Appendix A

Harrington Dam and Conservation Area Existing Environmental Conditions Report (includes appended report “Flow Characteristics of Harrington Creek at Harrington Dam and Youngsville Drain at Embro Dam”). Prepared by UTRCA, Updated October 2016

Harrington Dam and Conservation Area

Existing Environmental Conditions

Updated March 8, 2017

UPPER THAMES RIVER
CONSERVATION AUTHORITY

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Introduction

The Upper Thames River Conservation Authority in partnership with Zorra Township is undertaking an environmental assessment of the Harrington Dam under the Conservation Ontario Class Environmental Assessment process. This report describes much of the existing natural environment conditions for the Harrington Dam and Conservation Area. This report includes measurement, inventory, analysis, and observations undertaken by Upper Thames River Conservation Authority (UTRCA) resources during 2015 of streamflow, water quality, aquatic environment, natural heritage, cultural setting, and limited hydrogeological background information. Similar information is gathered and interpreted routinely by the Authority in support of watershed focused environmental efforts. Contributing local watershed context and historical information where available is brought forward for comparisons. Community contributions have been considered to date.

The information in this report will be considered in the presentation and analysis of alternatives for the Harrington Dam by the consultant. The consultant as contracted through the Terms of Reference for the overall Assessment has augmented the environmental information with further study of the physical environment and will interpret all the resources information collected.

Project Study Area

Harrington Dam and Conservation Area is on Harrington Creek which flows into the nearby Wildwood Reservoir. Harrington Creek is a tributary of Trout Creek, located in the Trout Creek watershed.

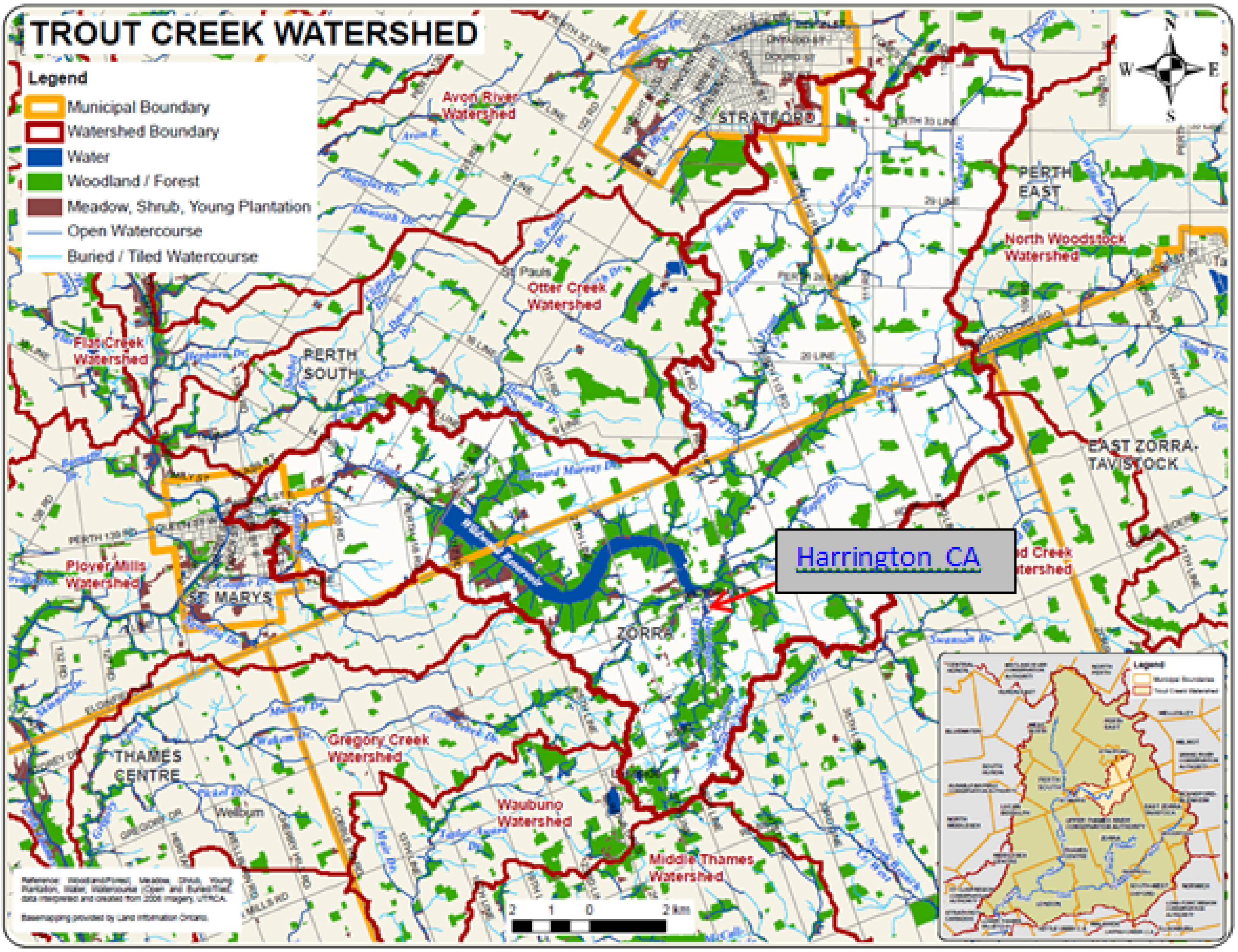

Figure 1: Trout Creek watershed with Harrington CA highlighted (Source: UTRCA)

The Trout Creek watershed drains an area of approximately 161 km^2 and is located in the centre of the Upper Thames River Conservation Authority watershed. Trout Creek outlets into the North Branch of the Thames River in the town of St. Marys. The watershed includes portions of the Townships of Zorra (44%), Perth South (32%), Perth East (22%), the Town of St. Marys (3%) and the City of Stratford (1%). Land use within the Trout Creek watershed is primarily agriculture (75%) with other land uses including natural vegetation (20%), urban (2%), water (2%), and aggregates (<1%).

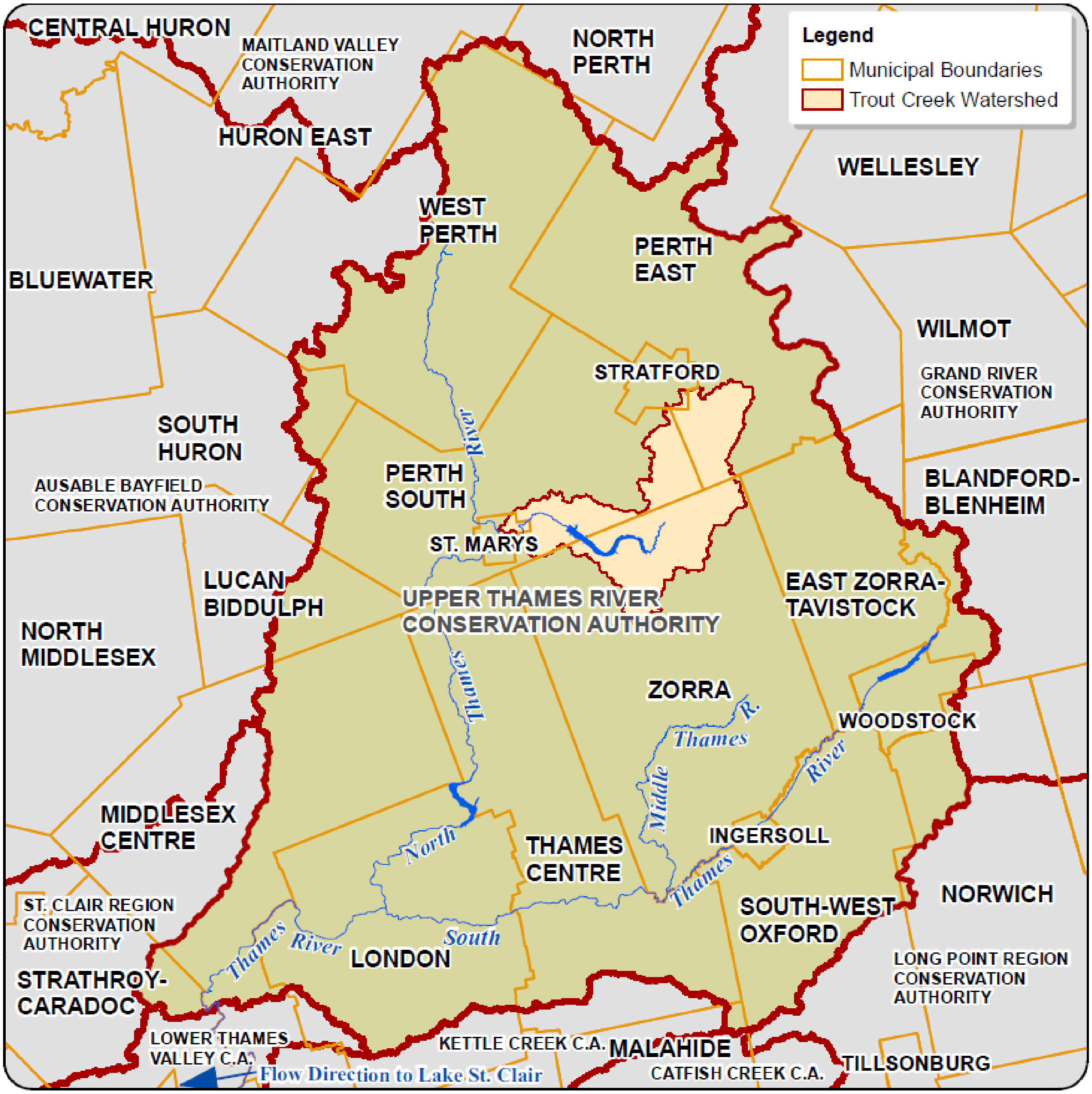

Figure 2: Trout Creek watershed in relation to the Upper Thames watershed (Source: UTRCA)

The study area for the Harrington Dam will include the lands within the Harrington Conservation Area (Harrington CA) and adjacent lands as necessary. Harrington CA is located on Oxford County Road 96 in Oxford County, Township of Zorra, Lot 30, Concession 2, as can be seen outlined on the map in Figure 3 below.

Harrington Conservation Area is a small conservation area (~ 4.9 hectares) and includes manicured grassland with a scattering of shade trees, a small conifer planting on the southeastern boundary, and a meadow/marsh community at the south end of the reservoir/pond. The reservoir/pond and Harrington Creek encompass about 0.8 – 1.2 hectares. A wildflower/prairie plot was planted in 2005 by the Upper Thames River Conservation Area (UTRCA) through the Communities for Nature Program.

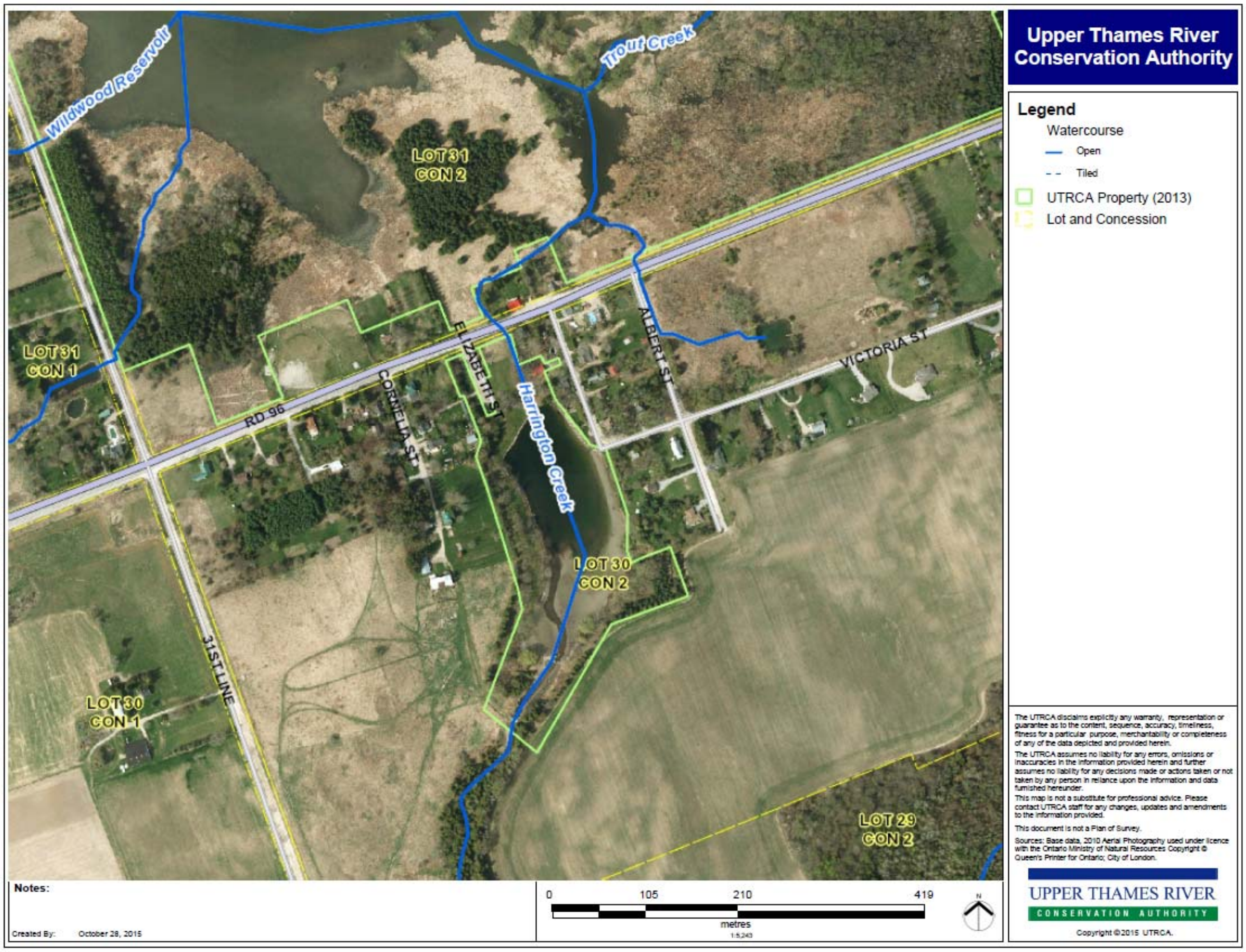

Figure 3: Harrington Conservation Area (Source: UTRCA)

Figure 4 shows the dams that exist upstream of Harrington CA. Dams labeled with a "POT" (potential) number have not been verified as to existence, whereas dams labeled with a "UT21" number are believed to have been surveyed at some point in the past. A Ducks Unlimited (DU)/UTRCA Dam exists downstream of the Harrington CA Dam within the Wildwood Reservoir and is currently under review by DU and UTRCA.

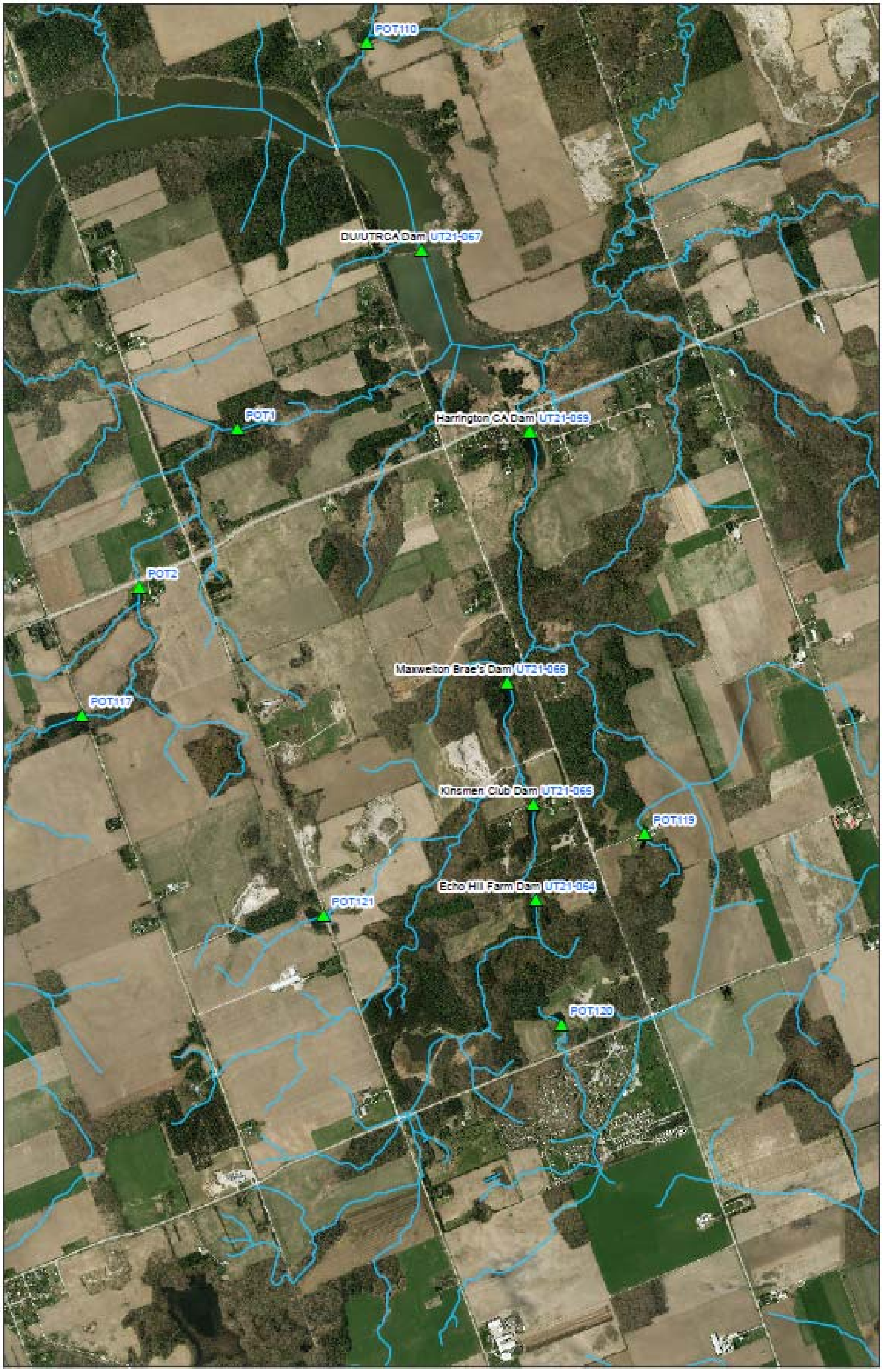

Figure 4: Location of dams upstream and downstream of Harrington Dam (Source: UTRCA)

Detailed information about various physical and biological features of the Harrington Dam and Conservation Area study is discussed below.

Trout Creek Watershed Action Plan

In late 2008, through funding from the Ontario Trillium Foundation, a Trout Creek Community-based Watershed Strategy was started. Residents of the Trout Creek watershed were involved in developing and implementing the watershed strategy. The strategy includes an action plan in which recommendations were made for restoration work to improve envrionmental health of the watershed. The Class Environmental Assessment for Harrington Dam may help to address some of the following recommendations that were made:

- Target priority areas identified in the Trout Creek watershed for rehabilitation
- Rehabilitate cold water streams to increase the number of streams able to support a cold water fishery and improve water quality downstream
- Approach landowners in the priority areas regarding participation in rehabilitation projects
- Continue to work with local municipalities, agencies, landowners, and commuity groups on exisiting rehabilitation projects in the Trout Creek watershed
- Involve secondary school students in the Trout Creek Watershed Report Card Program which examines forest conditions and surface water quality conditions

Flow Characteristics

To properly assess and design the different options that exist in regards to Harrington Dam it is necessary to understand the streamflow characteristics of Harrington Creek. These flow characteristics were studied and the details of this study are located in Appendix A: Flow Characteristics of Harrington Creek at Harrington Dam and Youngsville Drain at Embro Dam. The study determined that the 1248 hectare catchment area of Harrington Creek contributed greater unit area flow rates to the North Branch of the Thames River than other nearby tributaries such as at those monitored at the following stream gauge stations:

i) Trout Creek near Fairview
ii) Avon River above Stratford
iii) Fish Creek
iv) Trout Creek near St. Mary's

From May 24, 2008 – April 9, 2011, March 26, 2012 – September 12, 2012, and April 23, 2015 – August 28, 2015, the contribution of the flow measured downstream of Harrington Dam to the total flow out of the Trout Creek Subwatershed was 10.2%, 12.4%, and 10.5%, respectively. It was determined that Harrington Creek has a high resiliency to drought/low water as evidenced by a significantly smaller percent decrease in flow than that experienced at other watercourses in the watershed. Flow measurements during base flow conditions indicated that the flow upstream of the backwater effects of Harrington Dam was approximately 93% of the flow measured at the location downstream of Harrington Dam. Due to the low magnitude of the flows, the accuracy limitations of the flow velocity meter, and inflow to Harrington Creek in between the upstream and the downstream measurement locations, it is recommended that monitoring be continued to increase the confidence in assessing the flow characteristics Harrington Creek.

Hydrogeology

The UTRCA collected physical geography map information and well record information to describe general information on the hydrogeological setting of Harrington Conservation Area and the local area around the dam. Ministry of Environment and Climate Change (MOECC) well records were obtained. All information collected was transferred to the consultant Ecosystem Recovery Inc. for their analysis.

Topography, Geology, and Soils

The Harrington Pond catchment area includes Lakeside/Wildwood Complex (a provincially significant wetland), as well as Happy Hills and Lost Concession, two significant natural areas. Upstream of Harrington Pond is Harrington Creek, McCorquodale-Innes Drain, and Young Drain. Groundwater flow gradient is from the south to the north towards Wildwood Reservoir.

The following maps illustrate the physical surface and subsurface conditions and contribute to the understanding of surface and groundwater resources in the Harrington Creek catchment.

The general topographic setting of Harrington Conservation Area in the downstream reaches of the Harrington Creek catchment is shown on the map in Figure 5. Elevations on the Young and McCorquodale-Innes drains range between 375-380 m above mean sea level on the western reach of the drains, and are approximately 360 m on the eastern reach (boundary of the Mud Creek subwatershed), with a low elevation of 330 m at Harrington Pond.

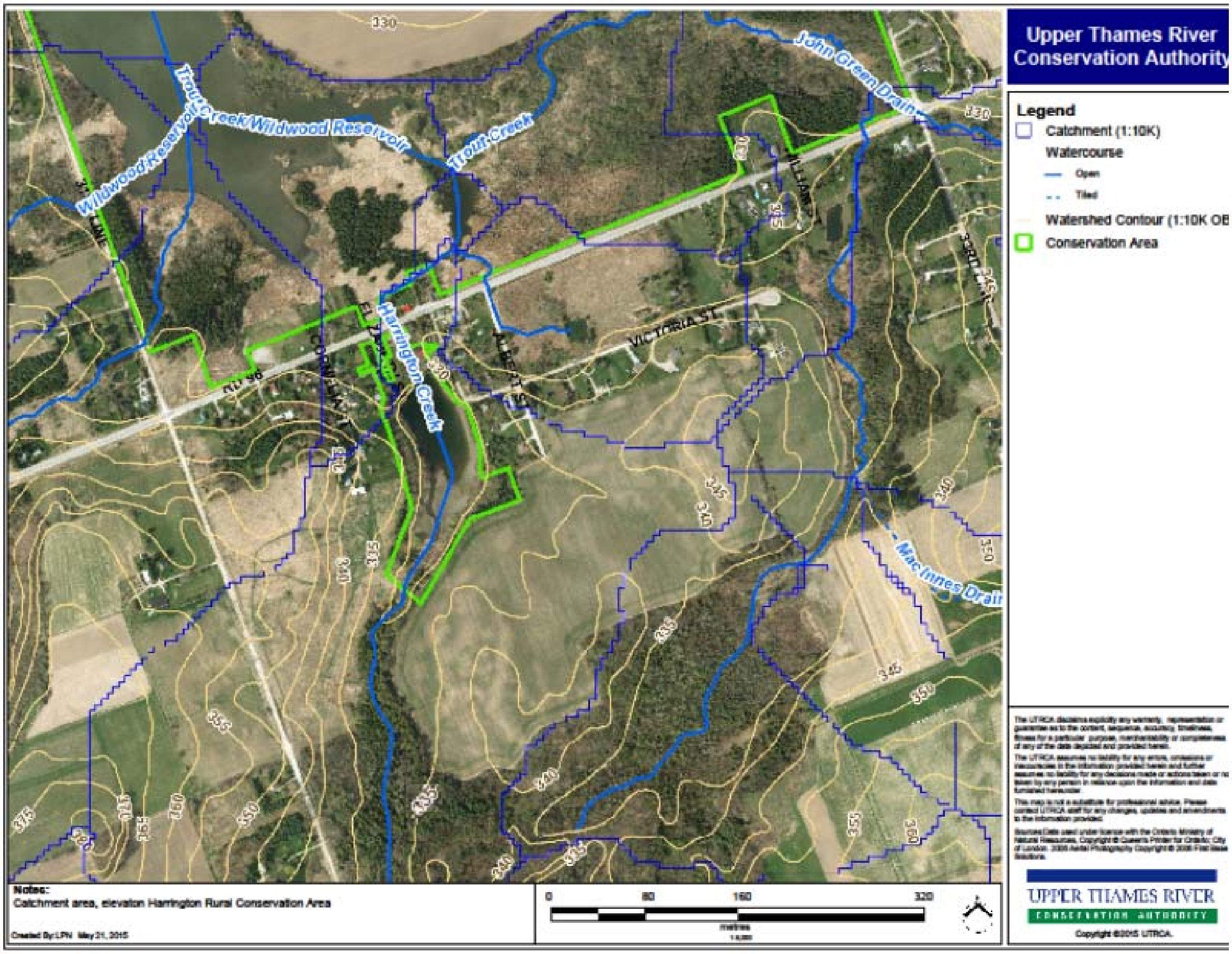

Figure 5: Catchment area and elevation of Harrington CA (Source: UTRCA)

The catchment area is characterized by sandy soils that extend from the southern to northern end of the area, with gravel in the northwestern edge. The sandy soils that dominate the catchment area suggest high infiltration and high groundwater recharge.

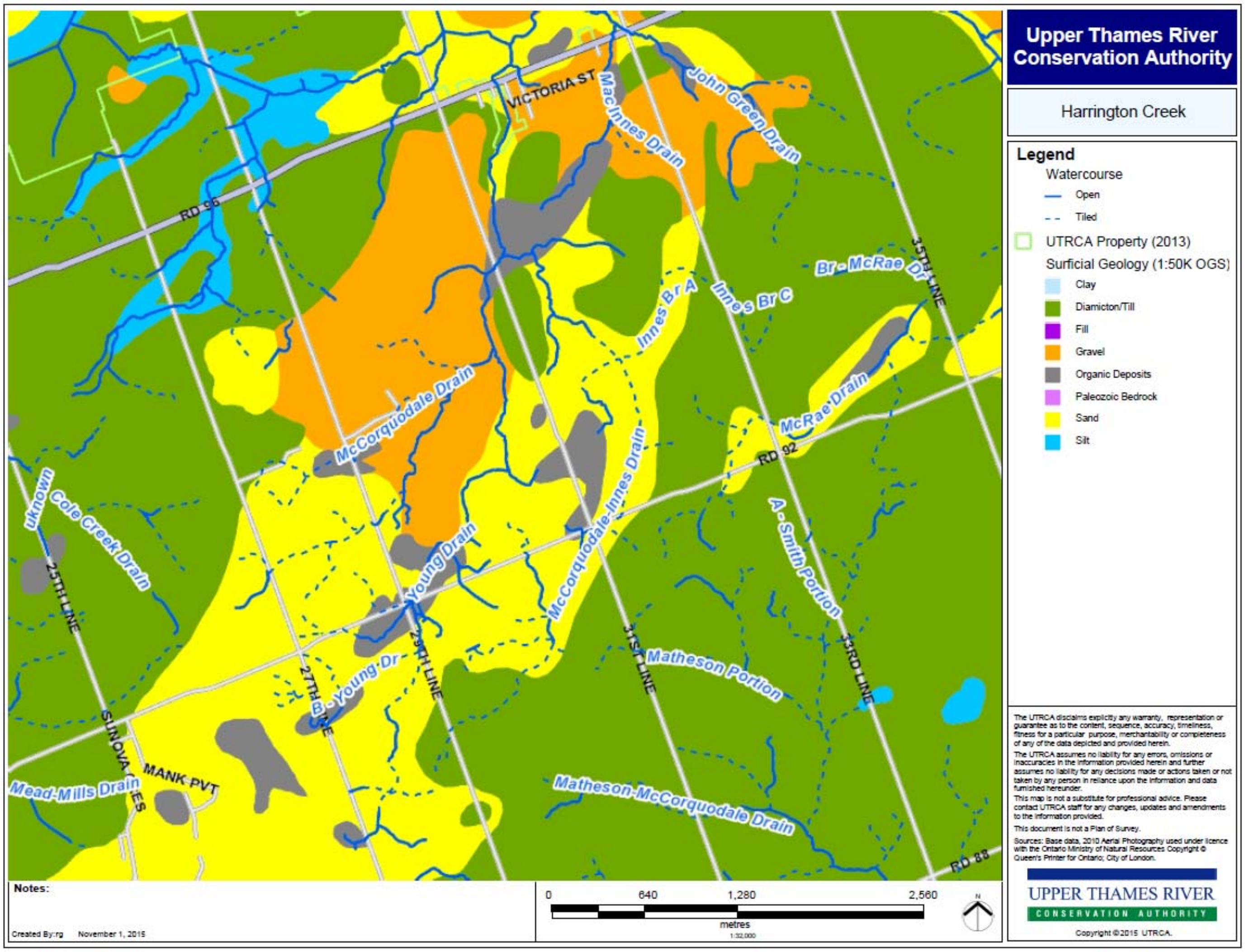

Figure 6: Surficial geology of the area around Harrington CA (Source: UTRCA)

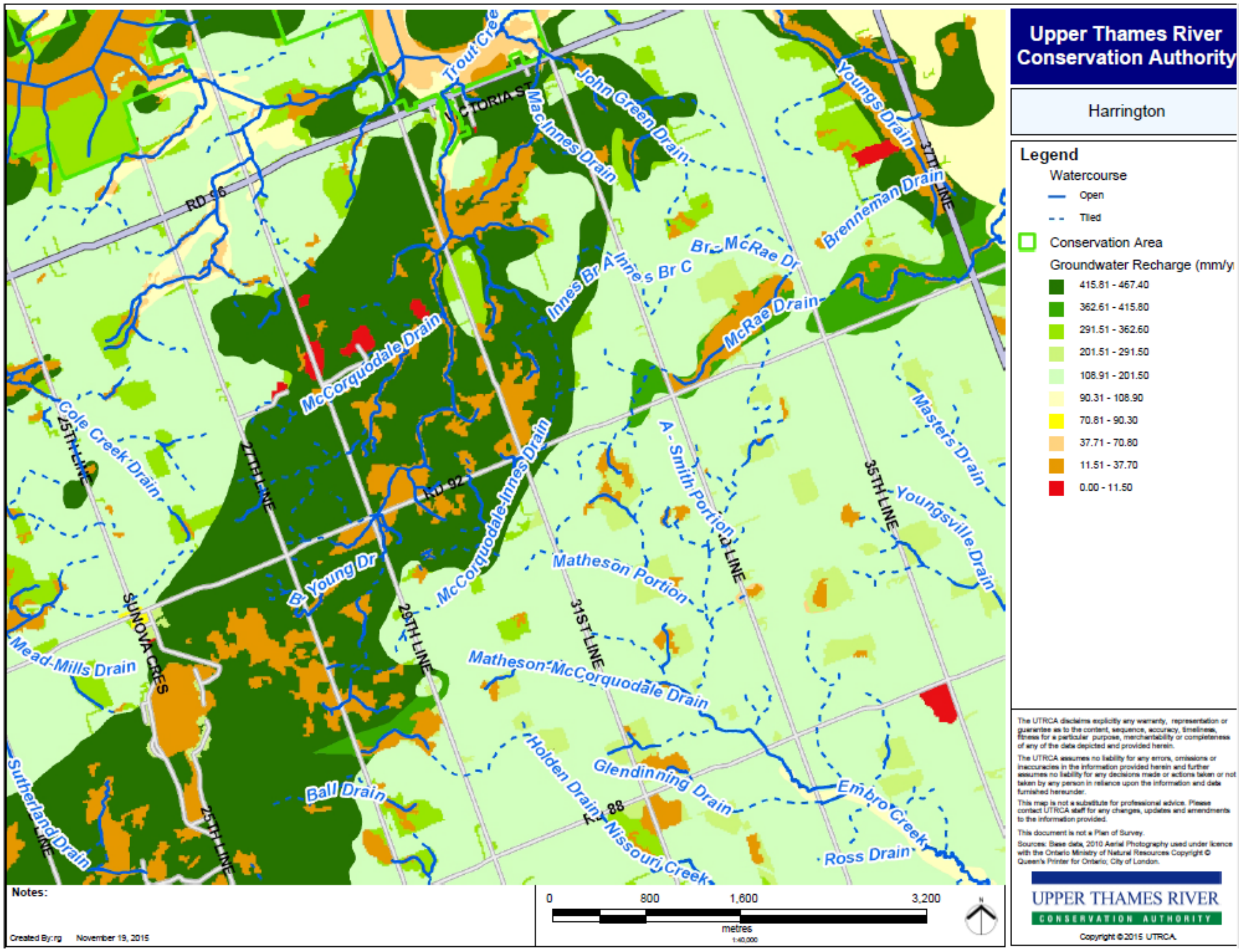

Figure 7: Groundwater recharge (mm/y) of the area around Harrington CA

Private Well Survey

All background information and individual well records were retrieved from the Ministry of the Environment and Climate Change (MOECC) and provided to Ecosystem Recovery Inc. for analysis by their sub-consultant Englobe (formerly LVM). Figure 8 shows the locations of the known wells in the area. The well location information suggests that some residences may share or do not have documented wells. The wells shown on the Harrington Dam are Bore Holes for the past Dam Safety investigations.

Figure 8: Known wells in the area of Harrington CA (Data Source: MOECC)

Surface Water Quality

A series of five water samples were collected at four locations in the area of Harrington CA: one upstream of the pond, two in the pond, and one downstream of the dam (see map in Figure 9). This monitoring provides a snapshot of water quality, and is limited to the conditions of April to October 2015. Harrington Pond also had one year of historical data from 1989, which has been included in the evaluation of the results, which can be found in Appendix B: Harrington Pond Water Quality Assessment.

Figure 9: Harrington Pond Water Quality Survey Sites 2015 (Source: UTRCA)

Most 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. There was some variation in flow based on minimal rain but only one date had rain with full runoff conditions (June 1) and one date had rain with partial runoff conditions (October 9).

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 using dataloggers recording in half hour intervals.

In general, the water quality in the Harrington-West Drain, where it was sampled upstream, downstream and in Harrington Pond, showed general low levels for the parameters measured in 2015 with numbers typically better than the average seen in the Upper Thames watershed streams. The headwaters of this area which includes a significant wetland complex and natural areas would likely contribute to the good quality of this stream.

The results for 1989 and 2015 were very similar for all parameters with the exception of nitrate which is slightly higher in 2015 compared to the 1989 data.

Temperature differences are apparent between upstream and downstream of the pond based on continuous measurements and show a greater difference as the summer progressed, likely as a result of the warming effect of the pond.

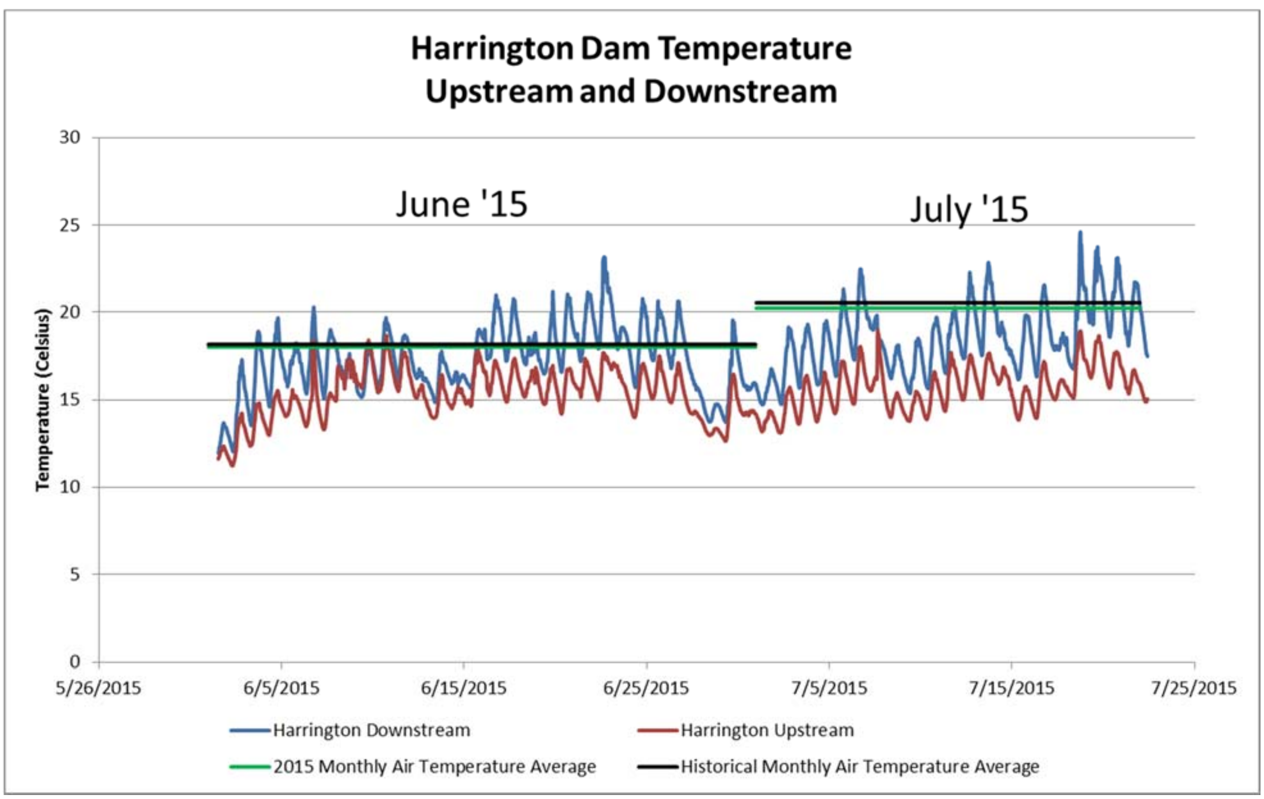

Figure 10: Harrington Pond Continuous Temperature Upstream and Downstream, Summer 2015 (Source: UTRCA)

Stream temperature data for June and July 2015 were taken during periods in which the monthly air temperature averages (ref. Environment Canada – London Airport) were similar to historical monthly air temperature averages.

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. Sampling of the bottom sediments would give an indication of any accumulation.

Aquatic Ecology

Electrofishing and benthic surveys were carried out during the spring, summer, and fall of 2015. The map in Figure 11 shows the different sampling sites. A list of recorded fish and benthic species, separated by sampling location, is provided in Appendix C: Harrington Dam area Fish and Benthic Records.

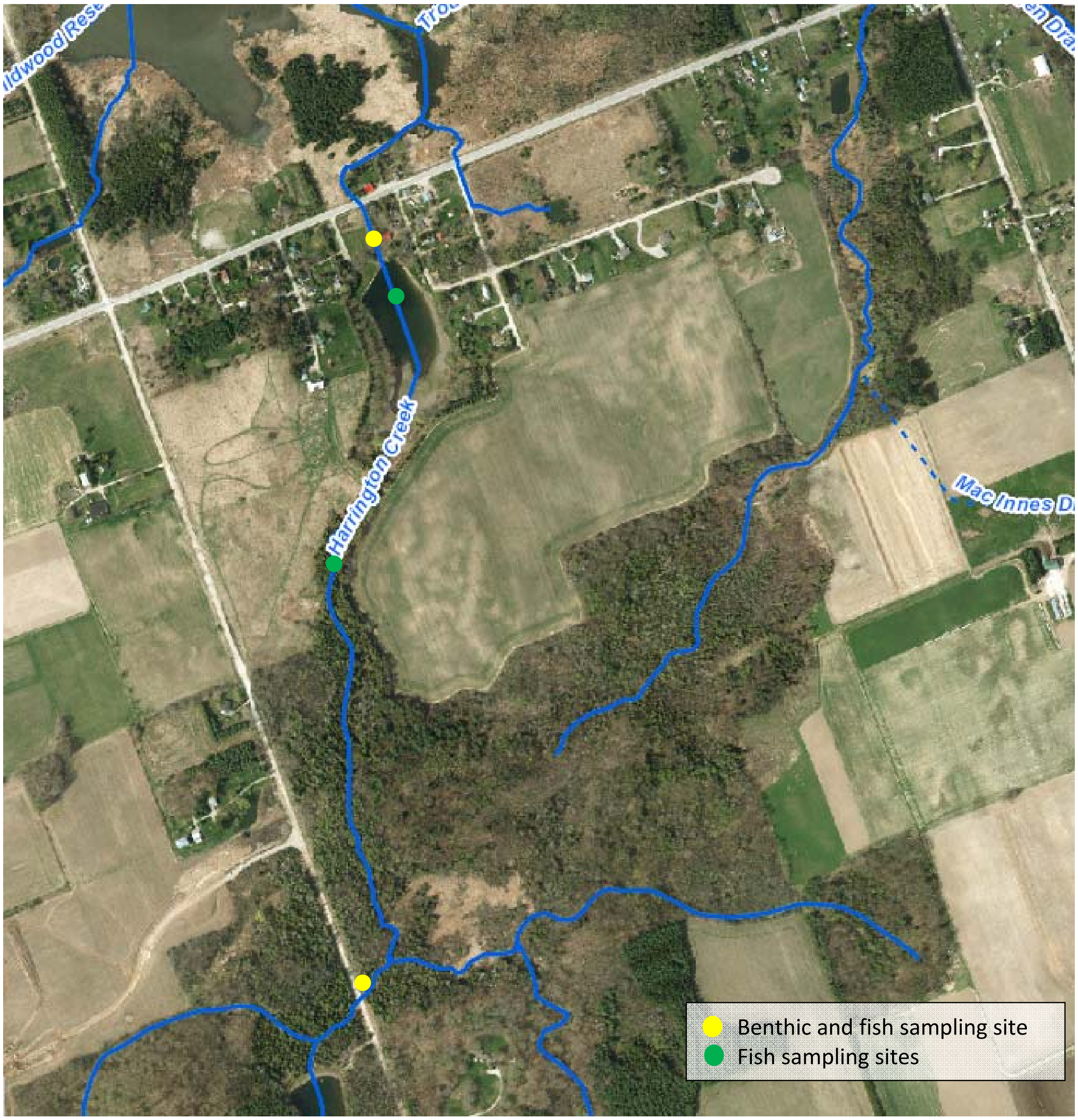

Figure 11: Harrington Dam area Benthic and Fish Sampling Sites (Source: UTRCA)

Fisheries Resources

An electrofishing survey of the Harrington Pond as well as upstream of the pond and downstream of the dam was conducted on April 15, 2015. The area downstream of the dam was surveyed again July 22, August 16, and October 19, 2015, while two upstream sites were sampled again November 11, 2015. All specimens were identified to species, recorded, and released. Sample records, including historic records, are tracked in an MS Access database and provided in Appendix C: Harrington CA Fish and Benthic Records.

Brook Trout and Mottled Sculpin were recorded upstream of the dam in 2015 as well as in previous years, indicating that Harrington Creek does offer suitable habitat for cold water species. Adult Rainbow Trout (remnant from fish derby stocking), Brook Trout, and sculpin found below the dam indicate that the numerous seeps counteract the warming effect of the pond creating pockets of cool water habitat where these individuals are surviving.

The stream reach below Harrington Dam appears to provide both permanent and seasonal habitat for warm water species. Most of the minnow and darter species are likely year-round residents while game fish such as Large and Smallmouth Bass, Northern Pike, and Yellow Perch appear to be seasonal residents. The presence of many young-of-the-year of these species in summer samples indicates this is valuable spawning and nursery habitat and an important source of recruitment for Wildwood Lake game fish. Other species likely to be spring and summer residents only include Common Carp and sucker and bullhead species. While adults have been found below the dam the absence of young-of-the-year of Rainbow Trout, Brook Trout, and Sculpin below the dam suggests that some individual adults of these cold water species likely passed over the dam and then were unable to move back upstream due to the dam. On the downstream side of the dam small breeding population numbers and unfavourable habitat conditions then become limiting factors preventing successful reproduction downstream of the dam.

Over the years our fish data has consistently indicated that there is a difference in species diversity upstream and downstream of the dam. Upstream the number of species found is low, only seven. Downstream species diversity is much higher with 30 species having been recorded. The species lists can be found in Appendix C. The low species diversity upstream is fairly typical of trout dominated systems but also likely reflects the impact of the barrier to fish movement presented by Harrington Dam. Should the dam be removed we would expect the coldwater species to utilize a larger proportion of the creek. On a seasonal basis they would utilize more of the downstream habitat for feeding. UTRCA aquatic biology staff have observed that some of the largest Brook Trout specimens, in the UTRCA watershed, have been found on other watercourses where Brook Trout have unrestricted access to healthy prey populations, such as those found upstream of Wildwood Lake. That suggests that removal of the Harrington dam would benefit the local Brook Trout population.

During a mid-May (5/14/2015) visit to Harrington CA, extensive carp spawning activity was observed in the shallow upper parts of the pond, indicating that the pond supports a large population of this invasive species. A lack of aquatic macrophyte growth and high turbidity levels also likely can be attributed to the carp population. As Common Carp prefer warm, vegetated areas of slow moving rivers and lakes the current conditions in the pond upstream of the Harrington Dam provide ideal conditions for Common Carp. A natural channel design, with water flowing through riffles and runs is not ideal carp habitat.

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 found in Table 1.

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

Table 1: Water quality ranges for FBI values

Benthic invertebrate sampling was conducted in the spring (May 8) and fall (September 23), 2015, at a site upstream of Harrington Pond and at a site downstream of the dam. 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. Sample records (including historic records) with calculated Family Biotic Index (FBI) are provided in Appendix C: Harrington CA Fish and Benthic Records.

For the two 2015 samples, the average FBI upstream of the pond was calculated to be 5.11, indicating "fair" water quality, and 6.22 downstream of the dam, indicating "fairly poor" water quality. The pollution sensitive taxa (caddisflies and stoneflies) found above the pond are replaced by very pollution tolerant taxa, primarily aquatic worms, below the dam, indicating a dramatic pond impact on water quality.

Only one historic downstream sample exists, with an FBI = 5.40, indicating "fair" water quality, but sampling has occurred extensively at the site upstream of the pond since 1997, with an average FBI = 5.37. This value is considerably better than the long term UTRCA average of FBI = 5.99, as well as the average of UTRCA 2015 sites evaluated to date of FBI = 5.68. A value of FBI = 6.17 was calculated for the 2012 Trout Creek Watershed Report Card (the catchment in which Harrington Creek is located). Harrington Dam, therefore, lowers Trout Creek water quality rather than improving it as unencumbered flows would do.

Benthic Sample Location	**Spring 2015 FBI**	**Fall 2015 FBI**	**Average FBI**	**Water Quality**
Harrington Creek upstream of Harrington Pond	4.68	5.53	5.11	Fair
Harrington creek downstream of Harrington Dam	6.73	5.71	6.22	Fairly poor
Trout Creek watershed 2012	N/A	N/A	6.17	Fairly poor
UTRCA watershed 2015	N/A	N/A	5.68	Fair
Provincial Guideline (target only)	N/A	N/A	< 5.00	Good

Table 2: Comparison of FBI values for Harrington CA, Trout Creek and UTRCA watersheds (Source: UTRCA)

Vegetation and Wildlife Inventory

This study examined the vegetation and bird and other wildlife at Harrington CA to determine the habitat quality and to flag any rare or sensitive species or communities that might be impacted if the Harrington Dam and reservoir area were changed.

A three-season botanical inventory was completed in 2015 of this 5 ha site. Of the 219 plant species found, 40% are non-native, which is average or moderate for similar sites in the Upper Thames watershed. While the diversity of plants is quite large for a small site, the overall quality of the vegetation communities is moderately poor to average. No species-at-risk or rare or uncommon species were found that would be a limiting factor to future site works or conservation area changes. Overall, the quality of the vegetation, which is a diverse mix of small habitat types, is rated as moderately poor to average.

The Harrington Pond/Reservoir itself does not support any native rooted aquatic plants, though there is sparse cover of a non-native pondweed. The reservoir has only a narrow fringe of wetland emergent plants along the southern edges. The large population of Common Carp in the reservoir is likely a cause as these fish muddy the water and uproot plants. The wetland emergent plant species found along the pond's shores are common along flowing waterbodies and in wetlands in the area. Many of these plant species would likely naturally re-establish along Harrington Creek and would not be a limiting factor to future site changes.

Harrington CA is within 100 m of a Provincially Significant Wetland known as the Lakeside Wildwood Complex. Thus, construction activities need to consider impacts on the wetland. It is likely that many wildlife species travel between the wetland and Harrington CA due to the close proximity. Only the treed edge (southeast edge) of Harrington CA is part of a larger significant natural heritage feature as defined by the Oxford Natural Heritage System (ONHS 2006). The remainder of the CA (pond/day use area) is not part of that feature. Neither the Provincially Significant Wetland nor natural heritage feature designations would be limiting factors to future site changes.

A three season bird survey was undertaken in 2015 as well. The 42 species of birds recorded in the CA are mostly common breeding or permanent residents of the area. One species-at-risk, the Barn Swallow (Threatened), was seen in Harrington CA, but there was no evidence of breeding within the CA. The reservoir or other parts of Harrington CA do not provide critical habitat for any sensitive bird species. Use of the pond by native waterfowl seemed to be on an occasional basis for feeding and resting versus nesting and rearing young. The fish biomass in the pond is largely unavailable to fish-eating birds such as kingfishers and herons due to the size of the fish (i.e., large, mature carp dominate).

While no sensitive wildlife species were recorded by the biologists, there have been reports from the public that Snapping Turtles use the reservoir. The Snapping Turtle is a species of Special Concern. Should the dam be removed, a slow, summer-time drawdown of the reservoir should safeguard any individuals by allowing them to move into nearby stream habitats, and ultimately, back into the restored creek within Conservation Area.

Other species noted by the public were Milksnake and Eastern Bluebird. Neither are Species at Risk and do not rely on ponds, instead preferring fields and forest edges. Concern was also noted by the public regarding the impact of dam removal on other wildlife such as Mute Swan (non-native), beaver or muskrat, and eagles. Many of these species are not exclusive to ponds and can carry out their functions in stream habitats. During planning for any projects these species can be further investigated as to existence, location, use of the Conservation Area, and avoidance, habitat protection or creation during the time before in field works are undertaken. Specific periods of construction during nesting or rearing could be avoided.

In conclusion, there are no sensitive plants, plant communities, birds or wildlife that would be threatened from changes to the environment in Harrington Conservation Area.

A detailed report of the vegetation, bird, and other wildlife inventory can be found in Appendix D: Harrington Conservation Area Vegetation and Bird Inventory 2015.

Cultural

History of Study Area

In a document that speaks to the history of the Harrington area, titled "Class of 1840", a story is told about two young men that arrived in Zorra Township in 1802, which at that time was "almost a solid wilderness", to search out a home. The men rested a night on a "…spring creek of clear water (that) flowed northward through the spot and it is known today as the village of Harrington". The men also interacted with residents of an "Indian camp that was twenty rods down the valley by the creek" (Rounds, 1990).

The village of Harrington was created in 1855, though the original grist mill was established years before, in 1846. According to the "Gazeteer and Directory of the Counties of Oxford and Norfolk and Woodstock, 1867", Harrington contained a handful of shops and a church, along with the mill (Rounds, 1990).

The area that comprises the current Harrington Conservation Area was historically privately owned by a few different landowners prior to being purchased by the Upper Thames River Conservation Authority. A summary of the chronology of the conservation area, which includes the mill and dam, is as follows (Upper Thames River Conservation Authority, 1973 and 2010):

- The original mill was built in 1846 by a man named Demerest
- The mill was purchased by Mr. Robert Duncan in 1920. The mill was destroyed by fire in 1923 and was replaced that same year.
- In 1948, Milton Betteridge suggested that the Harrington dam site be acquired as a conservation area. Inspection of the property by UTRCA representatives revealed the 10.7 meter spillway had been undermined and washed away. Works to repair the dam plus enlarge the pond from 1.6 to 3.2 hectares were estimated to cost approximately $10,000.
- In 1952, almost 5 hectares of property was purchased by the UTRCA, including the dam and pond (owned by Mr. Duncan) and adjoining property owned by Mrs. Levi Nimock and George Robinson. Work started in July of 1952 to repair the spillway and enlarge the pond. Work was completed by the end of that same year.
- Provincial operating funding support for recreation dams was cut in 1995. The Township of Zorra now contributes 100% of the dam operating costs.
- In 1966, the Authority purchased the mill from Mr. Duncan.
- The mill was in continuous operation from 1846 to 1966, except for a brief period of time in 1923 when it succumbed to fire, and two other times when the mill dam broke (1903 and 1949). A diesel engine was used in the latter years of the mill's operation when the water supply was too low to operate the turbine.
- In 1999, the UTRCA entered into a lease agreement with the Harrington and Area Community Association (HACA) for the long-term restoration of the mill and the maintenance of Harrington Conservation Area grounds.
- The Harrington Dam was overtopped twice in the summer of 2000 with subsequent repair work performed on the downstream embankment slopes adjacent to the spillway.

Current Uses

Harrington Conservation Area is a "Day-Use Only" area, with current uses including hiking, birding, fishing, and picnicking. In early 2015, a 1.5 km hiking trail was created around the pond. Harrington CA has been a fishing and picnic area for generations; a yearly fishing derby for children is presented by the Tavistock District Rod and Gun Club (the pond being stocked with various sizes of rainbow trout for the occasion), and HACA holds an annual BBQ as a fundraiser for the restoration of the mill.

Since 1999, HACA has worked to restore the grist mill from 1923, and currently offers tours upon request. Over $100, 000 has been raised by the Harrington Community for these restoration efforts. The community association is interested in having the mill function using water power as it did in the past.

In July 2015, a "Memorial Tree Sign" was unveiled within the Harrington CA. Through a new program run by the Township of Zorra, in the future, memorial trees purchased through UTRCA may be planted within the CA.

Other Uses

The Township of Zorra has investigated potential uses of water sources in Harrington Conservation Area for firefighting purposes in the area to establish a year –round source. While use of the existing well was examined it was not preferred due to costs and a more likely source would be a reservoir or holding tank. The Township Fire Chief has indicated that the Township would await the outcomes of the EA (Pers. Comm. Zorra – UTRCA, 2013-15).

Bibliography and reference documents

Jones, N.E. 2011. *Benthic Sampling in Natural and Regulated Rivers. Sampling Methodologies for Ontario's Flowing Waters*. Ontario Ministry of Natural Resources, Aquatic Research and Development Section, River and Stream Ecology Lab, Aquatic Research Series 2011-05. Retrieved from https://dr6j45jk9xcmk.cloudfront.net/documents/2668/stdprod-103416.pdf.

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Rounds, Sharon F. 1990. *Class of 1840.*

Upper Thames River Conservation Authority. July 2010. *Trout Creek Community-based Watershed Strategy, Watershed Action Plan*. Retrieved from http://thamesriver.on.ca/wp-content/uploads//TroutCreek/TroutCreek-WatershedActionPlan.pdf

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

See the following reference documents:

Harrington Dam Safety Review HATCH, 2007

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

Appendices

Appendix A: Flow Characteristics of Harrington Creek at Harrington Dam and Youngsville Drain at Embro Dam

Appendix B: Harrington Pond Water Quality Assessment

Appendix C: Harrington Dam area Fish and Benthic Records

Appendix D: Harrington Conservation Area Vegetation and Bird Inventory 2015

Appendix E: Historic Harrington Dam and Conservation Area News Articles

Appendix A

Flow Characteristics of Harrington Creek at Harrington Dam and Youngsville Drain at Embro Dam

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Updated October 13, 2016

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Purpose

To properly assess and design the different options that exist in regards to Harrington Dam and Embro Dam it is necessary to understand the streamflow characteristics of the water courses that pass through these water control structures. This report informs of the methodology, calculations, and data that has been collected to date for the Harrington Creek at the Harrington Dam and the Youngsville Drain at the Embro Dam. This report will also provide an analysis of the collected data as it relates to different stream flow characteristics including:

i) The average flow rates and the unit area flow rate of each catchment area
ii) The response of each stream to drought and low water conditions
iii) The contribution of each stream to the overall flow out of its subwatershed
iv) The effect of the water control structures on upstream and downstream flow rates

Stream flow response under flood conditions has not been evaluated in this report. Flood information is available in the respective Dam Safety reports for each dam.

Stream Flow Measurement Methods

Harrington – Stream Flow Measurement

In 2008, a HOBO data logger was installed on the pier of the Road 96 bridge in between Elizabeth St. and Victoria St. A pressure sensor in the unit measures the absolute pressure exerted upon it and the logger records this measurement every 15 minutes. Using barometric (atmospheric) pressure data from the London International Airport, pressure to head calculations, and in field measurements of water levels at the logger, it was possible to create a time series record of the water level in Harrington Creek at the location of the bridge pier.

The data logger recorded absolute pressures from:

i) May 24, 2008 – April 9, 2011
ii) March 26, 2012 – September 12, 2012
iii) April 23, 2015 – August 28, 2015

Irregular results were observed in the Harrington logger data from:

i) Nov. 11, 2008 – Mar. 11, 2009
ii) Dec. 5, 2009 – Mar. 23, 2010
iii) Nov. 20, 2010 – April 9, 2011

These irregular results were omitted from the water level calculation and the subsequent calculation and analysis of flows. The omitted irregular results coincided with colder water temperatures (<5^{o}C) and the time periods where snow and/or freezing could be expected. These winter conditions are considered to be the probable cause of the irregular logger readings.

A cross section approximately 20 – 30 m downstream from the bridge, in a stretch relatively clear of in-stream obstacles and eddies, was used to measure the flow of Harrington Creek downstream of the dam. A measuring tape was staked on both sides of the creek and was orientated perpendicular to the flow direction. A sliding depth gauge rod was used to measure the depth of the creek and to position the sensor of the Marsh McBirney 2000 Flo-mate velocity meter at 60% of the stream depth. A measurement was made approximately every 20 – 25 cm horizontally across the creek depending on the characteristics of the channel bed and the stream flow. At each measurement the stream depth, velocity at 60% of the stream depth, and the horizontal distance across the cross section was measured and recorded. The mid-section method, the primary method for calculating flows by the United States Geological Survey, was used to calculate the flow in Harrington Creek.

From July 2010 to August 2015, the field measured flow rate of Harrington Creek and the corresponding water level on the bridge pier staff gauge was recorded a total of ten times in a variety of high, low, and average flow conditions. Additionally on June 11, July 22, and August 28, 2015, the flow rate was also measured at cross sections 80 m upstream from the farm crossing South of Harrington Pond.

The location of the cross-sections where stream flow was measured at Harrington is indicated below in

Figure 1. The total catchment area for the most downstream cross section with the largest number of flow measurements is illustrated in Figure 2.

Figure 1: Locations of Cross Sections Used for Stream Flow Measurement at Harrington

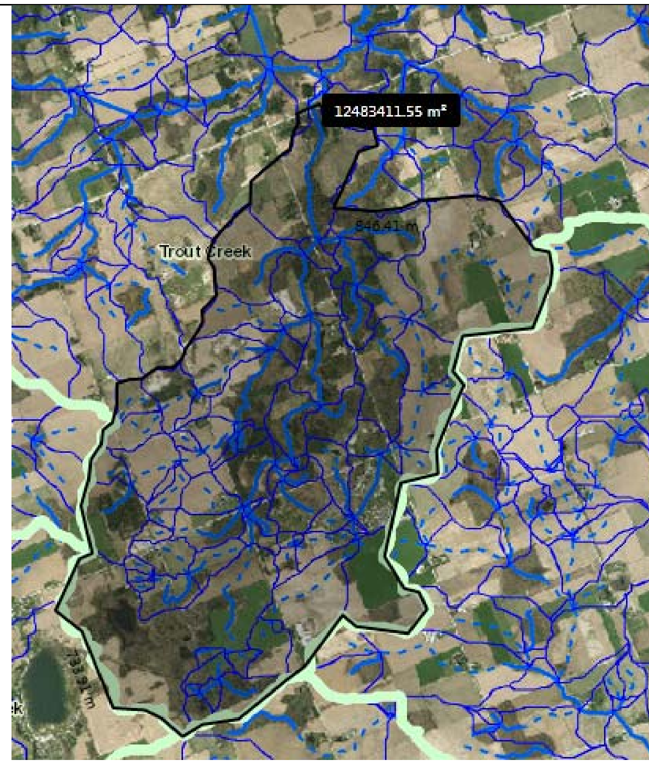


Figure 2: Catchment Area for Harrington Logger

A rating curve was developed to indicate the relationship between the stream flow measured at the most downstream cross section and water level at the Road 96 Bridge Pier; this relationship would allow the conversion of the time series of water level data into a time series of flows. It was determined that there was a logarithmic relationship between the stream flow in liters per second (L/s) and the water level in meters (m).

The observed water levels on the staff gauge and the measured flows have been provided in Table 1 and the rating curve has been provided in Figure 3.

Table 1: Observed Stage (m) and Measured Flow (L/s) of Harrington Creek by Road 96

Stage (m)	Flow (L/s)
0.140	120
0.150	120
0.170	150
0.180	150
0.182	200
0.190	180
0.220	250
0.230	280
0.275	480
0.309	680

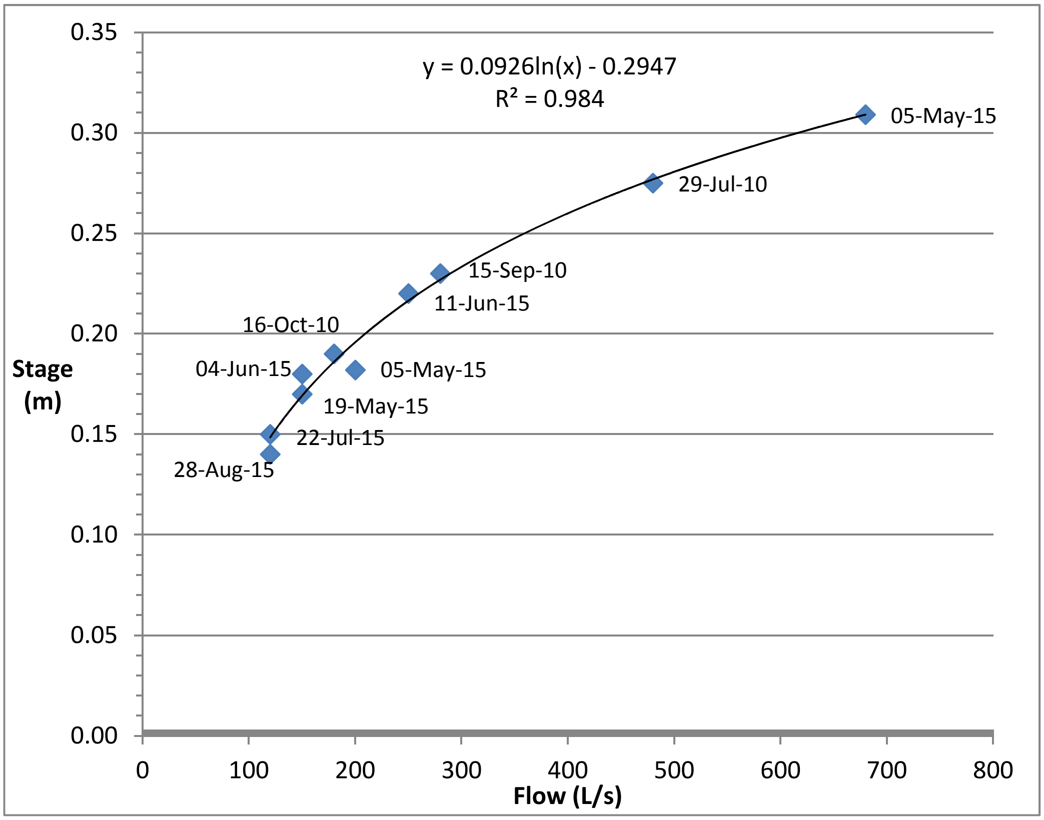


Figure 3: Rating Curve of Harrington Creek by Road 96

To determine the average unit area flow rate the average flow rate from the flow time series was divided by the total catchment area for Harrington Creek at the cross-section 20-30 m downstream of Harrington Dam. The catchment area was approximately 1,248 hectares (ha). The catchment area was determined using contour maps, tile drainage maps, outlines of subwatersheds, and the UTRCA Mapviewer calculator.

Embro – Stream Flow Measurement

There is no HOBO data logger or stream gauge to produce a record of pressure from which a time series of the water level or a time series of flows could be derived. There is also no staff gauge present at Embro which prohibits the development of a rating curve. A series of flow measurements were undertaken at Embro in conjunction with flow measurements at Harrington. The flow measurements at Embro were performed in the same manner as previously described for Harrington. The flow measurements were performed at a cross section approximately 25 m downstream of the outlet for Embro Dam. Additionally on June 11, July 22, and August 28, 2015, the flow rate was also measured at a cross section upstream of Embro pond, approximately 100 m upstream from the culvert on the North side of Road 84.

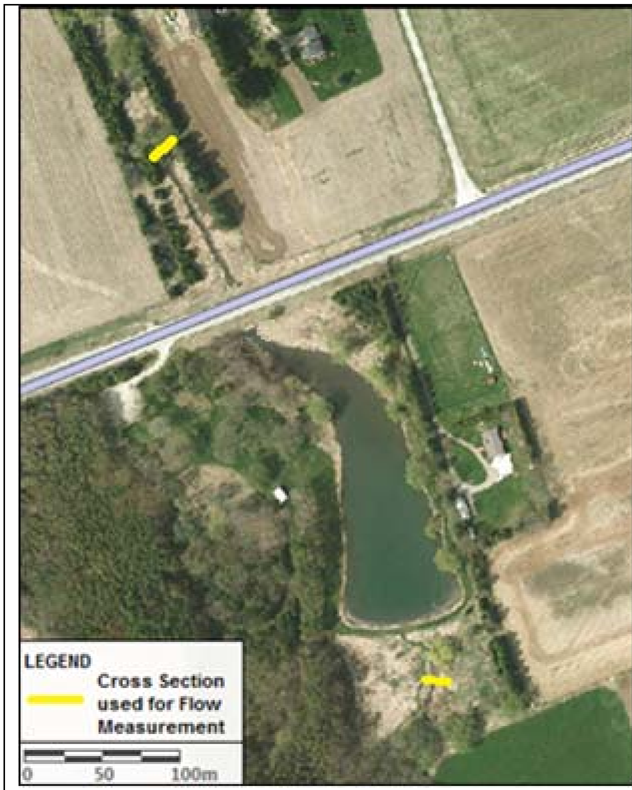


Figure 4: Locations of Cross Sections Used for Stream Flow Measurement at Embro

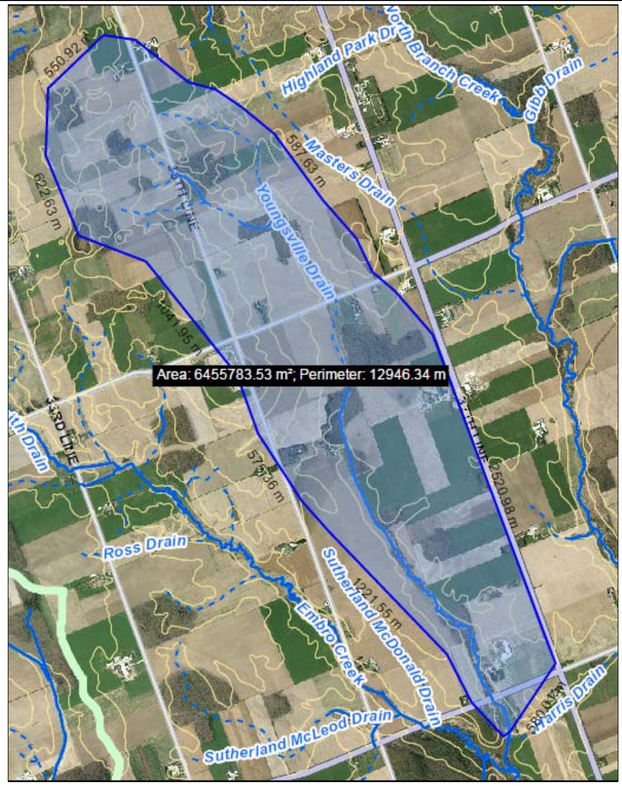


Figure 5: Catchment Area for most Downstream Cross Section at Embro Dam

The measured flow rate downstream of Embro Dam and the date of the measurement has been provided in Table 2.

Table 2: Measured Flow Rates (L/s) at Cross Section Downstream of Embro

Date	Embro Flow (L/s)
04-Jun-15	110
11-Jun-15	130
22-Jul-15	80
28-Aug-15	90
24-Sep-15	80

Analysis and Results

Harrington – Average Flow Rates and Unit Area Flow Rate

Times series flow data was used from other stream gauge monitoring stations to allow the comparison of the flow downstream of Harrington dam to the other flows from different catchment areas. A number of factors were considered when selecting which stream gauge monitoring stations to use, including:

i) Size of the catchment area
ii) Accuracy and reliability of the monitoring station
iii) Unaffected by water control operations (i.e. unregulated flow)

The following stream gauge stations were determined to best fit these criteria:

i) Fish Creek near Prospect Hill (02GD010)
ii) Avon above Stratford (02GD019)
iii) Trout Creek at Fairview (02GD019)
iv) Trout Creek near St. Mary's (02G009)

It should be noted that the monitoring station Trout Creek near St. Mary's is affected by dam control operations at the Wildwood dam. Flood control operations and flow augmentation both have an effect on the flows experienced at the Trout Creek near St. Mary's monitoring station. During the summer months the readings at the Trout Creek Near St. Mary's station are also affected by vegetation growth, which result in artificially high readings. To reduce the error caused by vegetation growth the flows measured for the months of June, July and August were replaced by the outflows measured at Wildwood Dam.

To maintain consistency only flow records within the time periods of available data from the HOBO data logger of Embro were used for this comparison. The catchment areas listed on the Environment Canada Hydrometric Statistics Data Station Information were used for the unit area flow rate calculation.

Table 3 below summarizes the average flow (L/s) and the unit area flow rate ((L/s)/ha) calculated for downstream of Harrington dam and for the monitoring stations selected for comparison.

Table 3: Average Flow (L/s) and Average Unit Area Flow Rate ((L/s)/ha) for the Harrington logger, Trout Creek near Fairview, Avon River above Stratford, Fish Creek, and Trout Creek near St. Mary's

Gauge	Area (ha)	Average Flow (L/s) for:			Unit Area Flow Rate ((L/s)/ha) for:		
		May 24, 2008-April 9, 2011	Mar 26, 2012-Sept 12, 2012	April 23, 2015-August 28, 2015	May 24, 2008-April 9, 2010	Mar 26, 2012-Sept 12, 2012	April 23, 2015-August 28, 2015
Harrington Logger	1248	210	150	180	0.169	0.121	0.144
Trout Creek Near Fairview	3600	510	80	390	0.143	0.0226	0.109
Avon above Stratford	7450	860	510	540	0.115	0.0683	0.0725
Fish Creek	14435	2,020	280	1,240	0.140	0.0196	0.0859
Trout Creek Near St. Mary's	14927	2,070	1,220	1,700	0.139	0.0819	0.114

These results have been illustrated in Figure 6 and in Figure 7.

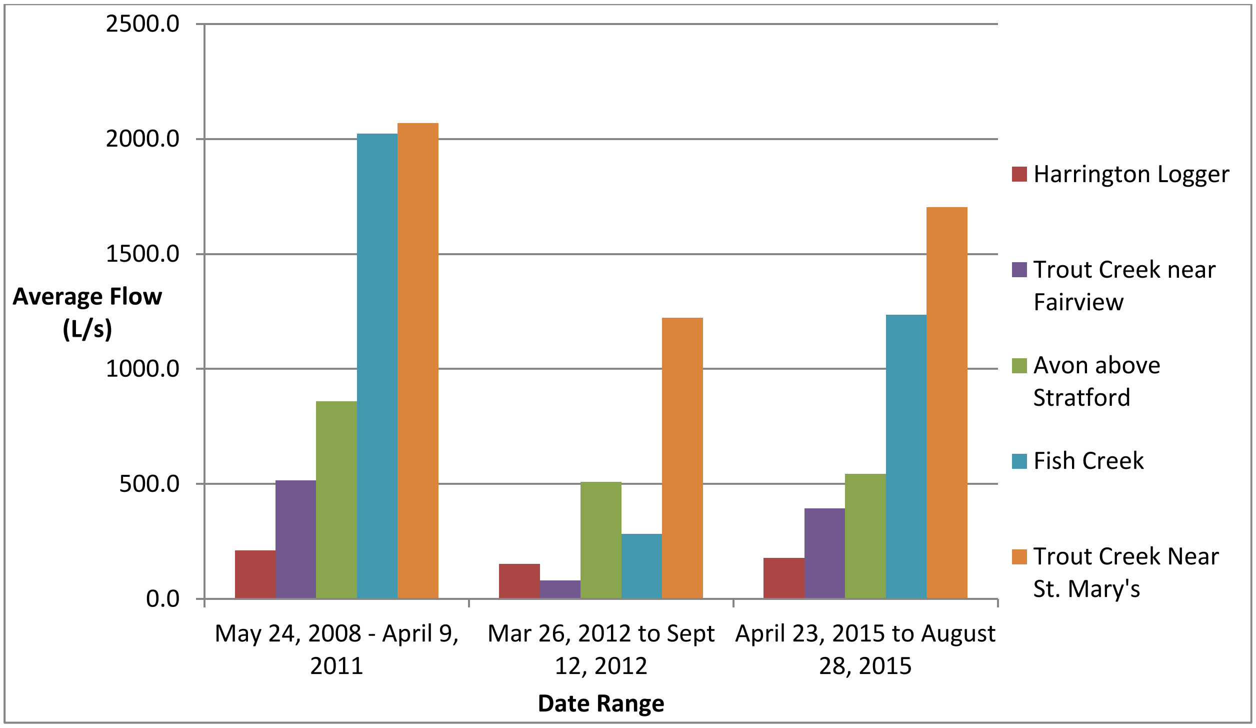


Figure 6: Average Flows (L/s) the Harrington logger, Trout Creek near Fairview, Avon River above Stratford, Fish Creek, and Trout Creek near St. Mary's

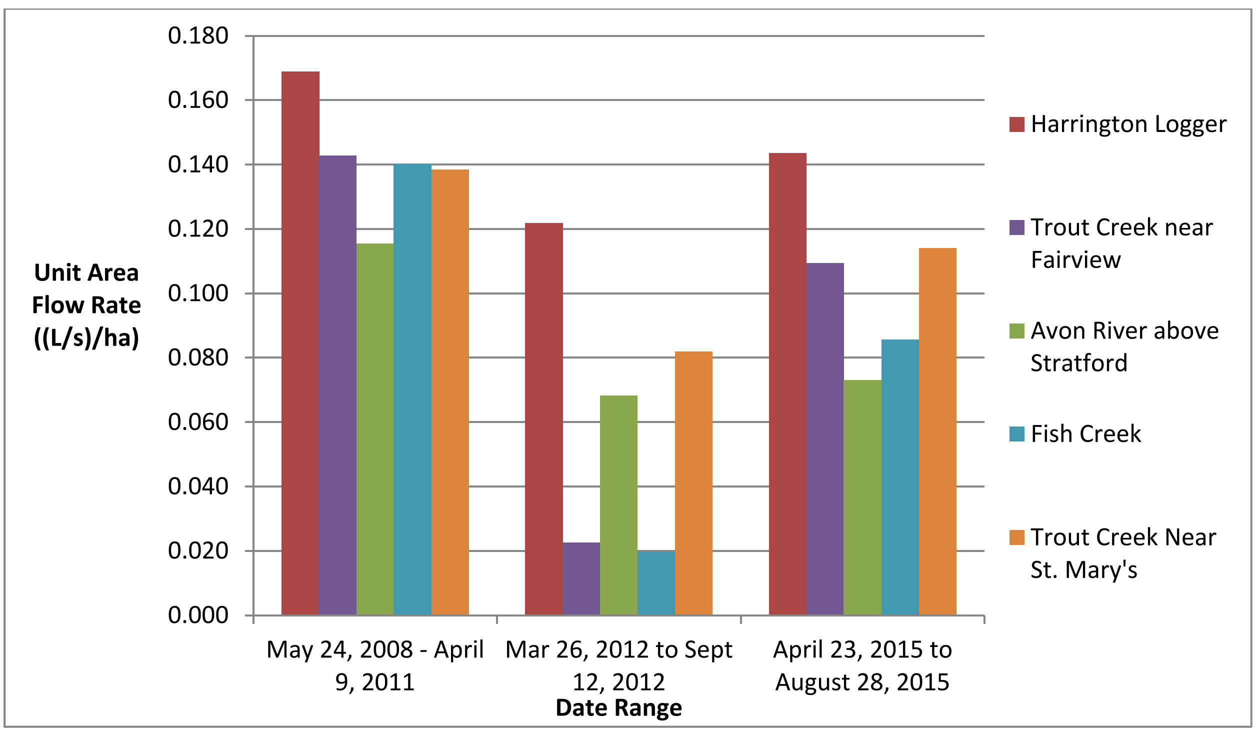


Figure 7: Average Unit Area Flow Rate ((L/s)/ha) of the Harrington logger, Trout Creek near Fairview, Avon River above Stratford, Fish Creek, and Trout Creek near St. Mary's

Harrington – Response to Drought and Low Water Conditions

From Table 3 above, it can be observed that the catchment area for the Harrington data logger was the smallest of the five catchment areas that were considered. The average stream flow at Harrington was the lowest of all of the water courses studied from May 24, 2008 – April 9, 2011 and from April 23, 2015 – August 28, 2015. The only time period where the average flow was not the lowest at Harrington was from March 26, 2012 – September 2012; this was a period of drought/low water condition as evidenced by the Low Water Level 2 status issued by the Upper Thames Low Water Response Team (UT-LWRT). The UT-LWRT implements the Ontario Low Water Response plan in the Upper Thames watershed. This plan entails communicating water conditions and advising on different water management techniques required to manage drought and low water conditions to the target audiences. A Low Water Level 2 status is only issued when stream flows are at approximately 50% of normal summer flows or when the watersheds precipitation for one month falls below 60% of the average precipitation. Figure 13, in the Precipitation section in the Appendix, illustrates the 30 Day Precipitation Totals from March 26, 2012 to September 12, 2012 measured at the Fairview station against the historical amounts. Additional precipitation data for all the flow periods of record is also located in the Precipitation section in the Appendix of this document. The percentage decrease of the average flow from May 24, 2008 – April 9, 2011 to March 26, 2012 – September 12, 2012 for each of the stream monitoring stations is summarized in Table 4.

Table 4: Percentage Decrease in Average Flow experienced from May 24, 2008 - April 9, 2011 to March 26, 2012 - September 12, 2012

Stream Flow Monitoring Station	Decrease in Average Flow Rate from May 24, 2008 – April 9, 2011 to March 26, 2012 – September 12, 2012
Harrington Logger	28%
Trout Creek near St. Mary's	41%
Avon above Stratford	41%
Trout Creek Near Fairview	84%
Fish Creek	86%

The stream gauge station on Trout Creek near St. Mary's is downstream of Wildwood dam and as such is affected by dam operations. A major factor in the moderate 41% decrease in average flow at Trout Creek near St. Mary's is due to low flow augmentation, which is the release of water stored in the Wildwood reservoir to supplement the low flows in the downstream watercourses. The moderate decrease in average flow at the Avon River above Stratford is likely due to moderate portion of the average flow being supplied by baseflow; the majority of this catchment area has been classified as having a medium groundwater recharge amount (~109 mm – 202 mm infiltrated/year) and is in close proximity to shallow overburden aquifers.

The relatively small decrease in flow at Harrington during the drought/low water condition is indicative of the fact that a large portion of the average flow at Harrington Creek is supplied by baseflow. The majority of the catchment area for the Harrington Logger has been previously classified as an area of high groundwater recharge (~415 mm – 470 mm infiltrated/year) and is in close proximity to shallow overburden aquifers. When the water level in the stream decreases below the level of the water table, groundwater flows into the stream resulting in a less significant decrease in stream flow. Areas of high groundwater recharge usually have higher volumes of water to contribute to the base flow of the streams in the area.

Figure 8 below illustrates the groundwater recharge characteristics of the Harrington catchment area and the Embro catchment area.

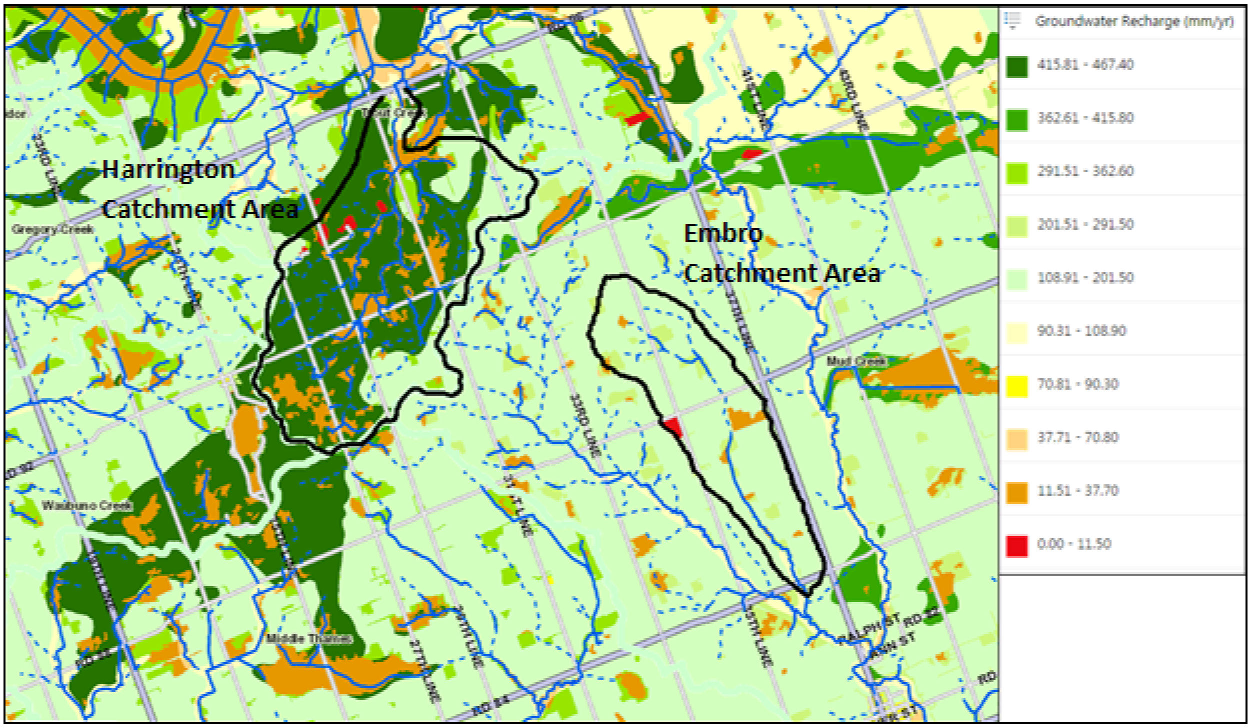


Figure 8: Groundwater Recharge Characteristics of the Harrington Catchment Area and the Embro Catchment Area

Harrington – Contribution to Subwatershed Flow

The catchment area for Harrington Creek, illustrated in Figure 2, composes approximately 8.4% of the total catchment area that drains to the Trout Creek near St. Mary's monitoring station. The Trout Creek near St. Mary's station is the most downstream stream gauge in the Trout Creek Subwatershed. From May 24, 2008 to April 9, 2011 and from April 23, 2015 to August 28, 2015, the flow from the catchment area for the Harrington logger equated to approximately 10.2% and 10.5% of the total flow that passes through the Trout Creek Subwatershed, respectively. These flow contributions are approximately 21% and 24% more than would be expected if estimates were based only on the size of the catchment area. During the drought/low water condition of 2012, the percentage of the total flow passing through the Trout Creek Subwatershed that originated in the catchment area for Harrington Creek increased to approximately 12.4%. This flow contribution during the drought/low water condition is approximately 48% more than the contribution that would be expected if estimates were based only on the size of the catchment area.

Harrington – Effect of Water Control Structures on Upstream and Downstream Flows

Table 5 summarizes the flows that were measured at the upstream and downstream locations at Harrington Dam.

Table 5: Flows measured Downstream of Harrington and Upstream of Backwater Effects from Harrington Dam

Date of Measurement	11-Jun-15	22-Jul-15	28-Aug-15
Flow downstream of Harrington Dam (L/s)	250	120	120
Flow upstream of Harrington Dam (L/s)	220	120	110
Upstream Flow as % of Downstream Flow	88%	100%	92%

At Harrington the flow upstream of the backwater effects of the dam was on average approximately 93% of the flow measured downstream of the dam.

This comparison was somewhat limited by the magnitude of the flows and the accuracy of the measurement equipment. With the flow meter only capable of measuring to the nearest 0.01 m/s and the average flow rate measured at Harrington being approximately 0.16 cubic meters per second (cms), rounding to the nearest 0.01 cms can have a significant effect on the answer. In addition to the accuracy limitations of the equipment, the effect of measuring the flow further upstream (which equates to a smaller catchment area) should also be considered when comparing the flows.

Embro – Average Flow Rates and Unit Area Flow Rate

As previously discussed there is no HOBO data logger or stream gauge monitoring station immediately downstream of Embro Dam. Obtaining a time series of flows of Youngsville Drain through Embro Dam was further complicated by the fact that there are no stream gauge monitoring stations in the Mud Creek subwatershed; the closest monitoring station is the Middle Thames monitoring station (02GD004) located near the intersection of 15^{th} line and Road 64. The Middle Thames monitoring station is approximately 25km downstream from Embro Pond and as such, several creeks and drains have added to the flow from Embro pond, most notably:

i) Embro Creek
ii) Mud Creek Drain
iii) Nissouri Creek
iv) Kintore Creek

The catchment area that flows to Embro pond is approximately 645.6 ha and makes up approximately 2.1% of the total catchment area (30600 ha) that drains to the Middle Thames monitoring station. It was decided to not use the Middle Thames monitoring station to generate a time series estimate of the flows from downstream of Embro pond. The accuracy of back calculations from the measured flow downstream of Thamesford to a calculated flow downstream of Embro Dam would be negatively affected by weather events that occurred within the larger catchment area of the Middle Thames monitoring station but outside of the Embro pond catchment area. Back calculations would be further complicated by the different flow paths and travel times of the many different creeks and drains to the monitoring station.

With the catchment area for Embro pond being close in proximity to the catchment area for the Harrington logger it can be reasonably expected that the two catchment areas would experience similar weather patterns. As the flow measurements downstream of Embro Dam and Harrington Dam were performed on the same days it was possible to determine an estimate of the relationship between the two flows under similar conditions. Table 6 below provides the stream flow measurements obtained in 2015 downstream of the Embro dam and downstream of the Harrington.

Table 6: Embro Stream flow Measurements as a Percentage of Harrington Stream Flow Measurements

Date	Embro Flow (L/s)	Harrington Flow (L/s)	Embro flow as Percentage of Harrington flow
04-Jun-15	110	150	73%
11-Jun-15	130	250	52%
22-Jul-15	80	120	67%
28-Aug-15	90	120	75%
24-Sep-15	80	90	88%

The relationship between the flow at Harrington and the flow at Embro has been illustrated in Figure 9 below.

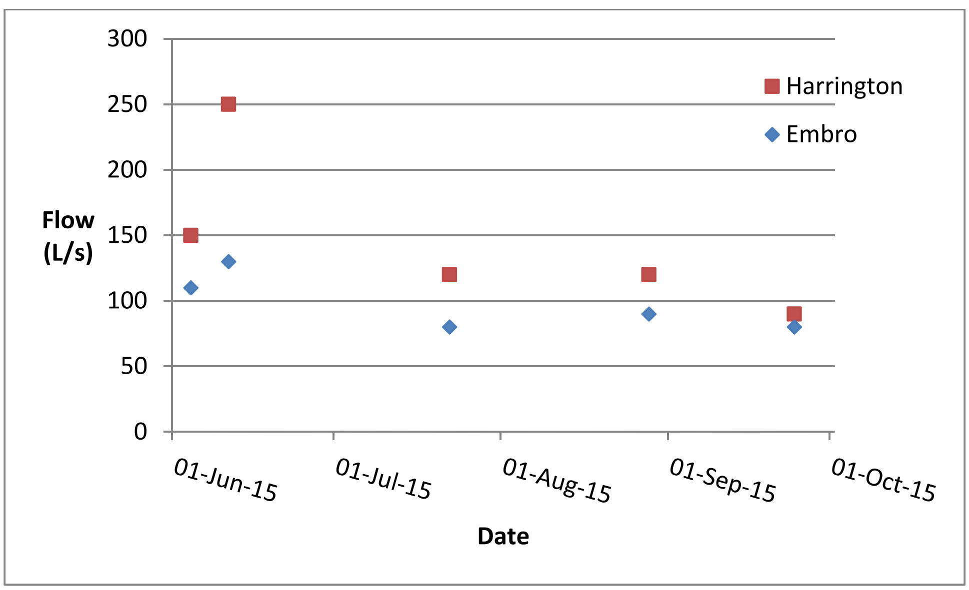


Figure 9: Comparison of Harrington and Embro Flows

Weighted average calculations were used to determine the average relationship of the flow rate measured downstream of Embro Dam in relation to the flow rate measured downstream of the data logger at Harrington. The steps for completing the weighted average calculation are detailed in Appendix - Weighted Average Calculation.

The weighted average calculations showed that the flow rate downstream of Embro Dam was approximately 69% of the flow rate near the Harrington data logger. By applying the relationship to the time series of flow rates from the Harrington data logger it was possible to estimate the average flow rate and the average unit area flow rate at downstream of Embro Dam.

Table 7 below summarizes the average flow (L/s) and the unit area flow rate ((L/s)/ha) calculated for the cross section 25 m downstream of Embro dam. These values are all based on the assumption that the flow rate downstream of Embro Dam is approximately equal to 69% of the flow rate at the Harrington data logger location.

Table 7: Average Flow (L/s) and Average Unit Area Flow Rate ((L/s)/ha) for calculated for Cross Section 25 m downstream of Embro Dam

Cross Section Location	Area (ha)	Average Flow (L/s) for:			Unit Area Flow Rate ((L/s)/ha) for:		
		May 24, 2008- April 9, 2011	Mar 26, 2012- Sept 12, 2012	April 23, 2015- August 28, 2015	May 24, 2008- April 9, 2010	Mar 26, 2012- Sept 12, 2012	April 23, 2015- August 28, 2015
Downstream of Embro Dam	645.6	150	100	120	0.232	0.155	0.186

Embro – Response to Drought and Low Water Conditions

The majority of the Embro catchment area has been classified as having a medium amount of groundwater infiltration approximately between 109 mm and 201 mm infiltrated per year. For this analysis it has been assumed that the response to drought/low water conditions of flows from the Youngsville drain will be similar to the response observed at Harrington. This assumption is based on flow measurements during non-drought years, field observations of multiple springs in the area, materials which indicate the presence of an aquifer (i.e. gravel pit), and the close proximity of areas classified as shallow aquifers to the Youngsville Drain catchment area. A map from the Thames River Basin Water Management Study Technical Report showing the predicted locations of shallow aquifers has been provided below in Figure 10.

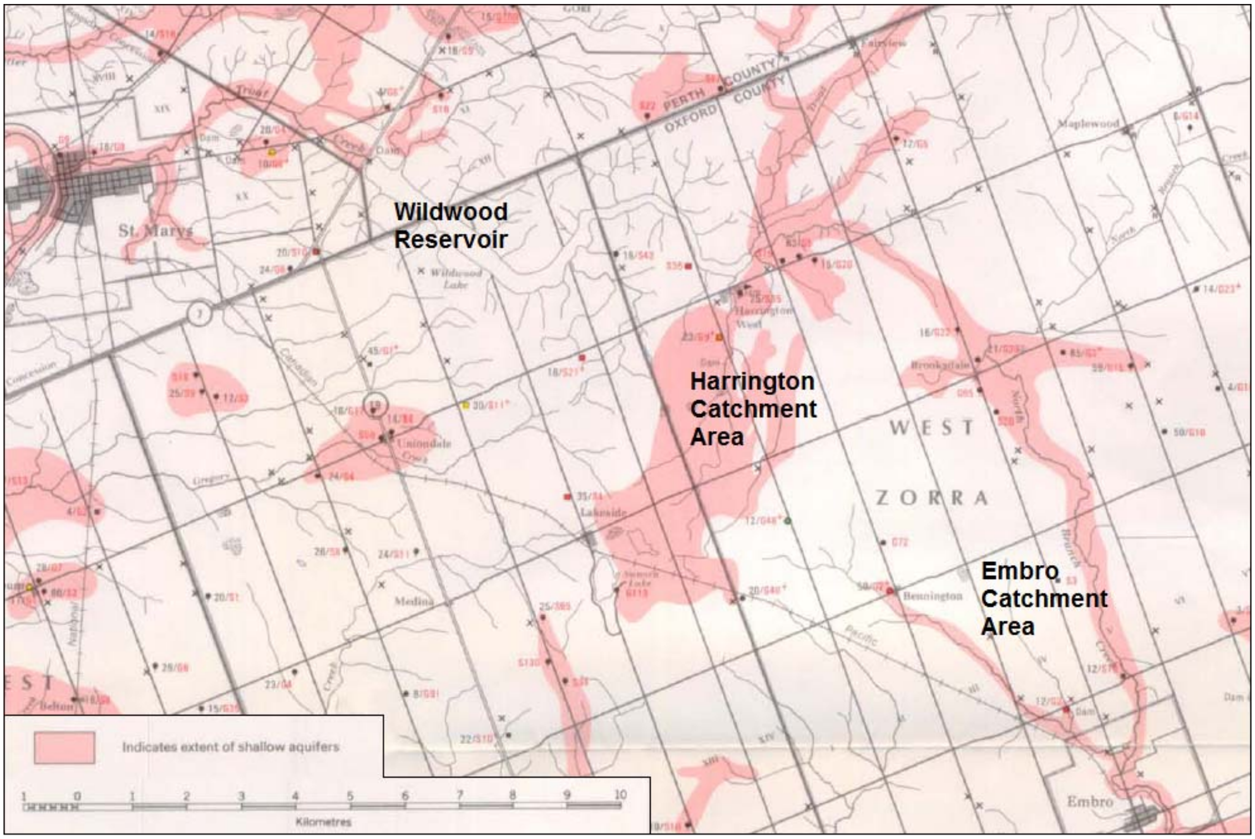


Figure 10: Areas of Shallow Overburden Aquifers from the Thames River Basin Study

Embro – Contribution to Subwatershed Flow

The catchment area that produces the flow downstream of Embro Dam is located in the Mud Creek Subwatershed. As previously noted there are no flow monitoring stations in the Mud Creek Subwatershed. The catchment area for downstream of the Embro Dam, illustrated in Figure 5, composes approximately 2.1% of the 30,600 ha catchment area of the closest monitoring station downstream of Thamesford in the Middle Thames Subwatershed. From May 24, 2008 to April 9, 2011 and from April 23, 2015 to August 28, 2015, the flow from the catchment area for downstream of Embro dam equated to approximately 3.5% and 6.4% of the total flow that passes through the monitoring station downstream of Thamesford, respectively. These flow contributions are approximately 67% and 200% more than would be expected if estimates were based only on the size of the catchment area. If the same percent decrease in flow observed at Harrington occurred at Embro during the drought/low water condition of 2012 then 12.4% of the total flow through the monitoring station downstream of Thamesford originated from the catchment area for the Embro dam. This flow contribution would represent a contribution approximately 470% more than the amount that would be expected than a contribution estimated based only on the size of the catchment area.

Embro – Effect of Water Control Structures on Upstream and Downstream Flows

Table 8**Error! Reference source not found.** summarizes the flows that were measured at the upstream and downstream locations at Harrington Dam and Embro Dam.

Table 8: Flows measured Downstream of Embro and Upstream of Backwater Effects from Embro Dam

Date of Measurement	11-Jun-15	22-Jul-15	28-Aug-15
Flow downstream of Embro Dam (cms)	0.13	0.08	0.09
Flow upstream of Embro Dam (cms)	0.13	0.07	0.08
Upstream Flow as % of Downstream Flow	100%	88%	89%

At Embro the flow upstream of the backwater effects of the dam was on average 92% of the flow measured downstream of the dam. This comparison was somewhat limited by the magnitude of the flows and the accuracy of the measurement equipment. With the flow meter only capable of measuring to the nearest 0.01 m/s and the average flow rate measured at Embro being approximately 0.10 cms, rounding to the nearest 0.01 cms has a significant effect on the answer. In addition to the accuracy limitations of the equipment, the effect of measuring the flow further upstream (which equates to a smaller catchment area) should also be considered when comparing the flows.

Conclusions

For all of the periods of records that were available for comparison the average unit area flow rates for downstream of Harrington Dam and downstream of Embro Dam were greater than the unit area flow rates calculated for:

i) Fish Creek near Prospect Hill
ii) Avon River above Stratford
iii) Trout Creek at Fairview
iv) Trout Creek near St. Mary's,

During periods of drought / low water conditions, the unit area flow rates downstream of Harrington Dam and downstream of Embro Dam did not experience a percentage decrease in flow as great as decrease that was experienced in the other water courses that were studied. The resiliency of Harrington Creek and Youngsville drain is likely due to the groundwater recharge characteristics of the catchment areas and the proximity of both catchment areas to shallow overburden aquifers.

For all of the available periods of record the contribution of flow from downstream of the Harrington Dam and the flow downstream of the Embro dam to the downstream receiving subwatershed was greater than the amount that would be expected based only on size of the catchment areas. From May 24, 2008 – April 9, 2011, March 26, 2012 – September 12, 2012, and April 23, 2015 – August 28, 2015 the contribution of the flow measured downstream of Harrington Dam to the total flow out of the Trout Creek Subwatershed was 10.2%, 12.4%, and 10.5% of the total flow, respectively.

It is more difficult to estimate the contribution of the flow measured downstream of Embro Dam to the total flow out of Mud Creek due to the absence of a flow monitoring station at the outlet of Mud Creek and the large distance between downstream of Embro Dam and the closest flow monitoring station in the Middle Thames Subwatershed downstream of Thamesford. If it is assumed that there are no losses as the water travels the distance of this flow path then from May 24, 2008 – April 9, 2011, March 26, 2012 – September 12, 2012, and April 23, 2015 – August 28, 2015, the contribution of the flow measured downstream of Embro Dam to the total flow measured at the stream gauge station downstream of Thamesford was 3.5%, 12.4%, and 6.4% of the total flow, respectively.

The three flow measurements that were taken upstream of the backwater effects of each dam indicated that the upstream flow was 93% and 92% of the flow downstream of Harrington and Embro, respectively. Due to the low magnitude of the flows, the accuracy limitations of the flow velocity meter, and inflow to the watercourses in between the upstream and the downstream measurement locations it is recommended that additional measurements and/or monitoring be performed. Additional flow measurements, or the installation of a HOBO logger and development of a rating curve at the upstream locations (and at downstream of Embro) would increase the confidence in assessing the effect of the water control structures on the flow.

It is recommended that a flow monitoring program continue at Harrington Dam and Embro Dam. Additional data would allow increased confidence in the results and the analyses of the flow characteristics and would be beneficial for future designs.

Appendix

Omitted Results

Figure 11 illustrates the Harrington creek water levels at the Rd. 96 bridge pier for the time period of May 24, 2008 to April 9, 2011. The yellow horizontal line indicates the water temperature of 5°C that was used to filter out irregular logger readings. The red rectangular outlines indicate data that was recorded at a temperature below the cut off line and as such was omitted from subsequent calculations and analyses.

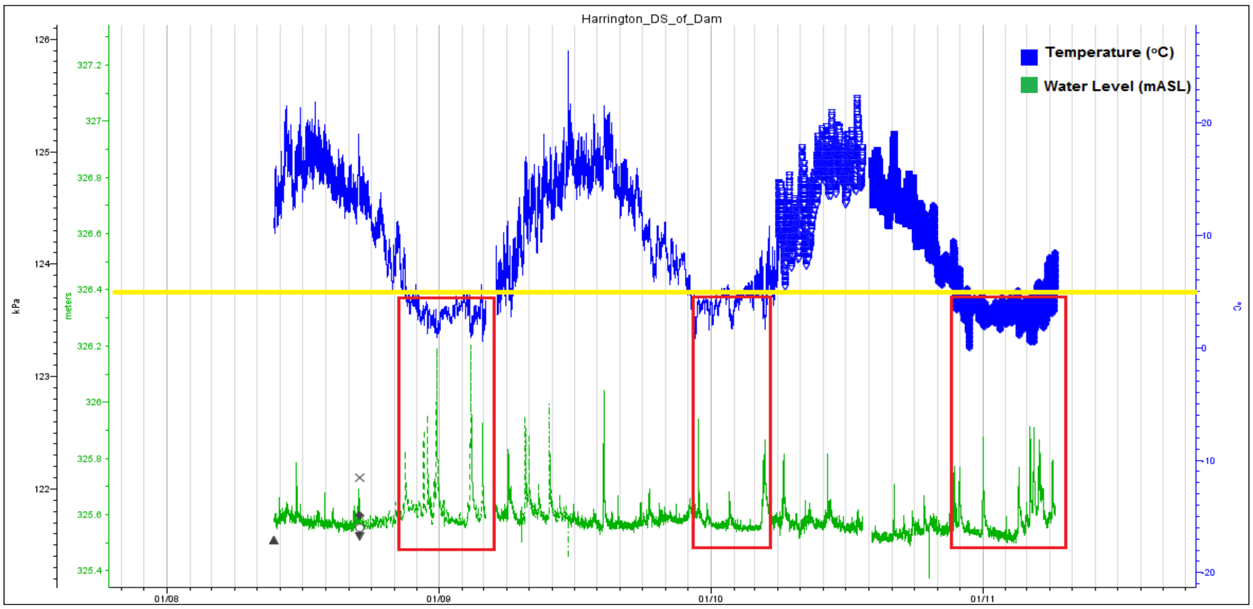


Figure 11: Water Temperature (°C) and Water Level (m) from HoboLogger Downstream of Harrington

Weighted Average Calculation

The weighted average was calculated using the following steps:

i) Average the Embro flow as a percentage of the Harrington flow at the 1st measurement (73% - June 4) and the Embro flow as a percentage of the Harrington flow at the 2nd measurement (52% - June 11)

ii) Multiply this average (62.5%) by the number of days between the 1st and 2nd measurement (7 days)

iii) Repeat this process for the 2nd and 3rd, 3rd and 4th, and the 4th and 5th measurements

iv) Sum all of the products produced in the first three steps (770 (%*days))

v) Divide the sum by the total number of days from the first measurement to the last measurement (112 days)

vi) The result is the weighted average $\frac{\% * \quad \cancel{days})}{\quad} = 69\%$

Precipitation

In order to characterize the precipitation that occurred in the catchment areas for the Harrington Pond and Embro Pond, measurements recorded during the periods of observation were compared against historical measurements.

The Ministry of Environment monitoring station in Stratford (UT-0066-01) was used to calculate the historical percentiles. This station recorded daily precipitation measurements from January 1, 1950 to December 31, 2005. The daily precipitation measurements were used to calculate the 30 day precipitation total. The 30 day precipitation total for a certain day is the sum total of all the precipitation that occurred on the day in question and all of the precipitation that occurred on the previous 29 days. When comparing data, the 30 day precipitation total is preferable to single day totals as it removes some of the statistical noise associated with single day measurements and it also provides a better indication of conditions in the study area.

The historical data was used to calculate the 25th, 50th, and 75th percentiles for the 30 day precipitation total for every day of the year.

The UTRCA monitoring station on Trout Creek near Fairview (UT-0020-01) was the source of the measurements obtained during the periods of observation. This station was chosen based on the proximity to the study areas, the availability of data for the periods of observation, and high confidence in the quality of the data. One disadvantage to this monitoring station is that it does not have the necessary instrumentation to measure snowfall; this results in the 30 day precipitation total being artificially lower than normal during the winter months.

Efforts made to collect additional precipitation information from alternative sources closer to study sites were unsuccessful due to non-standardized methods of collecting, recording, or storing information, and/or inability to obtain data from the alternative sources. The benefit of incorporating additional data from alternative sources would be limited in this circumstance as the purpose of examining precipitation in this report is to characterize general conditions as opposed to identify specific system responses to specific rainfall events.

Figure 12, Figure 13, and Figure 14, illustrate the 30 day precipitation totals during the period of observation compared to the historical 30 day precipitation total amounts for:

- March 24, 2008 to April 9, 2011,
- March 26, 2012 to September 12, 2012,
- and April 23, 2015 to September 23, 2015, respectively.

These graphs allow the interpretation as to whether the 30 day precipitation total was above, below, or within the normal range. Generally any total within the 25th to 75th percentile is considered within normal range, any value above the 75th percentile would be considered above normal range, and any value below the 25th percentile would be considered below normal range.

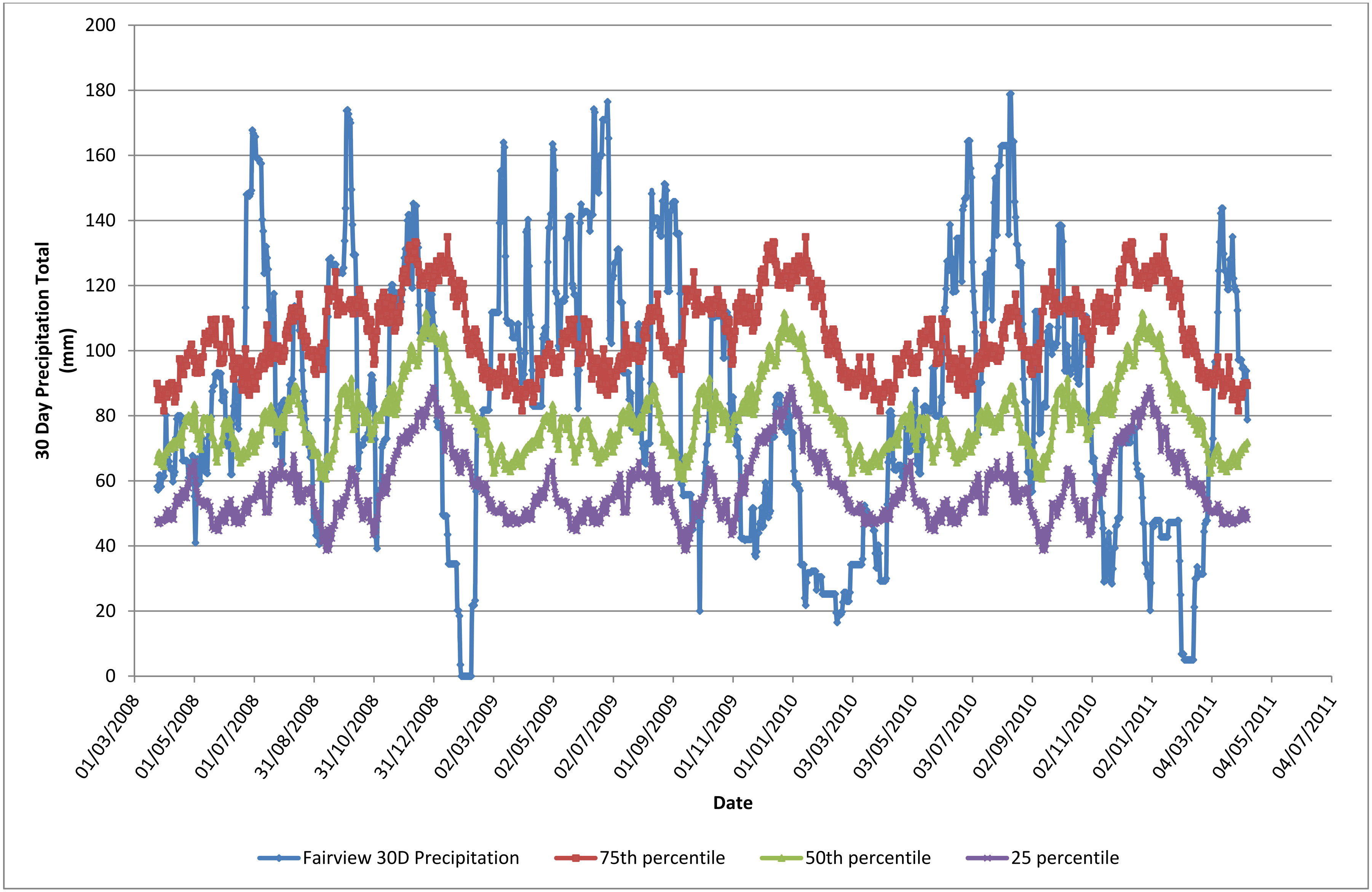


Figure 12: 30 Day Precipitation Totals from March 24, 2008 to April 9, 2011

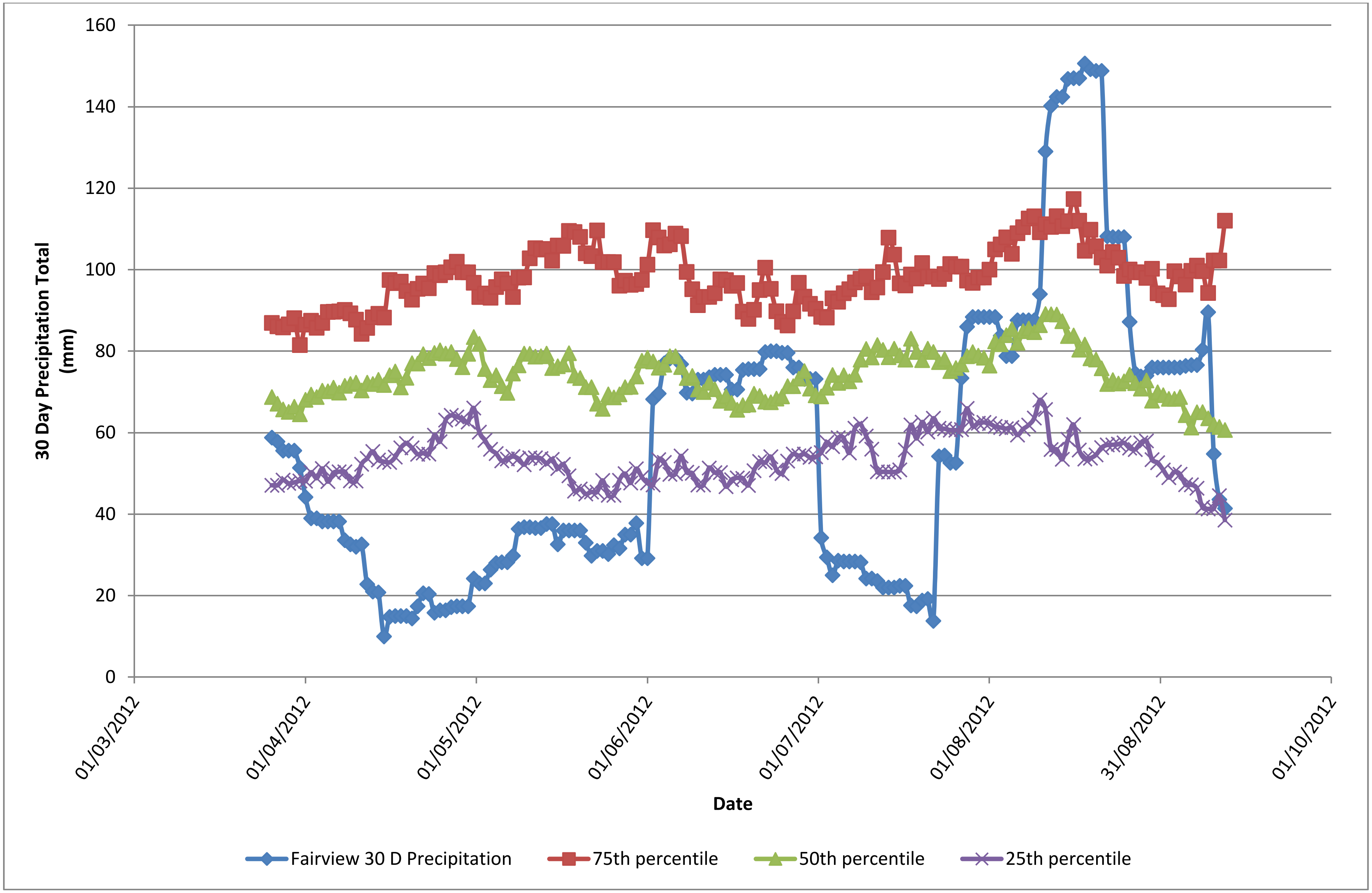


Figure 13: 30 Day Precipitation Totals from March 26, 2012 to September 12, 2012

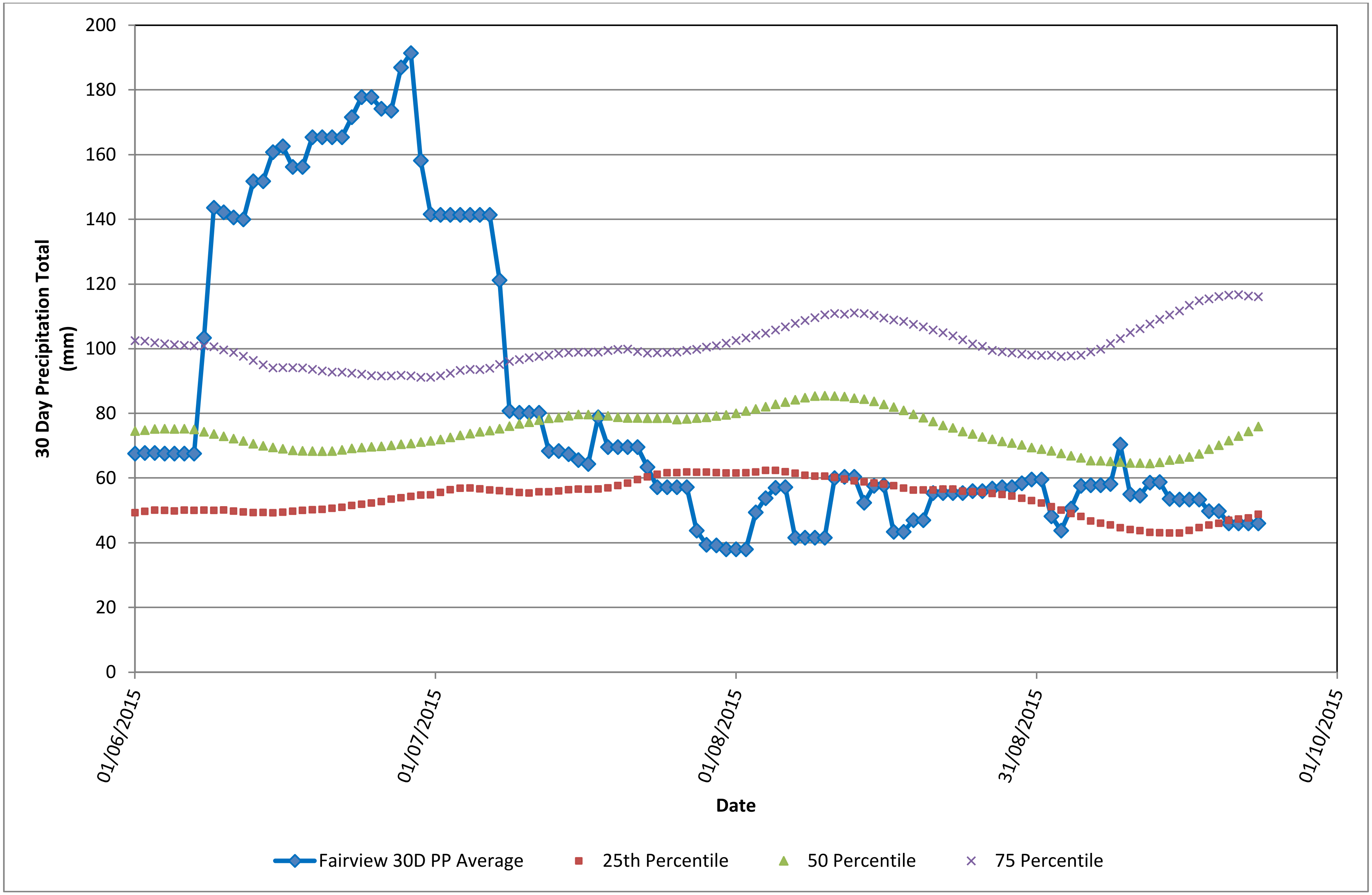


Figure 14: 30 Day Precipitation Totals from June 1, 2015 to September 23, 2015

Appendix B

Harrington Pond Water Quality Assessment. Prepared by UTRCA, Updated October 2016

Appendix B

Harrington Pond Water Quality Assessment

Updated October 13, 2016

Contents

Purpose and Background

Harrington Pond is located in the community of Harrington, has an upstream drainage area of 1200 hectares, and is located within the larger Trout Creek subwatershed. The headwaters flow into the pond through the Harrington-West Drain. Located in the headwaters are the Provincially Significant Wetland, the Lakeside/Wildwood Complex, as well as the Significant Natural Areas of Happy Hills and Lost Concession. 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 snapshot of water quality and is limited to the conditions of 5 sampling occasions from April to October in 2015 and with one year of past monitoring data in 1989 being evaluated as well.

As part of an evaluation of water quality in Harrington Pond, 5 samples were taken in 2015 at 4 locations, one upstream, 2 in pond, and one downstream (see Figure 1). Harrington Pond also had one year of historical data (1989) and this was included in the evaluation of the results. Three of the five 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. There was some variation in flow based on minimal rain but only one date had rain with full runoff conditions (June 1) and one date had rain with partial runoff conditions (October 9). 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 July 22 using a datalogger recording in half hour intervals.

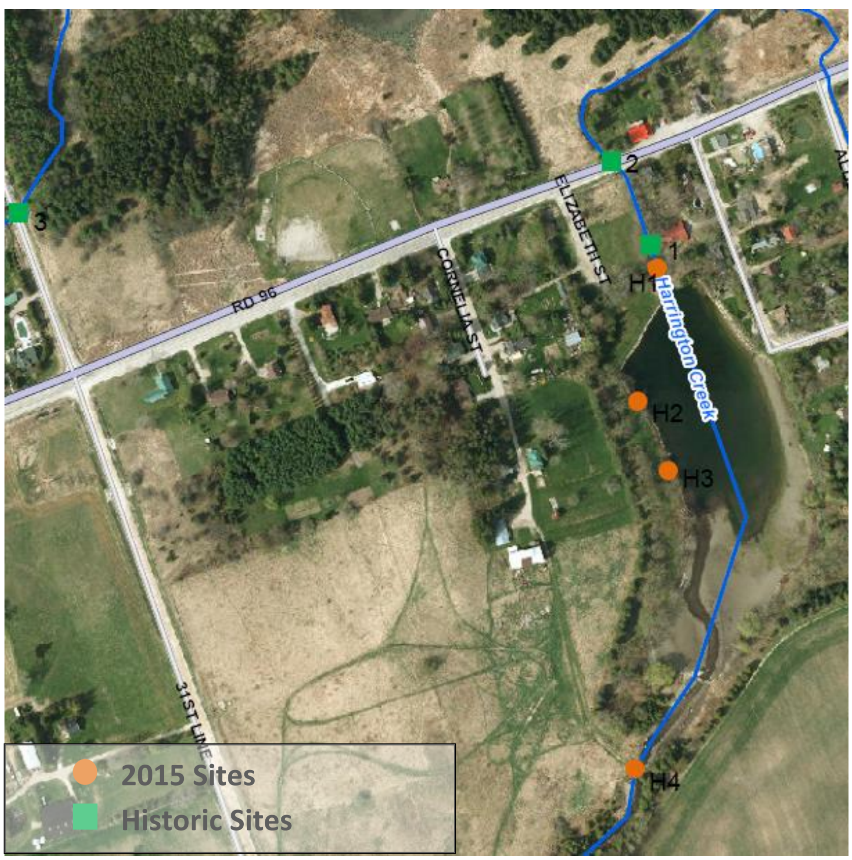


Figure 1: Harrington Pond water quality sampling sites

Results: Water Chemistry and Bacteria

Results are provided for 7 parameters which are related to land use activities. Pond samples were combined for analysis.

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:

- Stream temperature data for June and July 2015 were taken during periods in which the monthly air temperature averages (ref. Environment Canada – London Airport) were similar to historical monthly air temperature averages.
- The temperatures upstream are consistently cooler than downstream temperatures indicating the pond has a warming effect.
- The difference in temperature from upstream to downstream ranges from 0 to over 5C, with an average difference of 2.5C change and the difference becoming greater as the summer progresses.
- For both upstream and downstream, the stream temperature shows a diurnal pattern with day time highs and night time lows.
- The spot field measurements of temperature show the same pattern from upstream to downstream as the continuous dataloggers with upstream cooler than the pond and downstream.

Figure 2: Field Temperature 1989 and 2015

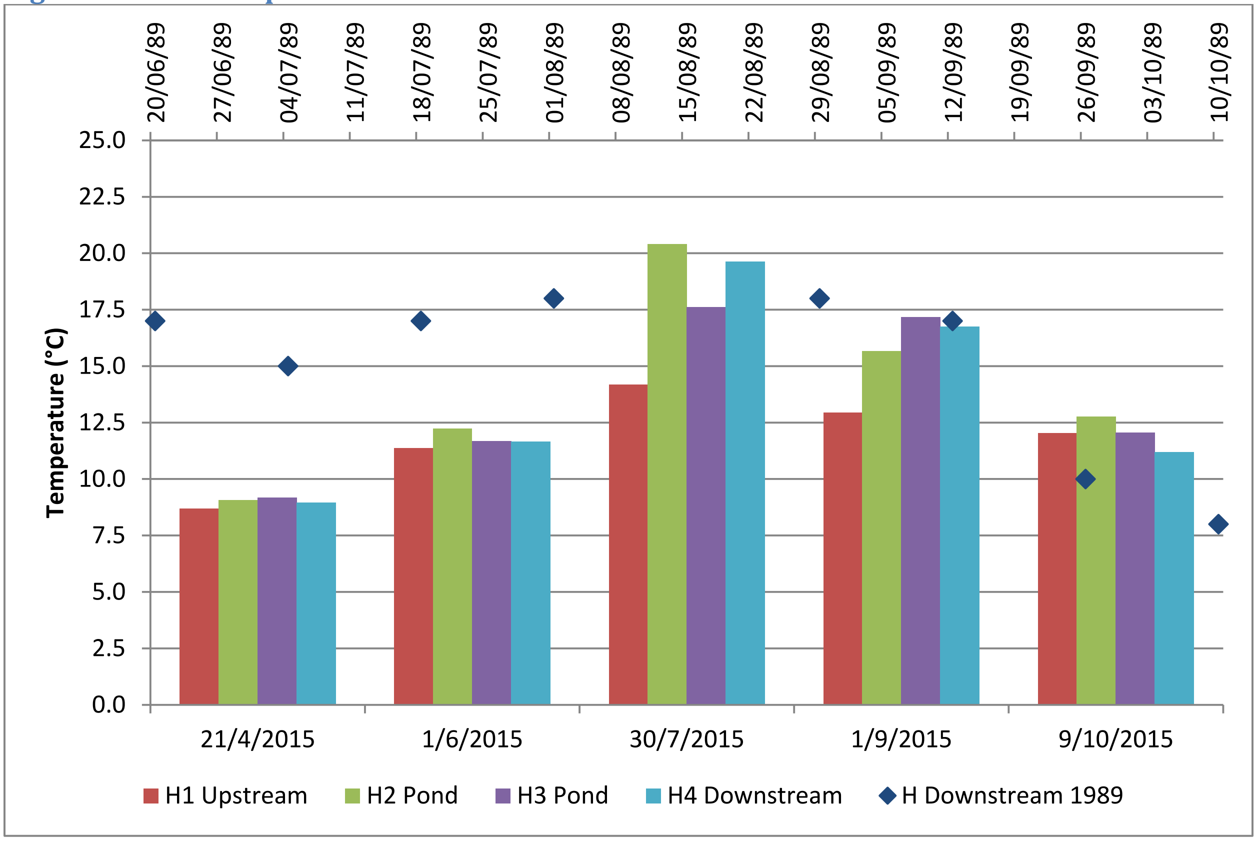
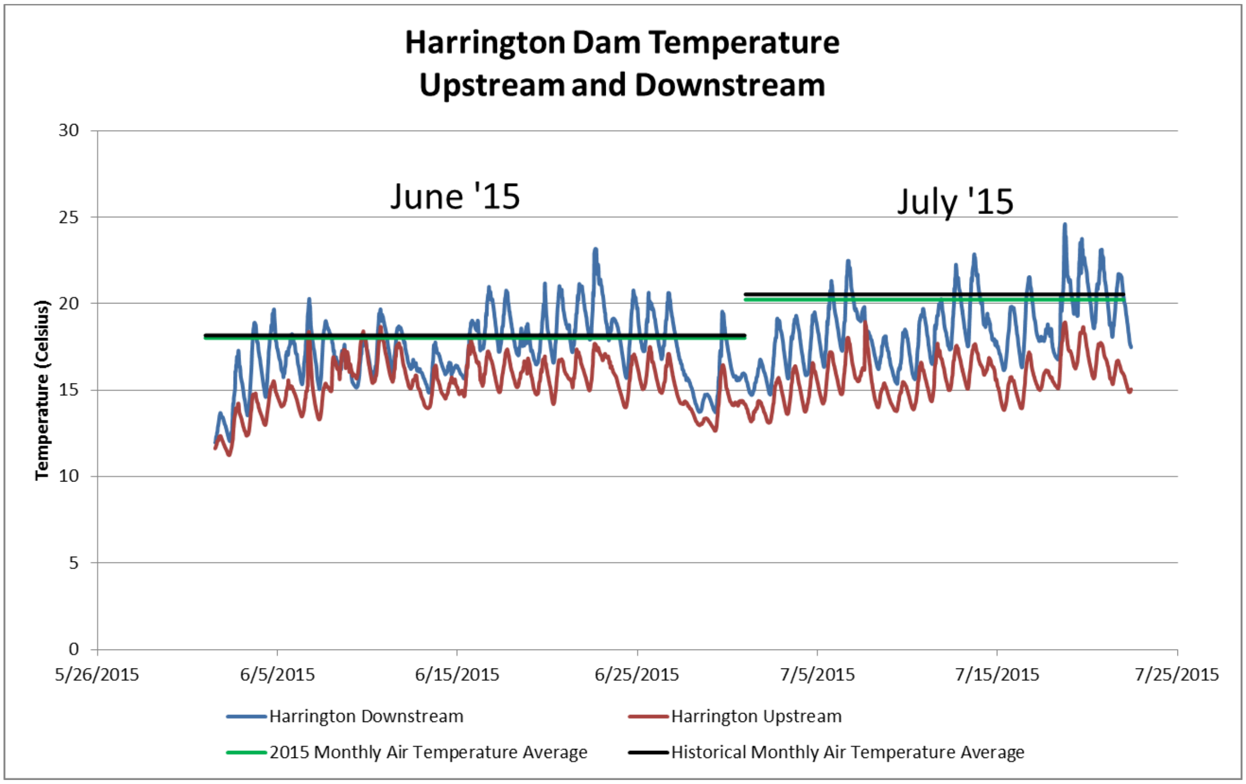


Figure 3: Harrington Pond continuous temperature upstream and downstream



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.

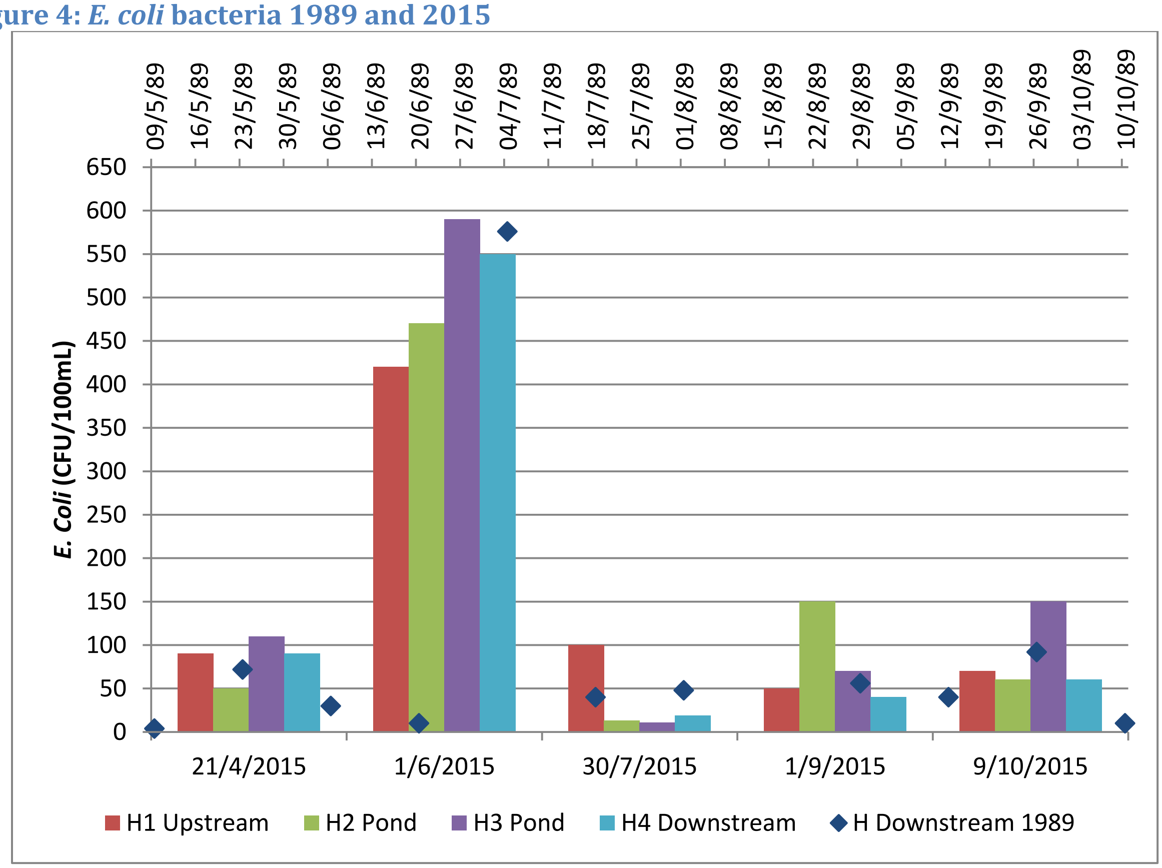
Sources: Potential sources of fecal bacteria include upstream runoff from biosolids/sewage, livestock or wildlife waste, faulty private septic systems, and other stormwater runoff.

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 Harrington Pond is not monitored as recreational water.

Monitoring Results:

- Concentrations of *E. coli* bacteria are fairly low and fall below or close to the provincial recreational guideline for most sampling dates for both 1989 and 2015.
- Rain events show higher *E. coli* levels as expected.
- *E. coli* levels are similar at samples upstream, in the pond and downstream.

Figure 4: *E. coli* bacteria 1989 and 2015



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:

- For all dates, concentrations of total phosphorus were low and close to the Provincial Objective compared to typical numbers seen for Trout Creek and other parts of the Upper Thames watershed.
- Orthophosphate levels are also low with some samples below the detection limit for 2015. 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.

Figure 5: Total Phosphorus 1989 and 2015

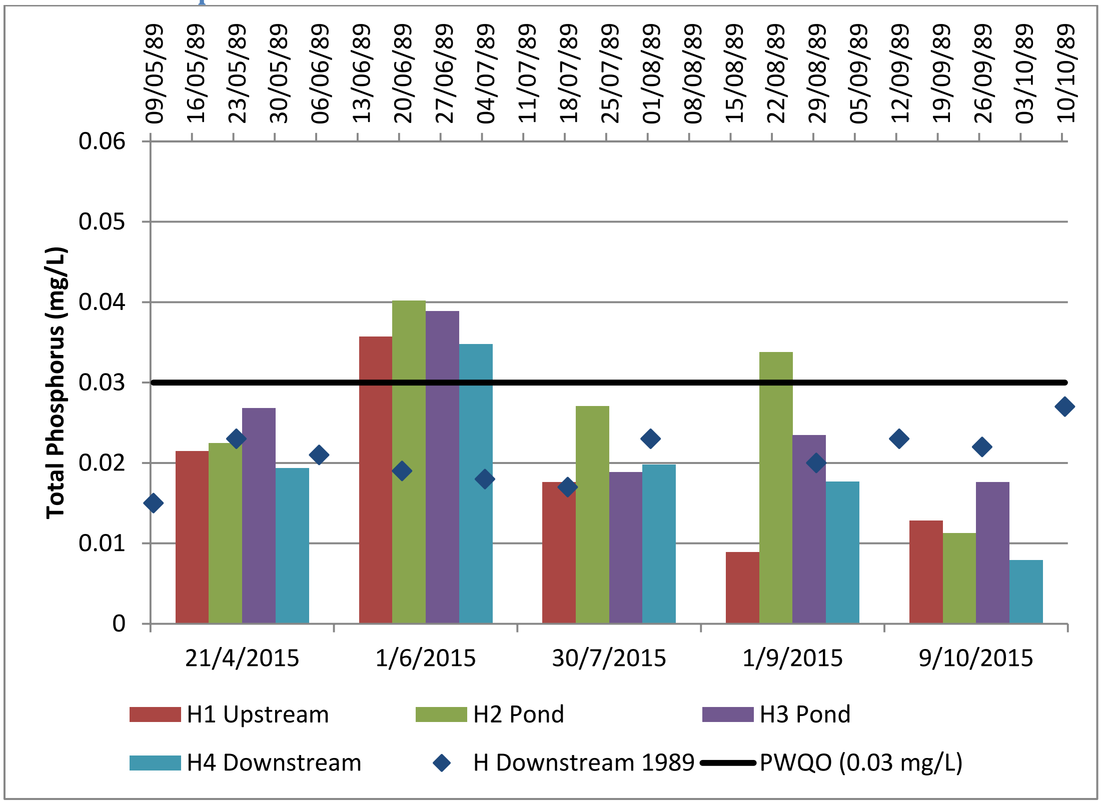
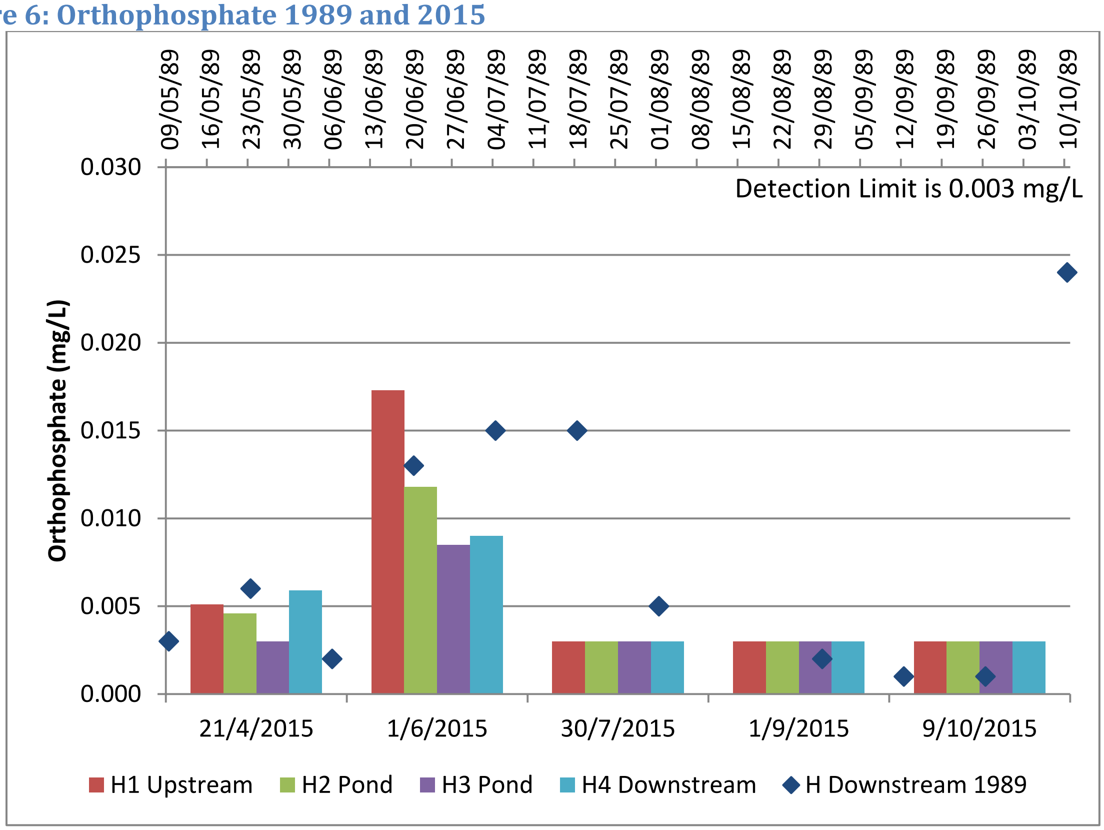


Figure 6: Orthophosphate 1989 and 2015



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.

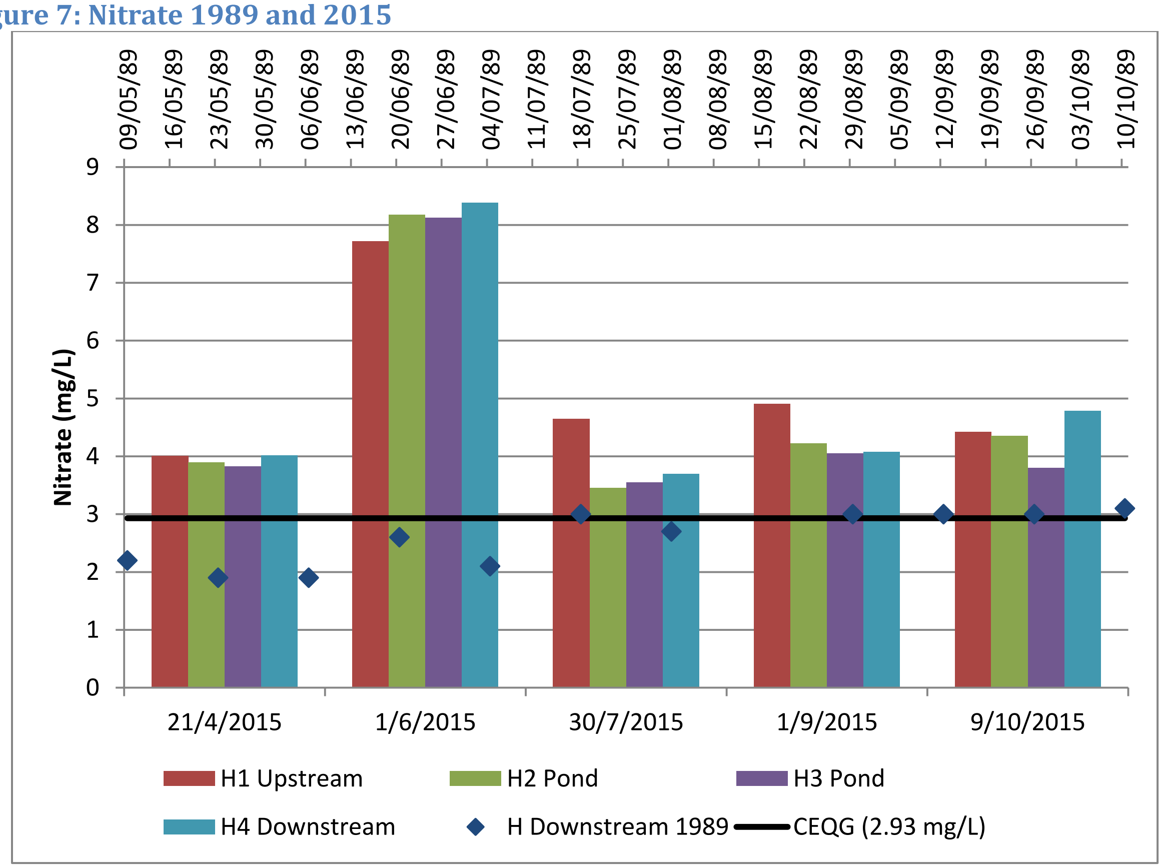
Sources: Nitrate sources can include sewage/animal waste, commercial fertilizers, septic systems, atmospheric deposition and natural decomposition of organic wastes.

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 and in a range typical of the Trout Creek watershed and other Upper Thames sites.
- Nitrates were higher during the rain event sample in 2015 which is to be expected for a water soluble nutrient.
- Nitrates were lower in the 1989 samples which were below or close to the guideline.

Figure 7: Nitrate 1989 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.

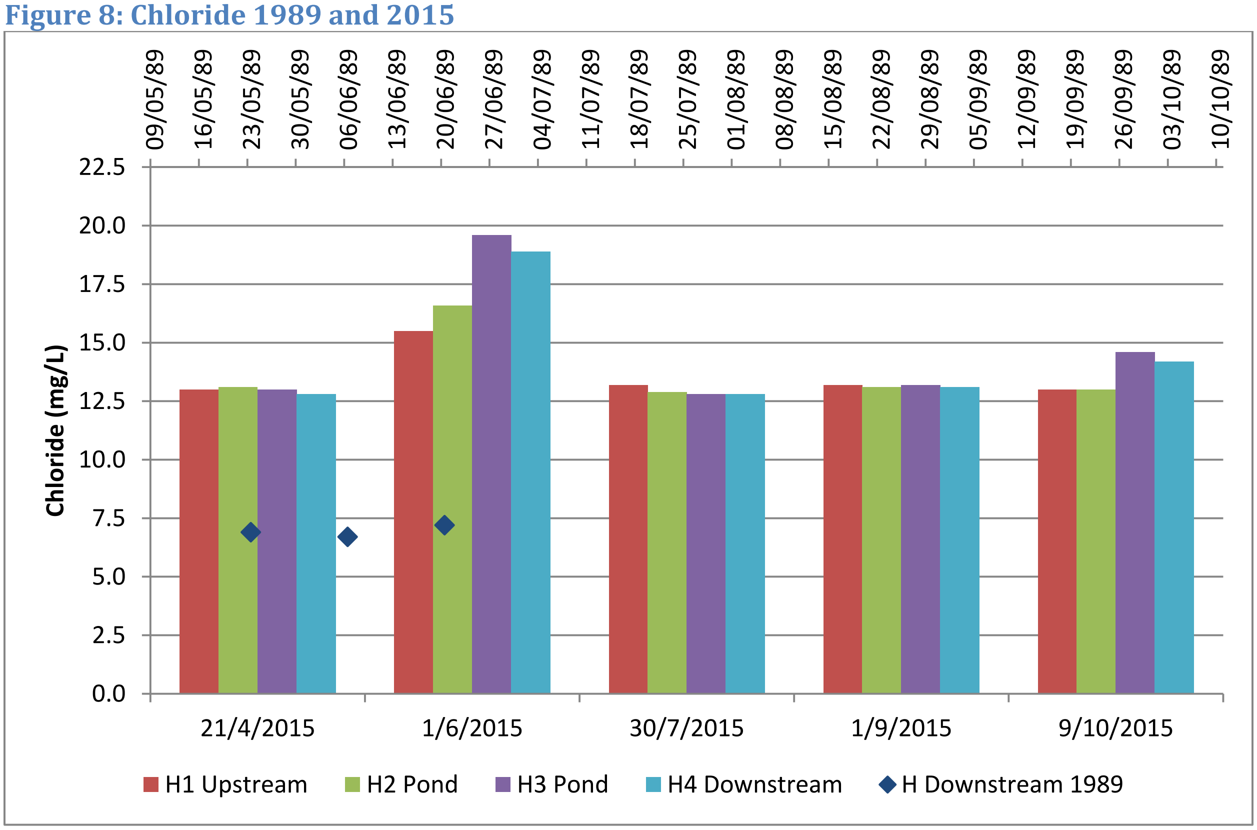
Sources: The highest loadings of chloride are typically associated with the application and storage of road salt (e.g.calcium chloride). Urban streams tend to have the highest chloride concentrations.

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 are well below the guideline for chloride for both 2015 and 1989 which is expected in a rural area.
- The June rain event had somewhat higher levels than the dry weather samples but still very low compared to the guideline.
- 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 1989 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.

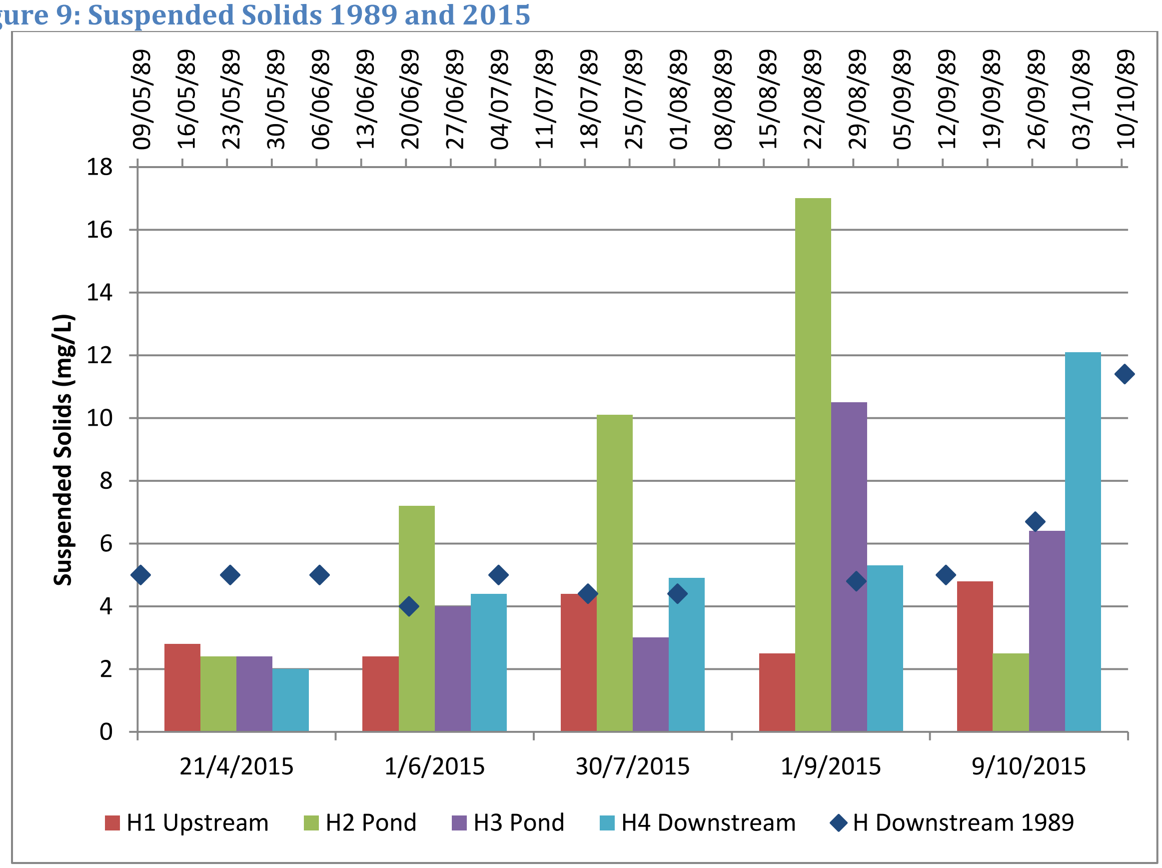
Sources: Soil erosion is the most common source of suspended solids to a watercourse. This can be from cultivated land, construction, development, eroded stream banks or natural erosion of stream beds.

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 somewhat higher than the upstream and downstream samples which can be related to the presence and capture of some accumulated bottom sediments during sampling.

Figure 9: Suspended Solids 1989 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 7mg/l to 13 mg/l and upstream and downstream readings similar.

Metals

A suite of metals, including copper, lead, zinc and iron was tested in each sample as part of standard laboratory tests on two sample dates (April 21 and June 1). Metals are long lasting in the environment where they tend to accumulate in streambed sediments. Metals can bio-accumulate in fish and wildlife and can be toxic to aquatic life at elevated levels. Metals tend to be low in non-urban areas and are typically very low across the Upper Thames watershed.

Results: All sample results on both dates showed very low to non-existent metals in the samples. Only one pond site on the rain event date showed levels of copper above the guideline and zinc at the guideline. This could be a result of some metals in the bottom sediments being captured during sampling.

Discussion

- In general, the water quality in the Harrington-West Drain, where it was sampled upstream, downstream and in Harrington Pond, showed general low levels for the parameters measured in 2015 with numbers typically better than the average seen in Upper Thames watershed streams. The headwaters of this area including a significant wetland complex and natural areas would likely contribute to the quality of this stream.
- The results for 1989 and 2015 were very similar for all parameters with the exception of nitrate which is slightly higher in 2015 compared to the 1989 data.
- Temperature differences are apparent between upstream and downstream of the pond based on continuous measurements and show a greater difference as the summer progressed, likely as a result of the warming effect of the pond.
- 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. Sampling of the bottom sediments would give an indication of any accumulation.

Appendix C

Harrington Dam Area Fish and Benthic Records. Prepared by UTRCA, Updated October 2016

Appendix C

Harrington Dam Area
Fish and Benthic Records

Update Oct 13, 2016

Contents

Fish diversity upstream of Harrington Pond

Species	Status - Global	Can	Ont.	Thames	Thames Distribution	Times Sampled
Blacknose Dace	G5		S5	Abundant	widespread	1
Brook Stickleback	G5		S5	Abundant	widespread	1
Brook Trout (coldwater)	G5T		S5	Uncommon	localized	3
Common Carp	G5		SNA	Abundant	widespread	1
Mottled Sculpin (coldwater)	G5		S5	Uncommon	localized	4
Rock Bass	G5		S5	Abundant	widespread	3
White Sucker	G5		S5	Abundant	widespread	3

Fish diversity downstream of Harrington Dam

Species	Status - Global	Can	Ont.	Thames	Thames Distribution	Times Sampled
Black Bullhead	G5		S4	Common	widespread	7
Blacknose Dace	G5		S5	Abundant	widespread	4
Blackside Darter	G5		S4	Abundant	widespread	13
Bluntnose Minnow	G5		S5	Abundant	widespread	12
Brook Stickleback	G5		S5	Abundant	widespread	2
Brook Trout (coldwater)	G5T		S5	Uncommon	localized	10
Brown Bullhead	G5		S5	Uncommon	widespread	1
Central Mudminnow	G5		S5	Abundant	widespread	5
Central Stoneroller	G5		S4	Abundant	widespread	3
Common Carp	G5		SNA	Abundant	widespread	9
Common Shiner	G5		S5	Abundant	widespread	5
Creek Chub	G5		S5	Abundant	widespread	6
Fathead Minnow	G5		S5	Abundant	widespread	5
Golden Shiner	G5		S5	Common	localized	4
Hornyhead Chub	G5		S4	Abundant	widespread	1
Johnny Darter	G5		S5	Abundant	widespread	10
Largemouth Bass	G5		S5	Abundant	widespread	11
Least Darter	G5		S4	Common	widespread	1
Mottled Sculpin (coldwater)	G5		S5	Uncommon	localized	10
Northern Hog Sucker	G5		S4	Abundant	widespread	2
Northern Pike	G5		S5	Common	widespread	6
Pumpkinseed	G5		S5	Abundant	widespread	7
Rainbow Darter	G5		S4	Uncommon	localized	12
Rainbow Trout	G5		SNA	Common	locally common	4
Rock Bass	G5		S5	Abundant	widespread	13
Smallmouth Bass	G5		S5	Abundant	widespread	12
Stonecat	G5		S4	Abundant	widespread	1
Striped Shiner	G5		S4	Abundant	widespread	2
White Sucker	G5		S5	Abundant	widespread	12
Yellow Perch	G5		S5	Common	widespread	9

Harrington Dam area fish sampling (2015)

Species (Common Name)	Scientific Name	COSEWIC	SARA	ESA 2007	SRank	Abundance	Distribution

Harrington Creek

Upstream of Harrington CA pond | UTM x: 500576 | UTM y: 4787140 | R269 | 4/15/2015

Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Mottled Sculpin	*Cottus bairdi*				S5	Uncommon	localized
Rock Bass	*Ambloplites rupestris*				S5	Abundant	widespread
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread

Upstream of Harrington CA pond | UTM x: 500576 | UTM y: 4787140 | R269 | 11/11/2015

Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Mottled Sculpin	*Cottus bairdi*				S5	Uncommon	localized
Rock Bass	*Ambloplites rupestris*				S5	Abundant	widespread

Harrington-West Drain

31st Line | UTM x: 500617 | UTM y: 4786411 | 815-UT | 11/11/2015

Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread

Harrington Creek

Harrington CA, Rd 96 | UTM x: 500623 | UTM y: 4787599 | HA04 | 4/15/2015

Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread
Blackside Darter	*Percina maculata*				S4	Abundant	widespread
Bluntnose Minnow	*Pimephales notatus*				S5	Abundant	widespread
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Fathead Minnow	*Pimephales promelas*				S5	Abundant	widespread
Mottled Sculpin	*Cottus bairdi*				S5	Uncommon	localized
Rainbow Darter	*Etheostoma caeruleum*				S4	Uncommon	localized
Rainbow Trout	*Oncorhynchus mykiss*				SNA	Common	locally common
Rock Bass	*Ambloplites rupestris*				S5	Abundant	widespread
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread

Harrington CA, Rd 96 | UTM x: 500623 | UTM y: 4787599 | HA04 | 7/22/2015

Black Bullhead	*Ameiurus melas*				S4	Common	widespread
Blackside Darter	*Percina maculata*				S4	Abundant	widespread
Bluntnose Minnow	*Pimephales notatus*				S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Central Mudminnow	*Umbra limi*				S5	Abundant	widespread
Common Carp	*Cyprinus carpio*				SNA	Abundant	widespread
Common Shiner	*Luxilus cornutus*				S5	Abundant	widespread
Creek Chub	*Semotilus atromaculatus*				S5	Abundant	widespread
Johnny Darter	*Etheostoma nigrum*				S5	Abundant	widespread

Largemouth Bass	*Micropterus salmoides*	S5	Abundant	widespread
Mottled Sculpin	*Cottus bairdi*	S5	Uncommon	localized
Northern Hog Sucker	*Hypentelium nigricans*	S4	Abundant	widespread
Northern Pike	*Esox lucius*	S5	Common	widespread
Pumpkinseed	*Lepomis gibbosus*	S5	Abundant	widespread
Rainbow Darter	*Etheostoma caeruleum*	S4	Uncommon	localized
Rainbow Trout	*Oncorhynchus mykiss*	SNA	Common	locally common
Rock Bass	*Ambloplites rupestris*	S5	Abundant	widespread
Smallmouth Bass	*Micropterus dolomieu*	S5	Abundant	widespread
White Sucker	*Catostomus commersoni*	S5	Abundant	widespread
Yellow Perch	*Perca flavescens*	S5	Common	widespread

Harrington CA, Rd 96	UTM x: 500623	UTM y: 4787599	HA04	8/16/2015
Blackside Darter	*Percina maculata*	S4	Abundant	widespread
Bluntnose Minnow	*Pimephales notatus*	S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*	S5	Uncommon	localized
Common Carp	*Cyprinus carpio*	SNA	Abundant	widespread
Creek Chub	*Semotilus atromaculatus*	S5	Abundant	widespread
Johnny Darter	*Etheostoma nigrum*	S5	Abundant	widespread
Largemouth Bass	*Micropterus salmoides*	S5	Abundant	widespread
Mottled Sculpin	*Cottus bairdi*	S5	Uncommon	localized
Northern Pike	*Esox lucius*	S5	Common	widespread
Rainbow Darter	*Etheostoma caeruleum*	S4	Uncommon	localized
Rock Bass	*Ambloplites rupestris*	S5	Abundant	widespread
Smallmouth Bass	*Micropterus dolomieu*	S5	Abundant	widespread
White Sucker	*Catostomus commersoni*	S5	Abundant	widespread

Harrington CA, Rd 96	UTM x: 500623	UTM y: 4787599	HA04	10/19/2015
Blacknose Dace	*Rhinichthys atratulus*	S5	Abundant	widespread
Blackside Darter	*Percina maculata*	S4	Abundant	widespread
Bluntnose Minnow	*Pimephales notatus*	S5	Abundant	widespread
Central Stoneroller	*Campostoma anomalum*	S4	Abundant	widespread
Common Carp	*Cyprinus carpio*	SNA	Abundant	widespread
Common Shiner	*Luxilus cornutus*	S5	Abundant	widespread
Johnny Darter	*Etheostoma nigrum*	S5	Abundant	widespread
Largemouth Bass	*Micropterus salmoides*	S5	Abundant	widespread
Least Darter	*Etheostoma microperca*	S4	Common	widespread
Northern Pike	*Esox lucius*	S5	Common	widespread
Pumpkinseed	*Lepomis gibbosus*	S5	Abundant	widespread
Rock Bass	*Ambloplites rupestris*	S5	Abundant	widespread
Smallmouth Bass	*Micropterus dolomieu*	S5	Abundant	widespread
White Sucker	*Catostomus commersoni*	S5	Abundant	widespread

Species (Common Name)	Scientific Name	COSEWIC	SARA	ESA 2007	SRank	Abundance	Distribution

Harrington Pond

Harrington CA		UTM x: 500663	UTM y: 4787512	TR25	4/15/2015

Species (Common Name)	Scientific Name	COSEWIC	SARA	ESA 2007	SRank	Abundance	Distribution
Common Carp	*Cyprinus carpio*				SNA	Abundant	widespread
Mottled Sculpin	*Cottus bairdi*				S5	Uncommon	localized
Rock Bass	*Ambloplites rupestris*				S5	Abundant	widespread
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread

Harrington Dam area fish sampling (1999 – 2014)

Species (Common Name)	Scientific Name	COSEWIC	SARA	ESA 2007	SRank	Abundance	Distribution

Harrington West Tributary

Road 92 and Line 29		UTM x: 500009	UTM y: 4784089	TR23	8/14/2008

Species (Common Name)	Scientific Name	COSEWIC	SARA	ESA 2007	SRank	Abundance	Distribution
Brook Stickleback	*Culaea inconstans*				S5	Abundant	widespread

Harrington Creek

Upstream of Harrington CA pond		UTM x: 500576	UTM y: 4787140	R269	10/13/1992

Species (Common Name)	Scientific Name	COSEWIC	SARA	ESA 2007	SRank	Abundance	Distribution
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Mottled Sculpin	*Cottus bairdi*				S5	Uncommon	localized

Upstream of Harrington CA pond		UTM x: 500576	UTM y: 4787140	R269	7/21/2009

Species (Common Name)	Scientific Name	COSEWIC	SARA	ESA 2007	SRank	Abundance	Distribution
Brook Trout	*Salvelinus fontinalis*				S5	Uncommon	localized
Mottled Sculpin	*Cottus bairdi*				S5	Uncommon	localized

Harrington Creek

Harrington CA, Rd 96		UTM x: 500600	UTM y: 4787662	HA04	11/29/2004

Species (Common Name)	Scientific Name	COSEWIC	SARA	ESA 2007	SRank	Abundance	Distribution
Black Bullhead	*Ameiurus melas*				S4	Common	widespread
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread
Blackside Darter	*Percina maculata*				S4	Abundant	widespread
Bluntnose Minnow	*Pimephales notatus*				S5	Abundant	widespread
Central Stoneroller	*Campostoma anomalum*				S4	Abundant	widespread
Common Shiner	*Luxilus cornutus*				S5	Abundant	widespread
Creek Chub	*Semotilus atromaculatus*				S5	Abundant	widespread
Largemouth Bass	*Micropterus salmoides*				S5	Abundant	widespread
Rainbow Darter	*Etheostoma caeruleum*				S4	Uncommon	localized
Rock Bass	*Ambloplites rupestris*				S5	Abundant	widespread
Smallmouth Bass	*Micropterus dolomieu*				S5	Abundant	widespread
Striped Shiner	*Luxilus chrysocephalus*				S4	Abundant	widespread
White Sucker	*Catostomus commersoni*				S5	Abundant	widespread
Yellow Perch	*Perca flavescens*				S5	Common	widespread

Harrington CA, Rd 96		UTM x: 500600	UTM y: 4787662	HA04	7/21/2009

Species (Common Name)	Scientific Name	COSEWIC	SARA	ESA 2007	SRank	Abundance	Distribution
Black Bullhead	*Ameiurus melas*				S4	Common	widespread
Blacknose Dace	*Rhinichthys atratulus*				S5	Abundant	widespread
Blackside Darter	*Percina maculata*				S4	Abundant	widespread

Brook Stickleback	*Culaea inconstans*	S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*	S5	Uncommon	localized
Central Stoneroller	*Campostoma anomalum*	S4	Abundant	widespread
Fathead Minnow	*Pimephales promelas*	S5	Abundant	widespread
Golden Shiner	*Notemigonus crysoleucas*	S5	Common	localized
Johnny Darter	*Etheostoma nigrum*	S5	Abundant	widespread
Largemouth Bass	*Micropterus salmoides*	S5	Abundant	widespread
Mottled Sculpin	*Cottus bairdi*	S5	Uncommon	localized
Rainbow Darter	*Etheostoma caeruleum*	S4	Uncommon	localized
Rock Bass	*Ambloplites rupestris*	S5	Abundant	widespread
Smallmouth Bass	*Micropterus dolomieu*	S5	Abundant	widespread
White Sucker	*Catostomus commersoni*	S5	Abundant	widespread
Yellow Perch	*Perca flavescens*	S5	Common	widespread

Harrington CA, Rd 96	UTM x:	500600	UTM y:	4787662	HA04	5/14/2011

Blackside Darter	*Percina maculata*	S4	Abundant	widespread
Bluntnose Minnow	*Pimephales notatus*	S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*	S5	Uncommon	localized
Central Mudminnow	*Umbra limi*	S5	Abundant	widespread
Mottled Sculpin	*Cottus bairdi*	S5	Uncommon	localized
Rainbow Darter	*Etheostoma caeruleum*	S4	Uncommon	localized
Rock Bass	*Ambloplites rupestris*	S5	Abundant	widespread
Smallmouth Bass	*Micropterus dolomieu*	S5	Abundant	widespread
White Sucker	*Catostomus commersoni*	S5	Abundant	widespread

Harrington CA, Rd 96	UTM x:	500600	UTM y:	4787662	HA04	8/28/2012

Black Bullhead	*Ameiurus melas*	S4	Common	widespread
Blackside Darter	*Percina maculata*	S4	Abundant	widespread
Bluntnose Minnow	*Pimephales notatus*	S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*	S5	Uncommon	localized
Brown Bullhead	*Ameiurus nebulosus*	S5	Uncommon	widespread
Central Mudminnow	*Umbra limi*	S5	Abundant	widespread
Common Carp	*Cyprinus carpio*	SNA	Abundant	widespread
Common Shiner	*Luxilus cornutus*	S5	Abundant	widespread
Golden Shiner	*Notemigonus crysoleucas*	S5	Common	localized
Johnny Darter	*Etheostoma nigrum*	S5	Abundant	widespread
Largemouth Bass	*Micropterus salmoides*	S5	Abundant	widespread
Northern Hog Sucker	*Hypentelium nigricans*	S4	Abundant	widespread
Pumpkinseed	*Lepomis gibbosus*	S5	Abundant	widespread
Rainbow Darter	*Etheostoma caeruleum*	S4	Uncommon	localized
Rainbow Trout	*Oncorhynchus mykiss*	SNA	Common	locally common
Rock Bass	*Ambloplites rupestris*	S5	Abundant	widespread
Smallmouth Bass	*Micropterus dolomieu*	S5	Abundant	widespread
Yellow Perch	*Perca flavescens*	S5	Common	widespread

Harrington CA, Rd 96	UTM x:	500600	UTM y:	4787662	HA04	10/25/2012

Black Bullhead	*Ameiurus melas*	S4	Common	widespread

Blackside Darter	*Percina maculata*			S4	Abundant	widespread
Bluntnose Minnow	*Pimephales notatus*			S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*			S5	Uncommon	localized
Common Carp	*Cyprinus carpio*			SNA	Abundant	widespread
Common Shiner	*Luxilus cornutus*			S5	Abundant	widespread
Creek Chub	*Semotilus atromaculatus*			S5	Abundant	widespread
Fathead Minnow	*Pimephales promelas*			S5	Abundant	widespread
Johnny Darter	*Etheostoma nigrum*			S5	Abundant	widespread
Largemouth Bass	*Micropterus salmoides*			S5	Abundant	widespread
Mottled Sculpin	*Cottus bairdi*			S5	Uncommon	localized
Pumpkinseed	*Lepomis gibbosus*			S5	Abundant	widespread
Rainbow Darter	*Etheostoma caeruleum*			S4	Uncommon	localized
Rock Bass	*Ambloplites rupestris*			S5	Abundant	widespread
Smallmouth Bass	*Micropterus dolomieu*			S5	Abundant	widespread
Striped Shiner	*Luxilus chrysocephalus*			S4	Abundant	widespread
White Sucker	*Catostomus commersoni*			S5	Abundant	widespread
Yellow Perch	*Perca flavescens*			S5	Common	widespread
Harrington CA, Rd 96		UTM x: 500600	UTM y:	4787662	HA04	7/12/2013
Blackside Darter	*Percina maculata*			S4	Abundant	widespread
Bluntnose Minnow	*Pimephales notatus*			S5	Abundant	widespread
Common Carp	*Cyprinus carpio*			SNA	Abundant	widespread
Fathead Minnow	*Pimephales promelas*			S5	Abundant	widespread
Johnny Darter	*Etheostoma nigrum*			S5	Abundant	widespread
Largemouth Bass	*Micropterus salmoides*			S5	Abundant	widespread
Mottled Sculpin	*Cottus bairdi*			S5	Uncommon	localized
Northern Pike	*Esox lucius*			S5	Common	widespread
Pumpkinseed	*Lepomis gibbosus*			S5	Abundant	widespread
Rainbow Darter	*Etheostoma caeruleum*			S4	Uncommon	localized
Rock Bass	*Ambloplites rupestris*			S5	Abundant	widespread
Smallmouth Bass	*Micropterus dolomieu*			S5	Abundant	widespread
White Sucker	*Catostomus commersoni*			S5	Abundant	widespread
Yellow Perch	*Perca flavescens*			S5	Common	widespread
Harrington CA, Rd 96		UTM x: 500600	UTM y:	4787662	HA04	7/19/2013
Blackside Darter	*Percina maculata*			S4	Abundant	widespread
Bluntnose Minnow	*Pimephales notatus*			S5	Abundant	widespread
Brook Trout	*Salvelinus fontinalis*			S5	Uncommon	localized
Common Carp	*Cyprinus carpio*			SNA	Abundant	widespread
Johnny Darter	*Etheostoma nigrum*			S5	Abundant	widespread
Largemouth Bass	*Micropterus salmoides*			S5	Abundant	widespread
Mottled Sculpin	*Cottus bairdi*			S5	Uncommon	localized
Northern Pike	*Esox lucius*			S5	Common	widespread
Pumpkinseed	*Lepomis gibbosus*			S5	Abundant	widespread
Rainbow Darter	*Etheostoma caeruleum*			S4	Uncommon	localized
Rock Bass	*Ambloplites rupestris*			S5	Abundant	widespread
Smallmouth Bass	*Micropterus dolomieu*			S5	Abundant	widespread

White Sucker	*Catostomus commersoni*					S5	Abundant	widespread	
Yellow Perch	*Perca flavescens*					S5	Common	widespread	
Harrington CA, Rd 96		UTM x:	500600	UTM y:	4787662		HA04		7/16/2014
Black Bullhead	*Ameiurus melas*					S4	Common	widespread	
Harrington CA, Rd 96		UTM x:	500600	UTM y:	4787662		HA04		10/9/2014
Black Bullhead	*Ameiurus melas*					S4	Common	widespread	
Blackside Darter	*Percina maculata*					S4	Abundant	widespread	
Bluntnose Minnow	*Pimephales notatus*					S5	Abundant	widespread	
Brook Trout	*Salvelinus fontinalis*					S5	Uncommon	localized	
Central Mudminnow	*Umbra limi*					S5	Abundant	widespread	
Common Carp	*Cyprinus carpio*					SNA	Abundant	widespread	
Creek Chub	*Semotilus atromaculatus*					S5	Abundant	widespread	
Fathead Minnow	*Pimephales promelas*					S5	Abundant	widespread	
Golden Shiner	*Notemigonus crysoleucas*					S5	Common	localized	
Hornyhead Chub	*Nocomis biguttatus*					S4	Abundant	widespread	
Johnny Darter	*Etheostoma nigrum*					S5	Abundant	widespread	
Largemouth Bass	*Micropterus salmoides*					S5	Abundant	widespread	
Mottled Sculpin	*Cottus bairdi*					S5	Uncommon	localized	
Pumpkinseed	*Lepomis gibbosus*					S5	Abundant	widespread	
Rainbow Darter	*Etheostoma caeruleum*					S4	Uncommon	localized	
Rock Bass	*Ambloplites rupestris*					S5	Abundant	widespread	
Smallmouth Bass	*Micropterus dolomieu*					S5	Abundant	widespread	
White Sucker	*Catostomus commersoni*					S5	Abundant	widespread	
Yellow Perch	*Perca flavescens*					S5	Common	widespread	

Harrington-West Drain

31st Line		UTM x:	500617	UTM y:	4786411		815-UT		10/25/1999
Brook Trout	*Salvelinus fontinalis*					S5	Uncommon	localized	
Mottled Sculpin	*Cottus bairdi*					S5	Uncommon	localized	
White Sucker	*Catostomus commersoni*					S5	Abundant	widespread	
31st Line		UTM x:	500617	UTM y:	4786411		815-UT		8/14/2008
Blacknose Dace	*Rhinichthys atratulus*					S5	Abundant	widespread	
Brook Trout	*Salvelinus fontinalis*					S5	Uncommon	localized	
White Sucker	*Catostomus commersoni*					S5	Abundant	widespread	

Global Rank (GRANK): Global ranks are assigned by a consensus of the network of natural heritage programs (conservation data centres), scientific experts, and The Nature Conservancy to designate a rarity rank based on the range-wide status of a species, subspecies or variety. The most important factors considered in assigning global (and provincial) ranks are the total number of known, extant sites world-wide, and the degree to which they are potentially or actively threatened with destruction. Other criteria include the number of known populations considered to be securely protected, the size of the various populations, and the ability of the taxon to persist at its known sites. The taxonomic distinctness of each taxon has also been considered. Hybrids, introduced species, and taxonomically dubious species, subspecies and varieties have not been included.
G1 Extremely rare; usually 5 or fewer occurrences in the overall range or very few remaining individuals; or because some factor(s) making it especially vulnerable to extinction.
G2 Very rare; usually between 5 and 20 occurrences in the overall range or with many individuals in fewer occurrences; or because of some factor(s) making it vulnerable to extinction.
G3 Rare to uncommon; usually between 20 and 100 occurrences; may have fewer occurrences, but with a large number of individuals in some populations; may be susceptible to large-scale disturbances.
G4 Common; usually more than 100 occurrences; usually not susceptible to immediate threats.
G5 Very common; demonstrably secure under present conditions.

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.
References: http://www.sararegistry.gc.ca/species/schedules_e.cfm?id=1 https://www.registrelep-sararegistry.gc.ca/sar/index/default_e.cfm?stype=speciesindex=1cosid=common=scientific=population=taxid=3locid=0desid= 0schid=0desid2=0 http://www.cosewic.gc.ca/eng/sct0/rpt/rpt_csar_e.pdf http://www.cosewic.gc.ca/eng/sct5/index_e.cfm (current to September 2009)

Provincial Rank (SRANK): Provincial (or Subnational) ranks are used by the Natural Heritage Information Centre to set protection priorities for rare species and natural communities. These ranks are not legal designations. Provincial ranks are assigned in a manner similar to that described for global ranks, but consider only those factors within the political boundaries of Ontario. By comparing the global and provincial ranks, the status, rarity, and the urgency of conservation, needs can be ascertained. The NHIC evaluates provincial ranks on a continual basis and produces updated lists at least annually. The NHIC welcomes information which will assist in assigning accurate provincial ranks.
S1 Extremely rare in Ontario; usually 5 or fewer occurrences in the province or very few remaining individuals; often especially vulnerable to extirpation.
S2 Very rare in Ontario; usually between 5 and 20 occurrences in the province or with many individuals in fewer occurrences; often susceptible to extirpation.
S3 Rare to uncommon in Ontario; usually between 20 and 100 occurrences in the province; may have fewer occurrences, but with a large number of individuals in some populations; may be susceptible to large-scale disturbances. Most species with an S3 rank are assigned to the watch list, unless they have a relatively high global rank.
S4 Common and apparently secure in Ontario; usually with more than 100 occurrences in the province.
S5 Very common and demonstrably secure in Ontario.
S? 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.
SE Exotic; not believed to be a native component of Ontario's flora

Harrington Dam area benthic water quality sampling summary

Harrington Creek upstream of dam

31st Line, 1.1 km south of Rd. 96 (near Harrington)

Site code: TR21 UTM X Coordinate: 500617 UTM Y Coordinate: 4786411

DATE	FBI	QUALITY
6/4/1997	5.63	Fair
6/22/1998	5.56	Fair
6/25/1999	5.67	Fair
6/25/1999	5.75	Fairly Poor
6/5/2000	5.33	Fair
10/2/2000	5.68	Fair
6/19/2001	4.93	Good
6/19/2002	4.86	Good
6/10/2003	5.04	Fair
5/31/2004	5.02	Fair
5/30/2006	5.35	Fair
10/6/2006	5.51	Fair
5/30/2007	5.42	Fair
10/1/2007	5.59	Fair
5/28/2008	5.59	Fair
10/3/2008	5.24	Fair
6/9/2009	5.67	Fair
9/29/2009	5.71	Fair
5/18/2010	4.94	Good
6/15/2010	5.51	Fair
10/5/2010	5.40	Fair
5/10/2011	4.65	Good
9/28/2011	5.84	Fairly Poor
5/9/2012	4.96	Good
9/26/2012	5.98	Fairly Poor
2/13/2013	4.95	Good
5/3/2013	4.85	Good
9/27/2013	6.57	Poor
5/8/2014	4.52	Good
9/26/2014	5.37	Fair
5/8/2015	4.68	Good
9/23/2015	5.53	Fair

Harrington Creek downstream of dam

Site code: TR41 UTM X Coordinate: 500623 UTM Y Coordinate 4787599

10/18/2010	5.40	Fair
5/8/2015	6.73	Poor
9/23/2015	5.71	Fair

Harrington Dam area benthic sampling data (1997 – 2015)

Taxonomic Name | **Common Name** | **Life Stage** | **# in Subsample** | **Biotic Index**

Harrington Creek upstream of pond

31st Line, 1.1 km south of Rd. 96 (near Harrington)

Site code: TR21 UTM X: 500617 UTM Y: 4786411

Sampled - 6/4/1997

REP: 1

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Acariformes	Water Mite	A	6	6
Baetidae	Small Mayfly	N	2	6
Chironomidae	Midge	L	38	6
Elmidae	Riffle Beetle	L	9	5
Elmidae	Riffle Beetle	A	2	5
Empididae	Dance Fly	L	9	6
Hyalellidae	Sideswimmer	A	6	8
Hydropsychidae	Net-spinning Caddisfly	L	7	5
Nematoda	Thread Worm	A	1	5
Nemouridae	Stonefly	N	5	2
Pisidiidae	Fingernail Clam	A	9	6
Simuliidae	Black Fly	P	1	5
Tabanidae	Horse Fly	L	3	5
Uenoidae	Caddisfly	L	2	3

Stream Health **Fair** **Family Biotic Index** **5.63**

Sampled - 6/22/1998

REP: 1

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Acariformes	Water Mite	A	1	6
Baetidae	Small Mayfly	N	16	6
Ceratopogonidae	Biting Midge	L	1	6
Chironomidae	Midge	P	4	6
Chironomidae	Midge	L	64	6
Elmidae	Riffle Beetle	L	5	5
Empididae	Dance Fly	L	2	6
Hydropsychidae	Net-spinning Caddisfly	L	1	5
Lepidostomatidae	*Lepistomatid* Caddisfly	L	2	1
Leptoceridae	Long-horned Caddisfly	L	1	4
Leuctridae	Stonefly	N	5	0
Oligochaeta	Aquatic Worm	A	2	8
Simuliidae	Black Fly	L	2	5
Tabanidae	Horse Fly	L	1	5

Stream Health **Fair** **Family Biotic Index** **5.56**

Sampled - 6/25/1999

REP: 1

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Acariformes	Water Mite	A	8	6
Baetidae	Small Mayfly	N	19	6
Capniidae	Stonefly	N	5	3
Chironomidae	Midge	L	72	6
Chironomidae	Midge	P	1	6
Elmidae	Riffle Beetle	A	1	5
Elmidae	Riffle Beetle	L	2	5
Empididae	Dance Fly	L	2	6
Isotomidae	Springtail	A	1	5
Lepidostomatidae	*Lepistomatid* Caddisfly	L	3	1
Nematoda	Thread Worm	A	3	5
Physidae	Pouch Snail	A	1	8
Pisidiidae	Fingernail Clam	A	1	6
Simuliidae	Black Fly	L	2	5
Tipulidae	Crane Fly	L	2	4

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
	Stream Health	**Fair**	**Family Biotic Index**	**5.67**
	REP: 2			
Acariformes	Water Mite	A	6	6
Baetidae	Small Mayfly	N	40	6
Capniidae	Stonefly	N	6	3
Chironomidae	Midge	L	89	6
Chironomidae	Midge	P	1	6
Elmidae	Riffle Beetle	L	4	5
Elmidae	Riffle Beetle	A	1	5
Empididae	Dance Fly	L	2	6
Hydropsychidae	Net-spinning Caddisfly	L	2	5
Nematoda	Thread Worm	A	1	5
Rhyacophilidae	Primative Caddisfly	L	2	1
Simuliidae	Black Fly	L	3	5
	Stream Health	**Fairly Poor**	**Family Biotic Index**	**5.75**
Sampled - 6/5/2000				
	REP: 1			
Acariformes	Water Mite	A	4	6
Baetidae	Small Mayfly	N	26	6
Chironomidae	Midge	P	8	6
Chironomidae	Midge	L	67	6
Elmidae	Riffle Beetle	L	4	5
Empididae	Dance Fly	L	1	6
Leuctridae	Stonefly	N	13	0
Nematoda	Thread Worm	A	2	5
Nemouridae	Stonefly	N	1	2
Oligochaeta	Aquatic Worm	A	2	8
Simuliidae	Black Fly	L	1	5
Tipulidae	Crane Fly	L	1	4
	Stream Health	**Fair**	**Family Biotic Index**	**5.33**
Sampled - 10/2/2000				
	REP: 1			
Acariformes	Water Mite	A	9	6
Chironomidae	Midge	P	7	6
Chironomidae	Midge	L	38	6
Elmidae	Riffle Beetle	L	5	5
Empididae	Dance Fly	L	7	6
Gammaridae	Sideswimmer	A	1	6
Hydropsychidae	Net-spinning Caddisfly	L	20	5
Lepidostomatidae	*Lepistomatid* Caddisfly	L	3	1
Lymnaeidae	Pond Snail	A	1	6
Nemouridae	Stonefly	N	1	2
Oligochaeta	Aquatic Worm	A	7	8
Physidae	Pouch Snail	A	1	8
Pisidiidae	Fingernail Clam	A	1	6
Simuliidae	Black Fly	L	4	5
Tipulidae	Crane Fly	L	1	4
	Stream Health	**Fair**	**Family Biotic Index**	**5.68**
Sampled - 6/19/2001				
	REP: 1			
Acariformes	Water Mite	A	1	6
Baetidae	Small Mayfly	N	66	6
Chironomidae	Midge	P	1	6
Chironomidae	Midge	L	66	6

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Elmidae	Riffle Beetle	L	9	5
Elmidae	Riffle Beetle	A	2	5
Empididae	Dance Fly	P	1	6
Empididae	Dance Fly	L	1	6
Gammaridae	Sideswimmer	A	2	6
Hydropsychidae	Net-spinning Caddisfly	L	4	5
Leuctridae	Stonefly	N	34	0
Nematoda	Thread Worm	A	2	5
Oligochaeta	Aquatic Worm	A	3	8
Physidae	Pouch Snail	A	1	8
Psychodidae	Sand Fly	L	1	10
Simuliidae	Black Fly	L	10	5
Turbellaria	Flatworm	A	1	6
	Stream Health **Good**		**Family Biotic Index**	**4.93**
Sampled - 6/19/2002				
	REP: 1			
Acariformes	Water Mite	A	4	6
Baetidae	Small Mayfly	N	58	6
Chironomidae	Midge	P	8	6
Chironomidae	Midge	L	64	6
Coenagrionidae	Narrow-winged Damselfly	N	1	8
Elmidae	Riffle Beetle	L	8	5
Elmidae	Riffle Beetle	A	4	5
Empididae	Dance Fly	L	2	6
Leuctridae	Stonefly	N	38	0
Nemouridae	Stonefly	N	2	2
Oligochaeta	Aquatic Worm	A	7	8
Pisidiidae	Fingernail Clam	A	1	6
Psychodidae	Sand Fly	L	1	10
Simuliidae	Black Fly	L	8	5
Tabanidae	Horse Fly	L	1	5
	Stream Health **Good**		**Family Biotic Index**	**4.86**
Sampled - 6/10/2003				
	REP: 1			
Acariformes	Water Mite	A	4	6
Baetidae	Small Mayfly	N	108	6
Ceratopogonidae	Biting Midge	L	1	6
Chironomidae	Midge	L	66	6
Chironomidae	Midge	P	12	6
Elmidae	Riffle Beetle	A	4	5
Elmidae	Riffle Beetle	L	36	5
Empididae	Dance Fly	L	7	6
Empididae	Dance Fly	P	1	6
Glossiphoniidae	Leech	A	2	8
Hyalellidae	Sideswimmer	A	1	8
Leuctridae	Stonefly	N	34	0
Nematoda	Thread Worm	A	1	5
Nemouridae	Stonefly	N	9	2
Pisidiidae	Fingernail Clam	A	2	6
Simuliidae	Black Fly	L	4	5
Tabanidae	Horse Fly	L	1	5
	Stream Health **Fair**		**Family Biotic Index**	**5.04**
Sampled - 5/31/2004				
	REP: 1			
Acariformes	Water Mite	A	7	6

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Baetidae	Small Mayfly	N	31	6
Ceratopogonidae	Biting Midge	L	2	6
Chironomidae	Midge	L	85	6
Chironomidae	Midge	P	2	6
Elmidae	Riffle Beetle	A	2	5
Elmidae	Riffle Beetle	L	11	5
Empididae	Dance Fly	L	10	6
Hyalellidae	Sideswimmer	A	1	8
Leptophlebiidae	Mayfly	N	1	4
Leuctridae	Stonefly	N	30	0
Limnephilidae	Northern Caddisfly	L	1	4
Nemouridae	Stonefly	N	1	2
Oligochaeta	Aquatic Worm	A	4	8
Pisidiidae	Fingernail Clam	A	12	6
Rhyacophilidae	Primative Caddisfly	L	1	1
Simuliidae	Black Fly	L	11	5
Tipulidae	Crane Fly	L	1	4

Stream Health **Fair** **Family Biotic Index** **5.02**

Sampled - 5/30/2006

REP: 1

Acariformes	Water Mite	A	7	6
Baetidae	Small Mayfly	N	48	6
Capniidae	Stonefly	N	18	3
Ceratopogonidae	Biting Midge	L	3	6
Chironomidae	Midge	P	3	6
Chironomidae	Midge	L	159	6
Elmidae	Riffle Beetle	L	60	5
Elmidae	Riffle Beetle	A	4	5
Empididae	Dance Fly	L	11	6
Gammaridae	Sideswimmer	A	1	6
Hydroptilidae	Micro-caddisfly	L	2	6
Leuctridae	Stonefly	N	14	0
Lymnaeidae	Pond Snail	A	1	6
Nemouridae	Stonefly	N	3	2
Oligochaeta	Aquatic Worm	A	2	8
Pisidiidae	Fingernail Clam	A	11	6
Simuliidae	Black Fly	L	11	5
Tabanidae	Horse Fly	L	1	5
Taeniopterygidae	Stonefly	N	3	2

Stream Health **Fair** **Family Biotic Index** **5.35**

Sampled - 10/6/2006

REP: 1

Acariformes	Water Mite	A	12	6
Asellidae	Sow Bug	A	1	8
Caenidae	Crawling Mayfly	N	1	6
Chironomidae	Midge	L	117	6
Chironomidae	Midge	P	20	6
Elmidae	Riffle Beetle	L	48	5
Elmidae	Riffle Beetle	A	1	5
Empididae	Dance Fly	L	5	6
Hyalellidae	Sideswimmer	A	20	8
Hydropsychidae	Net-spinning Caddisfly	L	8	5
Hydroptilidae	Micro-caddisfly	L	2	6
Hydroptilidae	Micro-caddisfly	P	1	6
Leptophlebiidae	Mayfly	N	5	4
Leuctridae	Stonefly	N	2	0

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Limnephilidae	Northern Caddisfly	L	2	4
Nematoda	Thread Worm	A	1	5
Nemouridae	Stonefly	N	30	2
Oligochaeta	Aquatic Worm	A	3	8
Physidae	Pouch Snail	A	8	8
Pisidiidae	Fingernail Clam	A	11	6
Rhyacophilidae	Primative Caddisfly	L	1	1
Simuliidae	Black Fly	L	1	5
Tipulidae	Crane Fly	L	1	4
	Stream Health **Fair**		**Family Biotic Index**	**5.51**

Sampled - 5/30/2007

REP: 1

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Acariformes	Water Mite	A	3	6
Baetidae	Small Mayfly	N	34	6
Capniidae	Stonefly	N	40	3
Ceratopogonidae	Biting Midge	L	2	6
Chironomidae	Midge	P	9	6
Chironomidae	Midge	L	170	6
Elmidae	Riffle Beetle	A	2	5
Elmidae	Riffle Beetle	L	49	5
Empididae	Dance Fly	L	10	6
Gomphidae	Clubtail Dragonfly	N	1	4
Hyalellidae	Sideswimmer	A	3	8
Hydropsychidae	Net-spinning Caddisfly	L	3	5
Leptohyphidae	Crawling Mayfly	N	1	4
Limnephilidae	Northern Caddisfly	L	1	4
Nemouridae	Stonefly	N	3	2
Oligochaeta	Aquatic Worm	A	2	8
Pisidiidae	Fingernail Clam	A	3	6
Simuliidae	Black Fly	L	11	5
Taeniopterygidae	Stonefly	N	1	2
Tipulidae	Crane Fly	L	3	4
	Stream Health **Fair**		**Family Biotic Index**	**5.42**

Sampled - 10/1/2007

REP: 1

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Acariformes	Water Mite	A	10	6
Baetidae	Small Mayfly	N	3	6
Caenidae	Crawling Mayfly	N	1	6
Capniidae	Stonefly	N	2	3
Chironomidae	Midge	P	19	6
Chironomidae	Midge	L	166	6
Elmidae	Riffle Beetle	L	27	5
Empididae	Dance Fly	L	3	6
Gammaridae	Sideswimmer	A	7	6
Heptageniidae	Stream Mayfly	N	1	3
Hyalellidae	Sideswimmer	A	10	8
Hydropsychidae	Net-spinning Caddisfly	L	9	5
Leptophlebiidae	Mayfly	N	6	4
Limnephilidae	Northern Caddisfly	L	3	4
Muscidae	Muscid Fly	L	6	6
Nematoda	Thread Worm	A	1	5
Nemouridae	Stonefly	N	7	2
Oligochaeta	Aquatic Worm	A	2	8
Physidae	Pouch Snail	A	4	8
Pisidiidae	Fingernail Clam	A	1	6
Pyralidae	Pyralid Moth	L	1	5

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Rhyacophilidae	Primative Caddisfly	L	10	1
Simuliidae	Black Fly	L	1	5
Taeniopterygidae	Stonefly	N	3	2
Tipulidae	Crane Fly	L	1	4

Stream Health	**Fair**		**Family Biotic Index**	**5.59**

Sampled - 5/28/2008

REP: 1

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Acariformes	Water Mite	A	6	6
Baetidae	Small Mayfly	N	18	6
Capniidae	Stonefly	N	16	3
Chironomidae	Midge	L	155	6
Chironomidae	Midge	P	9	6
Dytiscidae	Predacious Diving Beetle	L	1	5
Elmidae	Riffle Beetle	A	9	5
Elmidae	Riffle Beetle	L	26	5
Empididae	Dance Fly	L	6	6
Hyalellidae	Sideswimmer	A	2	8
Limnephilidae	Northern Caddisfly	L	1	4
Nematoda	Thread Worm	A	1	5
Nemouridae	Stonefly	N	8	2
Oligochaeta	Aquatic Worm	A	6	8
Perlodidae	Stonefly	N	1	2
Philopotamidae	Finger-net Caddisfly	L	1	4
Pisidiidae	Fingernail Clam	A	11	6
Simuliidae	Black Fly	L	10	5

Stream Health	**Fair**		**Family Biotic Index**	**5.59**

Sampled - 10/3/2008

REP: 1

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Acariformes	Water Mite	A	22	6
Caenidae	Crawling Mayfly	N	1	6
Capniidae	Stonefly	N	2	3
Ceratopogonidae	Biting Midge	L	4	6
Chironomidae	Midge	L	115	6
Chironomidae	Midge	P	15	6
Elmidae	Riffle Beetle	L	53	5
Elmidae	Riffle Beetle	A	1	5
Empididae	Dance Fly	L	10	6
Gammaridae	Sideswimmer	A	10	6
Glossosomatidae	Caddisfly	L	1	1
Hyalellidae	Sideswimmer	A	9	8
Hydropsychidae	Net-spinning Caddisfly	L	22	5
Lepidostomatidae	*Lepistomatid* Caddisfly	L	6	1
Leptoceridae	Long-horned Caddisfly	L	1	4
Leptophlebiidae	Mayfly	N	8	4
Molannidae		L	1	6
Nematoda	Thread Worm	A	4	5
Nemouridae	Stonefly	N	10	2
Oligochaeta	Aquatic Worm	A	4	8
Physidae	Pouch Snail	A	1	8
Pisidiidae	Fingernail Clam	A	6	6
Planorbidae	Orb Snail	A	1	6
Rhyacophilidae	Primative Caddisfly	L	16	1
Taeniopterygidae	Stonefly	N	5	2
Turbellaria	Flatworm	A	2	6

Stream Health	**Fair**		**Family Biotic Index**	**5.24**

Sampled - 6/9/2009

	REP: 1			
Acariformes	Water Mite	A	4	6
Baetidae	Small Mayfly	N	44	6
Capniidae	Stonefly	N	18	3
Ceratopogonidae	Biting Midge	L	7	6
Chironomidae	Midge	P	7	6
Chironomidae	Midge	L	186	6
Corixidae	Water Boatmen	A	1	5
Dytiscidae	Predacious Diving Beetle	L	1	5
Elmidae	Riffle Beetle	A	2	5
Elmidae	Riffle Beetle	L	4	5
Empididae	Dance Fly	L	2	6
Heptageniidae	Stream Mayfly	N	3	3
Hyalellidae	Sideswimmer	A	1	8
Hydropsychidae	Net-spinning Caddisfly	L	3	5
Hydroptilidae	Micro-caddisfly	L	2	6
Muscidae	Muscid Fly	L	1	6
Nematoda	Thread Worm	A	3	5
Oligochaeta	Aquatic Worm	A	12	8
Pisidiidae	Fingernail Clam	A	3	6
Simuliidae	Black Fly	L	63	5
Taeniopterygidae	Stonefly	N	1	2
Tipulidae	Crane Fly	L	1	4
	Stream Health	**Fair**	**Family Biotic Index**	**5.67**

Sampled - 9/29/2009

	REP: 1			
Acariformes	Water Mite	A	6	6
Baetidae	Small Mayfly	N	2	6
Caenidae	Crawling Mayfly	N	2	6
Ceratopogonidae	Biting Midge	L	3	6
Chironomidae	Midge	L	208	6
Chironomidae	Midge	P	14	6
Elmidae	Riffle Beetle	L	39	5
Elmidae	Riffle Beetle	A	2	5
Empididae	Dance Fly	L	9	6
Gammaridae	Sideswimmer	A	4	6
Hyalellidae	Sideswimmer	A	1	8
Hydropsychidae	Net-spinning Caddisfly	L	16	5
Limnephilidae	Northern Caddisfly	L	2	4
Nematoda	Thread Worm	A	7	5
Nemouridae	Stonefly	N	1	2
Oligochaeta	Aquatic Worm	A	1	8
Pisidiidae	Fingernail Clam	A	3	6
Planorbidae	Orb Snail	A	1	6
Rhyacophilidae	Primative Caddisfly	L	2	1
Simuliidae	Black Fly	L	1	5
Taeniopterygidae	Stonefly	N	4	2
	Stream Health	**Fair**	**Family Biotic Index**	**5.71**

Sampled - 5/18/2010

	REP: 1			
Acariformes	Water Mite	A	9	6
Baetidae	Small Mayfly	N	27	6
Capniidae	Stonefly	N	47	3
Chironomidae	Midge	L	80	6

Chironomidae	Midge	P	6	6
Dytiscidae	Predacious Diving Beetle	L	1	5
Elmidae	Riffle Beetle	A	7	5
Elmidae	Riffle Beetle	L	38	5
Empididae	Dance Fly	L	8	6
Heptageniidae	Stream Mayfly	N	1	3
Hyalellidae	Sideswimmer	A	1	8
Hydropsychidae	Net-spinning Caddisfly	L	1	5
Lepidostomatidae	*Lepistomatid* Caddisfly	L	1	1
Limnephilidae	Northern Caddisfly	L	6	4
Nematoda	Thread Worm	A	10	5
Nemouridae	Stonefly	N	16	2
Oligochaeta	Aquatic Worm	A	5	8
Philopotamidae	Finger-net Caddisfly	L	1	4
Pisidiidae	Fingernail Clam	A	5	6
Rhyacophilidae	Primative Caddisfly	L	2	1
Simuliidae	Black Fly	P	4	5
Simuliidae	Black Fly	L	29	5
Taeniopterygidae	Stonefly	N	1	2
Tipulidae	Crane Fly	L	1	4
Veliidae	Ripple Bug	A	1	-1
	Stream Health	**Good**	**Family Biotic Index**	**4.94**

Sampled - 6/15/2010

REP: 2

Acariformes	Water Mite	A	4	6
Baetidae	Small Mayfly	N	28	6
Capniidae	Stonefly	N	24	3
Ceratopogonidae	Biting Midge	L	2	6
Chironomidae	Midge	L	163	6
Chironomidae	Midge	P	4	6
Chloroperlidae	Stonefly	N	1	0
Dytiscidae	Predacious Diving Beetle	L	2	5
Elmidae	Riffle Beetle	L	28	5
Elmidae	Riffle Beetle	A	2	5
Empididae	Dance Fly	L	12	6
Hydroptilidae	Micro-caddisfly	L	2	6
Lepidostomatidae	*Lepistomatid* Caddisfly	L	2	1
Nematoda	Thread Worm	A	1	5
Nemouridae	Stonefly	N	3	2
Oligochaeta	Aquatic Worm	A	5	8
Pisidiidae	Fingernail Clam	A	2	6
Simuliidae	Black Fly	L	28	5
Tipulidae	Crane Fly	L	2	4
	Stream Health	**Fair**	**Family Biotic Index**	**5.51**

Sampled - 10/5/2010

REP: 1

Acariformes	Water Mite	A	24	6
Baetidae	Small Mayfly	N	3	6
Ceratopogonidae	Biting Midge	L	2	6
Chironomidae	Midge	P	14	6
Chironomidae	Midge	L	124	6
Elmidae	Riffle Beetle	L	52	5
Elmidae	Riffle Beetle	A	2	5
Empididae	Dance Fly	L	8	6
Hyalellidae	Sideswimmer	A	6	8
Hydropsychidae	Net-spinning Caddisfly	L	57	5

Hydroptilidae	Micro-caddisfly	L	1	6
Lepidostomatidae	*Lepistomatid* Caddisfly	L	2	1
Leptophlebiidae	Mayfly	N	1	4
Nematoda	Thread Worm	A	1	5
Nemouridae	Stonefly	N	7	2
Oligochaeta	Aquatic Worm	A	3	8
Philopotamidae	Finger-net Caddisfly	L	3	4
Pisidiidae	Fingernail Clam	A	4	6
Rhyacophilidae	Primative Caddisfly	L	5	1
Sialidae	Alderfly	N	1	4
Simuliidae	Black Fly	L	2	5
Taeniopterygidae	Stonefly	N	6	2
Tipulidae	Crane Fly	L	2	4
	Stream Health **Fair**		**Family Biotic Index**	**5.40**

Sampled - 5/10/2011

REP: 1

Acariformes	Water Mite	A	15	6
Baetidae	Small Mayfly	N	28	6
Capniidae	Stonefly	N	62	3
Ceratopogonidae	Biting Midge	L	1	6
Chironomidae	Midge	L	63	6
Chironomidae	Midge	P	7	6
Elmidae	Riffle Beetle	A	9	5
Elmidae	Riffle Beetle	L	48	5
Empididae	Dance Fly	P	1	6
Empididae	Dance Fly	L	12	6
Hyalellidae	Sideswimmer	A	8	8
Hydropsychidae	Net-spinning Caddisfly	L	1	5
Lepidostomatidae	*Lepistomatid* Caddisfly	L	7	1
Limnephilidae	Northern Caddisfly	L	3	4
Nematoda	Thread Worm	A	1	5
Nemouridae	Stonefly	N	42	2
Oligochaeta	Aquatic Worm	A	7	8
Physidae	Pouch Snail	A	1	8
Pisidiidae	Fingernail Clam	A	2	6
Rhyacophilidae	Primative Caddisfly	L	1	1
Tipulidae	Crane Fly	L	4	4
	Stream Health **Good**		**Family Biotic Index**	**4.65**

Sampled - 9/28/2011

REP: 1

Acariformes	Water Mite	A	21	6
Baetidae	Small Mayfly	N	1	6
Caenidae	Crawling Mayfly	N	1	6
Ceratopogonidae	Biting Midge	L	1	6
Chironomidae	Midge	P	21	6
Chironomidae	Midge	L	201	6
Elmidae	Riffle Beetle	L	14	5
Empididae	Dance Fly	L	8	6
Hyalellidae	Sideswimmer	A	8	8
Hydropsychidae	Net-spinning Caddisfly	L	7	5
Lepidostomatidae	*Lepistomatid* Caddisfly	L	1	1
Leptophlebiidae	Mayfly	N	2	4
Nematoda	Thread Worm	A	1	5
Nemouridae	Stonefly	N	3	2
Oligochaeta	Aquatic Worm	A	5	8
Pisidiidae	Fingernail Clam	A	3	6

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Rhyacophilidae	Primative Caddisfly	L	3	1
Taeniopterygidae	Stonefly	N	4	2
Tipulidae	Crane Fly	L	1	4
	Stream Health	**Fairly Poor**	**Family Biotic Index**	**5.84**

Sampled - 5/9/2012

REP: 1

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Acariformes	Water Mite	A	11	6
Asellidae	Sow Bug	A	10	8
Baetidae	Small Mayfly	N	41	6
Capniidae	Stonefly	N	22	3
Ceratopogonidae	Biting Midge	L	3	6
Chironomidae	Midge	L	151	6
Chironomidae	Midge	P	1	6
Dytiscidae	Predacious Diving Beetle	A	2	5
Elmidae	Riffle Beetle	L	30	5
Elmidae	Riffle Beetle	A	6	5
Empididae	Dance Fly	L	8	6
Gammaridae	Sideswimmer	A	2	6
Hydropsychidae	Net-spinning Caddisfly	L	1	5
Hydroptilidae	Micro-caddisfly	L	1	6
Lepidostomatidae	*Lepistomatid* Caddisfly	L	1	1
Leuctridae	Stonefly	N	14	0
Nematoda	Thread Worm	A	1	5
Nemouridae	Stonefly	N	47	2
Oligochaeta	Aquatic Worm	A	1	8
Philopotamidae	Finger-net Caddisfly	L	8	4
Pisidiidae	Fingernail Clam	A	3	6
Simuliidae	Black Fly	L	6	5
Simuliidae	Black Fly	P	1	5
Tipulidae	Crane Fly	L	1	4
	Stream Health	**Good**	**Family Biotic Index**	**4.96**

Sampled - 9/26/2012

REP: 1

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Acariformes	Water Mite	A	12	6
Asellidae	Sow Bug	A	58	8
Baetidae	Small Mayfly	N	18	6
Capniidae	Stonefly	N	2	3
Chironomidae	Midge	P	5	6
Chironomidae	Midge	L	117	6
Elmidae	Riffle Beetle	A	1	5
Elmidae	Riffle Beetle	L	26	5
Empididae	Dance Fly	L	4	6
Gammaridae	Sideswimmer	A	5	6
Hydropsychidae	Net-spinning Caddisfly	L	43	5
Leptoceridae	Long-horned Caddisfly	P	1	4
Nemouridae	Stonefly	N	7	2
Philopotamidae	Finger-net Caddisfly	L	2	4
Rhyacophilidae	Primative Caddisfly	L	1	1
Simuliidae	Black Fly	L	7	5
	Stream Health	**Fairly Poor**	**Family Biotic Index**	**5.98**

Sampled - 2/13/2013

REP: 1

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Acariformes	Water Mite	A	5	6
Asellidae	Sow Bug	A	37	8
Baetidae	Small Mayfly	N	28	6

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Capniidae	Stonefly	N	7	3
Chironomidae	Midge	L	114	6
Elmidae	Riffle Beetle	A	3	5
Elmidae	Riffle Beetle	L	11	5
Empididae	Dance Fly	L	6	6
Hydropsychidae	Net-spinning Caddisfly	L	2	5
Lepidostomatidae	*Lepistomatid* Caddisfly	L	10	1
Limnephilidae	Northern Caddisfly	L	1	4
Nemouridae	Stonefly	N	65	2
Oligochaeta	Aquatic Worm	A	1	8
Perlodidae	Stonefly	N	1	2
Physidae	Pouch Snail	A	1	8
Rhyacophilidae	Primative Caddisfly	L	5	1
Simuliidae	Black Fly	L	6	5
Tabanidae	Horse Fly	L	1	5
Taeniopterygidae	Stonefly	N	1	2
Tipulidae	Crane Fly	L	2	4
Turbellaria	Flatworm	A	1	6
Uenoidae	Caddisfly	L	5	3
	Stream Health	**Good**	**Family Biotic Index**	**4.95**

Sampled - 5/3/2013

REP: 1

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Acariformes	Water Mite	P	3	6
Asellidae	Sow Bug	A	25	8
Baetidae	Small Mayfly	N	17	6
Capniidae	Stonefly	N	16	3
Chironomidae	Midge	P	3	6
Chironomidae	Midge	L	79	6
Crangonyctidae	Sideswimmer	A	1	6
Elmidae	Riffle Beetle	A	6	5
Elmidae	Riffle Beetle	L	22	5
Empididae	Dance Fly	L	7	6
Hyalellidae	Sideswimmer	A	2	8
Hydropsychidae	Net-spinning Caddisfly	L	2	5
Lepidostomatidae	*Lepistomatid* Caddisfly	L	7	1
Limnephilidae	Northern Caddisfly	L	5	4
Nematoda	Thread Worm	A	2	5
Nemouridae	Stonefly	N	61	2
Oligochaeta	Aquatic Worm	A	6	8
Physidae	Pouch Snail	A	1	8
Pisidiidae	Fingernail Clam	A	1	6
Psychodidae	Sand Fly	L	1	10
Rhyacophilidae	Primative Caddisfly	L	1	1
Simuliidae	Black Fly	L	38	5
Simuliidae	Black Fly	P	5	5
Tipulidae	Crane Fly	L	5	4
Uenoidae	Caddisfly	L	4	3
	Stream Health	**Good**	**Family Biotic Index**	**4.85**

Sampled - 9/27/2013

REP: 1

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Acariformes	Water Mite	A	8	6
Asellidae	Sow Bug	A	156	8
Baetidae	Small Mayfly	N	2	6
Caenidae	Crawling Mayfly	N	2	6
Chironomidae	Midge	L	36	6
Chironomidae	Midge	P	7	6

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Collembola	Springtail	A	2	5
Dixidae	Dixa Fly	L	1	1
Elmidae	Riffle Beetle	A	8	5
Elmidae	Riffle Beetle	L	34	5
Empididae	Dance Fly	L	9	6
Glossosomatidae	Caddisfly	L	1	1
Heptageniidae	Stream Mayfly	N	1	3
Hyalellidae	Sideswimmer	A	3	8
Hydropsychidae	Net-spinning Caddisfly	L	39	5
Lepidostomatidae	*Lepistomatid* Caddisfly	L	1	1
Limnephilidae	Northern Caddisfly	L	2	4
Nemouridae	Stonefly	N	7	2
Oligochaeta	Aquatic Worm	A	3	8
Physidae	Pouch Snail	A	2	8
Rhyacophilidae	Primative Caddisfly	L	1	1
Simuliidae	Black Fly	L	1	5
Tabanidae	Horse Fly	L	1	5
Tipulidae	Crane Fly	L	1	4
	Stream Health **Poor**		**Family Biotic Index**	**6.57**

Sampled - 5/8/2014

REP: 1

Acariformes	Water Mite	A	6	6
Asellidae	Sow Bug	A	25	8
Baetidae	Small Mayfly	N	11	6
Capniidae	Stonefly	N	33	3
Ceratopogonidae	Biting Midge	L	1	6
Chironomidae	Midge	L	14	6
Dytiscidae	Predacious Diving Beetle	L	1	5
Elmidae	Riffle Beetle	A	9	5
Elmidae	Riffle Beetle	L	50	5
Empididae	Dance Fly	L	29	6
Glossosomatidae	Caddisfly	L	2	1
Haliplidae	Crawling Water Beetle	A	1	5
Hydropsychidae	Net-spinning Caddisfly	L	2	5
Lepidostomatidae	*Lepistomatid* Caddisfly	L	1	1
Limnephilidae	Northern Caddisfly	L	2	4
Nematoda	Thread Worm	A	7	5
Nemouridae	Stonefly	N	72	2
Oligochaeta	Aquatic Worm	A	13	8
Perlodidae	Stonefly	N	3	2
Pisidiidae	Fingernail Clam	A	1	6
Planorbidae	Orb Snail	A	1	6
Rhyacophilidae	Primative Caddisfly	L	4	1
Simuliidae	Black Fly	L	28	5
Simuliidae	Black Fly	P	1	5
Tabanidae	Horse Fly	L	2	5
Uenoidae	Caddisfly	L	6	3
	Stream Health **Good**		**Family Biotic Index**	**4.52**

Sampled - 9/26/2014

REP: 1

Acariformes	Water Mite	A	6	6
Asellidae	Sow Bug	A	41	8
Baetidae	Small Mayfly	N	12	6
Chironomidae	Midge	L	72	6
Chironomidae	Midge	P	10	6
Elmidae	Riffle Beetle	L	38	5

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Elmidae	Riffle Beetle	A	2	5
Empididae	Dance Fly	L	13	6
Glossosomatidae	Caddisfly	L	6	1
Hydropsychidae	Net-spinning Caddisfly	L	73	5
Lepidostomatidae	*Lepistomatid* Caddisfly	L	4	1
Leptophlebiidae	Mayfly	N	3	4
Limnephilidae	Northern Caddisfly	L	1	4
Nemouridae	Stonefly	N	17	2
Oligochaeta	Aquatic Worm	A	3	8
Philopotamidae	Finger-net Caddisfly	L	1	4
Rhyacophilidae	Primative Caddisfly	L	8	1
Simuliidae	Black Fly	L	3	5
Tipulidae	Crane Fly	L	1	4
Turbellaria	Flatworm	A	1	6
	Stream Health	**Fair**	**Family Biotic Index**	**5.37**

Sampled - 5/8/2015

REP: 1

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Acariformes	Water Mite	A	2	6
Asellidae	Sow Bug	A	6	8
Baetidae	Small Mayfly	N	54	6
Capniidae	Stonefly	N	36	3
Ceratopogonidae	Biting Midge	L	2	6
Chironomidae	Midge	L	26	6
Dytiscidae	Predacious Diving Beetle	L	1	5
Elmidae	Riffle Beetle	L	32	5
Elmidae	Riffle Beetle	A	8	5
Empididae	Dance Fly	L	48	6
Heptageniidae	Stream Mayfly	N	1	3
Hyalellidae	Sideswimmer	A	1	8
Hydropsychidae	Net-spinning Caddisfly	L	4	5
Lepidostomatidae	*Lepistomatid* Caddisfly	L	10	1
Limnephilidae	Northern Caddisfly	L	3	4
Nematoda	Thread Worm	A	6	5
Nemouridae	Stonefly	N	48	2
Oligochaeta	Aquatic Worm	A	5	8
Philopotamidae	Finger-net Caddisfly	L	1	4
Pisidiidae	Fingernail Clam	A	2	6
Rhyacophilidae	Primative Caddisfly	L	1	1
Simuliidae	Black Fly	L	21	5
Simuliidae	Black Fly	P	4	5
Tabanidae	Horse Fly	L	1	5
Tipulidae	Crane Fly	L	2	4
Uenoidae	Caddisfly	L	3	3
	Stream Health	**Good**	**Family Biotic Index**	**4.68**

Sampled - 9/23/2015

REP: 1

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Asellidae	Sow Bug	A	27	8
Baetidae	Small Mayfly	N	15	6
Capniidae	Stonefly	N	2	3
Chironomidae	Midge	L	138	6
Chironomidae	Midge	P	8	6
Elmidae	Riffle Beetle	A	4	5
Elmidae	Riffle Beetle	L	56	5
Empididae	Dance Fly	P	1	6
Empididae	Dance Fly	L	10	6
Glossosomatidae	Caddisfly	L	3	1

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Hyalellidae	Sideswimmer	A	1	8
Hydropsychidae	Net-spinning Caddisfly	L	36	5
Hydroptilidae	Micro-caddisfly	L	3	6
Limnephilidae	Northern Caddisfly	L	4	4
Nematoda	Thread Worm	A	1	5
Nemouridae	Stonefly	N	14	2
Oligochaeta	Aquatic Worm	A	3	8
Perlodidae	Stonefly	N	2	2
Philopotamidae	Finger-net Caddisfly	L	1	4
Pisidiidae	Fingernail Clam	A	1	6
Planorbidae	Orb Snail	A	1	6
Rhyacophilidae	Primitive Caddisfly	L	4	1
Simuliidae	Black Fly	P	1	5
Simuliidae	Black Fly	L	5	5
Tabanidae	Horse Fly	L	1	5
Tipulidae	Crane Fly	L	2	4

Stream Health **Fair** **Family Biotic Index** **5.53**

Harrington Creek downstream of dam

Site code: TR41 UTM X: 500623 UTM Y: 4787599

Sampled - 10/18/2010

REP: 1

Acariformes	Water Mite	A	10	6
Brachycentridae	Brachycentrid Caddisfly	L	1	2
Chironomidae	Midge	P	29	6
Elmidae	Riffle Beetle	A	1	5
Elmidae	Riffle Beetle	L	22	5
Empididae	Dance Fly	L	2	6
Hydropsychidae	Net-spinning Caddisfly	L	99	5
Nematoda	Thread Worm	A	3	5
Oligochaeta	Aquatic Worm	A	6	8
Philopotamidae	Finger-net Caddisfly	L	19	4
Pisidiidae	Fingernail Clam	A	13	6
Simuliidae	Black Fly	L	20	5
Tipulidae	Crane Fly	L	2	4
Turbellaria	Flatworm	A	81	6
Veliidae	Ripple Bug	A	1	-1

Stream Health **Fair** **Family Biotic Index** **5.40**

Sampled - 5/8/2015

REP: 1

Acariformes	Water Mite	A	4	6
Asellidae	Sow Bug	A	9	8
Baetidae	Small Mayfly	N	1	6
Capniidae	Stonefly	N	1	3
Ceratopogonidae	Biting Midge	L	1	6
Chironomidae	Midge	P	4	6
Chironomidae	Midge	L	54	6
Elmidae	Riffle Beetle	L	30	5
Empididae	Dance Fly	L	5	6
Helicopsychidae	Snail-case Caddisfly	L	5	3
Hydropsychidae	Net-spinning Caddisfly	L	20	5
Leptoceridae	Long-horned Caddisfly	L	1	4
Nematoda	Thread Worm	A	1	5
Oligochaeta	Aquatic Worm	A	147	8
Perlodidae	Stonefly	N	1	2
Philopotamidae	Finger-net Caddisfly	L	1	4

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Pisidiidae	Fingernail Clam	A	20	6
Simuliidae	Black Fly	L	3	5
Turbellaria	Flatworm	A	11	6
	Stream Health **Poor**		**Family Biotic Index**	**6.73**

Sampled - 9/23/2015

REP: 1

Taxonomic Name	Common Name	Life Stage	# in Subsample	Biotic Index
Acariformes	Water Mite	A	2	6
Asellidae	Sow Bug	A	4	8
Baetidae	Small Mayfly	N	4	6
Chironomidae	Midge	P	1	6
Chironomidae	Midge	L	34	6
Elmidae	Riffle Beetle	A	1	5
Elmidae	Riffle Beetle	L	28	5
Hydropsychidae	Net-spinning Caddisfly	L	93	5
Nemouridae	Stonefly	N	1	2
Oligochaeta	Aquatic Worm	A	19	8
Philopotamidae	Finger-net Caddisfly	L	4	4
Pisidiidae	Fingernail Clam	A	19	6
Simuliidae	Black Fly	L	5	5
Tipulidae	Crane Fly	L	1	4
Turbellaria	Flatworm	A	112	6
	Stream Health **Fair**		**Family Biotic Index**	**5.71**

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 - Monday, November 09, 2015

Appendix D

Harrington Conservation Area Vegetation and Bird Inventory. Prepared by UTRCA, Updated October 2016

Appendix D

Harrington Conservation Area

Vegetation and Bird Inventory

2015

Nov 11 DRAFT

Vegetation Inventory by: Brenda Gallagher, Vegetation Specialist and Forestry Technician

Bird Inventory by: John Schwindt, Aquatic Biologist

Report by: Cathy Quinlan, Terrestrial Biologist

UPPER THAMES RIVER

CONSERVATION AUTHORITY

Document #1928

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Cover Photos

Left: Brenda Gallagher surveying the vegetation at the edge of Harrington Reservoir, Summer 2015. Photo by Cathy Quinlan.

Right: Red-winged Blackbird. Photo by Brenda Gallagher.

Cite as:

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

Executive Summary

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

A three-season botanical inventory was completed in 2015 of this 5 ha site. Of the 219 plant species found, 40% are non-native. No species-at-risk or rare or uncommon species were found that require special consideration prior to possible changes to the dam and reservoir. Overall, the quality of the vegetation, which is a diverse mix of small habitat types, is rated as moderately poor to average.

The Harrington Pond/Reservoir itself does not support any native rooted aquatic plants and has only a narrow fringe of wetland emergent plants along the southern edges and a sparse cover of rooted aquatic plants (a non-native pondweed). The large population of Common Carp in the reservoir is likely a cause as these fish muddy the water and uproot plants. The wetland emergent plants found along the pond's shores are common along flowing waterbodies and in wetlands in the area. Many of these plant species would likely naturally re-establish along Harrington Creek if changes were made to the dam and reservoir.

Harrington CA is within 100 m of a Provincially Significant Wetland known as the Lakeside Wildwood Complex. Thus, construction activities need to consider impacts on the wetland. It is likely that many wildlife species travel between the wetland and Harrington CA due to the close proximity. Only the treed edge (southeast edge) of Harrington CA is part of a larger significant natural heritage feature as defined by the Oxford Natural Heritage System (ONHS 2006). Neither the Provincially Significant Wetland nor natural heritage feature designations would be impacted by changes to the dam and reservoir.

A three season bird survey was undertaken in 2015 as well. The 42 species of birds recorded in the CA are mostly common breeding or permanent residents of the area. One species-at-risk, the Barn Swallow (Threatened), was seen in Harrington CA, but it was not nesting here and so there are no actions that need to be taken to protect its breeding habitat. The reservoir or other parts of Harrington CA do not provide critical habitat for any sensitive bird species. Use of the pond by native waterfowl seemed to be on an occasional basis for feeding and resting versus nesting and rearing young. The fish biomass in the pond is largely unavailable to fish-eating birds such as kingfishers and herons due to the size of the fish (i.e., large, mature carp dominate).

While no sensitive wildlife species were recorded by the biologists, there have been reports from the public that Snapping Turtles use the reservoir. The Snapping Turtle is a species of Special Concern. A slow, summer-time drawdown of the reservoir should safeguard any individuals by allowing them to move into nearby stream habitats, and ultimately, back into the creek within Conservation Area.

In conclusion, there are no sensitive plants, plant communities, birds or wildlife that would be threatened from changes to the Harrington Dam and reservoir environment.

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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 Harrington Dam and Reservoir. The purposes of this study are to:

- document the vegetation communities within Harrington Conservation Area (CA) 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), and

- document the bird species that use the aquatic and terrestrial habitats of Harrington 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 three-season vegetation inventory was carried out in Harrington CA in 2015 by Brenda Gallagher, Vegetation Specialist and Forestry Technician with the Upper Thames River Conservation Authority (UTRCA). The entire CA was inventoried in May, again in July and lastly in August. Each season's inventory spanned two field days. Table 1 summarizes the survey effort.

Table 1. Vegetation Survey Dates in 2015

Dates Inventoried	No. Days
May 25, 26	2
July 7, 13	2
August 25, 27	2
Total days	**6**

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 were generated also.

Aquatic plants in the pond/reservoir were collected and identified by John Schwindt, Aquatic Biologist, when undertaking the fish inventory. Brenda Gallagher also recorded incidental wildlife sightings, especially of birds, amphibians, reptiles and mammals, while undertaking the vegetation inventories.

2.2 Results and Discussion

Figure 1 shows the three ELC vegetation communities plus the pond/reservoir (Shallow Aquatic) for Harrington CA. 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, but Community 3 FOD (Deciduous Forest) was left as a stand-alone community even though it is only 0.2 ha as it is quite unique and did not fit well with the surrounding communities. A full annotated checklist of vascular plants found in all three terrestrial communities is provided in Appendix A.

Table 2. Area of ELC Vegetation Communities

ELC Code	Community Description	Area	Terrestrial vs. Aquatic
1 -CUW	Cultural Woodland (Com 1)	1.6 ha	3.1 ha (terrestrial)
2 - CUS	Cultural Savanna (Com 2)	1.3 ha	
3 -FOD	Deciduous Forest (Com 3)	0.2 ha	
4 - SA	Shallow Aquatic (Com 4)	2.3 ha	2.3 ha (aquatic)
Total		**5.4 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 and overall. Descriptions of these parameters are provided in Appendix B. While the number of species found is high for such a small site, the overall quality of the vegetation is moderately poor to average. 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	Avg Wet-ness	Overall Quality Assessment
1	CUW	185	116	69	37	3.5	1	-1.2	Moderately Poor to Average
2	CUS	147	94	53	36	3.5	2	-1.0	Moderately Poor to Average
3	FOD	120	70	50	42	3.4	0	-0.6	Moderately Poor
Overall		**219**	**132**	**87**	**40**	**3.6**	**2**	**-1.0**	**Moderately Poor to Average**

Figure 1. Harrington Conservation Area ELC Vegetation Communities

2.2.1 Community 1, Cultural Woodland (CUW)

The Cultural Woodland of Community 1 is 1.6 ha in size and encompasses the southern part of the CA on both sides 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 Community 1 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 185 plant species were recorded: 116 native and 69 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: pond edge (wetland emergent plants), planted prairie plot, naturally succeeding thickets and woods and planted conifers. The percentage of non-native plants is 37%, which is about average or moderate for the Upper Thames watershed. The site is disturbed by a foot trail and past land use change (i.e., was formerly mowed lawn).

The MCC (Mean Coefficient of Conservatism) is 3.5, a moderately poor score. There is a predominance of wetland plants in this community (average Wetness is -1.2).

Mature trees include White Cedar, willows, pine, spruce, ash, and maples (Manitoba, Norway, Red, Silver, and Sugar). There are a variety of shrubs including dogwoods, Staghorn Sumac, raspberries, ninebark with some cranberries and Nannyberry.

Community 1 contained a wide range of wildflowers, both native and non-native, that prefer mostly sunny ground in moist to wet habitats. The most abundant native species found include asters, goldenrods, avens, Spotted Joe Pye-Weed, touch-me-nots, Field Mint and a variety of grasses. An interesting plant to note was the Yellow Lady's Slipper, an orchid, though not rare.

Photo 1. Community 1 ─ View looking south from the east side of the pond. Joe Pye-weed flowers in bloom and cedar trees on far side.

Photo 2. Community 1 ─ View looking south from trail on east side of the pond.

2.2.2 Community 2, Cultural Savanna (CUS)

The Cultural Savanna of Community 2 is located on the west side of Harrington Pond and is 1.3 ha in size. Cultural Savannas have a canopy cover of 23 - 35%, slightly lower than Cultural Woodlands. Cultural communities result from, or are maintained by, cultural or anthropogenic-based disturbances.

Community 2 has a variety of very small but different habitats within it. The understory is mostly manicured lawn grass with plantings of older trees such as Black Cherry, willow, White Birch, maples and spruce. It also includes a narrow fringe of wetland plants along the pond's shore as well as two planted tallgrass prairie plots and a meadow marsh near Road 96.

A total of 147 species were recorded, 94 native and 53 non-native. The percentage of non-native species (36%) is average and reflects the human disturbance and manicured nature of the site. The MCC is 3.5, a moderately poor score.

Common shrubs and trees include Nannyberry, Staghorn Sumac, Highbush Cranberry and dogwoods. Pond shore plants include Joe Pye-Weed, beggarticks, and jewelweeds. The diversity of pond edge/wetland plants is not as large and diverse as in Community 1 because the fringe of plants is very narrow as the pond is steeper edged here.

Photo 3. Community 2 ─ Cultural savanna of lawn with open grown trees and naturalized edges

Photo 4. Community 2 ─ Prairie plot planted in 2005 by the UTRCA and local community.

2.2.3 Community 3, Deciduous Forest (FOD)

The deciduous forest of Community 3 is small (0.2 ha) and includes the area immediately adjacent to Harrington Creek downstream of the dam as well as the area around Harrington Mill. Though smaller than the 0.5 ha minimum vegetation community size recommended by the ELC (Lee et al 1998), it was maintained as a stand-alone community because of its uniqueness.

This small forest community is dominated by mature trees with a dense understory of shrubs and herbaceous plants. Under the ELC, deciduous forests are characterized by a canopy of >60% cover consisting of >75% deciduous trees.

A total of 120 species were recorded from the community, 70 native species and 50 non-native species. The higher percent of non-native plants (42%) reflects the disturbances the area experiences (e.g., flooding, structures, and human foot traffic). The MCC score of 3.4 indicates the habitat is of moderately poor quality.

Dominant tree species included Silver Maple, ash (in decline), elms and Black Walnut with some cedar and spruce. Common shrubs include dogwoods, young ash, elderberry, currants and raspberries. The herbaceous layer consists of avens and goldenrod, with non-native goutweed and coltsfoot on the banks adjacent to the mill.

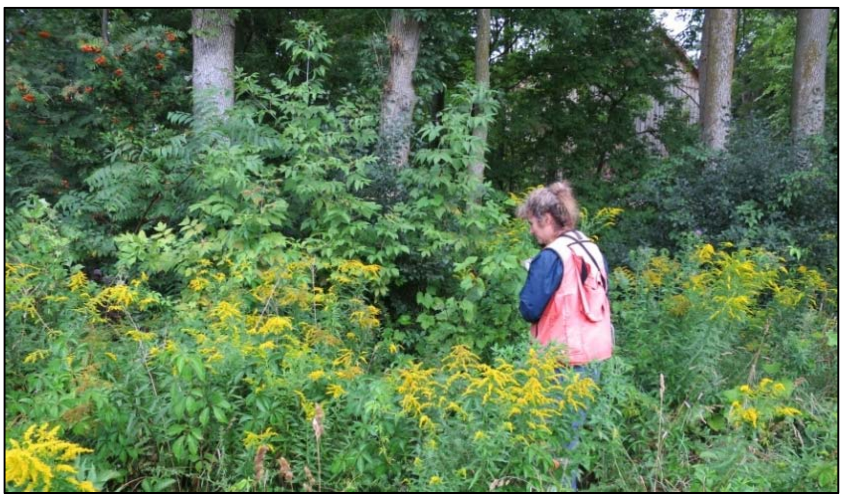


Photo 5. Community 3 ─ Brenda Gallagher inventories the west side of Harrington Creek.

Photo 6. Community 3 ─ Forest community abutting Harrington Creek

2.2.4 Community 4, Shallow Aquatic (SA)

The Harrington Pond/Reservoir is classified as Shallow Aquatic with standing water <2 m depth and a low percentage of any vegetation. While the spring 2010 air photo shown in Figure 1 shows mud flats at the south end of the pond, the mud flats are only visible during reservoir drawdowns in the fall to early spring period. However, the mud flats demonstrate that the pond is very shallow and silting in and the bottom substrate is very soft.

Any rooted shoreline vegetation is included in Communities 1 and 2. Algae and a small amount of Duckweed float on the surface of this shallow aquatic community. There is a sparse cover of a submerged rooted plant called Curly-leaved Pondweed, a non-native species.

The lack of a diversity of submergent and emergent aquatic plants may be due, in part, to the large population of mature Common Carp. This non-native fish disturbs the bottom sediments, uproot plants and cause the water to be very murky which, in turn, limits sunlight penetration through the water.

Photo 7. Community 4 — Shallow Aquatic (Harrington Pond/Reservoir) looking south from the dam.

Photo 8. Community 4 — Floating algae is visible on the pond/reservoir surface and on the submerged rocks (Sept 2015)

2.2.5 Pond Edge Plants

The fringe of wetland emergent plants growing at the pond shore is not large enough to be its own ELC community because it is less than 0.5 ha in size. The southeast side of the pond/reservoir has the most wetland emergent plants as it is shallowest, as seen on the air photo. The north part of the pond has fairly steep banks, so there are fewer pond edge plants there.

A separate list of plants found on the pond edge was generated (Appendix C) as this is the community that will most likely be affected by any proposed changes to the dam and reservoir. Most of these plants have a wetness coefficient of -5, the wettest score. None are rare or uncommon. Most of these wetland plants can also be found growing along the flowing sections of Harrington Creek and other slow moving streams and wetlands in the region.

The large population of Common Carp in the reservoir likely limits the population of emergent plants as these large fish root around in the sediments and uproot plants and muddy the water so that light does not penetrate.

Photo 9. Wetland emergent plants growing along the reservoir edge: cattails, joe pye-weed, turtle head, and dogwoods.

Photo 10. Peppermint blooms in August along the upstream edge of Harrington Pond.

2.2.6 Plants with High Coefficient of Conservatism (CC) Scores

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.

Table 4 summarizes the two plant species that had a CC score of 8: Butterfly-weed (or Butterfly Milkweed) and Indian Grass. Butterfly-weed and Indian Grass are not rare in our area, but they are faithful to their habitat type and, in this case, were planted in the prairie plots in Communities 1 and 2. No plants with a CC score of 9 or 10 were found.

Table 4. Plant Species with high CC Scores

Common Name	Scientific Name	CC Score	Community	Comments
Butterfly-weed	*Ascelpias tuberosa*	8	1, 2	Part of prairie plot, planted
Indian Grass	*Sorghastrum nutans*	8	2	Part of prairie plot, planted

2.2.7 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.

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

No plant species had a SRank of S1, S2 or S3 (very rare to rare to uncommon).

3.0 Bird Survey and Incidental Wildlife

3.1 Methodology

A three-season bird survey was undertaken in 2015 by John Schwindt, Aquatic Biologist with the UTRCA who has years of birding experience with the Breeding Bird Atlas and Christmas Bird Count. Incidental bird observations were made by Brenda Gallagher while she was undertaking the botanical inventories. Brenda is also an experienced birder.

Table 5 summarizes the dates of each of their visits. John Schwindt focused three of his five days to the spring breeding and migration period, and a day in summer and one in late summer. Approximately four hours were spent each time, with particular effort around the pond. Brenda Gallagher also spent six days at Harrington CA in roughly the same time period.

Table 5. Bird Survey Dates in 2015

Season	John Schwindt	Brenda Gallagher
Early Spring	15 Apr & 22 Apr	
Spring	14 May	25 May & 26 May
Early Summer	24 June	7 July & 13 July
Late Summer	26 Aug	25 Aug & 27 Aug
	5 days total	**6 days total**

3.2 Results

A total of 42 bird species from 24 different orders were seen by John Schwindt and Brenda Gallagher on their separate visits to Harrington CA from April to August, 2015. Appendix D provides a list of the bird species recorded. Two species are exotic or introduced (European Starling, Mute Swan). Of the 40 native species:

- 36 are common breeding, permanent residents or winter residents in Oxford County,
- 1 is a common migrant in Oxford (Double-crested Cormorant),
- 1 is an uncommon breeding species in Oxford (Osprey) ,
- 1 is an uncommon permanent resident in Oxford (Pileated Woodpecker), and
- 1 is a common breeding species in Oxford but Threatened in Ontario (Barn Swallow).

The Barn Swallow is a common breeding species found throughout southern Ontario but there was no breeding evidence at Harrington CA. 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.

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.

Of the uncommon species, Osprey and Pileated Woodpecker, there was no breeding evidence in Harrington CA.

None of the 42 bird species seen are exclusively pond dwellers. Species such as Canada Goose, Mallard, Belted Kingfisher, Osprey, and Spotted Sandpiper 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 versus nesting and rearing young. Much of the fish biomass in the pond is unavailable to fish-eating birds such as Osprey due to the size of the fish (e.g., there is a dominance of large carp in Harrington Reservoir).

Most of the songbirds seen at Harrington CA use the terrestrial habitats and nearby backyards and gardens.

Photo 11. Mute Swans, a non-native species, were present most of the 2015 season on Harrington Reservoir.

Photo 12. Song Sparrow. Photo by Brenda Gallagher

3.3 Other Wildlife Sightings

Brenda Gallagher recorded incidental wildlife seen while undertaking the botanical inventories. Appendix E lists the five mammals and two amphibians seen, all of which are common to our area. No species-at-risk wildlife was recorded. The Green Frog is the only animal seen with strong affiliation to permanent water bodies. The Green Frog overwinters in permanent water bodies thus the population within this CA may decline if the dam is removed.

There have been reports from the public that Snapping Turtles use the reservoir, although they were not seen by the biologists on this study. There are records of this species within 1 km of the study area as well. The Snapping Turtle is a species of Special Concern (S3). 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.

While there is no official habitat protection afforded to species of Special Concern, the Snapping Turtle would not be harmed by the removal of the reservoir and the restoration of the creek as they do live in creek systems. A slow, summer-time drawdown of the reservoir should safeguard any individuals in the pond by allowing them to move into nearby stream habitats, and ultimately, back into the restored creek within Conservation Area.

3.4 Other Species at Risk Records within 2 km of the Study Area

Other records of Snapping Turtle are present within 1 km of the study area. No other Species at Risk records exist within 2 km of the study area.

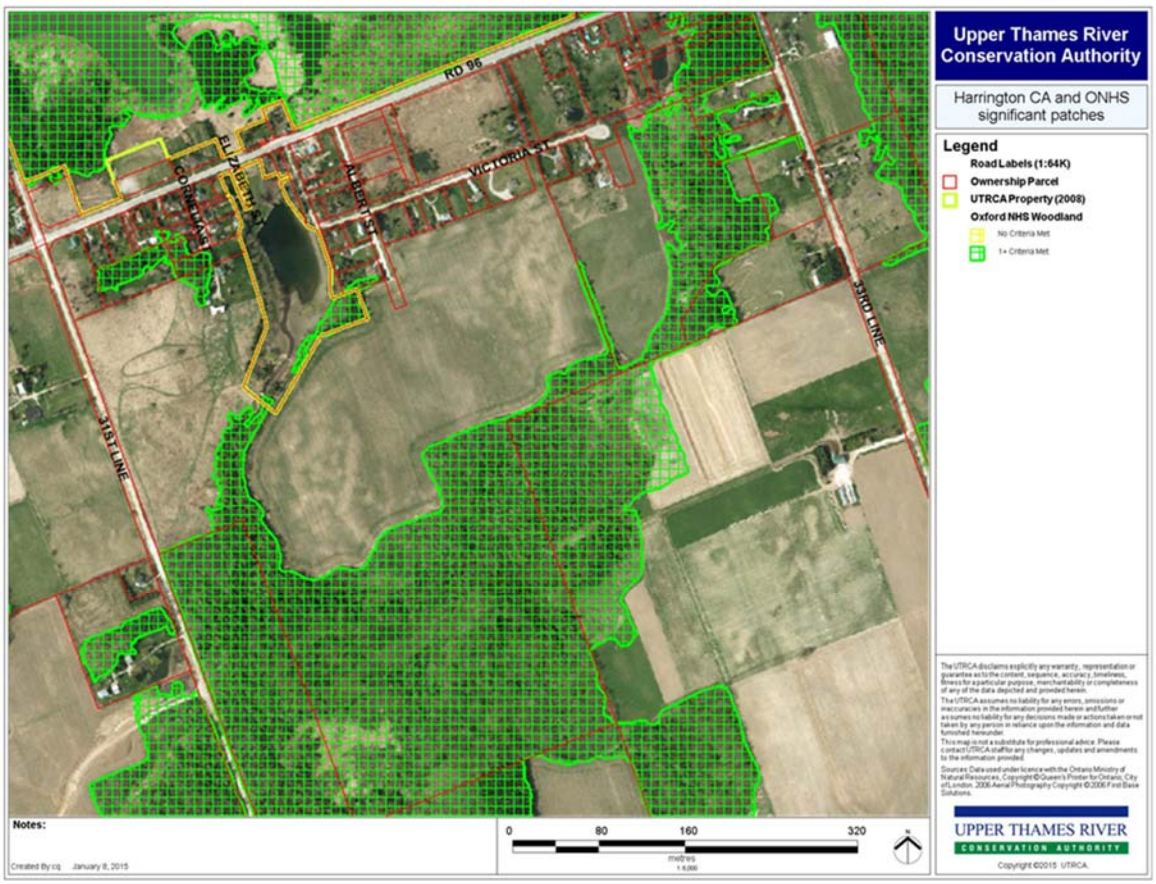
4.0 Significant Natural Heritage Features

4.1 Oxford Natural Heritage Study (ONHS)

The Oxford Natural Heritage Study (Oxford County 2006) identified significant woodland features in the county based on a set of ecological criteria. Figure 2 shows the significant features identified in and around Harrington CA. Harrington CA contains terrestrial habitats that are part of larger surrounding and connected woodland features that are considered significant on the county landscape.

The ONHS did not include meadows, marshes, ponds or manicured parkland (e.g., mowed lawn areas). Thus the pond/reservoir and open shoreline habitats around Harrington Pond were excluded from the significant natural heritage features. The next iteration of the ONHS study planned for 2016 will include meadows, marshes and ponds as part of the natural features so more of the CA may be identified as significant if it meets the size criteria.

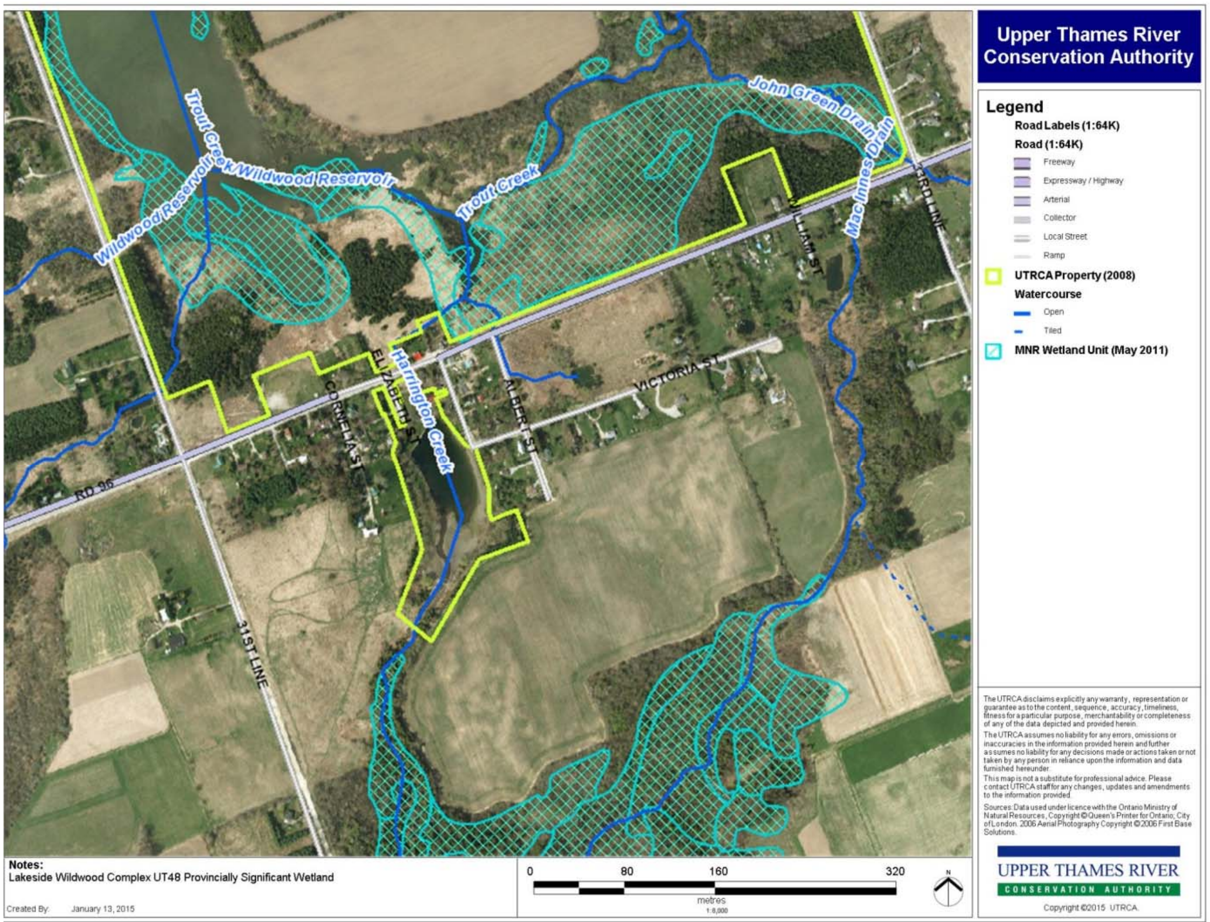
Figure 2. Significant Natural Heritage Patches Mapping from ONHS 2006



4.2 Wetlands

Figure 3 shows the evaluated wetlands near Harrington CA. The conservation area is surrounded by several large components of the Lakeside Wildwood Wetland Complex, a large Provincially Significant Wetland. The wetland extends both upstream along the Harrington Creek and downstream along Wildwood Reservoir but does not include the CA itself. The MNRF has indicated it would like to re-evaluate this large wetland complex in the near future to update the file.

Figure 3. Harrington Area Wetlands (Lakeside Wildwood Wetland Complex)



5.0 Discussion and Conclusions

5.1 Vegetation

The vegetation within Harrington Conservation Area is quite diverse owing to the mix of habitats including manicured parkland, pond edge, naturalized plots and mature forest along the downstream end of Harrington Creek. Efforts by the local community and UTRCA to plant more native plants in Harrington CA have added to the diversity of the plant life in the CA.

While the diversity of plants is quite large for a small site, the overall quality of the three vegetation communities is moderately poor to average. The overall percentage of non-native species is 40%, which is about average and expected for a small, disturbed area.

The Harrington Pond/Reservoir supports only a few aquatic species including Duckweed (native), Curly-leaved Pondweed (non-native) and algae.

The shoreline and shallow edges of the pond support some typical wetland emergent plants such as Common Cattail, Common Arrowhead, willows, Turtlehead, Spotted Joe-Pye-weed and dogwoods. However, the area is quite narrow and so there is not a large population of any of these plants. The large carp population in the reservoir may be a factor in the lack of vegetation as these fish uproot plants and stir up sediments making conditions very poor for plants. By comparison, natural shallow ponds often succeed into marsh/thicket habitat over time. Most of the plants that grow along the edge of Harrington pond/reservoir also grow along the shores of Harrington Creek and nearby creeks and rivers and wetlands and are not uncommon in our area.

No plant species at- risk were found nor were any rare or uncommon species. Two plants with a high Conservatism of Conservation score were found, but both are tallgrass prairie species that were planted in the plots at the edge of the CA.

5.2 Birds and Wildlife

Birding surveys over the spring, summer and fall of 2015 recorded 42 species. Two non-native species were found and 39 native species. Of the 40 native species, the majority are common birds in the county. Two birds uncommon in Oxford (Osprey and Pileated Woodpecker) were seen visiting Harrington CA, but not nesting.

One Threatened bird species, Barn Swallow, was seen. While Barn Swallows are common breeders in Oxford County, their overall population in Ontario has been declining and may be attributed to loss of barns and human structures, pesticide spraying of fields that reduce insect populations. Since they were not seen breeding in Harrington CA and are habitat generalists, there is no action that needs to be taken to protect them if any changes are made to the Harrington dam/reservoir.

Most of the songbirds seen at Harrington CA were feeding or nesting in the terrestrial areas, not the pond and are unlikely to be affected by any changes to the reservoir.

Of the native birds that use the pond (e.g., Canada Goose, Mallard, Osprey, Belted Kingfisher), none are exclusively pond dwellers and they make use of rivers and creeks as well. There are few small fish in the reservoir for fish-eaters such as herons and kingfishers since large carp dominate. These birds likely are attracted to the nearby Wildwood Reservoir and Conservation Area and, as a result, are in the area.

No rare or uncommon wildlife species were seen. The Green Frog overwinters in permanent water bodies, thus its population within Harrington CA may decline locally if the dam is removed.

5.3 Conclusions

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

No rare or uncommon plant species were found. No rare or uncommon breeding birds were found that need protection. The visiting Barn Swallow is threatened in Ontario but there was no evidence of breeding within Harrington CA. No rare to uncommon wildlife species were found either.

Harrington CA is within 100 m of a Provincially Significant Wetland known as the Lakeside Wildwood Complex. Thus, construction activities need to consider impacts on the wetland. It is likely that many wildlife species travel between the Lakeside Wildwood Wetland complex and Harrington CA due to the close proximity.

Only the treed edge (southeast edge) of Harrington CA is part of a larger significant natural heritage feature as defined by the Oxford Natural Heritage System (ONHS 2006). The remainder of the CA (Pond/ Day Use area) is not part of that feature.

In conclusion, there are no sensitive plants, plant communities, birds or wildlife that would be threatened from changes to Harrington Dam and Conservation Area.

Photo 13. Harrington Creek downstream of the dam

References

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Appendices

A. Annotated Checklist of Vascular Plant

B. Descriptive Indices for Vegetation Communities

C. Semi-aquatic emergent plants growing along the pond edge

D. Bird Sightings at Harrington CA (April 22 – Aug 26th, 2015)

E. Animal Sightings

Appendix A. Annotated Checklist of Vascular Plants for Harrington CA

Scientific Name	Common Name	Native or Adven-tive	WEED	CC	CWet	S-RANK	SARO	Com 1	Com 2	Com 3
Acer negundo	Manitoba Maple	N		0	-2	S5		x	x	x
Acer platanoides	Norway Maple	A	-3					x		
Acer rubrum	Red Maple	N		4	0	S5		x	x	x
Acer saccharinum	Silver Maple	N		5	-3	S5		x	x	x
Acer saccharum	Sugar Maple	N		4	3	S5		x	x	x
Achillea millefolium	Yarrow	A	-1						x	
Aegopodium podagraria	Goutweed	A	-3						x	x
Agrimonia gryposepala	Agrimony	N		2	2	S5		x		x
Alisma subcordatum	Water-plantain	N		3	-5	S4?		x	x	
Alliaria petiolata	Garlic Mustard	A	-3					x	x	x
Ambrosia artemisiifolia	Common Ragweed	N		0	3	S5		x	x	x
Amphicarpaea bracteata	Hog-peanut	N		4	0	S5		x		
Andropogon gerardii	Big Bluestem	N		7	1	S4		x	x	
Anemone canadensis	Canada Anemone	N		3	-3	S5		x		x
Angelica atropurpurea	Angelica	N		6	-5	S5		x	x	x
Arctium minus	Common Burdock	A	-2					x	x	x
Asclepias syriaca	Common Milkweed	N		0	5	S5		x	x	x
Asclepias tuberosa	Butterfly-weed	N		8	5	S4		x	x	
Barbarea vulgaris	Winter Cress	A	-1					x	x	x
Betula papyrifera	Paper Birch	N		2	2	S5			x	
Bidens cernua	Nodding Beggarticks	N		2	-5	S5		x	x	x
Bidens frondosa	Devil's Beggarticks	N		3	-3	S5		x	x	
Bromus inermis	Smooth Brome	A	-3					x	x	x
Caltha palustris	Marsh-marigold	N		5	-5	S5		x		
Campanula rapunculoides	Creeping Bellflower	A	-2						x	
Carex lacustris	Lake Sedge	N		5	-5	S5		x		
Carex stricta	Tussock Sedge	N		4	-5	S5			x	
Carex vulpinoidea	Fox Sedge	N		3	-5	S5		x		
Carpinus caroliniana	Blue-beech	N		6	0	S5			x	x
Carya cordiformis	Bitternut Hickory	N		6	0	S5			x	x
Cerastium fontanum	Mouse-eared Chickweed	A	-1					x	x	x
Chelone glabra	Turtlehead	N		7	-5	S5		x	x	x

Scientific Name	Common Name	Native or Adven-tive	WEED	CC	CWet	S-RANK	SARO	Com 1	Com 2	Com 3
Chenopodium album	Lamb's-quarters	A	-1					x		x
Cicuta maculata var. *maculata*	Spotted Water-hemlock	N		6	-5	S5			x	
Circaea canadensis	Enchanter's-nightshade	N		3	3	S5		x	x	x
Cirsium arvense	Canada Thistle	A	-1					x	x	x
Cirsium vulgare	Bull Thistle	A	-1					x	x	x
Cornus alternifolia	Alternate-leaved Dogwood	N		6	5	S5		x	x	x
Cornus amomum	Silky Dogwood	N		5	-4	S5		x	x	x
Cornus stolonifera	Red-osier Dogwood	N		2	-3	S5		x	x	x
Crataegus sp.	Hawthorn species	N		4	5			x		x
Cypripedium parviflorum var. *pubescens*	Large Yellow Lady's-slipper	N		5	-1	S5		x		
Dactylis glomerata	Orchard Grass	A	-1					x	x	x
Daucus carota	Wild Carrot	A	-2					x	x	x
Dipsacus fullonum	Teasel	A	-1					x	x	x
Echinochloa muricata var. microstachya	Barnyard Grass	N		4	-5	S5		x		
Echinocystis lobata	Wild Cucumber	N		3	-2	S5		x	x	x
Elymus repens	Quack Grass	A	-3					x	A	
Epilobium ciliatum	Willow-herb	N		3	3	S5		x		
Epilobium hirsutum	Great Hairy Willow-herb	A	-2					x	x	x
Equisetum arvense	Field Horsetail	N		0	0	S5		x	x	x
Equisetum fluviatile	Water Horsetail	N		7	-5	S5		x		
Erigeron annuus	Daisy Fleabane	N		0	1	S5		x	x	x
Erigeron canadensis	Horseweed	N		0	1	S5		x	x	
Erigeron philadelphicus	Philadelphia Fleabane	N		1	-3	S5		x	x	x
Erigeron strigosus	Narrow-leaved Fleabane	N		0	1	S5		x		
Eupatorium perfoliatum	Boneset	N		2	-4	S5		x	x	
Euthamia graminifolia	Grass-leaved Goldenrod	N		2	-2	S5		x	x	
Eutrochium maculatum var. *maculatum*	Spotted Joe-Pye-weed	N		3	-5	S5		x	x	
Fragaria virginiana	Wild Strawberry	N		2	1	S5		x	x	x
Frangula alnus	Glossy Buckthorn	A	-3					x	x	x

Scientific Name	Common Name	Native or Adven-tive	WEED	CC	CWet	S-RANK	SARO	Com 1	Com 2	Com 3
Fraxinus americana	White Ash	N		4	3	S4		x	x	x
Fraxinus pennsylvanica	Red/Green Ash	N		3	-3	S4		x	x	x
Galium mollugo	Wild Madder	A	-2					x	x	x
Galium odoratum	Sweet Woodruff	A	-1							x
Galium palustre	Marsh Bedstraw	N		5	-5	S5		x	x	x
Geranium robertianum	Herb Robert	A	-2					x	x	x
Geum aleppicum	Yellow Avens	N		2	-1	S5		x	x	x
Geum canadense	White Avens	N		3	0	S5		x	x	x
Geum laciniatum	Cut-leaved Avens	N		4	-3	S4		x	x	x
Geum vernum	Spring Avens	N		7	1	S4		x	x	
Glechoma hederacea	Gill-over-the-ground	A	-2					x	x	x
Helianthus annuus	Common Sunflower	A	-1					x		
Heliopsis helianthoides	Ox-eye	N		3	5	S5			x	
Hemerocallis fulva	Orange Day Lily	A	-3					x		x
Hesperis matronalis	Dame's Rocket	A	-3					x		
Humulus lupulus	Common Hop	A	-1					x		
Hypericum perforatum	Common St. John's-wort	A	-3						x	
Impatiens capensis	Spotted Touch-me-not	N		4	-3	S5		x	x	x
Iris pseudacorus	Yellow-flag	A	-2						x	
Juglans nigra	Black Walnut	N		5	3	S4		x	x	x
Juncus effusus	Soft Rush	N		4	-5	S5		x		
Lamium maculatum	Spotted Henbit	A	-1					A		
Laportea canadensis	Wood Nettle	N		6	-3	S5		x		x
Lapsana communis	Nipplewort	A	-2							x
Leersia oryzoides	Rice Cut Grass	N		3	-5	S5		x		
Lemna minor	Common Duckweed	N		2	-5	S5		x		
Leontodon autumnalis	Fall Hawkbit	A	-1						x	
Leonurus cardiaca	Motherwort	A	-2					x	x	x
Leucanthemum vulgare	Ox-eye Daisy	A	-1					x	x	
Lilium michiganense	Michigan Lily	N		7	-1	S5				x
Linaria vulgaris	Butter-and-eggs	A	-1					x	x	
Lobelia siphilitica	Great Lobelia	N		6	-4	S5		x		
Lonicera tatarica	Tartarian Honeysuckle	A	-3					x	x	x
Lycopus uniflorus	Bugleweed	N		5	-5	S5		x	x	x
Lysimachia ciliata	Fringed Loosestrife	N		4	-3	S5		x		x

Scientific Name	Common Name	Native or Adven-tive	WEED	CC	CWet	S-RANK	SARO	Com 1	Com 2	Com 3
Lysimachia nummularia	Moneywort	A	-3					x	x	
Malus pumila	Apple	A	-1					x	x	
Malus sp	Crabapple	A							x	
Malva neglecta	Common Mallow	A	-1					x		
Matricaria discoidea	Pineapple Weed	A	-1					x		
Matteuccia struthiopteris	American Ostrich Fern	N		5	-3	S5		x		
Medicago lupulina	Black Medick	A	-1					x	x	x
Mentha arvensis	Field Mint	N		3	-3	S5		x	x	x
Mentha x *piperita*	(M. aquatica X M. spicata)	A	-1					x	x	
Monarda fistulosa var. *fistulosa*	Wild Bergamot	N		6	3	S5		x	x	
Myosotis laxa	Smaller Forget-me-not	N		6	-5	S5		x	x	x
Myosotis sylvatica	Forget-me-not	A	-1					x		x
Oenothera biennis	Hairy Yellow Evening-primrose	N		0	3	S5		x	x	
Onoclea sensibilis	Sensitive Fern	N		4	-3	S5		x	x	
Oxalis stricta	European Wood-sorrel	N		0	3	S5		x	x	x
Panicum capillare	Witch Grass	N		0	0	S5		x		
Parthenocissus inserta	Virginia Creeper	N		3	3	S5		x	x	x
Parthenocissus quinquefolia	Virginia Creeper	N		6	1	S4?				x
Penstemon digitalis	Foxglove Beard-tongue	N		6	1	S4S5		x	x	
Penstemon hirsutus	Hairy Beard-tongue	N		7	5	S4			x	
Persicaria hydropiperoides	Water-pepper	N		5	-5	S5		x	x	
Persicaria maculosa	Lady's-thumb	A	-1					x		
Phalaris arundinacea	Reed Canary Grass	N		0	-4	S5		x		x
Phleum pratense	Timothy	A	-1					x	x	x
Phlox paniculata	Garden Phlox	A	-1					x		x
Phragmites australis ssp. australis	Common Reed	A	-3					x		
Physalis alkekengi	Chinese Lantern	A	-1					x		
Physocarpus opulifolius var. *opulifolius*	Ninebark	N		5	-2	S5		x		
Picea abies	Norway Spruce	A	-1					x	x	x

Scientific Name	Common Name	Native or Adven-tive	WEED	CC	CWet	S-RANK	SARO	Com 1	Com 2	Com 3
Picea glauca	White Spruce	N		6	3	S5		x	x	
Pilea pumila	Clearweed	N		5	-3	S5				x
Pinus strobus	White Pine	N		4	3	S5		x		x
Pinus sylvestris	Scots Pine	A	-3					x	x	
Plantago lanceolata	English Plantain	A	-1					x	x	x
Plantago major	Common Plantain	A	-1					x	x	x
Plantago rugelii	Rugel's Plantain	N		1	0	S5		x	x	x
Poa pratensis ssp. *pratensis*	Kentucky Bluegrass	N		0	1	S5		x	x	x
Podophyllum peltatum	May-apple	N		5	3	S5		x		
Populus deltoides ssp. *deltoides*	Cottonwood	N		4	-1	S5		x		
Potentilla norvegica	Rough Cinquefoil	N		0	0	S5		x		
Potentilla recta	Rough-fruited Cinquefoil	A	-2					x		
Prunella vulgaris ssp. *lanceolata*	Heal-all	N		1	0	S5		x	x	x
Prunus avium	Sweet Cherry	A	-2							x
Prunus nigra	Canada Plum	N		4	4	S4		x		
Prunus serotina	Wild Black Cherry	N		3	3	S5		x	x	x
Prunus virginiana	Choke Cherry	N		2	1	S5		x	x	x
Ranunculus acris	Common Buttercup	A	-2					x	x	x
Ranunculus hispidus var. caricetorum	Hispid Buttercup	N		7	0	S5		x	x	x
Ranunculus repens	Creeping Buttercup	A	-1					x		
Rhamnus cathartica	Common Buckthorn	A	-3					x	x	x
Rhus typhina	Staghorn Sumac	N		1	5	S5		x	x	
Ribes americanum	Wild Black Currant	N		4	-3	S5		x	x	x
Ribes rubrum	Garden Red Currant	A	-2							x
Rosa multiflora	Multiflora Rose	A	-3					x	x	x
Rubus idaeus ssp. *strigosus*	Wild Red Raspberry	N		0	-2	S5		x	x	
Rubus occidentalis	Black Raspberry	N		2	5	S5		x	x	x
Rudbeckia hirta var. *pulcherrima*	Black-eyed Susan	N		0	3	S5		x	x	
Rumex crispus	Curly Dock	A	-2					x	x	x
Rumex obtusifolius	Bitter Dock	A	-1					x	x	x
Sagittaria latifolia	Common Arrowhead	N		4	-5	S5		x	x	
Salix alba	White Willow	A	-2					x	x	
Salix bebbiana	Bebb's Willow	N		4	-4	S5		x	x	

Scientific Name	Common Name	Native or Adven-tive	WEED	CC	CWet	S-RANK	SARO	Com 1	Com 2	Com 3
Salix eriocephala	Heart-leaved Willow	N		4	-3	S5		x	x	
Salix interior	Sandbar Willow	N		3	-5	S5		x	x	
Salix nigra	Black Willow	N		6	-5	S4?		x	x	
Salix purpurea	Basket Willow	A	-2					x		
Sambucus canadensis	Common Elder	N		5	-2	S5		x		x
Sambucus racemosa	Red-berried Elder	N		5	2	S5		x		
Sanguinaria canadensis	Bloodroot	N		5	4	S5				x
Schedonorus pratensis	Meadow Fescue	A	-1					x	x	x
Scirpus atrovirens	Dark Green Bulrush	N		3	-5	S5		x	x	
Scirpus pendulus	Nodding Bulrush	N		3	-5	S5		x	x	
Setaria viridis	Green Foxtail	A	-1					x		
Silene latifolia	White Cockle	A	-2					x	x	x
Sisymbrium officinale	Hedge Mustard	A	-1					x		
Solanum dulcamara	Climbing Nightshade	A	-2					x	x	x
Solanum ptycanthum	Eastern Black Nightshade	A	-1							x
Solidago altissima ssp. *altissima*	Late Goldenrod	N		1	3	S5		x	x	x
Solidago canadensis var. *canadensis*	Canada Goldenrod	N		1	3	S5			x	x
Solidago gigantea	Tall Goldenrod	N		4	-3	S5		x		
Sonchus arvensis	Perennial Sow-thistle	A	-1					x	x	x
Sonchus asper	Spiny-leaved Sow-thistle	A	-1							x
Sonchus oleraceus	Annual Sow-thistle	A	-1						x	x
Sorbus aucuparia	European Mountain-ash	A	-2							x
Sorghastrum nutans	Indian Grass	N		8	2	S4			x	
Stellaria media	Common Chickweed	A	-1					x		
Symphyotrichum cordifolium	Heart-leaved Aster	N		5	5	S5		x		
Symphyotrichum lanceolatum ssp. *lanceolatum*	Panicled Aster	N		3	-3	S5		x	x	x
Symphyotrichum lateriflorum	Calico Aster	N		3	-2	S5		x	x	x
Symphyotrichum novae-angliae	New England Aster	N		2	-3	S5		x	x	x
Symphyotrichum pilosum var. *pilosum*	Hairy Aster	N		4	2	S5			x	

Scientific Name	Common Name	Native or Adven-tive	WEED	CC	CWet	S-RANK	SARO	Com 1	Com 2	Com 3
Symphyotrichum puniceum	Purple-stemmed Aster	N		6	-5	S5		x	x	
Symphyotrichum urophyllum	Arrow-leaved Aster	N		6	5	S4		x		
Symplocarpus foetidus	Skunk-cabbage	N		7	-5	S5		x	x	x
Syringa vulgaris	Common Lilac	A	-2							x
Taraxacum officinale	Common Dandelion	A	-2					x	x	x
Thalictrum pubescens	Tall Meadow-rue	N		5	-2	S5		x	x	x
Thuja occidentalis	White Cedar	N		4	-3	S5		x	x	x
Tilia americana	Basswood	N		4	3	S5		x	x	
Tragopogon pratensis	Yellow Goat's-beard	A	-1					x		
Trifolium hybridum	Alsike Clover	A	-1							x
Trifolium pratense	Red Clover	A	-2					x	x	x
Trifolium repens	White Clover	A	-1					x	x	x
Tussilago farfara	Coltsfoot	A	-2					x	x	x
Typha angustifolia	Narrow-leaved Cattail	A	-3					x		
Typha latifolia	Common Cattail	N		3	-5	S5		x	x	
Ulmus americana	American Elm	N		3	-2	S5		x	x	x
Ulmus rubra	Slippery Elm	N		6	0	S5				x
Urtica dioica ssp. *gracilis*	Stinging Nettle	N		2	-1	S5		x		
Verbascum thapsus	Common Mullein	A	-2					x	x	
Verbena hastata	Blue Vervain	N		4	-4	S5		x		
Verbena urticifolia	White Vervain	N		4	-1	S5		x	x	x
Veronica anagallis-aquatica	Water Speedwell	A	-1					x		
Veronica peregrina ssp. peregrina	Purslane Speedwell	N		0	-4	S5		x	x	x
Veronica persica	Persian Speedwell	A	-1					x	x	
Viburnum lentago	Nannyberry	N		4	-1	S5		x	x	
Viburnum opulus ssp. *Opulus*	European Highbush-cranberry	A	-1						x	
Viburnum opulus ssp. *Trilobum*	Highbush-cranberry	N		5	-3	S5		x	x	x
Vicia cracca	Cow Vetch	A	-1					x	x	x
Viola cucullata	Marsh Violet	N		5	-5	S5		x	x	x
Viola sororia	Common Blue Violet	N		4	1	S5				x
Vitis riparia	Riverbank Grape	N		0	-2	S5		x	x	x
Zizia aurea	Golden Alexanders	N		7	-1	S5		x	x	

Scientific Name	Common Name	Native or Adven-tive	WEED	CC	CWet	S-RANK	SARO	Com 1	Com 2	Com 3
	Total		-143	481	-126		0			
	Count	219	86	132	132		0	185	147	120
	Average/Mean		-1.7	3.6	-1.0					
OVERALL										
	Number of Native Species	132						116	94	70
	Number of Adventive Species	87						69	53	50
	Total Number of Species	219						185	147	120
	Percent Adventive Species	40						37	36	42
	Number of S1-S3	0								
	Number of S4-S5	132								
	Number of CC 8, 9 or 10 species	2								
BY COMMUNITY										
	Mean Weediness Score by Community							-1.7	-1.7	-0.8
	Mean CC Score by Community							3.5	3.5	3.4
	Mean Wetness Score by Community							-1.2	-1.0	-0.8
	Number of S1-S3 Species by Community							0	0	0

Appendix B. Species Lists ─ Notes and Notations

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		

Appendix C. Native Wetland Emergent Plants growing along the Reservoir Edge

Scientific Name	Common Name	CC	CWET	SRank S1-S3	SARO	Community		
						1	2	3
Alisma plantago-aquatica	Water-plantain	3	-5			X	X	
Angelica atropurpurea	Angelica	6	-5			X	X	X
Aster puniceus	Purple-stemmed Aster	6	-5			X	X	
Bidens cernua	Nodding Beggarticks	2	-5			X	X	X
Bidens frondosa	Devil's Beggarticks	3	-3			X	X	
Carex stricta	Tussock Sedge	4	-5				X	
Chelone glabra	Turtlehead	7	-5			X	X	X
Cicuta maculata	Spotted Water-hemlock	6	-5				X	
Cornus amomum	Silky Dogwood	5	-4			X	X	X
Cornus stolonifera	Red-osier Dogwood	2	-3			X	X	X
Equisetum fluviatile	Water Horsetail	7	-5			X		
Eupatorium maculatum	Spotted Joe-Pye-weed	3	-5			X	X	
Eupatorium perfoliatum	Boneset	2	-4			X	X	
Galium palustre	Marsh Bedstraw	5	-5				X	X
Impatiens capensis	Spotted Touch-me-not	4	-3			X	X	X
Juncus effusus	Soft Rush	4	-5			X		
Leersia oryzoides	Rice Cut Grass	3	-5			X		
Lycopus uniflorus	Bugleweed	5	-5			X	X	X
Myosotis laxa	Smaller Forget-me-not	6	-5			X	X	X
Persicaria hydropiperoides	Water-pepper	4	-5				X	
Sagittaria latifolia	Common Arrowhead	4	-5			X	X	
Salix bebbiana	Bebb's Willow	4	-4			X	X	
Salix eriocephala	Heart-leaved Willow	4	-3			X	X	
Salix exigua	Sandbar Willow	3	-5			X	X	
Salix nigra	Black Willow	6	-5			X	X	
Scirpus atrovirens	Dark Green Bulrush	3	-5			X	X	
Scirpus pendulus	Nodding Bulrush	3	-5			X	X	
Thalictrum pubescens	Tall Meadow-rue	5	-2			X	X	X
Verbena hastata	Blue Vervain	4	-4			X		
Typha latifolia	Common Cattail	3	-5				X	
	Total	**117**	**-135**	**0**	**0**			
	Count	**30**	**30**	**0**	**0**	**33**	**32**	**13**
	Mean	**4.2**	**-4.5**	**0**	**0**			

Abbreviations:
CC Coefficient of Conservatism
CW Coefficient of Wetness
SRank Provincial Rank, S1-extremely rare, S2-very rare, S3- rare to uncommon
SARO Species at Risk in Ontario

Appendix D. Bird Sightings at Harrington CA (Apr 22 – Aug 26, 2015)

Common Name	SARO	SRank (S1-S3)	Regional Status	Br	s	S	F	W
DUCKS, GEESE & SWANS								
Mallard			Common BS	4	C	C	A	C
Canada Goose			Common PR	4	A	C	A	C
Mute Swan			Introduced (SE)	3	R	R	R	R
STORKS, CORMORANTS, ANHINGAS, PELICANS								
Double-crested Cormorant			Common Migrant	1	U	U	C	O
VULTURES								
Turkey Vulture			Common BS	4	C	C	C	O
HAWKS, KITES, EAGLES								
Osprey			Uncommon BS	1	U	U	U	
PLOVERS, SANDPIPERS & ALLIES								
Spotted Sandpiper			Common BS	4	C	C	C	
Killdeer			Common BS	4	C	C	A	O
PIGEONS & DOVES								
Mourning Dove			Common PR	4	C	C	C	C
HUMMINGBIRDS								
Ruby-throated Hummingbird			Common BS	4	C	C	C	
KINGFISHERS								
Belted Kingfisher			Common BS	4	C	C	C	U
WOODPECKERS								
Northern Flicker			Common BS	4	C	C	C	R
Pileated Woodpecker			Uncommon PR	4	U	U	U	U
Downy Woodpecker			Common BS	4	C	C	C	C
TYRANT FLYCATHERS								
Eastern Kingbird			Common BS	4	C	C	C	
Eastern Phoebe			Common BS	4	C	U	C	U
VIREOS								
Red-eyed Vireo			Common BS	4	C	C	C	
Warbling Vireo			Common BS	4	C	C	C	
JAYS, CROWS, RAVENS								
American/Common Crow			Common PR	4	A	C	C	A
Blue Jay			Common BS	4	C	C	C	C
SWALLOWS								
Barn Swallow	THR		Common BS	4	C	C	C	
Northern Rough-winged Swallow			Common BS	4	C	C	C	
Tree Swallow			Common BS	4	C	C	C	U

Appendix D continued

Common Name	SARO	Srank (S1-S3)	Regional Status	Br	s	S	F	W
CHICKADEES & ALLIES								
Black-capped Chickadee			Common PR	4	C	C	C	C
WRENS								
House Wren			Common BS	4	C	C	C	
THRUSHES								
American Robin			Common BS	4	A	C	A	U
MOCKINGBIRDS, THRASHERS								
Gray Catbird			Common BS	4	C	C	C	O
STARLINGS								
European Starling			Common PR (SE)	4	C	C	A	C
WAXWINGS, SILKY-FLYCATHERS								
Cedar Waxwing			Common BS	4	C	C	C	E
WOOD-WARBLERS								
Common Yellowthroat			Common BS	4	C	C	C	O
Yellow Warbler			Common BS	4	C	C	C	
SPARROWS								
Chipping Sparrow			Common BS	4	C	C	C	O
Dark-eyed Junco			Common WR	0	C		C	C
Song Sparrow			Common BS	4	C	C	C	U
TANAGERS, CARDINALS & ALLIES								
Northern Cardinal			Common PR	4	C	C	C	C
Rose-breasted Grosbeak			Common BS	4	C	C	C	
Indigo Bunting			Common BS	4	C	C	C	
BLACKBIRDS								
Baltimore / Northern Oriole			Common BS	4	C	C	U	
Brown Headed Cowbird			Common BS	4	C	C	C	U
Common Grackle			Common BS	4	C	C	A	R
Red-winged Blackbird			Common BS	4	C	C	R	R
FINCHES								
American Goldfinch			Common PR	4	C	C	C	C
TOTAL of 42 Species	**1**	**0**						

NOTES

BS – Breeding Species, PR – Permanent Resident, WR – Winter Resident, SE = Status Exotic

Regional Status based on: Checklist of the Birds of Oxford County, 1st edition, May 2007 by Jeffrey H. Skevington and James M. Holdsworth. Available through The Woodstock Field Naturalists' Club.

…/continued

Appendix D continued

Br (Breeding Codes)

0 = no evidence of breeding

1 = status uncertain, possibly breeds

2 = formerly bred

3 = sporadically breeds

4 = regularly breeds

Seasonal Codes (relating to bird activities, not calendar dates)

s = Spring; period when a species is migrating to its breeding area

S = summer; the period when a species is nesting

F = Fall; the period when a species is migrating to its wintering area

W = Winter; the period when a species is over-wintering.

Abundance Codes

V = accidental vagrant

O = occasional; very few records; normally absent

R = rare; usually present annually, but seen infrequently

U = uncommon; present in low numbers, unlikely to be found daily without concerted effort

C = common; can be found daily, usually in moderate numbers

A = abundant; found daily in large numbers

E = erratic; numbers highly variable

Appendix E. Animal Sightings (Incidental)

Common Name	Scientific Name	SARO	SRank (S1-S3)	Regional Status
Mammals				
Eastern Chipmunk	Tamias striatus			Common
Eastern Cottontail	Sylvilagus floridanus			Common
Grey Squirrel	Sciurus carolinensis			Common
Red Squirrel	Sciurus vulgaris			Common
Groundhog (Woodchuck)	Marmota monax			Common
Reptiles and Amphibians				
Green Frog	Rana clamitans			Common
American Toad	Anaxyrus americanus			Common

Appendix E

Borehole Logs and Site Maps (Extracted from: Harrington Dam Embankment Stability Assessment). Prepared by Naylor Engineering Associates, October 2008

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

Borehole Number: 1

Ground Elevation: *53.05 m*

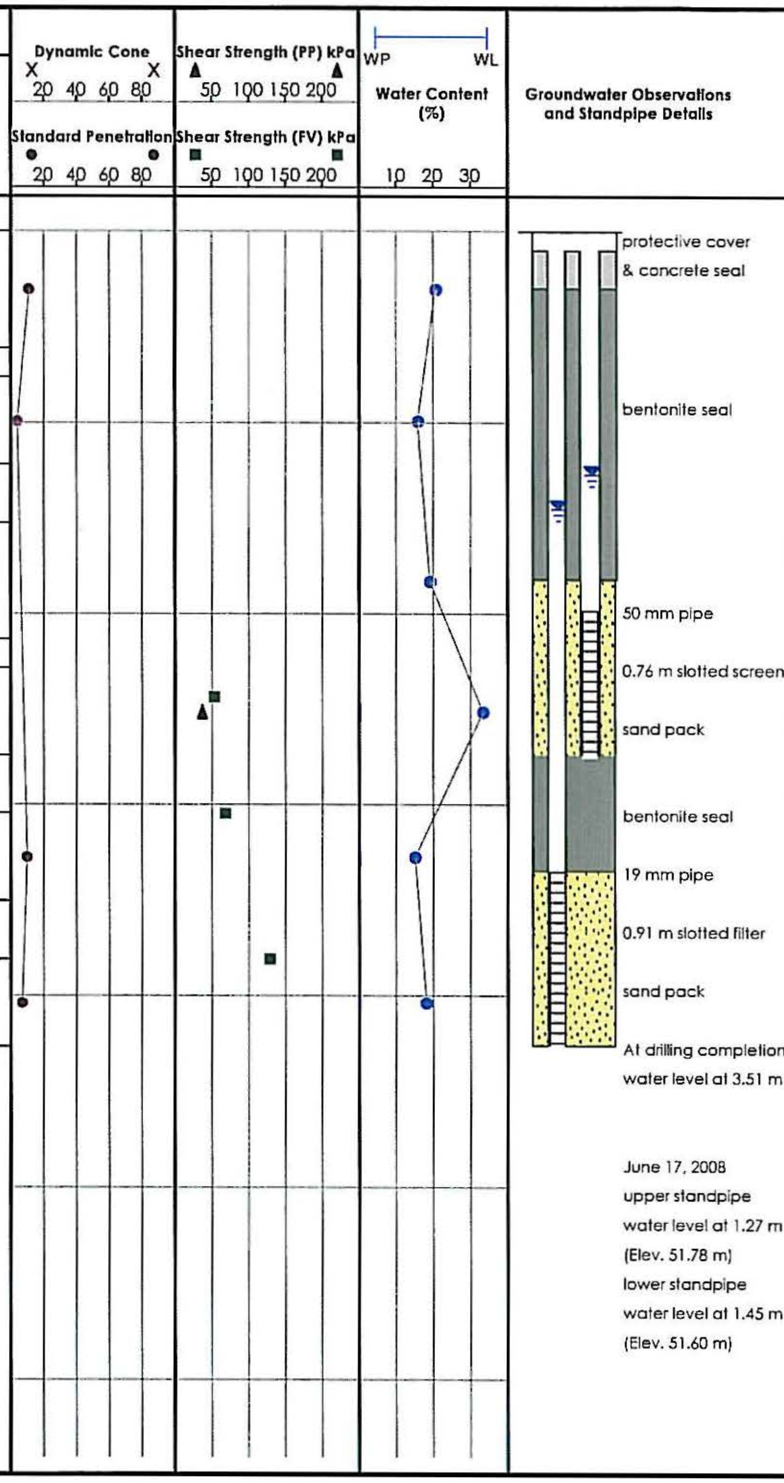
Project: *Harrington Dam Embankment Stability Assessment*

Location: *County Road 28, Harrington, Ontario*

Job No.: *7608G1*

Drill Date: *June 10, 2008*

Depth (m)	Description	Symbol	Elevation (m)	Number	Type	N-Value
0.00	Ground Elevation		53.05			
	FILL: dark brown silt (topsoil), wet					
	loose to compact brown silt, trace sand and clay, very moist			1	SS	11
1.00	very loose brown fine to medium sand, some silt, very moist		52.00	2	SS	4
	soft brown clayey, silt, some topsoil, WTPL			3	SS	*
2.00			51.00			
	dark brown sandy silt, some clay, saturated			4	TW	
3.00			50.00			
	SILT TILL: stiff grey silt, some clay, trace sand and fine gravel, APL			5	SS	10
4.00	some silt and sand layers, saturated		49.00	6	SS	7
	Borehole terminated at 4.27 m					
5.00			48.00			
6.00			47.00			



Reviewed by: *DK*

Drill Method: *Hollow Stem Auger*

Notes: **Sampler fell under weight of hammer*

Field Tech.: *RM*

Sheet: *1 of 1*

Drafted by: *AP(01a)*

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

Borehole Number: 2

Ground Elevation: *52.91 m*

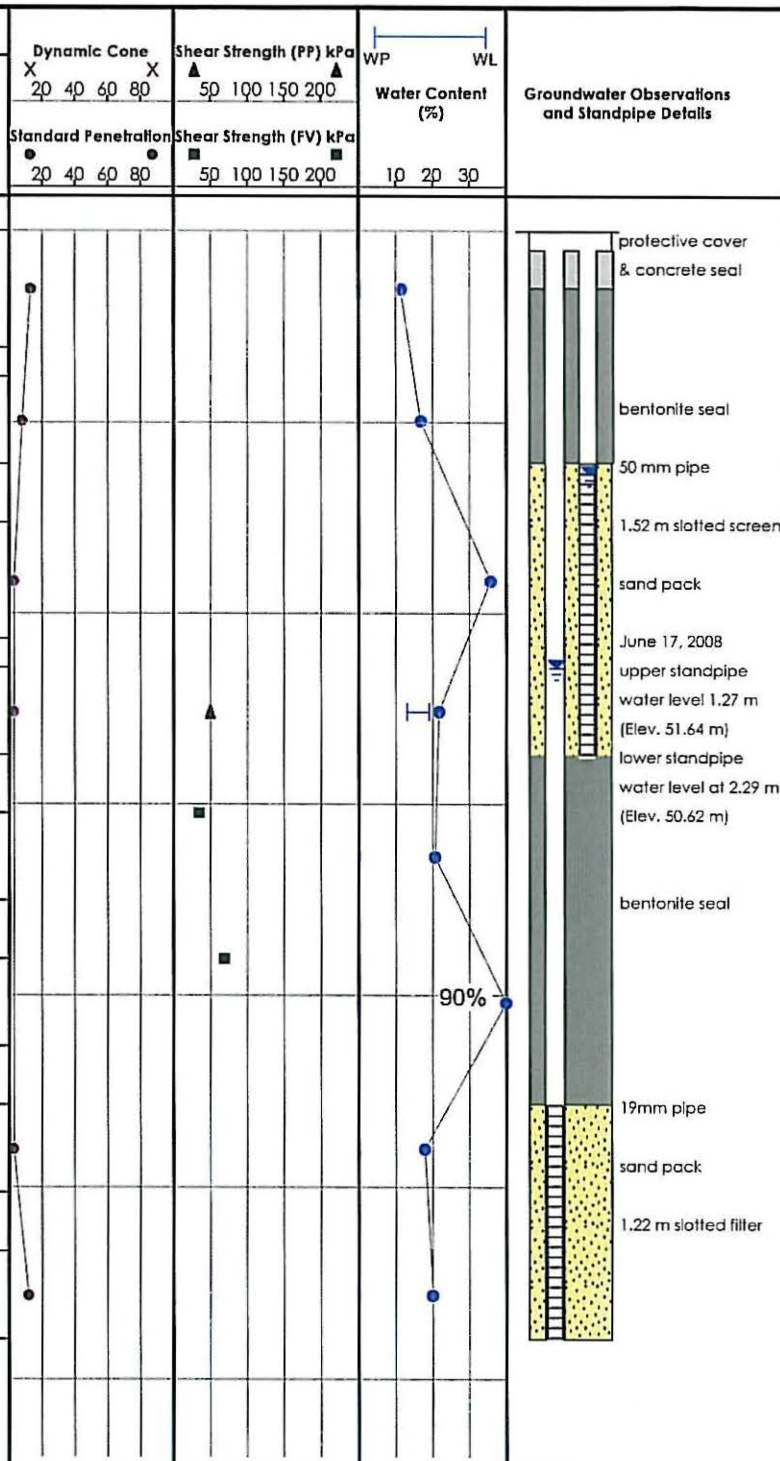
Project: *Harrington Dam Embankment Stability Assessment*

Location: *County Road 28, Harrington Ontario*

Job No.: *7608G1*

Drill Date: *June 11, 2008*

Depth (m)	SOIL PROFILE – Description	Elevation (m)	SAMPLE – Number	Type	N-Value
0.00	Ground Elevation	52.91			
	FILL: dark brown silt (topsoil), some brown silt and sand, very moist		1	SS	13
	compact brown silt, trace sand and clay, very moist				
1.00	loose grey/brown silty fine to medium sand, trace gravel and clay, saturated	52.00	2	SS	8
	soft black topsoil and grey silty clay, WTPL		3	SS	3
2.00		51.00			
	soft grey sandy silt, some clay, trace gravel, WTPL		4	SS	3
3.00	soft grey silt, some clay and sand, wet	50.00	5	TW	*
4.00	**PEAT:** black amorphous peat, WTPL, wood	49.00	6	SS	*
	SILT TILL: firm to stiff grey silt, some clay and trace sand, WTPL		7	SS	3
5.00		48.00	8	SS	12
	Borehole terminates at 5.79 m				
6.00		47.00			



Reviewed by: *DK*

Drill Method: *Hollow Stem Auger*

Notes: **Sampler fell under weight of hammer*

Field Tech.: *RM*

Sheet: *1 of 1*

Drafted by: *AP(01a)*

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

Borehole Number: 3

Ground Elevation: *50.12 m*

Project: *Harrington Dam Embankment Stability Assessment*

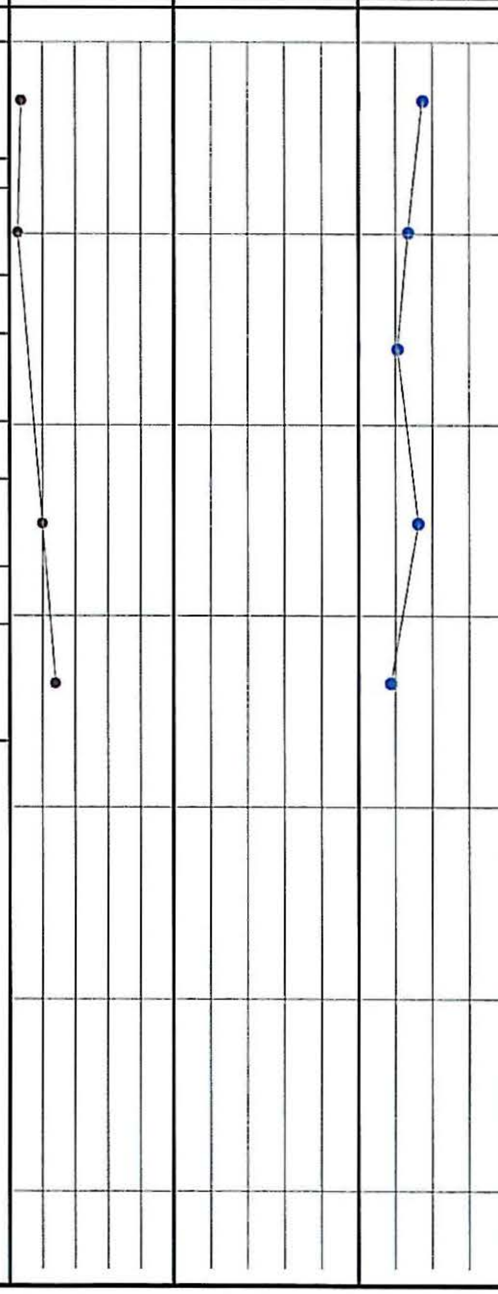
Location: *County Road 28, Harrington Ontario*

Job No.: *7608G1*

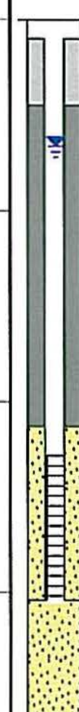
Drill Date: *June 11, 2008*

Depth (m)	Description	Symbol	Elevation (m)	Number	Type	N-Value
0.00	Ground Elevation		50.12			
	FILL: dark brown silt (topsoil), some brown silt, sand and gravel, very moist			1	SS	7
	loose brown silt, some clay, sand and gravel, moist					
	occassional boulders					
1.00	loose dark brown silt (topsoil), some sand, gravel and pieces of brick, moist		49.00	2	SS	5
	some black silty sand, saturated			3	SS	*
2.00	**PEAT:** brown fibrous peat, saturated		48.00			
	SAND: compact grey fine to coarse sand, some silt and gravel, saturated			4	SS	20
3.00	**SILT TILL:** compact brown sandy silt, some gravel, moist		47.00	5	SS	28
	Borehole terminates at 3.66 m					
4.00			46.00			
5.00			45.00			
6.00			44.00			

Dynamic Cone X 20 40 60 80 X
Standard Penetration ● 20 40 60 80 ●
Shear Strength (PP) kPa ▲ 50 100 150 200 ▲
Shear Strength (FV) kPa ■ 50 100 150 200 ■
WP WL
Water Content (%) 10 20 30



Groundwater Observations and Standpipe Details



protective cover & concrete

June 17, 2008 water level at 0.66 m (Elev. 49.46 m)

bentonite seal

50 mm pipe

0.76 m slotted screen

sand pack

At drilling completion, water level at 1.37 m

Reviewed by: *DK*

Drill Method: *Hollow Stem Auger*

Notes: **Sampler bouncing on wood*

Field Tech.: *RM*

Sheet: *1 of 1*

Drafted by: *AP(01a)*

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

Borehole Number: 4

Ground Elevation: *50.39 m*

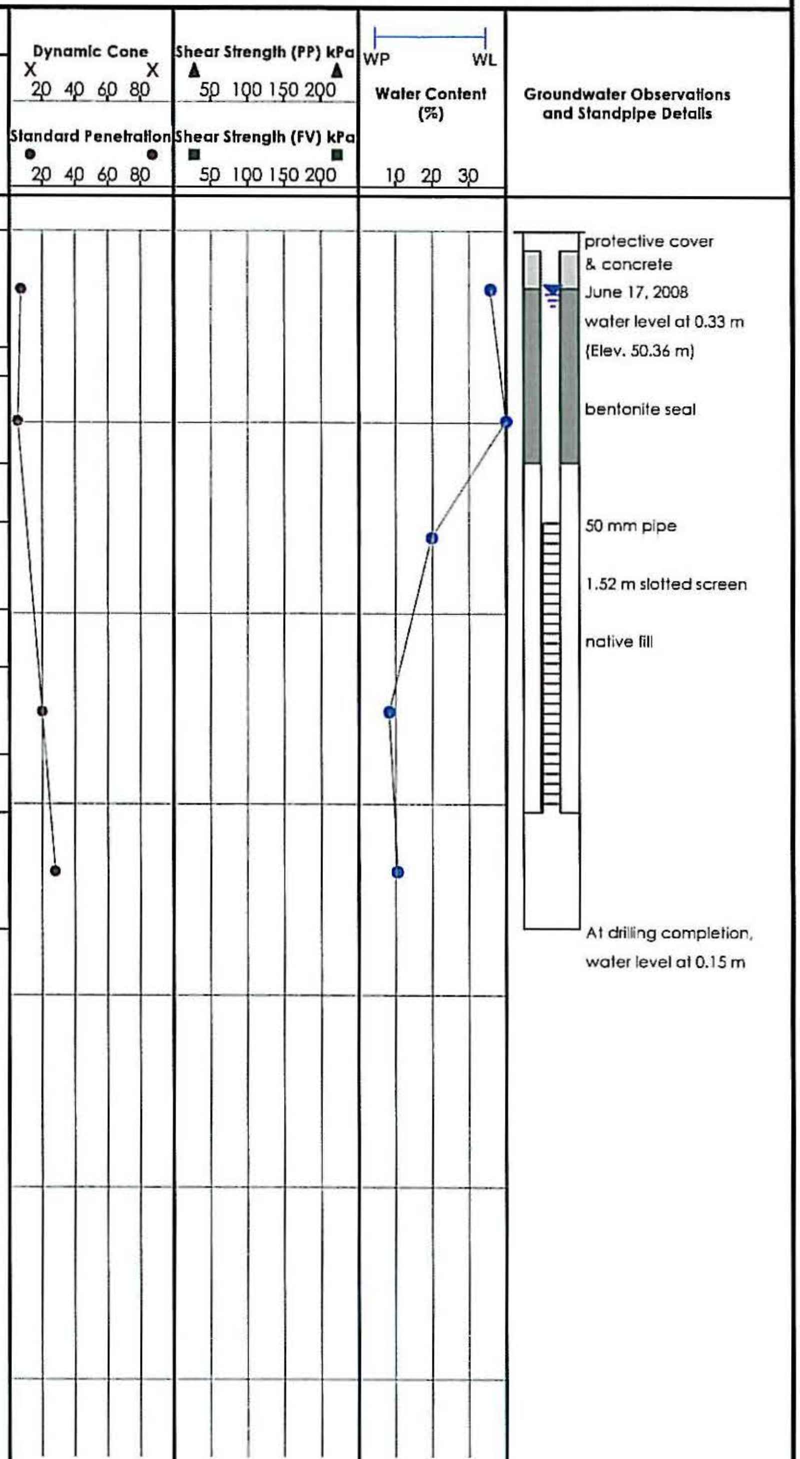
Project: *Harrington Dam Embankment Stability Assessment*

Location: *County Road 28, Harrington Ontario*

Job No.: *7608G1*

Drill Date: *June 11, 2008*

Depth (m)	Description	Elevation (m)	Sample Number	Type	N-Value
	Ground Elevation	50.39			
0.00	***FILL:*** dark brown silt (topsoil), wet: some peat and grey silty clay, WTPL				
		50.00	1	SS	2
1.00			2	SS	10
	SAND AND GRAVEL: loose brown sand and gravel, some silt and trace clay, saturated	49.00			
			3	SS	15
2.00					
		48.00	4	SS	24
3.00					
		47.00	5	SS	24
	Borehole terminates at 3.66 m				
4.00					
		46.00			
5.00					
		45.00			
6.00					
		44.00			



Reviewed by: *DK*
Drill Method: *Hollow Stem Auger*
Notes:

Field Tech.: *RM*
Sheet: *1 of 1*
Drafted by: *AP(01a)*

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

Handhole Number: HH1

Ground Elevation: *52.58 m*

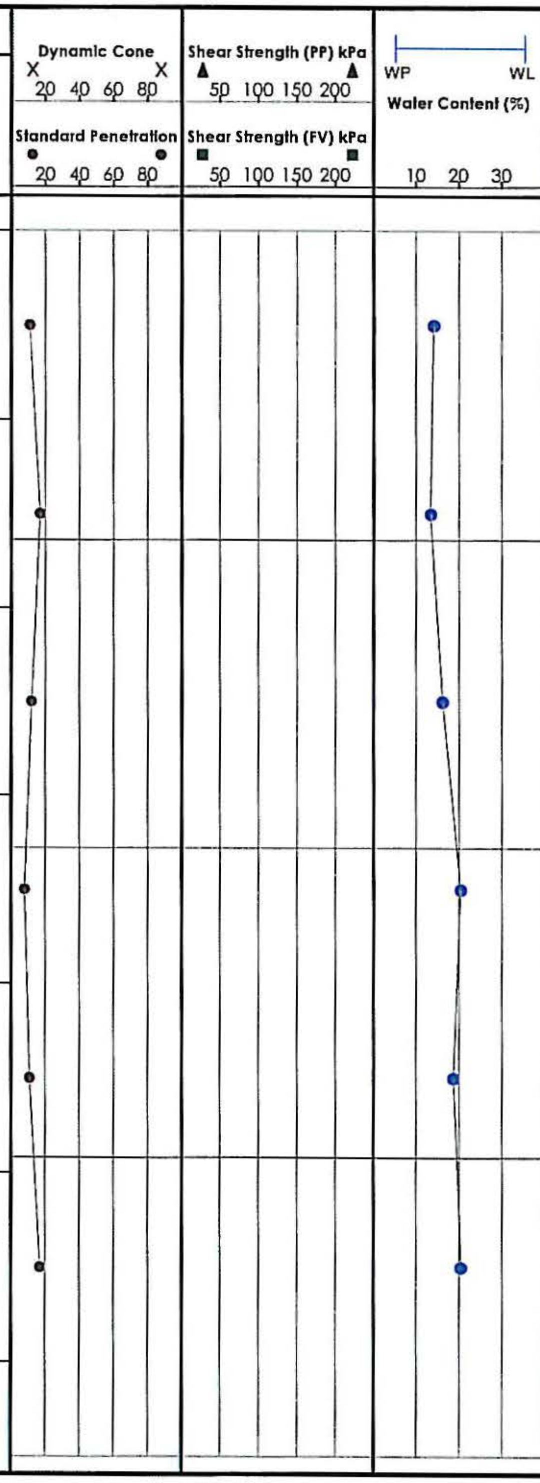
Project: *Harrington Dam Embankment Stability Assessment*

Location: *County Road 28, Harrington Ontario*

Job No.: *7608G1*

Drill Date: *June 25, 2008*

Depth (m)	SOIL PROFILE: Description	Symbol	Elevation	SAMPLE: Number	Type	N-Value
	Ground Elevation		52.58			
0.00	**FILL:** compact brown silt, some sand and clay, trace gravel, very moist			1	SS	11
	root from ash tree		52.00	2	SS	17
1.00			51.00	3	SS	12
2.00				4	SS	8
	grey, saturated		50.00	5	SS	11
3.00	wood			6	SS	17
	Borehole terminates at 3.66 m		49.00			



Groundwater Observations and Standpipe Details

bentonite seal

native backfill

At drilling completion, dry cave at 2.44 m

Reviewed by: *DK*

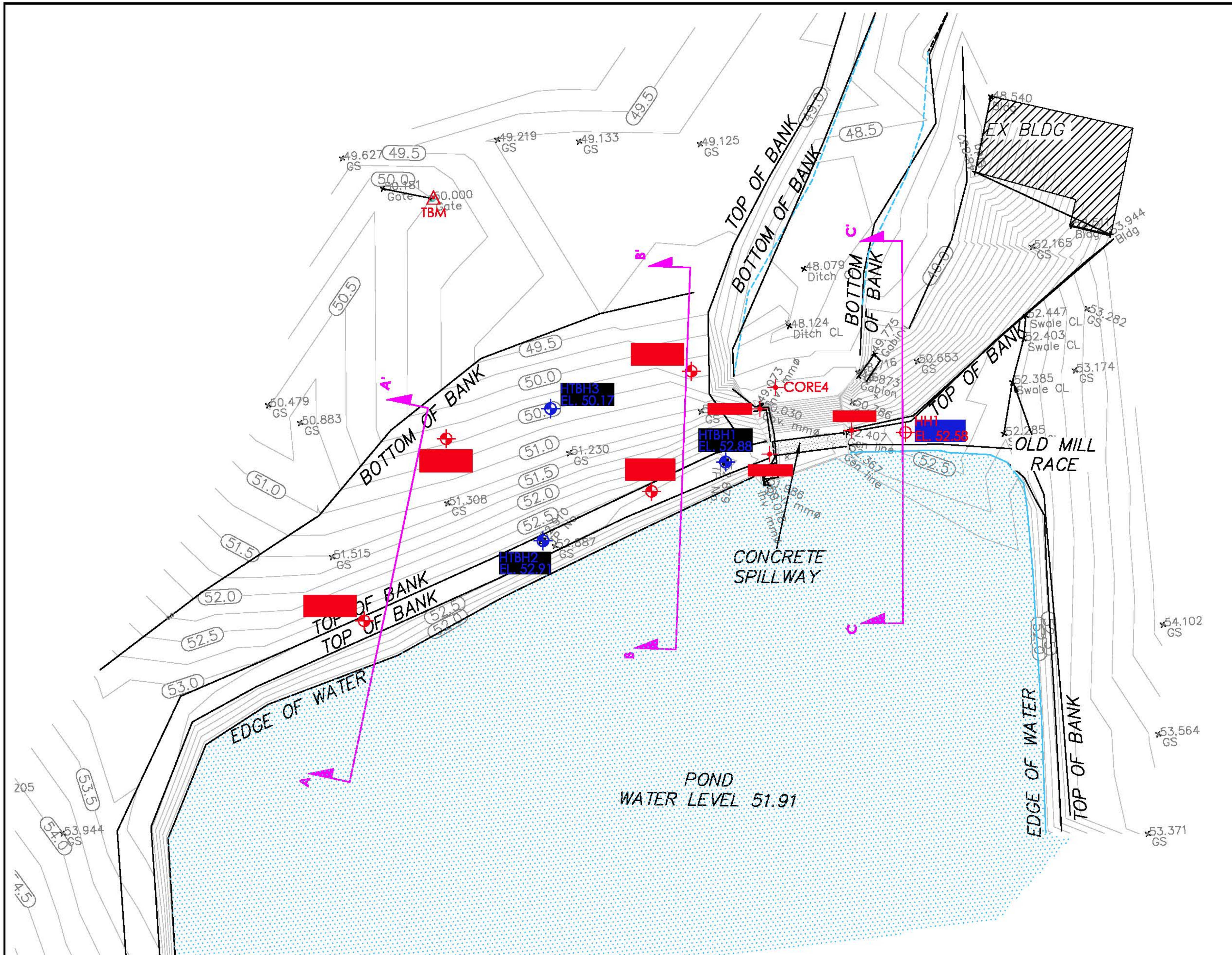
Drill Method: *Solid Stem Auger*

Notes:

Field Tech.: *NM*

Sheet: *1 of 1*

Drafted by: *Ap(00a2)*



Drawing Reference: Base drawing provided by R.J. Burnside Associates Ltd.

No.	Revisions	Date
0	**Report Issued**	**Oct. 2008**
1		
2		
3		

Legend

- Borehole Location (Current Investigation)
- Handhole Location (Current Investigation)
- Approximate Borehole Location (Acres International)
- Corehole Location (Current Investigation)
- EL. 52.58 — Ground Surface Elevation (m)
- Temporary Benchmark Top of centre concrete base for east post of gate Elevation 50.00 m (assumed local datum)
- A A' — Geologic Cross-Sections (Refer to Drawing No. 3)

0 5 10 15 20 25 m

SCALE 1:400

NORTH

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

Harrington Dam Embankment

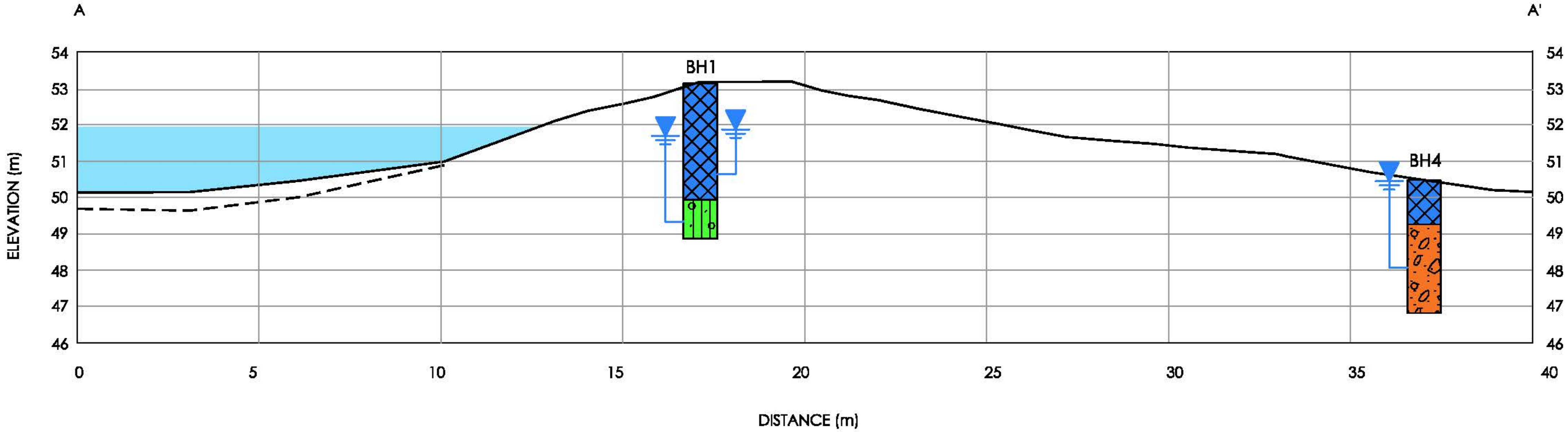
Stability Assessment

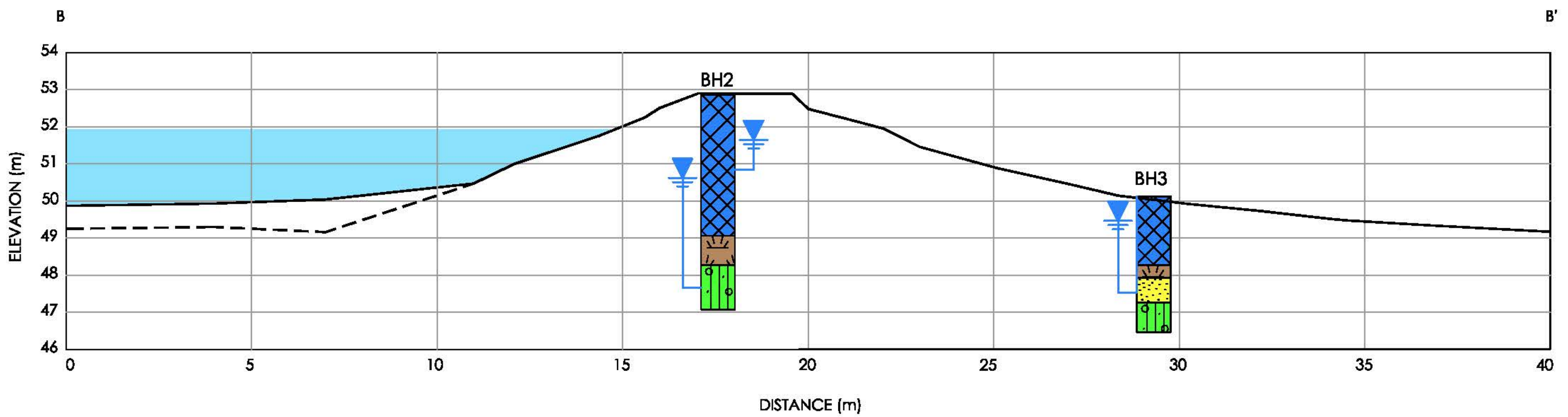
County Road 28

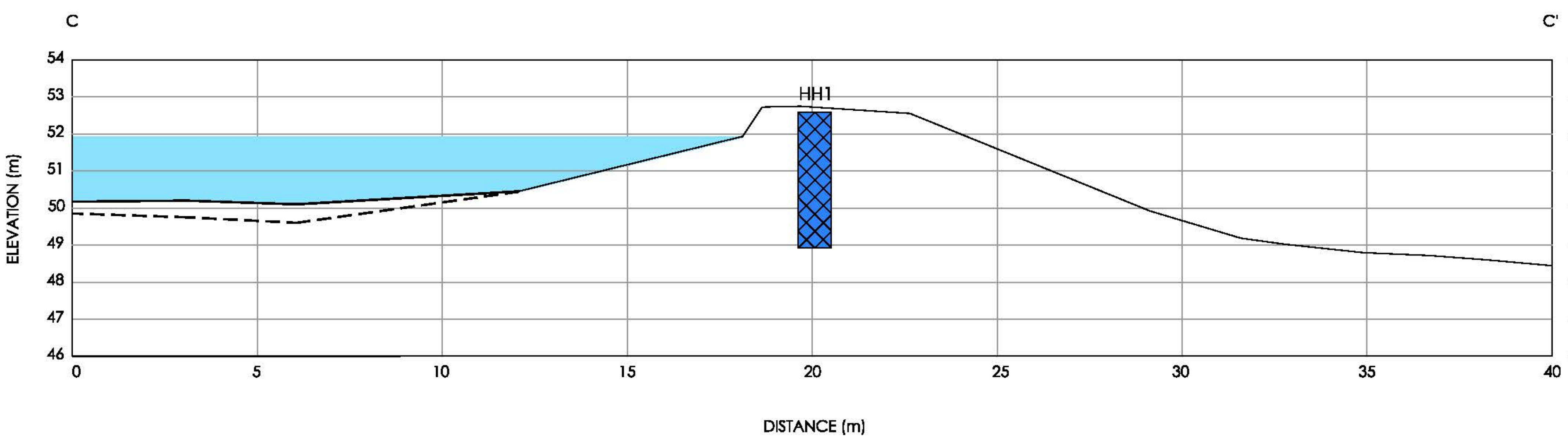
Harrington, Ontario

BOREHOLE LOCATION PLAN

Date	Scale	Job No.	Drawing No.
Oct. 2008	**1:400**	**7608G1**	**2**







No.	Revisions	Date
0	**Report Issued**	**Oct. 2008**
1		
2		
3		

Legend

- Fill
- Sand
- Peat
- Sand & Gravel
- Silt Till
- Water Level June 17, 2008
- Centre of Screen Location
- Existing Grade
- Approximate Top of Sediment
- Approximate Bottom of Sediment

Notes:

Seasonal fluctuations in groundwater levels would be expected.

The inferred stratigraphy shown on this cross-section is based on the subsurface stratigraphy contacted at the boreholes. The subsurface conditions between the boreholes will vary.

The ground surface under the water is based on depth (to refusal) measurements taken with a steel survey rod.

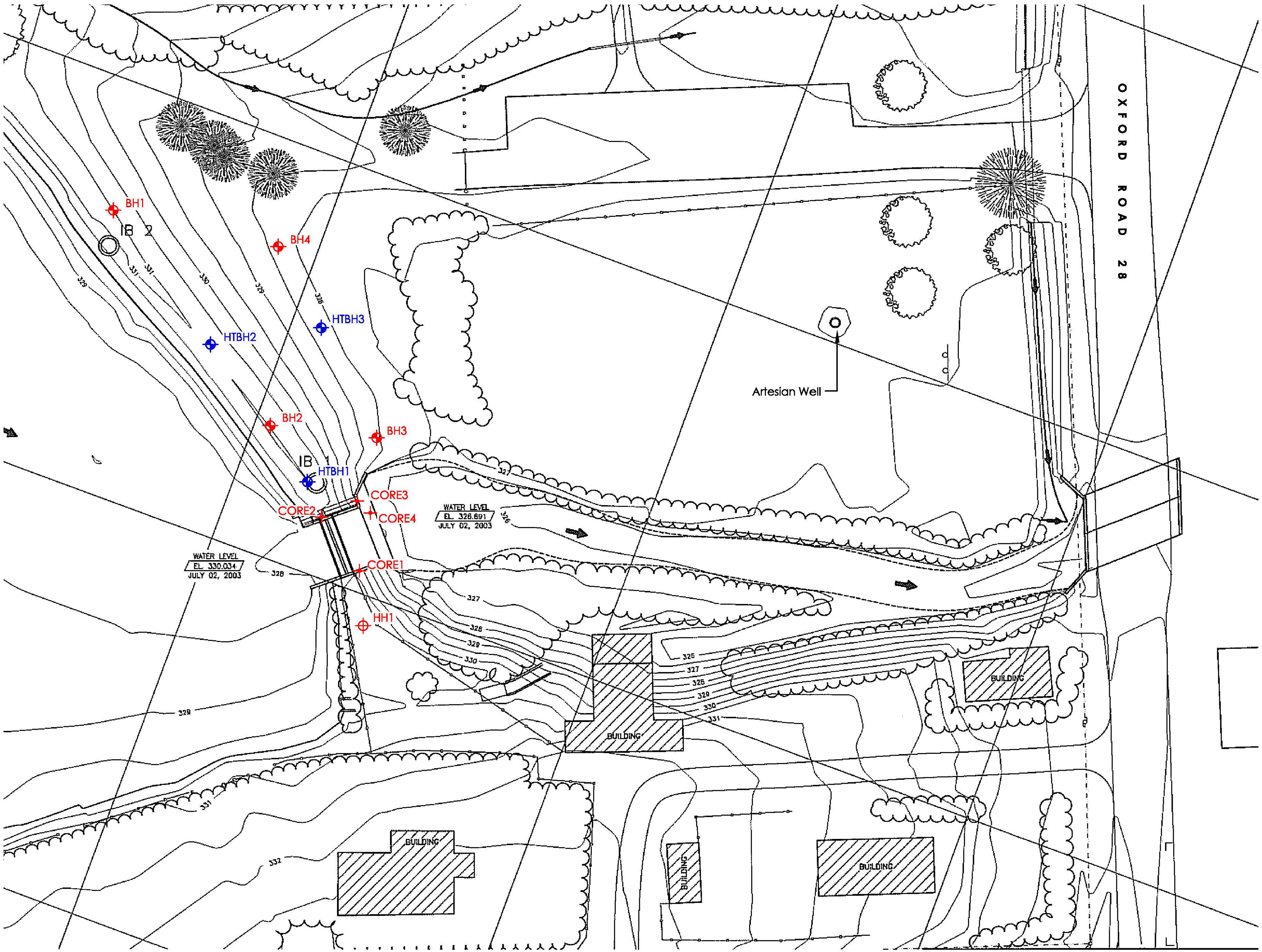
Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

Harrington Dam Embankment
Stability Assessment
County Road 28
Harrington, Ontario

CROSS SECTIONS A-A', B-B', C-C'

Date	Scale	Job No.	Drawing No.
Oct. 2008	**1:150**	**7608G1**	**3**

F:\7608\7608G1\7608G1_03.dwg
July 31, 2008 (ap)



No.	Revisions	Date
0	**Report Issued**	**Oct. 2008**
1		
2		
3		

Legend

- Borehole Location (Current Investigation)
- Handhole Location (Current Investigation)
- Approximate Borehole Location (Acres International)
- Corehole Location (Current Investigation)

0 5 10 15 m
SCALE 1:500

NORTH

Naylor Engineering Associates Ltd.
CONSULTING ENGINEERS

Harrington Dam Embankment
Stability Assessment
County Road 28
Harrington, Ontario

SITE CONDITIONS PLAN

Date	Scale	Job No.	Drawing No.
Oct. 2008	**1:500**	**7608G1**	**4**

Drawing Reference: Base drawing by Acres International, Drawing No. 14504-HD-002, Dated April 1, 2004.

F:\7608\7608G1\7608G1_04.dwg
October 27, 2008 /ks

Appendix F

Harrington Dam Class Environmental Assessment Fluvial Geomorphology Report. Prepared by ERI, February 2017

Upper Thames River Conservation Authority

Harrington Dam Class Environmental Assessment Fluvial Geomorphology Report

May 2017

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1. Fluvial Geomorphology

The intent of the fluvial geomorphic assessment was to characterize channel form and gain insight into channel processes along Harrington Creek in the vicinity of Harrington Pond. Harrington Creek drains into Wildwood Lake, north of Road 96; it is a tributary of Trout Creek. The geomorphic assessment included both a desktop review and data collection through field investigations; data collection completed by ERI was supplemented by UTRCA's topographic survey of the channel bed profile. Findings from the geomorphic assessment are presented by sub-section in this report.

1.1 Historical Assessment

A review of historical channel conditions was completed to gain insight into changes that have occurred within the study area. UTRCA provided airphotos dated from 1955, 1972, 1989, 2000, and 2010; additional aerial imagery was available from Google Maps (2013). Key observations are summarized in **Table 1-1;** a collection of historical airphotos of the study area is provided in **Figure 1-1**, **Figure 1-2**, and **Figure 1-3.**

Table 1-1. Key observations from the historical airphoto record

Year	Observation
1955	
1972	• Portions of Harrington Creek are obscured from view on the photo. • Upstream of Harrington pond, the tree density within the creek corridor appears to have increased; this may also reflect a time of year difference between the 1955 and 1972 photos. • No change in creek or pond planform configuration is evident in comparison to the 1955 image.
1989	• No change in creek or pond planform configuration is evident in comparison to the 1972 image.
2000	• The upstream west end of Harrington pond appears to have been modified. Shading within the pond may reflect wind on the water or draw-down. • No change in creek planform configuration is evident in comparison to the 1989 image.
2010	
2013	• Harrington pond size has increased, similar to the 2000 configuration. • No change in creek planform configuration is evident in comparison to the 2000 image upstream of the bridge.

Figure 1-1. Overview of historical channel change (1955-1972) along Harrington Creek in proximity to Harrington Pond

1955

1972

Figure 1-2. Overview of historical channel change (1989-2000) along Harrington Creek in proximity to Harrington Pond

Figure 1-3. Overview of historical channel change (2010-2013) along Harrington Creek in proximity to Harrington Pond

1.2 Existing Conditions

A geomorphic field investigation was undertaken on June 16, 2015 to assess existing conditions along Harrington Creek, both upstream and downstream of Harrington Pond. The field investigation included both reconnaissance level observations and detailed data collection.

During the field assessment, three reaches were identified. Reaches are defined as lengths of channel along which there is relative homogeneity of controlling and modifying influences and thus channel form and processes are similar. A description of dominant channel characteristics is provided by reach below. Although intended for urban watercourses, the Rapid Geomorphic Assessment (RGA) was applied to gain insight into overall channel stability and to identify dominant channel processes.

The focus of field data collection/measurements was predominantly upstream of the dam's backwater influence and included cross-section profiles and substrate characterization. A topographic survey of the channel bed morphology was undertaken by UTRCA and provided to the ERI team for analysis and integration into the fluvial geomorphic assessment. The reach delineation is demonstrated on **Figure 1-4**; the surveyed channel bed profile is illustrated in **Figure 1-5**, which includes a profile through Harrington Pond based on 2015 water depth mapping provided by UTRCA.

Figure 1-4. Reach delineation along Harrington Creek

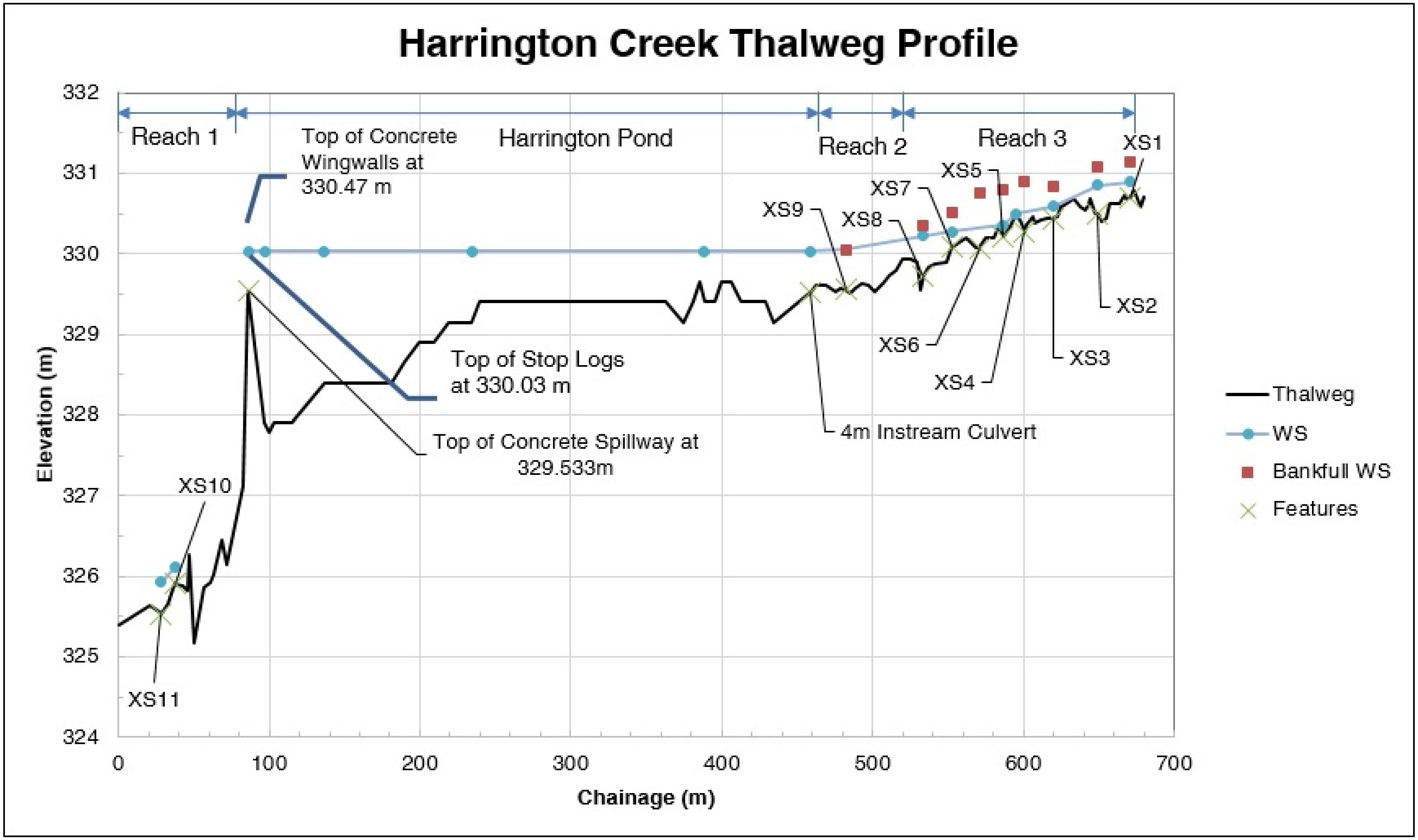

Figure 1-5. Channel bed profile along Harrington Creek

Reach 1. Downstream of Harrington Pond

At the outlet of Harrington pond, water flows over a 2.42 m high concrete outlet structure. Boulders and cobble placed at the transition between concrete and creek bed, convey water to the downstream portion of Harrington Creek. From the dam to Road 96, the watercourse was relatively straight, likely reflecting the channel condition associated with historic mill activity. Harrington creek crosses under Oxford Road 96 through a twin box culvert approximately 100 m downstream of the dam.

The bed morphology consisted of pool and riffle sequences and bed materials consisted of cobble and gravel. The deepest pool (0.46 m) occurred within 25 m downstream of the dam. Several fish were observed swimming downstream from this pool.

The cross-sections were trapezoidal and banks were steeper and higher along the west side of the channel. The bankfull channel was set within a deeper channel cross-section. Banks were well vegetated with trees and shrubs. Tree roots were exposed and minor undercutting (0.14 m) was measured.

A densely vegetated (shrub) island (5.7 m wide) separated the active channel from a 2.1 m wide and 0.25 m deep dry channel situated adjacent to the east valley wall. This secondary channel is the tailrace of the mill outlet and may be occupied during periods of high flow. The active channel on the other side of the ‘island’ was ~ 9.2m wide; the cross-section increased to ~ 17 m wide. Measurements were made at only two cross-sections (1 pool and 1 riffle), average channel dimensions are provided in

Table 1-2**.**

Overall, the creek was considered stable, downstream of Harrington Pond.

	
West bank along cross-section 10.	View downstream at Cross-section 11.

Table 1-2. Overview of Reach 1 cross-section parameters based on measurements at Cross-Sections 10 and 11.

Parameter	Range	Parameter	Range
BANKFULL		**LOW FLOW WATER**	
Width (m)	7.88	**Width (m)**	5.14
Depth (m)		**Depth (m)**	
Max.	0.79	**Max.**	0.28
Avg.	0.52	**Avg.**	0.17
Width:depth ratio (m/m)	15.22	**Width:depth ratio (m/m)**	33.6
Area (m^2)	4.26	**Area (m^2)**	0.86
Perimeter (m)	8.61	**Wetted perimeter (m)**	5.57
Bank Height (m)	0.75		
Bank undercutting (m)	0.14		
Bank Vegetation and rooting influence	Trees with exposed roots, shrubs		
Floodplain connectivity	Channel is well connected to a floodplain along the upstream facing left bank, but appears entrenched along the right bank		
Substrate Gradation (mm)			
D90	145		
D84	110		
D50	30		
D16	5		
D10	5		

Reach 2. Harrington Pond Trail Bridge to 79 m Upstream

Along this reach, Harrington Creek appears to be influenced by backwater conditions from the pond. The backwater condition, on the day of observation, appeared to extend approximately 79 m upstream. From the topographic survey, the UTRCA field crew noted that sediment covered the streambed for a distance of approximately 56 m upstream of the trail bridge.

Channel banks were well vegetated with grasses and herbaceous plants; the fine and dense rooting network extended to the water surface. Bank materials consisted of silty clay sediment that was considered very soft/moist. The bank configuration was generally irregular which is characteristic of banks influenced by backwater conditions in which hydration of bank materials leads to erosion; the rooting network of bankside vegetation holds the banks together in ‘clumps’. Undercutting of the banks occurred near the water surface. The relatively low banks indicated good floodplain accessibility during high flows. The floodplain sediment was moist along the west side of the channel; cedar trees flanked the bankside vegetation along the east side.

The cross-sections were uniform in configuration and increased gradually in width along this reach. A bankfull channel was not well defined since it appeared that flows higher than the channel bank spread over the vegetated west floodplain. This floodplain was very moist, suggesting frequent flooding, poor drainage and/or high groundwater content. Measurement of the active channel at one cross section (section 9) situated 23 m upstream of the trail bridge, enabled quantification of several cross-section parameters (

Table 1-3).

Table 1-3. Overview of Reach 2 cross-section parameters based on measurements at Cross-Section 9.

Parameter	Range	Parameter	Range
BANKFULL		**LOW FLOW WATER**	
Width (m)	7.50	**Width (m)**	7.26
Depth (m) **Max.** **Avg.**	 0.49 0.37	**Depth (m)** **Max.** **Avg.**	 0.45 0.34
Width:depth ratio (m/m)	20.34	**Width:depth ratio (m/m)**	21.34
Area (m^2)	2.77	**Area (m^2)**	2.47
Perimeter (m)	6.68	**Wetted perimeter (m)**	7.47
Bank Height (m)	0.75		
Bank undercutting (m)	none		
Bank Vegetation and rooting influence	grasses along both banks		
Floodplain connectivity	well-connected		
Substrate Gradation (mm) **D90** **D84** **D50** **D16** **D10**	all substrate consisted of sand and silt		

The bed morphology through this reach was poorly defined. Water depth ranged from 0.42 to 0.51 m. Bed materials consisted entirely of fine sediment (silt, sand) that had formed into ripples by the flow and organics at cross-section 9; the thickness of this sediment ranged from 5 to 20 cm. Further upstream, occasional cobbles and branches/logs were observed on the channel bed. A vegetated (grass) bar was observed in the channel, towards the upstream limit of the backwater influence.

Overall, the reach was considered to be stable. Given the low energy grade (see **Figure 1-5**), both aggradation and channel widening processes are gradually affecting channel form and processes.

View upstream at ~33 m upstream of bridge.

Substrate materials consisted of fine (silt, sand) sediment.

Reach 3. From 79 m to 220 m Upstream of Pedestrian Bridge

The upstream limit of the backwater conditions appeared to extend to a shallow and low gradient riffle feature. Harrington Creek, within this reach, was situated within a predominantly wooded (cedar) forest. Subtle terracing was observed in the floodplain in a few locations, suggesting that, in the long term, Harrington Creek has likely gradually migrated over its floodplain and downcut.

Floodplain materials, especially those along the west side of the channel were often moist and surface water channels originating from within the west floodplain were observed. Fallen and leaning trees were common within the reach and occupied the entire cross-section in several locations.

Overall, Harrington Creek had a somewhat sinuous planform configuration; no well-developed meander bends were observed. In several locations, large woody debris appears to have caused the channel to bifurcate or split. Accumulations of fine sediment (silt/sand) were observed in the 'lee' side of logs or fallen trees in the channel.

The channel banks were generally well vegetated with herbaceous plants, mosses and cedar trees. Tree roots were often exposed through the gradual winnowing of bank materials, and minor undercutting (e.g., 0.10 m) was measured. The bank were generally low, enabling access during flood flows. Materials were moist and hydrated near the bank toe.

The cross-sections within Reach 3 were generally considered to be wide and relatively shallow. The configuration tended to be relatively uniform, with no asymmetric forms observed. The cross-section configuration was determined at eight cross-sections in the field, including 3 pools and 6 riffle/runs.

The channel bed configuration consisted of riffles and shallow pools (depth ranged from 0.12 to 0.34 m) (**Figure 1-5**). The water surface grade, from the upstream to downstream cross-section was 0.65 %. Overall, the bed morphology appeared to be poorly developed. This is likely due to the influence of large woody debris and the high channel width-depth ratio which reduces scour potential of pools.

Throughout the reach, accumulations of sand (very fine to medium size) and silt were observed as lateral deposits (i.e., along the banks); often, the materials appeared to be a hydrated slurry of sediment. The measured grain size gradation within Reach 3 is summarized in **Table 1-4** which shows that pools substrate was somewhat smaller than riffle substrate. Occasional larger cobble and boulders were observed on the channel bed. Insight into general channel bed roughness was obtained by measuring the height that substrate materials projected into the water column at each cross-section; measurements revealed that the average maximum, intermediate and minimum protrusion heights were 17, 9 and 1.5 cm respectively.

Analysis of the topographic channel bed profile, provided by UTRCA, was undertaken. This revealed that the average water surface grade during the field survey (June 16, 2015) was 0.45 % and the average bankfull grade was 0.58 %. Quantification of riffle and pool parameters, for Reach 3 is provided in **Table 1-5**.

Application of the Rapid Geomorphic Assessment (RGA) for this reach indicated that the channel is 'in transition'. The dominant process within the reach was aggradation. Gradual widening of the cross-sections is also prevalent due to hydration effects.

Table 1-4. Overview of Reach 3 cross-section parameters based on measurements taken at Cross-Sections 1 to 8.

Bankfull				
Depth (m) **Max.** **Avg.**	 0.41-0.62 0.28-0.35	 0.47 0.32	 0.58-0.69 0.39-0.50	 0.63 0.43
Area (m^2)	1.64-5.47	3.38	2.43-2.84	2.57
Wetted width (m)	4.16-7.38	6.42	4.54-5.74	5.06
Width:depth ratio (m/m)	32.01-71.50	55.23	18.87-20.18	19.51
Wetted perimeter (m)	4.43-9.86	7.38	4.85-6.10	5.39

Table 1-5. Channel bed profile characteristics along Reach 3.

Parameter	Range	Average
Max. residual pool depth (m)		0.17
Pool area (2D along profile) (m^2)	0.03-1.11	0.38
Pool length (m)	6.30-22.00	15.33
Avg. pool depth	0.01-0.14	0.07
Riffle length (m)	3.50-32.25	12.31
Riffle grade (%)	0.26-3.51	1.58
Inter-riffle spacing	11.31 – 36.40	29.14

	
View upstream near downstream limit of Reach 3. Banks were low; the creek was well connected to its floodplain.	Seepage from the west flood plain entered the creek in several locations
	
Large woody debris were frequently in the channel.	Leaning trees were common along the reach.
	
Accessible floodplain and subtle terracing.	Upstream end of Reach 3

Appendix G

Stage 1 Archaeological Assessment. Prepared by Archaeological Research Associates, 2015

Archaeological Research Associates Ltd.

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DRAFT

Stage 1 Archaeological Assessment
Harrington Dam and Embro Dam
Class Environmental Assessment
963656 Road 96 and 843970 Road 84
Township of Zorra
Part of Lot 30, Concession 2 and
Part of Lot 15, Concession 4
Geographic Township of West Zorra
Oxford County, Ontario

Prepared for
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1023 Rife Road, Unit A
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&
The Upper Thames River Conservation Authority
&
The Ministry of Tourism, Culture and Sport

By
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Licenced under
P.J. Racher, M.A., CAHP
MTCS Licence #P007
Project #P007-0690
PIF #P007-0690-2015

12/06/2015

Original Report

EXECUTIVE SUMMARY

Under a contract awarded by Ecosystem Recovery Inc. in May 2015, Archaeological Research Associates Ltd. carried out a Stage 1 archaeological assessment of lands involved in the Class Environment Assessment of the Harrington Dam and the Embro Dam in the Township of Zorra, Oxford County, Ontario. The project is being conducted for the Upper Thames River Conservation Authority to evaluate alternatives for the two dams. This report documents the background research and fieldwork involved in the assessment, and presents conclusions and recommendations pertaining to archaeological concerns within the study area. The assessment was triggered by the requirements set out in the *Environmental Assessment Act*.

The Stage 1 assessment was conducted in May 2015 under licence #P007, PIF #P007-0690-2015. At the time of assessment, the Harrington Dam parcel comprised Harrington Pond, the Harrington Grist Mill, a gravel driveway, pedestrian bridges, maintained lawns, wooded areas and part of an agricultural field, whereas the Embro Dam parcel comprised Embro Pond, a pavilion, a culvert, maintained lawns and wooded areas. All field observations were made from accessible public lands; accordingly, no permissions were required for property access.

The results of the assessment indicate that the study area currently comprises a mixture of areas of archaeological potential and areas of no archaeological potential. Archaeological Research Associates Ltd. recommends that all areas of archaeological potential that could be impacted by the project be subject to a Stage 2 property assessment in advance of any construction impacts. The identified areas of no archaeological potential are not recommended for further assessment.

It is requested that this report be entered into the *Ontario Public Register of Archaeological Reports*, as provided for in Section 65.1 of the *Ontario Heritage Act.*

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GLOSSARY OF ABBREVIATIONS

ARA – Archaeological Research Associates Ltd.
CHVI – Cultural Heritage Value or Interest
MTC – (Former) Ministry of Tourism and Culture
MTCS – Ministry of Tourism, Culture and Sport
PIF – Project Information Form
S&Gs – Standards and Guidelines for Consultant Archaeologists
UTRCA – Upper Thames River Conservation Authority

PERSONNEL

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Technical Writers: C.J. Gohm, J. McDermid

1.0 PROJECT CONTEXT

1.1 Development Context

Under a contract awarded by Ecosystem Recovery Inc. in May 2015, ARA carried out a Stage 1 archaeological assessment of lands involved in the Class Environment Assessment of the Harrington Dam and the Embro Dam in the Township of Zorra, Oxford County, Ontario. The project is being conducted for the UTRCA to evaluate alternatives for the two dams. This report documents the background research and fieldwork involved in the assessment, and presents conclusions and recommendations pertaining to archaeological concerns within the study area. The assessment was triggered by the requirements set out in the *Environmental Assessment Act*.

The subject study area consists of an irregular-shaped 5.66 ha parcel of land at the Harrington Dam (963656 Road 96) and a rectilinear 3.14 ha parcel of land at the Embro Dam (843970 Road 84), both located in the western part of the Township of Zorra (see Map 1–Map 2). The Harrington Dam parcel is generally bounded by Road 96 (County Road 28) to the north, Victoria Street to the east, agricultural lands to the south and a maintained lawn to west, whereas the Embro Dam parcel is generally bounded by Road 84 (County Road 16) to the north, agricultural lands to the east and southeast and the remainder of the Embro Pond Conservation Area to the west. At the time of assessment, the Harrington Dam parcel comprised Harrington Pond, the Harrington Grist Mill, a gravel driveway, pedestrian bridges, maintained lawns, wooded areas and part of an agricultural field, whereas the Embro Dam parcel comprised Embro Pond, a pavilion, a culvert, maintained lawns and wooded areas. In legal terms, the Harrington Dam parcel falls on part of Lot 30, Concession 2 in the Geographic Township of West Zorra, whereas the Embro Dam parcel falls on part of Lot 15, Concession 4 in the Geographic Township of West Zorra.

The Stage 1 assessment was conducted in May 2015 under licence #P007, PIF #P007-0690-2015. All field observations were made from accessible public lands; accordingly, no permissions were required for property access. In compliance with the objectives set out in Section 1.0 of the *S&Gs* (MTC 2011:13–23), this investigation was carried out in order to:

- Provide information concerning the study area's geography, history and current land condition;
- Determine the presence of known archaeological sites in the study area;
- Present strategies to mitigate project impacts to such sites, if they are located;
- Evaluate in detail the study area's archaeological potential; and
- Recommend appropriate strategies for Stage 2 archaeological assessment, if some or all of the study area has archaeological potential.

The assessment was conducted in accordance with the provisions of the *Ontario Heritage Act*, R.S.O. 1990, c. O.18. All notes, photographs and records pertaining to the project are currently housed in ARA's processing facility located at 154 Otonabee Drive, Kitchener. Subsequent long-term storage will occur at ARA's secure storage facility located in Kitchener.

The MTCS is asked to review the results and recommendations presented in this report and express their satisfaction with the fieldwork and reporting through a *Letter of Review and Entry into the Ontario Public Register of Archaeological Reports*.

1.2 Historical Context

After a century of archaeological work in southern Ontario, scholarly understanding of the historic usage of lands in Oxford County has become very well-developed. What follows is a detailed summary of the archaeological cultures that have settled in the vicinity of the study area over the past 11,000 years; from the earliest Palaeo-Indian hunters to the most recent Euro-Canadian farmers.

1.2.1 Pre-Contact

1.2.1.1 Palaeo-Indian Period

The first documented evidence of occupation in southern Ontario dates to around 9000 BC, after the retreat of the Wisconsinan glaciers and the formation of Lake Algonquin, Early Lake Erie and Early Lake Ontario (Karrow and Warner 1990; Jackson et al. 2000:416–419). At that time (or perhaps even earlier) small Palaeo-Indian bands moved into the region, leading mobile lives based on the communal hunting of large game and the collection of plant-based food resources (Ellis and Deller 1990:38; MCL 1997:34). Current understanding suggests that Palaeo-Indian peoples ranged over very wide territories in order to live sustainably in a post-glacial environment with low biotic productivity. This environment changed considerably during this period, developing from a sub-arctic spruce forest to a boreal forest dominated by pine (Ellis and Deller 1990:52–54, 60).

An Early Palaeo-Indian period (ca. 9000–8400 BC) and a Late Palaeo-Indian period (ca. 8400–7500 BC) are discernable amongst the lithic spear and dart points. Early points are characterized by grooves or ‘flutes’ near the base while the later examples lack such fluting. All types would have been used to hunt caribou and other ‘big game’. Archaeological sites from both time-periods typically served as small campsites or ‘way-stations’ (occasionally with hearths or fire-pits), where tool manufacture/maintenance and hide processing would have taken place. For the most part, these sites tend to be small (less than 200 sq. m) and ephemeral (Ellis and Deller 1990:51–52, 60–62). Many parts of the Palaeo-Indian lifeway remain unknown.

1.2.1.2 Archaic Period

Beginning in the early 8th millennium BC, the biotic productivity of the environment began to increase as the climate warmed and southern Ontario was colonized by deciduous forests. This caused the fauna of the area to change as well, and ancient peoples developed new forms of tools and alternate hunting practices to better exploit both animal and plant-based food sources. These new archaeological cultures are referred to as ‘Archaic’. Thousands of years of gradual change in stone tool styles allows for the recognition of Early (7500–6000 BC), Middle (6000–2500 BC) and Late Archaic periods (2500–900 BC) (MCL 1997:34).

The Early and Middle Archaic periods are characterized by substantial increases in the number of archaeological sites and a growing diversity amongst stone tool types and exploited raw materials. Notable changes in Archaic assemblages include a shift to notched or stemmed projectile points, a growing prominence of net-sinkers (notched pebbles) and an increased reliance on artifacts like bone fish hooks and harpoons. In addition to these smaller items, archaeologists also begin to find evidence of more massive wood working tools such as ground stone axes and chisels (Ellis et al. 1990:65–67).

Towards the end of the Middle Archaic (ca. 3500 BC), the archaeological evidence suggests that populations were 1) increasing in size, 2) paying more attention to ritual activities, 3) engaging in long distance exchange (e.g. in items such as copper) and 4) becoming less mobile (Ellis et al. 1990:93; MCL 1997:34). Late Archaic peoples typically made use of shoreline/riverine sites located in rich environmental zones during the spring, summer and early fall, and moved further inland to deer hunting and fruit-gathering sites during late fall and winter (Ellis et al. 1990:114).

During the Late Archaic these developments continued, and new types of projectile points appeared along with the first true cemeteries. Excavations of burials from this time-frame indicate that human remains were often cremated and interred with numerous grave goods, including items such as projectile points, stone tools, red ochre, materials for fire-making kits, copper beads, bracelets, beaver incisors, and bear maxilla masks (Ellis et al. 1990:115–117). Interestingly, these true cemeteries may have been established in an attempt to solidify territorial claims, linking a given band or collection of bands to a specific geographic location.

From the tools unearthed at Archaic period sites it is clear that these people had an encyclopaedic understanding of the environment that they inhabited. The number and density of the sites that have been found suggest that the environment was exploited in a successful and sustainable way over a considerable period of time. The success of Archaic lifeways is attested to by clear evidence of steady population increases over time. Eventually, these increases set the stage for the final period of Pre-Contact occupation—the Woodland Period (Ellis et al. 1990:120).

1.2.1.3 Early and Middle Woodland Periods

The beginning of the Woodland period is primarily distinguished from the earlier Archaic by the widespread appearance of pottery. Although this difference stands out prominently amongst the archaeological remains, it is widely believed that hunting and gathering remained the primary subsistence strategy throughout the Early Woodland period (900–400 BC) and well into the Middle Woodland period (400 BC–AD 600). In addition to adopting ceramics, communities also grew in size during this period and participated in developed and widespread trade relations (Spence et al. 1990; MCL 1997:34).

The first peoples to adopt ceramics in the vicinity of the study area are associated with the Meadowood archaeological culture. This culture is characterized by distinctive Meadowood preforms, side-notched Meadowood points and Vinette 1 ceramics (thick and crude handmade pottery with cord-marked decoration). Meadowood peoples are believed to have been organized in bands of roughly 35 people, and some of the best documented sites are fall camps geared towards the hunting of deer and the gathering of nuts (Spence et al. 1990:128–137).

Ceramic traditions continued to develop during the subsequent Middle Woodland period, and three distinct archaeological cultures emerged in southern Ontario: 'Point Peninsula' north and northeast of Lake Ontario, 'Couture' near Lake St. Clair and 'Saugeen' in the rest of southwestern Ontario (see Map 3). These cultures all shared a similar method of decorating pottery, using either dentate or pseudo-scallop shell stamp impressions, but they differed in terms of preferred vessel shape, zones of decoration and surface finish (Spence et al. 1990:142–43).

The local Saugeen complex, which appears to have extended from Lake Huron to as far east as the Humber River and the Niagara Peninsula, is characterized by stamped pottery, distinctive projectile points, cobble spall scrapers and a lifeway geared towards the exploitation of seasonally-available resources such as game, nuts and fish (Spence et al. 1990:147–156). Although relatively distant from the study area, the Donaldson site along the Saugeen River may be representative of a typical Saugeen settlement; it was occupied in the spring by multiple bands that came to exploit spawning fish and bury members who had died elsewhere during the year (Finlayson 1977:563–578). The archaeological remains from this site include post-holes, hearth pits, garbage-dumps (middens), cemeteries and even a few identifiable rectangular structures (Finlayson 1977:234–514).

During the Middle to Late Woodland transition (AD 600–900), the first rudimentary evidence of maize (corn) horticulture appears in southern Ontario. Based on the available archaeological evidence, which comes primarily from the vicinity of the Grand and Credit Rivers, this pivotal development was not particularly widespread (Fox 1990a:171, Figure 6.1). The adoption of maize horticulture instead appears to be linked to the emergence of the Princess Point complex, whose material remains include decorated ceramics (combining cord roughening, impressed lines and punctuate designs), triangular projectile points, T-based drills, steatite and ceramic pipes, and ground stone chisels and adzes (Fox 1990a:174–188).

The distinctive artifacts and horticultural practices of Princess Point peoples have led to the suggestion that they were directly ancestral to the later Iroquoian-speaking populations of southern Ontario (Warrick 2000:427). These artifacts have not been found in the vicinity of the study area, however, suggesting that a gradual transition between Saugeen and Early Iroquoian lifeways took place here instead.

1.2.1.4 Late Woodland Period

In the Late Woodland period (ca. AD 900–1600), the practice of maize horticulture spread beyond the western end of Lake Ontario, allowing for population increases which in turn led to larger settlement sizes, higher settlement density and increased social complexity amongst the peoples involved. These developments are believed to be linked to the spread of Iroquoian-speaking populations in the area; ancestors of the historically-documented Huron, Neutral and Haudenosaunee Nations. Other parts of southern Ontario, including the Georgian Bay littoral, the Bruce Peninsula and the vicinity of Lake St. Clair, were inhabited by Algonkian-speaking peoples, who were much less agriculturally-oriented.

Late Woodland archaeological remains from the greater vicinity of the study area show three major stages of cultural development prior to European contact: ‘Early Iroquoian’, ‘Middle Iroquoian’ and ‘Late Iroquoian’ (Dodd et al. 1990; Lennox and Fitzgerald 1990; Williamson 1990).

Early Iroquoians (AD 900–1300) lived in small villages (ca. 0.4 ha) of between 75 and 200 people, and each settlement consisted of four or five longhouses up to 15 m in length. The houses contained central hearths and pits for storing maize (which made up 20–30% of their diet), and the people produced distinctive pottery with decorative incised rims (Warrick 2000:434–438). The best documented Early Iroquoian culture in the local area is the Glen Meyer complex, which is characterized by well-made and thin-walled pottery, ceramic pipes, gaming discs, and a variety of stone, bone, shell and copper artifacts (Williamson 1990:295–304).

Over the next century (AD 1300–1400), Middle Iroquoian culture became dominant in southern Ontario, and distinct ‘Uren’ and ‘Middleport’ stages of development have been identified. Both houses and villages dramatically increased in size during this time: longhouses grew to as much as 33 m in length, settlements expanded to 1.2 ha in size and village populations swelled to as many as 600 people. Middle Iroquoian villages were also better planned, suggesting emerging clan organization, and most seem to have been occupied for perhaps 30 years prior to abandonment (Dodd et al. 1990:356–359; Warrick 2000:439–446).

During the Late Iroquoian period (AD 1400–1600), the phase just prior to widespread European contact, it becomes possible to differentiate between the archaeologically-represented groups that would become the Huron and the Neutral Nations. The study area itself lies within the territorial boundaries of the Pre-Contact Neutral Nation, documented in lands as far west as Chatham and as far east as New York State.

The Neutral Nation is well represented archaeologically: typical artifacts include ceramic vessels and pipes, lithic chipped stone tools, ground stone tools, worked bone, antler and teeth, and exotic goods obtained through trade with other Aboriginal (and later European) groups (Lennox and Fitzgerald 1990:411–437). The population growth so characteristic of earlier Middleport times appears to have slowed considerably during the Late Iroquoian period, and the Pre-Contact Neutral population likely stabilized at around 20,000 by the early 16th century (Warrick 2000:446).

Pre-Contact Neutral villages were much larger than Middleport villages, with average sizes in the neighbourhood of 1.7 ha. Exceptional examples of these could reach 5 ha in size, containing longhouses over 100 m in length and housing 2,500 individuals. This seemingly rapid settlement growth is thought to have been linked to Middleport ‘baby boomers’ starting their own families and needing additional living space (Warrick 2000:446–449).

It has been suggested that the size of these villages, along with the necessary croplands to sustain them, may have had some enduring impacts on the landscapes that surrounded them. In particular, there has been a correlation postulated between Pre-Contact era corn fields and modern stands of white pine (Janusas 1987:69–70, Figure 7). Aside from these villages, the

Pre-Contact Neutral also made use of hamlets, agricultural field cabins, specialized camps (e.g., fishing camps) and cemeteries (MCL 1997:35; Warrick 2000:449).

For the most part, Pre-Contact Neutral archaeological sites occur in isolated clusters defined by some sort of geographic region, usually within a watershed or another well-defined topographic feature. It has been suggested that these clusters represent distinct tribal units, which may have been organized as a larger confederacy akin to the historic Five Nations Iroquois (Lennox and Fitzgerald 1990:410). Nineteen main clusters of villages have been identified, the closet manifestation of which is known simply as the 'London Cluster'. This cluster, which includes the Lawson, Windermere, Ronto, Smallman, Black Kat and Mathews sites, appears to have flourished primarily in the 15th century (Lennox and Fitzgerald 1990:Table 13.1).

Late Pre-Contact Neutral sites are largely absent in this part of southern Ontario, indicative of substantial shifts in local settlement patterns (see Map 4). By the early 16th century there was a definite contraction of earlier territories, perhaps linked to the consolidation of tribal units, and by AD 1534 the Neutral appear to have moved east of the Grand River (Warrick 2000:454). Although scholars once thought that this shift was linked to a desire for better access to European goods, the fact that the fur trade did not begin for several decades has led to the recognition of an alternate reason—war. Later historical sources suggest that the Neutral were engaged in hostilities with the Fire Nation (possibly the Mascouten), an Algonkian-speaking people to the southwest known archaeologically as the Western Basin Tradition. Remains from the frontier zone include strongly fortified villages and earthworks, clearly illustrating a defensive mindset (Lennox and Fitzgerald 1990:437–438; Warrick 2000:449–451).

The end of the Late Woodland period can be conveniently linked to the arrival and spread of European fur traders in southern Ontario, and a terminus of AD 1600 effectively serves to demarcate some substantial changes in Aboriginal material culture. Prior to the establishment of the fur trade, items of European manufacture are extremely rare on Pre-Contact Neutral sites, save for small quantities of reused metal scrap. With the onset of the fur trade ca. AD 1580, European trade goods appear in ever-increasing numbers, and glass beads, copper kettles, iron axes and iron knives have all been found during excavations (Lennox and Fitzgerald 1990:425–432).

1.2.2 Early Contact

1.2.2.1 European Explorers

One of the first Europeans to venture into what would become Ontario was Étienne Brûlé, who was sent by Samuel de Champlain in Summer 1610 to accomplish three goals: 1) to consolidate an emerging friendship between the French and the First Nations, 2) to learn their languages, and 3) to better understand their unfamiliar customs. Other Europeans would subsequently be sent by the French to train as interpreters. These men became *coureurs de bois*, "living Indian-style ... on the margins of French society" (Gervais 2004:182). Such 'woodsmen' played an essential role in all later communications with the First Nations.

Champlain himself made two trips to Ontario: in 1613, he journeyed up the Ottawa River searching for the North Sea, and in 1615/1616, he travelled up the Mattawa River and descended to Lake Nipissing and Lake Huron to explore Huronia (Gervais 2004:182–185). He learned about many First Nations groups during his travels, including prominent Iroquoian-speaking peoples such as the Wendat (Huron), Petun (Tobacco) and '*la nation neutre*' (the Neutrals), and a variety of Algonkian-speaking Anishinabeg bands.

Champlain's *Carte de la Nouvelle France* (1632) encapsulates his accumulated knowledge of the area (see Map 5). Although the distribution of the Great Lakes is clearly an abstraction in this early map, important details concerning the terminal Late Woodland occupation of southern Ontario are discernable. Numerous Aboriginal groups are identified throughout the area, for example, and prolific Neutral village sites can be seen 'west' and 'south' of *Lac St. Louis* (Lake Ontario).

1.2.2.2 Trading Contacts and Conflict

The first half of the 17th century saw a marked increase in trading contacts between the First Nations and European colonists, especially in southern Ontario. Archaeologically, these burgeoning relations are clearly manifested in the widespread appearance of items of European manufacture by AD 1630, including artifacts such as red and turquoise glass beads, scissors, drinking glasses, keys, coins, firearms, ladles and medallions. During this time, many artifacts such as projectile points and scrapers began to be manufactured from brass, copper and iron scrap, and some European-made implements completely replaced more traditional tools (Lennox and Fitzgerald 1990:432–437).

Nicholas Sanson's *Le Canada, ou Nouvelle France* (1656) provides an excellent representation of southern Ontario at this time of heightened contact. Here the lands of the Neutral Nation are clearly labelled with the French rendering of their Huron name, '*Attawandaron*' (see Map 6). Unfortunately, this increased contact had the disastrous consequence of introducing European diseases into First Nations communities. These progressed from localized outbreaks to much more widespread epidemics (MCL 1997:35; Warrick 2000:457). Archaeological evidence of disease-related population reduction appears in the form of reduced longhouse sizes, the growth of multi-ossuary cemeteries and the loss of traditional craft knowledge and production skills (Lennox and Fitzgerald 1990:432–433).

1.2.2.3 Five Nations Invasion

The importance of European trading contacts eventually led to increasing factionalism and tension between the First Nations, and different groups began to vie for control of the lucrative fur trade (itself a subject of competition between the French and British). In what would become Ontario, the Huron, the Petun, and their Anishinabeg trading partners allied themselves with the French. In what would become New York, the League of the Haudenosaunee (the Five Nations Iroquois at that time) allied themselves with the British. The latter alliance may have stemmed from Champlain's involvement in Anishinabeg and Huron attacks against Iroquoian strongholds in 1609 and 1615, which engendered enmity against the French (Lajeunesse 1960:xxix). Interposed between the belligerents, the members of the Neutral Nation refused to become involved in the conflict.

Numerous military engagements occurred between the two opposing groups during the first half of the 17th century, as competition over territories rich in fur-bearing animals increased. These tensions boiled over in the middle of the 17th century, leading to full-scale regional warfare (MNCFN 2010:5). In a situation likely exacerbated by epidemics brought by the Europeans and the decimation of their population, a party of roughly 1,000 Mohawk and Seneca warriors set upon Huronia in March 1649. The Iroquois desired to remove the Huron Nation altogether, as they were a significant obstacle to controlling the northern fur trade (Hunt 1940:91–92).

The Huron met their defeat in towns such as Saint Ignace and Saint Louis (Sainte-Marie was abandoned and burned by the Jesuits in the spring of 1649). Those that were not killed were either adopted in the Five Nations as captives or dispersed to neighbouring regions and groups (Ramsden 1990:384). The Petun shared a similar fate, and the remnants of the affected groups formed new communities outside of the disputed area, settling in Quebec (Wendake), in the area of Michilimackinac and near Lake St. Clair (where they were known as the Wyandot).

Anishinabeg populations from southern Ontario, including the Ojibway, Odawa and Pottawatomi, fled westward to escape the Iroquois (Schmalz 1977:2). The Neutral were targeted in 1650 and 1651, and the Iroquois took multiple frontier villages (one with over 1,600 men) and numerous captives (Coyne 1895:18). The advance of the Iroquois led to demise of the Neutral Nation as a distinct cultural entity (Lennox and Fitzgerald 1990:456).

For the next four decades, southern Ontario remained an underpopulated wilderness (Coyne 1895:20). This rich hunting ground was exploited by the Haudenosaunee to secure furs for trade with the Dutch and the English, and settlements were established along the north shore of Lake Ontario at places like Teiaiagon on the Humber River and Ganatswekwyagon on the Rouge River (Williamson 2008:51). The Haudenosaunee are also known to have traded with the northern Anishinabeg during the second half of the 17th century (Smith 1987:19).

Due to their mutually violent history, the Haudenosaunee did not permit French explorers and missionaries to travel directly into southern Ontario for much of the 17th century. Instead, they had to journey up the Ottawa River to Lake Nipissing and then paddle down the French River into Georgian Bay (Lajeunesse 1960:xxix). New France was consequently slow to develop in southern Ontario, at least until the fall of several Iroquoian strongholds in 1666 and the opening of the St. Lawrence and Lake Ontario route to the interior (Lajeunesse 1960:xxxii).

In 1669, the Haudenosaunee allowed an expedition of 21 men to pass through their territory. This expedition, which included François Dollier de Casson (a Sulpician priest) and René Bréhant de Galinée, managed to reach and explore the Grand River, which they named *le Rapide* after the swiftness of its current. These men descended the Grand to reach Lake Erie, and they wintered at the future site of Port Dover (Coyne 1895:21). Galinée's map is one of the earliest documented representations of the interior of southwestern Ontario (see Map 7). In it, he notes the locations of several former Neutral villages at the western end of Lake Ontario, likely consisting of abandoned ruins.

1.2.2.4 Anishinabeg Influx

The fortunes of the Five Nations began to change in the 1690s, as disease and casualties from battles with the French took a toll on the formerly-robust group (Smith 1987:19). On July 19, 1701, the Haudenosaunee ceded lands in southern Ontario to King William III with the provision that they could still hunt freely in their former territory (Coyne 1895:28). However, judging from the land cessions to follow, this agreement appears to have lacked any sort of binding formality.

According to the traditions of the Algonkian-speaking Anishinabeg, Ojibway, Odawa and Potawatomi bands began to mount an organized counter-offensive against the Iroquois in the late 17th century (MNCFN 2010:5). Around the turn of the 18th century, the Anishinabeg of the Great Lakes expanded into Haudenosaunee lands, and attempted to trade directly with the French and the English (Smith 1987:19). This led to a series of battles between the opposing groups, in which the Anishinabeg were more successful (Coyne 1895:28).

Haudenosaunee populations subsequently withdrew into New York State, and Anishinabeg bands established themselves in southern Ontario. Many of these bands were mistakenly grouped together by the immigrating Europeans under the generalized designations of ‘Chippewa/ Ojibway’ and ‘Mississauga’. ‘Mississauga’, for example, quickly became a term applied to many Algonkian-speaking groups around Lake Erie and Lake Ontario (Smith 1987:19), despite the fact that the Mississaugas were but one part of the larger Ojibway Nation (MNCFN 2010:3).

The Anishinabeg are known to have taken advantage of the competition between the English and French over the fur trade, and they were consequently well-supplied with European goods. The Mississaugas, for example, traded primarily with the French and received “everything from buttons, shirts, ribbons to combs, knives, looking glasses, and axes” (Smith 1987:22). The British, on the other hand, were well-rooted in New York State and enjoyed mutually beneficial relations with the Haudenosaunee.

As part of this influx, many members of the Algonkian-speaking Ojibway, Potawatomi and Odawa First Nations came back to Lake Huron littoral. Collectively, these people came to be known as the Chippewas of Saugeen Ojibway Territory (also Saugeen Ojibway Nation). These Algonkian-speakers established themselves in the Bruce Peninsula, all of Bruce and Grey Counties, and parts of Huron, Dufferin, Wellington, and Simcoe Counties (Schmalz 1977:233).

Throughout the 1700s and into the 1800s, Anishinabeg populations hunted, fished, gardened and camped along the rivers, floodplains and forests of southern Ontario (Warrick 2005:2). However, their ‘footprint’ was exceedingly light, and associated archaeological sites are both rare and difficult to detect. Around 1720, French traders are known to have established a trading post at the western end of Lake Ontario, and the Mississaugas were actively involved in the regional fur trade (MNCFN 2010:09). In September 1750, construction began on another trading post in the vicinity of present-day Toronto, which was called Fort Rouillé, or Fort Toronto. Fort Rouillé was completed in Spring 1751 and served as an outstation for the larger Fort Niagara until it was abandoned and burned in 1759 (Williamson 2008:56).

Historical maps from the 18th century shed valuable light on the cultural landscape of what would become southern Ontario. H. Popple's *A Map of the British Empire in America* (1733), for example, shows the Neutral and Huron/Petun Nations destroyed by the Haudenosaunee ca. 1650, and also demonstrates the ephemeral environmental impact of the mobile Anishinabeg (see Map 8). This map also includes an early rendering of the Thames River, although its full extent was clearly not yet understood.

1.2.2.5 Relations and Ambitions

The late 17th and early 18th centuries bore witness to the continued growth and spread of the fur trade across all of what would become the Province of Ontario. The French, for example, established and maintained trading posts along the Upper Great Lakes, offering enticements to attract fur traders from the First Nations. Even further north, Britain's Hudson Bay Company dominated the fur trade. Violence was common between the two parties, and peace was only achieved with the Treaty of Utrecht in 1713 (Ray 2015). Developments such as these resulted in an ever-increasing level of contact between European traders and local Aboriginal communities.

As the number of European men living in Ontario increased, so too did the frequency of their relations with Aboriginal women. Male employees and former employees of French and British companies began to establish families with these women, a process which resulted in the ethnogenesis of a distinct Aboriginal people: the Métis. Comprised of the descendants of those born from such relations (and subsequent intermarriage), the Métis emerged as a distinct Aboriginal people during the 1700s (MNO 2015).

Métis settlements developed along freighting waterways and watersheds, and were tightly linked to the spread and growth of the fur trade. These settlements were part of larger regional communities, connected by "the highly mobile lifestyle of the Métis, the fur trade network, seasonal rounds, extensive kinship connections and a shared collective history and identity" (MNO 2015).

In 1754, hostilities over trade and the territorial ambitions of the French and the British led to the Seven Years' War (often called the French and Indian War in North America), in which many Anishinabeg bands fought on behalf of the French. After the French surrender in 1760, these bands adapted their trading relationships accordingly, and formed a new alliance with the British (Smith 1987:22). In addition to cementing British control over the Province of Quebec, the Crown's victory over the French also proved pivotal in catalyzing the Euro-Canadian settlement process. The resulting population influx caused the demographics of many areas to change considerably.

R. Sayer and J. Bennett's *General Map of the Middle British Colonies in America* (1776) provides an excellent view of the ethnic landscape of southern Ontario prior to the widespread arrival of European settlers. This map clearly depicts the Thames River ('the Long River without Falls'), the Grand River ('the Great River'), the territory of the Ojibway and the virtually untouched lands of southwestern Ontario (see Map 9).

1.2.3 The Euro-Canadian Era

1.2.3.1 British Colonialism

With the establishment of absolute British control came a new era of land acquisition and organized settlement. In the *Royal Proclamation* of 1763, which followed the Treaty of Paris, the British government recognized the title of the First Nations to the land they occupied. In essence, the ‘right of soil’ had to be purchased by the Crown prior to European settlement (Lajeunesse 1960:cix). Numerous treaties and land surrenders were accordingly arranged by the Crown, and great swaths of territory were acquired from the Ojibway and other First Nations. These first purchases established a pattern “for the subsequent extinction of Indian title” (Gentilcore and Head 1984:78).

The first land purchases in Ontario took place along the shores of Lake Ontario and Lake Erie, as well as in the immediate ‘back country’. Such acquisitions began in August 1764, when a 3.0 km strip of land on the west side of the Niagara River was surrendered by the Seneca First Nation (Surtees 1994:97; NRC 2010). Although many similar territories were purchased by the Crown in subsequent years, it was only with the conclusion of the American Revolutionary War (1775–1783) that the British began to feel a pressing need for additional land. In the aftermath of the conflict, waves of United Empire Loyalists came to settle in the Province of Quebec, driving the Crown to seek out property for those who had been displaced. This influx had the devastating side effect of sparking the slow death of the fur trade, which was a primary source of income for many First Nations groups.

By the mid-1780s, the British recognized the need to 1) secure a military communication route from Lake Ontario to Lake Huron other than the vulnerable passage through Niagara, Lake Erie and Lake St. Clair; 2) acquire additional land for the United Empire Loyalists; and 3) modify the administrative structure of the Province of Quebec to accommodate future growth. The first two concerns were addressed through the negotiation of numerous ‘land surrenders’ with Anishinabeg groups north and west of Lake Ontario, and the third concern was mitigated by the establishment of the first administrative districts in the Province of Quebec.

On July 24, 1788, Sir Guy Carleton, Baron of Dorchester and Governor-General of British North America, divided the Province of Quebec into the administrative districts of Hesse, Nassau, Mecklenburg and Lunenburg (AO 2011). The vicinity of the study area fell within the Hesse District at this time, which consisted of a massive tract of land encompassing all of the western and inland parts of the province extending due north from the tip of Long Point on Lake Erie in the east. According to early historians, “this division was purely conventional and nominal, as the country was sparsely inhabited … the necessity for minute and accurate boundary lines had not become pressing” (Mulvany et al. 1885:13).

Further change came in December 1791, when the Parliament of Great Britain’s *Constitutional Act* created the Provinces of Upper Canada and Lower Canada from the former Province of Quebec. Colonel John Graves Simcoe was appointed as Lieutenant-Governor of Upper Canada, and he became responsible for governing the new province, directing its settlement and establishing a constitutional government modelled after that of Britain (Coyne 1895:33).

Simcoe initiated several schemes to populate and protect the newly-created province, employing a settlement strategy that relied on the creation of shoreline communities with effective transportation links between them. These communities, inevitably, would be composed of lands obtained from the First Nations, and many more purchases were subsequently arranged. The eastern and southern parts of Oxford County, for example, were acquired on December 7, 1792 as part of the second 'Between the Lakes Purchase', conducted to enhance Governor Haldimand's original purchase from 1784. In this transaction, the Mississaugas received goods worth 1,180.74 Quebec pounds as compensation for approximately 1,215,000 ha (NRC 2010).

In July 1792, Simcoe divided the province into 19 counties consisting of previously-settled lands, new lands open for settlement and lands not yet acquired by the Crown. These new counties stretched from Essex in the west to Glengarry in the east. Three months later, in October 1792, an Act of Parliament was passed whereby the four districts established by Lord Dorchester were renamed as the Western, Home, Midland and Eastern Districts. The vicinity of the study area nominally fell within the boundaries of Kent County in the Western District at this time, which comprised all of the territory of Upper Canada that was not included in the other 18 counties (AO 2011). In essence, Kent was the largest county ever created, stretching from Lake Erie to Hudson's Bay (McGeorge 1939:36). This arrangement would not last, however, and the 'northern' parts of Kent County would soon be sectioned off to form separate counties.

1.2.3.2 Oxford County

Shortly after the creation of Upper Canada, the original arrangement of the province's districts and counties was deemed inadequate. As population levels increased, smaller administrative bodies became desirable, resulting in the division of the largest units into more 'manageable' component parts. The first major changes in the vicinity of the study area took place in 1798, when an Act of Parliament called for the realignment of the Home and Western Districts and the formation of the London and Niagara Districts. Many new counties and townships were subsequently created (AO 2011).

The vicinity of the study area became part of Oxford County in the London District at this time. D.W. Smyth's *A Map of the Province of Upper Canada* (1800) and J. Purdy's *A Map of Cabotia* (1814) show the layout of the first townships in this area (see Map 10–Map 11). Although Oxford County would endure for the entirety of the Euro-Canadian era, it was not excluded from the many changes associated with the evolving administrative landscape. In 1821, for example, the county was enlarged through the addition of the Townships of Nissouri and Zorra (see Map 12). In the 1830s and early 1840s, the layout of what would become southern Ontario was significantly altered through the creation of the Huron, Brock, Wellington, Talbot and Simcoe Districts (AO 2011). Oxford became part of the Brock District in November 1839 and part of Canada West in the new United Province of Canada in February 1841 (see Map 13).

The earliest settler in Oxford County was Thomas Horner, who first came to the Township of Blenheim from New Jersey in 1793 to inspect the area and select a mill site. Horner's uncle, Thomas Watson, Esquire, had aided Governor Simcoe when he was imprisoned by the Americans, and Simcoe had invited Watson's friends and relations to settle in Blenheim in 1792.

Watson sent his son (also named Thomas) with Horner in response to Simcoe's request. To accommodate the arrival of Horner and other settlers, Simcoe had the first three concessions of Blenheim surveyed by "Surveyor Jones and his Indian Party" (Shenston 1852:29).

A second grant was made by Governor Simcoe in 1795 to Major Thomas Ingersoll, a Loyalist soldier from Massachusetts. The grant was a reward for Ingersoll's service in the Revolutionary War and was made on the condition that 40 families had to be settled on the land within 10 years. By 1805, 40 families had attempted settlement of the area, but many had been discouraged by the hardness of life there and abandoned their holdings. At the time, the historically-surveyed Dundas Street was the only road traversing the area, and it was more of a roughhewn and boggy trail than a real road (MTO 1984). As a result, Ingersoll lost his charter and moved to Port Credit where he died in 1812 (Frost and Stoyles 2003:4).

Between 1815 and 1824, heavy immigration from the Old World resulted in the doubling of the non-Aboriginal population of Upper Canada from 75,000 to 150,000. This dramatic increase was a result of the outcome of the War of 1812 and the Crown's efforts to populate the province's interior. A total of six major land-cession agreements were then pursued, which would yield nearly 3,000,000 ha of lands for Euro-Canadian settlement (Surtees 1994:112). These agreements were concerned with lands located well beyond the original waterfront settlements of Upper Canada, and included the Lake Simcoe-Nottawasaga, Ajetance, Rice Lake, Rideau, Long Woods and Huron Tract Purchases (Surtees 1994:113–119).

In October 1818, John Askin, Superintendent of Indian Affairs at Amherstburg, was sent to the Thames River area between London and Chatham in order to arrange for the purchase of a large tract of land to the north. Askin met with the chiefs of the Ojibway bands of the Chenal Ecarté, the St. Clair River, Bear Creek, the Ausable River and the Thames River, and began negotiations for lands on the Thames River and on Lake Huron just north of the Ausable River, extending inland as far as the Grand River Tract. The Ojibway leaders agreed to sell the land, and stipulated that 1) six reserves be set aside for them and that 2) a blacksmith and farm instructor be stationed near the reserves (Surtees 1994:117).

Based on Askin's report, the government decided to purchase the subject tract through two agreements: the 'Long Woods Purchase' and the 'Huron Tract Purchase'. The Long Woods area interested the Crown the most, as it was immediately north of the Thames River and was the next logical destination for Euro-Canadian settlers. Askin met with the Ojibway in 1819, and a provisional agreement was created which involved the surrender of 210,000 ha in exchange for an annuity of 600 pounds in currency and goods. The Huron Tract provisional agreement was also negotiated that same year, in which over 1,000,000 ha were to be sold for an annuity of 1,375 pounds in currency and goods (Surtees 1994:117–118).

Neither agreement was executed, however, as objections over the nature of the cash payments led to the revision of both proposals. The Long Woods Purchase was finally completed on November 28, 1822, and almost 552,190 ha were exchanged for 600 pounds in currency (NRC 2010). Specifically, a *per capita* payment of 2 pounds 10 shillings was agreed upon, to a maximum of 240 persons (Surtees 1994:118). The Huron Tract Purchase took longer to settle, and it was not pursued in earnest until John Galt's Canada Company began to materialize. This purchase was completed on July 10, 1827 for 1,375 pounds in currency (NRC 2010). Over the ensuing years, these lands would become parts of Waterloo, Wellington, Huron, Lambton, Middlesex and Oxford Counties. The vicinity of the study area was acquired as part of the Huron Tract Purchase, which extended westerly from the South Thames River and the western limits of the second 'Between the Lakes Purchase'.

Eventually, county roads were improved and the pace of settlement in the county increased, with the bulk of immigrants coming from Scotland, England and Ireland. By 1842, the population of Oxford County had reached 16,271 (Smith 1846:20). Settlement subsequently occurred at such a pace that, by 1846, no remaining Crown Lands were available for sale in the entirety of the county (Smith 1846:20). Woodstock, located in the northwest corner of the Township of East Oxford, served as the District town throughout this period of rapid growth (Smith 1846:20, 233).

As the population of the county increased, so did public frustration with the Government, which was largely Crown-appointed and dominated by members of the privileged 'Family Compact'. In 1837, many Oxonians (people of Oxford County) led by their local member of the Legislative Assembly, Dr. Charles Duncombe, joined the Upper Canada Rebellion. Their efforts were soon thwarted, and Duncombe was forced to flee to America (Stagg 2013). Success came in 1839, however, with the creation of the Brock District. This new district consisted solely of Oxford County (formerly part of the London District)—a move that was intended to provide the county with more political autonomy (AO 2011). The new political system made settlement in Canada West more attractive, particularly to Americans, and caused the population of Oxford County to surge to 31,448 by 1852.

Following the abolishment of the district system in 1849, the counties of Canada West were reconfigured once again. Oxford County emerged to stand on its own as an independent municipality at this time, comprising the Townships of Blandford, Blenheim, Dereham, East Nissouri, North Oxford, East Oxford, West Oxford, North Norwich, South Norwich, East Zorra and West Zorra (see Map 14). The county was known for its high, rolling lands that offered excellent opportunities for cultivation, as well as its many waterways, including the Grand River, the Thames River, Otter Creek and Catfish Creek (Smith 1846:20).

In 1853, the arrival of the Great Western Railway encouraged further settlement within Oxford County. The railway allowed the area's residents to prosper as producers and exporters of grain and cheese. Increased demand for such products, accompanied by increasing prices, created considerable prosperity during the Crimean War (1853–1856) and the American Civil War (1861–1865). By the late 19th century, the county was traversed by multiple railway lines, and major population centres had developed in each township (see Map 15).

On January 1, 1975, major revisions to Oxford County's structure occurred when the historic townships were amalgamated into five new municipalities: Zorra, East Zorra-Tavistock, Blandford-Blenheim, South-West Oxford and Norwich. The urban centres of Ingersoll, Tillsonburg and Woodstock were retained, although there were modifications to their layouts.

1.2.3.3 Township of West Zorra

In historic times, the Township of Zorra was bounded by the Townships of Downie and South Easthope to the north, the Townships of Wilmot and Blandford to the east, the Township of North Oxford to the south and the Township of Nissouri to the west. According to early historical sources, the township contained "very excellent land, and the timber is generally hard wood, maple, oak, elm, beech, etc." (Smith 1846:226), and "its general aspect is rolling, and the soil rich and fertile, producing excellent crops of grain and fruit" (Sutherland 1862:94). The land was well-watered by various tributaries of the Thames River, providing power for milling operations (Sutherland 1862:94).

The Township of Zorra was surveyed by Shubal Parke in 1820, and by January 1820, a total of 27,951 ha had been granted in parcels of various sizes. Most of the parcels were 40.5 ha (100 acres) or 81.0 ha (200 acres) in size, but Thaddeus Davis was granted 2,051.4 ha (5,069 acres) and Thomas Merritt and James Kerby were granted 404.7 ha (1,000 acres). Joseph Randell, Daniel Randell, Robert Roseburgh, Thomas Roseburgh, Samuel Roseburgh, Lewis Evans, Shubal Parke and Thomas Woomack were only granted 20.2 ha (50 acres) each. The township was first organized in 1822, and only 58.7 ha (145 acres) had been cleared at that time (Shenston 1852:164–165).

The population of Zorra as a whole was 2,722 in 1842, and there was one grist mill and three saw mills in operation. A total of 24,370 ha were taken up by ca. 1846, 4,301 ha of which were under cultivation (Smith 1846:226). The Township of Zorra was divided into the municipalities of West and East Zorra in 1845, and West Zorra comprised the portion of the Township of Zorra located west of the line between Concessions 8 and 9 (Shenston 1852:28; Sutherland 1862:94). The first lot sold by the government was Lot 12, Concession 4, the northern half of which was acquired by Barnabus Ford, Jr. and the southern half of which was acquired by Abel Ford in January 1832 (Shenston 1852:173).

By 1851, the population of West Zorra was 3,302, and by 1861, it was 3,691. The majority of the population was of Scottish origin at that time (Sutherland 1862:94), and there were 64 McKays, 25 Murrays, 24 Rosses, 19 Sutherlands, 15 McLeods and 13 McDonalds on an enumerator list from the mid-19th century (Shenston 1852:173). In the mid-19th century, there were three saw mills, two grist mills, one wheat and barley mill, one oat mill, one carding and fulling mill and one tannery in the township (Shenston 1852:173). In 1862, the major roads in the township included the "Ingersoll, North Oxford, East Nissouri, and West Zorra Gravel Road" and the "North Oxford and West Zorra Gravel Road" (Sutherland 1862:94).

As a testament to the prosperity of the farming industry in West Zorra, "The West Zorra Agricultural Society" was formed in 1854 and ran an annual exhibition. The association met at the Albion Hotel in Embro, and the show ground was on the green opposite the hotel. Prizes were awarded for "horses, cattle, sheep, swine, dairy produce, grain, vegetables, domestic manufactures, farming implements, other mechanic works, fruit and field roots" (Sutherland 1862:94). The Western Ontario Pacific Railway (operated by Canadian Pacific) was surveyed in 1886 and opened in 1887, whereas the St. Marys & Western Ontario Railway and the Tillsonburg, Lake Erie & Pacific Railway (both operated by Canadian Pacific) were opened in 1908 and abandoned in 1995 (Zadro and Delamere 2009).

The principal historic communities in West Zorra included Harrington in the northwest and Embro in the south-centre, although smaller settlements also developed at Brooksdale, Youngsville and Maplewood (see Map 16). Harrington (originally called Springville) had a population of approximately 100 in 1862, and it contained a post office, a school, saw, flouring and oatmeal mills, general stores as well as shoe, carpenter, cabinet-maker, wagon and other workshops at that time (Sutherland 1862:128). Embro developed 9.6 km from the 'Governor's Road' (Dundas Street) and it had excellent hydraulic power for mill purposes. By 1846, Embro had a population of roughly 150 and contained one grist and saw mill, a carding machine and cloth factory, a distillery, a tannery, three stores, two taverns, one wagon maker, two blacksmiths, three shoemakers and one tailor (Smith 1846:54). By 1862, the settlement had a population of 551 and boasted three flouring and grist mills, one saw mill, a woollen factory, a tannery and a post office, and its business included mercantile stores, workshops and a brick hotel called the Albion (Sutherland 1862:122–124).

1.2.3.4 The Study Area

As discussed in Section 1.1, the Harrington Dam parcel falls on part of Lot 30, Concession 2 in the Geographic Township of West Zorra, whereas the Embro Dam parcel falls on part of Lot 15, Concession 4 in the Geographic Township of West Zorra. The lots in this area were laid out during the early 19th century, and the vicinity of the study area was well-settled for the remainder of the Euro-Canadian period.

In an attempt to reconstruct the historic land use of the study area, ARA examined three historical maps that documented past residents, structures (e.g., homes, businesses and public buildings) and features during the mid- and late 19th century. Specifically, the following maps were consulted:

- G.C. Tremaine's *Tremaine's Map of Oxford County, Canada West* (1857) at a scale of 60 chains to 1 inch (OHCMP 2015),
- *Harrington* from Walker & Miles' *Topographical and Historical Atlas of the County of Oxford* (1876) at a scale of 10 chains to 1 inch (McGill University 2001); and
- *West Zorra Township* from Walker & Miles' *Topographical and Historical Atlas of the County of Oxford* (1876) at a scale of 45 chains to 1 inch (McGill University 2001).

The consulted historical maps were georeferenced and integrated into ARA's GIS database, and the limits of the study area are illustrated in Map 17–Map 19. The content of these maps is referenced throughout the following historic land use summary.

G.C. Tremaine's *Tremaine's Map of Oxford County, Canada West* (1857) indicates that the community of Harrington was well-established around the Harrington Dam parcel, and the Harrington Pond and Grist Mill are illustrated within the study area (a saw mill is also shown to the west). The lands southwest of the community were owned by William Ross, whereas the lands to the southeast were owned by L.D. Demarest (Demorest). According to Sutherland's *County of Oxford Gazetteer and General Business Directory for 1862-3,* D.L. Demorest was a post master and saw mill owner, Richard Paige was the proprietor of the Harrington Mills, and Sutherland & White were the proprietors of the Harrington Oatmeal Mill (Sutherland 1862:129).

The Embro Dam parcel, on the other hand, falls within lands owned by George Leonard, and a grist mill is shown within the study area. Sutherland's *County of Oxford Gazetteer and General Business Directory for 1862-3* lists Mrs. Munro as the proprietress of Spring Creek Mills on Lot 15, Concession 4 (Sutherland 1862:103).

West Zorra Township from Walker & Miles' *Topographical and Historical Atlas of the County of Oxford* (1876) indicates that the majority of Lot 30, Concession 2 was owned by S.F. Rounds at that time, and a school house and church are illustrated in the northwestern and south-central parts, respectively. S.F. Rounds is listed as an American-born farmer and mill owner who settled in the Township of West Zorra in 1837, and he collected his mail from the Harrington post office. The northern part of the lot comprised the community of Harrington, and *Harrington* from Walker & Miles' *Topographical and Historical Atlas of the County of Oxford* (1876) provides a comprehensive picture of the settlement. The mill pond is shown, as is the Harrington Grist Mill on the east bank of 'Trout Creek' (now Harrington-West Drain). Regarding the Embro Dam parcel, *West Zorra Township* from Walker & Miles' *Topographical and Historical Atlas of the County of Oxford* (1876) indicates that Lot 15, Concession 4 was owned by Thomas Sutherland, and a grist mill is illustrated on the east side of 'Spring Brook' (now Youngsville Drain). Few biographical details are listed for Sutherland, save for the fact that he collected his mail from the Embro post office (McGill University 2001).

The Harrington Grist Mill is a major feature of the Harrington Dam parcel, and it was built by United Empire Loyalist D.L. Demorest. It operated continuously from 1846 to 1966, save for short periods in 1903 (when the mill dam broke), 1923 (when the mill was destroyed by fire) and 1949 (when the mill dam broke again). The original structure consisted of pine timbers and a split shingle roof, and it was powered by an overshot wheel (later replaced by a more efficient turbine in the 1880s). The mill initially used the French Burr stone system for producing flour, but in the late 1890s, modern milling equipment was introduced in the form of an oat roller and chopper (the oat roller at the mill was manufactured by Whitelaw Machinery of Woodstock). The mill was acquired by the UTRCA in 1966, and it then remained closed and unused (HCC 2008).

In 1999, the Harrington Community Club entered into a lease agreement in order to preserve and restore the mill as a museum and educational site. The work involved "re-installations, new foundation and re-alignments to loosen up the running gear" (Dale 2010:6). The restorations also included recladding the structure in board and batten, installing a new roof, restoring the oat roller from the 1890s and restoring the turbine (Fischer and Harris 2007:219). Interestingly, there is an advertisement for Harrington Mills, Gristing and Chopping in Walker & Miles' *Topographical and Historical Atlas of the County of Oxford* (1876), listing the proprietor as J.S. Betzner. The advertisement reads: "Harrington Mills, J.S. Betzner, Proprietor, Gristing and Chopping, Done on Short Notice. Highest Market Price for Wheat and other Grain" (Walker & Miles 1876:94).

ARA also consulted a historic aerial image of the properties from 1954 to gain a better understanding of their more recent land use (see Map 20). The Harrington Dam parcel comprised Harrington Pond, the Harrington Grist Mill and a laneway running along the western edge of the study area at this time. The Embro Dam parcel comprised Spring Brook and adjacent grassed and wooded areas, but no structures or features are visible (University of Toronto 2009).

1.2.4 Summary of Past and Present Land Use

During Pre-Contact and Early Contact times, the vicinity of the study area would have comprised a mixture of deciduous trees and open areas. It seems clear that the First Nations managed the landscape to some degree, but the extent of such management is unknown. During the early 19^{th} century, Euro-Canadian settlers arrived in the area and began to clear the forests for agricultural purposes. Over the course of the Euro-Canadian era, the Harrington Dam parcel would have fallen within the community of Harrington and contained a mill pond surrounded by homes, roadways and businesses. The Embro Dam parcel contained a mill pond surrounded by agricultural lands and wooded areas. At the time of assessment, the Harrington Dam parcel comprised Harrington Pond, the Harrington Grist Mill, a gravel driveway, pedestrian bridges, maintained lawns, wooded areas and part of an agricultural field, whereas the Embro Dam parcel comprised Embro Pond, a pavilion, a culvert, maintained lawns and wooded areas.

1.2.5 Additional Background Information

Given that no other archaeological assessment reports have been prepared for the project, and that no other assessments have been documented in the immediate area (see Section 1.3.1), additional relevant background information was not available to inform ARA's archaeological potential modelling or recommendations (MTC 2011:125).

1.3 Archaeological Context

1.3.1 Previous Archaeological Work

In order to determine whether any archaeological assessments had been previously conducted within the limits of, or immediately adjacent to the study area, ARA submitted an inquiry to the Archaeology Data Coordinator (MTCS 2015) and conducted extensive independent background research. As a result of these investigations, it was determined that there are no reports on record documenting past work within a 50 m radius.

1.3.2 Summary of Registered or Known Archaeological Sites

An archival search was conducted using the MTCS's Ontario Archaeological Sites Database in order to determine the presence of any registered archaeological resources which might be located within a 1 km radius of the study area (MTCS 2015). The results of this search indicate that there are no previously-identified archaeological sites within these limits. The lack of documented archaeological sites in the vicinity of the study area should not be taken as an indicator that the area was unattractive or undesirable for human occupation. Instead, this absence of sites is likely related to a lack of local archaeological exploration.

1.3.3 Natural Environment

Environmental factors played a substantial role in shaping early land-use and site selection processes, particularly in small Pre-Contact societies with non-complex, subsistence-oriented economies. Euro-Canadian settlers also gravitated towards favourable environments, particularly those with agriculturally-suitable soils. In order to fully comprehend the archaeological context of the study area, the following four features of the local natural environment must be considered: 1) forests; 2) drainage systems; 3) physiography; and 4) soil types.

The study area lies within the deciduous forest, which is the southernmost forest region in Ontario and is dominated by agricultural and urban areas. This region generally has the greatest diversity of tree species, while at the same time having the lowest proportion of forest. It has most of the tree and shrubs species found in the Great Lakes–St. Lawrence forest (e.g., eastern white pine, red pine, eastern hemlock, white cedar, yellow birch, sugar and red maple, basswood, red oak, black walnut, butternut, tulip, magnolia, black gum, and many types of oaks and hickories), and also contains black walnut, butternut, tulip, magnolia, black gum, many types of oaks, hickories, sassafras and red bud. The deciduous forest region has the most diverse forest life in Ontario, including rare species such as the southern flying squirrel, red-bellied woodpecker, black rat snake, milk snake and gray tree frog (MNRF 2014).

With an area of almost 3,000,000 ha, the deciduous forest region has largely been cleared, and only scattered woodlots remain on sites too poor for agriculture (MNRF 2014). In Pre-Contact times, however, these dense forests would have been particularly bountiful. It is believed that the First Nations of the Great Lakes region exploited close to 500 plant species for food, beverages, food flavourings, medicines, smoking, building materials, fibres, dyes and basketry (Mason 1981:59–60). Furthermore, this diverse vegetation would have served as both home and food for a wide range of game animals, including white tailed deer, turkey, passenger pigeon, cottontail rabbit, elk, muskrat and beaver (Mason 1981:60).

In terms of local drainage systems, the Harrington Dam parcel lies within the Trout Creek watershed, which makes up 5% of the Upper Thames River watershed and drains parts of Zorra, Perth South, Perth East, St. Marys and Stratford into the North Thames River at St. Marys. The Embro Dam parcel lies within the Mud Creek watershed, which also makes up 5% of the Upper Thames River watershed and drains parts of Zorra and East Zorra-Tavistock into the Middle Thames River downstream of Embro (UTRCA 2012). Specifically, the Harrington Dam parcel is traversed by a tributary of Trout Creek (Harrington-West Drain) and is located 294 m south of Trout Creek and 397 m southeast of the Wildwood Reservoir. The Embro Dam parcel is traversed by a tributary of North Branch Creek West (Youngsville Drain) and is located 4.1 km west of Mud Creek and 4.0 km northwest of the Middle Thames River.

Physiographically, the study area lies within the region known as the Oxford Till Plain, which occupies a central position in the peninsula of southwestern Ontario. This plain covers approximately 156,000 ha and has a drumlinized surface. The till consists of a pale brown calcareous loam with limestone and grey/pale brown dolostone (Chapman and Putnam 1984:143). The underlying bedrock consists of limestone and dolostone belonging to the Middle Devonian Detroit River group (Davidson 1989:42).

The soils within the Harrington Dam parcel consist primarily of Muck (M) in the north and Guelph loam (Gl) to the south, although there is also some Bottom Land (B.L.) and Fox sandy loam-rolling phase (Fxsl-r) in the southwest. The Embro Dam parcel consists entirely of Guelph loam (Wicklund and Richards 1961:Soil Map). The characteristics of these soils can be summarized as follows:

- Muck: An Alluvial soil consisting of deep organic deposits underlain by sand, silt and clay with a depressional topography, a stone-free matrix and very poor drainage qualities;
- Guelph loam: A Grey-Brown Podzolic consisting of calcareous loam till with a smooth moderately-to-steeply rolling topography, a slightly stony matrix and good drainage qualities;
- Bottom Land: An Alluvial soil consisting of recent alluvium with a level topography, a stone-free matrix and variable drainage qualities; and
- Fox sandy loam-rolling phase: A Grey-Brown Podzolic consisting of calcareous sand with a smooth very gently sloping to rolling topography, a stone-free matrix and good drainage qualities.

In summary, the study area possesses a number of environmental characteristics which would have made it attractive to both Pre-Contact and Euro-Canadian populations. The rich deciduous forest and the nearby water sources would have attracted a wide variety of game animals, and consequently, early hunters. The areas of well-drained soils would have been ideal for the maize horticulture of Middle to Late Woodland peoples and the mixed agriculture practiced by later Euro-Canadian populations. The proximity of the study area to Trout Creek, Mud Creek and the Upper and Middle Thames Rivers—principal transportation routes in both Pre-Contact and Euro-Canadian times—would also have influenced its settlement and land-use history.

1.3.4 Archaeological Fieldwork and Property Conditions

The Stage 1 property inspection was carried out on May 19, 2015 under licence #P007, PIF #P007-0690-2015. The assessment involved the visual survey of the study area and the documentation of all areas of archaeological potential. All field observations were made from accessible public lands; accordingly, no permissions were required for property access.

Key personnel involved in the assessment included P.J. Racher, Project Director; C.E. Gohm, Operations Manager; C.J. Gohm, Deliverables Manager; V. Cafik, Assistant Project Manager; and H. Buckton, Field Director.

At the time of assessment, the Harrington Dam parcel comprised Harrington Pond, the Harrington Grist Mill, a gravel driveway, pedestrian bridges, maintained lawns, wooded areas and part of an agricultural field, whereas the Embro Dam parcel comprised Embro Pond, a pavilion, a culvert, maintained lawns and wooded areas. The specific weather and lighting conditions for the day of assessment are summarized in Section 2.2. No unusual physical features were encountered during the property inspection that affected the results of the Stage 1 assessment.

2.0 STAGE 1 BACKGROUND STUDY

2.1 Summary

The Stage 1 assessment, conducted under licence #P007, PIF #P007-0690-2015, was accomplished through an examination of the archaeology, history, geography and current land condition of the vicinity of the study area. This background study was carried out using archival sources (e.g., historical publications and records) and current academic and archaeological publications (e.g., archaeological studies and reports). It also included the analysis of modern topographic maps (at a 1:50,000 scale), recent satellite imagery and historical maps/atlases of the most detailed scale available (i.e., 60 chains to 1 inch, 10 chains to 1 inch and 45 chains to 1 inch).

With occupation beginning approximately 11,000 years ago, the greater vicinity of the study area comprises a complex chronology of Pre-Contact and Euro-Canadian histories (see Section 1.2). Artifacts associated with Palaeo-Indian, Archaic, Woodland and Early Contact traditions are well-attested in Oxford County, and Euro-Canadian archaeological sites dating to pre-1900 and post-1900 contexts are likewise common. The lack of documented archaeological sites in the vicinity of the study area should not be taken as an indicator that the area was unattractive or undesirable for human occupation. Instead, this absence is more likely related to a lack of local archaeological exploration (see Section 1.3.2).

As mentioned in Section 1.3.3, the natural environment of the study area would have been attractive to both Pre-Contact and Euro-Canadian populations as a result of proximity to Harrington-West Drain, Trout Creek, Youngsville Drain and North Branch Creek West (all primary water sources). The areas of well-drained soils and the diverse local vegetation would also have encouraged settlement throughout Ontario's lengthy history. Euro-Canadian populations would have been particularly drawn to Road 96, Elizabeth Street and Victoria Street at the Harrington Dam parcel as well as Road 84 and 37th Line at the Embro Dam parcel (all historically-surveyed thoroughfares).

In summary, the Stage 1 assessment included an up-to-date listing of sites from the MTCS's Ontario Archaeological Sites Database (within at least a 1 km radius), the consideration of previous local archaeological fieldwork (within at least a 50 m radius), the analysis of topographic and historic maps (at the most detailed scale available), and the study of aerial photographs/satellite imagery. In this manner, the standards for background research set out in Section 1.1 of the *S&Gs* (MTC 2011:14–15) were met.

2.2 Field Methods (Property Inspection)

In order to gain first-hand knowledge of the geography, topography and current condition of the study area, a property inspection was conducted on May 19, 2015. Although optional, Section 1.2 of the *S&Gs* (MTC 2011:15–17) outlines the appropriateness of such an option when a greater level of detail is needed to recommend further assessment strategies. All field observations were made from accessible public lands; accordingly, no permissions were required for property access.

Environmental conditions were ideal during the property inspection, with partly cloudy skies, a high of 14 °C and good lighting. ARA therefore confirms that fieldwork was carried out under weather and lighting conditions that met the requirements set out in Section 1.2 Standard 2 of the *S&Gs* (MTC 2011:16).

Given the narrow nature of the study area around each pond, the lands were subjected to a systematic survey at an interval of ≤ 15 m in accordance with the requirements set out in Section 1.2 of the *S&Gs* (MTC 2011:15–17). Specifically, the systematic survey began in the northeastern part of each parcel and progressed clockwise around the southern and western parts. The visually surveyed areas were examined under ideal weather and lighting conditions with high ground surface visibility.

The property inspection/visual survey confirmed that all features of archaeological potential (e.g., historically-surveyed roadways, etc.) were present where they were previously identified, and did not result in the identification of any additional features of archaeological potential not visible on mapping (e.g., relic water channels, patches of well-drained soils, etc.). No new structures or built features (e.g., heritage structures, plaques, monuments, cemeteries, etc.) were identified that would affect assessment strategies (MTC 2011:16–17). The property inspection result in the identification of several areas of no archaeological potential, however, which are discussed in Section 2.3.

2.3 Analysis and Conclusions

In addition to the relevant historical sources and the results of past excavations and surveys (see Section 1.2–Section 1.3), the archaeological potential of a property can be assessed using its soils, hydrology and landforms as considerations. What follows is an in-depth analysis of the archaeological potential of the study area, which incorporates the results of the property inspection conducted in May 2015.

Throughout southern Ontario, scholars have noted a strong association between site locations and waterways. Young, Horne, Varley, Racher and Clish, for example, state that "either the number of streams and/or stream order is <u>always</u> a significant factor in the positive prediction of site presence" (1995:23). They further note that certain types of landforms, such as moraines, seem to have been favoured by different groups throughout prehistory (Young et al. 1995:33). According to Janusas (1988:1), "the location of early settlements tended to be dominated by the proximity to reliable and potable water resources." Site potential modeling studies (Peters 1986; Pihl 1986) have found that most prehistoric archaeological sites are located within 300 m of either extant water sources or former bodies of water, such as post-glacial lakes.

While many of these studies do not go into detail as to the basis for this pattern, Young, Horne, Varley, Racher and Clish (1995) suggest that the presence of streams would have been a significant attractor for a host of plant, game and fish species, encouraging localized human exploitation and settlement. Additionally, lands in close proximity to streams and other water courses were highly valued for the access they provided to transportation and communication routes. Primary water sources (e.g., lakes, rivers, streams and creeks) and secondary water sources (e.g., intermittent streams and creeks, springs, marshes and swamps) are therefore of pivotal importance for identifying archaeological potential (MTC 2011:17).

Section 1.3.1 of the *S&Gs* (MTC 2011:17–18) emphasizes the following six features and characteristics as being additional indicators of positive potential for Pre-Contact archaeological materials: 1) features associated with extinct water sources (glacial lake shorelines, relic river channels, shorelines of drained lakes, etc.); 2) the presence of pockets of well-drained soils (for habitation and agriculture); 3) elevated topography (e.g. drumlins, eskers, moraines, knolls, etc.); 4) distinctive landforms that may have been utilized as spiritual sites (waterfalls, rocky outcrops, caverns, etc.); 5) proximity to valued raw materials (quartz, ochre, copper, chert outcrops, medicinal flora, etc.); and 6) accessibility of plant and animal food sources (spawning areas, migratory routes, prairie lands, etc.).

Conversely, it must be understood that non-habitational sites (e.g., burials, lithic quarries, kill sites, etc.) may be located anywhere. Potential modeling appears to break down when it comes to these idiosyncratic sites, many of which have more significance than their habitational counterparts due to their relative rarity. The Stage 1 archaeological assessment practices outlined in Section 1.4.1 of the *S&Gs* (MTC 2011:20–21) ensure that these important sites are not missed, as no areas can be exempt from test pit survey unless both a background study and property inspection have been completed (unless the lands are already exempt due to disturbance, etc.).

With the development of integrated 'complex' economies in the Euro-Canadian era, settlement tended to become less dependent upon local resource procurement/production and more tied to wider economic networks. As such, proximity to transportation routes (roads, canals, etc.) became the most significant predictor of site location, especially for Euro-Canadian populations. In the early Euro-Canadian era (pre-1850), when transport by water was the norm, sites tended to be situated along major rivers and creeks—the ‘highways’ of their day. With the opening of the interior of the province to settlement after about 1850, sites tended to be more commonly located along historically-surveyed roads. Section 1.3.1 of the *S&Gs* (MTC 2011:18) recognizes trails, passes, roads, railways and portage routes as examples of such early transportation routes.

In addition to transportation routes, Section 1.3.1 of the *S&Gs* (MTC 2011:18) emphasizes three other indicators of positive potential for Euro-Canadian archaeological materials: 1) areas of early settlement (military outposts, pioneer homesteads or cabins, early wharfs or dock complexes, pioneer churches, early cemeteries, etc.); 2) properties listed on a municipal register, designated under the *Ontario Heritage Act* or otherwise categorized as a federal, provincial or municipal historic landmark/site; and 3) properties identified with possible archaeological sites, historical events, activities or occupations, as identified by local histories or informants.

Based on the location, drainage and topography of the subject lands and the application of land-use modelling, it seems clear that the study area, in its pristine state, would have potential for both Pre-Contact and Euro-Canadian archaeological sites. Local indicators of archaeological potential include four primary water sources (Harrington-West Drain, Trout Creek, Youngsville Drain and North Branch Creek West), five historically-surveyed roadways (Road 96, Elizabeth Street, Victoria Street, Road 84 and 37th Line) and two areas of early Euro-Canadian settlement (Harrington and Embro). The representation of historic mills on both properties in mapping from 1857 and 1876 suggests that these areas have significant potential for Euro-Canadian material culture and features.

In its current state, however, the study area retains only part of this archaeological potential (see Image 1–Image 4). Section 2.1 of the *S&Gs* (MTC 2011:28) states that lands that 1) are sloped > 20°, 2) are permanently wet, 3) consist of exposed bedrock or 4) have been subject to extensive and deep land alterations can be considered exempt from requiring Stage 2 assessment. These guidelines serve as effective criteria for identifying areas of no archaeological potential.

ARA's property inspection/visual survey, coupled with the analysis of modern satellite imagery and topographic mapping, resulted in the identification of several areas of disturbance within the assessed area (see Image 5–Image 10). Specifically, deep land alterations have resulted in the removal of archaeological potential from 1) the driveways/walkways associated with the grist mill and pedestrian bridges at the Harrington Dam parcel, 2) the footprint of the Harrington Grist Mill and a look-out platform at the Harrington Dam parcel, 3) the footprint of a concrete-footed pavilion at the Embro Dam parcel and 4) culverts and/or dams at the north and south ends of the ponds at both parcels. Natural areas of no archaeological potential included several permanently wet areas associated with the waterways and ponds at both parcels (see Image 11–Image 12), and two area of lands sloped > 20° at the Embro Dam parcel (see Image 13–Image 14). The remainder of the assessed area either has potential for Pre-Contact and Euro-Canadian archaeological materials or requires test-pitting to confirm disturbance.

Based on the results of the visual survey, both the Harrington and Embro Dam parcels currently comprise a mixture of areas of archaeological potential and areas of no archaeological potential. In total, 4.49% (0.25 ha) of the Harrington Dam parcel falls within an agricultural field and requires pedestrian survey at an interval of ≤ 5 m, 52.00% (2.94 ha) falls within 300 m of a feature of archaeological potential and requires test pit survey at an interval of ≤ 5 m, 3.45% (0.20 ha) was identified as disturbed and 40.06% (2.27 ha) was found to be permanently wet. Regarding the Embro Dam parcel, 66.79% (2.09 ha) falls within 300 m of a feature of archaeological potential and requires test pit survey at an interval of ≤ 5 m, 0.19% (0.01 ha) was identified as disturbed, 30.96% (0.97 ha) was found to be permanently wet and 2.06% (0.07 ha) was sloped > 20°. The identified areas of archaeological potential and areas of no archaeological potential (separated by class or category) are depicted in Map 21–Map 22.

3.0 RECOMMENDATIONS

The results of the assessment indicated that the study area currently comprises a mixture of areas of archaeological potential and areas of no archaeological potential (see Map 21–Map 22). ARA recommends that all areas of archaeological potential that could be impacted by the project be subject to a Stage 2 property assessment in advance of construction.

In accordance with the requirements set out in Section 2.1 of the *S&Gs* (MTC 2011:28–39), the following assessment strategies should be utilized:

- For recently cultivated or actively cultivated lands, the assessment must be conducted using the pedestrian survey method at an interval of ≤ 5 m. All ground surfaces must be recently ploughed, weathered by one heavy rainfall, and provide at least 80% visibility. If archaeological materials are encountered in the course of the pedestrian survey, the transect interval must be closed to 1 m and a close inspection of the ground must be conducted for 20 m in all directions.
- For lands where ploughing is not possible or viable (e.g., wooded areas; pasture with high rock content; abandoned farmland with heavy brush and weed growth; and gardens, parkland or lawns which will remain in use for several years after the survey), the assessment must be conducted using the test pit survey method. A test pit survey interval of ≤ 5 m is required in all areas less than 300 m from any feature of archaeological potential, and a test pit survey interval of ≤ 10 m is required in all areas more than 300 m from any feature of archaeological potential. Each test pit must be excavated into the first 5 cm of subsoil, and the resultant pits must be examined for stratigraphy, cultural features and/or evidence of fill. The soil from each test pit must be screened through mesh with an aperture of no greater than 6 mm and examined for archaeological materials.

The identified areas of no archaeological potential are not recommended for further assessment. It is requested that this report be entered into the *Ontario Public Register of Archaeological Reports*, as provided for in Section 65.1 of the *Ontario Heritage Act.*

4.0 ADVICE ON COMPLIANCE WITH LEGISLATION

Section 7.5.9 of the *S&Gs* requires that the following information be provided for the benefit of the proponent and approval authority in the land use planning and development process (MTC 2011:126–127):

- This report is submitted to the Minister of Tourism, Culture and Sport as a condition of licensing in accordance with Part VI of the *Ontario Heritage Act*, R.S.O. 1990, c 0.18. The report is reviewed to ensure that it complies with the standards and guidelines that are issued by the Minister, and that the archaeological fieldwork and report recommendations ensure the conservation, protection and preservation of the cultural heritage of Ontario. When all matters relating to archaeological sites within the project area of a development proposal have been addressed to the satisfaction of the Ministry of Tourism, Culture and Sport, a letter will be issued by the ministry stating that there are no further concerns with regard to alterations to archaeological sites by the proposed development.
- It is an offence under Sections 48 and 69 of the *Ontario Heritage Act* for any party other than a licensed archaeologist to make any alteration to a known archaeological site or to remove any artifact or other physical evidence of past human use or activity from the site, until such time as a licensed archaeologist has completed archaeological fieldwork on the site, submitted a report to the Minister stating that the site has no further cultural heritage value or interest, and the report has been filed in the Ontario Public Register of Archaeology Reports referred to in Section 65.1 of the *Ontario Heritage Act*.
- Should previously undocumented archaeological resources be discovered, they may be a new archaeological site and therefore subject to Section 48 (1) of the *Ontario Heritage Act*. The proponent or person discovering the archaeological resources must cease alteration of the site immediately and engage a licensed consultant archaeologist to carry out archaeological fieldwork, in compliance with Section 48 (1) of the *Ontario Heritage Act*.
- The *Cemeteries Act*, R.S.O. 1990 c. C.4 and the *Funeral, Burial and Cremation Services Act*, 2002, S.O. 2002, c.33 (when proclaimed in force) require that any person discovering human remains must notify the police or coroner and the Registrar of Cemeteries at the Ministry of Consumer Services.

5.0 IMAGES

Image 1: Current Land Conditions, Harrington Dam
(Photo Taken on May 19, 2015; Facing Southwest)

Image 2: Current Land Conditions, Harrington Dam
(Photo Taken on May 19, 2015; Facing Southwest)

Image 3: Current Land Conditions, Embro Dam
(Photo Taken on May 19, 2015; Facing Southeast)

Image 4: Current Land Conditions, Embro Dam
(Photo Taken on May 19, 2015; Facing Northeast)

Image 5: Area of No Archaeological Potential, Harrington Dam – Disturbed
(Photo Taken on May 19, 2015; Facing North)

Image 6: Area of No Archaeological Potential, Harrington Dam – Disturbed
(Photo Taken on May 19, 2015; Facing Southwest)

Image 7: Area of No Archaeological Potential, Harrington Dam – Disturbed
(Photo Taken on May 19, 2015; Facing North)

Image 8: Area of No Archaeological Potential, Harrington Dam – Disturbed
(Photo Taken on May 19, 2015; Facing Southeast)

Image 9: Area of No Archaeological Potential, Harrington Dam – Disturbed
(Photo Taken on May 19, 2015; Facing Northwest)

Image 10: Area of No Archaeological Potential, Embro Dam – Disturbed
(Photo Taken on May 19, 2015; Facing South)

Image 11: Area of No Archaeological Potential, Harrington Dam – Permanently Wet
(Photo Taken on May 19, 2015; Facing Southeast)

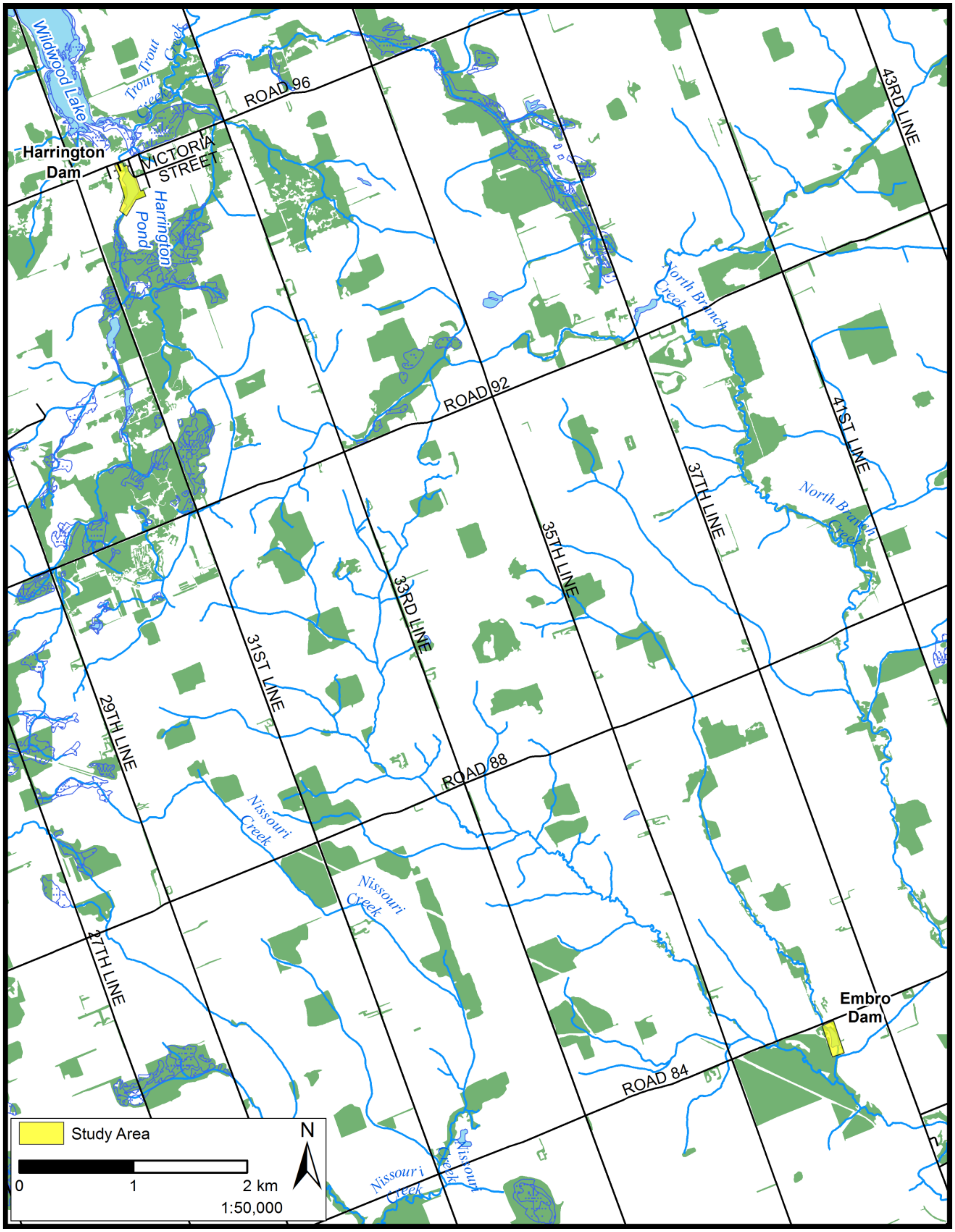
Image 12: Area of No Archaeological Potential, Embro Dam – Permanently Wet
(Photo Taken on May 19, 2015; Facing Southeast)

Image 13: Area of No Archaeological Potential, Embro Dam – Slope > 20°
(Photo Taken on May 19, 2015; Facing North)

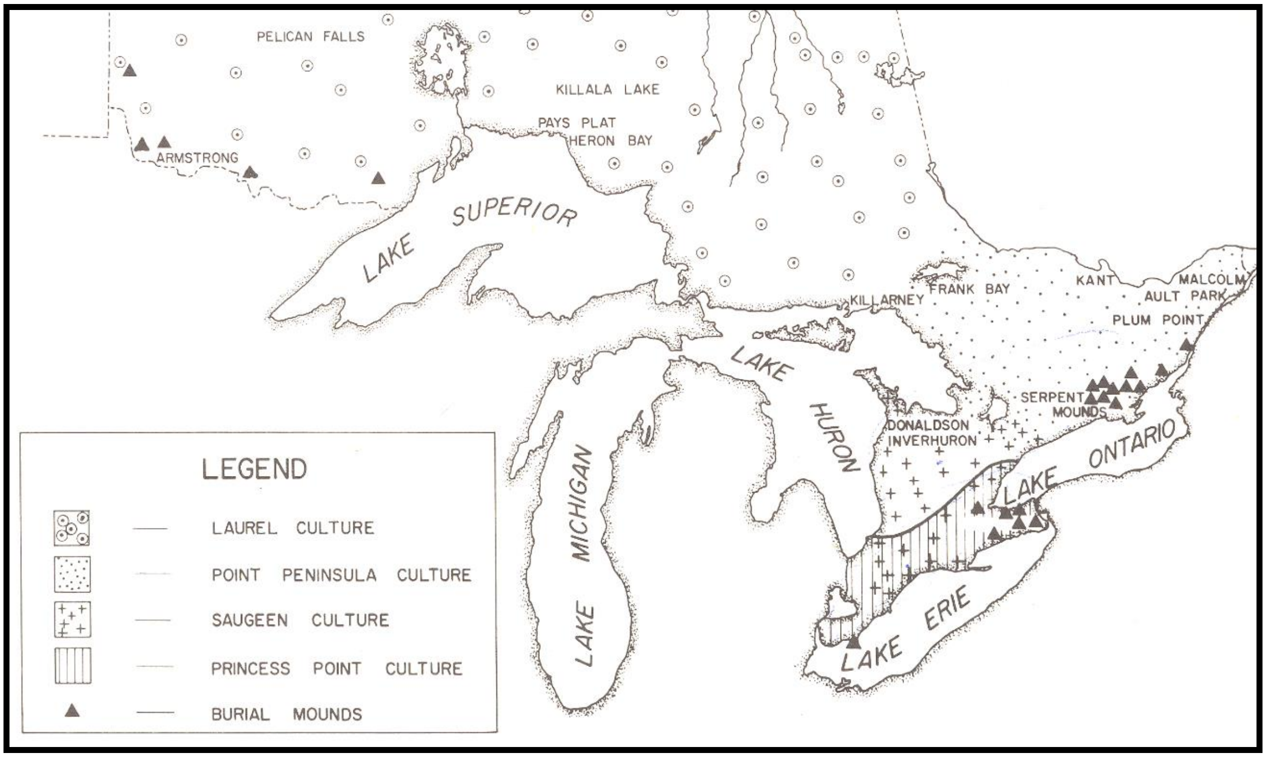
Image 14: Area of No Archaeological Potential, Embro Dam – Slope > 20°
(Photo Taken on May 19, 2015; Facing Northwest)

6.0 MAPS

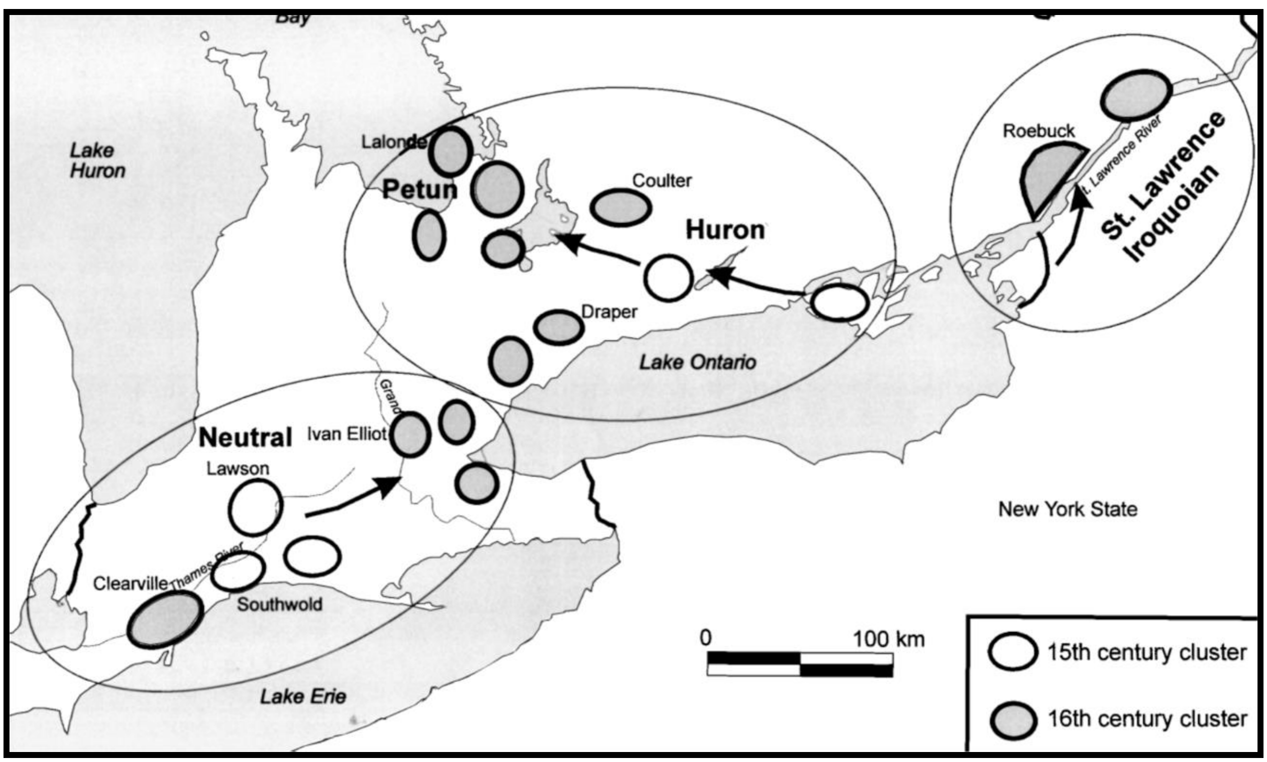
Map 1: Location of the Study Area in the Province of Ontario
(NRC 2002)



Map 2: Location of the Study Area in the Township of Zorra
(Produced by ARA under licence from Ontario MNRF, © Queen's Printer 2015)



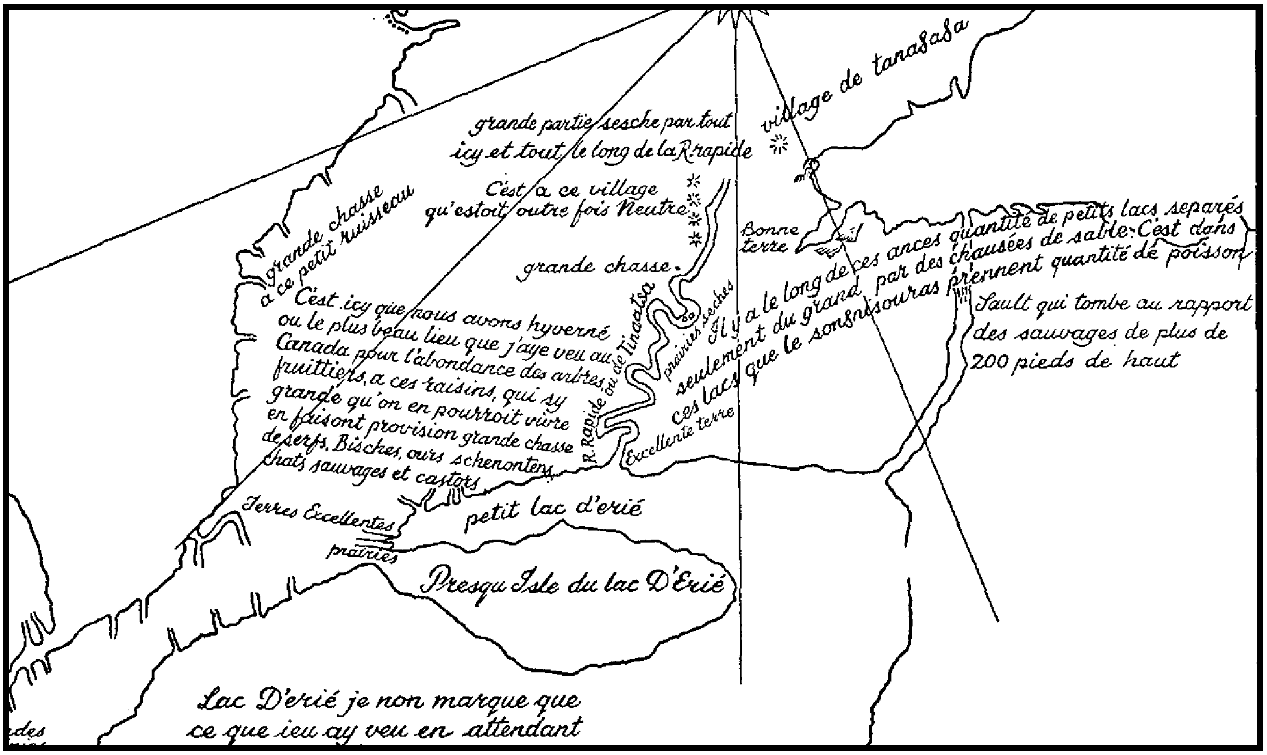
Map 3: Map of Middle Woodland Period Complexes
(Wright 1972:Map 4)



Map 4: Pre-Contact Iroquoian Site Clusters
(Warrick 2000:Figure 10)

Map 5: Detail from S. de Champlain's *Carte de la Nouvelle France* (1632)
(Gentilcore and Head 1984:Map 1.2)

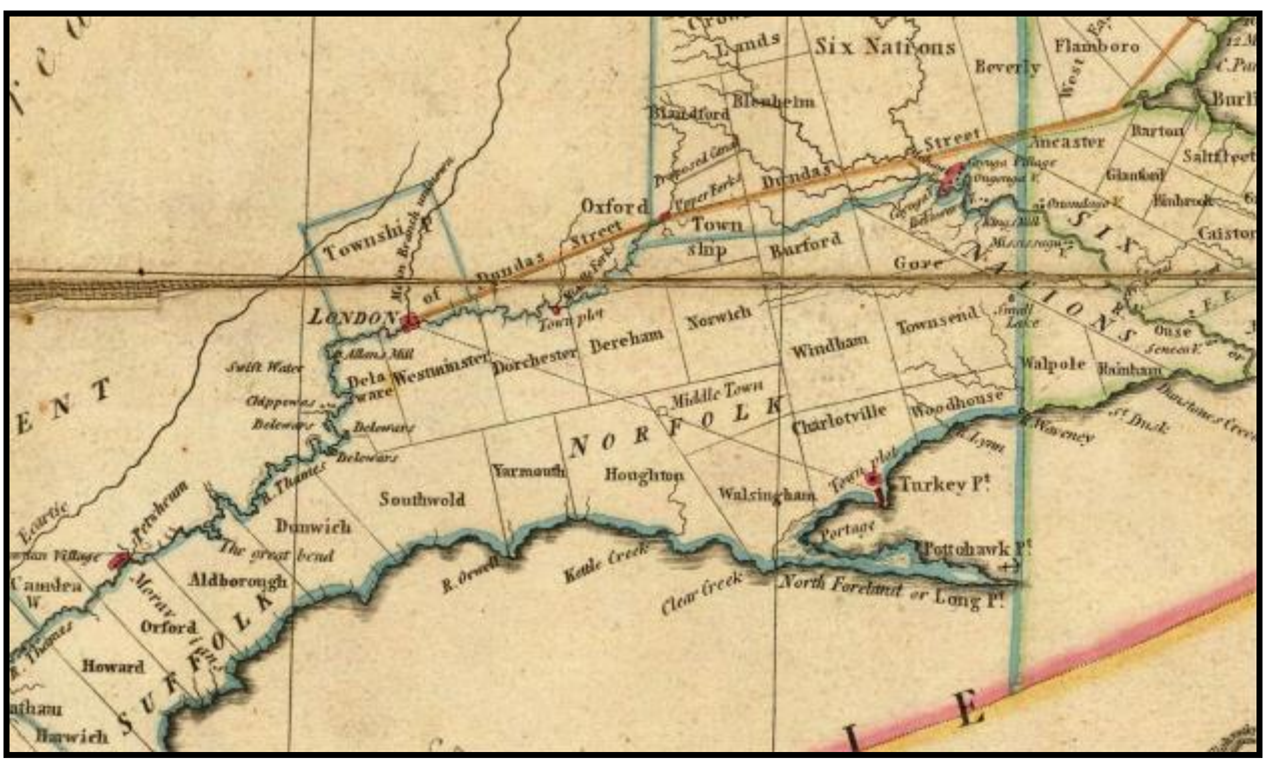
Map 6: Detail from N. Sanson's *Le Canada, ou Nouvelle France* (1656)
(Gentilcore and Head 1984:Map 1.10)



Map 7: Detail from the Map of Galinée's Voyage (1670)
(Lajeunesse 1960:Map 2)

Map 8: Detail from H. Popple's *A Map of the British Empire in America* (1733)
(Cartography Associates 2009)

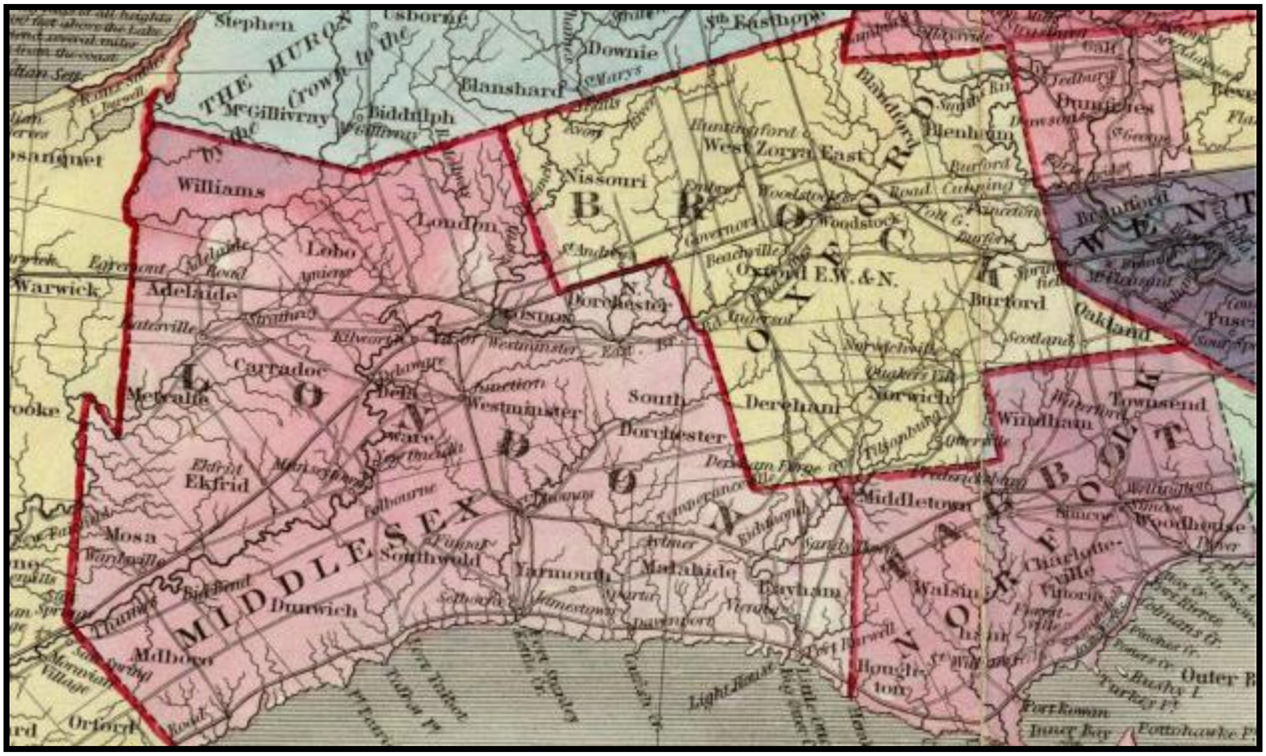
Map 9: Detail from R. Sayer and J. Bennett's *General Map of the Middle British Colonies in America* (1776)
(Cartography Associates 2009)



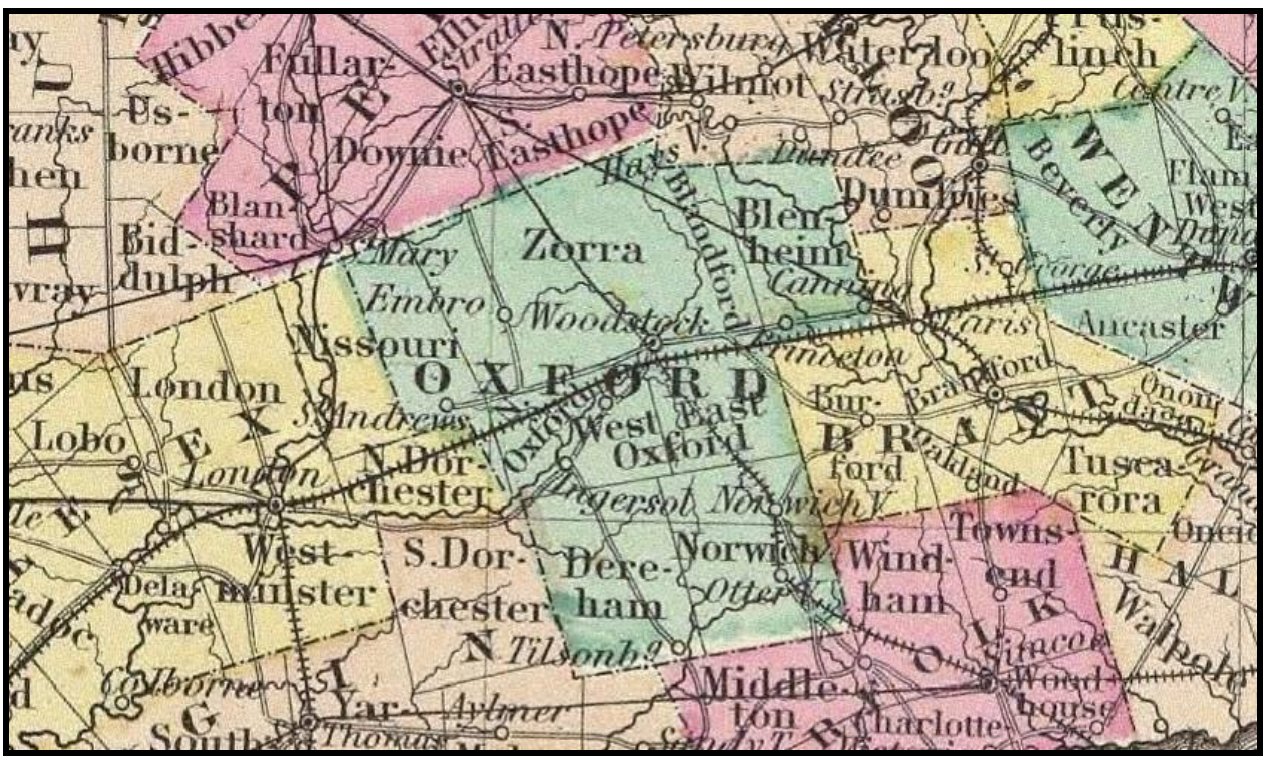
Map 10: Detail from D.W. Smyth's *A Map of the Province of Upper Canada* (1800)
(Cartography Associates 2009)

Map 11: Detail from J. Purdy's *A Map of Cabotia* (1814)
(Cartography Associates 2009)

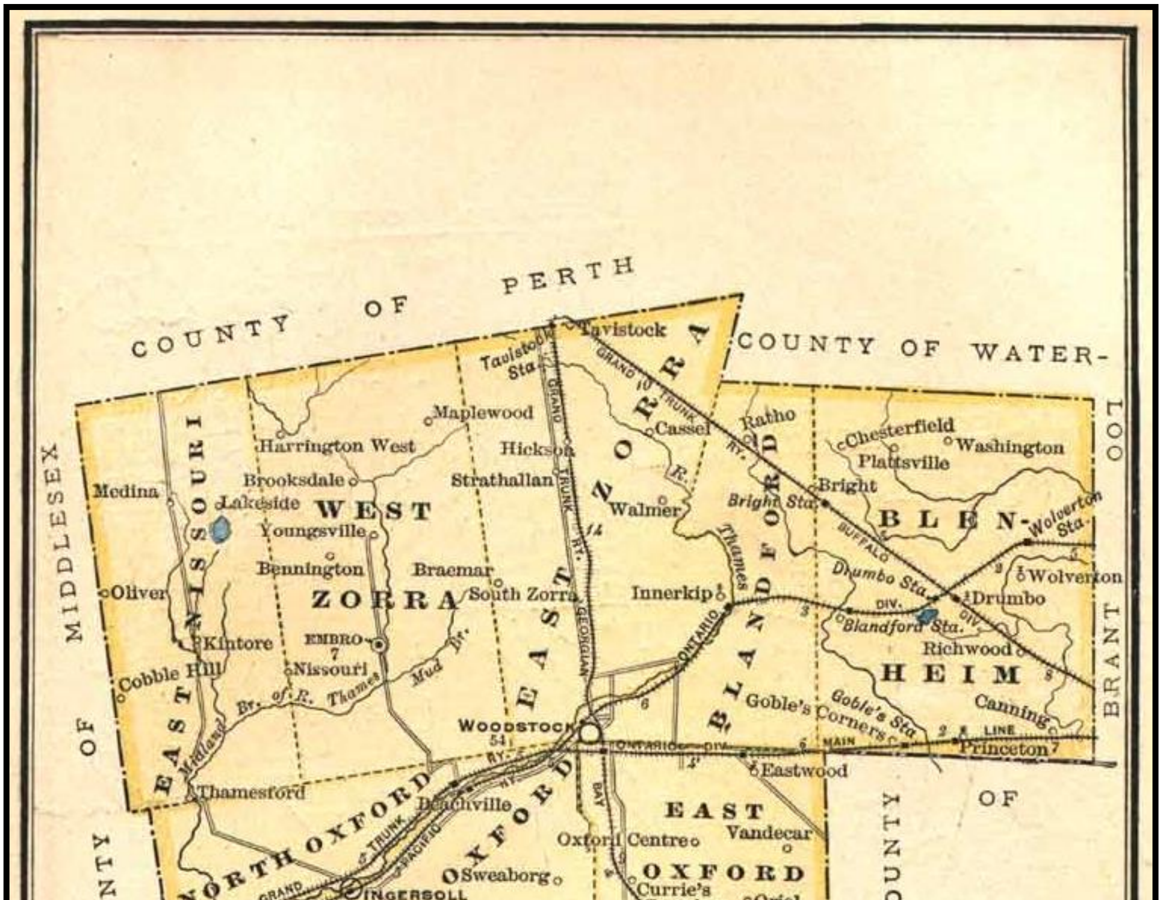
Map 12: Detail from J. Arrowsmith's *Upper Canada* (1837)
(Cartography Associates 2009)



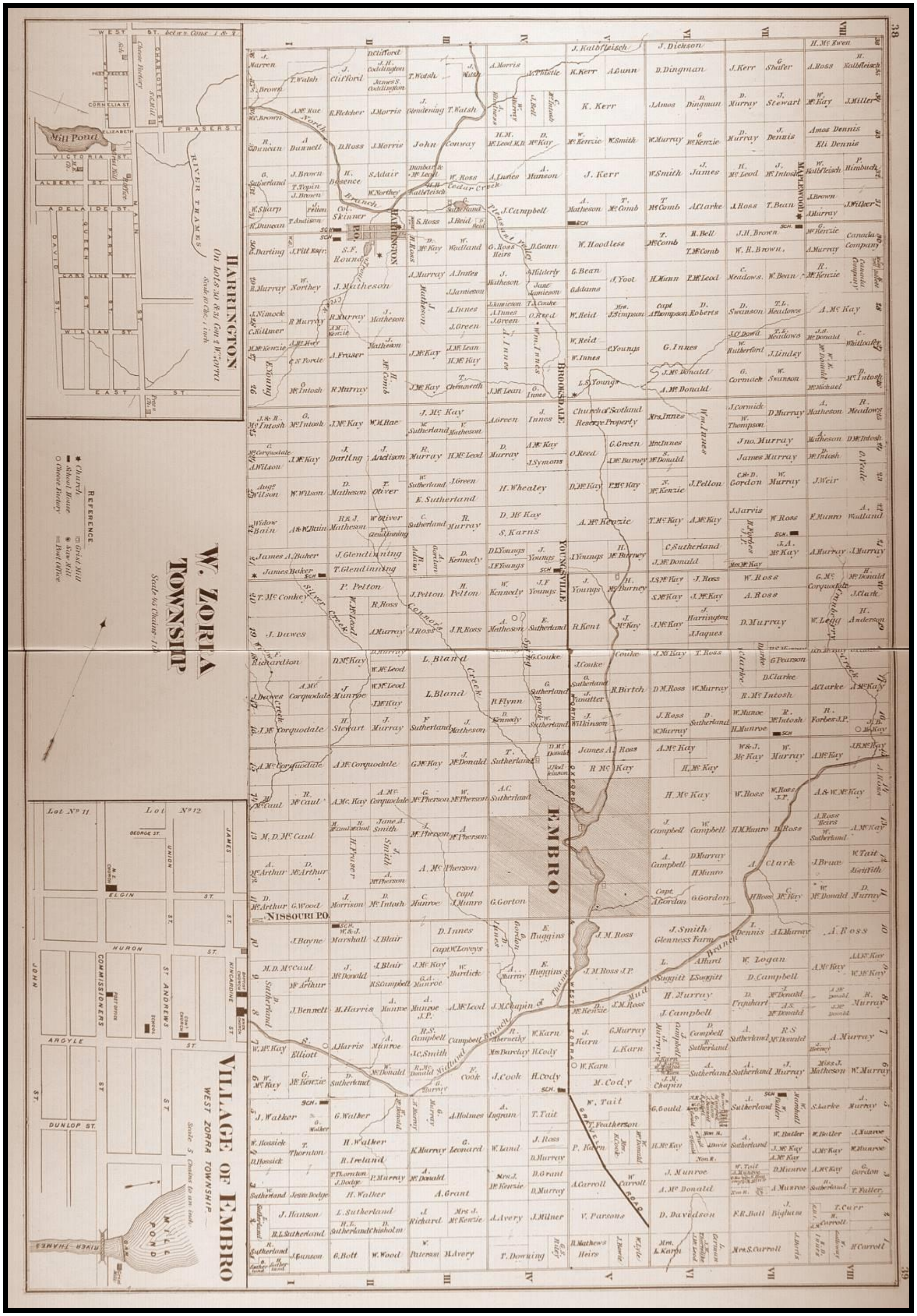
Map 13: Detail from J. Bouchette's *Map of the Provinces of Canada* (1846)
(Cartography Associates 2009)



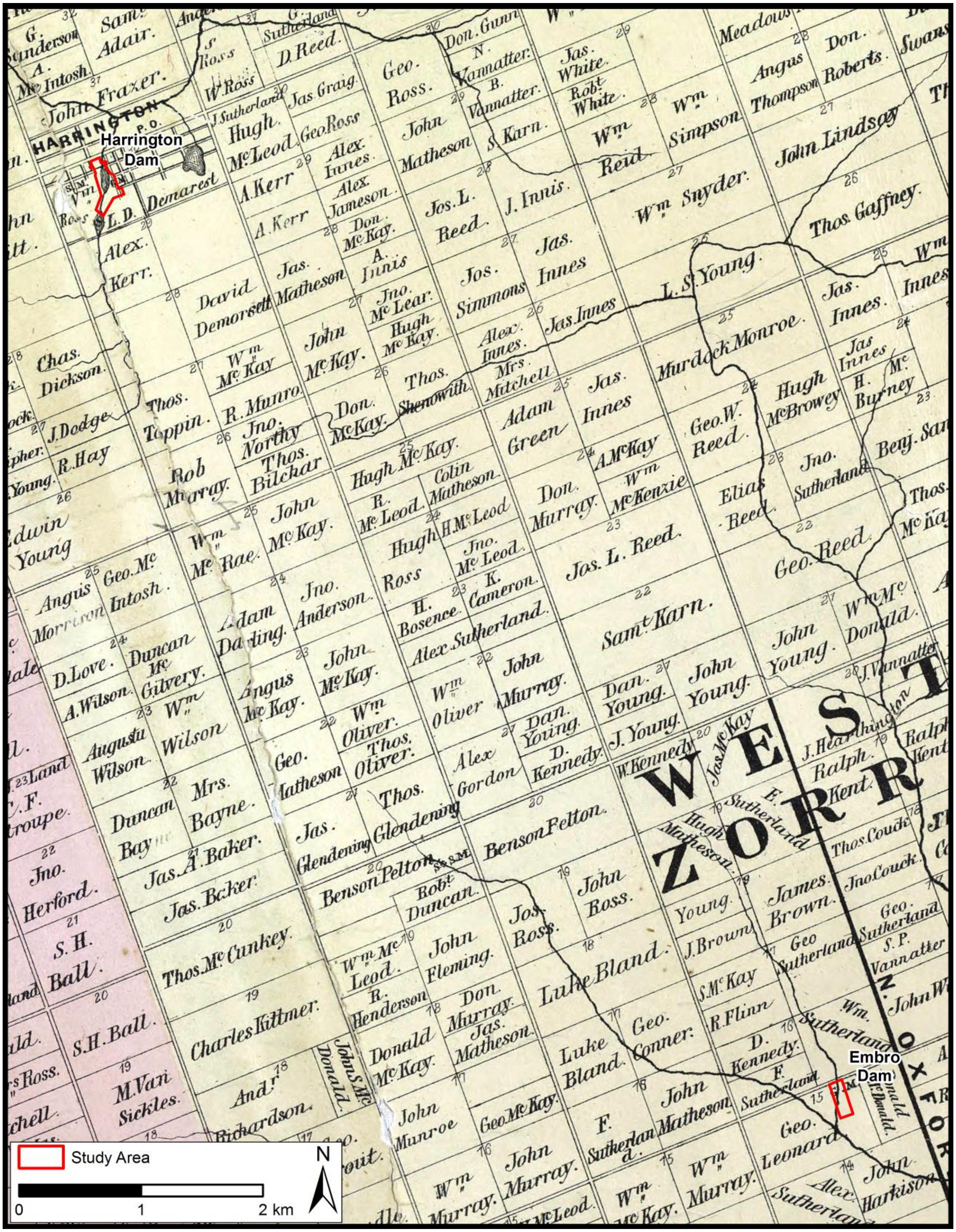
Map 14: Detail from G.W. Colton's *Canada West* (1856)
(Cartography Associates 2009)



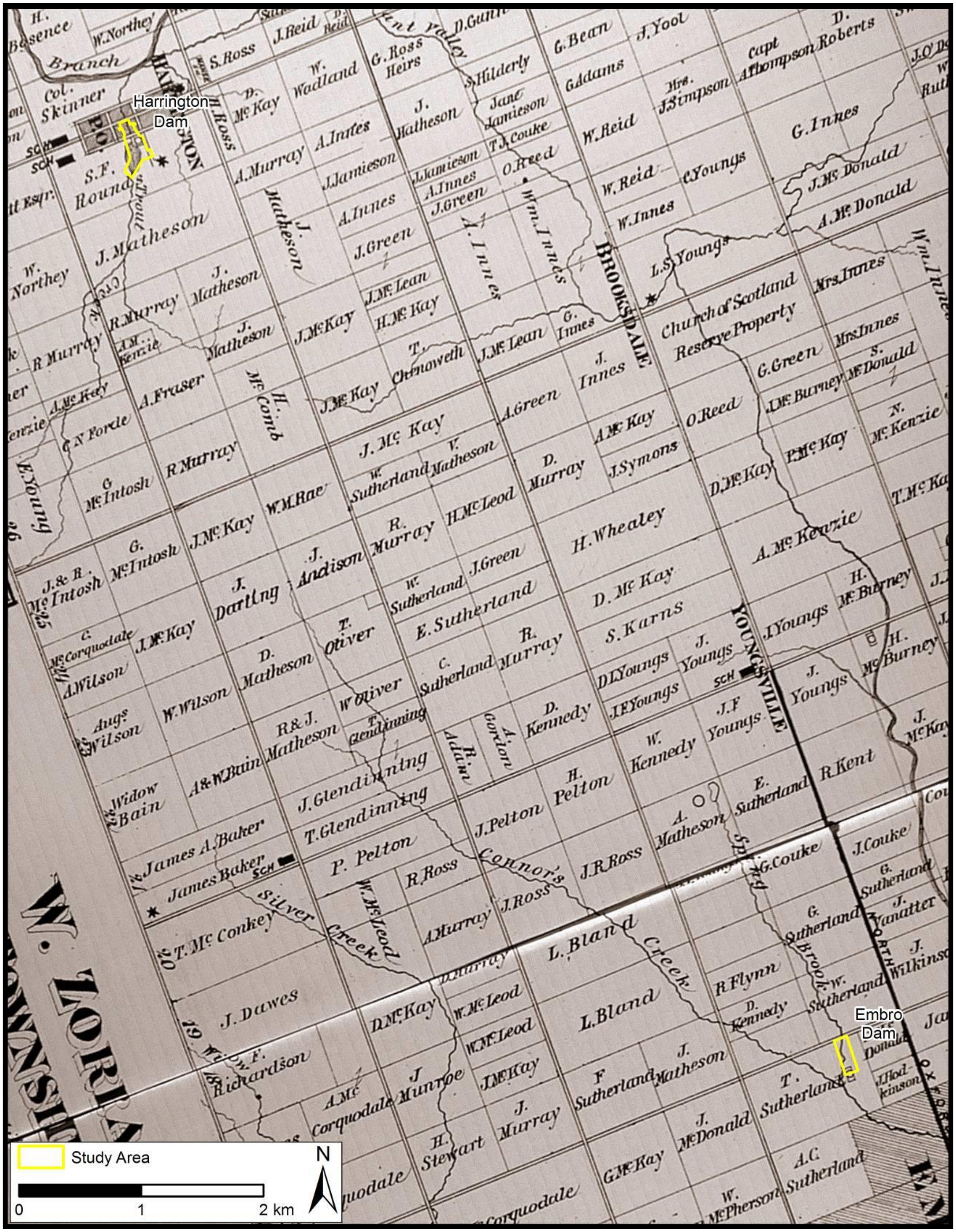
Map 15: Oxford County from W.J. Gage and Co.'s *Gage's County Atlas* (1886)
(W.J. Gage and Co. 1886)



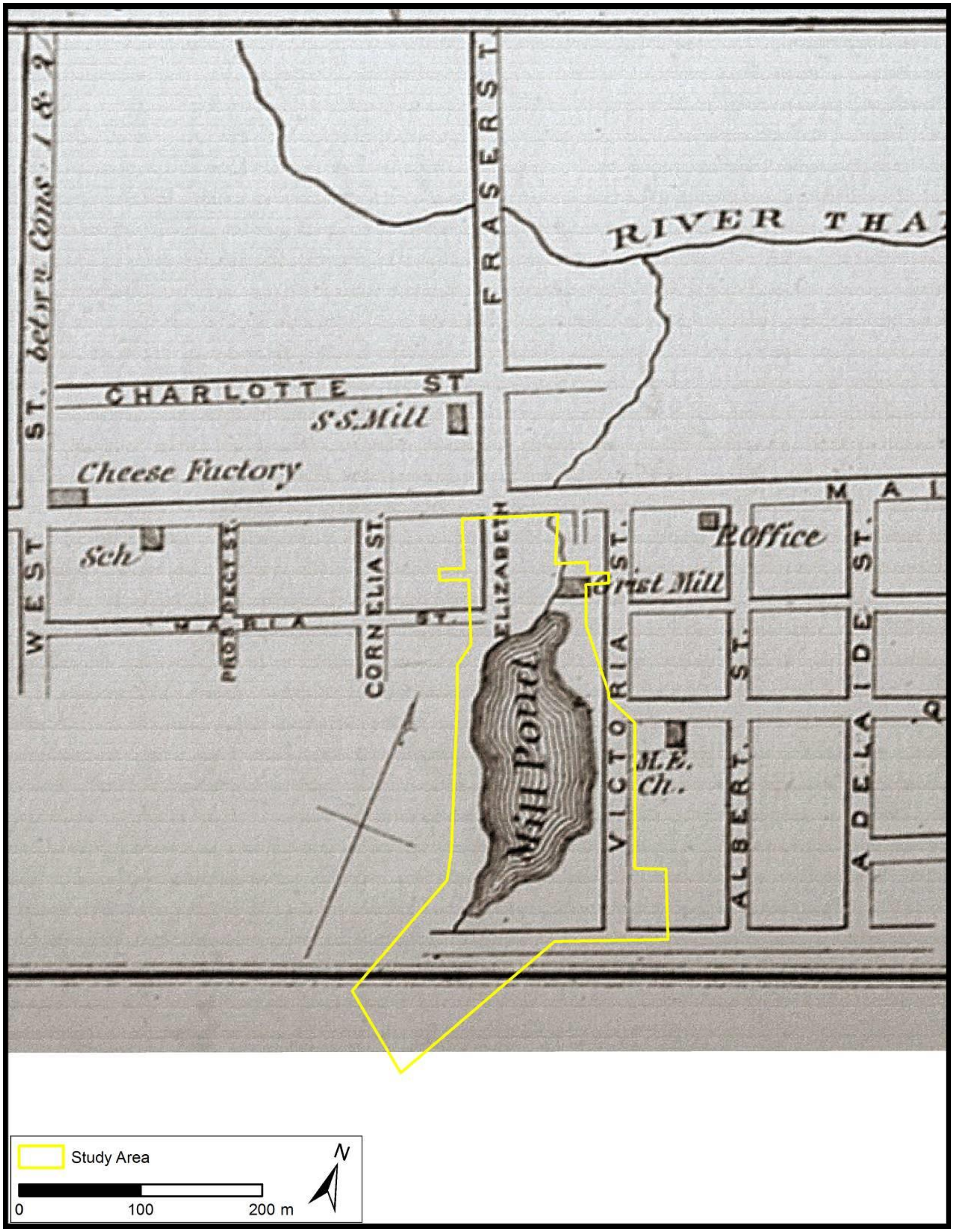
Map 16: ***West Zorra Township*** **from Walker & Miles'** ***Topographical and Historical Atlas of the County of Oxford*** **(1876)**
(McGill University 2001)



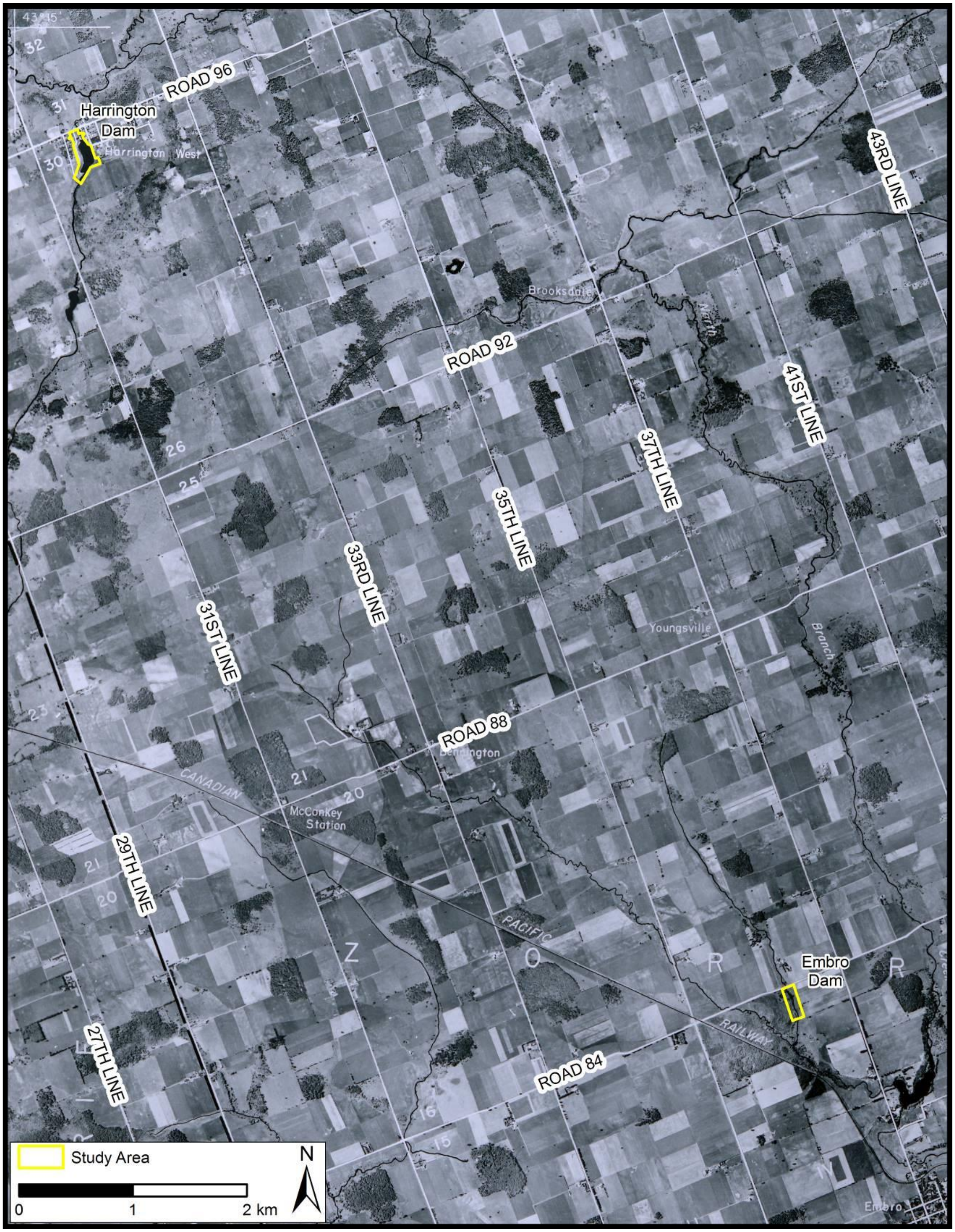
Map 17: Detail from G.C. Tremaine's *Tremaine's Map of the County of Oxford, Ontario* (1857), Showing the Study Area
(OHCMP 2015)



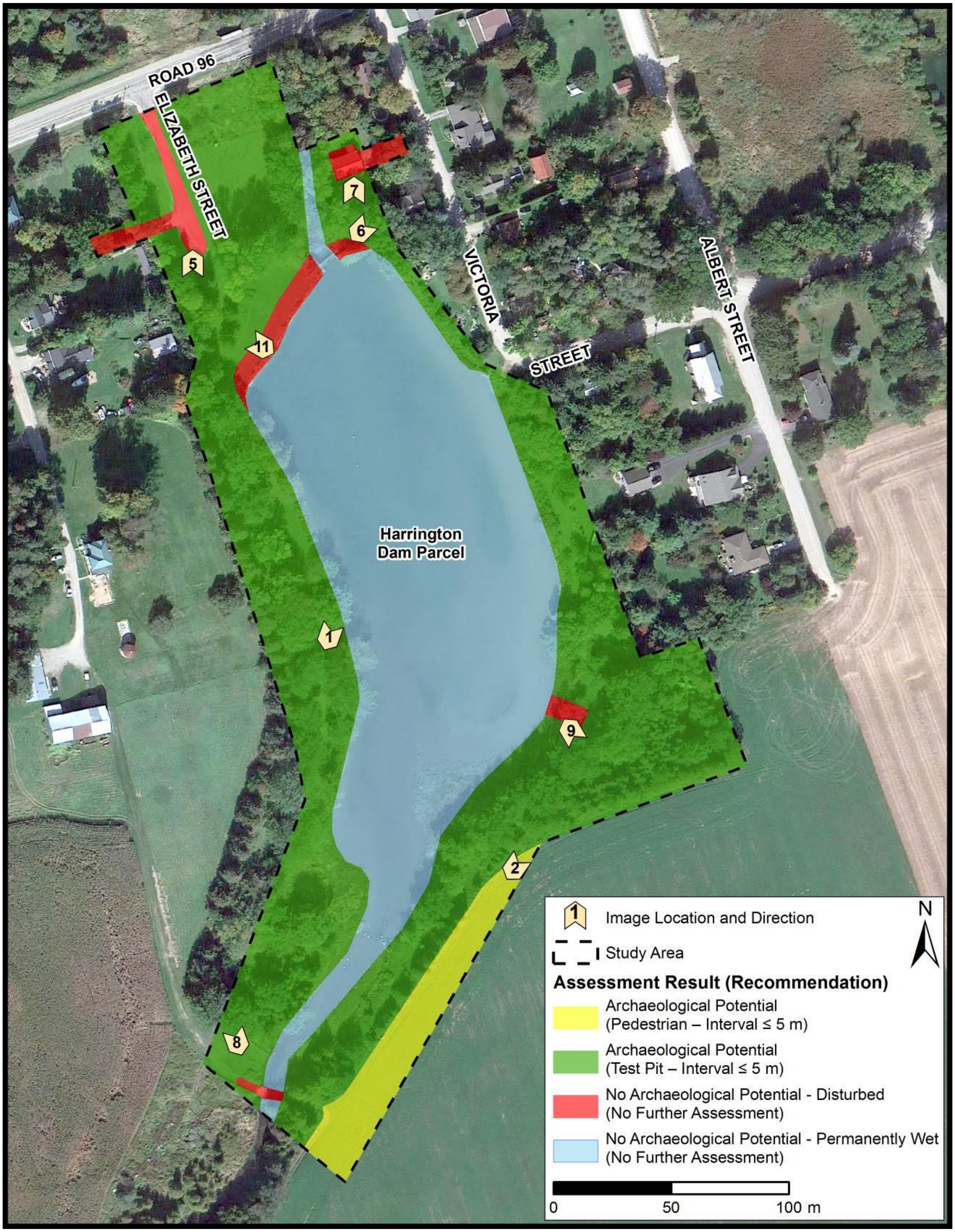
Map 18: ***West Zorra Township*** **from Walker & Miles'** ***Topographical and Historical Atlas of the County of Oxford*** **(1876), Showing the Study Area**
(McGill University 2001)



Map 19: Detail of *Harrington* from Walker & Miles' *Topographical and Historical Atlas of the County of Oxford* (1876)
(McGill University 2001)



Map 20: Historic Aerial Image (1954), Showing the Study Area
(University of Toronto 2009)



Map 21: Assessment Results, Harrington Dam
(Google Earth 2013)

Map 22: Assessment Results, Embro Dam
(Google Earth 2013)

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Appendix H

Dam Hazard Classification Memo. Prepared by ERI, July 2015

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550 Parkside Drive, Unit B1, Waterloo, ON, N2L 5V4
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Memorandum

To:	Rick Goldt, C.E.T	**Date:**	July 28, 2015
From:	David Arseneau, P.Eng.	**ERI Project No.:**	1505
Re:	Harrington Dam Hazard Potential Classification Update		

Background

The Harrington Dam was constructed in 1846 for a water-powered grist mill operation. The latest upgrades occurred in 1952 after a large section of the spillway was undermined and washed away. The land (1952) and mill (1966) were purchased from the owner by the conservation authority. In 2000, repairs on the dam were conducted due to the dam being overtopped twice resulting in damages to the downstream embankment slopes adjacent to the spillway. During this event, the channel reach at the spillway was eroded due to high outflows. The dam is an earth embankment dam with a three bay, reinforced concrete gravity spillway. The dam is approximately 4m in height and 95m in length with a reservoir area of 0.03 km^2. The side slopes of the embankment are approximately 2 to 6:1 (horizontal: vertical).

Current Hazard Classification

A dam safety assessment report for Harrington Dam was completed in 2007 (Acres), which included a dam hazard potential classification. The report references the Ministry of Natural Resource's 1999 Dam Safety Guidelines. The dam hazard potential classifications are summarized in the Dam Safety Guidelines and is reproduced below in **Table 1-1**. The Harrington Dam was assessed for hydrotechnical issues and scored a rating of very low for flood and earthquake hazards referencing economic loss or loss of life. The environmental hazard potential was expected not to exceed a rating of very low. Based on the 1999 Dam Safety Guidelines, the minimum inflow design floods for dams are determined based on the height and storage characteristics of the dam and the hazard potential rating. The Harrington Dam is classified as a small dam in both height and storage and with a rating of very low, the minimum inflow design floods are required to be the 25-year to 50-year flood. A hydraulic and hydrologic assessment were completed in order to confirm the very low rating for loss of life and determine the appropriate minimum IDF. The rating of very low for flood flows was confirmed and an IDF of 50-year, 3-day summer event was chosen. The IDF was utilized to determine if Harrington Dam had appropriate freeboard to safely pass the flood flows. It was determined that the dam will be overtopped and the spillway is not adequate to pass the IDF.

Updates to DHC Methodology

The Hazard Potential Classifications and Inflow Design Flood criteria have been modified since the completion of the 2007 Dam Safety Assessment for Harrington Dam. The revised hazard potential ratings are summarized in **Table 1-2**. The hazard potential ratings have been revised as low, moderate, high and very high. The hazard categories have been revised to life safety, property loss, environmental losses and cultural – built heritage losses. The hazard categories for each hazard potential rating have been modified and improved to be more descriptive. The assessment of life safety is conducted with the application of the 2 x 2 rule which is described in the notes that correspond to the summary of the updated classifications in **Table 1-2**. Property damage is assessed based on third party losses, does not include costs associated with the failure of the dam, and losses must include present and anticipated development. The selection of the minimum inflow design floods can be determined based on the hazard potential ratings of each hazard categories. It is recommended that the hazard potential classification be reviewed and updated if major works are being completed for the study site.

Table 1-1. Hazard Potential Classifications for Dams: SELECTION CRITERIA (MNR, 1999)

Hazard Potential	Loss of Life	Economic and Social Losses	Environmental Losses
Very Low	Potential for loss of life: 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 loss of life: 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 loss of life: 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 lands 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 loss of life: 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(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, refers to “Guidelines for Proponents, Rehabilitation of Mines”, issued by Ontario Ministry of Northern Development and Mines, 1995

Table 1-2. Hazard Potential Classification (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 <u>reversible</u> 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 <u>viable</u> portion of the population of a species classified under the Ontario Endangered Species Act as Extirpated, Threatened or Endangered or <u>irreversible</u> 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.

Revised DHC

The dam hazard potential classifications requires update based on the 2011 Guidelines and due to the Class EA being completed for Harrington Dam. Aerial photographs of Harrington Dam were examined and it was determined that no significant land use changes occurred from 2006 to 2013 and it is presumed that no significant land use changes are expected to occur in the foreseeable future (**Figure 1**). There is one dwelling within the inundation zone that may be impacted by a flood. The 2007 DSA conducted hydraulic modelling under normal (sunny day) conditions and determined whether water levels would impact the dwelling. The results demonstrated that approximately 0.08m of water within the area of the residence at an elevation of 327.8. The door sill is at 328.91m and there will be no potential for loss of life. Therefore, a hazard potential for life safety of low would be appropriate for the study area. Given that only one property would be within the inundation zone, it is not expected that property losses would exceed the low hazard potential. There are no registered heritage sites within the study area and thus a low hazard potential for cultural-built heritage loss would be appropriate. Hazard potential for environmental losses would not be expected to exceed a low rating. Therefore, the overall incremental hazard potential for Harrington Dam would be low based on these hazard potential ratings.

Summary of Revised Hazard Potential Ratings:

- Life Safety: LOW
- Property Losses: LOW
- Environmental Losses: LOW
- Cultural-Built Heritage Losses: LOW

Canadian Dam Safety Guidelines

In addition to the MNR Dam Safety Guidelines, the Canadian Dam Association (CDA) specifies safety guidelines for dams. The CDA dam classifications are summarized in **Table 1-3**. The dam classification system breaks down hazard potentials into population at risk and incremental losses. PAR assigns a rating to how many people will be affected in the event of a flood and is determined based on the presence of temporary or permanent residents. The incremental losses hazard potentials are similar to the MNR guidelines with loss of life, environmental, cultural and economic losses. The population at risk only requires people within the floodwaters to be inconvenienced (not necessarily injured), therefore given that a permanent residence is within the inundation zone, a PAR rating of high would be applicable. As mentioned above, the 2007 Dam Safety Assessment determined that the residence within the inundation zone would not be severely affected and therefore a loss of life of zero is expected and rating of low is applicable. The economic losses would be low due to water levels only generating approximately 8cm of water within the area of the residence. The environmental and cultural losses are expected to be low. The overall rating is typically based on the highest rating and therefore an overall hazard potential rating of high is applicable.

Summary of CDA Hazard Potential Ratings:

- Population at Risk: HIGH
- Loss of Life: LOW
- Environmental Losses: LOW
- Cultural Losses: LOW
- Economic Losses: LOW

2006

2013

Figure 1: Aerial Photo Comparison of Study Area (Google Inc., 2015)

Table 1-3. Dam Classification (CDA, 2007)

Dam class	Population at risk [note 1]	Incremental losses		
		Loss of Life [note 2]	**Environmental and cultural values**	**Infrastructure and economics**
Low	None	0	Minimal short-term loss No long-term loss	Low economic losses; area contains limited infrastructure or services
Significant	Temporary only	Unspecified	No significant loss or deterioration of fish or wildlife habitat Loss of marginal habitat only Restoration or compensation in kind highly possible	Losses to recreational facilities, seasonal workplaces, and infrequently used transportation routes
High	Permanent	10 or fewer	Significant loss or deterioration of *important* fish or wildlife habitat Restoration or compensation in kind possible but impractical	High economic losses affecting infrastructure, public transportation, and commercial facilities
Very high	Permanent	100 or fewer	Significant loss or deterioration of *critical* fish or wildlife habitat Restoration or compensation in kind possible but impractical	Very high economic losses affecting important infrastructure or services (e.g., highway, industrial facility, storage facilities for dangerous substances)
Extreme	Permanent	More than 100	Major loss of *critical* fish or wildlife habitat Restoration or compensation in kind impossible	Extreme losses affecting critical infrastructure or services (e.g., hospital, major industrial complex, major storage facilities for dangerous substances)

Note 1. Definitions for population at risk:

None – There is no identifiable population at risk, so there is no possibility of loss of life other than through unforeseeable misadventure.

Temporary – People are only temporarily in the dam-breach inundation zone (e.g., seasonal cottage use, passing through on transportation routes, participating in recreational activities).

Permanent – The population at risk is ordinarily located in the dam-breach inundation zone (e.g., as permanent residents); three consequence classes (high, very high, extreme) are proposed to allow for more detailed estimates of potential loss of life (to assist in decision-making if the appropriate analysis is carried out).

Note 2. Implications for loss of life:

Unspecified – The appropriate level of safety required at a dam where people are temporarily at risk depends on the number of people, the exposure time, the nature of their activity, and other conditions. A higher class could be appropriate, depending on the requirements. However, the design flood requirement, for example, might not be higher if the temporary population is not likely to be present during the flood season

References

Acres International. July, 2007. Dam Safety Assessment Report for Harrington Dam. Prepared for Upper Thames River Conservation Authority.

Canadian Dam Association. 2007. Dam Safety Guidelines.

Google Inc. 2015. Google Earth (Version 7.1.5.1557) [Software]. Available from http://www.google.com/earth/

Ministry of Natural Resources. September 1999. Ontario Dam Safety Guidelines

Ministry of Natural Resources. August 2011. Classification and Inflow Design Flood Criteria. Technical Bulletin

Appendix I

Sediment Testing Results. Prepared by ALS, September 2015

ECOSYSTEM RECOVERY INC.
ATTN: David Arseneau
1023 Rife Road, Unit A
Cambridge On N1R 5S3

Date Received: 20-AUG-15
Report Date: 04-SEP-15 07:36 (MT)
Version: FINAL

Client Phone: 519-621-1500

Certificate of Analysis

Lab Work Order #: L1660729
Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

Comments: Grain size data is attached to the end of the report

LAURA ERMETA
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1660729-1 HAR U/S Sampled By: CLIENT on 20-AUG-15 @ 11:15 Matrix: SOIL							
Physical Tests							
Conductivity	0.435		0.0040	mS/cm		29-AUG-15	R3256335
% Moisture	70.8		0.10	%	20-AUG-15	21-AUG-15	R3250064
pH	6.87		0.10	pH units		22-AUG-15	R3251697
Cyanides							
Cyanide, Weak Acid Diss	0.091		0.050	ug/g	24-AUG-15	25-AUG-15	R3253230
Saturated Paste Extractables							
SAR	0.40		0.10	SAR		29-AUG-15	R3256812
Calcium (Ca)	150		1.0	mg/L		29-AUG-15	R3256812
Magnesium (Mg)	16.5		1.0	mg/L		29-AUG-15	R3256812
Sodium (Na)	19.6		1.0	mg/L		29-AUG-15	R3256812
Metals							
Antimony (Sb)	<1.0		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Arsenic (As)	2.0		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Barium (Ba)	93.1		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Beryllium (Be)	<0.50		0.50	ug/g	28-AUG-15	31-AUG-15	R3257094
Boron (B)	8.0		5.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Boron (B), Hot Water Ext.	1.52		0.10	ug/g	28-AUG-15	29-AUG-15	R3256801
Cadmium (Cd)	<0.50		0.50	ug/g	28-AUG-15	31-AUG-15	R3257094
Chromium (Cr)	13.3		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Cobalt (Co)	4.1		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Copper (Cu)	12.2		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Lead (Pb)	11.1		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Mercury (Hg)	0.0572		0.0050	ug/g	28-AUG-15	30-AUG-15	R3256457
Molybdenum (Mo)	<1.0		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Nickel (Ni)	7.7		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Selenium (Se)	<1.0		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Silver (Ag)	<0.20		0.20	ug/g	28-AUG-15	31-AUG-15	R3257094
Thallium (Tl)	<0.50		0.50	ug/g	28-AUG-15	31-AUG-15	R3257094
Uranium (U)	<1.0		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Vanadium (V)	14.3		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Zinc (Zn)	66.8		5.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Speciated Metals							
Chromium, Hexavalent	<0.20		0.20	ug/g	20-AUG-15	21-AUG-15	R3250857
Volatile Organic Compounds							
Acetone	1.10		0.50	ug/g	21-AUG-15	24-AUG-15	R3252144
Benzene	<0.0068		0.0068	ug/g	21-AUG-15	24-AUG-15	R3252144
Bromodichloromethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Bromoform	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Bromomethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Carbon tetrachloride	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Chlorobenzene	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Dibromochloromethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1660729-1 HAR U/S Sampled By: CLIENT on 20-AUG-15 @ 11:15 Matrix: SOIL							
Volatile Organic Compounds							
Chloroform	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,2-Dibromoethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,2-Dichlorobenzene	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,3-Dichlorobenzene	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,4-Dichlorobenzene	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Dichlorodifluoromethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,1-Dichloroethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,2-Dichloroethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,1-Dichloroethylene	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
cis-1,2-Dichloroethylene	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
trans-1,2-Dichloroethylene	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,3-Dichloropropene (cis & trans)	<0.042		0.042	ug/g		24-AUG-15	
Methylene Chloride	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,2-Dichloropropane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
cis-1,3-Dichloropropene	<0.030		0.030	ug/g	21-AUG-15	24-AUG-15	R3252144
trans-1,3-Dichloropropene	<0.030		0.030	ug/g	21-AUG-15	24-AUG-15	R3252144
Ethylbenzene	<0.018		0.018	ug/g	21-AUG-15	24-AUG-15	R3252144
n-Hexane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Methyl Ethyl Ketone	<0.50		0.50	ug/g	21-AUG-15	24-AUG-15	R3252144
Methyl Isobutyl Ketone	<0.50		0.50	ug/g	21-AUG-15	24-AUG-15	R3252144
MTBE	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Styrene	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,1,1,2-Tetrachloroethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,1,2,2-Tetrachloroethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Tetrachloroethylene	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Toluene	<0.080		0.080	ug/g	21-AUG-15	24-AUG-15	R3252144
1,1,1-Trichloroethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,1,2-Trichloroethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Trichloroethylene	<0.010		0.010	ug/g	21-AUG-15	24-AUG-15	R3252144
Trichlorofluoromethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Vinyl chloride	<0.020		0.020	ug/g	21-AUG-15	24-AUG-15	R3252144
o-Xylene	<0.020		0.020	ug/g	21-AUG-15	24-AUG-15	R3252144
m+p-Xylenes	<0.030		0.030	ug/g	21-AUG-15	24-AUG-15	R3252144
Xylenes (Total)	<0.050		0.050	ug/g		24-AUG-15	
Surrogate: 4-Bromofluorobenzene	94.8		70-130	%	21-AUG-15	24-AUG-15	R3252144
Surrogate: 1,4-Difluorobenzene	97.7		70-130	%	21-AUG-15	24-AUG-15	R3252144
Hydrocarbons							
F1 (C6-C10)	<5.0		5.0	ug/g	21-AUG-15	24-AUG-15	R3252144
F1-BTEX	<5.0		5.0	ug/g		28-AUG-15	
F2 (C10-C16)	<30	DLHM	30	ug/g	20-AUG-15	21-AUG-15	R3252895
F2-Naphth	<30		30	ug/g		28-AUG-15	

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1660729-1 HAR U/S Sampled By: CLIENT on 20-AUG-15 @ 11:15 Matrix: SOIL							
Hydrocarbons							
F3 (C16-C34)	160	DLHM	150	ug/g	20-AUG-15	21-AUG-15	R3252895
F3-PAH	160		150	ug/g		28-AUG-15	
F4 (C34-C50)	<150	DLHM	150	ug/g	20-AUG-15	21-AUG-15	R3252895
Total Hydrocarbons (C6-C50)	<210		210	ug/g		28-AUG-15	
Chrom. to baseline at nC50	YES				20-AUG-15	21-AUG-15	R3252895
Surrogate: 2-Bromobenzotrifluoride	84.8		60-140	%	20-AUG-15	21-AUG-15	R3252895
Surrogate: 3,4-Dichlorotoluene	107.7		60-140	%	21-AUG-15	24-AUG-15	R3252144
Polycyclic Aromatic Hydrocarbons							
Acenaphthene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Acenaphthylene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Anthracene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Benzo(a)anthracene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Benzo(a)pyrene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Benzo(b)fluoranthene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Benzo(g,h,i)perylene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Benzo(k)fluoranthene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Chrysene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Dibenzo(ah)anthracene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Fluoranthene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Fluorene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Indeno(1,2,3-cd)pyrene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
1+2-Methylnaphthalenes	<0.13		0.13	ug/g		28-AUG-15	
1-Methylnaphthalene	<0.090	DLHM	0.090	ug/g	20-AUG-15	28-AUG-15	R3254254
2-Methylnaphthalene	<0.090	DLHM	0.090	ug/g	20-AUG-15	28-AUG-15	R3254254
Naphthalene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Phenanthrene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Pyrene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Surrogate: 2-Fluorobiphenyl	91.2		50-140	%	20-AUG-15	28-AUG-15	R3254254
Surrogate: p-Terphenyl d14	85.3		50-140	%	20-AUG-15	28-AUG-15	R3254254
Organochlorine Pesticides							
Aldrin	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
gamma-hexachlorocyclohexane	<0.30	RRR	0.30	ug/g	20-AUG-15	24-AUG-15	R3252425
a-chlordane	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
Chlordane (Total)	<0.85		0.85	ug/g		24-AUG-15	
g-chlordane	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
op-DDD	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
pp-DDD	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
Total DDD	<0.85		0.85	ug/g		24-AUG-15	
o,p-DDE	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
pp-DDE	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
Total DDE	<0.85		0.85	ug/g		24-AUG-15	

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1660729-1 HAR U/S							
Sampled By: CLIENT on 20-AUG-15 @ 11:15							
Matrix: SOIL							
Organochlorine Pesticides							
op-DDT	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
pp-DDT	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
Total DDT	<0.85		0.85	ug/g		24-AUG-15	
Dieldrin	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
Endosulfan I	<1.0	DLUI	1.0	ug/g	20-AUG-15	24-AUG-15	R3252425
Endosulfan II	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
Endosulfan (Total)	<1.2		1.2	ug/g		24-AUG-15	
Endrin	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
Heptachlor	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
Heptachlor Epoxide	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
Hexachlorobenzene	<0.30	RRR	0.30	ug/g	20-AUG-15	24-AUG-15	R3252425
Hexachlorobutadiene	<0.30	RRR	0.30	ug/g	20-AUG-15	24-AUG-15	R3252425
Hexachloroethane	<0.30	RRR	0.30	ug/g	20-AUG-15	24-AUG-15	R3252425
Methoxychlor	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
Surrogate: 2-Fluorobiphenyl	101.7		50-140	%	20-AUG-15	24-AUG-15	R3252425
Surrogate: d14-Terphenyl	90.4		50-140	%	20-AUG-15	24-AUG-15	R3252425
Report Remarks : DLM- Extract was run at a dilution due to high sample matrix background. DLHM- Detection limit adjusted: Sample has high moisture content.							
L1660729-2 HAR D/S							
Sampled By: CLIENT on 20-AUG-15 @ 11:00							
Matrix: SOIL							
Physical Tests							
Conductivity	0.344		0.0040	mS/cm		29-AUG-15	R3256335
% Moisture	77.2		0.10	%	20-AUG-15	21-AUG-15	R3250064
pH	6.76		0.10	pH units		22-AUG-15	R3251697
Cyanides							
Cyanide, Weak Acid Diss	0.092		0.050	ug/g	24-AUG-15	25-AUG-15	R3253230
Saturated Paste Extractables							
SAR	0.45		0.10	SAR		29-AUG-15	R3256812
Calcium (Ca)	234		1.0	mg/L		29-AUG-15	R3256812
Magnesium (Mg)	27.4		1.0	mg/L		29-AUG-15	R3256812
Sodium (Na)	27.6		1.0	mg/L		29-AUG-15	R3256812
Metals							
Antimony (Sb)	<1.0		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Arsenic (As)	2.7		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Barium (Ba)	235		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Beryllium (Be)	<0.50		0.50	ug/g	28-AUG-15	31-AUG-15	R3257094
Boron (B)	6.7		5.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Boron (B), Hot Water Ext.	1.18		0.10	ug/g	28-AUG-15	29-AUG-15	R3256801
Cadmium (Cd)	<0.50		0.50	ug/g	28-AUG-15	31-AUG-15	R3257094
Chromium (Cr)	14.9		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Cobalt (Co)	4.5		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Copper (Cu)	16.2		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1660729-2 HAR D/S							
Sampled By: CLIENT on 20-AUG-15 @ 11:00							
Matrix: SOIL							
Metals							
Lead (Pb)	11.7		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Mercury (Hg)	0.0563		0.0050	ug/g	28-AUG-15	30-AUG-15	R3256457
Molybdenum (Mo)	<1.0		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Nickel (Ni)	10.2		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Selenium (Se)	<1.0		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Silver (Ag)	<0.20		0.20	ug/g	28-AUG-15	31-AUG-15	R3257094
Thallium (Tl)	<0.50		0.50	ug/g	28-AUG-15	31-AUG-15	R3257094
Uranium (U)	<1.0		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Vanadium (V)	15.2		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Zinc (Zn)	71.1		5.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Speciated Metals							
Chromium, Hexavalent	<0.20		0.20	ug/g	20-AUG-15	21-AUG-15	R3250857
Volatile Organic Compounds							
Acetone	1.25		0.50	ug/g	21-AUG-15	24-AUG-15	R3252144
Benzene	<0.0068		0.0068	ug/g	21-AUG-15	24-AUG-15	R3252144
Bromodichloromethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Bromoform	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Bromomethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Carbon tetrachloride	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Chlorobenzene	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Dibromochloromethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Chloroform	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,2-Dibromoethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,2-Dichlorobenzene	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,3-Dichlorobenzene	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,4-Dichlorobenzene	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Dichlorodifluoromethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,1-Dichloroethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,2-Dichloroethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,1-Dichloroethylene	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
cis-1,2-Dichloroethylene	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
trans-1,2-Dichloroethylene	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,3-Dichloropropene (cis & trans)	<0.042		0.042	ug/g		24-AUG-15	
Methylene Chloride	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,2-Dichloropropane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
cis-1,3-Dichloropropene	<0.030		0.030	ug/g	21-AUG-15	24-AUG-15	R3252144
trans-1,3-Dichloropropene	<0.030		0.030	ug/g	21-AUG-15	24-AUG-15	R3252144
Ethylbenzene	<0.018		0.018	ug/g	21-AUG-15	24-AUG-15	R3252144
n-Hexane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Methyl Ethyl Ketone	0.79		0.50	ug/g	21-AUG-15	24-AUG-15	R3252144
Methyl Isobutyl Ketone	<0.50		0.50	ug/g	21-AUG-15	24-AUG-15	R3252144

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1660729-2 HAR D/S Sampled By: CLIENT on 20-AUG-15 @ 11:00 Matrix: SOIL							
Volatile Organic Compounds							
MTBE	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Styrene	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,1,1,2-Tetrachloroethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,1,2,2-Tetrachloroethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Tetrachloroethylene	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Toluene	<0.080		0.080	ug/g	21-AUG-15	24-AUG-15	R3252144
1,1,1-Trichloroethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
1,1,2-Trichloroethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Trichloroethylene	<0.010		0.010	ug/g	21-AUG-15	24-AUG-15	R3252144
Trichlorofluoromethane	<0.050		0.050	ug/g	21-AUG-15	24-AUG-15	R3252144
Vinyl chloride	<0.020		0.020	ug/g	21-AUG-15	24-AUG-15	R3252144
o-Xylene	<0.020		0.020	ug/g	21-AUG-15	24-AUG-15	R3252144
m+p-Xylenes	<0.030		0.030	ug/g	21-AUG-15	24-AUG-15	R3252144
Xylenes (Total)	<0.050		0.050	ug/g		24-AUG-15	
Surrogate: 4-Bromofluorobenzene	87.7		70-130	%	21-AUG-15	24-AUG-15	R3252144
Surrogate: 1,4-Difluorobenzene	99.0		70-130	%	21-AUG-15	24-AUG-15	R3252144
Hydrocarbons							
F1 (C6-C10)	<5.0		5.0	ug/g	21-AUG-15	24-AUG-15	R3252144
F1-BTEX	<5.0		5.0	ug/g		28-AUG-15	
F2 (C10-C16)	<30	DLHM	30	ug/g	20-AUG-15	21-AUG-15	R3252895
F2-Naphth	<30		30	ug/g		28-AUG-15	
F3 (C16-C34)	320	DLHM	150	ug/g	20-AUG-15	21-AUG-15	R3252895
F3-PAH	320		150	ug/g		28-AUG-15	
F4 (C34-C50)	260	DLHM	150	ug/g	20-AUG-15	21-AUG-15	R3252895
Total Hydrocarbons (C6-C50)	580		210	ug/g		28-AUG-15	
Chrom. to baseline at nC50	YES				20-AUG-15	21-AUG-15	R3252895
Surrogate: 2-Bromobenzotrifluoride	78.6		60-140	%	20-AUG-15	21-AUG-15	R3252895
Surrogate: 3,4-Dichlorotoluene	102.7		60-140	%	21-AUG-15	24-AUG-15	R3252144
Polycyclic Aromatic Hydrocarbons							
Acenaphthene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Acenaphthylene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Anthracene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Benzo(a)anthracene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Benzo(a)pyrene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Benzo(b)fluoranthene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Benzo(g,h,i)perylene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Benzo(k)fluoranthene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Chrysene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Dibenzo(ah)anthracene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Fluoranthene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Fluorene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1660729-2 HAR D/S Sampled By: CLIENT on 20-AUG-15 @ 11:00 Matrix: SOIL							
Polycyclic Aromatic Hydrocarbons							
Indeno(1,2,3-cd)pyrene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
1+2-Methylnaphthalenes	<0.13		0.13	ug/g		28-AUG-15	
1-Methylnaphthalene	<0.090	DLHM	0.090	ug/g	20-AUG-15	28-AUG-15	R3254254
2-Methylnaphthalene	<0.090	DLHM	0.090	ug/g	20-AUG-15	28-AUG-15	R3254254
Naphthalene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Phenanthrene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Pyrene	<0.15	DLHM	0.15	ug/g	20-AUG-15	28-AUG-15	R3254254
Surrogate: 2-Fluorobiphenyl	88.0		50-140	%	20-AUG-15	28-AUG-15	R3254254
Surrogate: p-Terphenyl d14	82.4		50-140	%	20-AUG-15	28-AUG-15	R3254254
Organochlorine Pesticides							
Aldrin	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
gamma-hexachlorocyclohexane	<0.30	RRR	0.30	ug/g	20-AUG-15	24-AUG-15	R3252425
a-chlordane	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
Chlordane (Total)	<0.85		0.85	ug/g		24-AUG-15	
g-chlordane	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
op-DDD	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
pp-DDD	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
Total DDD	<0.85		0.85	ug/g		24-AUG-15	
o,p-DDE	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
pp-DDE	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
Total DDE	<0.85		0.85	ug/g		24-AUG-15	
op-DDT	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
pp-DDT	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
Total DDT	<0.85		0.85	ug/g		24-AUG-15	
Dieldrin	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
Endosulfan I	<0.90	DLUI	0.90	ug/g	20-AUG-15	24-AUG-15	R3252425
Endosulfan II	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
Endosulfan (Total)	<1.1		1.1	ug/g		24-AUG-15	
Endrin	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
Heptachlor	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
Heptachlor Epoxide	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
Hexachlorobenzene	<0.30	RRR	0.30	ug/g	20-AUG-15	24-AUG-15	R3252425
Hexachlorobutadiene	<0.30	RRR	0.30	ug/g	20-AUG-15	24-AUG-15	R3252425
Hexachloroethane	<0.30	RRR	0.30	ug/g	20-AUG-15	24-AUG-15	R3252425
Methoxychlor	<0.60	RRR	0.60	ug/g	20-AUG-15	24-AUG-15	R3252425
Surrogate: 2-Fluorobiphenyl	94.4		50-140	%	20-AUG-15	24-AUG-15	R3252425
Surrogate: d14-Terphenyl	101.2		50-140	%	20-AUG-15	24-AUG-15	R3252425
Report Remarks : DLM- Extract was run at a dilution due to high sample matrix background. DLHM- Detection limit adjusted: Sample has high moisture content.							
L1660729-3 EMB U/S Sampled By: CLIENT on 20-AUG-15 @ 12:40 Matrix: SOIL							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1660729-3 EMB U/S							
Sampled By: CLIENT on 20-AUG-15 @ 12:40							
Matrix: SOIL							
Physical Tests							
Conductivity	0.415		0.0040	mS/cm		29-AUG-15	R3256335
% Moisture	65.7		0.10	%	20-AUG-15	21-AUG-15	R3250064
pH	6.84		0.10	pH units		22-AUG-15	R3251697
Cyanides							
Cyanide, Weak Acid Diss	0.102		0.050	ug/g	24-AUG-15	25-AUG-15	R3253230
Saturated Paste Extractables							
SAR	0.30		0.10	SAR		29-AUG-15	R3256812
Calcium (Ca)	114		1.0	mg/L		29-AUG-15	R3256812
Magnesium (Mg)	13.3		1.0	mg/L		29-AUG-15	R3256812
Sodium (Na)	12.6		1.0	mg/L		29-AUG-15	R3256812
Metals							
Antimony (Sb)	<1.0		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Arsenic (As)	2.6		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Barium (Ba)	81.2		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Beryllium (Be)	<0.50		0.50	ug/g	28-AUG-15	31-AUG-15	R3257094
Boron (B)	6.3		5.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Boron (B), Hot Water Ext.	1.18		0.10	ug/g	28-AUG-15	29-AUG-15	R3256801
Cadmium (Cd)	<0.50		0.50	ug/g	28-AUG-15	31-AUG-15	R3257094
Chromium (Cr)	14.4		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Cobalt (Co)	4.2		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Copper (Cu)	13.2		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Lead (Pb)	9.2		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Mercury (Hg)	0.0380		0.0050	ug/g	28-AUG-15	30-AUG-15	R3256457
Molybdenum (Mo)	<1.0		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Nickel (Ni)	9.4		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Selenium (Se)	<1.0		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Silver (Ag)	<0.20		0.20	ug/g	28-AUG-15	31-AUG-15	R3257094
Thallium (Tl)	<0.50		0.50	ug/g	28-AUG-15	31-AUG-15	R3257094
Uranium (U)	<1.0		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Vanadium (V)	18.1		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Zinc (Zn)	64.2		5.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Speciated Metals							
Chromium, Hexavalent	<0.20		0.20	ug/g	20-AUG-15	21-AUG-15	R3250857
Volatile Organic Compounds							
Acetone	<1.0	DLHM	1.0	ug/g	21-AUG-15	26-AUG-15	R3252341
Benzene	<0.014	ABL	0.014	ug/g	21-AUG-15	24-AUG-15	R3252341
Bromodichloromethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Bromoform	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Bromomethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Carbon tetrachloride	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Chlorobenzene	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Dibromochloromethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1660729-3 EMB U/S							
Sampled By: CLIENT on 20-AUG-15 @ 12:40							
Matrix: SOIL							
Volatile Organic Compounds							
Chloroform	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,2-Dibromoethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,2-Dichlorobenzene	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,3-Dichlorobenzene	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,4-Dichlorobenzene	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Dichlorodifluoromethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,1-Dichloroethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,2-Dichloroethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,1-Dichloroethylene	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
cis-1,2-Dichloroethylene	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
trans-1,2-Dichloroethylene	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,3-Dichloropropene (cis & trans)	<0.085		0.085	ug/g		26-AUG-15	
Methylene Chloride	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,2-Dichloropropane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
cis-1,3-Dichloropropene	<0.060	ABL	0.060	ug/g	21-AUG-15	24-AUG-15	R3252341
trans-1,3-Dichloropropene	<0.060	ABL	0.060	ug/g	21-AUG-15	24-AUG-15	R3252341
Ethylbenzene	<0.036	ABL	0.036	ug/g	21-AUG-15	24-AUG-15	R3252341
n-Hexane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Methyl Ethyl Ketone	<1.0	ABL	1.0	ug/g	21-AUG-15	24-AUG-15	R3252341
Methyl Isobutyl Ketone	<1.0	ABL	1.0	ug/g	21-AUG-15	24-AUG-15	R3252341
MTBE	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Styrene	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,1,1,2-Tetrachloroethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,1,2,2-Tetrachloroethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Tetrachloroethylene	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Toluene	<0.16	ABL	0.16	ug/g	21-AUG-15	24-AUG-15	R3252341
1,1,1-Trichloroethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,1,2-Trichloroethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Trichloroethylene	<0.020	ABL	0.020	ug/g	21-AUG-15	24-AUG-15	R3252341
Trichlorofluoromethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Vinyl chloride	<0.040	ABL	0.040	ug/g	21-AUG-15	24-AUG-15	R3252341
o-Xylene	<0.040	ABL	0.040	ug/g	21-AUG-15	24-AUG-15	R3252341
m+p-Xylenes	<0.060	ABL	0.060	ug/g	21-AUG-15	24-AUG-15	R3252341
Xylenes (Total)	<0.072		0.072	ug/g		26-AUG-15	
Surrogate: 4-Bromofluorobenzene	77.1		70-130	%	21-AUG-15	24-AUG-15	R3252341
Surrogate: 1,4-Difluorobenzene	82.3		70-130	%	21-AUG-15	24-AUG-15	R3252341
Hydrocarbons							
F1 (C6-C10)	<10	DLHM	10	ug/g	21-AUG-15	26-AUG-15	R3252341
F1-BTEX	<10		10	ug/g		28-AUG-15	
F2 (C10-C16)	<20	DLHM	20	ug/g	20-AUG-15	21-AUG-15	R3252895
F2-Naphth	<20		20	ug/g		28-AUG-15	

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1660729-3 EMB U/S Sampled By: CLIENT on 20-AUG-15 @ 12:40 Matrix: SOIL							
Hydrocarbons							
F3 (C16-C34)	130	DLHM	100	ug/g	20-AUG-15	21-AUG-15	R3252895
F3-PAH	130		100	ug/g		28-AUG-15	
F4 (C34-C50)	<100	DLHM	100	ug/g	20-AUG-15	21-AUG-15	R3252895
Total Hydrocarbons (C6-C50)	<140		140	ug/g		28-AUG-15	
Chrom. to baseline at nC50	YES				20-AUG-15	21-AUG-15	R3252895
Surrogate: 2-Bromobenzotrifluoride	93.2		60-140	%	20-AUG-15	21-AUG-15	R3252895
Surrogate: 3,4-Dichlorotoluene	49.0	SOL:MI	60-140	%	21-AUG-15	26-AUG-15	R3252341
Polycyclic Aromatic Hydrocarbons							
Acenaphthene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Acenaphthylene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Anthracene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Benzo(a)anthracene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Benzo(a)pyrene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Benzo(b)fluoranthene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Benzo(g,h,i)perylene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Benzo(k)fluoranthene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Chrysene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Dibenzo(ah)anthracene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Fluoranthene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Fluorene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Indeno(1,2,3-cd)pyrene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
1+2-Methylnaphthalenes	<0.085		0.085	ug/g		28-AUG-15	
1-Methylnaphthalene	<0.060	DLHM	0.060	ug/g	20-AUG-15	28-AUG-15	R3254254
2-Methylnaphthalene	<0.060	DLHM	0.060	ug/g	20-AUG-15	28-AUG-15	R3254254
Naphthalene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Phenanthrene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Pyrene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Surrogate: 2-Fluorobiphenyl	91.2		50-140	%	20-AUG-15	28-AUG-15	R3254254
Surrogate: p-Terphenyl d14	85.9		50-140	%	20-AUG-15	28-AUG-15	R3254254
Organochlorine Pesticides							
Aldrin	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
gamma-hexachlorocyclohexane	<0.20	RRR	0.20	ug/g	20-AUG-15	24-AUG-15	R3252425
a-chlordane	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
Chlordane (Total)	<0.57		0.57	ug/g		24-AUG-15	
g-chlordane	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
op-DDD	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
pp-DDD	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
Total DDD	<0.57		0.57	ug/g		24-AUG-15	
o,p-DDE	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
pp-DDE	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
Total DDE	<0.57		0.57	ug/g		24-AUG-15	

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1660729-3 EMB U/S Sampled By: CLIENT on 20-AUG-15 @ 12:40 Matrix: SOIL							
Organochlorine Pesticides							
op-DDT	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
pp-DDT	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
Total DDT	<0.57		0.57	ug/g		24-AUG-15	
Dieldrin	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
Endosulfan I	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
Endosulfan II	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
Endosulfan (Total)	<0.57		0.57	ug/g		24-AUG-15	
Endrin	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
Heptachlor	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
Heptachlor Epoxide	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
Hexachlorobenzene	<0.20	RRR	0.20	ug/g	20-AUG-15	24-AUG-15	R3252425
Hexachlorobutadiene	<0.20	RRR	0.20	ug/g	20-AUG-15	24-AUG-15	R3252425
Hexachloroethane	<0.20	RRR	0.20	ug/g	20-AUG-15	24-AUG-15	R3252425
Methoxychlor	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
Surrogate: 2-Fluorobiphenyl	101.1		50-140	%	20-AUG-15	24-AUG-15	R3252425
Surrogate: d14-Terphenyl	101.9		50-140	%	20-AUG-15	24-AUG-15	R3252425
Report Remarks : ABL-Analysis compromised due to type of sample jar received. Losses may have occurred according to 511 Regulation. Detection limit adjusted for high moisture. Report Remarks : DLM- Extract was run at a dilution due to high sample matrix background. DLHM- Detection limit adjusted: Sample has high moisture content.							
L1660729-4 EMB D/S Sampled By: CLIENT on 20-AUG-15 @ 12:20 Matrix: SOIL							
Physical Tests							
Conductivity	0.267		0.0040	mS/cm		29-AUG-15	R3256335
% Moisture	65.5		0.10	%	20-AUG-15	21-AUG-15	R3250064
pH	6.94		0.10	pH units		22-AUG-15	R3251697
Cyanides							
Cyanide, Weak Acid Diss	<0.050		0.050	ug/g	20-AUG-15	21-AUG-15	R3252350
Saturated Paste Extractables							
SAR	0.30		0.10	SAR		29-AUG-15	R3256812
Calcium (Ca)	174		1.0	mg/L		29-AUG-15	R3256812
Magnesium (Mg)	26.2		1.0	mg/L		29-AUG-15	R3256812
Sodium (Na)	16.0		1.0	mg/L		29-AUG-15	R3256812
Metals							
Antimony (Sb)	<1.0		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Arsenic (As)	3.2		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Barium (Ba)	133		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Beryllium (Be)	<0.50		0.50	ug/g	28-AUG-15	31-AUG-15	R3257094
Boron (B)	8.4		5.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Boron (B), Hot Water Ext.	1.46		0.10	ug/g	28-AUG-15	29-AUG-15	R3256801
Cadmium (Cd)	<0.50		0.50	ug/g	28-AUG-15	31-AUG-15	R3257094
Chromium (Cr)	18.3		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1660729-4 EMB D/S							
Sampled By: CLIENT on 20-AUG-15 @ 12:20							
Matrix: SOIL							
Metals							
Cobalt (Co)	5.2		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Copper (Cu)	16.4		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Lead (Pb)	11.3		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Mercury (Hg)	0.0458		0.0050	ug/g	28-AUG-15	30-AUG-15	R3256457
Molybdenum (Mo)	<1.0		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Nickel (Ni)	12.3		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Selenium (Se)	<1.0		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Silver (Ag)	<0.20		0.20	ug/g	28-AUG-15	31-AUG-15	R3257094
Thallium (Tl)	<0.50		0.50	ug/g	28-AUG-15	31-AUG-15	R3257094
Uranium (U)	<1.0		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Vanadium (V)	22.5		1.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Zinc (Zn)	79.7		5.0	ug/g	28-AUG-15	31-AUG-15	R3257094
Speciated Metals							
Chromium, Hexavalent	<0.20		0.20	ug/g	20-AUG-15	21-AUG-15	R3250857
Volatile Organic Compounds							
Acetone	<1.0	ABL	1.0	ug/g	21-AUG-15	24-AUG-15	R3252341
Benzene	<0.014	ABL	0.014	ug/g	21-AUG-15	24-AUG-15	R3252341
Bromodichloromethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Bromoform	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Bromomethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Carbon tetrachloride	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Chlorobenzene	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Dibromochloromethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Chloroform	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,2-Dibromoethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,2-Dichlorobenzene	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,3-Dichlorobenzene	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,4-Dichlorobenzene	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Dichlorodifluoromethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,1-Dichloroethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,2-Dichloroethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,1-Dichloroethylene	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
cis-1,2-Dichloroethylene	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
trans-1,2-Dichloroethylene	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,3-Dichloropropene (cis & trans)	<0.085		0.085	ug/g		25-AUG-15	
Methylene Chloride	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,2-Dichloropropane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
cis-1,3-Dichloropropene	<0.060	ABL	0.060	ug/g	21-AUG-15	24-AUG-15	R3252341
trans-1,3-Dichloropropene	<0.060	ABL	0.060	ug/g	21-AUG-15	24-AUG-15	R3252341
Ethylbenzene	<0.036	ABL	0.036	ug/g	21-AUG-15	24-AUG-15	R3252341
n-Hexane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1660729-4 EMB D/S Sampled By: CLIENT on 20-AUG-15 @ 12:20 Matrix: SOIL							
Volatile Organic Compounds							
Methyl Ethyl Ketone	<1.0	ABL	1.0	ug/g	21-AUG-15	24-AUG-15	R3252341
Methyl Isobutyl Ketone	<1.0	ABL	1.0	ug/g	21-AUG-15	24-AUG-15	R3252341
MTBE	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Styrene	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,1,1,2-Tetrachloroethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,1,2,2-Tetrachloroethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Tetrachloroethylene	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Toluene	<0.16	ABL	0.16	ug/g	21-AUG-15	24-AUG-15	R3252341
1,1,1-Trichloroethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
1,1,2-Trichloroethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Trichloroethylene	<0.020	ABL	0.020	ug/g	21-AUG-15	24-AUG-15	R3252341
Trichlorofluoromethane	<0.10	ABL	0.10	ug/g	21-AUG-15	24-AUG-15	R3252341
Vinyl chloride	<0.040	ABL	0.040	ug/g	21-AUG-15	24-AUG-15	R3252341
o-Xylene	<0.040	ABL	0.040	ug/g	21-AUG-15	24-AUG-15	R3252341
m+p-Xylenes	<0.060	ABL	0.060	ug/g	21-AUG-15	24-AUG-15	R3252341
Xylenes (Total)	<0.072		0.072	ug/g		25-AUG-15	
Surrogate: 4-Bromofluorobenzene	77.9		70-130	%	21-AUG-15	24-AUG-15	R3252341
Surrogate: 1,4-Difluorobenzene	82.9		70-130	%	21-AUG-15	24-AUG-15	R3252341
Hydrocarbons							
F1 (C6-C10)	<5.0		5.0	ug/g	21-AUG-15	26-AUG-15	R3252341
F1-BTEX	<5.0		5.0	ug/g		28-AUG-15	
F2 (C10-C16)	<20	DLHM	20	ug/g	20-AUG-15	21-AUG-15	R3252895
F2-Naphth	<20		20	ug/g		28-AUG-15	
F3 (C16-C34)	<100	DLHM	100	ug/g	20-AUG-15	21-AUG-15	R3252895
F3-PAH	<100		100	ug/g		28-AUG-15	
F4 (C34-C50)	<100	DLHM	100	ug/g	20-AUG-15	21-AUG-15	R3252895
Total Hydrocarbons (C6-C50)	<140		140	ug/g		28-AUG-15	
Chrom. to baseline at nC50	YES				20-AUG-15	21-AUG-15	R3252895
Surrogate: 2-Bromobenzotrifluoride	82.9		60-140	%	20-AUG-15	21-AUG-15	R3252895
Surrogate: 3,4-Dichlorotoluene	49.4	SOL:MI	60-140	%	21-AUG-15	26-AUG-15	R3252341
Polycyclic Aromatic Hydrocarbons							
Acenaphthene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Acenaphthylene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Anthracene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Benzo(a)anthracene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Benzo(a)pyrene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Benzo(b)fluoranthene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Benzo(g,h,i)perylene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Benzo(k)fluoranthene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Chrysene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Dibenzo(ah)anthracene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1660729-4 EMB D/S Sampled By: CLIENT on 20-AUG-15 @ 12:20 Matrix: SOIL							
Polycyclic Aromatic Hydrocarbons							
Fluoranthene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Fluorene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Indeno(1,2,3-cd)pyrene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
1+2-Methylnaphthalenes	<0.085		0.085	ug/g		28-AUG-15	
1-Methylnaphthalene	<0.060	DLHM	0.060	ug/g	20-AUG-15	28-AUG-15	R3254254
2-Methylnaphthalene	<0.060	DLHM	0.060	ug/g	20-AUG-15	28-AUG-15	R3254254
Naphthalene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Phenanthrene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Pyrene	<0.10	DLHM	0.10	ug/g	20-AUG-15	28-AUG-15	R3254254
Surrogate: 2-Fluorobiphenyl	89.5		50-140	%	20-AUG-15	28-AUG-15	R3254254
Surrogate: p-Terphenyl d14	84.6		50-140	%	20-AUG-15	28-AUG-15	R3254254
Organochlorine Pesticides							
Aldrin	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
gamma-hexachlorocyclohexane	<0.20	RRR	0.20	ug/g	20-AUG-15	24-AUG-15	R3252425
a-chlordane	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
Chlordane (Total)	<0.57		0.57	ug/g		24-AUG-15	
g-chlordane	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
op-DDD	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
pp-DDD	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
Total DDD	<0.57		0.57	ug/g		24-AUG-15	
o,p-DDE	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
pp-DDE	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
Total DDE	<0.57		0.57	ug/g		24-AUG-15	
op-DDT	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
pp-DDT	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
Total DDT	<0.57		0.57	ug/g		24-AUG-15	
Dieldrin	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
Endosulfan I	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
Endosulfan II	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
Endosulfan (Total)	<0.57		0.57	ug/g		24-AUG-15	
Endrin	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
Heptachlor	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
Heptachlor Epoxide	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
Hexachlorobenzene	<0.20	RRR	0.20	ug/g	20-AUG-15	24-AUG-15	R3252425
Hexachlorobutadiene	<0.20	RRR	0.20	ug/g	20-AUG-15	24-AUG-15	R3252425
Hexachloroethane	<0.20	RRR	0.20	ug/g	20-AUG-15	24-AUG-15	R3252425
Methoxychlor	<0.40	RRR	0.40	ug/g	20-AUG-15	24-AUG-15	R3252425
Surrogate: 2-Fluorobiphenyl	103.4		50-140	%	20-AUG-15	24-AUG-15	R3252425
Surrogate: d14-Terphenyl	110.6		50-140	%	20-AUG-15	24-AUG-15	R3252425

Report Remarks : ABL-Analysis compromised due to type of sample jar received. Losses may have occurred according to 511 Regulation. Detection limit adjusted for high moisture.

Report Remarks : DLM- Extract was run at a dilution due to high sample matrix background.

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1660729-4 EMB D/S Sampled By: CLIENT on 20-AUG-15 @ 12:20 Matrix: SOIL DLHM- Detection limit adjusted: Sample has high moisture content.							
L1660729-5 HAR U/S TCLP Sampled By: CLIENT on 20-AUG-15 @ 11:15 Matrix: SOIL							
Sample Preparation							
Initial pH	8.19		0.10	pH units		21-AUG-15	R3252585
Final pH	4.79		0.10	pH units		21-AUG-15	R3252585
TCLP Extractables							
Cyanide, Weak Acid Diss	<0.10		0.10	mg/L		24-AUG-15	R3252758
Fluoride (F)	<10		10	mg/L		26-AUG-15	R3254613
Nitrate and Nitrite as N	<4.0		4.0	mg/L		26-AUG-15	R3254613
Nitrate-N	<2.0		2.0	mg/L		26-AUG-15	R3254613
Nitrite-N	<2.0		2.0	mg/L		26-AUG-15	R3254613
TCLP Metals							
Arsenic (As)	<0.050		0.050	mg/L		24-AUG-15	R3252744
Barium (Ba)	0.88		0.50	mg/L		24-AUG-15	R3252744
Boron (B)	<2.5		2.5	mg/L		24-AUG-15	R3252744
Cadmium (Cd)	<0.0050		0.0050	mg/L		24-AUG-15	R3252744
Chromium (Cr)	<0.050		0.050	mg/L		24-AUG-15	R3252744
Lead (Pb)	<0.050		0.050	mg/L		24-AUG-15	R3252744
Mercury (Hg)	<0.00010		0.00010	mg/L		24-AUG-15	R3252294
Selenium (Se)	<0.25		0.25	mg/L		24-AUG-15	R3252744
Silver (Ag)	<0.0050		0.0050	mg/L		24-AUG-15	R3252744
Uranium (U)	<0.25		0.25	mg/L		24-AUG-15	R3252744
L1660729-6 HAR D/S TCLP Sampled By: CLIENT on 20-AUG-15 @ 11:00 Matrix: SOIL							
Sample Preparation							
Initial pH	8.02		0.10	pH units		21-AUG-15	R3252585
Final pH	5.17		0.10	pH units		21-AUG-15	R3252585
TCLP Extractables							
Cyanide, Weak Acid Diss	<0.10		0.10	mg/L		24-AUG-15	R3252758
Fluoride (F)	<10		10	mg/L		26-AUG-15	R3254613
Nitrate and Nitrite as N	<4.0		4.0	mg/L		26-AUG-15	R3254613
Nitrate-N	<2.0		2.0	mg/L		26-AUG-15	R3254613
Nitrite-N	<2.0		2.0	mg/L		26-AUG-15	R3254613
TCLP Metals							
Arsenic (As)	<0.050		0.050	mg/L		24-AUG-15	R3252744
Barium (Ba)	1.51		0.50	mg/L		24-AUG-15	R3252744
Boron (B)	<2.5		2.5	mg/L		24-AUG-15	R3252744
Cadmium (Cd)	<0.0050		0.0050	mg/L		24-AUG-15	R3252744
Chromium (Cr)	<0.050		0.050	mg/L		24-AUG-15	R3252744
Lead (Pb)	<0.050		0.050	mg/L		24-AUG-15	R3252744
Mercury (Hg)	<0.00010		0.00010	mg/L		24-AUG-15	R3252294

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1660729-6 HAR D/S TCLP Sampled By: CLIENT on 20-AUG-15 @ 11:00 Matrix: SOIL							
TCLP Metals							
Selenium (Se)	<0.25		0.25	mg/L		24-AUG-15	R3252744
Silver (Ag)	<0.0050		0.0050	mg/L		24-AUG-15	R3252744
Uranium (U)	<0.25		0.25	mg/L		24-AUG-15	R3252744
L1660729-7 EMB U/S TCLP Sampled By: CLIENT on 20-AUG-15 @ 12:40 Matrix: SOIL							
Sample Preparation							
Initial pH	7.98		0.10	pH units		21-AUG-15	R3252585
Final pH	5.03		0.10	pH units		21-AUG-15	R3252585
TCLP Extractables							
Cyanide, Weak Acid Diss	<0.10		0.10	mg/L		24-AUG-15	R3252758
Fluoride (F)	<10		10	mg/L		26-AUG-15	R3254613
Nitrate and Nitrite as N	<4.0		4.0	mg/L		26-AUG-15	R3254613
Nitrate-N	<2.0		2.0	mg/L		26-AUG-15	R3254613
Nitrite-N	<2.0		2.0	mg/L		26-AUG-15	R3254613
TCLP Metals							
Arsenic (As)	<0.050		0.050	mg/L		24-AUG-15	R3252744
Barium (Ba)	0.78		0.50	mg/L		24-AUG-15	R3252744
Boron (B)	<2.5		2.5	mg/L		24-AUG-15	R3252744
Cadmium (Cd)	<0.0050		0.0050	mg/L		24-AUG-15	R3252744
Chromium (Cr)	<0.050		0.050	mg/L		24-AUG-15	R3252744
Lead (Pb)	<0.050		0.050	mg/L		24-AUG-15	R3252744
Mercury (Hg)	<0.00010		0.00010	mg/L		24-AUG-15	R3252294
Selenium (Se)	<0.25		0.25	mg/L		24-AUG-15	R3252744
Silver (Ag)	<0.0050		0.0050	mg/L		24-AUG-15	R3252744
Uranium (U)	<0.25		0.25	mg/L		24-AUG-15	R3252744
L1660729-8 EMB D/S TCLP Sampled By: CLIENT on 20-AUG-15 @ 12:20 Matrix: SOIL							
Sample Preparation							
Initial pH	8.35		0.10	pH units		21-AUG-15	R3252585
Final pH	5.79		0.10	pH units		21-AUG-15	R3252585
TCLP Extractables							
Cyanide, Weak Acid Diss	<0.10		0.10	mg/L		24-AUG-15	R3252758
Fluoride (F)	<10		10	mg/L		26-AUG-15	R3254613
Nitrate and Nitrite as N	<4.0		4.0	mg/L		26-AUG-15	R3254613
Nitrate-N	<2.0		2.0	mg/L		26-AUG-15	R3254613
Nitrite-N	<2.0		2.0	mg/L		26-AUG-15	R3254613
TCLP Metals							
Arsenic (As)	<0.050		0.050	mg/L		24-AUG-15	R3252744
Barium (Ba)	0.84		0.50	mg/L		24-AUG-15	R3252744
Boron (B)	<2.5		2.5	mg/L		24-AUG-15	R3252744
Cadmium (Cd)	<0.0050		0.0050	mg/L		24-AUG-15	R3252744

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1660729-8 EMB D/S TCLP Sampled By: CLIENT on 20-AUG-15 @ 12:20 Matrix: SOIL							
TCLP Metals							
Chromium (Cr)	<0.050		0.050	mg/L		24-AUG-15	R3252744
Lead (Pb)	<0.050		0.050	mg/L		24-AUG-15	R3252744
Mercury (Hg)	<0.00010		0.00010	mg/L		24-AUG-15	R3252294
Selenium (Se)	<0.25		0.25	mg/L		24-AUG-15	R3252744
Silver (Ag)	<0.0050		0.0050	mg/L		24-AUG-15	R3252744
Uranium (U)	<0.25		0.25	mg/L		24-AUG-15	R3252744

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	F1 (C6-C10)	DLHM	L1660729-3, -4
Duplicate	Acetone	DLHM	L1660729-3, -4
Duplicate	Antimony (Sb)	DUP-H	L1660729-1, -2, -3, -4
Laboratory Control Sample	n-Hexane	MES	L1660729-3, -4
Matrix Spike	Acetone	MES	L1660729-3, -4
Matrix Spike	Dichlorodifluoromethane	MES	L1660729-3, -4

Sample Parameter Qualifier key listed:

Qualifier	Description
ABL	Approximate Result: May Be Biased Low
DLHM	Detection Limit Adjusted: Sample has High Moisture Content
DLUI	Detection Limit Raised: Unknown Interference generated an apparent false positive test result.
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.
MES	Data Quality Objective was marginally exceeded (by < 10% absolute) for < 10% of analytes in a Multi-Element Scan / Multi-Parameter Scan (considered acceptable as per OMOE & CCME).
RRR	Refer to Report Remarks for issues regarding this analysis
SOL:MI	Surrogate recovery outside acceptable limits due to matrix interference

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
B-HWS-R511-WT	Soil	Boron-HWE-O.Reg 153/04 (July 2011)	HW EXTR, EPA 6010B

A dried solid sample is extracted with calcium chloride, the sample undergoes a heating process. After cooling the sample is filtered and analyzed by ICP/OES.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

ALS Test Code	Matrix	Test Description	Method Reference**
CHLORDANE-T-CALC-WT	Soil	Chlordane Total sums	CALCULATION

Aqueous sample is extracted by liquid/liquid extraction with a solvent mix. After extraction, a number of clean up techniques may be applied, depending on the sample matrix and analyzed by GC/MS.

ALS Test Code	Matrix	Test Description	Method Reference**
CN-TCLP-WT	Waste	Cyanide for O. Reg 347	APHA 4500CN C E
CN-WAD-R511-WT	Soil	Cyanide (WAD)-O.Reg 153/04 (July 2011)	MOE 3015/APHA 4500CN I-WAD

The sample is extracted with a strong base for 16 hours, and then filtered. The filtrate is then distilled where the cyanide is converted to cyanogen chloride by reacting with chloramine-T, the cyanogen chloride then reacts with a combination of barbituric acid and isonicotinic acid to form a highly colored complex.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

ALS Test Code	Matrix	Test Description	Method Reference**
CR-CR6-IC-WT	Soil	Hexavalent Chromium in Soil	SW846 3060A/7199

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846, Method 7199, published by the United States Environmental Protection Agency (EPA). The procedure involves analysis for chromium (VI) by ion chromatography using diphenylcarbazide in a sulphuric acid solution.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

ALS Test Code	Matrix	Test Description	Method Reference**
DDD-DDE-DDT-CALC-WT	Soil	DDD, DDE, DDT sums	CALCULATION

Aqueous sample is extracted by liquid/liquid extraction with a solvent mix. After extraction, a number of clean up techniques may be applied, depending on the sample matrix and analyzed by GC/MS.

ALS Test Code	Matrix	Test Description	Method Reference**
EC-R511-WT	Soil	Conductivity-O.Reg 153/04 (July 2011)	MOEE E3138

A representative subsample is tumbled with de-ionized (DI) water. The ratio of water to soil is 2:1 v/w. After tumbling the sample is then analyzed by a conductivity meter.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

ALS Test Code	Matrix	Test Description	Method Reference**
ENDOSULFAN-T-CALC-WT	Soil	Endosulfan Total sums	CALCULATION

Reference Information

Aqueous sample is extracted by liquid/liquid extraction with a solvent mix. After extraction, a number of clean up techniques may be applied, depending on the sample matrix and analyzed by GC/MS.

F-TCLP-WT	Waste	Fluoride (F) for O. Reg 347	APHA 4110 B-Ion Chromatography
F1-F4-511-CALC-WT	Soil	F1-F4 Hydrocarbon Calculated Parameters	CCME CWS-PHC, Pub #1310, Dec 2001-S

Analytical methods used for analysis of CCME Petroleum Hydrocarbons have been validated and comply with the Reference Method for the CWS PHC.

Hydrocarbon results are expressed on a dry weight basis.

In cases where results for both F4 and F4G are reported, the greater of the two results must be used in any application of the CWS PHC guidelines and the gravimetric heavy hydrocarbons cannot be added to the C6 to C50 hydrocarbons.
In samples where BTEX and F1 were analyzed , F1-BTEX represents a value where the sum of Benzene, Toluene, Ethylbenzene and total Xylenes has been subtracted from F1.

In samples where PAHs, F2 and F3 were analyzed, F2-Naphth represents the result where Naphthalene has been subtracted from F2. F3-PAH represents a result where the sum of Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Dibenzo(a,h)anthracene, Fluoranthene, Indeno(1,2,3-cd)pyrene, Phenanthrene, and Pyrene has been subtracted from F3.

Unless otherwise qualified, the following quality control criteria have been met for the F1 hydrocarbon range:
1. All extraction and analysis holding times were met.
2. Instrument performance showing response factors for C6 and C10 within 30% of the response factor for toluene.
3. Linearity of gasoline response within 15% throughout the calibration range.

Unless otherwise qualified, the following quality control criteria have been met for the F2-F4 hydrocarbon ranges:
1. All extraction and analysis holding times were met.
2. Instrument performance showing C10, C16 and C34 response factors within 10% of their average.
3. Instrument performance showing the C50 response factor within 30% of the average of the C10, C16 and C34 response factors.
4. Linearity of diesel or motor oil response within 15% throughout the calibration range.

F1-HS-511-WT	Soil	F1-O.Reg 153/04 (July 2011)	E3398/CCME TIER 1-HS

Fraction F1 is determined by extracting a soil or sediment sample as received with methanol, then analyzing by headspace-GC/FID.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

F2-F4-511-WT	Soil	F2-F4-O.Reg 153/04 (July 2011)	MOE DECPH-E3398/CCME TIER 1

Fractions F2, F3 and F4 are determined by extracting a soil sample with a solvent mix. The solvent recovered from the extracted soil sample is dried and treated to remove polar material. The extract is analyzed by GC/FID.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

HG-200.2-CVAA-WT	Soil	Mercury in Soil by CVAAS	EPA 200.2/1631E (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAAS.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

HG-TCLP-WT	Waste	Mercury (CVAA) for O.Reg 347	SW846 7470A
LEACH-TCLP-WT	Waste	Leachate Procedure for Reg 347	EPA 1311

Inorganic and Semi-Volatile Organic contaminants are leached from waste samples in strict accordance with US EPA Method 1311, "Toxicity Characteristic Leaching Procedure" (TCLP). Test results are reported in leachate concentration units (normally mg/L).

MET-200.2-CCMS-WT	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CRC ICPMS.

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may be environmentally available. This method does not dissolve all silicate materials and may result in a partial extraction. depending on the sample matrix, for some metals, including, but not limited to Al, Ba, Be, Cr, Sr, Ti, Tl, and V.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

MET-TCLP-WT	Waste	O.Reg 347 TCLP Leachable Metals	EPA 200.8

Reference Information

METHYLNAPS-CALC-WT	Soil	ABN-Calculated Parameters	SW846 8270
MOISTURE-WT	Soil	% Moisture	Gravimetric: Oven Dried
N2N3-TCLP-WT	Waste	Nitrate/Nitrite-N for O. Reg 347	APHA 4110 B-Ion Chromatography
PAH-511-WT	Soil	PAH-O.Reg 153/04 (July 2011)	SW846 3510/8270

A representative sub-sample of soil is fortified with deuterium-labelled surrogates and a mechanical shaking techniqueis used to extract the sample with a mixture of methanol and toluene. The extracts are concentrated and analyzed by GC/MS. Depending on the analytical GC/MS column used benzo(j)fluoranthene may chromatographically co-elute with benzo(b)fluoranthene or benzo(k)fluoranthene.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

PEST-OC-511-WT	Soil	OC Pesticides-O.Reg 153/04 (July 2011)	SW846 8270 (511)

Soil sample is extracted in a solvent, after extraction a number of clean up techniques may be applied, depending on the sample matrix and analyzed by GC/MS.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

PH-R511-WT	Soil	pH-O.Reg 153/04 (July 2011)	MOEE E3137A

A minimum 10g portion of the sample is extracted with 20mL of 0.01M calcium chloride solution by shaking for at least 30 minutes. The aqueous layer is separated from the soil and then analyzed using a pH meter and electrode.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

SAR-R511-WT	Soil	SAR-O.Reg 153/04 (July 2011)	SW846 6010C

A dried, disaggregated solid sample is extracted with deionized water, the aqueous extract is separated from the solid, acidified and then analyzed using a ICP/OES.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011).

VOC-1,3-DCP-CALC-WT	Soil	Regulation 153 VOCs	SW8260B/SW8270C
VOC-511-HS-WT	Soil	VOC-O.Reg 153/04 (July 2011)	SW846 8260 (511)

Soil and sediment samples are extracted in methanol and analyzed by headspace-GC/MS.

Analysis conducted in accordance with the Protocol for Analytical Methods Used in the Assessment of Properties under Part XV.1 of the Environmental Protection Act (July 1, 2011), unless a subset of the Analytical Test Group (ATG) has been requested (the Protocol states that all analytes in an ATG must be reported).

XYLENES-SUM-CALC-WT	Soil	Sum of Xylene Isomer Concentrations	CALCULATION

Total xylenes represents the sum of o-xylene and m&p-xylene.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
WT	ALS ENVIRONMENTAL - WATERLOO, ONTARIO, CANADA

Chain of Custody Numbers:

Reference Information

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid weight of sample
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3
Contact: David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
B-HWS-R511-WT	**Soil**							
Batch R3256801								
WG2160183-3 DUP		**L1662898-1**						
Boron (B), Hot Water Ext.		0.21	0.20		ug/g	8.0	40	29-AUG-15
WG2160183-2 IRM		**SALINITY_SOIL4**						
Boron (B), Hot Water Ext.			86.5		%		70-130	29-AUG-15
WG2160183-1 MB								
Boron (B), Hot Water Ext.			<0.10		ug/g		0.1	29-AUG-15
WG2160183-4 MS		**L1662898-1**						
Boron (B), Hot Water Ext.			102.9		%		60-140	29-AUG-15
CN-WAD-R511-WT	**Soil**							
Batch R3252350								
WG2153548-3 DUP		**L1660281-10**						
Cyanide, Weak Acid Diss		<0.050	<0.050	RPD-NA	ug/g	N/A	35	21-AUG-15
WG2153548-2 LCS								
Cyanide, Weak Acid Diss			83.1		%		80-120	21-AUG-15
WG2153548-1 MB								
Cyanide, Weak Acid Diss			<0.050		ug/g		0.05	21-AUG-15
WG2153548-4 MS		**L1660281-10**						
Cyanide, Weak Acid Diss			92.4		%		70-130	21-AUG-15
Batch R3253230								
WG2157085-3 DUP		**L1659445-12**						
Cyanide, Weak Acid Diss		0.116	0.134		ug/g	15	35	25-AUG-15
WG2157085-2 LCS								
Cyanide, Weak Acid Diss			117.3		%		80-120	25-AUG-15
WG2157085-1 MB								
Cyanide, Weak Acid Diss			<0.050		ug/g		0.05	25-AUG-15
WG2157085-4 MS		**L1659445-12**						
Cyanide, Weak Acid Diss			106.5		%		70-130	25-AUG-15
CR-CR6-IC-WT	**Soil**							
Batch R3250857								
WG2153601-4 CRM		**WT-SQC012**						
Chromium, Hexavalent			75.3		%		70-130	21-AUG-15
WG2153601-3 DUP		**L1660312-16**						
Chromium, Hexavalent		<0.20	<0.20	RPD-NA	ug/g	N/A	35	21-AUG-15
WG2153601-2 LCS								
Chromium, Hexavalent			94.6		%		80-120	21-AUG-15
WG2153601-1 MB								
Chromium, Hexavalent			<0.20		ug/g		0.2	21-AUG-15

Quality Control Report

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3
Contact: David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
EC-R511-WT	**Soil**							
Batch R3256335								
WG2160189-4	**DUP**	**WG2160189-3**						
Conductivity		0.174	0.176		mS/cm	1.1	20	29-AUG-15
WG2160489-1	**LCS**							
Conductivity			100.0		%		90-110	29-AUG-15
WG2160189-1	**MB**							
Conductivity			<0.0040		mS/cm		0.044	29-AUG-15
F1-HS-511-WT	**Soil**							
Batch R3252144								
WG2154427-3	**DUP**	**WG2154427-5**						
F1 (C6-C10)		<5.0	<5.0	RPD-NA	ug/g	N/A	50	24-AUG-15
WG2154427-2	**LCS**							
F1 (C6-C10)			80.9		%		80-120	24-AUG-15
WG2154427-1	**MB**							
F1 (C6-C10)			<5.0		ug/g		5	24-AUG-15
Surrogate: 3,4-Dichlorotoluene			74.3		%		60-140	24-AUG-15
WG2154427-7	**MS**	**WG2154427-6**						
F1 (C6-C10)			80.2		%		60-140	24-AUG-15
Batch R3252341								
WG2154724-3	**DUP**	**WG2154724-5**						
F1 (C6-C10)		<10	<10	RPD-NA	ug/g	N/A	50	26-AUG-15
WG2154724-2	**LCS**							
F1 (C6-C10)			83.4		%		80-120	24-AUG-15
WG2154724-1	**MB**							
F1 (C6-C10)			<5.0		ug/g		5	24-AUG-15
Surrogate: 3,4-Dichlorotoluene			76.2		%		60-140	24-AUG-15
WG2154724-7	**MS**	**WG2154724-6**						
F1 (C6-C10)			76.7		%		60-140	26-AUG-15
F2-F4-511-WT	**Soil**							
Batch R3252895								
WG2153651-3	**CRM**	**ALS PHC2 IRM**						
F2 (C10-C16)			82.2		%		70-130	21-AUG-15
F3 (C16-C34)			90.6		%		70-130	21-AUG-15
F4 (C34-C50)			94.0		%		70-130	21-AUG-15
WG2153651-5	**DUP**	**WG2153651-4**						
F2 (C10-C16)		18	18		ug/g	2.9	40	21-AUG-15
F3 (C16-C34)		<50	<50	RPD-NA	ug/g	N/A	40	21-AUG-15
F4 (C34-C50)		<50	<50	RPD-NA	ug/g	N/A	40	21-AUG-15

Quality Control Report

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3
Contact: David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
F2-F4-511-WT	**Soil**							
Batch R3252895								
WG2153651-2 LCS								
F2 (C10-C16)			92.4		%		80-120	21-AUG-15
F3 (C16-C34)			106.2		%		80-120	21-AUG-15
F4 (C34-C50)			110.5		%		80-120	21-AUG-15
WG2153651-1 MB								
F2 (C10-C16)			<10		ug/g		10	21-AUG-15
F3 (C16-C34)			<50		ug/g		50	21-AUG-15
F4 (C34-C50)			<50		ug/g		50	21-AUG-15
Surrogate: 2-Bromobenzotrifluoride			82.8		%		60-140	21-AUG-15
HG-200.2-CVAA-WT	**Soil**							
Batch R3256457								
WG2160202-2 CRM		**WT-CANMET-TILL1**						
Mercury (Hg)			93.0		%		70-130	30-AUG-15
WG2160202-6 DUP		**WG2160202-5**						
Mercury (Hg)		0.0504	0.0517		ug/g	2.6	40	30-AUG-15
WG2160202-4 LCS								
Mercury (Hg)			98.5		%		80-120	30-AUG-15
WG2160202-1 MB								
Mercury (Hg)			<0.0050		mg/kg		0.005	30-AUG-15
MET-200.2-CCMS-WT	**Soil**							
Batch R3257094								
WG2160202-2 CRM		**WT-CANMET-TILL1**						
Antimony (Sb)			93.7		%		70-130	31-AUG-15
Arsenic (As)			102.4		%		70-130	31-AUG-15
Barium (Ba)			103.6		%		70-130	31-AUG-15
Beryllium (Be)			103.5		%		70-130	31-AUG-15
Cadmium (Cd)			89.4		%		70-130	31-AUG-15
Chromium (Cr)			103.9		%		70-130	31-AUG-15
Cobalt (Co)			101.5		%		70-130	31-AUG-15
Copper (Cu)			96.7		%		70-130	31-AUG-15
Lead (Pb)			85.9		%		70-130	31-AUG-15
Molybdenum (Mo)			97.9		%		70-130	31-AUG-15
Nickel (Ni)			100.4		%		70-130	31-AUG-15
Selenium (Se)			96.4		%		70-130	31-AUG-15
Silver (Ag)			96.0		%		70-130	31-AUG-15
Thallium (Tl)			87.7		%		70-130	31-AUG-15

Quality Control Report

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3

Contact: David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-WT	**Soil**							
Batch R3257094								
WG2160202-2 CRM		**WT-CANMET-TILL1**						
Uranium (U)			101.2		%		70-130	31-AUG-15
Vanadium (V)			109.0		%		70-130	31-AUG-15
Zinc (Zn)			100.2		%		70-130	31-AUG-15
WG2160202-6 DUP		**WG2160202-5**						
Antimony (Sb)		4.41	2.61	DUP-H	ug/g	51	30	31-AUG-15
Arsenic (As)		12.4	14.5		ug/g	16	30	31-AUG-15
Barium (Ba)		72.9	72.1		ug/g	1.1	40	31-AUG-15
Beryllium (Be)		0.50	0.47		ug/g	5.0	30	31-AUG-15
Boron (B)		5.6	5.9		ug/g	4.5	30	31-AUG-15
Cadmium (Cd)		0.484	0.574		ug/g	17	30	31-AUG-15
Chromium (Cr)		59.1	60.3		ug/g	2.1	30	31-AUG-15
Cobalt (Co)		16.6	16.6		ug/g	0.4	30	31-AUG-15
Copper (Cu)		59.2	56.4		ug/g	4.7	30	31-AUG-15
Lead (Pb)		25.9	26.6		ug/g	2.6	40	31-AUG-15
Molybdenum (Mo)		4.59	4.47		ug/g	2.7	40	31-AUG-15
Nickel (Ni)		81.9	86.9		ug/g	5.9	30	31-AUG-15
Selenium (Se)		<0.20	<0.20	RPD-NA	ug/g	N/A	30	31-AUG-15
Silver (Ag)		1.10	1.60		ug/g	36	40	31-AUG-15
Thallium (Tl)		0.116	0.119		ug/g	2.6	30	31-AUG-15
Uranium (U)		0.821	0.891		ug/g	8.2	30	31-AUG-15
Vanadium (V)		101	96.1		ug/g	4.8	30	31-AUG-15
Zinc (Zn)		83.8	80.7		ug/g	3.7	30	31-AUG-15
WG2160202-3 LCS								
Antimony (Sb)			98.1		%		80-120	31-AUG-15
Arsenic (As)			94.6		%		80-120	31-AUG-15
Barium (Ba)			99.7		%		80-120	31-AUG-15
Beryllium (Be)			103.2		%		80-120	31-AUG-15
Boron (B)			101.0		%		80-120	31-AUG-15
Cadmium (Cd)			102.8		%		80-120	31-AUG-15
Chromium (Cr)			93.2		%		80-120	31-AUG-15
Cobalt (Co)			93.7		%		80-120	31-AUG-15
Copper (Cu)			93.6		%		80-120	31-AUG-15
Lead (Pb)			95.1		%		80-120	31-AUG-15

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3
Contact: David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-WT	**Soil**							
Batch R3257094								
WG2160202-3 LCS								
Molybdenum (Mo)			103.8		%		80-120	31-AUG-15
Nickel (Ni)			92.2		%		80-120	31-AUG-15
Selenium (Se)			94.6		%		80-120	31-AUG-15
Silver (Ag)			90.0		%		80-120	31-AUG-15
Thallium (Tl)			91.1		%		80-120	31-AUG-15
Uranium (U)			90.5		%		80-120	31-AUG-15
Vanadium (V)			96.1		%		80-120	31-AUG-15
Zinc (Zn)			94.1		%		80-120	31-AUG-15
WG2160202-1 MB								
Antimony (Sb)			<0.10		mg/kg		0.1	31-AUG-15
Arsenic (As)			<0.10		mg/kg		0.1	31-AUG-15
Barium (Ba)			<0.50		mg/kg		0.5	31-AUG-15
Beryllium (Be)			<0.10		mg/kg		0.1	31-AUG-15
Boron (B)			<5.0		mg/kg		5	31-AUG-15
Cadmium (Cd)			<0.020		mg/kg		0.02	31-AUG-15
Chromium (Cr)			<0.50		mg/kg		0.5	31-AUG-15
Cobalt (Co)			<0.10		mg/kg		0.1	31-AUG-15
Copper (Cu)			<0.50		mg/kg		0.5	31-AUG-15
Lead (Pb)			<0.50		mg/kg		0.5	31-AUG-15
Molybdenum (Mo)			<0.10		mg/kg		0.1	31-AUG-15
Nickel (Ni)			<0.50		mg/kg		0.5	31-AUG-15
Selenium (Se)			<0.20		mg/kg		0.2	31-AUG-15
Silver (Ag)			<0.10		mg/kg		0.1	31-AUG-15
Thallium (Tl)			<0.050		mg/kg		0.05	31-AUG-15
Uranium (U)			<0.050		mg/kg		0.05	31-AUG-15
Vanadium (V)			<0.20		mg/kg		0.2	31-AUG-15
Zinc (Zn)			<2.0		mg/kg		2	31-AUG-15
MOISTURE-WT	**Soil**							
Batch R3250064								
WG2153723-3 DUP		**L1659744-10**						
% Moisture		5.16	5.05		%	2.1	20	21-AUG-15
WG2153723-2 LCS								
% Moisture			99.9		%		90-110	21-AUG-15
WG2153723-1 MB								

Quality Control Report

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3
Contact: David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MOISTURE-WT	**Soil**							
Batch R3250064								
WG2153723-1 MB								
% Moisture			<0.10		%		0.1	21-AUG-15
PAH-511-WT	**Soil**							
Batch R3254254								
WG2153749-5 DUP		**WG2153749-4**						
1-Methylnaphthalene		<0.030	<0.030	RPD-NA	ug/g	N/A	40	26-AUG-15
2-Methylnaphthalene		<0.030	<0.030	RPD-NA	ug/g	N/A	40	26-AUG-15
Acenaphthene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	26-AUG-15
Acenaphthylene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	26-AUG-15
Anthracene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	26-AUG-15
Benzo(a)anthracene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	26-AUG-15
Benzo(a)pyrene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	26-AUG-15
Benzo(b)fluoranthene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	26-AUG-15
Benzo(g,h,i)perylene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	26-AUG-15
Benzo(k)fluoranthene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	26-AUG-15
Chrysene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	26-AUG-15
Dibenzo(ah)anthracene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	26-AUG-15
Fluoranthene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	26-AUG-15
Fluorene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	26-AUG-15
Indeno(1,2,3-cd)pyrene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	26-AUG-15
Naphthalene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	26-AUG-15
Phenanthrene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	26-AUG-15
Pyrene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	26-AUG-15
WG2153749-3 IRM		**ALS PAH1 RM**						
1-Methylnaphthalene			96.1		%		50-140	26-AUG-15
2-Methylnaphthalene			99.8		%		50-140	26-AUG-15
Acenaphthene			68.5		%		50-140	26-AUG-15
Acenaphthylene			109.1		%		50-140	26-AUG-15
Anthracene			72.3		%		50-140	26-AUG-15
Benzo(a)anthracene			103.7		%		50-140	26-AUG-15
Benzo(a)pyrene			96.5		%		50-140	26-AUG-15
Benzo(b)fluoranthene			101.3		%		50-140	26-AUG-15
Benzo(g,h,i)perylene			96.9		%		50-140	26-AUG-15
Benzo(k)fluoranthene			98.5				50-140	

Client:	ECOSYSTEM RECOVERY INC. 1023 Rife Road, Unit A Cambridge On N1R 5S3
Contact:	David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-511-WT	**Soil**							
Batch R3254254								
WG2153749-3 IRM		**ALS PAH1 RM**						
Benzo(k)fluoranthene			98.5		%		50-140	26-AUG-15
Chrysene			119.7		%		50-140	26-AUG-15
Dibenzo(ah)anthracene			124.3		%		50-140	26-AUG-15
Fluoranthene			111.8		%		50-140	26-AUG-15
Fluorene			69.2		%		50-140	26-AUG-15
Indeno(1,2,3-cd)pyrene			89.5		%		50-140	26-AUG-15
Naphthalene			93.5		%		50-140	26-AUG-15
Phenanthrene			103.2		%		50-140	26-AUG-15
Pyrene			109.1		%		50-140	26-AUG-15
WG2153749-2 LCS								
1-Methylnaphthalene			87.3		%		50-140	26-AUG-15
2-Methylnaphthalene			88.0		%		50-140	26-AUG-15
Acenaphthene			89.7		%		50-140	26-AUG-15
Acenaphthylene			90.2		%		50-140	26-AUG-15
Anthracene			89.7		%		50-140	26-AUG-15
Benzo(a)anthracene			86.3		%		50-140	26-AUG-15
Benzo(a)pyrene			93.3		%		50-140	26-AUG-15
Benzo(b)fluoranthene			88.5		%		50-140	26-AUG-15
Benzo(g,h,i)perylene			74.0		%		50-140	26-AUG-15
Benzo(k)fluoranthene			86.6		%		50-140	26-AUG-15
Chrysene			93.1		%		50-140	26-AUG-15
Dibenzo(ah)anthracene			80.8		%		50-140	26-AUG-15
Fluoranthene			87.9		%		50-140	26-AUG-15
Fluorene			90.2		%		50-140	26-AUG-15
Indeno(1,2,3-cd)pyrene			78.5		%		50-140	26-AUG-15
Naphthalene			87.6		%		50-140	26-AUG-15
Phenanthrene			87.4		%		50-140	26-AUG-15
Pyrene			93.3		%		50-140	26-AUG-15
WG2153749-1 MB								
1-Methylnaphthalene			<0.030		ug/g		0.03	26-AUG-15
2-Methylnaphthalene			<0.030		ug/g		0.03	26-AUG-15
Acenaphthene			<0.050		ug/g		0.05	26-AUG-15
Acenaphthylene			<0.050		ug/g		0.05	26-AUG-15
Anthracene			<0.050		ug/g		0.05	26-AUG-15

Quality Control Report

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3

Contact: David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PAH-511-WT	**Soil**							
Batch R3254254								
WG2153749-1 MB								
Benzo(a)anthracene			<0.050		ug/g		0.05	26-AUG-15
Benzo(a)pyrene			<0.050		ug/g		0.05	26-AUG-15
Benzo(b)fluoranthene			<0.050		ug/g		0.05	26-AUG-15
Benzo(g,h,i)perylene			<0.050		ug/g		0.05	26-AUG-15
Benzo(k)fluoranthene			<0.050		ug/g		0.05	26-AUG-15
Chrysene			<0.050		ug/g		0.05	26-AUG-15
Dibenzo(ah)anthracene			<0.050		ug/g		0.05	26-AUG-15
Fluoranthene			<0.050		ug/g		0.05	26-AUG-15
Fluorene			<0.050		ug/g		0.05	26-AUG-15
Indeno(1,2,3-cd)pyrene			<0.050		ug/g		0.05	26-AUG-15
Naphthalene			<0.050		ug/g		0.05	26-AUG-15
Phenanthrene			<0.050		ug/g		0.05	26-AUG-15
Pyrene			<0.050		ug/g		0.05	26-AUG-15
Surrogate: 2-Fluorobiphenyl			89.4		%		50-140	26-AUG-15
Surrogate: p-Terphenyl d14			85.3		%		50-140	26-AUG-15
PEST-OC-511-WT	**Soil**							
Batch R3252425								
WG2153809-4 DUP		**WG2153809-3**						
Aldrin		<0.020	<0.020	RPD-NA	ug/g	N/A	40	24-AUG-15
a-chlordane		<0.020	<0.020	RPD-NA	ug/g	N/A	40	24-AUG-15
g-chlordane		<0.020	<0.020	RPD-NA	ug/g	N/A	40	24-AUG-15
op-DDD		<0.020	<0.020	RPD-NA	ug/g	N/A	40	24-AUG-15
pp-DDD		<0.020	<0.020	RPD-NA	ug/g	N/A	40	24-AUG-15
o,p-DDE		<0.020	<0.020	RPD-NA	ug/g	N/A	40	24-AUG-15
pp-DDE		<0.020	<0.020	RPD-NA	ug/g	N/A	40	24-AUG-15
op-DDT		<0.020	<0.020	RPD-NA	ug/g	N/A	40	24-AUG-15
pp-DDT		<0.020	<0.020	RPD-NA	ug/g	N/A	40	24-AUG-15
Dieldrin		<0.020	<0.020	RPD-NA	ug/g	N/A	40	24-AUG-15
Endosulfan I		<0.020	<0.020	RPD-NA	ug/g	N/A	40	24-AUG-15
Endosulfan II		<0.020	<0.020	RPD-NA	ug/g	N/A	40	24-AUG-15
Endrin		<0.020	<0.020	RPD-NA	ug/g	N/A	40	24-AUG-15
gamma-hexachlorocyclohexane		<0.010	<0.010	RPD-NA	ug/g	N/A	40	24-AUG-15
Heptachlor		<0.020	<0.020	RPD-NA	ug/g	N/A	40	24-AUG-15

ALS Environmental

Quality Control Report

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3

Contact: David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PEST-OC-511-WT	**Soil**							
Batch R3252425								
WG2153809-4 DUP		**WG2153809-3**						
Heptachlor Epoxide		<0.020	<0.020	RPD-NA	ug/g	N/A	40	24-AUG-15
Hexachlorobenzene		<0.010	<0.010	RPD-NA	ug/g	N/A	40	24-AUG-15
Hexachlorobutadiene		<0.010	<0.010	RPD-NA	ug/g	N/A	40	24-AUG-15
Hexachloroethane		<0.010	<0.010	RPD-NA	ug/g	N/A	40	24-AUG-15
Methoxychlor		<0.020	<0.020	RPD-NA	ug/g	N/A	40	24-AUG-15
WG2153809-2 LCS								
Aldrin			99.8		%		50-140	24-AUG-15
a-chlordane			94.5		%		50-140	24-AUG-15
g-chlordane			98.4		%		50-140	24-AUG-15
op-DDD			92.4		%		50-140	24-AUG-15
pp-DDD			88.8		%		50-140	24-AUG-15
o,p-DDE			88.7		%		50-140	24-AUG-15
pp-DDE			94.0		%		50-140	24-AUG-15
op-DDT			86.8		%		50-140	24-AUG-15
pp-DDT			87.5		%		50-140	24-AUG-15
Dieldrin			89.8		%		50-140	24-AUG-15
Endosulfan I			89.3		%		50-140	24-AUG-15
Endosulfan II			106.5		%		50-140	24-AUG-15
Endrin			112.4		%		50-140	24-AUG-15
gamma-hexachlorocyclohexane			97.1		%		50-140	24-AUG-15
Heptachlor			96.2		%		50-140	24-AUG-15
Heptachlor Epoxide			89.5		%		50-140	24-AUG-15
Hexachlorobenzene			93.7		%		50-140	24-AUG-15
Hexachlorobutadiene			100.9		%		50-140	24-AUG-15
Hexachloroethane			99.9		%		50-140	24-AUG-15
Methoxychlor			95.1		%		50-140	24-AUG-15
WG2153809-1 MB								
Aldrin			<0.020		ug/g		0.02	24-AUG-15
a-chlordane			<0.020		ug/g		0.02	24-AUG-15
g-chlordane			<0.020		ug/g		0.02	24-AUG-15
op-DDD			<0.020		ug/g		0.02	24-AUG-15
pp-DDD			<0.020		ug/g		0.02	24-AUG-15
o,p-DDE			<0.020		ug/g		0.02	24-AUG-15
pp-DDE			<0.020		ug/g		0.02	24-AUG-15

Quality Control Report

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3
Contact: David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PEST-OC-511-WT	**Soil**							
Batch R3252425								
WG2153809-1	**MB**							
op-DDT			<0.020		ug/g		0.02	24-AUG-15
pp-DDT			<0.020		ug/g		0.02	24-AUG-15
Dieldrin			<0.020		ug/g		0.02	24-AUG-15
Endosulfan I			<0.020		ug/g		0.02	24-AUG-15
Endosulfan II			<0.020		ug/g		0.02	24-AUG-15
Endrin			<0.020		ug/g		0.02	24-AUG-15
gamma-hexachlorocyclohexane			<0.010		ug/g		0.01	24-AUG-15
Heptachlor			<0.020		ug/g		0.02	24-AUG-15
Heptachlor Epoxide			<0.020		ug/g		0.02	24-AUG-15
Hexachlorobenzene			<0.010		ug/g		0.01	24-AUG-15
Hexachlorobutadiene			<0.010		ug/g		0.01	24-AUG-15
Hexachloroethane			<0.010		ug/g		0.01	24-AUG-15
Methoxychlor			<0.020		ug/g		0.02	24-AUG-15
Surrogate: 2-Fluorobiphenyl			93.9		%		50-140	24-AUG-15
Surrogate: d14-Terphenyl			94.7		%		50-140	24-AUG-15
WG2153809-5	**MS**	**WG2153809-3**						
Aldrin			90.5		%		50-140	24-AUG-15
a-chlordane			76.6		%		50-140	24-AUG-15
g-chlordane			78.1		%		50-140	24-AUG-15
op-DDD			74.4		%		50-140	24-AUG-15
pp-DDD			89.6		%		50-140	24-AUG-15
o,p-DDE			74.2		%		50-140	24-AUG-15
pp-DDE			76.5		%		50-140	24-AUG-15
op-DDT			72.7		%		50-140	24-AUG-15
pp-DDT			80.2		%		50-140	24-AUG-15
Dieldrin			73.4		%		50-140	24-AUG-15
Endosulfan I			71.4		%		50-140	24-AUG-15
Endosulfan II			74.2		%		50-140	24-AUG-15
Endrin			100.5		%		50-150	24-AUG-15
gamma-hexachlorocyclohexane			80.0		%		50-140	24-AUG-15
Heptachlor			83.7		%		50-140	24-AUG-15
Heptachlor Epoxide			74.4		%		50-140	24-AUG-15
Hexachlorobenzene			79.9		%		50-140	24-AUG-15
Hexachlorobutadiene			85.2		%		50-140	24-AUG-15

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3
Contact: David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PEST-OC-511-WT	**Soil**							
Batch R3252425								
WG2153809-5 MS		**WG2153809-3**						
Hexachloroethane			84.7		%		50-140	24-AUG-15
Methoxychlor			85.0		%		50-140	24-AUG-15
PH-R511-WT	**Soil**							
Batch R3251697								
WG2154220-1 DUP		**L1660729-1**						
pH		6.87	6.83	J	pH units	0.04	0.3	22-AUG-15
WG2155305-2 LCS								
pH			7.05		pH units		6.7-7.3	22-AUG-15
SAR-R511-WT	**Soil**							
Batch R3256812								
WG2160189-4 DUP		**WG2160189-3**						
Calcium (Ca)		27.6	33.9		mg/L	21	40	29-AUG-15
Sodium (Na)		1.3	1.5		mg/L	14	40	29-AUG-15
Magnesium (Mg)		2.2	2.4		mg/L	10	40	29-AUG-15
WG2160189-2 IRM		**WT SAR1**						
Calcium (Ca)			109.3		%		70-130	29-AUG-15
Sodium (Na)			103.4		%		70-130	29-AUG-15
Magnesium (Mg)			106.3		%		70-130	29-AUG-15
WG2160189-1 MB								
Calcium (Ca)			<1.0		mg/L		1	29-AUG-15
Sodium (Na)			<1.0		mg/L		1	29-AUG-15
Magnesium (Mg)			<1.0		mg/L		1	29-AUG-15
VOC-511-HS-WT	**Soil**							
Batch R3252144								
WG2154427-3 DUP		**WG2154427-5**						
1,1,1,2-Tetrachloroethane		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
1,1,2,2-Tetrachloroethane		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
1,1,1-Trichloroethane		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
1,1,2-Trichloroethane		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
1,1-Dichloroethane		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
1,1-Dichloroethylene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
1,2-Dibromoethane		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
1,2-Dichlorobenzene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
1,2-Dichloroethane		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15

Quality Control Report

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3
Contact: David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
VOC-511-HS-WT	**Soil**							
Batch R3252144								
WG2154427-3 DUP		**WG2154427-5**						
1,2-Dichloropropane		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
1,3-Dichlorobenzene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
1,4-Dichlorobenzene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
Acetone		<0.50	<0.50	RPD-NA	ug/g	N/A	40	24-AUG-15
Benzene		<0.0068	<0.0068	RPD-NA	ug/g	N/A	40	24-AUG-15
Bromodichloromethane		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
Bromoform		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
Bromomethane		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
Carbon tetrachloride		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
Chlorobenzene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
Chloroform		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
cis-1,2-Dichloroethylene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
cis-1,3-Dichloropropene		<0.030	<0.030	RPD-NA	ug/g	N/A	40	24-AUG-15
Dibromochloromethane		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
Dichlorodifluoromethane		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
Ethylbenzene		<0.018	<0.018	RPD-NA	ug/g	N/A	40	24-AUG-15
n-Hexane		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
Methylene Chloride		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
MTBE		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
m+p-Xylenes		0.039	0.039		ug/g	0.6	40	24-AUG-15
Methyl Ethyl Ketone		<0.50	<0.50	RPD-NA	ug/g	N/A	40	24-AUG-15
Methyl Isobutyl Ketone		<0.50	<0.50	RPD-NA	ug/g	N/A	40	24-AUG-15
o-Xylene		0.038	0.037		ug/g	0.6	40	24-AUG-15
Styrene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
Tetrachloroethylene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
Toluene		<0.080	<0.080	RPD-NA	ug/g	N/A	40	24-AUG-15
trans-1,2-Dichloroethylene		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
trans-1,3-Dichloropropene		<0.030	<0.030	RPD-NA	ug/g	N/A	40	24-AUG-15
Trichloroethylene		<0.010	<0.010	RPD-NA	ug/g	N/A	40	24-AUG-15
Trichlorofluoromethane		<0.050	<0.050	RPD-NA	ug/g	N/A	40	24-AUG-15
Vinyl chloride		<0.020	<0.020	RPD-NA	ug/g	N/A	40	24-AUG-15
WG2154427-2 LCS								
1,1,1,2-Tetrachloroethane			101.0		%		60-130	24-AUG-15

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3
Contact: David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
VOC-511-HS-WT	**Soil**							
Batch R3252144								
WG2154427-2 LCS								
1,1,2,2-Tetrachloroethane			114.8		%		60-130	24-AUG-15
1,1,1-Trichloroethane			105.1		%		60-130	24-AUG-15
1,1,2-Trichloroethane			106.0		%		60-130	24-AUG-15
1,1-Dichloroethane			82.0		%		60-130	24-AUG-15
1,1-Dichloroethylene			89.4		%		60-130	24-AUG-15
1,2-Dibromoethane			99.6		%		70-130	24-AUG-15
1,2-Dichlorobenzene			100.5		%		70-130	24-AUG-15
1,2-Dichloroethane			106.9		%		60-130	24-AUG-15
1,2-Dichloropropane			109.7		%		70-130	24-AUG-15
1,3-Dichlorobenzene			97.2		%		70-130	24-AUG-15
1,4-Dichlorobenzene			98.2		%		70-130	24-AUG-15
Acetone			116.7		%		60-140	24-AUG-15
Benzene			101.0		%		70-130	24-AUG-15
Bromodichloromethane			108.4		%		50-140	24-AUG-15
Bromoform			113.4		%		70-130	24-AUG-15
Bromomethane			98.8		%		50-140	24-AUG-15
Carbon tetrachloride			103.6		%		70-130	24-AUG-15
Chlorobenzene			98.2		%		70-130	24-AUG-15
Chloroform			104.0		%		70-130	24-AUG-15
cis-1,2-Dichloroethylene			102.0		%		70-130	24-AUG-15
cis-1,3-Dichloropropene			101.4		%		70-130	24-AUG-15
Dibromochloromethane			105.8		%		60-130	24-AUG-15
Dichlorodifluoromethane			75.6		%		50-140	24-AUG-15
Ethylbenzene			91.7		%		70-130	24-AUG-15
n-Hexane			103.8		%		70-130	24-AUG-15
Methylene Chloride			104.9		%		70-130	24-AUG-15
MTBE			102.1		%		70-130	24-AUG-15
m+p-Xylenes			94.6		%		70-130	24-AUG-15
Methyl Ethyl Ketone			105.6		%		60-140	24-AUG-15
Methyl Isobutyl Ketone			119.1		%		60-140	24-AUG-15
o-Xylene			103.2		%		70-130	24-AUG-15
Styrene			106.9		%		70-130	24-AUG-15
Tetrachloroethylene			108.4		%		60-130	24-AUG-15

Quality Control Report

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3
Contact: David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
VOC-511-HS-WT	**Soil**							
Batch R3252144								
WG2154427-2 LCS								
Toluene			108.9		%		70-130	24-AUG-15
trans-1,2-Dichloroethylene			101.3		%		60-130	24-AUG-15
trans-1,3-Dichloropropene			99.2		%		70-130	24-AUG-15
Trichloroethylene			103.5		%		60-130	24-AUG-15
Trichlorofluoromethane			105.2		%		50-140	24-AUG-15
Vinyl chloride			93.0		%		60-140	24-AUG-15
WG2154427-1 MB								
1,1,1,2-Tetrachloroethane			<0.050		ug/g		0.05	24-AUG-15
1,1,2,2-Tetrachloroethane			<0.050		ug/g		0.05	24-AUG-15
1,1,1-Trichloroethane			<0.050		ug/g		0.05	24-AUG-15
1,1,2-Trichloroethane			<0.050		ug/g		0.05	24-AUG-15
1,1-Dichloroethane			<0.050		ug/g		0.05	24-AUG-15
1,1-Dichloroethylene			<0.050		ug/g		0.05	24-AUG-15
1,2-Dibromoethane			<0.050		ug/g		0.05	24-AUG-15
1,2-Dichlorobenzene			<0.050		ug/g		0.05	24-AUG-15
1,2-Dichloroethane			<0.050		ug/g		0.05	24-AUG-15
1,2-Dichloropropane			<0.050		ug/g		0.05	24-AUG-15
1,3-Dichlorobenzene			<0.050		ug/g		0.05	24-AUG-15
1,4-Dichlorobenzene			<0.050		ug/g		0.05	24-AUG-15
Acetone			<0.50		ug/g		0.5	24-AUG-15
Benzene			<0.0068		ug/g		0.0068	24-AUG-15
Bromodichloromethane			<0.050		ug/g		0.05	24-AUG-15
Bromoform			<0.050		ug/g		0.05	24-AUG-15
Bromomethane			<0.050		ug/g		0.05	24-AUG-15
Carbon tetrachloride			<0.050		ug/g		0.05	24-AUG-15
Chlorobenzene			<0.050		ug/g		0.05	24-AUG-15
Chloroform			<0.050		ug/g		0.05	24-AUG-15
cis-1,2-Dichloroethylene			<0.050		ug/g		0.05	24-AUG-15
cis-1,3-Dichloropropene			<0.030		ug/g		0.03	24-AUG-15
Dibromochloromethane			<0.050		ug/g		0.05	24-AUG-15
Dichlorodifluoromethane			<0.050		ug/g		0.05	24-AUG-15
Ethylbenzene			<0.018		ug/g		0.018	24-AUG-15
n-Hexane			<0.050		ug/g		0.05	24-AUG-15
Methylene Chloride			<0.050		ug/g		0.05	24-AUG-15

Quality Control Report

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3
Contact: David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
VOC-511-HS-WT	**Soil**							
Batch R3252144								
WG2154427-1 MB								
MTBE			<0.050		ug/g		0.05	24-AUG-15
m+p-Xylenes			<0.030		ug/g		0.03	24-AUG-15
Methyl Ethyl Ketone			<0.50		ug/g		0.5	24-AUG-15
Methyl Isobutyl Ketone			<0.50		ug/g		0.5	24-AUG-15
o-Xylene			<0.020		ug/g		0.02	24-AUG-15
Styrene			<0.050		ug/g		0.05	24-AUG-15
Tetrachloroethylene			<0.050		ug/g		0.05	24-AUG-15
Toluene			<0.080		ug/g		0.08	24-AUG-15
trans-1,2-Dichloroethylene			<0.050		ug/g		0.05	24-AUG-15
trans-1,3-Dichloropropene			<0.030		ug/g		0.03	24-AUG-15
Trichloroethylene			<0.010		ug/g		0.01	24-AUG-15
Trichlorofluoromethane			<0.050		ug/g		0.05	24-AUG-15
Vinyl chloride			<0.020		ug/g		0.02	24-AUG-15
Surrogate: 1,4-Difluorobenzene			99.6		%		70-130	24-AUG-15
Surrogate: 4-Bromofluorobenzene			100.7		%		70-130	24-AUG-15
WG2154427-4 MS		**WG2154427-5**						
1,1,1,2-Tetrachloroethane			98.0		%		50-140	24-AUG-15
1,1,2,2-Tetrachloroethane			111.0		%		50-140	24-AUG-15
1,1,1-Trichloroethane			101.2		%		50-140	24-AUG-15
1,1,2-Trichloroethane			136.4		%		50-140	24-AUG-15
1,1-Dichloroethane			80.3		%		50-140	24-AUG-15
1,1-Dichloroethylene			80.6		%		50-140	24-AUG-15
1,2-Dibromoethane			112.7		%		50-140	24-AUG-15
1,2-Dichlorobenzene			99.8		%		50-140	24-AUG-15
1,2-Dichloroethane			104.5		%		50-140	24-AUG-15
1,2-Dichloropropane			101.9		%		50-140	24-AUG-15
1,3-Dichlorobenzene			94.9		%		50-140	24-AUG-15
1,4-Dichlorobenzene			94.6		%		50-140	24-AUG-15
Acetone			74.9		%		50-140	24-AUG-15
Benzene			96.3		%		50-140	24-AUG-15
Bromodichloromethane			98.2		%		50-140	24-AUG-15
Bromoform			117.8		%		50-140	24-AUG-15
Bromomethane			82.0		%		50-140	24-AUG-15
Carbon tetrachloride			97.9		%		50-140	24-AUG-15

Quality Control Report

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3

Contact: David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
VOC-511-HS-WT	**Soil**							
Batch R3252144								
WG2154427-4 MS		**WG2154427-5**						
Chlorobenzene			99.2		%		50-140	24-AUG-15
Chloroform			100.4		%		50-140	24-AUG-15
cis-1,2-Dichloroethylene			100.3		%		50-140	24-AUG-15
cis-1,3-Dichloropropene			90.1		%		50-140	24-AUG-15
Dibromochloromethane			108.6		%		50-140	24-AUG-15
Dichlorodifluoromethane			62.4		%		50-140	24-AUG-15
Ethylbenzene			91.4		%		50-140	24-AUG-15
n-Hexane			93.3		%		50-140	24-AUG-15
Methylene Chloride			97.0		%		50-140	24-AUG-15
MTBE			99.3		%		50-140	24-AUG-15
m+p-Xylenes			93.8		%		50-140	24-AUG-15
Methyl Ethyl Ketone			107.8		%		50-140	24-AUG-15
Methyl Isobutyl Ketone			109.6		%		50-140	24-AUG-15
o-Xylene			97.9		%		50-140	24-AUG-15
Styrene			100.9		%		50-140	24-AUG-15
Tetrachloroethylene			109.4		%		50-140	24-AUG-15
Toluene			111.9		%		50-140	24-AUG-15
trans-1,2-Dichloroethylene			92.3		%		50-140	24-AUG-15
trans-1,3-Dichloropropene			117.1		%		50-140	24-AUG-15
Trichloroethylene			100.3		%		50-140	24-AUG-15
Trichlorofluoromethane			90.1		%		50-140	24-AUG-15
Vinyl chloride			76.3		%		50-140	24-AUG-15
Batch R3252341								
WG2154724-3 DUP		**WG2154724-5**						
1,1,1,2-Tetrachloroethane		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
1,1,2,2-Tetrachloroethane		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
1,1,1-Trichloroethane		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
1,1,2-Trichloroethane		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
1,1-Dichloroethane		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
1,1-Dichloroethylene		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
1,2-Dibromoethane		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
1,2-Dichlorobenzene		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
1,2-Dichloroethane		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15

Quality Control Report

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3
Contact: David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
VOC-511-HS-WT	**Soil**							
Batch R3252341								
WG2154724-3 DUP		**WG2154724-5**						
1,2-Dichloropropane		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
1,3-Dichlorobenzene		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
1,4-Dichlorobenzene		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
Acetone		<1.0	<1.0	RPD-NA	ug/g	N/A	40	26-AUG-15
Benzene		<0.014	<0.014	RPD-NA	ug/g	N/A	40	24-AUG-15
Bromodichloromethane		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
Bromoform		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
Bromomethane		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
Carbon tetrachloride		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
Chlorobenzene		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
Chloroform		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
cis-1,2-Dichloroethylene		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
cis-1,3-Dichloropropene		<0.060	<0.060	RPD-NA	ug/g	N/A	40	24-AUG-15
Dibromochloromethane		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
Dichlorodifluoromethane		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
Ethylbenzene		<0.036	<0.036	RPD-NA	ug/g	N/A	40	24-AUG-15
n-Hexane		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
Methylene Chloride		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
MTBE		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
m+p-Xylenes		<0.060	<0.060	RPD-NA	ug/g	N/A	40	24-AUG-15
Methyl Ethyl Ketone		<1.0	<1.0	RPD-NA	ug/g	N/A	40	24-AUG-15
Methyl Isobutyl Ketone		<1.0	<1.0	RPD-NA	ug/g	N/A	40	24-AUG-15
o-Xylene		<0.040	<0.040	RPD-NA	ug/g	N/A	40	24-AUG-15
Styrene		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
Tetrachloroethylene		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
Toluene		<0.16	<0.16	RPD-NA	ug/g	N/A	40	24-AUG-15
trans-1,2-Dichloroethylene		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
trans-1,3-Dichloropropene		<0.060	<0.060	RPD-NA	ug/g	N/A	40	24-AUG-15
Trichloroethylene		<0.020	<0.020	RPD-NA	ug/g	N/A	40	24-AUG-15
Trichlorofluoromethane		<0.10	<0.10	RPD-NA	ug/g	N/A	40	24-AUG-15
Vinyl chloride		<0.040	<0.040	RPD-NA	ug/g	N/A	40	24-AUG-15
WG2154724-2 LCS								
1,1,1,2-Tetrachloroethane			104.3		%		60-130	24-AUG-15

Environmental

Quality Control Report

Workorder: L1660729 Report Date: 04-SEP-15

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3
Contact: David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
VOC-511-HS-WT	**Soil**							
Batch R3252341								
WG2154724-2 LCS								
1,1,2,2-Tetrachloroethane			110.0		%		60-130	24-AUG-15
1,1,1-Trichloroethane			107.0		%		60-130	24-AUG-15
1,1,2-Trichloroethane			117.8		%		60-130	24-AUG-15
1,1-Dichloroethane			106.8		%		60-130	24-AUG-15
1,1-Dichloroethylene			111.0		%		60-130	24-AUG-15
1,2-Dibromoethane			108.3		%		70-130	24-AUG-15
1,2-Dichlorobenzene			110.0		%		70-130	24-AUG-15
1,2-Dichloroethane			107.5		%		60-130	24-AUG-15
1,2-Dichloropropane			123.9		%		70-130	24-AUG-15
1,3-Dichlorobenzene			105.5		%		70-130	24-AUG-15
1,4-Dichlorobenzene			107.4		%		70-130	24-AUG-15
Acetone			129.3		%		60-140	24-AUG-15
Benzene			119.8		%		70-130	24-AUG-15
Bromodichloromethane			104.8		%		50-140	24-AUG-15
Bromoform			95.4		%		70-130	24-AUG-15
Bromomethane			111.7		%		50-140	24-AUG-15
Carbon tetrachloride			101.2		%		70-130	24-AUG-15
Chlorobenzene			110.2		%		70-130	24-AUG-15
Chloroform			113.6		%		70-130	24-AUG-15
cis-1,2-Dichloroethylene			111.1		%		70-130	24-AUG-15
cis-1,3-Dichloropropene			108.5		%		70-130	24-AUG-15
Dibromochloromethane			104.0		%		60-130	24-AUG-15
Dichlorodifluoromethane			76.9		%		50-140	24-AUG-15
Ethylbenzene			104.4		%		70-130	24-AUG-15
n-Hexane			134.0	MES	%		70-130	24-AUG-15
Methylene Chloride			117.4		%		70-130	24-AUG-15
MTBE			105.2		%		70-130	24-AUG-15
m+p-Xylenes			108.4		%		70-130	24-AUG-15
Methyl Ethyl Ketone			119.7		%		60-140	24-AUG-15
Methyl Isobutyl Ketone			112.2		%		60-140	24-AUG-15
o-Xylene			103.0		%		70-130	24-AUG-15
Styrene			98.4		%		70-130	24-AUG-15
Tetrachloroethylene			102.6		%		60-130	24-AUG-15

Quality Control Report

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3
Contact: David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
VOC-511-HS-WT	**Soil**							
Batch R3252341								
WG2154724-2 LCS								
Toluene			110.5		%		70-130	24-AUG-15
trans-1,2-Dichloroethylene			123.0		%		60-130	24-AUG-15
trans-1,3-Dichloropropene			108.4		%		70-130	24-AUG-15
Trichloroethylene			101.9		%		60-130	24-AUG-15
Trichlorofluoromethane			110.8		%		50-140	24-AUG-15
Vinyl chloride			120.2		%		60-140	24-AUG-15
WG2154724-1 MB								
1,1,1,2-Tetrachloroethane			<0.050		ug/g		0.05	24-AUG-15
1,1,2,2-Tetrachloroethane			<0.050		ug/g		0.05	24-AUG-15
1,1,1-Trichloroethane			<0.050		ug/g		0.05	24-AUG-15
1,1,2-Trichloroethane			<0.050		ug/g		0.05	24-AUG-15
1,1-Dichloroethane			<0.050		ug/g		0.05	24-AUG-15
1,1-Dichloroethylene			<0.050		ug/g		0.05	24-AUG-15
1,2-Dibromoethane			<0.050		ug/g		0.05	24-AUG-15
1,2-Dichlorobenzene			<0.050		ug/g		0.05	24-AUG-15
1,2-Dichloroethane			<0.050		ug/g		0.05	24-AUG-15
1,2-Dichloropropane			<0.050		ug/g		0.05	24-AUG-15
1,3-Dichlorobenzene			<0.050		ug/g		0.05	24-AUG-15
1,4-Dichlorobenzene			<0.050		ug/g		0.05	24-AUG-15
Acetone			<0.50		ug/g		0.5	24-AUG-15
Benzene			<0.0068		ug/g		0.0068	24-AUG-15
Bromodichloromethane			<0.050		ug/g		0.05	24-AUG-15
Bromoform			<0.050		ug/g		0.05	24-AUG-15
Bromomethane			<0.050		ug/g		0.05	24-AUG-15
Carbon tetrachloride			<0.050		ug/g		0.05	24-AUG-15
Chlorobenzene			<0.050		ug/g		0.05	24-AUG-15
Chloroform			<0.050		ug/g		0.05	24-AUG-15
cis-1,2-Dichloroethylene			<0.050		ug/g		0.05	24-AUG-15
cis-1,3-Dichloropropene			<0.030		ug/g		0.03	24-AUG-15
Dibromochloromethane			<0.050		ug/g		0.05	24-AUG-15
Dichlorodifluoromethane			<0.050		ug/g		0.05	24-AUG-15
Ethylbenzene			<0.018		ug/g		0.018	24-AUG-15
n-Hexane			<0.050		ug/g		0.05	24-AUG-15
Methylene Chloride			<0.050		ug/g		0.05	24-AUG-15

Quality Control Report

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3

Contact: David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
VOC-511-HS-WT	**Soil**							
Batch R3252341								
WG2154724-1 MB								
MTBE			<0.050		ug/g		0.05	24-AUG-15
m+p-Xylenes			<0.030		ug/g		0.03	24-AUG-15
Methyl Ethyl Ketone			<0.50		ug/g		0.5	24-AUG-15
Methyl Isobutyl Ketone			<0.50		ug/g		0.5	24-AUG-15
o-Xylene			<0.020		ug/g		0.02	24-AUG-15
Styrene			<0.050		ug/g		0.05	24-AUG-15
Tetrachloroethylene			<0.050		ug/g		0.05	24-AUG-15
Toluene			<0.080		ug/g		0.08	24-AUG-15
trans-1,2-Dichloroethylene			<0.050		ug/g		0.05	24-AUG-15
trans-1,3-Dichloropropene			<0.030		ug/g		0.03	24-AUG-15
Trichloroethylene			<0.010		ug/g		0.01	24-AUG-15
Trichlorofluoromethane			<0.050		ug/g		0.05	24-AUG-15
Vinyl chloride			<0.020		ug/g		0.02	24-AUG-15
Surrogate: 1,4-Difluorobenzene			105.5		%		70-130	24-AUG-15
Surrogate: 4-Bromofluorobenzene			98.7		%		70-130	24-AUG-15
WG2154724-4 MS		**WG2154724-5**						
1,1,1,2-Tetrachloroethane			103.1		%		50-140	24-AUG-15
1,1,2,2-Tetrachloroethane			116.2		%		50-140	24-AUG-15
1,1,1-Trichloroethane			102.0		%		50-140	24-AUG-15
1,1,2-Trichloroethane			122.9		%		50-140	24-AUG-15
1,1-Dichloroethane			106.2		%		50-140	24-AUG-15
1,1-Dichloroethylene			100.5		%		50-140	24-AUG-15
1,2-Dibromoethane			113.0		%		50-140	24-AUG-15
1,2-Dichlorobenzene			106.2		%		50-140	24-AUG-15
1,2-Dichloroethane			114.2		%		50-140	24-AUG-15
1,2-Dichloropropane			126.2		%		50-140	24-AUG-15
1,3-Dichlorobenzene			98.0		%		50-140	24-AUG-15
1,4-Dichlorobenzene			101.0		%		50-140	24-AUG-15
Acetone			141.0	MES	%		50-140	24-AUG-15
Benzene			118.0		%		50-140	24-AUG-15
Bromodichloromethane			109.0		%		50-140	24-AUG-15
Bromoform			100.7		%		50-140	24-AUG-15
Bromomethane			103.5		%		50-140	24-AUG-15
Carbon tetrachloride			94.5		%		50-140	24-AUG-15

Quality Control Report

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3
Contact: David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
VOC-511-HS-WT	**Soil**							
Batch R3252341								
WG2154724-4 MS		**WG2154724-5**						
Chlorobenzene			107.1		%		50-140	24-AUG-15
Chloroform			114.6		%		50-140	24-AUG-15
cis-1,2-Dichloroethylene			110.5		%		50-140	24-AUG-15
cis-1,3-Dichloropropene			101.9		%		50-140	24-AUG-15
Dibromochloromethane			108.1		%		50-140	24-AUG-15
Dichlorodifluoromethane			40.9	MES	%		50-140	24-AUG-15
Ethylbenzene			90.9		%		50-140	24-AUG-15
n-Hexane			95.1		%		50-140	24-AUG-15
Methylene Chloride			120.3		%		50-140	24-AUG-15
MTBE			103.7		%		50-140	24-AUG-15
m+p-Xylenes			96.6		%		50-140	24-AUG-15
Methyl Ethyl Ketone			136.8		%		50-140	24-AUG-15
Methyl Isobutyl Ketone			124.9		%		50-140	24-AUG-15
o-Xylene			91.6		%		50-140	24-AUG-15
Styrene			87.1		%		50-140	24-AUG-15
Tetrachloroethylene			89.5		%		50-140	24-AUG-15
Toluene			100.9		%		50-140	24-AUG-15
trans-1,2-Dichloroethylene			115.2		%		50-140	24-AUG-15
trans-1,3-Dichloropropene			99.7		%		50-140	24-AUG-15
Trichloroethylene			95.6		%		50-140	24-AUG-15
Trichlorofluoromethane			92.7		%		50-140	24-AUG-15
Vinyl chloride			102.4		%		50-140	24-AUG-15
CN-TCLP-WT	**Waste**							
Batch R3252758								
WG2155995-3 DUP		**L1660225-1**						
Cyanide, Weak Acid Diss		<0.10	<0.10	RPD-NA	mg/L	N/A	20	24-AUG-15
WG2155995-2 LCS								
Cyanide, Weak Acid Diss			94.8		%		70-130	24-AUG-15
WG2155995-1 MB								
Cyanide, Weak Acid Diss			<0.10		mg/L		0.1	24-AUG-15
WG2155995-4 MS		**L1660225-1**						
Cyanide, Weak Acid Diss			91.0		%		50-150	24-AUG-15
F-TCLP-WT	**Waste**							

Quality Control Report

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3
Contact: David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
F-TCLP-WT	**Waste**							
Batch R3254613								
WG2157829-3 DUP		**L1660225-1**						
Fluoride (F)		<10	<10	RPD-NA	mg/L	N/A	30	26-AUG-15
WG2157829-2 LCS								
Fluoride (F)			90.2		%		70-130	26-AUG-15
WG2157829-1 MB								
Fluoride (F)			<10		mg/L		10	26-AUG-15
WG2157829-4 MS		**L1660225-1**						
Fluoride (F)			98.4		%		50-150	26-AUG-15
HG-TCLP-WT	**Waste**							
Batch R3252294								
WG2155827-3 DUP		**L1660225-1**						
Mercury (Hg)		<0.00010	<0.00010	RPD-NA	mg/L	N/A	50	24-AUG-15
WG2155827-2 LCS								
Mercury (Hg)			97.3		%		70-130	24-AUG-15
WG2155827-1 MB								
Mercury (Hg)			<0.00010		mg/L		0.0001	24-AUG-15
WG2155827-4 MS		**L1660225-1**						
Mercury (Hg)			94.3		%		50-140	24-AUG-15
MET-TCLP-WT	**Waste**							
Batch R3252744								
WG2155709-4 DUP		**WG2155709-3**						
Silver (Ag)		<0.0050	<0.0050	RPD-NA	mg/L	N/A	40	24-AUG-15
Arsenic (As)		0.096	0.093		mg/L	2.6	40	24-AUG-15
Boron (B)		<2.5	<2.5	RPD-NA	mg/L	N/A	40	24-AUG-15
Barium (Ba)		<0.50	<0.50	RPD-NA	mg/L	N/A	40	24-AUG-15
Cadmium (Cd)		<0.0050	<0.0050	RPD-NA	mg/L	N/A	40	24-AUG-15
Chromium (Cr)		<0.050	<0.050	RPD-NA	mg/L	N/A	40	24-AUG-15
Lead (Pb)		<0.050	<0.050	RPD-NA	mg/L	N/A	40	24-AUG-15
Selenium (Se)		<0.25	<0.25	RPD-NA	mg/L	N/A	40	24-AUG-15
Uranium (U)		<0.25	<0.25	RPD-NA	mg/L	N/A	40	24-AUG-15
WG2155709-2 LCS								
Silver (Ag)			102.4		%		70-130	24-AUG-15
Arsenic (As)			95.6		%		70-130	24-AUG-15
Boron (B)			91.6		%		70-130	24-AUG-15
Barium (Ba)			95.2		%		70-130	24-AUG-15
Cadmium (Cd)			95.5		%		70-130	24-AUG-15

Quality Control Report

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3
Contact: David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-TCLP-WT	**Waste**							
Batch R3252744								
WG2155709-2 LCS								
Chromium (Cr)			95.2		%		70-130	24-AUG-15
Lead (Pb)			97.2		%		70-130	24-AUG-15
Selenium (Se)			97.6		%		70-130	24-AUG-15
Uranium (U)			99.2		%		70-130	24-AUG-15
WG2155709-1 MB								
Silver (Ag)			<0.0050		mg/L		0.005	24-AUG-15
Arsenic (As)			<0.050		mg/L		0.05	24-AUG-15
Boron (B)			<2.5		mg/L		2.5	24-AUG-15
Barium (Ba)			<0.50		mg/L		0.5	24-AUG-15
Cadmium (Cd)			<0.0050		mg/L		0.005	24-AUG-15
Chromium (Cr)			<0.050		mg/L		0.05	24-AUG-15
Lead (Pb)			<0.050		mg/L		0.05	24-AUG-15
Selenium (Se)			<0.25		mg/L		0.25	24-AUG-15
Uranium (U)			<0.25		mg/L		0.25	24-AUG-15
WG2155709-5 MS		**WG2155709-3**						
Silver (Ag)			93.9		%		50-150	24-AUG-15
Arsenic (As)			102.0		%		50-150	24-AUG-15
Boron (B)			98.1		%		50-150	24-AUG-15
Barium (Ba)			99.1		%		50-150	24-AUG-15
Cadmium (Cd)			101.3		%		50-150	24-AUG-15
Chromium (Cr)			100.0		%		50-150	24-AUG-15
Lead (Pb)			98.9		%		50-150	24-AUG-15
Selenium (Se)			102.8		%		50-150	24-AUG-15
Uranium (U)			102.7		%		50-150	24-AUG-15
N2N3-TCLP-WT	**Waste**							
Batch R3254613								
WG2157829-3 DUP		**L1660225-1**						
Nitrate-N		<2.0	<2.0	RPD-NA	mg/L	N/A	30	26-AUG-15
Nitrite-N		<2.0	<2.0	RPD-NA	mg/L	N/A	30	26-AUG-15
WG2157829-2 LCS								
Nitrate-N			98.9		%		70-130	26-AUG-15
Nitrite-N			101.3		%		70-130	26-AUG-15
WG2157829-1 MB								
Nitrate-N			<2.0		mg/L		2	26-AUG-15

Quality Control Report

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3
Contact: David Arseneau

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
N2N3-TCLP-WT	**Waste**							
Batch R3254613								
WG2157829-1 MB								
Nitrite-N			<2.0		mg/L		2	26-AUG-15
WG2157829-4 MS		**L1660225-1**						
Nitrate-N			96.4		%		50-150	26-AUG-15
Nitrite-N			95.4		%		50-150	26-AUG-15

Quality Control Report

Workorder: L1660729 Report Date: 04-SEP-15

Client: ECOSYSTEM RECOVERY INC.
1023 Rife Road, Unit A
Cambridge On N1R 5S3
Contact: David Arseneau

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
DLHM	Detection Limit Adjusted: Sample has High Moisture Content
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.
J	Duplicate results and limits are expressed in terms of absolute difference.
MES	Data Quality Objective was marginally exceeded (by < 10% absolute) for < 10% of analytes in a Multi-Element Scan / Multi-Parameter Scan (considered acceptable as per OMOE & CCME).
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

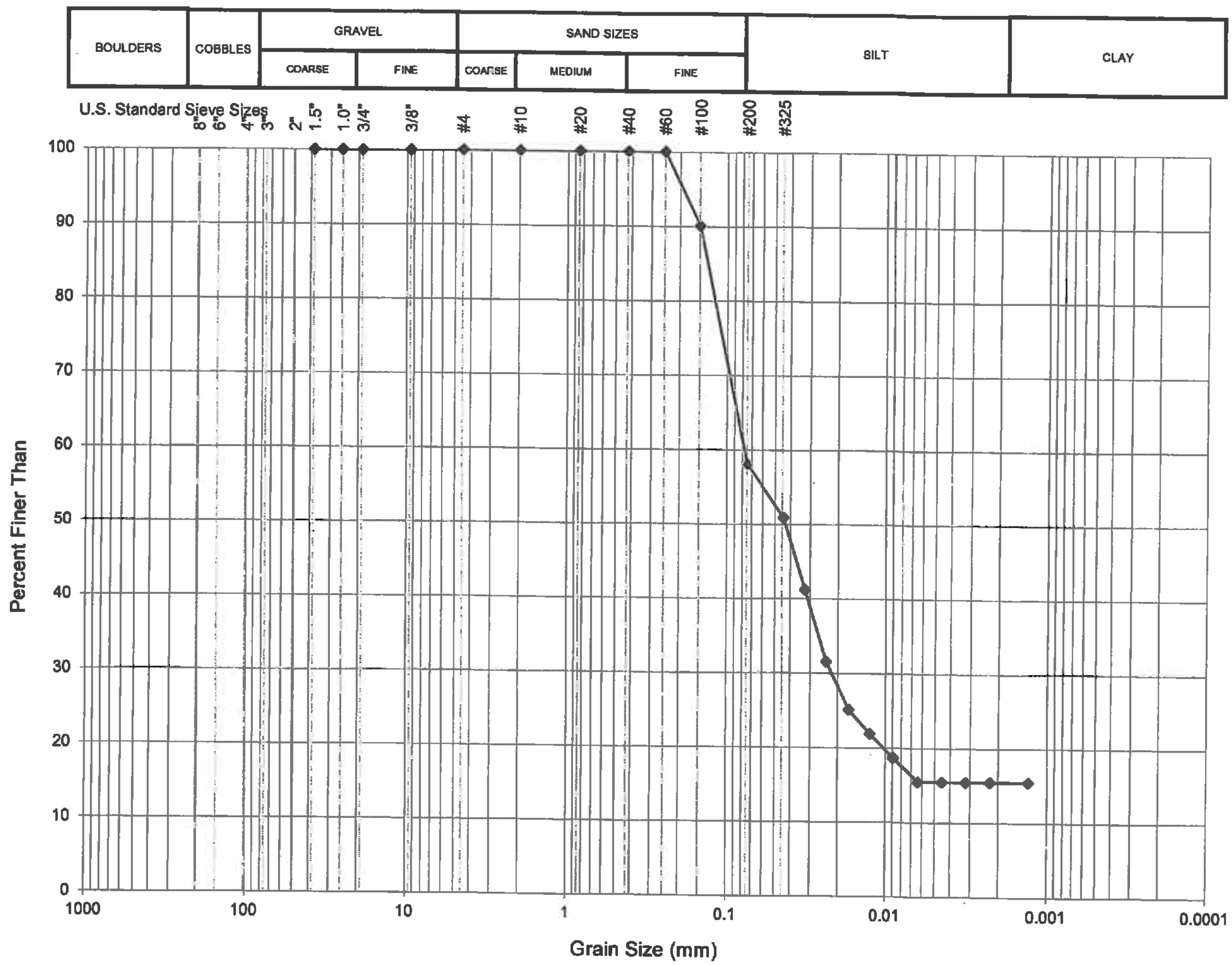
ALS Environmental

WATERLOO

PARTICLE SIZE DISTRIBUTION CURVE

ASTM METHOD D422-63

Project Name:	ECOSYSTEM RECOVERY INC
Project Number:	EP24780
Sample Location:	
Sample Number:	HAR U/S
Sample Depth:	
Lab ID Number:	L1660729-1
Technician:	MPBH
Sampler:	
Dates:	
Collected On:	8/20/2015
Analyzed:	9/3/2015



DESCRIPTION	SOIL CLASSIFICATION DESCRIPTIVE MODIFIERS		SUMMARY
SAND AND SILT WITH CLAY	AND	36 - 50 %	GRAVEL 0 %
Sample is Silica	ADJECTIVE (e.g. sandy)	21 - 35 %	SAND 42 %
ESTIMATED HAZEN NUMBER: 1.29E-05 cm/s	WITH	11 - 20 %	SILT + CLAY 58 %
NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM	TRACE	1 - 10 %	

GRAIN SIZE DETERMINATIONS

Project Name:	ECOSYSTEM RECOVERY INC	Sample Location:	
Project Number:	EP24780	Sample Number:	HAR U/S
Sampler:		Sample Depth:	
Technician:	MPBH	Date Sampled:	8/20/2015
Lab ID Number:	L1660729-1	Date Submitted:	8/20/2015
		Date Completed:	9/3/2015

Total Sample Weight	148 grams		Specific Gravity:	2.650
Hydro. Sample Weight	50.000 grams		Liquid Specific Gravity:	1.000
% Past #10	1.000 * 100		Grav Factor:	1.606
Sub Factor	2.960			

Sieve Size	Weight Retained (grams)	Percent Retained	Diameter (mm)	Cum. % Retained	Cum. % Passing
38.1 mm. DIA.:	0.000	0.000	38.100	0.000	100.000
25.4 mm. DIA.:	0.000	0.000	25.400	0.000	100.000
19.0 mm. DIA.:	0.000	0.000	19.000	0.000	100.000
9.5 mm. DIA.:	0.000	0.000	9.500	0.000	100.000
NO. 4 SIEVE :	0.000	0.000	4.500	0.000	100.000
NO. 10 SIEVE :	0.000	0.000	2.000	0.000	100.000
NO. 20 SIEVE :	0.000	0.000	0.850	0.000	100.000
NO. 40 SIEVE :	0.000	0.000	0.425	0.000	100.000
NO. 60 SIEVE :	0.000	0.000	0.250	0.000	100.000
NO. 100 SIEVE:	5.000	10.000	0.150	10.000	90.000
NO. 200 SIEVE:	16.000	32.000	0.075	42.000	58.000

Time (min)		Temperature (C)	Diameter (mm)	% Suspended (Subsample)	% Suspended (Total Sample)
1.00	18.0	23.7	0.044	50.821	50.821
2.00	15.0	23.7	0.032	41.184	41.184
4.00	12.0	23.7	0.024	31.548	31.548
8.00	10.0	23.7	0.017	25.124	25.124
15.00	9.0	23.7	0.013	21.911	21.911
30.00	8.0	23.7	0.009	18.699	18.699
60.00	7.0	23.7	0.006	15.487	15.487
120.00	7.0	23.7	0.005	15.487	15.487
240.00	7.0	23.7	0.003	15.487	15.487
480.00	7.0	23.7	0.002	15.487	15.487
1440.00	7.0	23.7	0.001	15.487	15.487

GRAIN SIZE	% BY WT.	DIA. RANGE (mm)
% GRAVEL :	0.00	> 4.5
% COARSE SAND :	0.00	2.0 - 4.5
% MEDIUM SAND :	0.00	0.425 - 2.0
% FINE SAND :	42.00	0.075 - 0.425
% SILT :	42.51	0.075 - 0.002
% CLAY :	15.49	< 0.002
% CLAY :	15.49	< 0.005

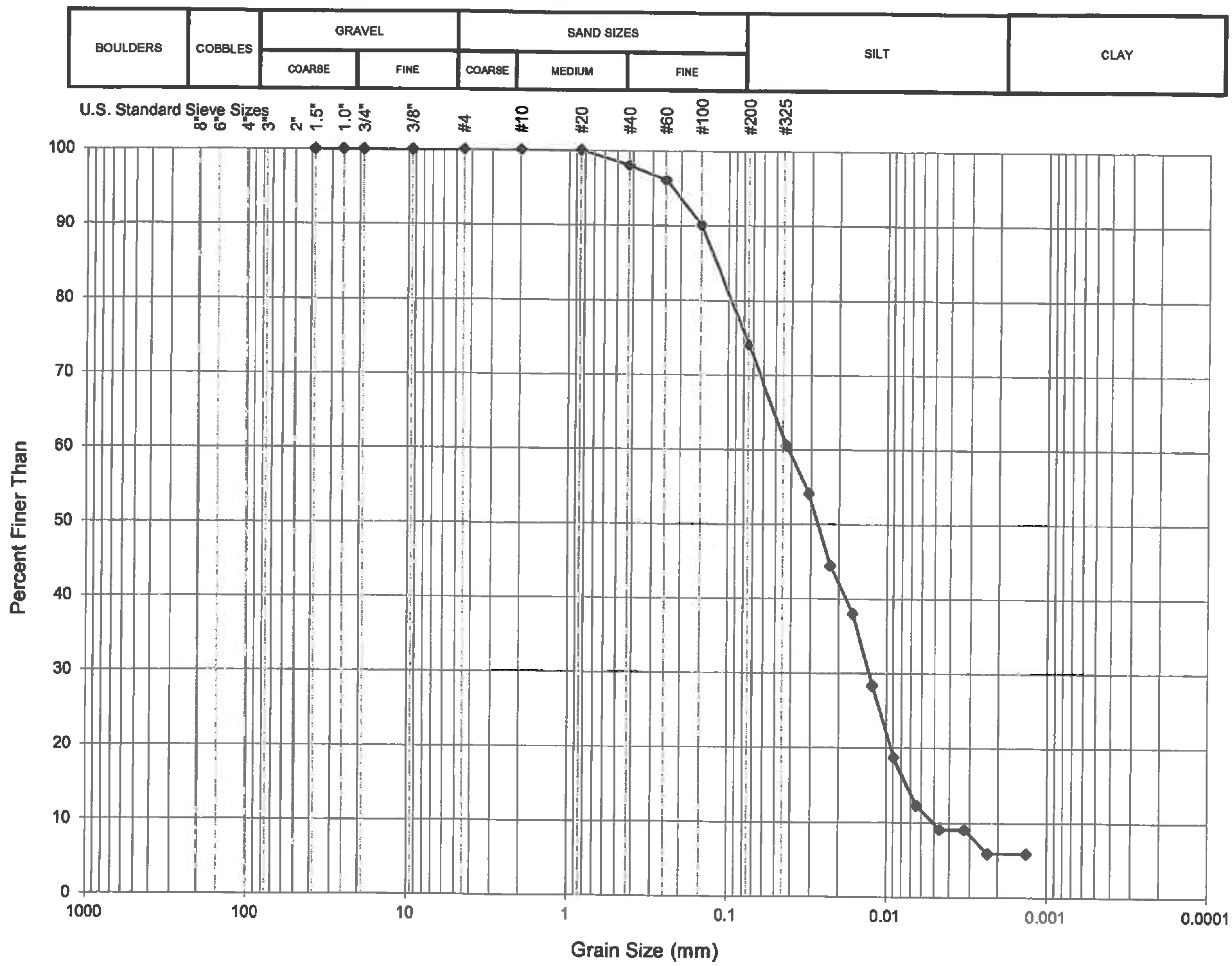
ALS Environmental

WATERLOO

PARTICLE SIZE DISTRIBUTION CURVE

ASTM METHOD D422-63

Project Name:	ECOSYSTEM RECOVERY INC
Project Number:	EP24780
Sample Location:	
Sample Number:	HAR D/S
Sample Depth:	
Lab ID Number:	L1660729-2
Technician:	MPBH
Sampler:	
Dates:	
Collected On:	8/20/2015
Analyzed:	9/3/2015



DESCRIPTION	SOIL CLASSIFICATION DESCRIPTIVE MODIFIERS		SUMMARY	
SANDY SILT, TRACE CLAY	AND	36 - 50 %	GRAVEL	0 %
	ADJECTIVE (e.g. sandy)	21 - 35 %	SAND	26 %
ESTIMATED HAZEN NUMBER: 2.58E-05 cm/s	WITH	11 - 20 %	SILT + CLAY	74 %
NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM	TRACE	1 - 10 %		

GRAIN SIZE DETERMINATIONS

Project Name:	ECOSYSTEM RECOVERY INC	Sample Location:	
Project Number:	EP24780	Sample Number:	HAR D/S
Sampler:		Sample Depth:	
Technician:	MPBH	Date Sampled:	8/20/2015
Lab ID Number:	L1660729-2	Date Submitted:	8/20/2015
		Date Completed:	9/3/2015

Total Sample Weight	112 grams	Specific Gravity:	2.650
Hydro. Sample Weight	50.000 grams	Liquid Specific Gravity:	1.000
% Past #10	1.000 * 100	Grav Factor:	1.606
Sub Factor	2.240		

Sieve Size	Weight Retained (grams)	Percent Retained	Diameter (mm)	Cum. % Retained	Cum. % Passing
38.1 mm. DIA.:	0.000	0.000	38.100	0.000	100.000
25.4 mm. DIA.:	0.000	0.000	25.400	0.000	100.000
19.0 mm. DIA.:	0.000	0.000	19.000	0.000	100.000
9.5 mm. DIA.:	0.000	0.000	9.500	0.000	100.000
NO. 4 SIEVE :	0.000	0.000	4.500	0.000	100.000
NO. 10 SIEVE :	0.000	0.000	2.000	0.000	100.000
NO. 20 SIEVE :	0.000	0.000	0.850	0.000	100.000
NO. 40 SIEVE :	1.000	2.000	0.425	2.000	98.000
NO. 60 SIEVE :	1.000	2.000	0.250	4.000	96.000
NO. 100 SIEVE:	3.000	6.000	0.150	10.000	90.000
NO. 200 SIEVE:	8.000	16.000	0.075	26.000	74.000

Time (min)		Temperature (C)	Diameter (mm)	% Suspended (Subsample)	% Suspended (Total Sample)
1.00	21.0	23.7	0.043	60.457	60.457
2.00	19.0	23.7	0.031	54.033	54.033
4.00	16.0	23.7	0.023	44.396	44.396
8.00	14.0	23.7	0.016	37.972	37.972
15.00	11.0	23.7	0.012	28.336	28.336
30.00	8.0	23.7	0.009	18.699	18.699
60.00	6.0	23.7	0.006	12.275	12.275
120.00	5.0	23.7	0.005	9.063	9.063
240.00	5.0	23.7	0.003	9.063	9.063
480.00	4.0	23.7	0.002	5.851	5.851
1440.00	4.0	23.7	0.001	5.851	5.851

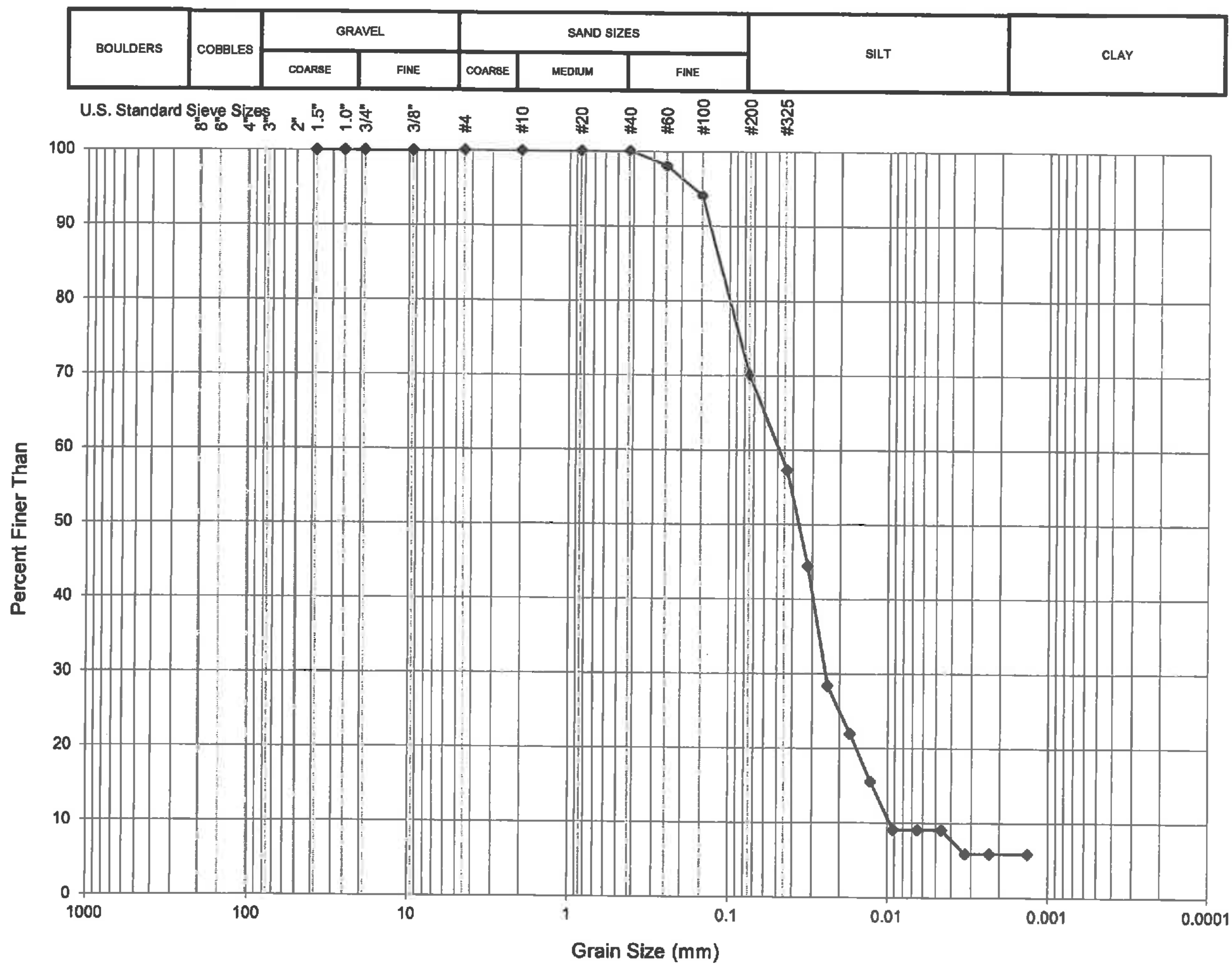
GRAIN SIZE	% BY WT.	DIA. RANGE (mm)
% GRAVEL :	0.00	> 4.5
% COARSE SAND :	0.00	2.0 - 4.5
% MEDIUM SAND :	2.00	0.425 - 2.0
% FINE SAND :	24.00	0.075 - 0.425
% SILT :	68.15	0.075 - 0.002
% CLAY :	5.85	< 0.002
% CLAY :	9.84	< 0.005

ALS Environmental
WATERLOO

PARTICLE SIZE DISTRIBUTION CURVE

ASTM METHOD D422-63

Project Name:	ECOSYSTEM RECOVERY INC
Project Number:	EP24780
Sample Location:	
Sample Number:	EMB U/S
Sample Depth:	
Lab ID Number:	L1660729-3
Technician:	MPBH
Sampler:	
Dates:	
Collected On:	8/20/2015
Analyzed:	9/3/2015



DESCRIPTION	SOIL CLASSIFICATION DESCRIPTIVE MODIFIERS		SUMMARY		
SANDY SILT, TRACE CLAY	AND	36 - 50 %	GRAVEL	0	%
	ADJECTIVE (e.g. sandy)	21 - 35 %	SAND	30	%
ESTIMATED HAZEN NUMBER: 9.35E-05 cm/s	WITH	11 - 20 %	SILT + CLAY	70	%
NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM	TRACE	1 - 10 %			

GRAIN SIZE DETERMINATIONS

Project Name:	ECOSYSTEM RECOVERY INC	Sample Location:	
Project Number:	EP24780	Sample Number:	EMB U/S
Sampler:		Sample Depth:	
Technician:	MPBH	Date Sampled:	8/20/2015
Lab ID Number:	L1660729-3	Date Submitted:	8/20/2015
		Date Completed:	9/3/2015

Total Sample Weight	159 grams		Specific Gravity:	2.650
Hydro. Sample Weight	50.000 grams		Liquid Specific Gravity:	1.000
% Past #10	1.000 * 100		Grav Factor:	1.606
Sub Factor	3.180			

Sieve Size	Weight Retained (grams)	Percent Retained	Diameter (mm)	Cum. % Retained	Cum. % Passing
38.1 mm. DIA.:	0.000	0.000	38.100	0.000	100.000
25.4 mm. DIA.:	0.000	0.000	25.400	0.000	100.000
19.0 mm. DIA.:	0.000	0.000	19.000	0.000	100.000
9.5 mm. DIA.:	0.000	0.000	9.500	0.000	100.000
NO. 4 SIEVE :	0.000	0.000	4.500	0.000	100.000
NO. 10 SIEVE :	0.000	0.000	2.000	0.000	100.000
NO. 20 SIEVE :	0.000	0.000	0.850	0.000	100.000
NO. 40 SIEVE :	0.000	0.000	0.425	0.000	100.000
NO. 60 SIEVE :	1.000	2.000	0.250	2.000	98.000
NO. 100 SIEVE:	2.000	4.000	0.150	6.000	94.000
NO. 200 SIEVE:	12.000	24.000	0.075	30.000	70.000

Time (min)		Temperature (C)	Diameter (mm)	% Suspended (Subsample)	% Suspended (Total Sample)
1.00	20.0	23.7	0.043	57.245	57.245
2.00	16.0	23.7	0.032	44.396	44.396
4.00	11.0	23.7	0.024	28.336	28.336
8.00	9.0	23.7	0.017	21.911	21.911
15.00	7.0	23.7	0.013	15.487	15.487
30.00	5.0	23.7	0.009	9.063	9.063
60.00	5.0	23.7	0.007	9.063	9.063
120.00	5.0	23.7	0.005	9.063	9.063
240.00	4.0	23.7	0.003	5.851	5.851
480.00	4.0	23.7	0.002	5.851	5.851
1440.00	4.0	23.7	0.001	5.851	5.851

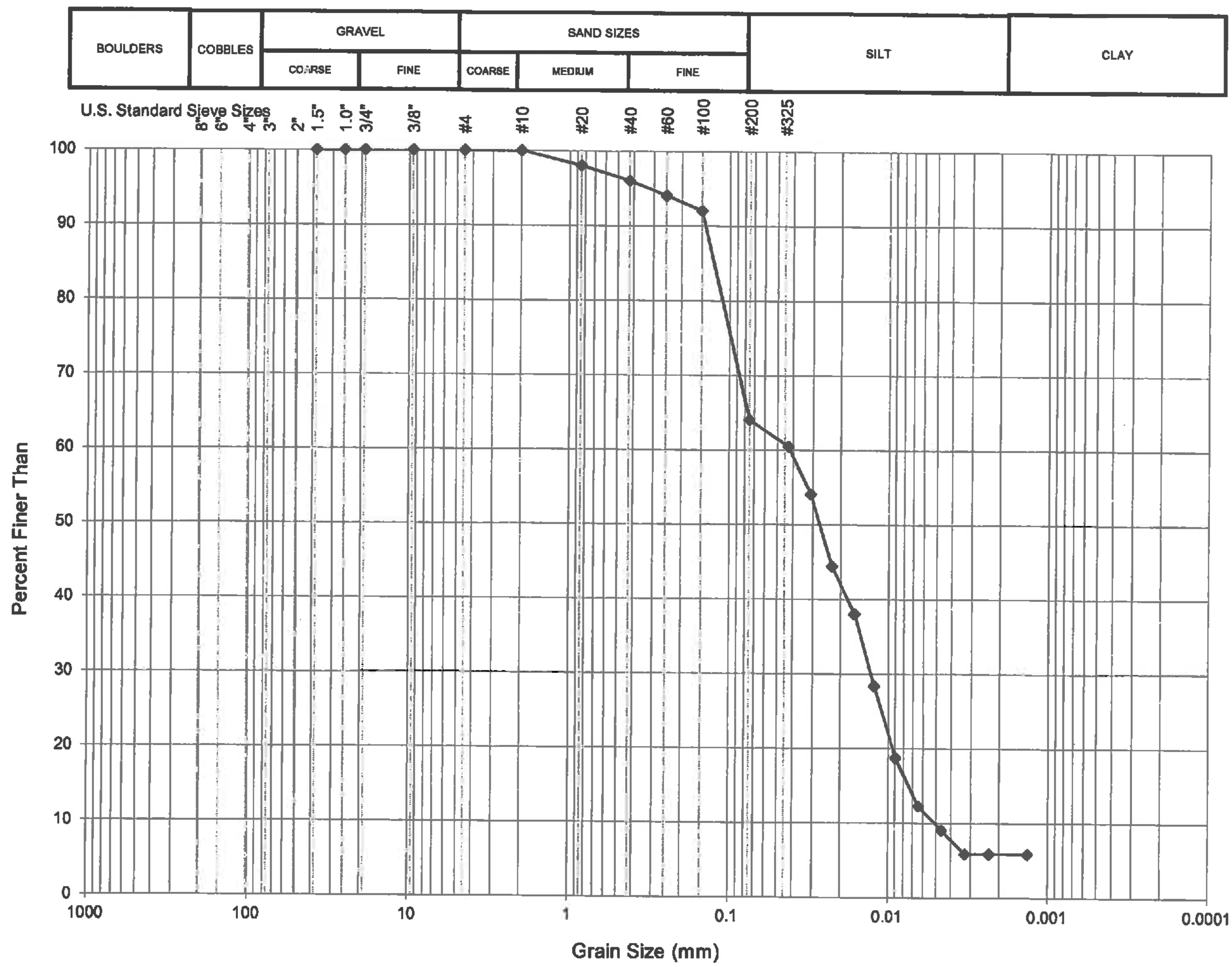
GRAIN SIZE	% BY WT.	DIA. RANGE (mm)
% GRAVEL :	0.00	> 4.5
% COARSE SAND :	0.00	2.0 - 4.5
% MEDIUM SAND :	0.00	0.425 - 2.0
% FINE SAND :	30.00	0.075 - 0.425
% SILT :	64.15	0.075 - 0.002
% CLAY :	5.85	< 0.002
% CLAY :	9.06	< 0.005

ALS Environmental
WATERLOO

PARTICLE SIZE DISTRIBUTION CURVE

ASTM METHOD D422-63

Project Name:	ECOSYSTEM RECOVERY INC
Project Number:	EP24780
Sample Location:	
Sample Number:	EMB D/S
Sample Depth:	
Lab ID Number:	L1660729-4
Technician:	MPBH
Sampler:	
Dates:	
Collected On:	8/20/2015
Analyzed:	9/3/2015



DESCRIPTION	**SOIL CLASSIFICATION DESCRIPTIVE MODIFIERS**		**SUMMARY**		
SILT AND CLAY, TRACE CLAY	AND	36 - 50 %	GRAVEL	0	%
	ADJECTIVE (e.g. sandy)	21 - 35 %	SAND	36	%
ESTIMATED HAZEN NUMBER: 2.58E-05 cm/s	WITH	11 - 20 %	SILT + CLAY	64	%
NOTE: UNIFIED SOIL CLASSIFICATION SYSTEM	TRACE	1 - 10 %			

GRAIN SIZE DETERMINATIONS

Project Name:	ECOSYSTEM RECOVERY INC	Sample Location:	
Project Number:	EP24780	Sample Number:	EMB D/S
Sampler:		Sample Depth:	
Technician:	MPBH	Date Sampled:	8/20/2015
Lab ID Number:	L1660729-4	Date Submitted:	8/20/2015
		Date Completed:	9/3/2015

Total Sample Weight	173	grams	Specific Gravity:	2.650
Hydro. Sample Weight	50.000	grams	Liquid Specific Gravity:	1.000
% Past #10	1.000	* 100	Grav Factor:	1.606
Sub Factor	3.460			

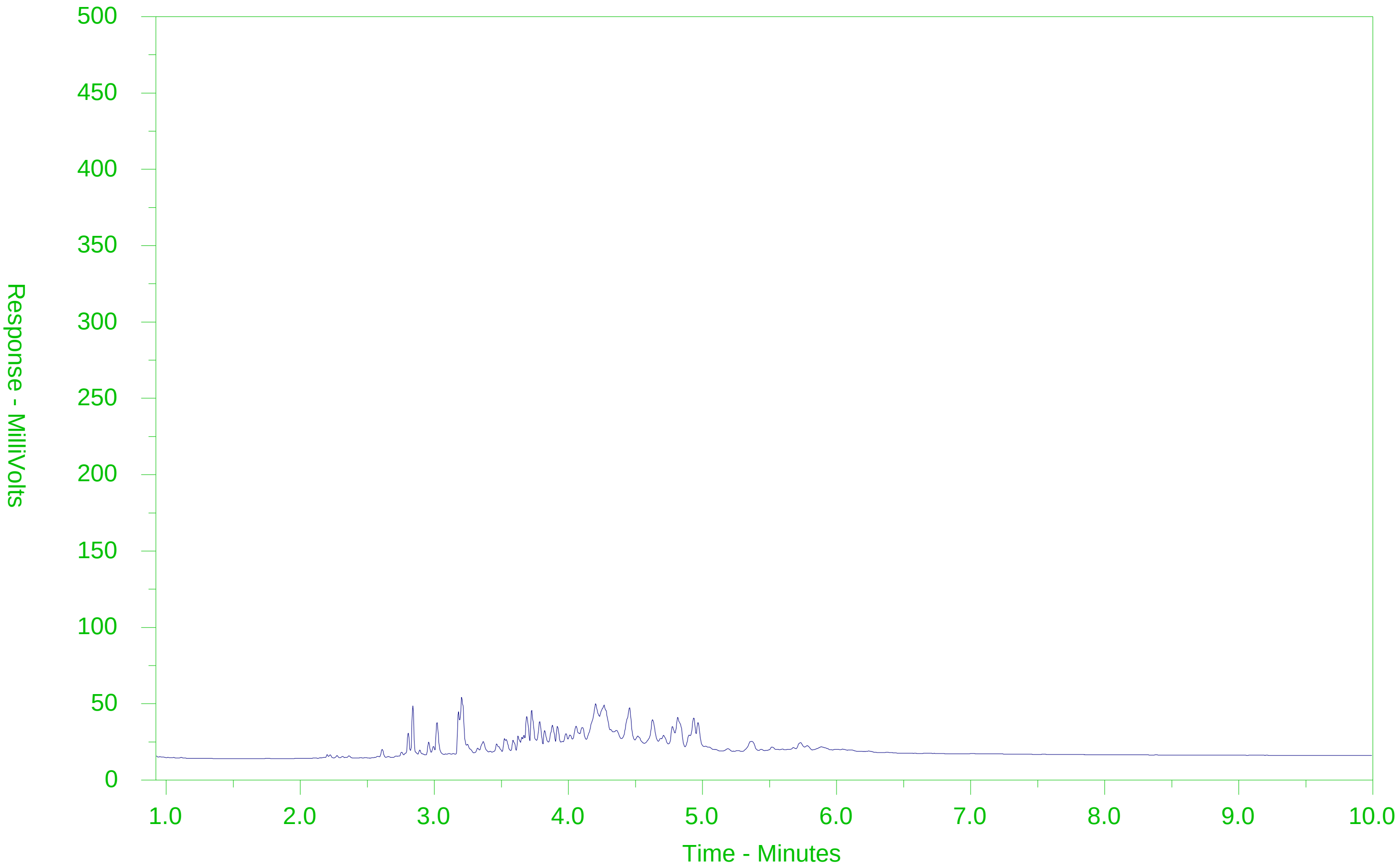
Sieve Size	Weight Retained (grams)	Percent Retained	Diameter (mm)	Cum. % Retained	Cum. % Passing
38.1 mm. DIA.:	0.000	0.000	38.100	0.000	100.000
25.4 mm. DIA.:	0.000	0.000	25.400	0.000	100.000
19.0 mm. DIA.:	0.000	0.000	19.000	0.000	100.000
9.5 mm. DIA.:	0.000	0.000	9.500	0.000	100.000
NO. 4 SIEVE :	0.000	0.000	4.500	0.000	100.000
NO. 10 SIEVE :	0.000	0.000	2.000	0.000	100.000
NO. 20 SIEVE :	1.000	2.000	0.850	2.000	98.000
NO. 40 SIEVE :	1.000	2.000	0.425	4.000	96.000
NO. 60 SIEVE :	1.000	2.000	0.250	6.000	94.000
NO. 100 SIEVE:	1.000	2.000	0.150	8.000	92.000
NO. 200 SIEVE:	14.000	28.000	0.075	36.000	64.000

Time (min)		Temperature (C)	Diameter (mm)	% Suspended (Subsample)	% Suspended (Total Sample)
1.00	21.0	23.7	0.043	60.457	60.457
2.00	19.0	23.7	0.031	54.033	54.033
4.00	16.0	23.7	0.023	44.396	44.396
8.00	14.0	23.7	0.016	37.972	37.972
15.00	11.0	23.7	0.012	28.336	28.336
30.00	8.0	23.7	0.009	18.699	18.699
60.00	6.0	23.7	0.006	12.275	12.275
120.00	5.0	23.7	0.005	9.063	9.063
240.00	4.0	23.7	0.003	5.851	5.851
480.00	4.0	23.7	0.002	5.851	5.851
1440.00	4.0	23.7	0.001	5.851	5.851

GRAIN SIZE	% BY WT.	DIA. RANGE (mm)
% GRAVEL :	0.00	> 4.5
% COARSE SAND :	0.00	2.0 - 4.5
% MEDIUM SAND :	4.00	0.425 - 2.0
% FINE SAND :	32.00	0.075 - 0.425
% SILT :	58.15	0.075 - 0.002
% CLAY :	5.85	< 0.002
% CLAY :	9.84	< 0.005

CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L1660729-1
Client Sample ID: HAR U/S



←F2→	←F3→	←F4→	
nC10	nC16	nC34	nC50
174°C	287°C	481°C	75°C
346°F	549°F	898°F	1067°F
←Gasoline→		←Motor Oils/ Lube Oils/ Grease→	
←Diesel/ Jet Fuels→			

The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

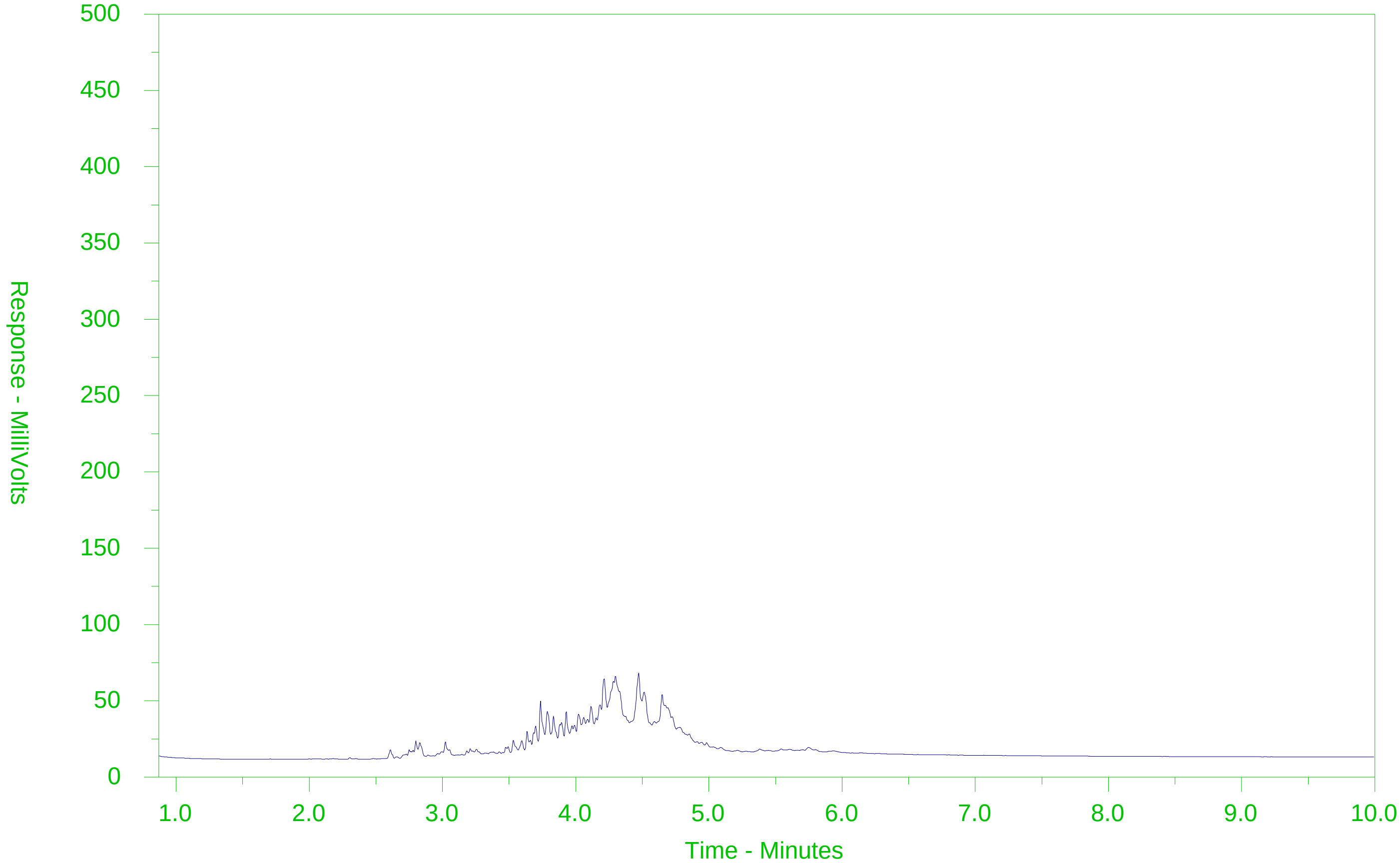
The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor and the scale at the left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR Library can be found at www.alsglobal.com.

CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L1660729-2
Client Sample ID: HAR D/S



← F2 →	← F3 →	← F4 →	
nC10	nC16	nC34	nC50
174°C	287°C	481°C	75°C
346°F	549°F	898°F	1067°F
← Gasoline →		← Motor Oils/ Lube Oils/ Grease →	
← Diesel/ Jet Fuels →			

The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

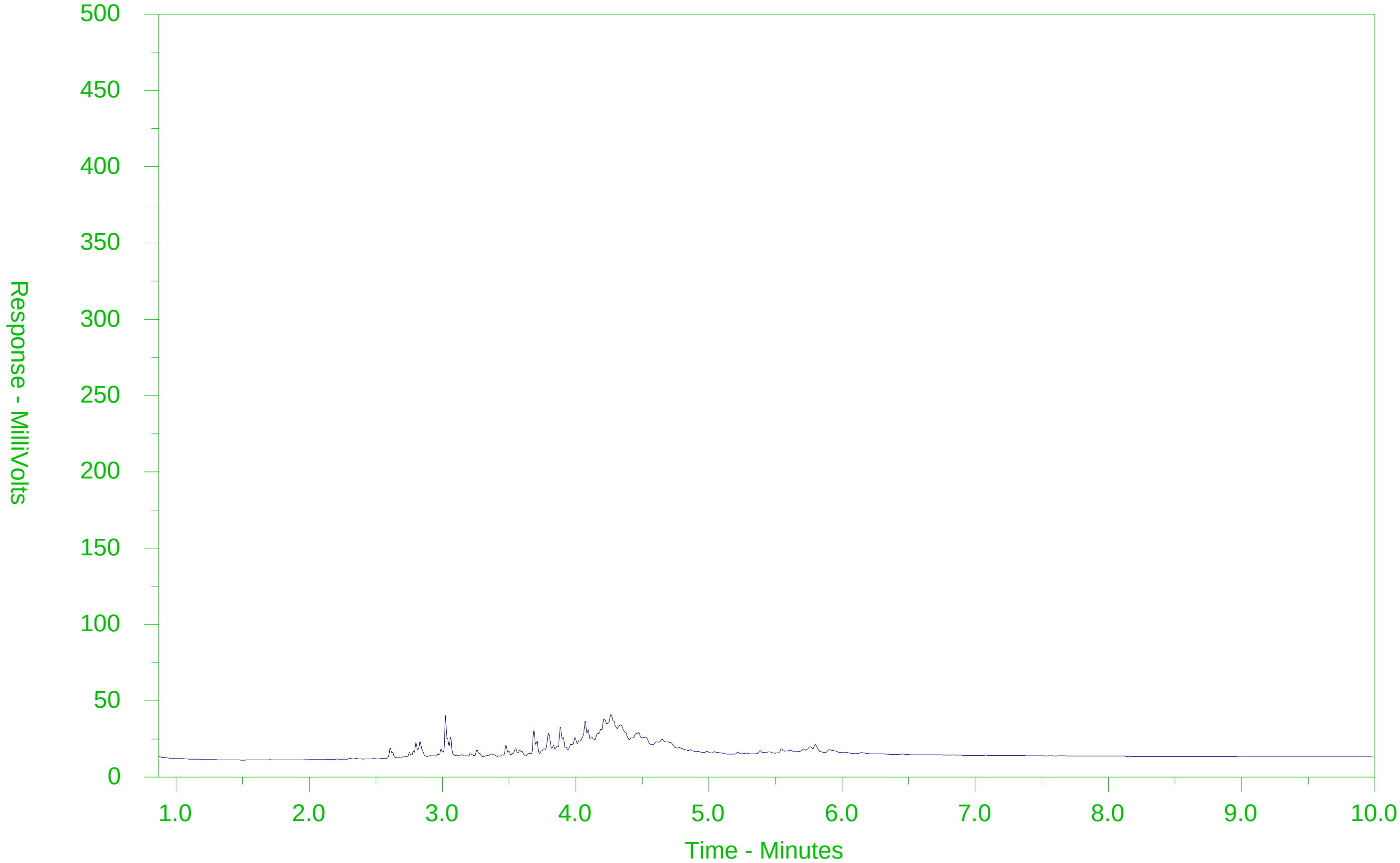
The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor and the scale at the left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR Library can be found at www.alsglobal.com.

CCME F2-F4 **HYDROCARBON DISTRIBUTION REPORT**

ALS Sample ID: L1660729-3
Client Sample ID: EMB U/S



←F2→	←F3→	←F4→	
nC10	nC16	nC34	nC50
174°C	287°C	481°C	75°C
346°F	549°F	898°F	1067°F
←Gasoline→		←Motor Oils/ Lube Oils/ Grease→	
←Diesel/ Jet Fuels→			

The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

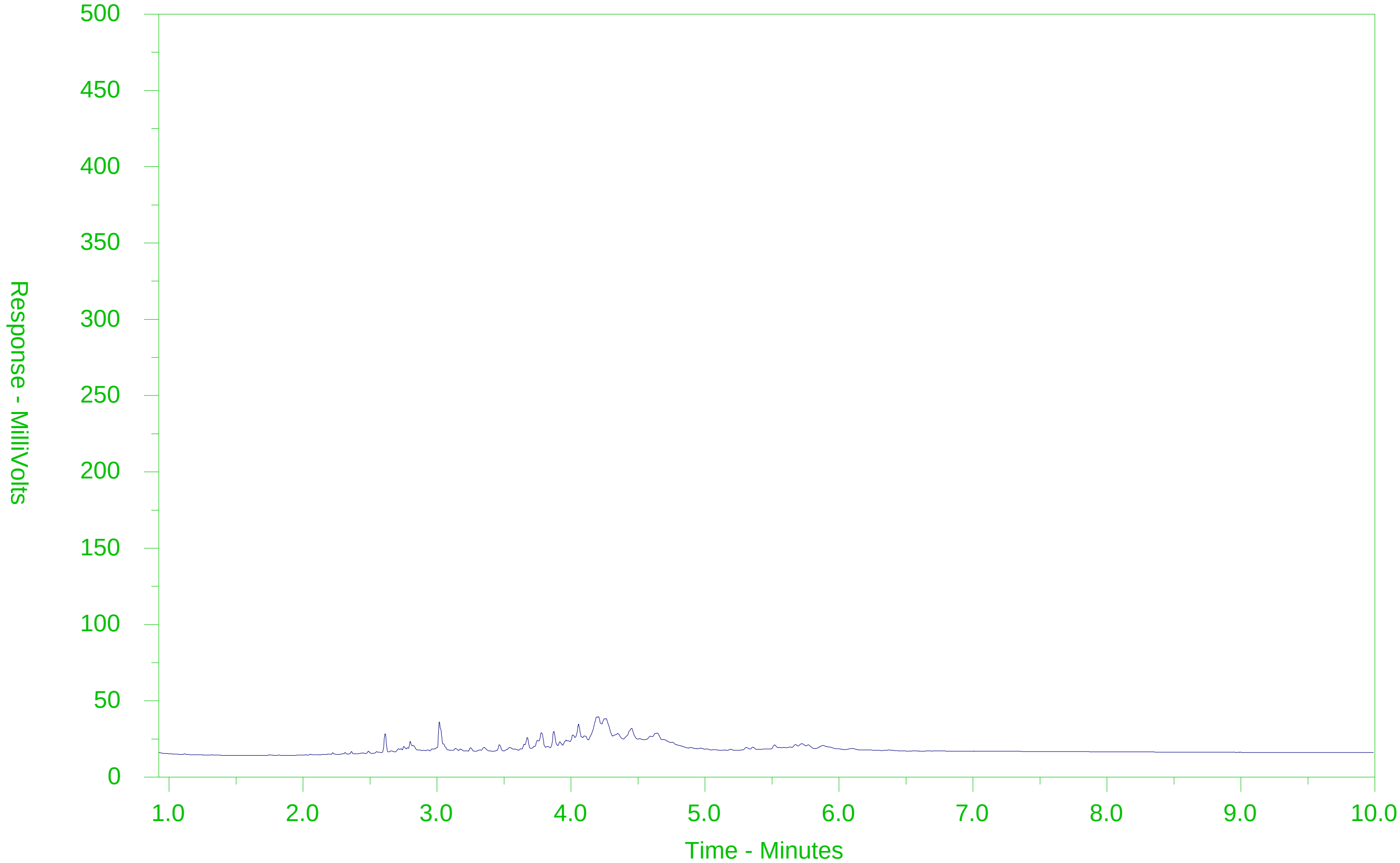
The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

Peak heights in this report are a function of the sample concentration, the sample amount extracted, the sample dilution factor and the scale at the left.

Note: This chromatogram was produced using GC conditions that are specific to ALS Canada CCME F2-F4 method. Refer to the ALS Canada CCME F2-F4 Hydrocarbon Library for a collection of chromatograms from common reference samples (fuels, oils, etc.). The HDR Library can be found at www.alsglobal.com.

CCME F2-F4 HYDROCARBON DISTRIBUTION REPORT

ALS Sample ID: L1660729-4
Client Sample ID: EMB D/S



←F2→	←F3→	←F4→	
nC10	nC16	nC34	nC50
174°C	287°C	481°C	75°C
346°F	549°F	898°F	1067°F
←Gasoline→		←Motor Oils/ Lube Oils/ Grease→	
←Diesel/ Jet Fuels→			

The CCME F2-F4 Hydrocarbon Distribution Report (HDR) is intended to assist you in characterizing hydrocarbon products that may be present in your sample.

The scale at the bottom of the chromatogram indicates the approximate retention times of common petroleum products and four n-alkane hydrocarbon marker compounds. Retention times may vary between samples, but general patterns and distributions will remain similar.

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ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1660729-COFC

COC Number: 14 -

Page ____ of ____

Report To	
Company:	Ecosystem Recovery (cash client)
Contact:	David Arseneau
Address:	1023 Rife Road, Unit A Cambridge, ON N1R 5S3
Phone:	

Report Format / Distribution

Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)
Quality Control (QC) Report with Report ☑ Yes ☐ No
☐ Criteria on Report - provide details below if box checked
Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax david.arseneau@ecosystemrecovery.ca
Email 2

Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)

- R ☑ Regular (Standard TAT if received by 3 pm - business days)
- P ☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT
- E ☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT
- E2 ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge

Specify Date Required for E2,E or P:

Invoice To Same as Report To ☑ Yes ☐ No
Copy of Invoice with Report ☐ Yes ☐ No
Company:
Contact:

Invoice Distribution
Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax david.arseneau@ecosystemrecovery.ca
Email 2

Project Information
ALS Quote #: Q48358
Job #:
PO / AFE:
LSD: Aug-20

Oil and Gas Required Fields (client use)
Approver ID: Cost Center:
GL Account: Routing Code:
Activity Code:
Location:

ALS Lab Work Order # (lab use only) L1660729
ALS Contact: Sampler:

Analysis Request
Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	GRAIN SIZE-WT	PAH-511-WT	PEST-OC-511-P-WT	R511-INORGANICS-P-WT	VOC-R511,F1-F4-P-WT	INORGANICS-TCLP-P-WT	Number of Containers
1	HAR U/S	20-08-15	11:15	Soil	R	R	R	R	R		5
2	HAR D/S	20-AUG-15	11:00	Soil	R	R	R	R	R		5
3	EMB U/S	20-AUG-15	12:40	Soil	R	R	R	R	R		5
4	EMB D/S	20-AUG-15	12:20	Soil	R	R	R	R	R		5
5	HAR U/S	20-AUG-15	11:15	Waste						R	2
6	HAR D/S	20-AUG-15	11:00	Waste						R	2
7	EMB U/S	20-AUG-15	12:40	Waste						R	2
8	EMB D/S	20-AUG-15	12:20	Waste						R	2

Drinking Water (DW) Samples[1] (client use)
Are samples taken from a Regulated DW System? ☐ Yes ☑ No
Are samples for human drinking water use? ☐ Yes ☑ No

Special Instructions / Specify Criteria to add on report (client Use)

SAMPLE CONDITION AS RECEIVED (lab use only)
Frozen ☐ SIF Observations Yes ☐ No ☐
Ice packs Yes ☒ No ☐ Custody seal intact Yes ☐ No ☐
Cooling Initiated ☐
INITIAL COOLER TEMPERATURES °C | FINAL COOLER TEMPERATURES °C
6

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date: 20AUG15	Time: 2:40	Received by:	Date:	Time:	Received by:	Date: 20/08/15	Time: 14:40

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

NA-FM-0326e v09 Front/04 January 2014

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

Appendix J

Agency and Public Correspondence

Public Consultation Index

Notice of Intent	
Agency & Stakeholder Contact List	
Landowner Notice	May 20, 2015
Public Information Centre #1	
Notice of First Public Information Centre	June 10, 2015
PIC Materials (Presentation and Boards)	June 25, 2015
Blank Comment Form	June 25, 2015
Sign Up Sheet	June 25, 2015
Completed Comment Forms	June 25, 2015 to July 17, 2015
Public Information Centre #2	
Notice of Second Public Information Centre	April 22, 2016
PIC Materials (Presentation and Boards)	May 12, 2016
PIC Meeting Minutes	May 12, 2016
Blank Comment Form	May 26, 2016
Sign Up Sheet	May 12, 2016
Completed Comment Forms	May 12, 2016 to June 16, 2016
Public Information Centre #3	
Notice of Third Public Information Centre	October 06, 2016
PIC Materials (Presentation and Boards)	October 20, 2016
PIC Meeting Minutes	October 20, 2016
Blank Comment Form	October 24, 2016
Sign Up Sheet	October 20, 2016
Completed Comment Forms	October 20, 2016 to November 23, 2016

Upper Thames River Conservation Authority

Harrington Dam

Class Environmental Assessment

NOTICE OF INTENT

Upper Thames River Conservation Authority (UTRCA), through their consultant Ecosystem Recovery Inc., is undertaking a Class Environmental Assessment for the Harrington Dam in the Township of Zorra. The map below shows the location of the study area.

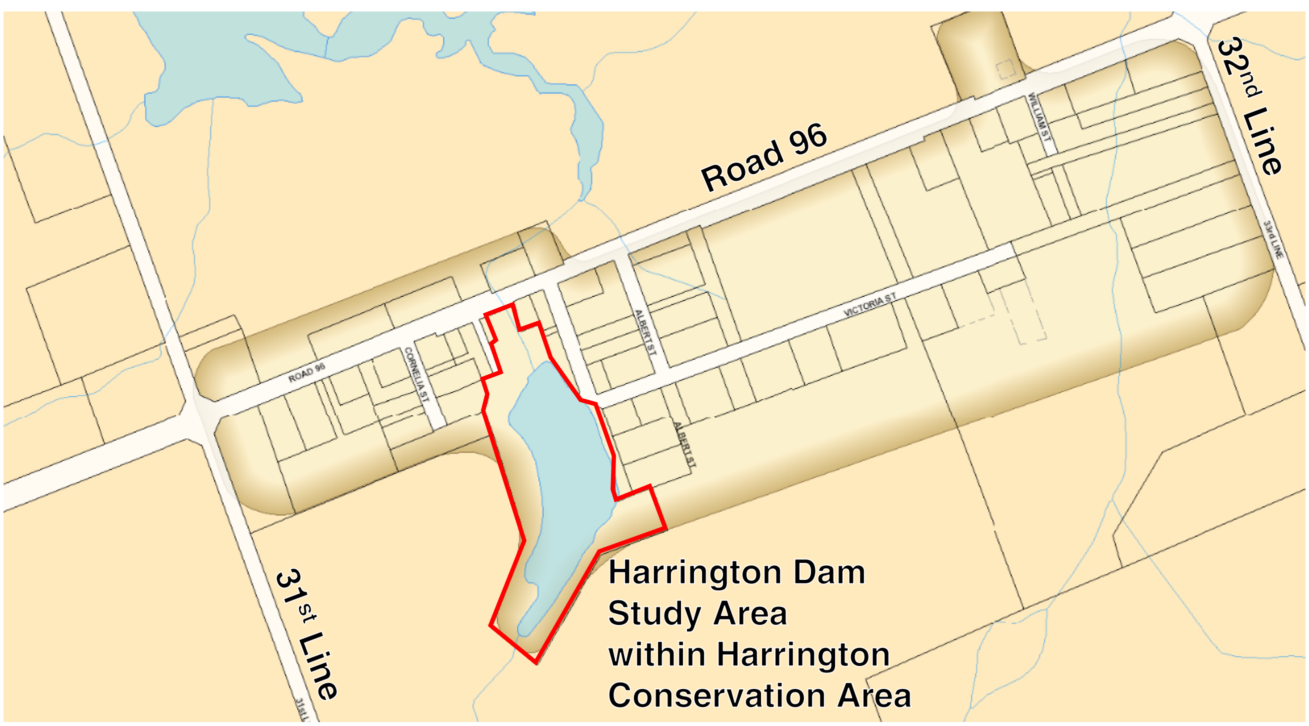
The UTRCA commissioned a Dam Safety Review (DSR) of the Harrington Dam which was completed in 2007. The DSR identified issues with the spillway capacity and embankment stability of the dam. This Class EA study was initiated to assess the existing site conditions and constraints, and to develop potential alternatives to address the identified issues at the dam.

The project will be carried out under the *Conservation Ontario Class Environmental Assessment for Remedial Flood and Erosion Control Works* document.

The Project Team invites public input and comments, and will incorporate them into the planning and design of this project. The public will be notified in advance of a Public Information Centre that will be held to present information on the project and receive public feedback. To submit comments, request further information, or to join the project mailing list, please contact:

Mr. Rick Goldt, C.E.T.
Supervisor, Water Control Structures
Upper Thames River Conservation Authority
1424 Clarke Road
London, Ontario, N5V 5B9
Tel: 519-451-2800 ext. 244
Fax: 519-451-1188
goldtr@thamesriver.on.ca

Mr. Wolfgang Wolter
Senior Project Manager
Ecosystem Recovery Inc.
550 Parkside Drive, Unit B1
Waterloo, Ontario, N2L 5V4
Tel: 519-621-1500
Fax: 226-240-1080
wolfgang.wolter@ecosystemrecovery.ca



HARRINGTON AND EMBRO DAMS CLASS EA
AGENCY & STAKEHOLDER CONTACT LIST

A.	**PROVINCIAL**					
	AGENCY NAME	CONTACT PERSON	NOTICE SENT	RESPONSE (Y/N)	FOLLOW UP (Y/N)	COMMENT?
1	UTRCA Land Use Regulations 1424 Clarke Road London, Ontario, N5V 5B9 Tel: 519.451.2800 Ext. 237 Fax: 519.451.1188 winfieldk@thamesriver.on.ca	Karen Winfield Land Use Regulations Officer				
2	Conservation Ontario 120 Bayview Parkway Newmarket, Ontario L3Y 4W3 905-895-0716	TBD	Jun-15			
3	Ministry of the Environment London Regional and District Offices 733 Exeter Rd London ON N6E 1L3 Tel: 519-873-5000 Fax: 519-873-5020	TBD EA Planning Coordinator	Jun-15			
4	Ministry of the Environment Environmental Assessment and Approvals Branch EAABGen@ontario.ca	*only Notice of Commencement and Completion via email				
5	Ministry of Natural Resources and Forestry Aylmer - District Office 615 John St N Aylmer ON N5H 2S8 Tel: 519-773-9241	TBD District Planner	Jun-15			
6	Ministry of Tourism, Culture & Sport 401 Bay Street 17th Floor Toronto, ON M7A 0A7	Heritage Planner	Jun-15	17-Jul-15		Please send presentation from PIC 1
B.	**FEDERAL**					
	AGENCY NAME	CONTACT PERSON	NOTICE SENT	RESPONSE (Y/N)	FOLLOW UP (Y/N)	COMMENT?
1	Central and Arctic Region Fisheries and Oceans Canada 520 Exmouth Street Sarnia, ON, N1G 4Y2	Regional Manager	Jun-15			
C.	**MUNICIPALITIES**					
	AGENCY NAME	CONTACT PERSON	NOTICE SENT	RESPONSE (Y/N)	FOLLOW UP (Y/N)	COMMENT?
1	Township of Zorra Phone: 519-485-2490 Ext 226 Fax: 519-485-2520 dmacleod@zorra.on.ca	Don MacLeod Chief Administrative Officer				
D.	**UTILITIES**					
	AGENCY NAME	CONTACT PERSON	NOTICE SENT	RESPONSE (Y/N)	FOLLOW UP (Y/N)	COMMENT?
1	Need to identify utilities that may be impacted at each project site	TBD				
E.	**FIRST NATIONS/ABORIGINAL (Provisional)**					
	AGENCY NAME	CONTACT PERSON	NOTICE SENT	RESPONSE (Y/N)	FOLLOW UP (Y/N)	COMMENT?
1	Ministry of Aboriginal Affairs 160 Bloor Street East, 9th Floor Toronto, ON, M7A 2E6	Ms. Heather Levesque Manager, Consultation Unit	Jun-15	27-Jul-15		First Natons in the project area: Six Nations of Grand River, Oneida Nation of the Thames, Chippewas of the Thames, Haudenosaunee Confederacy, Munsee-Delaware Nation
2	AANDC 25 St. Clair Avenue East, 8th Floor Toronto, ON, M4T 1M2	Environment Unit Re: EA Coordination	Jun-15			
3	Oneida Nation of the Thames 2212 Elm Avenue SOUTHWOLD, Ontario NOL 2GO (519) 652-3244 (Fax) 652-2930 Sheri.Doxtator@oneida.on.ca	Chief Sheri Doxtator	Jun-15			
4	Chippewas of the Thames 320 Chippewa Road, RR#1 Muncey Ontario, Canada phone: 519-289-5555	TBD	Jun-15			

	Fax: 519-289-2230 email: info@cottfn.com					
5	Caldwell First Nation Box 338 14 Orange Street Leamington, Ontario, N8H 1P5 phone: 519-322-1766 fax: 519-322-1533 email: cfnchief@live.com	Chief Louise Hillier	Jun-15			
F.	**COMMUNITY GROUPS / NGO'S**					
	AGENCY NAME	CONTACT PERSON	NOTICE SENT	RESPONSE (Y/N)	FOLLOW UP (Y/N)	COMMENT?
1	Embro Pond Association PO BOX 348 Embro, Ontario N0J 1J0 email: embropond@hotmail.com	TBD	Jun-15			
2	Harrington and Area Community Association 539 Victoria St S Harrington, ON N0J 1J0 phone: 519-475-4097	Doug Diplock, Chair Philip Kerr, Vice-Chair	Jun-15			
3	Thames River Anglers Thames River Anglers Association 2202 Coronation Drive London, Ontario, N6G 0B9 email: traa@anglers.org	TBD	Jun-15			
4	Trout Unlimited Unit #1, 27 Woodlawn Road West Guelph, ON, N1H 1G8 phone: (519) 763-0888	Stacey Stevens Ontario Office Coordinator	Jun-15			
5	Ontario Nature 214 King Street West, Suite 612 Toronto, ON M5H 3S6 Tel: 416-444-8419 Fax: 416-444-9866 E-mail: info@ontarionature.org	TBD	Jun-15			
6	Ontario Federation of Anglers and Hunters 4601 Guthrie Drive, PO Box 2800 Peterborough, ON, K9J 8L5 Phone: 705-748-OFAH (6324) Fax: 705-748-9577 Email: ofah@ofah.org	TBD	Jun-15			
7	Ducks Unlimited Canada 740 Huronia Road, Unit 1 Barrie, ON L4N 6C6 Tel: 705-721-4444 Fax: 705-721-4999 Email: du_barrie@ducks.ca	TBD	Jun-15			
8	Woodstock Field Naturalist's Club P.O. Box 20037 RPO Woodstock Centre Woodstock, ON, N4S 8X8 Email: WoodstockFNC@gmail.com	Roger Boyd President	Jun-15			
9	Oxford County Trails Council Email: oxfordtrails@gmail.com	TBD				
10	Stratford Field Naturalists c/o Sharon McKay P.O. Box 21113 RPO Stratford, ON N5A 7V4 Email: naturestratford@gmail.com	Marilyn Ohler, President	Jun-15			
11	Tavistock and District Rod & Gun Club Box #1 R.R. #3, Embro, ON, N0J1J0 Tel: 519-275-1867 E-mail: tdrgc@outlook.com Site: www.tdrgc.com	Tim Segeren, 2015 Club President				

Ecosystem Recovery Inc.
B1-550 Parkside Drive
Waterloo, Ontario, N2L 5V4
Phone: 519.621.1500
www.ecosystemrecovery.ca

June 12, 2015

NAME
TITLE
ADDRESS
ADDRESS

Dear NAME:

Re: Harrington Dam and Embro Dam Class Environmental Assessments
Notice of Intent and First Public Information Centre

Upper Thames River Conservation Authority (UTRCA), through their consultant Ecosystem Recovery Inc., is undertaking Class Environmental Assessments for the Harrington Dam and Embro Dam in the Township of Zorra. Each dam will be subject to a separate Class EA to address identified issues with the existing structures. Please see the attached Notices of Intent and First Public Information Centre.

The project will be carried out under the *Conservation Ontario Class Environmental Assessment for Remedial Flood and Erosion Control Works* document.

The draft problem statement for each dam is shown below, forming the basis for further investigations and analysis:

> Significant concerns related to the structural integrity and hydraulic capacity of the Harrington/Embro Dam have been identified through recent engineering assessments. A Class Environmental Assessment will be initiated to evaluate a range of alternatives to address the identified issues in consideration of the environmental, social, economic, and technical aspects of the dams.

If you have any input or comments regarding the planning and design of these projects please do not hesitate to contact us.

Sincerely,
Ecosystem Recovery Inc.

Wolfgang Wolter
Senior Project Manager

wolfgang.wolter@ecosystemrecovery.ca
519-621-1503

Ecosystem Recovery Inc.
550 Parkside Drive, Unit B1
Waterloo, Ontario, N2L 5V4
Phone: 519.621.1500
www.ecosystemrecovery.ca

May 20, 2015

Mr. Larry Jensen
[redacted]

Dear Mr. Jensen:

Re: Harrington Dam Class Environmental Assessment

The Upper Thames River Conservation Authority (UTRCA) will be undertaking a *Conservation Ontario Class Environmental Assessment for Remedial Flood and Erosion Control Works* (Class EA) for the Harrington Dam, in collaboration with their consultant Ecosystem Recovery Inc. The Class EA has been initiated due to a recent Dam Safety Review (DSR) of the Harrington Dam which was completed in 2007. The DSR identified issues with the spillway capacity and embankment stability of the dam. This Class EA study will assess the existing site conditions and constraints and will develop potential alternatives to address the identified issues at the dam.

During the initial stages of the study (scheduled to occur in the months of May and June 2015), the UTRCA and the consulting team will need to collect information relevant to the study through a series of site visits. The field work area includes the Harrington Dam Pond as well as the creek directly upstream and downstream of the dam. The type of information to be collected may consist of the following:

- Characterization of vegetative and terrestrial communities;
- Characterization of aquatic species and habitat in the creek and pond;
- Measuring of water levels and hydraulic data;
- Recording of creek characteristics, banks, floodplain, channel features;
- Locating any visible infrastructure near the site; and
- Photographic records of the study area.

UTRCA staff will also be undertaking a topographic survey of the channel and relevant areas to develop a geometric representation of the site for use in developing alternatives in the Class EA process.

UTRCA and consulting staff should not interfere with your regular activities, and will identify themselves to you if you have any questions.

Please feel free to contact the undersigned at UTRCA if you have any questions.

Sincerely,
Ecosystem Recovery Inc.

Wolfgang Wolter
Senior Project Manager

Wolfgang.Wolter@ecosystemrecovery.ca
(519) 621-1503

Ecosystem Recovery Inc.
550 Parkside Drive, Unit B1
Waterloo, Ontario, N2L 5V4
Phone: 519.621.1500
www.ecosystemrecovery.ca

May 20, 2015

Ms. Bernice Robinson
[redacted]

Dear Ms. Robinson:

Re: Harrington Dam Class Environmental Assessment

The Upper Thames River Conservation Authority (UTRCA) will be undertaking a *Conservation Ontario Class Environmental Assessment for Remedial Flood and Erosion Control Works* (Class EA) for the Harrington Dam, in collaboration with their consultant Ecosystem Recovery Inc. The Class EA has been initiated due to a recent Dam Safety Review (DSR) of the Harrington Dam which was completed in 2007. The DSR identified issues with the spillway capacity and embankment stability of the dam. This Class EA study will assess the existing site conditions and constraints and will develop potential alternatives to address the identified issues at the dam.

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Please feel free to contact the undersigned at UTRCA if you have any questions.

Sincerely,
Ecosystem Recovery Inc.

Wolfgang Wolter
Senior Project Manager

Wolfgang.Wolter@ecosystemrecovery.ca
(519) 621-1503

Public Information Centre #1

Upper Thames River Conservation Authority

Harrington Dam

Class Environmental Assessment

NOTICE OF INTENT AND FIRST PUBLIC INFORMATION CENTRE

THE STUDY

Upper Thames River Conservation Authority (UTRCA), through their consultant Ecosystem Recovery Inc., is undertaking a Class Environmental Assessment for the Harrington Dam in the Township of Zorra. The map on the reverse of this page shows the location of the study area.

The UTRCA commissioned a Dam Safety Review (DSR) of the Harrington Dam which was completed in 2007. The DSR identified issues with the spillway capacity and embankment stability of the dam. This Class EA study was initiated to assess the existing site conditions and constraints, and to develop potential alternatives to address the identified issues at the dam.

The project will be carried out under the *Conservation Ontario Class Environmental Assessment for Remedial Flood and Erosion Control Works* document.

WE WANT TO HEAR FROM YOU

Public consultation is a key component of this study. The Project Team invites public input and comments, and will incorporate them into the planning and design of this project. Three public information centres are proposed for this Class EA: June 2015 to provide an overview of the study and Class EA process; September 2015 to review alternative solutions and evaluation criteria; and November 2015 to present the preferred alternative for the Harrington Dam. The first public information centre will take place at the following time and location:

Date:	**June 25th, 2015**
Time:	**7:00 p.m. to 9:00 p.m.**
Place:	**Harrington Hall and Library** **539 Victoria Street** **Harrington, Ontario**

An overview presentation will be held at 7:00 p.m. followed by questions and discussion.

STUDY CONTACTS

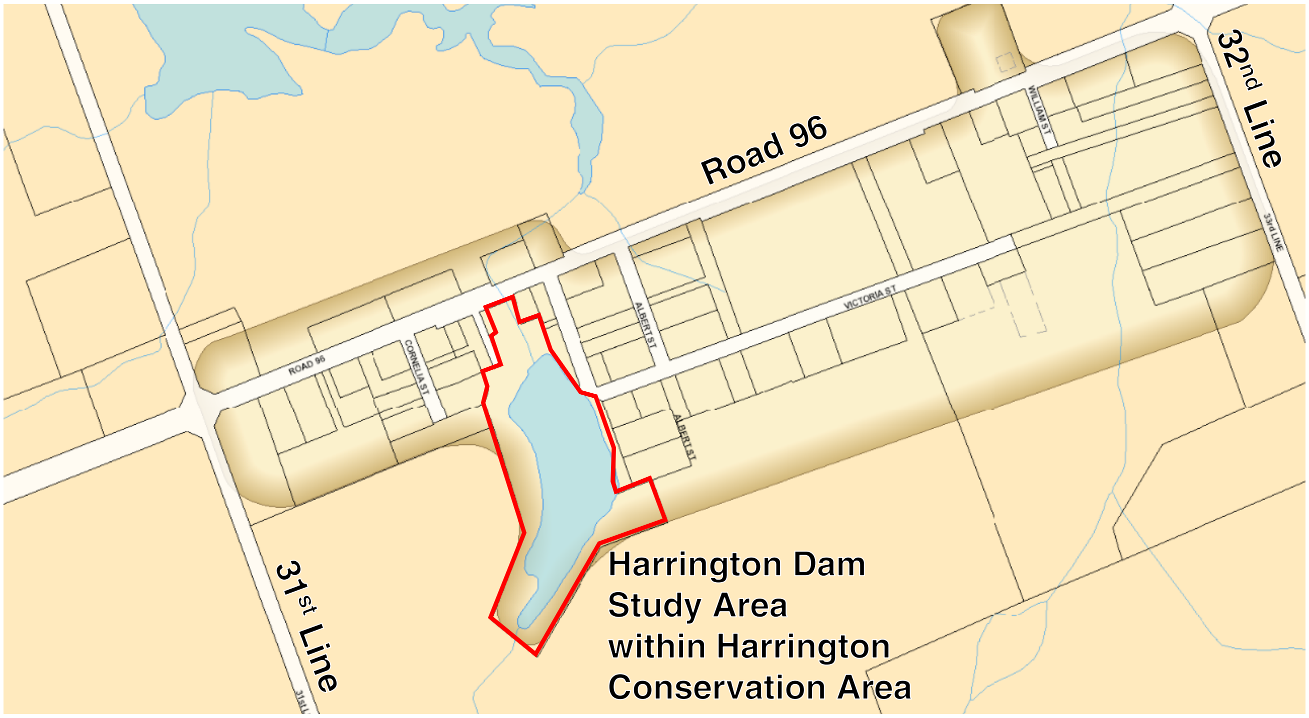
To submit comments, request further information, or to join the project mailing list, please send an email to the project email address:

harrington_dam@thamesriver.on.ca

Contact information for the project team leaders is listed below:

Mr. Rick Goldt, C.E.T.
Supervisor, Water Control Structures
Upper Thames River Conservation Authority
1424 Clarke Road
London, Ontario, N5V 5B9
Tel: 519-451-2800 ext. 244
Fax: 519-451-1188
goldtr@thamesriver.on.ca

Mr. Wolfgang Wolter
Senior Project Manager
Ecosystem Recovery Inc.
550 Parkside Drive, Unit B1
Waterloo, Ontario, N2L 5V4
Tel: 519-621-1500
Fax: 226-240-1080
wolfgang.wolter@ecosystemrecovery.ca


Road 96
32nd Line
31st Line
ROAD 96
CORNELIA ST
ALBERT ST
VICTORIA ST
WILLIAM ST
33rd LINE
Harrington Dam
Study Area
within Harrington
Conservation Area

Public Information Centre #1
PIC Presentation Slides

Harrington Dam
Class Environmental Assessment

Public Information Centre #1

Upper Thames River Conservation Authority
Harrington Hall and Library
June 25th, 2015   7:00 p.m. to 9:00 p.m.

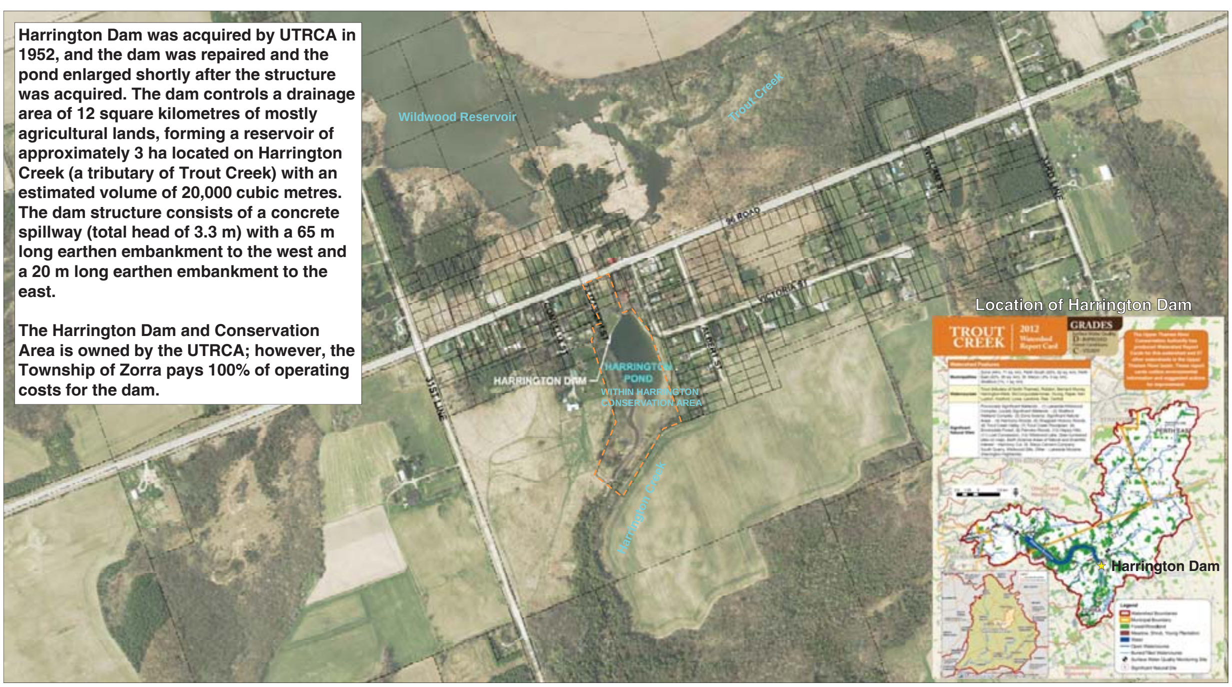
UPPER THAMES RIVER CONSERVATION AUTHORITY

ecosystem recovery inc. PROFESSIONAL ENGINEERS

Harrington Dam Study Area

Harrington Dam was acquired by UTRCA in 1952, and the dam was repaired and the pond enlarged shortly after the structure was acquired. The dam controls a drainage area of 12 square kilometres of mostly agricultural lands, forming a reservoir of approximately 3 ha located on Harrington Creek (a tributary of Trout Creek) with an estimated volume of 20,000 cubic metres. The dam structure consists of a concrete spillway (total head of 3.3 m) with a 65 m long earthen embankment to the west and a 20 m long earthen embankment to the east.

The Harrington Dam and Conservation Area is owned by the UTRCA; however, the Township of Zorra pays 100% of operating costs for the dam.



Upper Thames River Conservation Authority
Public Information Centre

UPPER THAMES RIVER CONSERVATION AUTHORITY

ecosystem recovery inc. PROFESSIONAL ENGINEERS

Harrington Dam and Area Description

The Harrington Dam is approximately 90m to 95m long, with two earthen embankments flanking a concrete spillway.

The earthen embankments of the dam are founded on soil overburden, rather than bedrock or engineered soil.

Some areas of the Harrington Conservation Area have been restored and enhanced by community groups and schools.

The dam contains water year round and includes approximately 3.3 m of head acting across the dam.

The dam spillway is considered to have an inadequate capacity for safety and stability purposes; the water level in the reservoir can be adjusted by adding stop logs to the spillway.

The Harrington Dam is located within the Harrington Conservation Area; the adjacent mill building has recently been restored by the Harrington Community Club.

Problem Statement: Why is a Class EA Necessary?

Significant concerns related to the structural integrity and hydraulic capacity of the Harrington Dam have been identified through recent engineering assessments.

- ***Acres International. July, 2007***. *Dam Safety Assessment Report for Harrington Dam: Identified issues with insufficient spillway capacity, spillway instability and embankment stability*
- ***Naylor Engineering Associates. September 2008***. *Geotechnical Investigation Harrington Dam Embankment Stability Assessment: The existing dam does not meet current standards and is not considered stable under existing conditions*

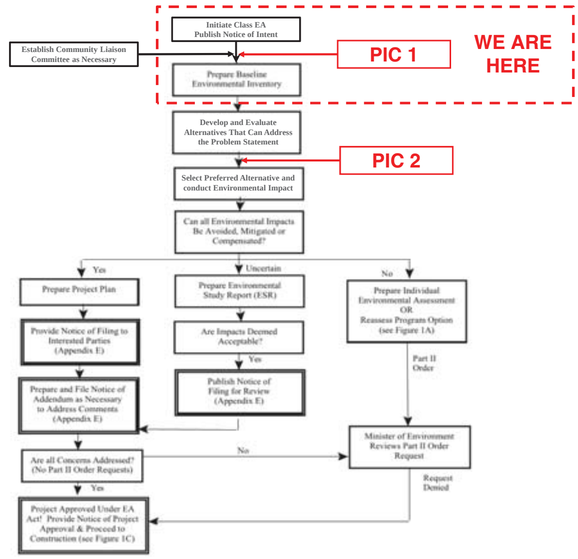
A Class Environmental Assessment has been initiated to evaluate a range of alternatives to address the identified issues in consideration of the environmental, social, economic, and technical aspects of the dam.

Class Environmental Assessment Process and Problem Statement

Class EA Process for Conservation Ontario Class Environmental Assessment for Remedial Flood and Erosion Control Works

In a nutshell:

- Publish Notice of Intent to advise all affected about the study
- Undertake a program to collect background information and relevant data on the study area
- Prepare a characterization of the study area as it relates to the problem statement, this includes technical, social and cost factors
- Develop alternatives that could address the issues
- Evaluate alternatives against a criteria (technical, social and cost)
- Select the preferred alternative
- Prepare concept level plans to depict the preferred alternative
- Prepare the EA report (project plan) and file for 30 days



Public Participation as Part of the Class EA Process

The process requires that proponents make public contact at two occasions, typically the Notice of Intent and Notice of Filing. These Notices invite interested members of the public to review and comment on the study process and results.

The UTRCA has elected to conduct three Public Information Centres (PICs) in addition to the two mandatory public contact notices, to deliver information to the community and to receive comments, feedback and input into the study. The PICs occur:

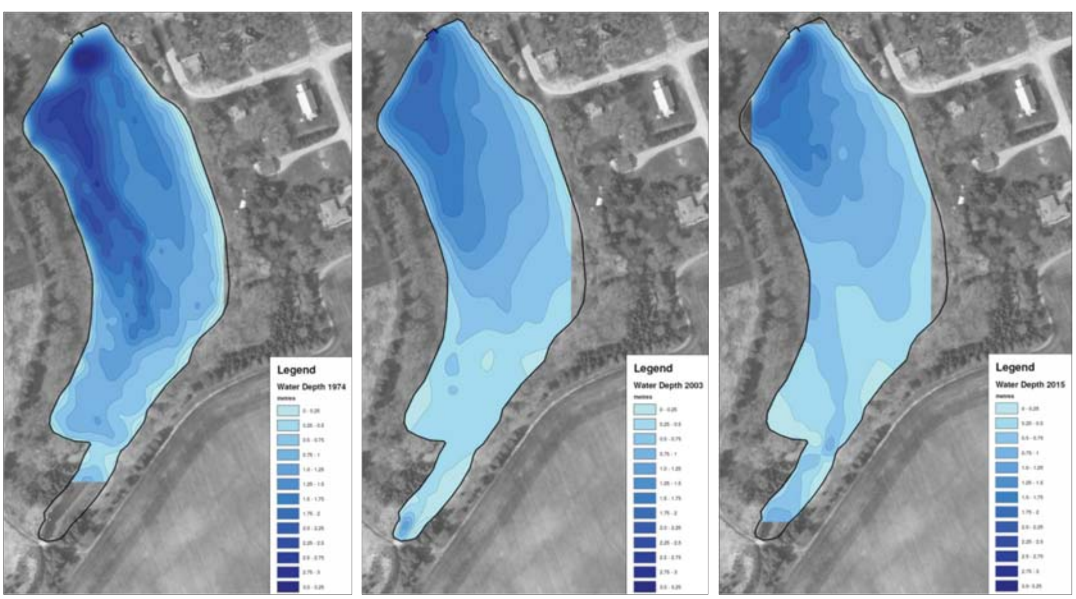
- **June 2015** – Introduction to the Study and Class EA Process
- **September 2015** (planned) – Presentation of Baseline Characterization and Potential Alternatives
- **November 2015** (planned) – Presentation of Preferred Alternative

Field Data Collection and Site Characterization

A range of technical, environmental, and social factors will be characterized at the study site to provide insight into the generation of potential alternatives for the dam, as well as the evaluation of those alternatives.

Topographic Survey	Aquatic Biology	Geotechnical Engineering and Hydrogeology	Civil Engineering (Dam Structure and Hazard Assessment)
Hydrology	Terrestrial Biology	Sediment Quality	Water Quality
Fluvial Geomorphology	Cultural/Social Environment	Archaeology	Sediment Survey

Field Data Collection and Site Characterization – Sediment Survey



Next Steps and Contact Information

Next Steps for our project team include:

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harrington_dam@thamesriver.on.ca

For further information please contact:

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UPPER THAMES RIVER CONSERVATION AUTHORITY

Upper Thames River Conservation Authority
Public Information Centre

ecosystem recovery inc. PROFESSIONAL ENGINEERS

Public Information Centre #1

PIC Presentation Boards

Harrington Dam
Class Environmental Assessment

Public Information Centre #1

Upper Thames River Conservation Authority
Harrington Hall and Library
June 25^{th}, 2015   7:00 p.m. to 9:00 p.m.

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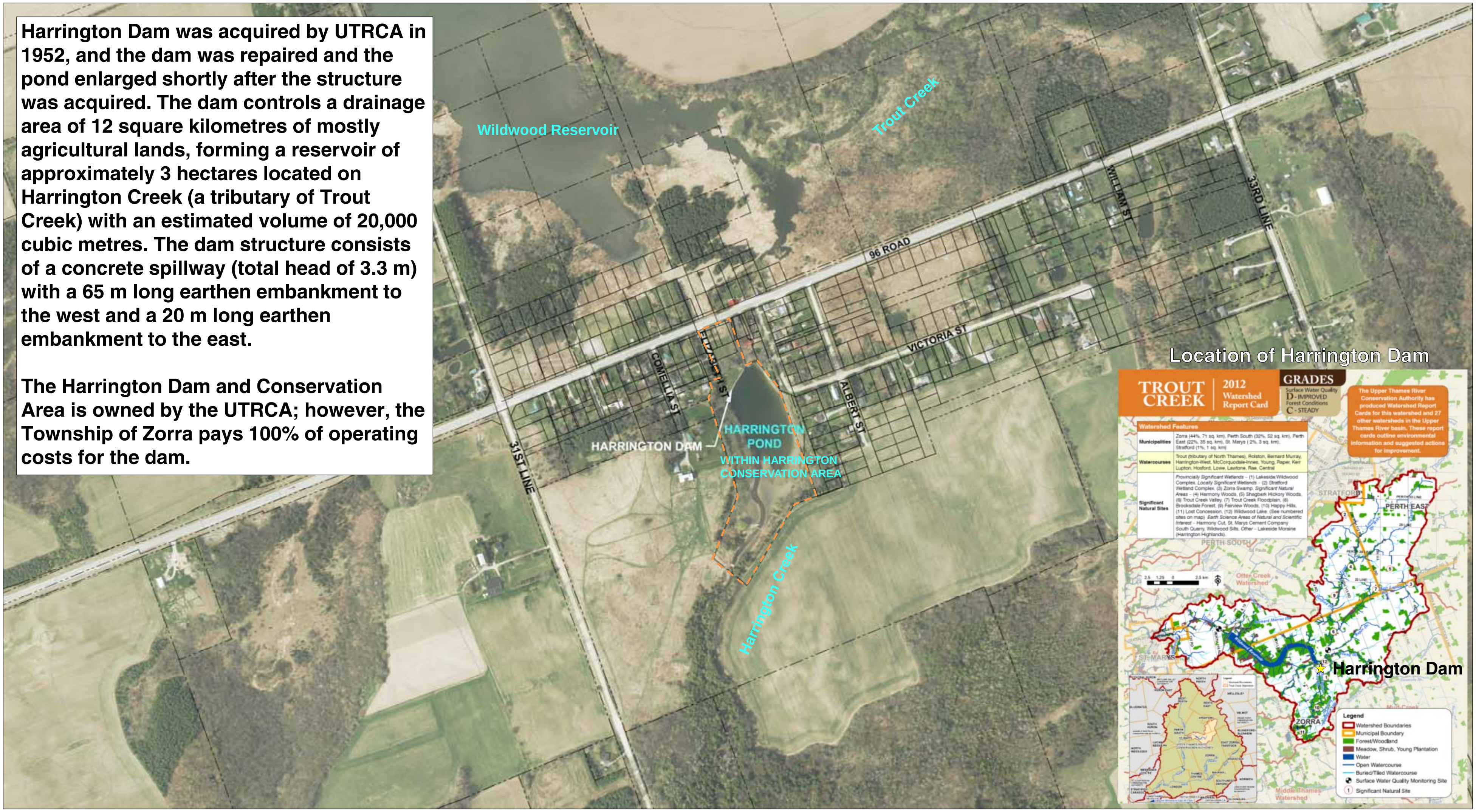
Harrington Dam Study Area

Harrington Dam was acquired by UTRCA in 1952, and the dam was repaired and the pond enlarged shortly after the structure was acquired. The dam controls a drainage area of 12 square kilometres of mostly agricultural lands, forming a reservoir of approximately 3 hectares located on Harrington Creek (a tributary of Trout Creek) with an estimated volume of 20,000 cubic metres. The dam structure consists of a concrete spillway (total head of 3.3 m) with a 65 m long earthen embankment to the west and a 20 m long earthen embankment to the east.

The Harrington Dam and Conservation Area is owned by the UTRCA; however, the Township of Zorra pays 100% of operating costs for the dam.



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Class Environmental Assessment Process and Problem Statement

Problem Statement

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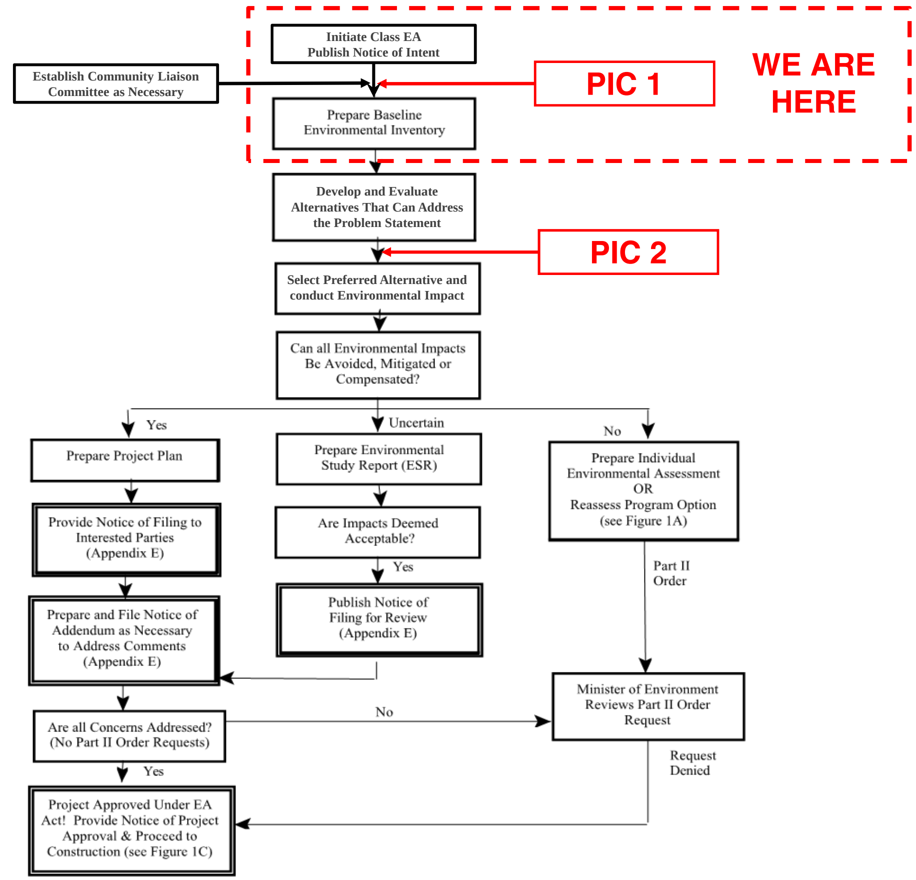
Class EA Process for Conservation Ontario Class Environmental Assessment for Remedial Flood and Erosion Control Works



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Field Data Collection and Site Characterization

A range of technical, environmental, and social factors will be characterized at the study site to provide insight into the generation of potential alternatives for the dam, as well as the evaluation of those alternatives.

Topographic Survey

Topographic characterization of the study area using GPS, total station, or level surveys.

A topographic survey is required to establish physical constraints on potential alternatives for the dam and pond, as well as to develop concept designs.

Topographic surveys are currently underway at the Harrington Dam site.

Aquatic Biology

Characterization of aquatic life in the pond, as well as upstream and downstream of the pond, including an inventory of fish and benthic macroinvertebrates (bugs).

Understanding of the aquatic biology at each site is critical to characterize the current impacts of the pond and dam, and potential impacts and opportunities for proposed alternatives.

Aquatic biology surveys and analysis are currently underway.

Geotechnical Engineering and Hydrogeology

Geotechnical engineering and hydrogeology will consider the stability of the dam embankments and the flow of groundwater through and around the dam (seepage).

Characterization of the current dam stability and seepage is critical in developing potential alternatives for the dam, as well as understanding the risks and impacts of various alternatives.

Geotechnical stability assessments have been previously completed and led to the initiation of this study. Further review will take place in the context of this Class EA.

Civil Engineering (Dam Structure and Hazard Assessment)

A characterization of the current dam structure will be undertaken, including an update of the Dam Hazard Classification, under the *Lakes and Rivers Improvement Act*, to understand risks to downstream persons and property.

Legislation and guidelines for the management of dam structures have changed in recent years, requiring the results of the previous Dam Safety Assessments to be reclassified and a new Dam Hazard Classification established.

The assessment and revision of the Dam Hazard Classification is currently in progress.

Hydrology

Hydrologic characterization of the site includes monitoring and rating of river flows upstream and downstream of the dam.

An understanding of the site hydrology is required to inform the operational parameters so that potential alternatives can be generated, and to inform a number of other technical disciplines such as aquatic biology, water quality, and fluvial geomorphology.

Characterization of site hydrology is currently underway, including flow measurements during rain events and comparison to other similar watersheds.

Terrestrial Biology

The terrestrial biology of the site includes the range of vegetative and wildlife species that inhabit the site, as well as connectivity to adjacent natural areas and the significance of species found on site (i.e., Species at Risk, Endangered Species).

Understanding of the terrestrial biology of the site is required to establish and characterize the impacts of potential alternatives for the dam, and to recommend restoration and enhancement strategies for the site.

Terrestrial biology surveys are currently underway at the site.

Sediment Quality

Characterization of the sediment quality in the reservoir involves the collection of sediment samples and analysis at a laboratory to identify a range of constituents of interest (i.e., metals, nutrients, pesticides, hazardous materials).

An understanding of the sediment quality at the site is critical for understanding the potential impacts of proposed alternatives for the dam, particularly related to the costs associated with removal and disposal. In addition, upstream pollutant sources may be identified.

Sediment testing at the reservoir will be undertaken during summer 2015.

Water Quality

Water quality sampling at the site involves collection of water samples during dry weather and wet weather conditions, at locations upstream and downstream of the dam as well as within the pond. Samples are analysed at a laboratory for constituents of interest (i.e., metals, nutrients, pesticides, temperature, dissolved oxygen).

Analysing water quality at the site is required to understand the impact of the current dam and pond on the watercourse, specifically on the ability of the watercourse to support aquatic life.

Water quality samples will be completed throughout the summer of 2015.

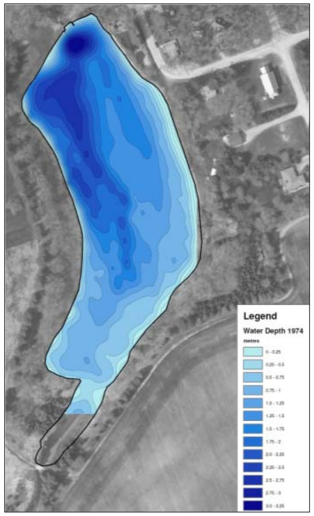
Field Data Collection and Site Characterization

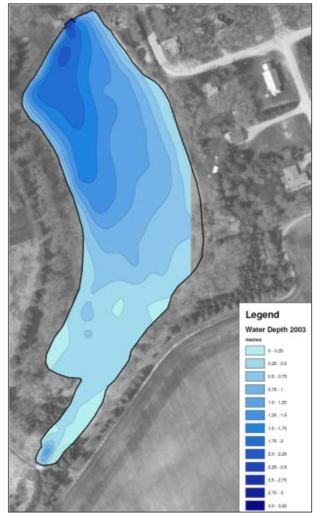
Sediment Survey

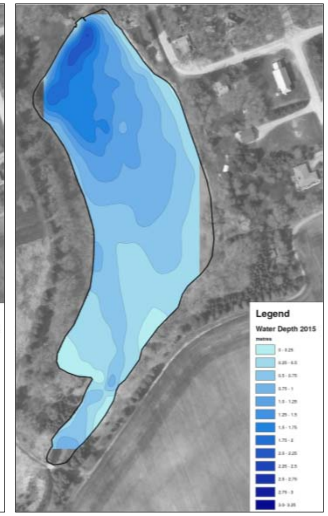
Survey of the pond bottom and depths of sediment are completed using GPS survey equipment.

A sediment survey is required to estimate the current quantity of sediment in the pond and to estimate the rate at which sediment is accumulating in the pond, to inform potential alternatives for the dam.

Preliminary sediment depths and volumes have been determined at the pond; contour maps showing water depth (indirectly showing sediment accumulation) are shown at right.







Archaeology

A Stage 1 archaeological assessment is being completed for the study area to identify known archaeological sites in the area, evaluate the site's archaeological potential, and recommend mitigation strategies if needed. The assessment will be completed under the provisions of the Ontario Heritage Act.

An archaeological assessment is required to identify potential archaeological and heritage sites that may impact alternatives for the dam, forming constraints and providing opportunities for enhancement and protection of heritage sites.

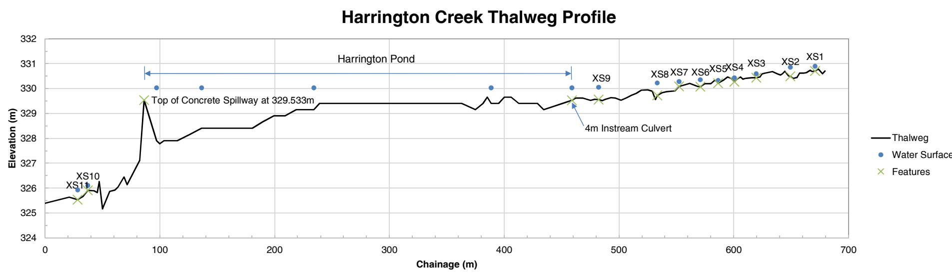
The assessment is currently in progress.

Fluvial Geomorphology

Fluvial geomorphology aims to understand the processes and functions of rivers and creeks, and their role in transporting sediment and providing habitat for aquatic life. A geomorphic characterization of the site, as well as the watercourse upstream and downstream of the site, has been partially completed.

An understanding of the natural watercourse function around the pond is important to characterize impacts of potential alternatives, as well as the current impact of the pond and dam on river processes.

The geomorphic characterization is currently in progress.



Cultural/Social Environment

The cultural and social environment of the site includes current and historical uses of the site, and its role as a community gathering and recreational place.

A thorough characterization and understanding of the cultural and social environment is required to understand the impacts of potential alternatives for the dam, and serves to ensure that the "human environment" is considered alongside technical, environmental, and economic criteria.

The review of cultural and social environment is ongoing, and will be supplemented by the input of interested and engaged residents.

UPPER THAMES RIVER CONSERVATION AUTHORITY

Upper Thames River Conservation Authority
Public Information Centre

ecosystem recovery inc. PROFESSIONAL ENGINEERS

Next Steps and Contact Information

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Upper Thames River Conservation Authority

Harrington Dam

Class Environmental Assessment

PUBLIC INFORMATION CENTRE – COMMENT FORM

Upper Thames River Conservation Authority (UTRCA), through their consultant Ecosystem Recovery Inc., is undertaking a Class Environmental Assessment (Class EA) for the Harrington Dam in the Township of Zorra. The UTRCA commissioned a Dam Safety Review (DSR) of the Harrington Dam which was completed in 2007. The DSR identified issues with the spillway capacity and embankment stability of the dam. This Class EA study was initiated to assess the existing site conditions and constraints, and to develop potential alternatives to address the identified issues at the dam.

The project will be carried out under the *Conservation Ontario Class Environmental Assessment for Remedial Flood and Erosion Control Works* document.

Public consultation is a key component of this study. Although the study is in an early stage, the project team welcomes public input and comments, and will incorporate them into the planning and design of this project. Please provide any comments in the space provided below.

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Thank you for your participation.

Please print your name and address below, and leave your completed Comment Form in the box provided.

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wolfgang.wolter@ecosystemrecovery.ca

Name: ____

Address & Postal Code: ____

E-mail Address: ____

Harrington Dam Class EA

Public Information Centre #1, June 25, 2015

Sign Up sheet to receive notices and information during the EA project

Name (print)	Full Address	Mailing address (if different)	Phone #	Email (print)	Would like to receive: (please check mark)	
					Notices	PIC materials
BERNIE SCHAEFER	[redacted]					
Miles POTTER					✓	✓
Sam Coghlan					✓	✓
Don MacLeod					✓	✓
MARIE KEASEY					–	–
Marcus Ryan					✓	✓
Nancy Skillings					✓	✓

Personal information on this form is collected under the authority of the Conservation Authorities Act and will be used for the purposes of the Embro Dam Class EA only. Questions about the collection of personal information should be directed to: General Manager, Upper Thames River Conservation Authority, 1424 Clarke Rd., London, Ontario. N5V 5B9, (519) 451-2800.

…rrington Dam Class EA

ecosystem recovery inc. PROFESSIONAL ENGINEERS

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Name (print)	Full Address	Mailing address (if different)	Phone #	Email (print)	Would like to receive: (please check mark)	
					Notices	PIC materials
DOUG DIPLOCK	[redacted]				✓	✓
DOROTHY COURTNAGE						
BRENDA KRANTZ					✓	✓
WENDY WILLMS					✓	✓
PHILIP KERR					✓	✓
Alycin Hayes					✓	✓
DAVE BLUM					✓	✓

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Name (print)	Full Address	Mailing address (if different)	Phone #	Email (print)	Would like to receive: (please check mark)	
					Notices	PIC materials
David + Joan WINDLER	[redacted]				✓	✓
Tim VAN DE KEMP					✓	✓
Jennifer Hewitt + Luther					✓	✓
John McVURKIN						

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Name (print)	Full Address	Mailing address (if different)	Phone #	Email (print)	Would like to receive: (please check mark)	
					Notices	PIC materials
JOE & ANNA EBERT	[redacted]				✓	
BRENDA BLUM					✓	
Margaret Lupton						✓

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Name (print)	Full Address	Mailing address (if different)	Phone #	Email (print)	Would like to receive: (please check mark)	
					Notices	PIC materials
Hazel Hewitt		[redacted]	[redacted]	[redacted]		
George Roberts				[redacted]		
John Murkin				[redacted]		

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UPPER THAMES RIVER CONSERVATION AUTHORITY

Upper Thames River Conservation Authority
Harrington Dam
Class Environmental Assessment

ecosystem recovery inc. PROFESSIONAL ENGINEERS

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THERE ARE OLD (VICTORIAN) STRUCTURES THAT DO NOT MEET CURRENT SAFETY ~~STRU~~ GUIDLINES, BUT THEIR CONTINUED EXISTANCE IS ESSENTIALLY "GRAND FATHERED" IN BECAUSE OF THERE AGE.

Thank you for your participation.

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Name: MILES POTTER

Address & Postal Code: [redacted]

E-mail Address: [redacted]

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- This pond is integral to the identity & existence of Harrington, historically and recreationally. Harrington will cease to exist without it.
- Wells (shallow dug, approx. 12) will go dry without the pond

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Name: Philip Kerr

Address & Postal Code: [redacted]

E-mail Address: [redacted]

UPPER THAMES RIVER
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I suggest the Harrington area community be Recruited and involved in the wildlife observations & studies. ~~?~~ Wildlife Research is my area of expertise and I would also like to be involved.

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wolfgang.wolter@ecosystemrecovery.ca

Name: Alycin Hayes

Address & Postal Code: [redacted]

E-mail Address: [redacted]

UPPER THAMES RIVER
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Upper Thames River Conservation Authority

Harrington Dam

Class Environmental Assessment

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Public consultation is a key component of this study. Although the study is in an early stage, the project team welcomes public input and comments, and will incorporate them into the planning and design of this project. Please provide any comments in the space provided below.

I have lived across the street from the mill for 15 years and want to comment on the significance of the millpond & dam to the community. It is very important to me and others that this be protected — it has significant historical value! My property and much of this area has wet areas - springs and artesian wells - so the wetness is not necessarily a reflection of dam structure. The importance of keeping the millpond & dam is very important

Thank you for your participation.

Please print your name and address below, and leave your completed Comment Form in the box provided.

You may also email your comments to harrington_dam@thamesriver.on.ca, or mail/fax your comments to:

Mr. Rick Goldt, C.E.T.
Supervisor, Water Control Structures
Upper Thames River Conservation Authority
1424 Clarke Road
London, Ontario, N5V 5B9
Tel: 519-451-2800 ext. 244
Fax: 519-451-1188
goldtr@thamesriver.on.ca

Mr. Wolfgang Wolter
Senior Project Manager
Ecosystem Recovery Inc.
550 Parkside Drive, Unit B1
Waterloo, Ontario, N2L 5V4
Tel: 519-621-1500
Fax: 226-240-1080
wolfgang.wolter@ecosystemrecovery.ca

Name: Nancy Skellings

Address & Postal Code [redacted]

E-mail Address [redacted]

JUNE 25/15

Suggestion:

When selecting dams to visit as part of a tour, include dams (if any nearby) that demonstrate approaches to revenue generation. If there are not any nearby, please at least do a vigorous literature search of possible revenue [redacted] creation ideas.

Sam Co[redacted]

Harrington and Area Community Ass0ciation
(HACA)

c/o Doug Diplock , Chair

Harrington Pond Environmental Assessment Team

Dear Team Members,

During your enquiries and assessments you will have come to realize the many species of birds, animals, plants, insects, and amphibians that call the Pond and the area around it home. These species form an ecosystem that has developed to be dependent on the Pond for its existence.

Aside from the obvious environmental benefits of a healthy ecosystem what does the existence of The Pond, from a human perspective, mean to people who live in the area and to visitors?

The Pond in Harrington has always been a focal point of the village and people who live in various parts of Ontario have always associated Harrington with The Pond. Residents who live here often describe the location of their homes as being east of The Pond or West of The Pond, or just below The Pond or even, in deed, on The Pond. The Pond, and the Grist Mill, early on, became the reason for Harrington's existence and is one of the historical links to our cultural heritage in this small village.

The Mill was originally built in 1847 and is one of the few remaining historical structures from that era that provides a very real link to History. The Mill, and the Millpond, have existed in a symbiotic relationship for well over 150 years. The Mill, millpond, and surrounding natural ecosystem form a cultural landscape that would be threatened by the loss of an integral component of this landscape – The Pond.

The Harrington and Area Community Association (HACA) is an incorporated entity, with an elected board and membership, as the name implies, of residents who currently or in the past, have lived in the area. The Association is deeply involved in Community Issues.

In 1999 HACA entered into an agreement with UTRCA for the management and maintenance of the Harrington Conservation Area including the Grist Mill.

The volunteers in the area have worked countless hours, raised significant amounts of money, and obtained Provincial and Municipal Grants to assist in the restoration of the Mill. Part of the restoration process will see the Mill again functioning as before, with power being supplied by the water from the Pond.

HACA has worked closely with Government Agencies, Township Officials, outside Agencies and other Service Clubs to enhance enjoyment of the Conservation Area. All of these activities within the Conservation Area use the Pond as a focal point.

A fishing derby, held on the opening of trout season each spring, attracts hundreds of young children and for some, it is an introduction to fishing and outdoor activities that will continue for a lifetime.

During the spring and summer months and into the early fall the Pond is visited by hundreds of fishermen and fisherwomen on a regular basis. Some have even stated it is the only fishing hole they have found that is accessible by wheelchair-bound individuals.

Each August a BBQ is held on the banks of The Pond, attended by individuals from all across South Western Ontario. The BBQ is a major fundraising event for HACA and helps to support many local endeavours such as Concerts, Dances for all ages, Holiday Celebrations and more.

A birding/hiking trail has been established that encircles the Pond and is complete with a viewing stand at the south end of The Pond. Each year, in all Seasons, many hikers and birding enthusiasts use the trail and the opportunity to view wildlife and commune with Nature.

The Village of Harrington, as is all of Zorra, is serviced by Volunteer Firefighters. The Pond is the only source of water in the north section of Zorra that is accessible in winter months and has been vital to the Fire Department on several occasions. A loss of The Pond could be detrimental to safety and well-being of the neighbourhood inhabitants.

Cost, of course, is always an issue, and while the least expensive path would be to, in the absence of any imminent threat to life or property, just leave the Pond as it is, and as it has existed for years. The most expensive path may well be the one that threatens the existence of a small village, a cultural and historical link to our past and a fragile ecosystem.

Any decision made on the future of The Pond will have an impact on all of these issues, and indeed on the existence of the village, the lives of the people in the area and future generations.

The Harrington and Area Community Association respectfully request that all these points be considered as you determine your various recommendations.

Sincerely,

Doug Diplock

Chairperson

Harrington and Area Community Association

From Cathy Eastman – email of July 14, 2015 to UTRCA

I am a resident of Harrington...what drew my husband and I to build our home on the location and with the orientation it has is the Harrington Pond. Moving from London to this little gem of Oxford county was one of the best decisions we made. We exchanged the noise of traffic to the overhead clamour of Canada geese landing on the pond. Our 3 children have spent numerous afternoons either walking around, sitting by or floating on the pond. We have enjoyed identifying the various kinds of wildlife that live in the pond and park area. A quick walk from our home across the mill bridge/dam and we walk past many people fishing in the tranquil setting. This area is enjoyed by not only residents of Harrington, but people travelling from across the county. It is a significant natural resource as a spring fed pond and home to many endangered species...it would be a shame to upset the balance of nature and lose this historic site.

Email from Brand Jul 17, 2015

Wonderful memories of being a youngster and enjoying the facilities. The pond water was crystal clear for swimming. In fact, you might see a fish beside you or even a turtle. The park area was well maintained and family members gathered there for picnics and fishing. I recall the old wooden outhouse, then a modern one with brick blocks (no running water but a real improvement). My mother even pondered the idea of buying and running the convenience store on the main street. As I 'matured' into a teenager, I would bring my girlfriend and sister for swims at the pond. Even our cat, harnessed on a leash, took a walk with my wife while I fished. On becoming a parent, our young daughters would run to their heart's content, roll in the grass and then sit at the picnic table for some refreshments. At times, we would stroll around the pond, remarking on the history of the area. Later as our girls also matured, they took up the hobby of fishing beside their dad.

It is by chance that I became a member of the Tavistock Rod and Gun Club some nearly fifteen years ago. Over the years, the club has held the annual Kids' Fishing Derby on the grounds and stocked the pond with trout. We always had good rapport with the Upper Thames for permits and also with the Harrington Pond Committee. Our Club focus is for the children to fish and enjoy the conservation area. Hopefully this will also encourage the parents to bring them back year after year. Many 'city slickers' were not aware of the pond and the peaceful country setting.

Dave Franks

[redacted]

Ministry of Aboriginal Affairs

160 Bloor St. East, 9th Floor
Toronto, ON M7A 2E6
Tel: (416) 326-4740
Fax: (416) 325-1066
www.aboriginalaffairs.gov.on.ca

Ministère des Affaires Autochtones

160, rue Bloor Est, 9e étage
Toronto ON M7A 2E6
Tél. : (416) 326-4740
Téléc. : (416) 325-1066
www.aboriginalaffairs.gov.on.ca

Ontario

Reference: EA #2015-182

Wolfgang Wolter
Ecosystems Recovery Inc.
B1 – 550 Parkside Drive
Waterloo, ON N2L 5V4

Re: Harrington Dam and Embro Dan Class Environmental Assessments Notice of Intent and First Public Information Centre

Dear Mr. Wolter:

Thank you for informing the Ministry of Aboriginal Affairs (MAA) of your project. Please note that MAA treats all letters, emails, general notices, etc. about a project as a request for information about which Aboriginal communities may have rights or interests in the project area.

As a member of the government review team, the Ministry of Aboriginal Affairs (MAA) identifies First Nation and Métis communities who may have the following interests in the area of your project:

- reserves;
- land claims or claims in litigation against Ontario;
- existing or asserted Aboriginal or treaty rights, such as harvesting rights; or
- an interest in the area of the project.

MAA is not the approval or regulatory authority for your project, and receives very limited information about projects in the early stages of their development. In circumstances where a Crown-approved project may negatively impact a claimed Aboriginal or treaty right, the Crown may have a duty to consult the Aboriginal community advancing the claim. The Crown often delegates procedural aspects of its duty to consult to proponents. Please note that the information in this letter should not be relied on as advice about whether the Crown owes a duty to consult in respect of your project, or what consultation may be appropriate. Should you have any questions about your consultation obligations, please contact the appropriate ministry.

You should be aware that many First Nations and/or Métis communities either have or assert rights to hunt and fish in their traditional territories. For First Nations, these territories typically include lands and waters outside of their reserves.

In some instances, project work may impact aboriginal archaeological resources. If any Aboriginal archaeological resources could be impacted by your project, you should contact your regulating or approving Ministry to inquire about whether any additional Aboriginal communities should be contacted. Aboriginal communities with an interest in archaeological resources may include communities who are not presently located in the vicinity of the proposed project.

With respect to your project, and based on the brief materials you have provided, we can advise that the project appears to be located in an area where First Nations may have existing or asserted rights or claims in Ontario's land claims process or litigation, that could be impacted by your project. Contact information is below:

Six Nations of the Grand River Territory P.O. Box 5000, 1695 Chiefswood Road OHSWEKEN, Ontario N0A 1M0	Chief Ava Hill (519) 445-2201 (Fax) 445-4208 Avahill@sixnations.ca
Oneida Nation of the Thames 2212 Elm Avenue SOUTHWOLD, Ontario N0L 2G0	Chief Sheri Doxtator (519) 652-3244 (Fax) 652-9287 Sheri.Doxtator@oneida.on.ca
Chippewas of the Thames First Nation 320 Chippewa Road R.R. #1 MUNCEY, Ontario N0L 1Y0	Chief Richard "Joe" Miskokomon (519) 289-5555 (Fax) 289-2230 chief@cottfn.com cdeleary@cottfn.com
Haudenosaunee Confederacy Chiefs Council 2634 6th Line Road RR 2 Ohsweken, ON N0A 1M0	Hohahes Leroy Hill Secretary to Haudenosaunee Confederacy Chiefs Council Cell 519 717 7326 jocko@sixnationsns.com

For your information, MAA notes that the following First Nation may be interested in your project given the proximity of their community or reserve lands to the area of the proposed project or because of your project's potential environmental impacts:

Munsee-Delaware Nation R. R. #1 MUNCEY, Ontario N0L 1Y0	Chief Roger Thomas (519) 289-5396 (Fax) 289-5156 Chief.thomas@munsee-delaware.org

The information upon which the above comments are based is subject to change. First Nation or Métis communities can make claims at any time, and other developments can occur that could result in additional communities being affected by or interested in your undertaking.

Through Aboriginal Affairs and Northern Development (AANDC), the Government of Canada sometimes receives claims that Ontario does not receive, or with which Ontario does not become involved. AANDC's Consultation and Accommodation Unit (CAU) established a "single window" to respond to requests for baseline information held by AANDC on established or potential Aboriginal Treaty and rights. To request information from the Ontario Subject Matter Expert send an email to: UCA-CAU@aadnc-aandc.gc.ca

Additional details about your project or changes to it that suggest impacts beyond what you have provided to date may necessitate further consideration of which Aboriginal communities may be affected by or interested in your undertaking. If you think that further consideration may be required, please bring your inquiry to whatever government body oversees the regulatory process for your project. MAA does not wish to be kept informed of the progress of the project; please be sure to remove MAA from the mailing list.

Yours truly,

Corwin Troje
Manager, Ministry Partnerships Unit
Aboriginal Relations and Ministry Partnerships Branch

Ministry of Tourism, Culture and Sport
Culture Services Unit
Programs and Services Branch
401 Bay Street, Suite 1700
Toronto ON M7A 0A7
Tel. 416 212-7420
Fax: 416 314-7175

Ministère du Tourisme, de la Culture et du Sport
Unité des services culturels
Direction des programmes et des services
401, rue Bay, Bureau 1700
Toronto ON M7A 0A7
Tél. : 416 212-7420
Téléc. : 416 314-7175

Ontario

July 17, 2015 (EMAIL ONLY)

Wolfgang Wolter
Ecosystem Recovery Inc.
550 Parkside Drive, Unit B1
Waterloo, ON N2L 5V4
E: wolfgang.wolter@ecosystemrecovery.ca

MTCS File #: 0003068
Proponent: Upper Thames River Conservation Authority (UTRCA)
Subject: Class Environmental Assessment for the Harrington Dam, Township of Zorra, Oxford County, Ontario

Dear Wolfgang Wolter:

This note is in response to the Notice of Intent and Public Information Centre received by the Ministry of Tourism, Culture and Sport (MTCS) regarding the above noted Environmental Assessment. MTCS's interest in this EA project relates to its mandate of conserving Ontario's cultural heritage, which includes:

- Archaeological resources (land and marine);
- Built heritage (including bridges and monuments); and,
- Cultural heritage landscapes.

MTCS would be interested in receiving digital copies of the slides/information boards available at the first PIC on June 25, 2015. Please feel free to email us digital copies or a link to the appropriate website.

While some cultural heritage resources may have already been formally identified, others may be identified through screening and evaluation. Aboriginal communities may have knowledge that can contribute to the identification of cultural heritage resources, and we suggest that any engagement with Aboriginal communities includes a discussion about known or potential cultural heritage resources that are of value to these communities. Municipal Heritage Committees, historical societies and other local heritage organizations may also have knowledge that contributes to the identification of cultural heritage resources.

Archaeological Resources

The potential for archaeological resources on these lands needs to be screened for and MTCS's *Criteria for Evaluating Archaeological Potential* can assist with the determination as to whether an archaeological assessment is needed.

Information regarding registered archaeological sites may be obtained through contacting the following email address: *archaeologysites@ontario.ca*. If the EA lands exhibits archaeological potential and there are to be impacts/ground disturbance, then an archaeological assessment (AA) by an *OHA* licensed archaeologist, who is responsible for submitting the report to MTCS for review, is needed.

Built Heritage and Cultural Heritage Landscapes:

Here is a link to MTCS's *"Criteria for Evaluating Potential for Built Heritage Resources and Cultural Heritage Landscapes"*; it determines whether the EA lands may impact known or potential built heritage resources and cultural heritage landscapes. Dams and any associated structures have the potential for cultural heritage value.

MTCS's has *Info Sheet #5: Heritage Impact Assessments and Conservation Plans* which outlines the scope of HIAs. Please send HIAs to MTCS for review, and make them available to local organizations or individuals who have expressed interest in heritage. The HIA report and its recommendations should be considered as part of the EA process.

Environmental Assessment Reporting

All technical heritage studies and their recommendations are to be addressed and incorporated into EA projects. Please advise MTCS whether any technical heritage studies will be completed for your EA project, and provide them to MTCS before issuing a Notice of Completion. If your screening has identified no known or potential cultural heritage resources, or no impacts to these resources, please include the completed checklists and supporting documentation in the EA report or file.

Thank you for the opportunity to provide input on the Class Environmental Assessment for the Harrington Dam. MTCS remains interested in remaining on the circulation list and continue to be informed as the EA process proceeds. Please do not hesitate to contact MTCS if you have any questions regarding the above.

Sincerely yours,

Penny Young
Penny.Young@Ontario.ca
Heritage Planner
Culture Services Unit
t. 416-212-7420

cc: Rick Goldt, Upper Thames River Conservation Authority

Please notify MTCS if archaeological resources are impacted by EA project work. All activities impacting archaeological resources must cease immediately, and a licensed archaeologist is required to carry out an archaeological assessment in accordance with the Ontario Heritage Act and the Standards and Guidelines for Consultant Archaeologists.

If human remains are encountered, all activities must cease immediately and the local police as well as the Cemeteries Regulation Unit of the Ministry of Government and Consumer Services must be contacted. In situations where human remains are associated with archaeological resources, MTCS should also be notified to ensure that the site is not subject to unlicensed alterations which would be a contravention of the Ontario Heritage Act.