 4 summarizes the dates of each of the visits, coinciding with the botanical work.

Table 4. Bird and Wildlife Observations - Dates visited in 2015

Season	Dates
Late Spring	June 1, 2, 3
Early Summer	July 13, 15, 16
Late Summer	Aug 31, Sept 1, 2
Total	**9 days**

3.2 Bird Sightings

A total of 43 bird species from 24 different orders were seen. Appendix C1 provides a list of the bird species sorted by order and Appendix C2 provides a list of birds sorted alphabetically. Of the 43 native species, there were:

- 38 common breeding species and/or permanent residents,
- 2 uncommon breeding species (Bald Eagle and Green Heron),
- 1 uncommon breeding species or common winter resident (Red-breasted Nuthatch), and
- 2 uncommon visitors (Great Egret and Trumpeter Swan)

Most of the songbirds seen use the wooded habitats and nearby fields. None of the bird species seen are exclusively pond dwellers. Local breeding species such as Canada Goose, Mallard, Belted Kingfisher, Great Blue Heron, and Green Heron feed in or by standing water but utilize rivers and streams as well. None of these species are rare or sensitive in Ontario. Other migrating waterfowl may use the pond temporarily during the migration seasons.

The Trumpeter Swan seen was a juvenile. This species has an interesting history. It was extirpated from Ontario and Eastern Canada over 200 years ago and was reintroduced successfully starting in the 1980s (www.wyemarsh.com/swans). The population is expanding and there are over 335 breeding pairs in Ontario (NHIC database).

Photo 12. Song Sparrow. Photo by Brenda Gallagher

3.2 Wildlife Sightings

Brenda Gallagher recorded incidental wildlife seen while undertaking the botanical inventories. Appendix D lists the seven herptiles (reptiles and amphibians), seven Lepidoptera (butterflies) and five mammals seen. All species are common to our area. In 2014 and 2016, UTRCA staff also found the Eastern Red-spotted Newt in the aquatic larval stage.

The Green Frog, American Bullfrog and Snapping Turtle are the only animals seen with a strong affiliation to permanent water bodies. The Green Frog and Snapping Turtle overwinters in permanent water bodies thus the local population within this CA may decline if the dam is removed.

3.3 Species at Risk and Rare to Uncommon Animal Species

Several species with SARO (Species at Risk in Ontario) status and/or S1-S3 SRANKS were found and are listed in Table 4.

Table 4. Species at Risk and Rare to Uncommon Animal Species

Common Name	SARO Status	SRANK S1-S3	Notes
Barn Swallow	Threatened		No nesting structures nearby
Bald Eagle	Special Concern	S2N,S4B	Likely foraging Thames River corridor
Great Egret	--	S2B	Rare breeder in Ont., not breeding here
Snapping Turtle	Special Concern	S3	
Monarch	Special Concern	S2N,S4B	

The **Barn Swallow** (Threatened), seen at Fullarton CA (not nesting), is a common breeding species found throughout southern Ontario. Barn Swallow is listed as Threatened by SARO (Species at Risk in Ontario), meaning the species lives in the wild in Ontario, is not endangered, but is likely to become endangered if steps are not taken to address factors threatening it. There was no breeding evidence at Fullarton CA. According to the Ministry of Natural Resources and Forestry (http://www.ontario.ca/page/barn-swallow), Barn Swallows often live in close association with humans, building their cup-shaped mud nests almost exclusively on human-made structures such as open barns, under bridges and in culverts. Barn Swallows have experienced a significant population decline since the mid-1980s. While there have been losses in the number of available nest sites, such as open barns, and in the amount of foraging habitat in open agricultural areas, the causes of the recent population decline are not well understood. This bird's nests are often destroyed when old buildings in rural areas are demolished or fall down. Massive pesticide spraying of fields can also reduce the insect population Barn Swallows need for food.

The **Bald Eagle** is a species of Special Concern. Special Concern means the species lives in the wild in Ontario, is not endangered or threatened, but may become threatened or endangered due to a combination of biological characteristics and identified threats. Special concern species do NOT receive species or habitat protection, however. Bald Eagle populations has made a come-back since the 1950s and 1960s after certain pesticides and chemicals were banned. They more commonly use large rivers such as the Thames, to forage for fish.

The **Great Egret**, has an SRANK of S2B, meaning it is a very rare breeder in Ontario. It is an uncommon visitor in Perth County. There was no breeding evidence at Fullarton CA (just one individual).

Snapping Turtles, a species of Special Concern (S3) were seen using the reservoir and there are records within the nearby Thames River. It is a long-lived species that takes years to come to sexual maturity and a lifetime to replace itself in the population. Persecution and road mortality are key threats to the population. See sections 4.4 and 5.2 for more information.

The **Monarch** butterfly is also a species of Special Concern. The Monarch populations have fallen drastically over the last decade or so, likely due to the elimination of milkweeds along its migration route in the USA and Canada and threats to its overwintering areas in Mexico.

Photo 13. Snapping Turtle. Photo by Scott Gillingwater, UTRCA.

4.0 Significant Natural Heritage Features

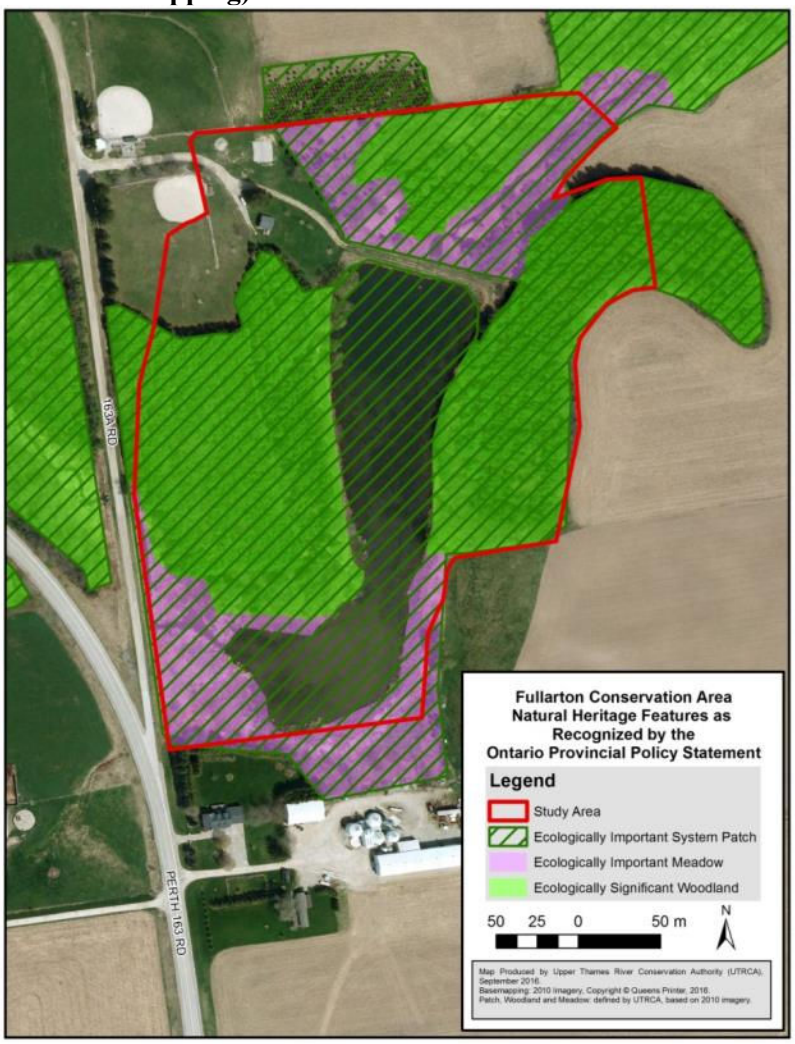
4.1 Woodlands and Natural Heritage Systems

Presently, Perth County designates all woodlands 1ha or larger as significant (see Figure 2). All of the woodland areas within Fullarton CA meet this minimum criterion and are significant.

Perth County does not have a Natural Heritage Systems Study (NHSS), but one is anticipated within the next year or two. The UTRCA has completed the GIS mapping of the natural heritage system using the same methodology and criteria as the draft Oxford Natural Heritage Systems Study (2016). The study includes non-wooded habitats such as meadows, thickets, marshes, and ponds in addition to woodlands/forests. Figure 2 shows the natural heritage patches that meet one or more criteria for ecological importance. All of the non-manicured areas in Fullarton CA are included and deemed ecologically important.

Removing the dam and reservoir and restoring the creek and naturalizing the former pond with native plants will only add to the importance of the area. No existing woodlands will be altered.

Figure 2. Natural Heritage Patches that meet criteria for Ecological Importance (UTRCA mapping)



4.2 Wetlands

Figure 3 shows the unevaluated wetland that runs along the banks of the Neil Drain and into Fullarton CA. Unevaluated wetlands are mapped by both the MNRF and UTRCA using aerial photo interpretation in combination with other data layers such as soils, elevation, groundwater, historic forest cover maps, etc. Both agencies define the area as an unevaluated wetland. There has been no on-site wetland evaluation to verify features. (MNRF map shows Fullarton pond is an evaluated wetland…but incorrect)

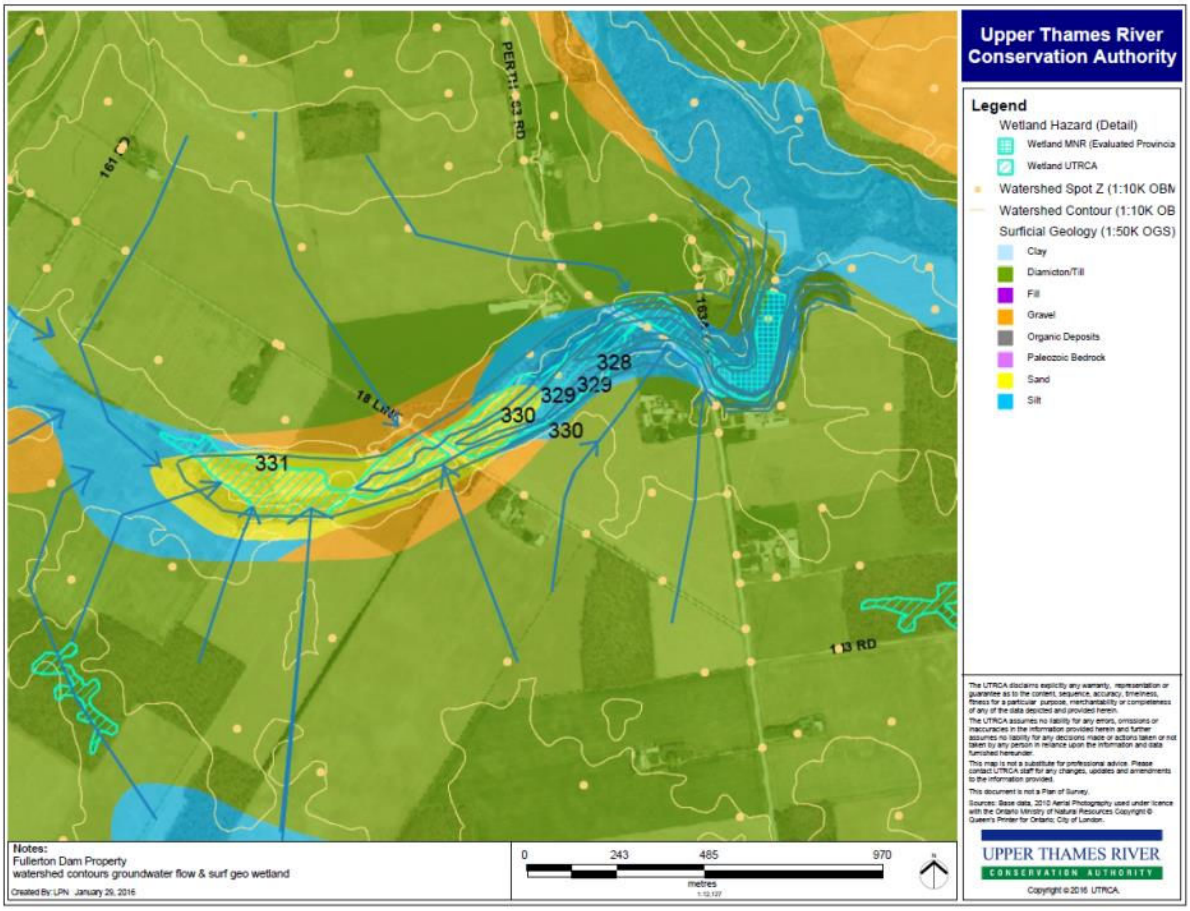
The Neil Drain is a cool/cold water system with groundwater discharge points along the watercourse that create the wetland conditions (see Figure 4). The UTRCA fisheries biologist attempted to sample the benthic organisms at a few spots on the Neil Drain some years back and noted it had a boggy/organic bottom indicating the entire area may have been a swamp historically. There is a shallow aquifer less than 10 m depth in the area as well (see Groundwater report as part of the Fullarton EA). The Neil Drain is a short watercourse with likely good gradient, making it a good site for trout reintroduction.

Aside from the shallow marsh (Community 4) within Fullarton CA, the remainder of this wetland feature is unlikely to be affected by any potential changes to the dam and reservoir. Because of the good gradient on the drain, there is probably no back-water effect from the dam beyond 163 Road. However, if the dam is removed, the road culverts should be examined to ensure they are not perched. Because this is a groundwater dependent wetland, wetland plants will likely reestablish along the restored creek in Fullarton CA (riverine wetland).

There are not many wetlands in the nearby area. The closest evaluated wetland, the Motherwell Blue Heron Swamp, is located 3 kms away east of the North Thames and so is not hydrologically connected.

Figure 3. Unevaluated wetland along Neil Drain (MNRF and UTRCA mapping)

Figure 4. Surficial Geology and Groundwater Flow along the Neil Drain and Fullarton CA



Map Notes:

- The shallow aquifer is in contact with the wetland, thus it is a groundwater dependent ecosystem.
- The long blue arrows indicate shallow groundwater flow and contour lines indicate likely average static level in shallow aquifer
- Water levels are highest in the west (~331 m) and decline towards Fullarton CA
- *Source: Linda Nicks, Hydrogeologist, UTRCA.*

4.3 Areas of Natural and Scientific Interest – Earth and Life Science

Areas of Natural and Scientific Interest (ANSIs) are areas of land and water containing unique natural landscapes or features. These features have been scientifically identified as having life or earth science values related to protection, scientific study or education (www.ontario.ca/page/ontarios-parks-and-protected-areas). There are two kinds of ANSIs:

Life science ANSIs represent biodiversity and natural landscapes. They include specific types of forests, valleys, prairies, wetlands, native plants, native animals and their supportive environments. Life science ANSIs contain relatively undisturbed vegetation and landforms and their associated species and communities. There are no Life Science ANSIs in or near the Fullarton CA.

Earth science ANSIs are geological in nature and contain significant examples of bedrock, fossils, landforms or ongoing geological processes. Figure 5 shows two overlapping earth science ANSIs in the Fullarton area: the North Thames Valley ANSI (orange hatch lines) and the candidate Fullarton Moraine ANSI (olive green hatch lines).

Earth science ANSIs can normally sustain more intensive land uses than life science ANSIs, such as agriculture and more intensive forest management practices. Activities that could impact the integrity of an Earth Science ANSI include aggregate extraction and housing developments requiring extensive re-contouring of the landscape. In general, appropriate activities for Earth Science ANSIs are those that conserve the topography, geological exposures, or other features and processes.

The removal of a man-made dam and restoration of the creek would not interfere with these ANSI features. The Fullarton CA receives tax exemption under the CLTIP (Conservation Land Tax Incentive Program) because it is situated on an earth science ANSI.

Figure 5. Earth Science ANSIs near Fullarton CA

4.4 Species at Risk Records within 2 km of the Study Area

Aside from the species mentioned in section 3.3 (Barn Swallow, Bald Eagle, Snapping Turtle and Monarch) , there are no other Species At Risk records in the UTRCA or NHIC database, either in the Fullarton CA or within 2 kms.

5.0 Discussion and Conclusions

5.1 Vegetation

The vegetation within the Fullarton Conservation Area study area is moderately diverse owing to the mix of habitats including woodland, conifer plantation, marsh, and meadow and pond edge. While the diversity of plants is quite large (229 species) for a small 9 ha site, the overall quality of the five vegetation communities is moderately poor to average. The overall percentage of non-native species is 37%, which is about average and expected for a small, disturbed area. The vegetation communities are early to mid-succession, due to the fact that it has established or restored (planted) since the 1960s and 1980s.

Most of the vegetation communities are unaffected by the existing dam/reservoir or any future alterations to it. The coniferous plantations are located mostly on higher ground as well as the cultural meadow/lawn area. The Cultural Woodland (Community 1) downstream of the dam contains a wetland floodplain community. This community is affected by the natural creek, but has not been influenced by the reservoir above the dam. The creek levels should not change as a result of dam removal. The creek has had natural cycles, overflowing its banks occasionally due to spring flooding or beaver. This, in combination with some groundwater discharge, maintains the wetland features in this vegetation community.

Only the shallow marsh (Community 4) at the upstream end of the pond along Neil Drain is directly tied to the reservoir and would be impacted by changes to the dam. This community has developed within the shallow, calm waters of the reservoir. This small marsh provides diversity to the Fullarton CA, but it not a rare habitat type. If the dam is removed and the creek restored to a flowing regime, the marsh may decrease or increase in size depending on topography and the level of groundwater discharge in the immediate area. Many of the species that occur in the existing marsh would likely grow in the riparian area along the restored creek.

The Fullarton Pond/Reservoir was not surveyed specifically for aquatic plants. White Water Buttercup (uncommon in Perth County but not uncommon in Ontario) was present in large numbers in 2016. If the dam was removed and the creek restored, pond plants such as the White Water Buttercup would not remain.

No plant species at- risk were found in the study area or within 2 km of the study area. No plants with a high Coefficient of Conservatism score were found, indicating most plants are generalist species found in a wide variety of habitats, including disturbed or young sites. Hispid Buttercup was the only plant found with an SRANK of S3 (rare to uncommon), however, it is relatively common in the Upper Thames watershed.

5.2 Birds & Wildlife

Incidental bird and wildlife observations over the six field days (spring, summer and fall) of 2015 were made. Some 43 bird species, all native, were recorded. Most were common breeding species and/or permanent residents. Two uncommon breeding species (Bald Eagle and Green Heron) were seen. The Bald was not breeding but there was evidence that the Green Heron was nesting in the willows. There was one uncommon breeding species or common winter resident (Red-breasted Nuthatch) was seen, but no evidence of breeding. The Great Egret and Trumpeter Swan, both uncommon visitors, also were seen.

None of the 43 bird species seen are exclusively pond dwellers. Species such as Canada Goose, Mallard, Belted Kingfisher and Bald Eagle feed in or by standing water but these species utilize rivers and streams as well. Use of the pond/reservoir by native waterfowl seemed to be on an occasional basis for

feeding and resting but there may be an occasional nesting family. Most of the songbirds seen use the wooded habitats and nearby fields.

Eight herptiles (reptiles and amphibians), seven Lepidoptera (butterflies) and five mammals were seen. All species are common to our area. The Red-spotted Newt, Green Frog, American Bullfrog and Snapping Turtle are the only animals with a strong affiliation to permanent water bodies/ponds. They all overwinter in still permanent water bodies (i.e., not fast moving streams), thus the local populations within this CA may decline if the dam is removed.

5.3 Wildlife Species at Risk and Special Concern

One threatened species, the Barn Swallow, was seen in the study area. There was no breeding evidence at Fullarton CA. Since it nests in old buildings, its nesting habitat will be unaffected by changes to the dam/reservoir.

Three Special Concern species were seen: Bald Eagle, Snapping Turtle and Monarch. Special concern species do not receive provincial species or habitat protection, but they are important to recognize.

Bald Eagles were not breeding at the Fullarton CA and they likely forage throughout the North Thames River corridor for fish. Thus, there is no action that is needed for this species.

Snapping Turtles were seen in the Fullarton Reservoir and there are records of this species within the nearby Thames River as well. Habitat for this species will be lost in Fullarton CA if the reservoir is drained and restored to a creek as this species does not usually use cold/cool water streams because of the temperature. However, they are known to use cold water streams on occasion. Snapping Turtles can hibernate in slower-moving streams with deeper pools, but prefer still-water habitats such as ponds (Scott Gillingwater, Species at Risk Biologist, UTRCA, personal communication). Harm to individual turtles and other amphibians can be avoided during dam deconstruction by slowly releasing water in the summer. This timing gives turtles enough time to locate a new area for hibernation before the cold weather arrives. Creation of an off-line pond may provide habitat for this and other reptiles and amphibians that are currently using the reservoir, but there is limited space in the CA.

The Monarch butterfly is also a species of Special Concern. The Monarch populations have fallen drastically over the last decade or so, likely due to inclement weather, the elimination of milkweeds along the migration routes in the USA and Canada and threats to its overwintering areas in Mexico. There is no specific action at Fullarton CA that is required. Establishment of more riparian vegetation, including its host plant milkweeds, and other nectar plants, will help support this butterfly locally.

5.4 Significant Woodlands, Wetlands and ANSIs

The woodlands within Fullarton CA are defined as Significant Woodlands in Perth County as they are 1 ha or larger. They will not be altered by the possible removal of the dam and reservoir. In time, the former pond will likely fill in with herbaceous and then woody plant communities, thus providing an enlarged area of significant woodland cover.

Most of the unevaluated wetland along the Neil Drain will be unaffected by any changes to dam/reservoir. Hydrogeological information indicates this is a groundwater-dependent wetland and not influenced to any great degree by backwater from the reservoir. The shallow marsh at the upstream end of the Fullarton Reservoir may decrease or increase in size if the dam is removed, but wetland vegetation is will colonize the area around the restored creek, similar to upstream.

The North Thames Valley Earth Science ANSI and candidate Fullarton Moraine ANSI that occur in the Fullarton CA area would be unaffected by changes to the dam/reservoir as no major changes to the topography will be made.

5.5 Conclusions and Recommendations

This report examined the vegetation and wildlife of Fullarton CA to flag any rare or sensitive species that might be impacted if the Fullarton Dam is decommissioned and the creek restored.

No plant species-at-risk were found. However, the aquatic plants in the pond were not surveyed and it is recommended that they be. The Barn Swallow (Threatened) was the only animal species at risk found, but it was not nesting in the CA and no action is required.

The Snapping Turtle, a species of Special Concern, may be negatively impacted by changes to the dam/reservoir since they use the pond and rarely use cold water streams. To protect Snapping Turtles that may overwinter in the pond sediments, the drawdown of the reservoir should be done slowly in the summer, allowing them time to find new sites prior to hibernation. An off-line pond could be created to provide overwintering habitat for the Snapping Turtle and amphibian species.

The unevaluated Neil Drain/Fullarton wetland should be unaffected by the proposed dam removal. The pond area may revert to a shallow marsh community and possibly, in time, a wooded habitat. The watercourse will find its own path through the former pond area, fluctuating naturally with the seasons.

No County Significant Woodland features will be affected by the proposed changes to the dam.

Recommendations

1: Survey the aquatic plants in the pond to ensure no rare species are impacted.

2: If the dam is decommissioned, the drawdown of the reservoir should be done very slowly over summer providing time for Snapping Turtles and other amphibians to find new sites prior to hibernation.

3. If the dam/reservoir is decommissioned, examine the benefits and feasibility of constructing an off-line pond to accommodate snapping turtles and other aquatic wildlife species.

4: If the dam/reservoir is decommissioned, examine the road culverts along the Neil Drain after drawdown to see if any are perched as a result of the water level changes. Correcting perched culvert problems will allow the creek to flow unobstructed.

5: If the dam is decommissioned, monitor the plant species that colonize the former pond bed and augment with seed/plants of native wetland species if needed.

6. If the dam is decommissioned and the creek restored, maintain the trail where it is currently, away from the sensitive creek edges and the unconsolidated sediments from the pond bottom. Consider providing viewing points to the creek that elevates the visitor above the shoreline vegetation height (e.g., a mound or a wooden viewing platform).

Photo 14. Beggar Ticks (*Bidens ceruna*) by the creek downstream of dam

Photo 15. Road culvert on the Neil Drain upstream of Road 163A. A marsh/meadow habitat has established close to the water, with woodland farther back.

References

Lee, H., W. Bakowsky, J. Riley, J. Bowles, M. Puddister, P. Uhlig and S. McMurray. 1998. *Ecological Land Classification for Southern Ontario. First approximation and its application.* Ontario Ministry of Natural Resources, Southcentral Science Section, Science Development and Transfer Branch. SCSS Field Guide FG-02.

Ministry of Natural Resources and Forestry, http://www.ontario.ca/page/barn-swallow.

Appendices

A. Annotated Checklist of the Vascular Plants of Fullarton CA

B. Notes on Descriptive Indices and Plant Status

C1. Bird Checklist from Fullarton Study Area sorted by Order

C2. Bird Checklist sorted alphabetically

D. Animal Sightings (Incidental)

E. Historical Notes and Aerial Photographs

Appendix A. Annotated Checklist of Vascular Plants for Fullarton CA

Names		Indices				Rank, Status		Community				
Scientific Name	Common Name	N_A	Weed	CC	C Wet	S-RANK S1-S3	SARO	1	2	3	4	5
Acer negundo	Manitoba Maple	N		0	-2					x		
Acer platanoides	Norway Maple	A	-3					x				
Acer saccharum	Sugar Maple	N		4	3			x		x		x
Acer saccharinum	Silver Maple	N		5	-3			x	x	x	x	x
Achillea millefolium	Yarrow	A	-1					x	x	x	x	x
Actaea pachypoda	White Baneberry	N		6	5					x		
Actaea rubra	Red Baneberry	N		5	5			x		x		x
Agrimonia gryposepala	Agrimony	N		2	2			x		x	x	x
Alisma subcordatum	Water-plantain	N		3	-5			x				
Alliaria petiolata	Garlic Mustard	A	-3					x	x	x	x	x
Amaranthus retroflexus	Redroot Pigweed	A	-1						x			
Ambrosia artemisiifolia	Common Ragweed	N		0	3			x	x		x	
Ambrosia trifida	Giant Ragweed	N		0	-1			x	x			
Anemone canadensis	Canada Anemone	N		3	-3			x	x	x	x	x
Anemone virginiana var. virginiana	Thimbleweed	N		4	5			x				
Apocynum androsaemifolium	Spreading Dogbane	N		3	5					x		
Apocynum cannabinum	Indian Hemp	N		3	0			x	x	x	x	x
Arctium lappa	Great Burdock	A	-2					x		x	x	x
Arctium minus	Common Burdock	A	-2					x	x	x	x	x
Arisaema triphyllum	Jack-in-the-pulpit	N		5	-2			x		x		x
Asclepias incarnata	Swamp Milkweed	N		6	-5					x	x	
Asclepias syriaca	Common Milkweed	N		0	5			x	x	x	x	x
Barbarea vulgaris	Winter Cress	A	-2					x	x	x		
Bidens cernua	Nodding Beggarticks	N		2	-5			x			x	

Names		Indices				Rank, Status		Community				
Scientific Name	Common Name	N_A	Weed	CC	C Wet	S-RANK S1-S3	SARO	1	2	3	4	5
Bidens frondosa	Devil's Beggarticks	N		3	-3			x		x	x	
Bromus inermis	Smooth Brome	A	-3					x	x	x	x	x
Caltha palustris	Marsh-marigold	N		5	-5			x			x	
Capsella bursa-pastoris	Shepherd's-purse	A	-1						x			
Carya cordiformis	Bitternut Hickory	N		6	0			x		x		x
Carex cristatella	Crested Sedge	N		3	-4					x		
Carex lacustris	Lake Sedge	N		5	-5			x			x	
Carex retrorsa	Retrorse Sedge	N		5	-5							x
Carex stricta	Tussock Sedge	N		4	-5			x			x	
Carex utriculata	Beaked Sedge	N		7	-5						x	
Carex vulpinoidea	Fox Sedge	N		3	-5			x		x	x	
Caulophyllum thalictroides	Blue Cohosh	N		6	5			x				
Cerastium fontanum	Mouse-eared Chickweed	A	-1						x			x
Chenopodium album	Lamb's-quarters	A	-1						x			
Chelone glabra	Turtlehead	N		7	-5			x		x	x	
Chenopodiastrum simplex	Maple-leaved Goosefoot	N		0	5				x			
Cicuta bulbifera	Bulb-bearing Water-hemlock	N		5	-5			x			x	
Cichorium intybus	Chicory	A	-1					x	x	x	x	x
Cirsium arvense	Canada Thistle	A	-1					x	x	x	x	
Circaea canadensis	Enchanter's-nightshade	N		3	3			x		x	x	x
Cirsium vulgare	Bull Thistle	A	-1					x		x	x	x
Clinopodium vulgare	Wild Basil	N		4	5			x	x	x	x	x
Convolvulus arvensis	Field Bindweed	A	-1					x	x			
Erigeron canadensis	Horseweed	N		0	1			x				
Cornus alternifolia	Alternate-leaved Dogwood	N		6	5			x		x		x
Cornus amomum	Silky Dogwood	N		5	-4					x	x	

Names		Indices				Rank, Status		Community				
Scientific Name	Common Name	N_A	Weed	CC	C Wet	S-RANK S1-S3	SARO	1	2	3	4	5
Cornus racemosa	Grey Dogwood	N		2	-2			x		x	x	x
Cornus stolonifera	Red-osier Dogwood	N		2	-3			x		x	x	x
Crataegus sp.	Hawthorn species	N		4	5			x		x		x
Dactylis glomerata	Orchard Grass	A	-1					x	x	x	x	x
Daucus carota	Wild Carrot	A	-2					x	x	x	x	x
Digitaria sanguinalis	Large Crab Grass	A	-1					x	x			
Dryopteris clintoniana	Clinton's Wood Fern	N		7	-4			x				
Echinochloa crus-galli	Barnyard Grass	A	-1						x			
Echinocystis lobata	Wild Cucumber	N		3	-2			x		x	x	x
Echinochloa muricata var. microstachya	Barnyard Grass	N		4	-5			x				
Elaeagnus umbellata	Autumn-olive	A	-3							x		x
Eleocharis acicularis	Needle Spike-rush	N		5	-5						x	
Elymus virginicus var. virginicus	Virginia Wild-rye	N		5	-2						x	
Epilobium ciliatum	Willow-herb	N		3	3			x			x	x
Epipactis helleborine	Helleborine	A	-2							x		x
Epilobium hirsutum	Great Hairy Willow-herb	A	-2					x			x	x
Equisetum arvense	Field Horsetail	N		0	0			x	x	x	x	x
Eragrostis pectinacea var. pectinacea	Tufted Lovegrass	N		0	0			x				
Erigeron annuus	Daisy Fleabane	N		0	1			x	x	x	x	x
Erigeron philadelphicus	Philadelphia Fleabane	N		1	-3			x		x		x
Erigeron strigosus	Narrow-leaved Fleabane	N		0	1			x	x		x	x
Erysimum cheiranthoides	Wormseed Mustard	A	-1					x				

Names		Indices				Rank, Status		Community				
Scientific Name	Common Name	N_A	Weed	CC	C Wet	S-RANK S1-S3	SARO	1	2	3	4	5
Eupatorium perfoliatum	Boneset	N		2	-4			x			x	
Euthamia graminifolia	Grass-leaved Goldenrod	N		2	-2			x	x	x	x	x
Eutrochium maculatum var. maculatum	Spotted Joe-Pye-weed	N		3	-5			x	x	x	x	x
Fagus grandifolia	American Beech	N		6	3					x		
Frangula alnus	Glossy Buckthorn	A	-3					x		x	x	x
Fraxinus americana	White Ash	N		4	3					x	x	x
Fraxinus pennsylvanica	Red/Green Ash	N		3	-3			x	x	x	x	x
Fragaria vesca	Woodland Strawberry	N		4	4			x		x		x
Fragaria virginiana	Wild Strawberry	N		2	1			x	x	x	x	x
Galium mollugo	Wild Madder	A	-2					x	x	x	x	x
Galium palustre	Marsh Bedstraw	N		5	-5			x			x	
Geranium robertianum	Herb Robert	A	-2					x		x		x
Geum aleppicum	Yellow Avens	N		2	-1			x	x	x	x	x
Geum canadense	White Avens	N		3	0			x	x	x	x	x
Geum laciniatum	Cut-leaved Avens	N		4	-3			x			x	x
Geum vernum	Spring Avens	N		7	1						x	x
Glechoma hederacea	Gill-over-the-ground	A	-2						x	x	x	x
Hesperis matronalis	Dame's Rocket	A	-3					x		x		x
Hypericum perforatum	Common St. John's-wort	A	-3					x	x	x	x	x
Impatiens capensis	Spotted Touch-me-not	N		4	-3			x	x	x	x	x
Iris pseudacorus	Yellow-flag	A	-2					x			x	
Juglans nigra	Black Walnut	N		5	3			x		x	x	x
Juncus dudleyi	Dudley's Rush	N		1	0			x				
Juncus effusus	Soft Rush	N		4	-5						x	
Lathyrus latifolius	Everlasting Pea	A	-1					x				
Leersia oryzoides	Rice Cut Grass	N		3	-5						x	

Names		Indices				Rank, Status		Community				
Scientific Name	Common Name	N_A	Weed	CC	C Wet	S-RANK S1-S3	SARO	1	2	3	4	5
Lemna minor	Common Duckweed	N		2	-5						x	
Leontodon autumnalis	Fall Hawkbit	A	-1					x	x		x	x
Leucanthemum vulgare	Ox-eye Daisy	A	-1					x	x	x	x	x
Lilium michiganense	Michigan Lily	N		7	-1							x
Lonicera tatarica	Tartarian Honeysuckle	A	-3					x		x		x
Luzula multiflora ssp. Mulitflora	Common Wood-rush	N		6	3						x	
Lycopus americanus	American Water-horehound	N		4	-5			x		x	x	
Lycopus uniflorus	Bugleweed	N		5	-5			x		x	x	
Lysimachia ciliata	Fringed Loosestrife	N		4	-3			x		x	x	x
Lysimachia nummularia	Moneywort	A	-3					x				x
Lythrum salicaria	Purple Loosestrife	A	-3								x	
Maianthemum racemosum	False Solomon's-seal	N		4	3			x		x		x
Maianthemum stellatum	Starry False Solomon's-seal	N		6	1			x		x		
Malva neglecta	Common Mallow	A	-1						x			
Malus pumila	Apple	A	-1					x		x	x	x
Matricaria discoidea	Pineapple Weed	A	-1						x			
Medicago lupulina	Black Medick	A	-1					x	x	x	x	x
Mentha arvensis	Field Mint	N		3	-3			x		x	x	
Mentha x piperita	(M. aquatica X M. spicata)	A	-1					x		x	x	
Morus alba	White Mulberry	A	-3									x
Nasturtium officinale	Water Cress	A	-1					x			x	
Oenothera biennis	Hairy Yellow Evening-primrose	N		0	3			x	x			
Onoclea sensibilis	Sensitive Fern	N		4	-3			x				

Names		Indices				Rank, Status		Community				
Scientific Name	Common Name	N_A	Weed	CC	C Wet	S-RANK S1-S3	SARO	1	2	3	4	5
Origanum vulgare	Wild Marjoram	A	-2								x	x
Oxalis stricta	European Wood-sorrel	N		0	3			x	x	x	x	x
Panicum capillare	Witch Grass	N		0	0				x			
Parthenocissus inserta	Virginia Creeper	N		3	3			x		x	x	
Persicaria hydropiperoides	Water-pepper	N		5	-5			x				
Persicaria maculosa	Lady's-thumb	A	-1						x			
Phalaris arundinacea	Reed Canary Grass	N		0	-4			x	x	x	x	x
Phleum pratense	Timothy	A	-1					x	x		x	x
Physocarpus opulifolius var. opulifolius	Ninebark	N		5	-2				x	x		
Picea abies	Norway Spruce	A	-1					x	x	x		x
Picea glauca	White Spruce	N		6	3			x		x		x
Pilea pumila	Clearweed	N		5	-3			x			x	
Pinus strobus	White Pine	N		4	3			x		x		x
Pinus sylvestris	Scots Pine	A	-3					x		x		x
Plantago lanceolata	English Plantain	A	-1					x	x	x	x	x
Plantago major	Common Plantain	A	-1					x	x		x	x
Plantago rugelii	Rugel's Plantain	N		1	0			x	x	x	x	x
Poa pratensis ssp. pratensis	Kentucky Bluegrass	N		0	1			x	x	x		x
Populus balsamifera	Balsam Poplar	N		4	-3						x	
Populus deltoides ssp. deltoides	Cottonwood	N		4	-1				x			
Portulaca oleracea	Common Purslane	A	-2						x			
Potentilla recta	Rough-fruited Cinquefoil	A	-2					x	x	x		x
Potentilla simplex	Common Cinquefoil	N		3	4				x	x	x	x
Prunus avium	Sweet Cherry	A	-2							x	x	x
Prunus nigra	Canada Plum	N		4	4							x
Prunus serotina	Wild Black	N		3	3					x		x

Names		Indices				Rank, Status		Community				
Scientific Name	Common Name	N_A	Weed	CC	C Wet	S-RANK S1-S3	SARO	1	2	3	4	5
	Cherry											
Prunus virginiana	Choke Cherry	N		2	1			x		x	x	x
Prunella vulgaris ssp. lanceolata	Heal-all	N		1	0			x	x	x	x	x
Quercus macrocarpa	Bur Oak	N		5	1					x		
Quercus rubra	Red Oak	N		6	3				x			x
Ranunculus acris	Common Buttercup	A	-2					x	x	x	x	x
Ranunculus hispidus var. hispidus	Hispid Buttercup	N		7	0	S3		x			x	
Ranunculus recurvatus	Hooked Buttercup	N		4	-3			x		x		x
Rhamnus cathartica	Common Buckthorn	A	-3					x	x	x	x	x
Ribes americanum	Wild Black Currant	N		4	-3			x		x	x	x
Ribes cynosbati	Prickly Gooseberry	N		4	5			x		x		
Ribes rubrum	Garden Red Currant	A	-2					x		x	x	
Rosa multiflora	Multiflora Rose	A	-3							x		x
Rubus allegheniensis	Common Blackberry	N		2	2			x	x			
Rubus idaeus ssp. strigosus	Wild Red Raspberry	N		0	-2			x	x	x	x	x
Rubus occidentalis	Black Raspberry	N		2	5			x	x	x	x	x
Rumex crispus	Curly Dock	A	-2					x	x		x	
Rumex obtusifolius	Bitter Dock	A	-1					x	x	x		
Rumex orbiculatus	Great Water Dock	N		6	-5						x	
Sagittaria latifolia	Common Arrowhead	N		4	-5			x			x	
Salix alba	White Willow	A	-2					x		x	x	x
Salix interior	Sandbar Willow	N		3	-5						x	x
Sambucus canadensis	Common Elder	N		5	-2						x	x
Sambucus racemosa	Red-berried Elder	N		5	2			x		x		x

Names		Indices				Rank, Status		Community				
Scientific Name	Common Name	N_A	Weed	CC	C Wet	S-RANK S1-S3	SARO	1	2	3	4	5
Sanguinaria canadensis	Bloodroot	N		5	4					x		x
Sanguisorba minor ssp. muricata	Garden Burnet	A	-1									x
Saponaria officinalis	Bouncing Bet	A	-3					x			x	
Schedonorus pratensis	Meadow Fescue	A	-1					x	x		x	
Schoenoplectus tabernaemontani	Soft-stem Bulrush	N		5	-5			x			x	
Scirpus atrovirens	Dark Green Bulrush	N		3	-5			x		x	x	
Scirpus pendulus	Nodding Bulrush	N		3	-5						x	
Scutellaria galericulata	Common Skullcap	N		6	-5			x		x	x	
Setaria viridis	Green Foxtail	A	-1						x			
Silene vulgaris	Bladder Campion	A	-1					x				
Solidago altissima ssp. altissima	Late Goldenrod	N		1	3			x	x	x	x	x
Solidago canadensis var. canadensis	Canada Goldenrod	N		1	3			x	x	x		x
Solanum dulcamara	Climbing Nightshade	A	-2					x		x	x	x
Sonchus arvensis ssp. arvensis	Perennial Sow-thistle	A	-1								x	x
Sonchus asper	Spiny-leaved Sow-thistle	A	-1					x				x
Sonchus oleraceus	Annual Sow-thistle	A	-1					x			x	x
Sorbus aucuparia	European Mountain-ash	A	-2									x
Spiraea alba	Meadowsweet	N		3	-4						x	
Stellaria media	Common Chickweed	A	-1						x			
Symplocarpus foetidus	Skunk-cabbage	N		7	-5			x		x	x	x
Symphyotrichum lanceolatum ssp. lanceolatum	Panicled Aster	N		3	-3			x	x	x	x	x

Names		Indices				Rank, Status		Community				
Scientific Name	Common Name	N_A	Weed	CC	C Wet	S-RANK S1-S3	SARO	1	2	3	4	5
Symphyotrichum lateriflorum	Calico Aster	N		3	-2			x	x	x	x	x
Symphyotrichum novae-angliae	New England Aster	N		2	-3			x	x	x	x	x
Symphyotrichum puniceum	Purple-stemmed Aster	N		6	-5			x		x	x	x
Symphyotrichum urophyllum	Arrow-leaved Aster	N		6	5					x		
Taraxacum officinale	Common Dandelion	A	-2					x	x	x	x	x
Thalictrum pubescens	Tall Meadow-rue	N		5	-2			x		x	x	
Thuja occidentalis	White Cedar	N		4	-3			x		x		x
Toxicodendron rydbergii	Rydberg's Poison Ivy	N		0	0					x	x	x
Tragopogon pratensis	Yellow Goat's-beard	A	-1					x	x		x	
Triosteum aurantiacum	Horse-gentian	N		7	5							x
Trillium erectum	Red Trillium	N		6	1			x				
Trillium grandiflorum	White Trillium	N		5	5					x		x
Trifolium hybridum	Alsike Clover	A	-1						x			
Trifolium pratense	Red Clover	A	-2					x	x	x	x	x
Trifolium repens	White Clover	A	-1					x	x	x		x
Typha angustifolia	Narrow-leaved Cattail	A	-3							x	x	
Typha latifolia	Common Cattail	N		3	-5			x			x	
Ulmus americana	American Elm	N		3	-2			x		x	x	x
Ulmus pumila	Siberian Elm	A	-1					x				
Ulmus rubra	Slippery Elm	N		6	0			x				
Urtica dioica ssp. gracilis	Stinging Nettle	N		2	-1					x	x	
Veronica anagallis-aquatica	Water Speedwell	A	-1					x			x	
Veronica arvensis	Corn Speedwell	A	-1					x				
Verbena hastata	Blue Vervain	N		4	-4			x		x	x	
Veronica	Common	A	-2							x		x

Names		Indices				Rank, Status		Community				
Scientific Name	Common Name	N_A	Weed	CC	C Wet	S-RANK S1-S3	SARO	1	2	3	4	5
officinalis	Speedwell											
Veronica polita	Speedwell	A	-1						x			
Verbena urticifolia	White Vervain	N		4	-1			x	x	x	x	x
Viburnum lentago	Nannyberry	N		4	-1			x		x	x	x
Viburnum opulus ssp. Trilobum	Highbush-cranberry	N		5	-3			x		x		x
Vicia cracca	Cow Vetch	A	-1					x	x	x	x	x
Vinca minor	Common Periwinkle	A	-2								x	
Viola blanda	Sweet White Violet	N		6	-2					x	x	x
Viola canadensis var. canadensis	Canada Violet	N		6	5			x		x		
Viola cucullata	Marsh Violet	N		5	-5			x		x	x	x
Viola pubescens var. pubescens	Downy Yellow Violet	N		5	4			x		x		
Viola sororia	Common Blue Violet	N		4	1			x				x
Vitis riparia	Riverbank Grape	N		0	-2			x	x	x	x	x
Total			**-140**	**518**	**-109**							
Count		**228**	**84**	**144**	**144**	**1**	**0**	**161**	**84**	**132**	**133**	**125**
Average/Mean			**-1.67**	**3.6**	**-0.8**							
OVERALL:												
Number of Native Species		**144**										
Number of Adventive Species		**84**										
Total Number of Species		**228**										
Percent Adventive Species		**37%**										
Mean Weediness Score		**-1.7**										
Number of S1-S3		**1**										
Number of CC 8, 9 or 10 species		**0**										
BY COMMUNITY:												
Mean Weediness Score (-1 to -3)								**-1.7**	**-1.5**	**-1.9**	**-1.7**	**-1.9**
NHIC Exotic status (1 to 5)								**4.5**	**4.7**	**4.6**	**4.5**	**4.4**
Mean CC Score by Community								**3.36**	**2.23**	**3.46**	**3.35**	**3.36**
Mean Wetness Score								**-0.9**	**0.5**	**-0.2**	**-2.0**	**0.1**
Number of S1-S3 Species								**1**	**0**	**0**	**1**	**1**

Note: Ranunculus aquatilis, White Water Buttercup, found in the reservoir (Community 6) in 2016

Appendix B. Notes on Descriptive Indices and Species Status

Descriptive indices such as Mean Conservatism Coefficient (MCC) and Wetness Index (CW) can decrease the variability that is caused by misidentification of species (Coles-Ritchie *et al*. 2004). This is because similar dominant species are often ecological equivalents, in that they are found in similar habitats and perform similar ecosystem functions. For this reason, taxonomic differences, which can be difficult to identify in the field, may not be important when trying to understand the functioning of the riparian ecosystem (Coles-Ritchie *et al*. 2004). Descriptive indices have the advantage of minimizing the influence of differences in species that are unimportant for the index. The most useful indices are those with many gradations that are based on scientific information about vegetation.

Code and Measure	Description	Examples
CC **Coefficient of Conservatism**	Each native plant species is assigned a coefficient of conservatism (CC) score between 0 and 10 using the floristic quality assessment system for southern Ontario (Oldham *et al*., 1995) CCs represent an estimated probability that a plant species is likely to occur in a landscape relatively unaltered from what is believed to be pre-European settlement conditions (DNR Wisconsin 2001). Higher CCs are given to plants more specialized in habitat or condition and conserve themselves to very specific environments and communities (i.e., fidelity to a habitat).	0 to 3: Plants found in a wide variety of plant communities, including disturbed sites 4 to 6: Plants that typically are associated with a specific plant community but tolerate moderate disturbance. Most woodland species fall in this category 7 to 8: Plants associated with a plant community in an advanced successional stage that has undergone minor disturbance. 9 to 10: Plants with a high degree of fidelity to a narrow range of synecological parameters or habitat specialists.
MCC **Mean Conservatism Coefficient**	MCC is used as a measure of the pristiness or lack of disturbance of a site (Oldham *et al*. 1995). Communities or sites with high MCCs contain more plants unlikely to be found in disturbed habitat. Middlesex Natural Heritage Study (UTRCA 2003) found MCC scores of 3.0 to 5.0 in woodland sites. Burke *et al*. 2007 found MCC scores of 4.1 to 5.3 at 12 woodlots with 75 km of London. ***Formula***: Add all of the CC scores for a particular site or community and then divide by the number of species (native only).	3.0 to 5.0 MNHS, UTRCA 2003 4.1 to 5.3 Burke 2007 3.3 to 3.8 London Dykes (UTRCA 2013) London Subwatershed Study, thresholds for woodland protection: <4.0 low priority 4.0 to 4.5 medium priority >4.5 high priority

Appendix B continued		
Number of Conservative Species	The number of plant species with a CC of 8 to 10 gives an indication of site quality and highlights species of concern for management. Dr. Jane Bowls (pers. com) indicated that using CC of 8 to 10 for Conservative Plants is a combination of intuition, convention, experience and data. Species with 0 to 2 CC score are generalists, and 8 to 10 are specialists. The rest are the in-betweens. ***Formula***: Count the number of species with CC score of 8, 9 and 10.	CC scores: 0 to 2 generalist species 3 to 7 in-betweens 8 to 10 specialist species
WEED **Weediness Score**	Each non-native plant species has been assigned a weediness score between -1 and -3, where -1 represents a weed with low invasiveness and a -3 a very invasive species (Oldham *et al*, 1995). The Weediness Score represents an estimated probability that a non-native plant is likely to infest and negatively impact a natural area by displacing native plants.	-1 little or no impact on natural areas -2 occasional impacts on natural areas, generally infrequent or localized -3 major potential impacts on natural areas
MWS **Mean Weediness Score**	The mean weediness score can be used like MCC to measure the representation of weedy adventive (alien) species abundance in a site (Moc 2001). In combination with the percentage of non-native plants, this measure can be used as an indicator of disturbance. Also, it is an indication of the threat to native species from highly invasive adventive species. ***Formula:*** Add all the weediness scores from a particular site or community and divide by the number of non-native species.	-1.0 to -1.6 little or no impact on natural areas -1.7 to -2.3 occasional impacts on natural areas, generally infrequent or localized -2.4 to -3.0 major potential impacts on natural areas **The above is an estimation devised by C. Quinlan at UTRCA using equal divisions between -1 and -3.*
CW (CWet) **Coefficient of Wetness**	Each plant species is assigned a value from -5 to +5 based on the probability of being found in a wetland or not. Usually only native species are used, even though a CW exists for adventive species also.	-5 occurs in wetlands under natural conditions (obligate wetland species) -4 to -2 usually occurs in wetlands, but occasionally found in non-wetlands -1 to 1 equally likely to be occur in wetlands or non-wetlands (facultative) 2 to 4 occasionally occurs in wetlands, but usually occurs in non-wetlands 5 almost never occurs in wetlands under natural conditions (obligate upland)

Appendix B continued

Code and Measure	Description	Values, Examples, Assessments
WI **Wetness Index (Mean Wetness Coefficient)**	Wetness Index is an assessment of a plant community as to whether it has a predominance of wetland species or not. It is not an indication of site quality. The MNHS 2003 found mean wetness coefficients from individual woodland patches ranged from -2.5 to +2.1. Formula: Add all the CW scores (native species only) from a particular site or community and divide by the number of native species found (Michigan DNR).	Examples: -0.4 to -1.1 London Dykes -2.5 to 2.1 MNHS 2003 woodlands Overall: <0 site has a predominance of native wetland species >0 site has a predominance of native upland species

Provincial (SARO) Status:
The Committee on the Status of Species at Risk in Ontario (COSSARO), an independent committee of experts, considers which plants and animals should be listed as at risk. There are seven categories:

Extinct	A wildlife species that no longer exists
EXT - Extirpated	A wildlife species no longer existing in the wild in Ontario but exists elsewhere
END - Endangered	A wildlife species facing imminent extirpation or extinction in Ontario
THR - Threatened	A wildlife species likely to become endangered if limiting factors are not reversed.
SC – Special Concern	A wildlife species that may become a threatened or endangered species because of a combination of biological characteristics and identified threats.
NAR – Not at Risk	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances
UNK – Data Deficient	A category that applies when the available information in insufficient (a) to resolve a wildlife species' eligibility for assessment of (b) to permit an assessment of the wildlife species' risk of extinction

SRanks – Provincial Ranks
SRANKS are used by the Natural Heritage Information Centre (NHIC) to set protection priorities for rare species and natural communities in Ontario.

SX	Presumed Extirpated	**S1**	Extremely rare in Ontario
SH	Possibly Extirpated (Historical)	**S2**	Very rare in Ontario
SNR	Unranked, or, if following a ranking, rank uncertain (e.g. S3?). S? species are thought to be rare in Ontario but there is insufficient information available to assign a more accurate rank.	**S3**	Rare to uncommon in Ontario
SE	Exotic; not believed to be a native component of Ontario's flora	**S4**	Common and apparently secure in Ontario
SNA	Not Applicable; a conservation status rank is not applicable because the species is not a suitable target for conservation activities (e.g. is exotic or migrant)	**S5**	Very common and demonstrably secure in Ontario
SU	Status unknown		
S2N,S4B	B=breeding, N=non-breeding populations (e.g., breeding area vs. over-wintering area)		

Appendix C1. Bird Checklist from Fullarton Study Area sorted by Order

Common Name	SARO Status	SRANK S1-S3	Regional Status
WATERFOWL			
Canada Goose			Common PR
Mallard			Common BS
Trumpeter Swan			Exotic/Introduced
GALLINACEOUS BIRDS			
Wild Turkey			Common PR
BITTERNS, HERONS & ALLIES			
Great Blue Heron			Common BS or PR
Great Egret		S2B	Uncommon Visitor
Green Heron			Uncommon BS
VULTURES			
Turkey Vulture			Common BS
HAWKS, KITES, EAGLES			
Bald Eagle	SC	S2N,S4B	Uncommon BS
Red-tailed Hawk			Common BS
PLOVERS, SANDPIPERS & ALLIES			
Killdeer			Common BS
PIGEONS & DOVES			
Mourning Dove			Common PR
GOATSUCKERS & SWIFTS			
American Robin			Common BS or PR
HUMMINGBIRDS			
Ruby-throated Hummingbird			Common BS
KINGFISHERS			
Belted Kingfisher			Common BS
WOODPECKERS			
Downy Woodpecker			Common PR
Hairy Woodpecker			Common PR
TYRANT FLYCATCHERS			
Eastern Kingbird			Common BS
Eastern Phoebe			Common BS
Great Crested Flycatcher			Common BS
Willow Flycatcher			Common BS
VIREOS			
Red-eyed Vireo			Common BS

…/2

Common Name	SARO Status	SRANK S1-S3	Regional Status
JAYS, CROWS & RAVENS			
American/Common Crow			Common PR
Blue Jay			Common PR
SWALLOWS			
Barn Swallow	THR		Common BS
Tree Swallow			Common BS
CHICKADEES & ALLIES			
Black-capped Chickadee			Common PR
Red-breasted Nuthatch			Uncommon BS, Common WR
White-breasted Nuthatch			Common PR
WRENS			
House Wren			Common BS
MOCKINGBIRDS & THRASHERS			
Gray Catbird			Common BS
WAXWINGS & SILKY-FLYCATCHERS			
Cedar Waxwing			Common PR
WOOD-WARBLERS			
Common Yellowthroat			Common BS
SPARROWS			
Chipping Sparrow			Common BS
Rufous-sided (Eastern) Towhee			Common BS
Song Sparrow			Common BS
TANAGERS, CARDINALS & ALLIES			
Indigo Bunting			Common BS
Northern Cardinal			Common PR
Rose-breasted Grosbeak			Common BS
BLACKBIRDS			
Common Grackle			Common BS
Northern (Baltimore) Oriole			Common BS
Red-winged Blackbird			Common BS
FINCHES			
American Goldfinch			Common PR
24 orders, 43 species	**2**	**2**	

BS - Breeding Species, PR - Permanent Resident, WR - Winter Resident

SARO Status - Committee on the Status of Species at Risk in Ontario (COSSARO), an independent committee of experts, considers which plants and animals should be listed as at risk. See Appendix B.

SRANK - Provincial Ranks used by the Natural Heritage Information Centre (NHIC) to set protection priorities for rare species and natural communities in Ontario. S1 (Extremely Rare), S2 (Very Rare), S3 (Rare to Uncommon).

Appendix C2. Bird Checklist sorted alphabetically

Common Name	Scientific Name	SARO Status	SRANK S1-S3
American Crow	Corvus brachyrhynchos		
American Goldfinch	Carduelis tristis		
American Robin	Turdus migratorius		
Bald Eagle	Haliaeetus leucocephalus	SC	S2N,S4B
Black-capped Chickadee	Parus atricapillus		
Belted Kingfisher	Ceryle alcyon		
Blue Jay	Cyanocitta cristata		
Barn Swallow	Hirundo rustica	THR	
Canada Goose	Branta canadensis		
Cedar Waxwing	Bombycilla cedrorum		
Chipping Sparrow	Spizella passerina		
Common Grackle	Quiscalus quiscula		
Common Yellowthroat	Geothlypis trichas		
Downy Woodpecker	Picoides pubescens		
Eastern Kingbird	Tyrannus tyrannus		
Eastern Phoebe	Sayornis phoebe		
Great Blue Heron	Ardea herodias		
Great Crested Flycatcher	Myiarchus crinitus		
Gray Catbird	Dumetella carolinensis		
Great Egret	Casmerodius albus		S2B
Green Heron	Butorides striatus		
Hairy Woodpecker	Picoides villosus		
House Wren	Troglodytes aedon		
Indigo Bunting	Passerina cyanea		
Killdeer	Charadrius vociferus		
Mallard	Anas platyrhynchos		
Mourning Dove	Zenaida macroura		
Northern Cardinal	Cardinalis cardinalis		
Northern (Baltimore) Oriole	Icterus galbula		
Rose-breasted Grosbeak	Pheucticus ludovicianus		
Red-breasted Nuthatch	Sitta canadensis		
Red-eyed Vireo	Vireo olivaceus		
Rufous-sided (Eastern) Towhee	Pipilo erythrophthalmus		
Red-tailed Hawk	Buteo jamaicensis		
Ruby-throated Hummingbird	Archilochus colubris		
Red-winged Blackbird	Agelaius phoeniceus		
Song Sparrow	Melospiza melodia		
Trumpeter Swan	Cygnus buccinator		
Tree Swallow	Tachycineta bicolor		
Turkey Vulture	Cathartes aura		
White-breasted Nuthatch	Sitta carolinensis		
Willow Flycatcher	Empidonax traillii		
Wild Turkey	Meleagris gallopavo		
Total Birds at Fullarton CA	**43**	**2**	**2**

See Appendix B for descriptions of SARO Status and SRANKs.

Appendix D. Animal Sightings (Incidental)

Common Name	Scientific Name	Exotic	SARO	S-RANK S1-S3	Regional Status
HERPTILES					
American Bullfrog	Rana catesbeiana				Uncommon?
Eastern Garter Snake	Thamnophis sirtalis sirtalis				Common
Green Frog	Rana clamitans melanota				Common
Midland Painted Turtle	Chrysemys picta marginata				Common
Northern Leopard Frog	Rana pipiens				Common
Snapping Turtle	Chelydra serpentina serpentina		**SC**	**S3**	*
Wood Frog	Rana sylvatica				Common
E. Red-spotted Newt	Notophythalmus viridenscens				Common
Total Herptiles	**8**	**0**	**1**	**1**	
LEPIDOPTERA					
Cabbage White	Pieris rapae	SE			Common Exotic
Clouded Sulphur	Colias philodice				Common
Mourning Cloak	Nymphalis antiopa				Common
Monarch	Danaus plexippus		**SC**	**S2N,S4B**	*
Red Admiral	Vanessa atalanta				Common
Red-spotted Purple	Basilarchia arthemis astyanax				Common
Spring Azure	Celastrina argiolus				Common
Total Lepidoptera	**7**	**1**	**1**	**1**	
MAMMALS					
Beaver	Castor canadensis				Common
Eastern Cottontail	Sylvilagus floridanus				Common
Eastern Gray Squirrel	Sciurus carolinensis				Common
Muskrat	Ondatra zibethicus				Common
White-tailed Deer	Odocoileus virginianus				Common
Total Mammals	**5**	**0**	**0**	**0**	
Overall total	**20**	**1**	**2**	**2**	

Note:
Eastern Red-spotted Newt seen in 2014 by Brenda Gallagher and in 2016 by Steve Sauder, UTRCA.

Appendix E. Historical Notes and Aerial Photographs

The 1955 air photo shows the pre-Fullarton CA time frame. The area was mostly farmland except woods by the river. There appears to be a house and barn where the pavilion is today. The Neil Drain was just a narrow watercourse, not well vegetated (likely pastured).

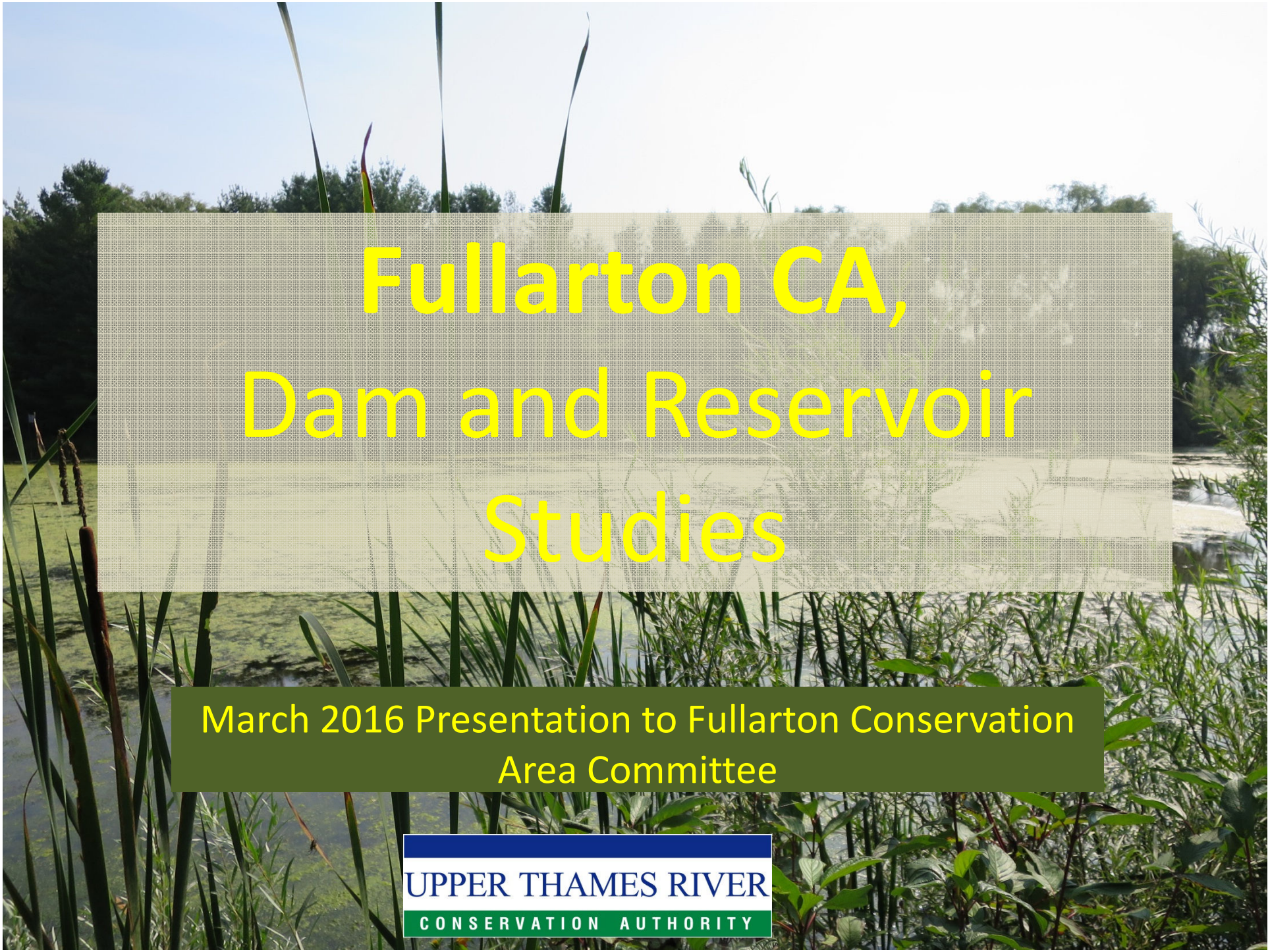
From ***25 years of Conservation*** (1973):

- Initial steps towards creating the Fullarton CA were taken in Oct 1952 when J Wilson Brown reported that 77 acres of property, containing a good trout stream, on the Perth County Road south of the village, were for sale.
- The property was purchased in 1953 from Alonzo Hart estate (or Mr. Allen); development started in September 1955.
- "An earth dam, nine feet high and 300 ft long was built and a five-acre pond created. The dam was completed in November 1955 and the pond in the spring of 1958."
- "In 1962 the county sold the Authority, for the sum of one dollar, 5 ½ acres of land across from the CA for use as a roadside park. Downed timber and weeds were removed and in 1964 the property was used as a test plot for the control of thorn trees, a scourge of farm lands in that section."
- "In 1964 the Authority turned over to the township 4 acres under a 99-yr lease, for creation of a recreation centre as a Centennial project. The Authority also assisted by providing a water supply for the centre and shared in the cost of constructing rest rooms. The centre was officially opened on June 25, 1966 when KE Lantz, Assistant Deputy Minister of Agriculture for Ontario, unveiled an inscribed plaque."
- "During the winter of 1966-67, a large quantity of silt was removed from the pond to increase fish habitat. The pond was deepened and, in the spring of 1967 was restocked with trout. Fullarton is also considered an ideal spot for dog trials."
- Ball diamond #1 put in prior to 1972. Ball diamond #2 put in later by municipality.
- Wildwood crew maintained the site until 1996, after which we handed over management to Fullarton Twp then West Perth. Ongoing agreement.
-
- 1960s UTRCA planted conifer trees on the east side of the pond.
- 1980s UTRCA planted conifers on the west side of the pond.

1955 Aerial Photograph

1972 Aerial Photograph

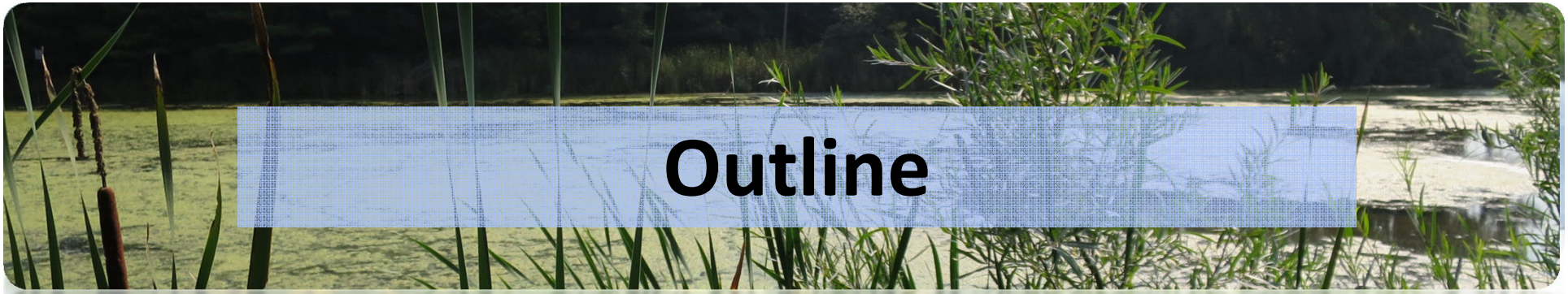
1978 Aerial Photograph



Fullarton CA, Dam and Reservoir Studies

March 2016 Presentation to Fullarton Conservation Area Committee

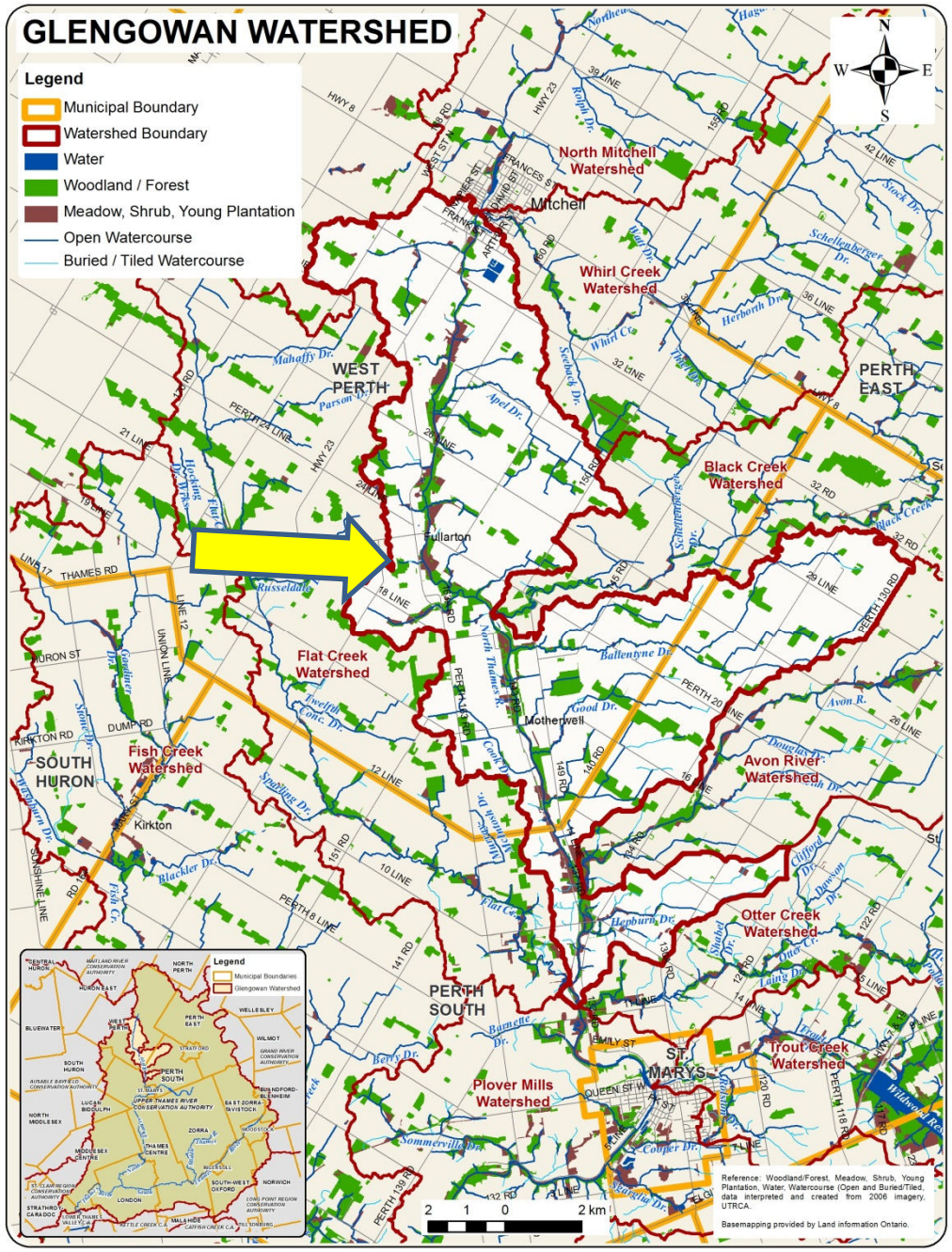
UPPER THAMES RIVER
CONSERVATION AUTHORITY



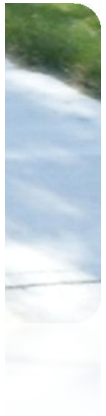
Outline

Review Information Collected by UTRCA:

- Site
- Dam Condition
- Vegetation Inventory
- Bird and Wildlife Inventory
- Fish Inventory
- Benthic Inventory
- Surface Water Quality
- Ground Water
- Sediment
- Recreation
- Future Work
- Remove options,examples
- Funding

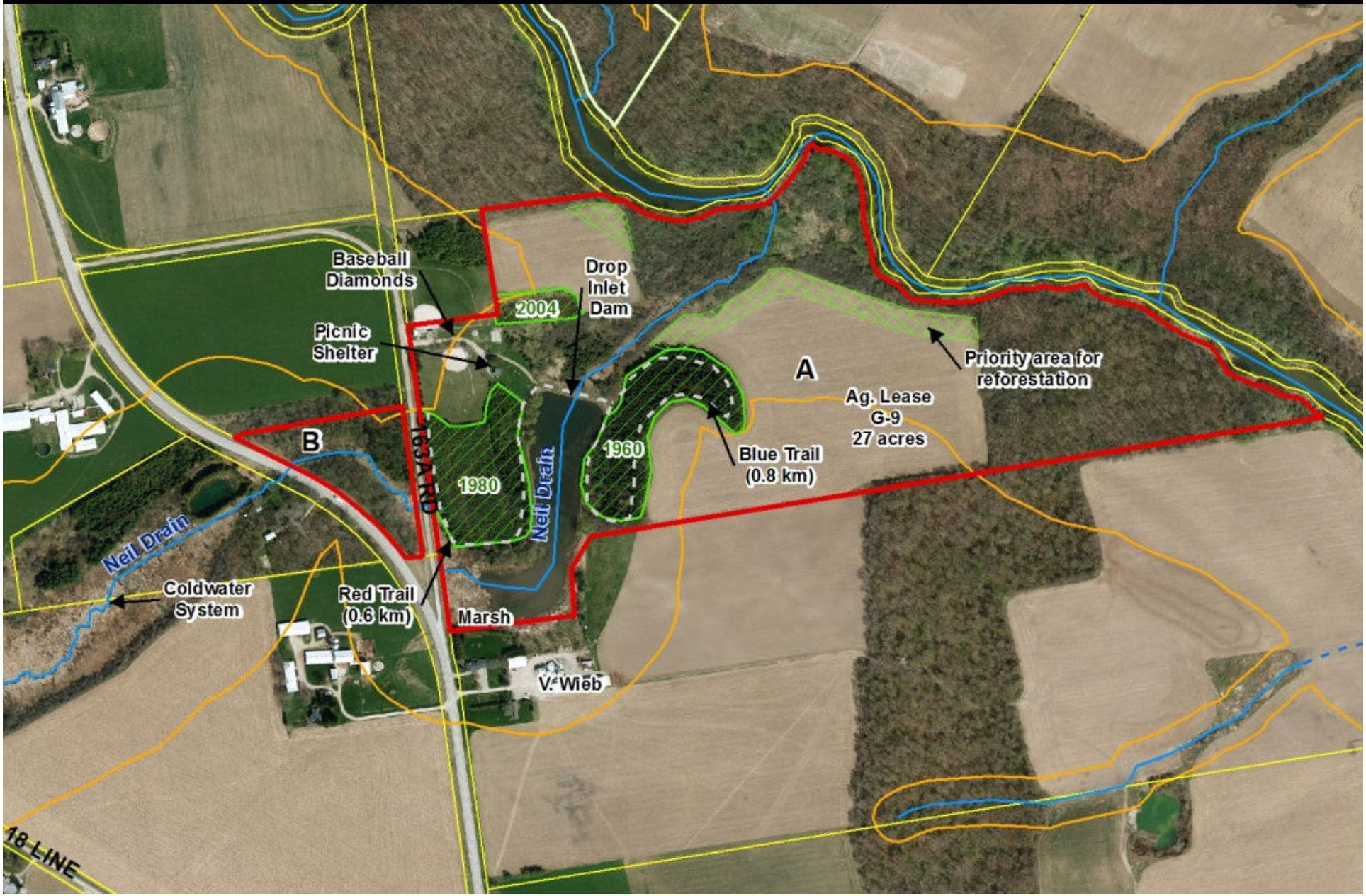


Fullarton CA is within the Glengowan Watershed



1955 Air Photo, Pre-dam

Fullarton CA - 2010 Air Photo



Recreation Structures
West Perth

Fullarton Dam

Fullarton Dam

Expenditures

Prior to 2003: Emergency Spillway, Outlet Improvements, Trash rack

Not offset by grant

2003-2005: $22,000 for Dam Safety Study

Offset by grant

2006-2010: $7,000 for Signs, Stability Review

Offset by grant

Future Considerations

2016 -2021: A) Upgrade: $100,000 (2016$)- Shoreline Erosion Control, Raise Crest, Drainage

Provincial grant? Municipal Levy

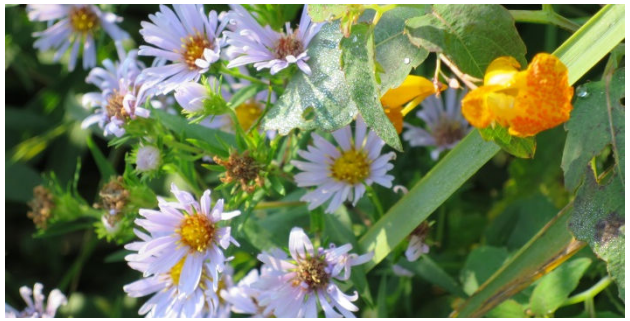
B) Removal: Reporting – support - LRIA screening - Class EA, CEAA? – Plan – Remove / Restoration - Monitor - Adjust

Provincial Grant? Federal Grant? Municipal levy - other?

Vegetation Inventory 2015

- Three season inventory (May, July, Aug)
- Study area ~100 m from pond
- 229 species recorded, 37% non-native
- Vegetation of moderate quality
- No rare or uncommon plants
- Marsh, conifer plantations, old field
- Pond has small wetland fringe

- **If dam removed, upstream marsh may get smaller, but that habitat may extend along creek instead**



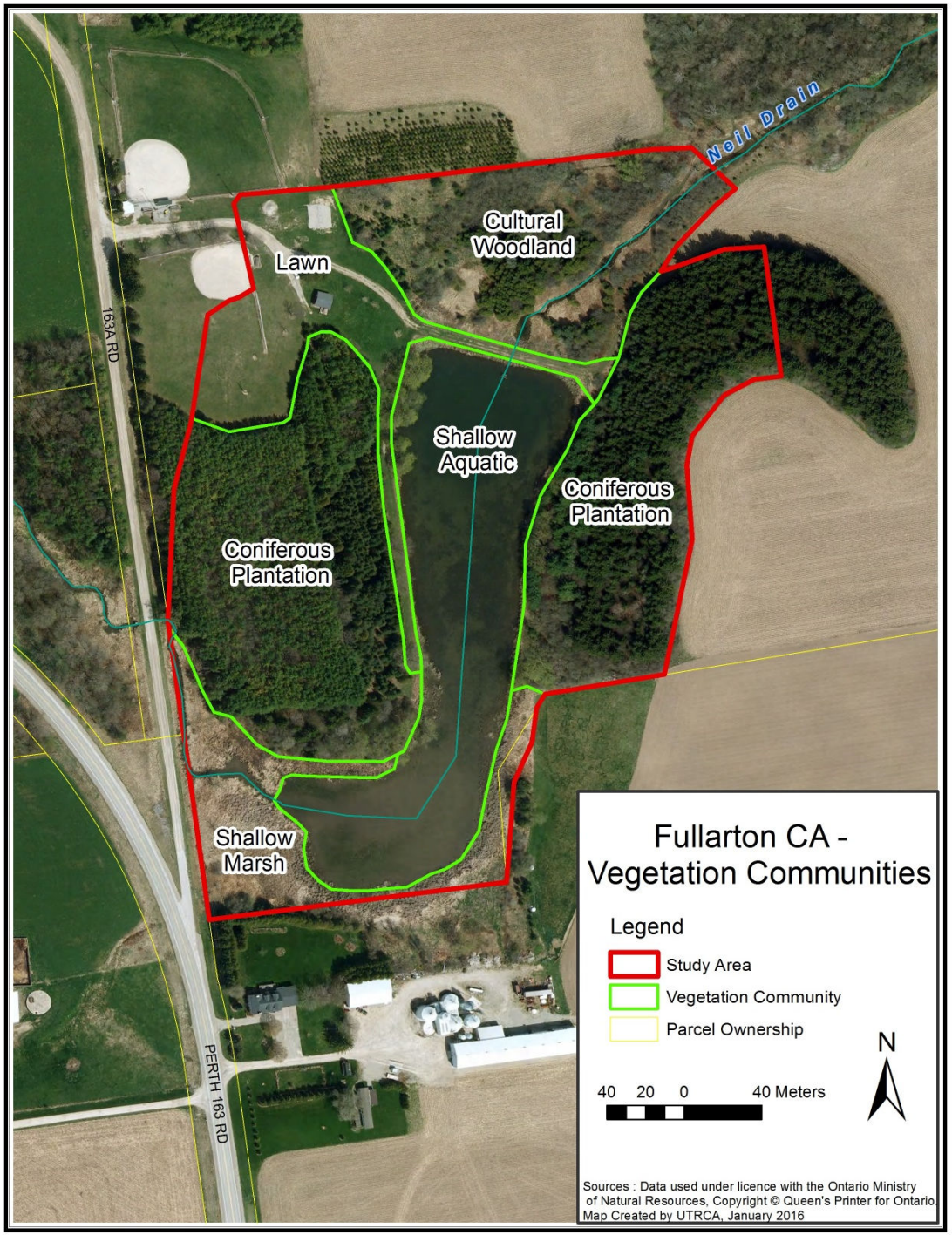
Vegetation Communities

Cultural Woodland - Cedar, maples, ash, walnut, spruce and pines, dogwoods, raspberries, elms, grasses

Coniferous Plantation – White Pine, Norway Spruce, Cedar

Shallow Marsh – cattails, willow, grasses, sedges, jewelweed

Shallow Aquatic – water ≤ 2 m deep, some submerged, rooted or floating vegetation



Birds and Wildlife

- Incidental observations during veg. inventory
- Total of 6 days of observations May-Sep 2015
- **43 bird** species, mostly common breeding species or permanent residents
  - 2 rare species: Bald Eagle, Barn Swallow (not nesting),
  - Uncommon migrants: Great Egret, Trumpeter Swan
  - Uncommon breeding: Willow Flycatcher
- **3 reptile and 5 amphibian species**
  - Snapping turtle is Special Concern
- **7 mammal species**, all common
- **8 butterfly** species
  - Monarch is provincially rare (S2N)

- **Only a few species would be negatively impacted by a change from reservoir to creek: Wood Frog, Green Frog**

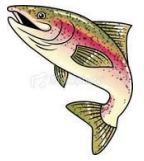

Cedar Waxwing


Common Yellowthroat

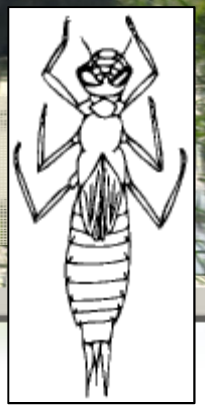
Photos by Brenda Gallagher

Fish Inventory 2015

- Downstream of reservoir, a total of 34 fish species have been found, with 26 sampled last year.
- 13 species were found in and upstream of the pond with 11 recorded in 2015, including a cold water indicator species.
- A backpack electro fisher was used for all samples except one pond sample that utilized minnow traps. Sampling was conducted during the summer and fall of 2015.

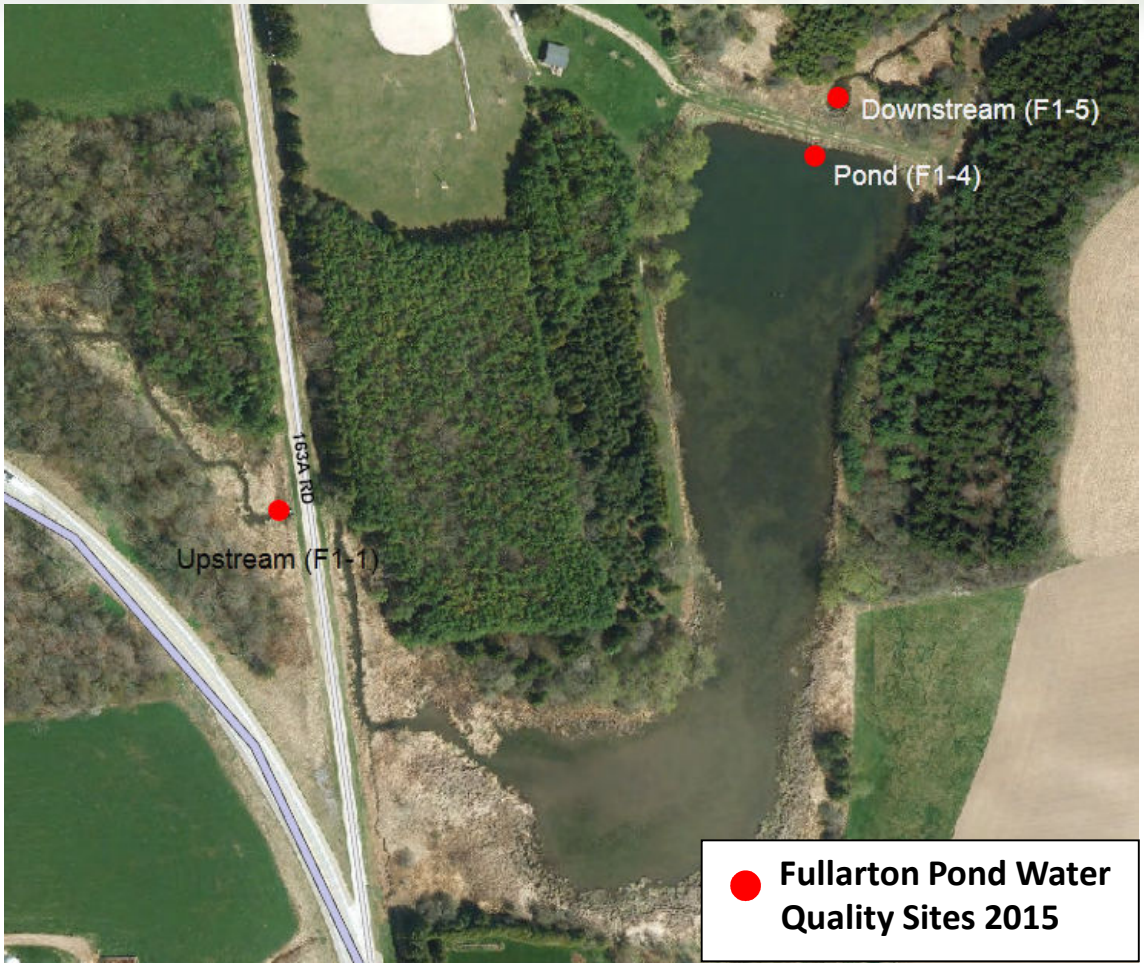


Benthic Inventory 2015



- Spring and fall surveys were conducted up and downstream of the reservoir.
- Benthic invertebrates in all samples were primarily pollution tolerant and mid-tolerant taxa, with only a few sensitive species present.
- Biotic index scores indicated all samples were in the “fairly poor” category, similar to the overall UTRCA average.
- Habitat assessments indicate near optimal habitat at the site below the dam while conditions were marginal upstream where flows were influenced by the dam causing excessive silt loading.

Surface Water Quality

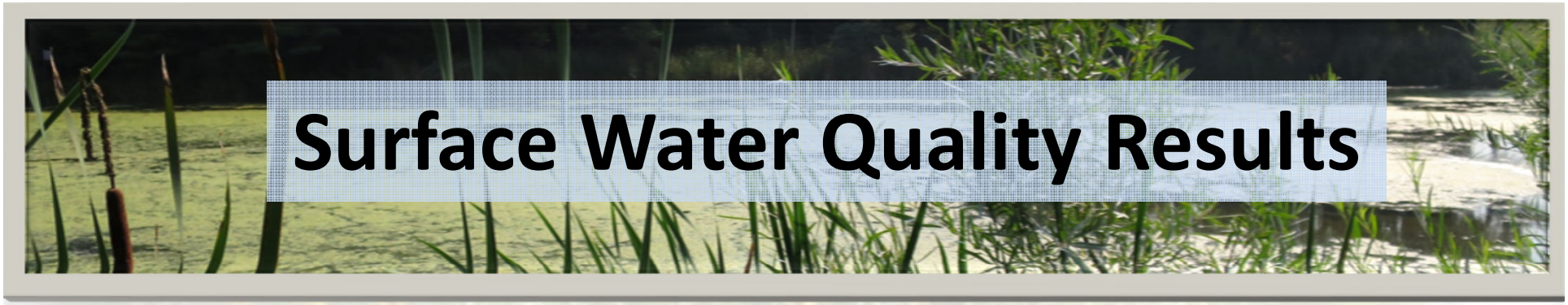


- The Neil Drain was sampled three times in summer of 2015 at 3 locations (upstream of Fullarton Pond, in pond above dam and below dam)
- Analysed for Phosphorus, Nitrate, Chloride, E. coli, Suspended Solids
- Data provided a general look at water quality in 2015 based on a small number of samples

Surface Water Quality Summary

- Water quality in the Neil Drain, based on the limited amount of data, showed general low levels for parameters measured with results typically better than the average seen in Upper Thames watershed streams.
- Recommend further sampling, especially if dam is removed, to monitor downstream impacts.

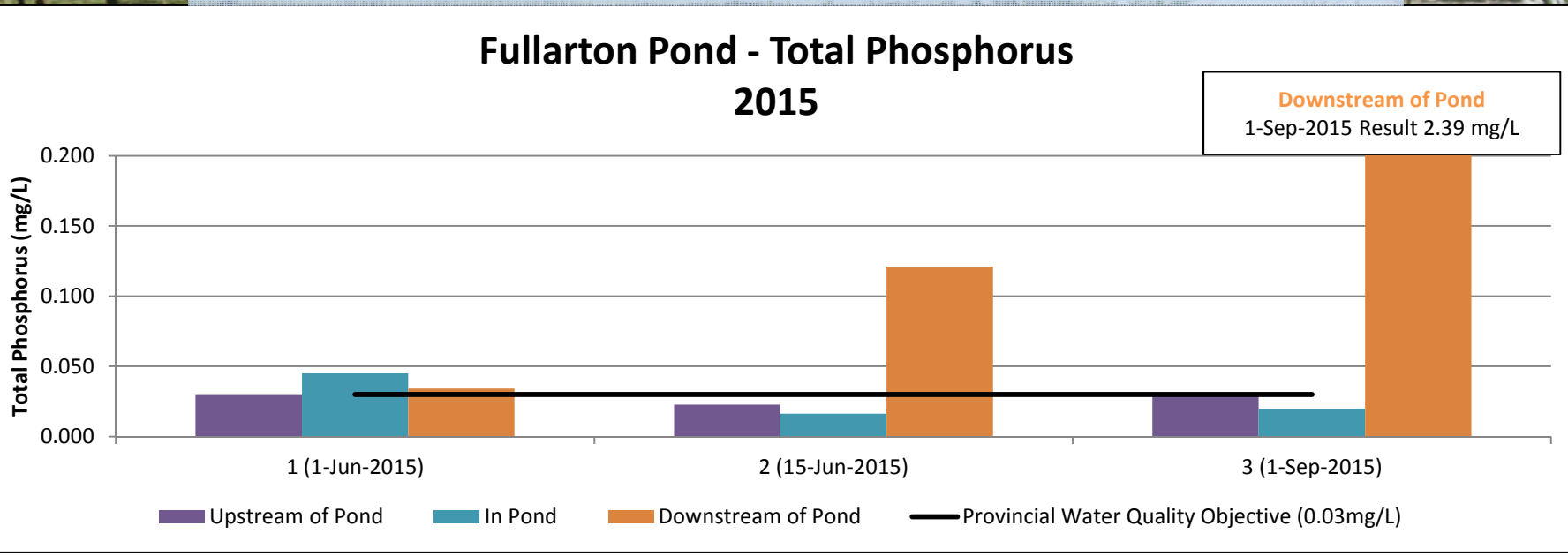
- Ponds act as settling basin for sediment and associated contaminants, such as phosphorus. These sediments can re-suspend during disturbance such as high flow conditions. Sampling of the bottom sediments would give an indication of any accumulation of these contaminants, and potential for discharge downstream.

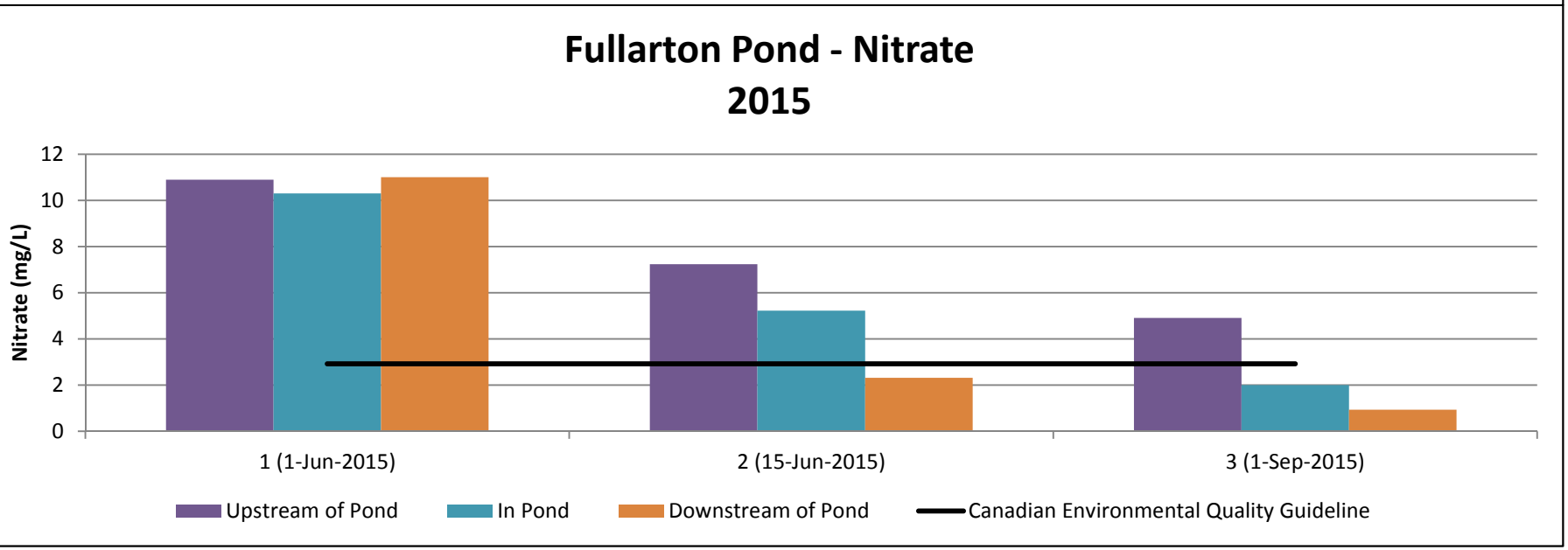


Surface Water Quality Results

- The **total phosphorus** levels for 2015 were at or below the Provincial Water Quality Objective of 0.03mg/L, except for two downstream samples where levels were higher. These two samples also had a high level of suspended solids, likely from bottom sediments, which tend to accumulate higher nutrients.
- Most of the **nitrate** levels were above the Canadian Environmental Quality Guideline of 2.93 mg/L with the downstream being below the guideline for 2 of 3 samples and the pond being below once.
- **Chlorides** were well below the Canadian Environmental Quality Guideline of 120 mg/L with the highest result being 28.2 mg/L.
- Most ***E. coli*** results were above the recreational guideline of 100 CFU/100mL, typical of local streams. Two samples taken on September 1 (downstream and pond) were below the guideline.

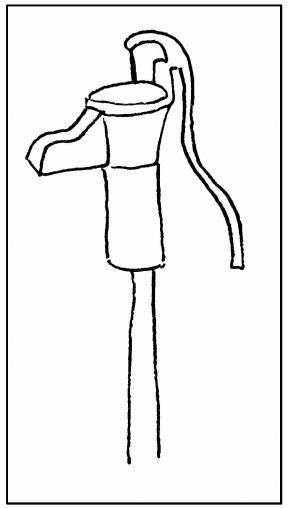
Surface Water Quality





Groundwater

- Shallow overburden and deep bedrock aquifer present
- Shallow aquifer is less than 10 m depth
  - shallow dug or bored wells in the immediate area
- Deep bedrock wells
  - Bedrock encountered at 35-40 m depth
  - Dry bedrock at 35 m (breathing wells)
  - Wells completed to approximately 100m with a static level of approximately 65-75 m indicating karst is present

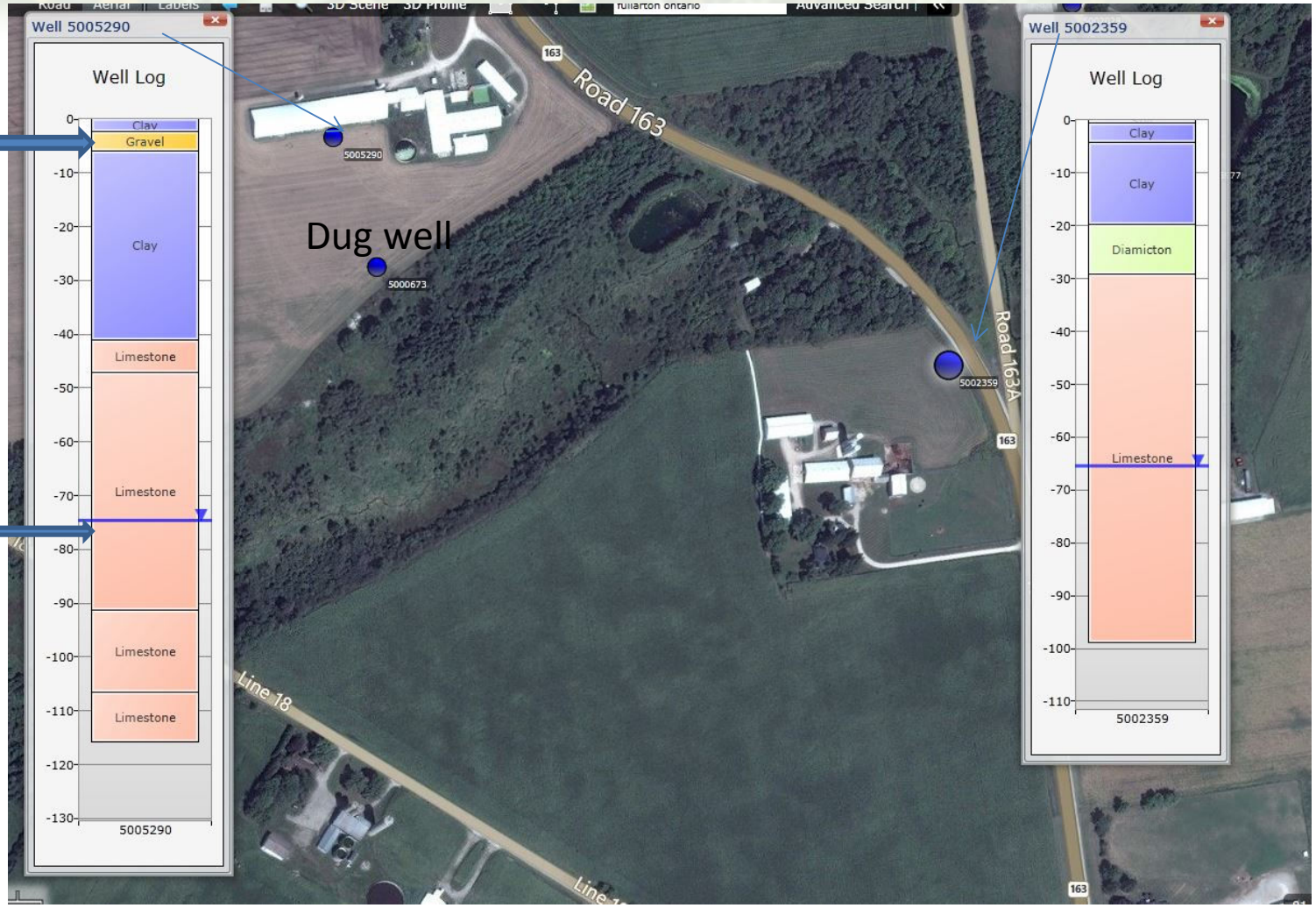


Groundwater

Shallow aquifer- dug well

Static water level

Deep bedrock well- 115 m



Groundwater

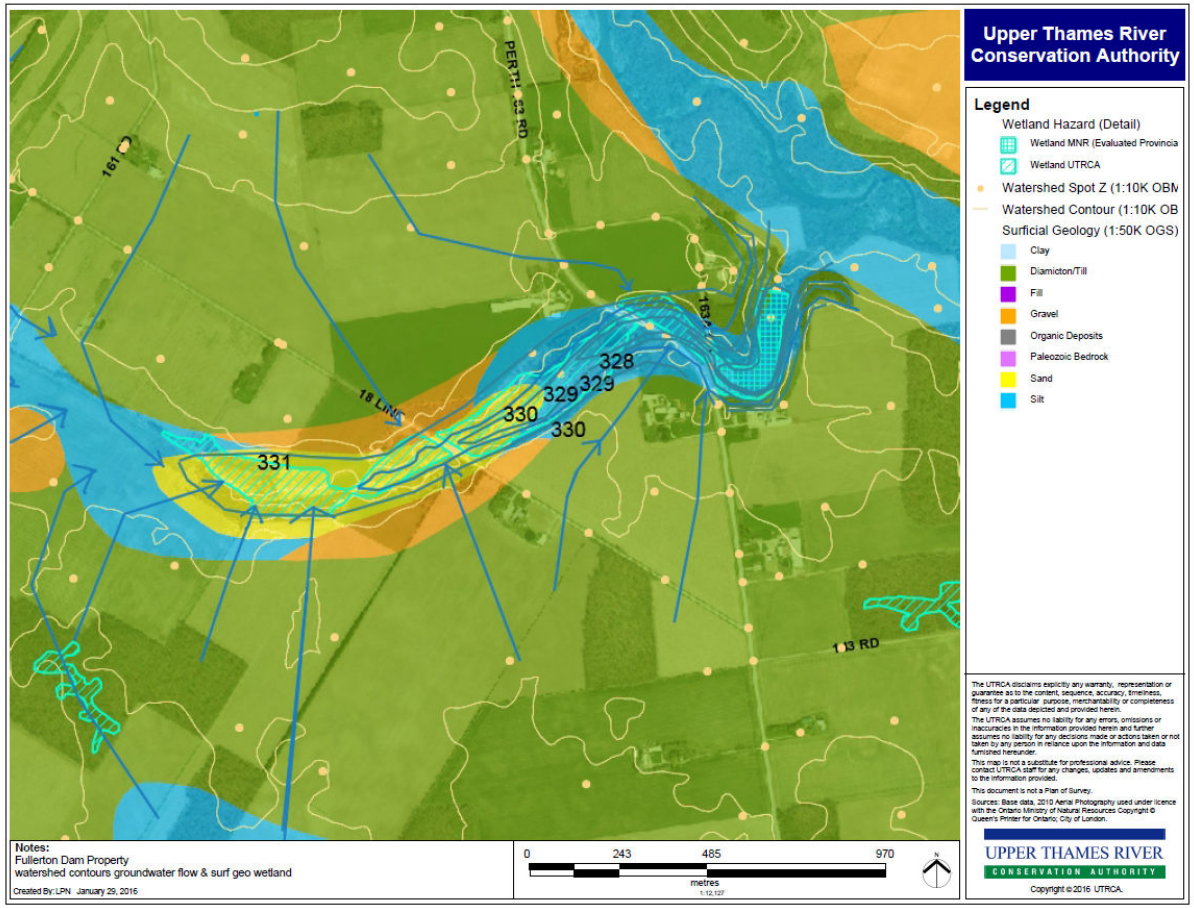
Surficial Geology and groundwater flow

Shallow aquifer is in contact with wetlands

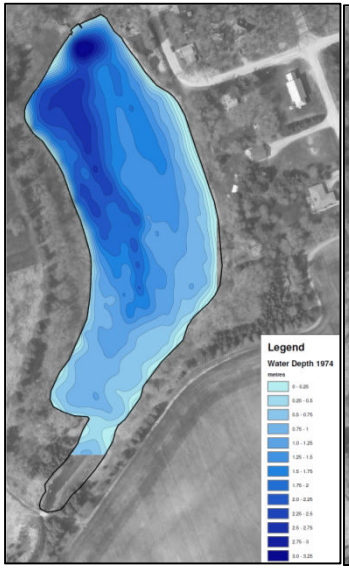
- Arrows indicate shallow groundwater flow and contours indicated likely average static level in shallow aquifer
- Groundwater dependent ecosystem
- Water levels are highest in the west at approximately 331 m and decline towards the CA property

Groundwater quality:

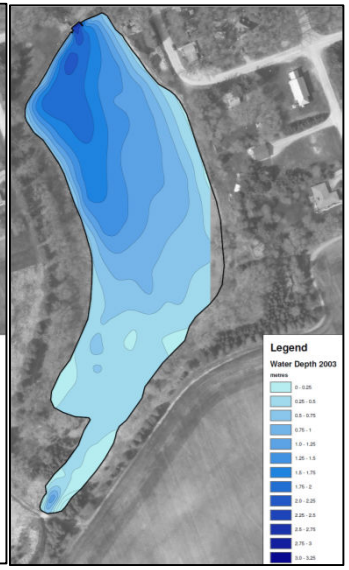
- There are no wells on the property to determine water quality shallow or deep
- Quality in the bedrock aquifer (close by monitoring well 54) is excellent
- Dry bedrock aquifer indicates extensive karst



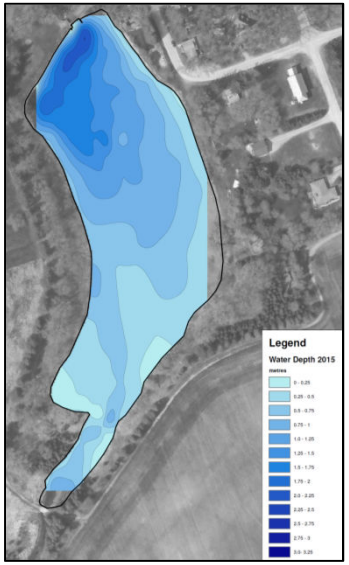
Harrington Pond Sedimentation



Pond Depth 1974

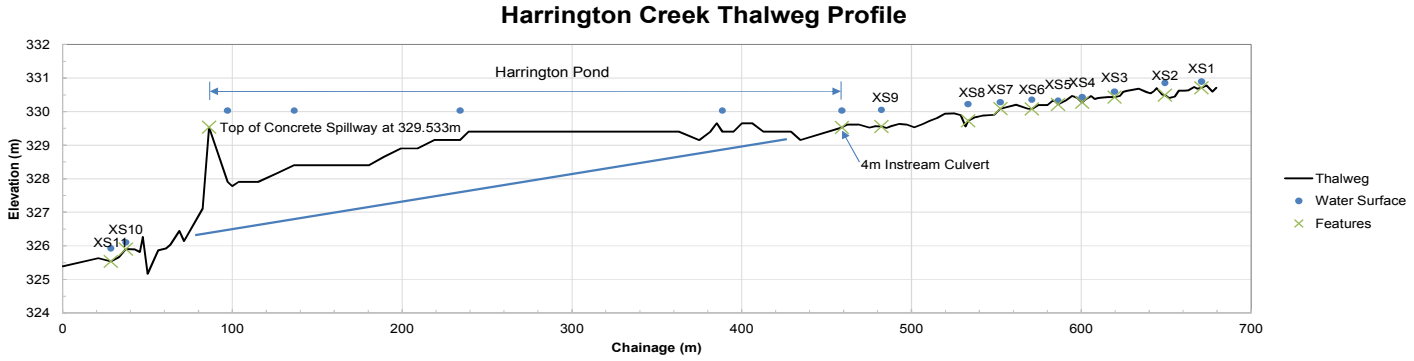


Pond Depth 2003



Pond Depth 2015

Estimated loss in reservoir volume 1955 – 2015 = 40% to 45%

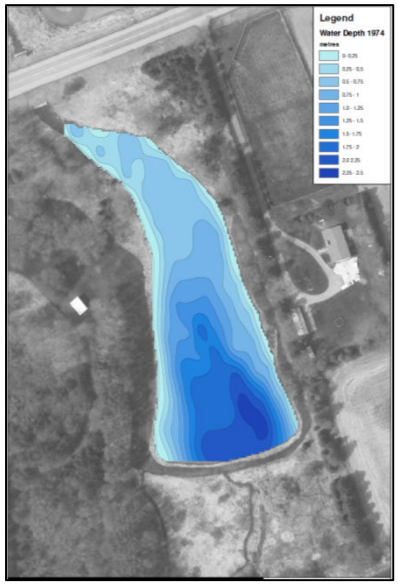


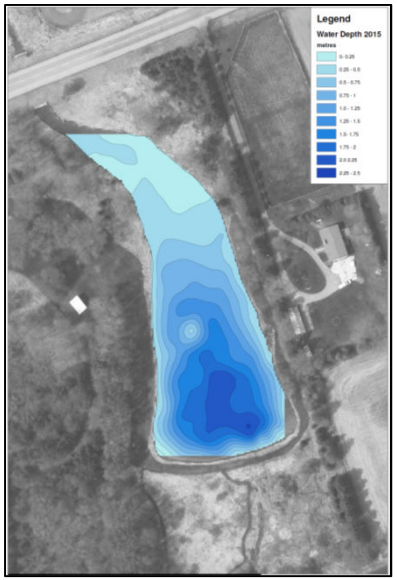
UPPER THAMES RIVER CONSERVATION AUTHORITY

Harrington Dam Class Environmental Assessment

Stem Recovery inc. PROFESSIONAL ENGINEERS

Embro Pond Sedimentation



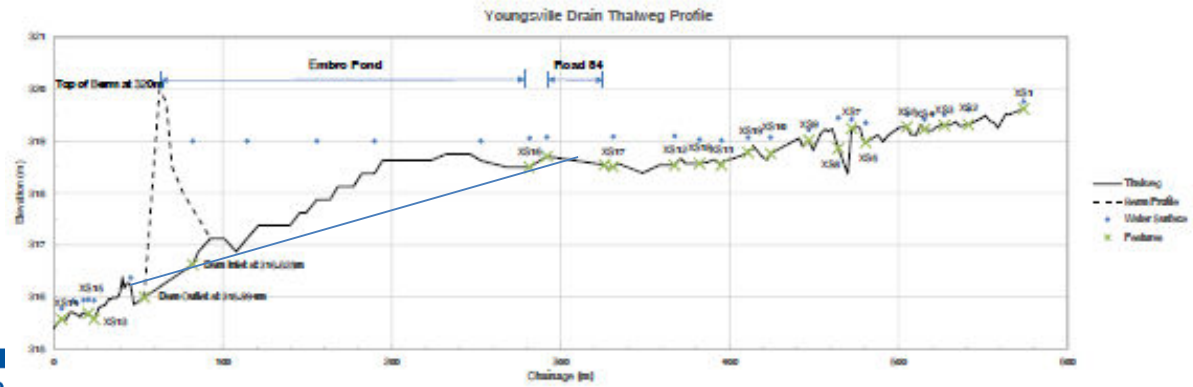


Pond Depth 1974

Pond Depth 2015

RG1

Estimated loss in reservoir volume 1965 – 2015 = 30% to 35%



UPPER THAMES RIVER CONSERVATION AUTHORITY

ecosystem ecovery inc. PROFESSIONAL ENGINEERS

Embro Dam Class Environmental Assessment

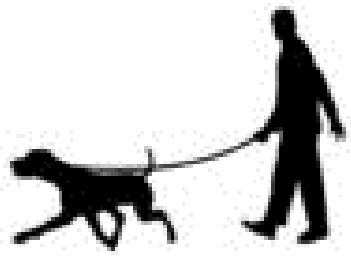
Slide 21

RG11 Rick Goldt, 3/17/2016

Observations about Recreation

UTRCA Staff noticed the following:

- Visitor Use? hiking, walking or birding
- Some dog walkers seen
- Reservoir not used much for fishing
- Most visitors come to baseball field
- Trails can be maintained with or without dam



Future Work

- More work needed on:
  - Reservoir depth
  - Sediment depth in reservoir
  - Stream profile surveys downstream to upstream
  - Stream flow levels to determine flow conditions
  - Log Water temperatures
  - Review wetland considerations
  - Cultural (recreation) / Archeology?

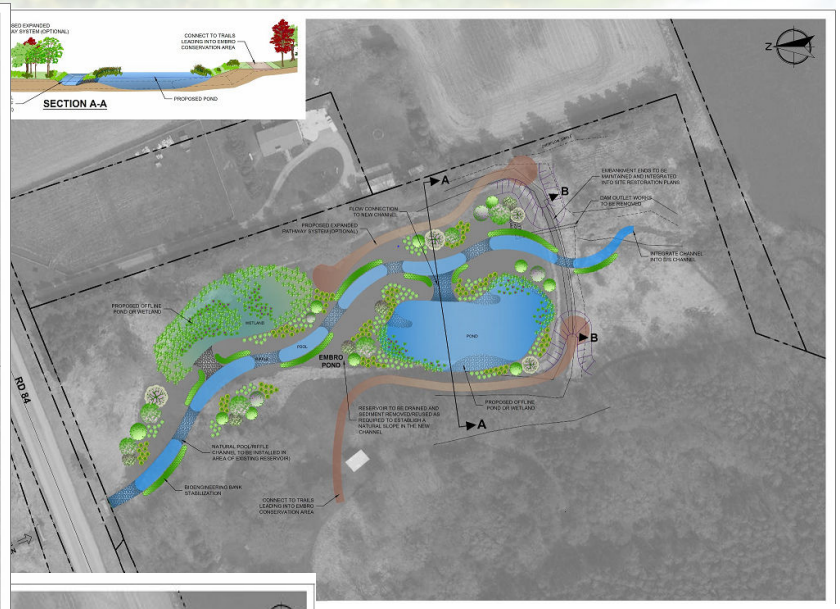
Remove Options

EMBRO DAM CLASS ENVIRONMENTAL ASSESSMENT

ALTERNATIVE 2
REMOVE DAM AND CONSTRUCT NATURAL CHANNEL

ecosystem recovery inc PROFESSIONAL ENGINEERS

FIGURE 4-2



Arran Elderslie

Federal money to remove Lockerby Dam

Thursday, October 23, 2014 9:52:46 EDT AM

The Lockerby Dam, located in rural Arran Elderslie, between Paisley and Chesley.

The Saugeen Valley Conservation Authority (SVCA) has been named the recipient of federal funding as part of the Recreational Fisheries Conservation Partnerships Program (RFCPP).

Bruce-Grey-Owen Sound MP Larry Miller announced the funding in a news release Monday afternoon.

The SVCA has been approved for funding up to $125,000 to support its project that involves the removal of the Lockerby Dam, which is located in the Municipality of Arran Elderslie.

In the news release, Miller said he is pleased to see the SVCA selected as a recipient for funding from the federal government.

"I am very pleased to see that the Saugeen Valley Conservation Authority was approved for funding through the Recreational Fisheries Conservation Partnerships Program to support the removal of the Lockerby Dam," said Miller. "I know that this has been an ongoing project for the SVCA and I am looking forward to seeing them move forward with this important project to support the local fishery."

"This funding will allow the Conservation Authority to move forward with communicating the project with the public, adjacent landowners, the Municipality and further, to determine an appropriate method of removal and final rehabilitation of the site to a natural state," said Wayne Brohman, general manager of SVCA.

The removal of the dam is something that the SVCA has been considering for a number of years. A report was completed in 2006 that recommended the removal of the dam and the rehabilitation of the reservoir.

The removal of the aging concrete dam, a current barrier for upstream fish migration, will improve the fish habitat both upstream and downstream with key improvements to water quality in the North Saugeen River.

Under the RFCPP, the Government of Canada partners with local groups to implement a variety of projects that restore, rebuild or rehabilitate recreational fisheries habitats in Canada. The RFCPP was announced as part of the 2013 federal budget, receiving $10 million over two years. The 2014 federal budget added $15 million to the program and extended it to 2016.

As a member of the Hunting and Angling Caucus, Miller was directly involved in lobbying for federal support for recreational fisheries and the inclusion of this program in the 2013 and 2014 budgets, the news release stated.

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Mildmay dam to be removed, South Bruce council decides

BY PAULINE KERR
Special to the WHT

South Bruce council has decided to move forward on the removal of Weiler Dam in Mildmay.

At an earlier meeting, council voted to accept "option four" as presented by the engineer, removal of the dam, but left further decisions to budget time.

Faced with the prospect of possibly losing funding of $135,000, council decided at the end of January, in a recorded vote, in favour of a letter committing the municipality to the project. The vote was unanimous. Council was told the federal government was pressing for a firm commitment of $25,000 for the project in this year's budget.

Council discussed it with the community group that has been conducting a search for funding, and remarked on the November, 2014 deadline that passed with no sign of anything concrete.

"They're still doing an ongoing search for funding; we're risking the funding we do have. Let's get on with it," Coun. Mark Goetz said.

The decision could still be appealed to the Ontario Municipal Board.

Option four includes removing the dam that forms Weiler Pond, and turning the space into attractive parkland. Council hopes to get community groups on board for that part of the project.

One of the key reasons for removing the dam is lack of support from the Department of Fisheries and Oceans, and the local conservation authority. As was determined in the environment assessment, the dam serves no useful function and removing the dam would actually restore the natural habitat.

Council is faced with the prospect of closing several bridges in need of a lot of work in the near future – bridges that are used daily. Council decided they could not justify the expense of replacing "an unnecessary structure."

Funding Considerations

2003 - Water & Erosion Control Infrastructure (WECI) Program (MNR)

- $5M 50% grants towards CA Studies and Repairs for existing infrastructure
- includes potential removal
- 900 structures – 250 dams, plus dykes, channels, erosion control
- No funding increase since 2013 - Priorities to Flood Control (life and property) w. other benefits, recreation structures now predominately without grants.

2014 (to 2016)- Recreational Fisheries Conservation Partnerships Program (RFCPP). Removal ~ 50%

Other - OMNRF Land Stewardship and Habitat Restoration Program
- WECI improved ranking opportunity for removal

Removal: Reporting – Community support - LRIA screening - Class EA, CEAA? – Plan – Remove / Restoration - Monitor - Adjust

Photos


WARNING
Area Subject to Flooding
Use At Own Risk
Fullarton Dam
In Emergency: 911
Information: (519) 451-2800
UPPER THAMES RIVER