# Appendix I

# Hydrogeology Report

GENIVAR

101-17262-00

October 31, 2013

Bruce Grundon
GENIVAR Inc.
600 Cochrane Drive, Suite 500
Markham, ON  L3R 5K3

**Re: Mayfield Road Environmental Assessment**
**Existing Conditions - Hydrogeology**

Dear Mr. Grundon:

Please find attached a hydrogeological assessment of the proposed alternatives for the improvements to Mayfield Road between Chinguacousy Road and Heart Lake Road.

Should you have any questions or comments, please don't hesitate to contact the undersigned.

Yours truly,
**GENIVAR Inc.**

Derek S Brunner

Derek S. Brunner, M.Sc., P.Geo.
Hydrogeologist / Project Manager

/db

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## List of Figures

# 1. Introduction

## 1.1 Background

The Region of Peel (the Region) retained GENIVAR Inc. (GENIVAR) to undertake a Schedule C Class Environmental Assessment (EA) for Mayfield Road between Chinguacousy Road and Hurontario Street and from Hurontario Street to Heart Lake Road in Brampton (Figure 1). The study is expected to provide appropriate long-term improvement alternatives for the horizon year 2031. As part of the EA process, a hydrogeological study is required for the project alignment to determine any issues related to groundwater, private water well users or the natural environment. The current condition of the road is four lanes between Heart Lake Road and Hurontario Street (planned to be 6 lanes by 2031) and two lanes between Hurontario Street and Chinguacousy Road (also planned to be 6 lanes by 2031). The bridge crossing Etobicoke Creek has already been designed to accommodate six lanes. The four-lane section between Heart Lake Road and Kennedy Road was constructed on caissons to prevent settling due to the presence of peat beneath the road.

As part of the hydrogeological assessment, the geological and hydrogeological conditions along the proposed route were reviewed. A general overview of the conditions expected along Mayfield Road is provided. In addition, specific areas of concern identified in the overview were more closely examined. These areas include proposed creek and wetland crossings.

## 1.2 Scope of Work

The assessment involved review of existing geological mapping, a cross-section from the YPDT model, geotechnical reports and MOE water well records within 500 m of the proposed alignment. Along with a general overview of the geological and hydrogeological conditions, the local shallow subsurface conditions within the specific areas of concern have been discussed in greater detail.

# 2. Site Description

## 2.1 Physiography

The project site is located within the South Slope physiographic region (Chapman and Putnam, 1984), just south of the Oak Ridges Moraine. It is in the area north of the Peel Plain that is also commonly referred to as the “North Slope” (Karrow, 2005) although it is considered part of the South Slope. The ground surface consists of gently undulating till plain with limited relief. Thin lake sediments are found in low-lying areas, similar to those found within the Peel Plain. Two physiographic features dominate the landscape. The Kelso moraine is a low till ridge located just to the north running parallel to Mayfield Road. North of the ridge is a linear depression containing lake sediments. Etobicoke Creek flows through this area and around the east end of the ridge. Tributaries to Fletcher Creek rise off of the south side of the moraine. The second feature is the Brampton Esker, which rises north of Mayfield Road and runs in a southerly direction between Kennedy Road and Heart Lake Road. This is a palimpsest landform, as it occurred during a previous glacial period, and the land surface inherited its form from this feature. Deposition of the esker likely took place in an ice front re-entrant bordering glacial lake Peel (Karrow, 2005). It is a ridge of sand and gravel that is approximately 7 km long, 0.2 – 0.6 km in width, and 15 m high. Kettle holes and bogs are common along this feature, typically in the form of steep-sided depressions. Heart Lake is the most prominent of these kettle features. Till covers most of the esker, from 1-3 m in thickness.

## 2.2 Drainage

The study area falls within two watersheds, separated by a low ridge just north of Mayfield Road. On the south end of this ridge from Chinguacousy Road to approximately the CPR crossing, tributaries to Fletcher’s Creek drain to the south, where it enters the Credit River at Meadowvale. A number of these

tributaries cross Mayfield Road, though most of them are dry at most times of the year. The lands to the east of the CPR crossing are drained by Etobicoke Creek. The headwaters flow from the north side of the Kelso moraine and around the east end, before draining south through Brampton, past the west side of Pearson Airport and into Lake Ontario. The main branch of Etobicoke Creek crosses Mayfield Road between Hurontario Street and Kennedy Road.

## 2.3 Land Use

The study area is currently situated at the edge of development within the City of Brampton. Most of the area south of Mayfield Road is developed, except between McLaughlin and Chinguacousy, where agricultural land dominates. To the north is mostly agricultural, with the exception of the community of Snelgrove, located in the vicinity of Hurontario Street. A significant portion of the land between Kennedy Road and Heart Lake Road is covered by wetlands.

# 3. Regional Geology and Hydrogeology

## 3.1 Surficial Geology

Surficial geology in the study area generally consists of the sandy silt to silty clay Halton Till. Depressions in the gently undulating surface tend to contain thin (1 – 3 m thick) and discontinuous layers of glaciolacustrine silts and clay. Recent alluvial deposits are located in the floodplain of Etobicoke Creek. Peat and bog deposits are found between Heart Lake Road and Kennedy Road, associated with the Brampton Esker. Surficial geology is provided in Figure 2.

## 3.2 Subsurface Geology

The subsurface stratigraphy has been described by Karrow (2005) and is presented from youngest to oldest as follows:

- Recent Alluvium
- Organic Deposits
- Glaciolacustrine Deposits
- Halton Till
- Maple Formation
- Newmarket Till
- Sunnybrook Drift
- York Till

**Recent alluvium** is generally associated with deposition in the floodplains of modern watercourses. It consists of a wide range of geological materials, from gravel to sand to silt to clay. Organic material is also common in some areas. They tend to be thin (1 – 3 m) and extend at most 100 – 200 m from the streams.

**Organic deposits** in the study area tend to be associated with depressions exhibiting poor drainage, such as in the kettle bogs of the Brampton Esker. Accumulations of muck and peat are common in these areas, and tend to provide unstable ground conditions for construction. They can be anywhere from 2 – 5 m in thickness and may be thicker in places.

**Glaciolacustrine deposits** generally consist of fine grained silt and clay and are generally found in depressions within the study area. They are often laminated and display cyclic deposition / rhythmites.

They tend to be thin and discontinuous (1 – 3 m in thickness) and are likely related to deposition in glacial lakes (such as Lake Peel).

**Halton Till** is found at ground surface over most of the study area and is the youngest till present. It is composed of sandy silt to silty clay and is generally up to 10 m in thickness in the study area. The Kelso moraine is composed of Halton Till. The Halton Till is considered to be an aquitard.

**Maple formation** is the loose definition given to the varied sediments that underlie the Halton Till. They consist of an assemblage of ice-contact outwash and glaciolacustrine deposits that were rapidly deposited over wide areas during glacial retreat. The Brampton Esker is considered to be part of the Maple formation. Some of these materials can be considered as aquifers.

**Newmarket Till** is a stony sandy till that underlies the surficial Halton Till and Maple formation. It is considered to be an aquitard.

**Sunnybrook Drift** is a clayey to silty till that underlies the Newmarket Till. This till likely pinches out against the rising bedrock surface, but may be present in the deep buried valley at Meadowvale.

**York Till** is a sandy clay till with a large number of shale clasts. It is not expected to be found west of the Humber River.

## 3.3 Bedrock Geology

Bedrock in the study area likely consists of the reddish brown Queenston Shale. Available mapping suggests that there are areas where bedrock is quite shallow (less than 8 m), such as between the CPR tracks and just west of McLaughlin Road. In other locations, drift thickness maps suggest that the bedrock is almost 50 m below ground surface (bgs). A bedrock valley is indicated in a bedrock topography map in the area of Heart Lake Road (White, 1975). Karrow (2005) also mentions a bedrock valley that extends from Snelgrove (Mayfield Road and Hurontario Street) to Long Branch (Lake Ontario) that is 10 – 30 m deep.

# 4. Local Geology and Hydrogeology

Local geology and hydrogeology along the project alignment were investigated using the following sources:

- Cross-section from the YPDT conceptual model
- MOE water well records along Mayfield Road
- Previous geotechnical investigations along the route
- Shop drawings for previous widening of Mayfield Road

## 4.1 YPDT Conceptual Model

A cross-section was obtained from YPDT-CAMC along the study alignment to provide a preliminary conceptual representation of the underlying stratigraphic units (Figure 3). The section shows Halton till at ground surface over the entire study area in thicknesses ranging between 5 m and 25 m. It overlies the Oak Ridges Moraine (ORM) or equivalent unit west of Chinguacousy Road, which is up to 10 m thick and directly overlies bedrock. Between Chinguacousy Road and McLaughlin Road, the Halton Till directly overlies up to 10 m of Newmarket Till and bedrock, which rises to about 10 m bgs. East of McLaughlin, the ORM underlies the surface till and is found atop the downward sloping bedrock surface, becoming up to 20 m in thickness just East of Hurontario Street. It thins from 10 m to nearly absent beneath Heart Lake Road. Beneath the ORM is the Thorncliffe formation aquifer, which is interpreted to be up to 30 m in thickness and overlying bedrock. The ORM and the Thorncliffe formation are separated by a thin wedge of Newmarket Till (up to about 8 m in thickness) east of Kennedy Road.

The section is missing several key units described in the previous section, including recent alluvium, organics, Sunnybrook and York Tills. It is likely that the “ORM or equivalent” in the figure refers to the Maple formation of Karrow (2005).

## 4.2 MOE Water Well Records

Water well records were obtained from MOE within 500 m of the study area (Figure 4). Wells along Mayfield road were selected and plotted on a cross-section (Figure 5). In the western portion of the alignment in the vicinity of Chinguacousy Road, clay is found at ground surface between 5 and 25 m in thickness. The clay contains up to 10 m thick layers of silt, sand and gravel, and overlies bedrock, which ranges between 15 and 50 m bgs. Bedrock rises to 5 – 10 m bgs towards McLaughlin Road, and is overlain by clay. As the alignment approaches Hurontario Street, depth to bedrock increases to approximately 40 – 50 m bgs. The overburden becomes more complex as well. While a thin layer of clay is still found at ground surface (5 – 10 m in thickness), beneath this unit are interbedded layers of sand, silt and clay of varying thicknesses. These conditions persist towards Heart Lake Road, where the surficial clays become much thicker (15 – 40 m) with isolated sand, silt and gravel pockets. Groundwater levels identified in the MOE database were sporadic and typically were located near the bottom of the well. As such, these data are not considered to be a reliable indicator of actual groundwater conditions.

The data found in the MOE water well database was found to be much more complicated than the interpretations provided by the YPDT cross-section. Aside from surficial clays being identified across the entire study area, no specific regional aquifer / aquitard relationships could be determined from the data.

## 4.3 Geotechnical Investigation

A series of geotechnical investigations were undertaken as part of the previous widening of Mayfield Road between Hurontario Street and Heart Lake Road (Thurber, 2003; Thurber, 2005; Thurber, 2007; Atlas Dewatering, 2009) and as part of watermain installation from Kennedy Street to Heart Lake Road (JEGEL, 2005). The initial investigation (Thurber, 2003) considered ground conditions in the area around the bridge crossing of Etobicoke Creek and the wetland areas adjacent to the road between Kennedy Road and Heart Lake Road. The general conditions in the vicinity of the creek crossing consisted of fill overlying recent alluvial deposits, overlying layers of non-cohesive sands and silts. Groundwater was measured to be very close to ground surface. The wetland areas posed more of a challenge, as thick deposits of peat were found. The discovery of these deposits was the impetus behind the investigations that followed.

Subsequently, boreholes were advanced along the road and in the wetland areas to determine the thickness of the peat and to provide a work plan for the construction of the road and two stormwater management (SWM) ponds. The investigations showed varying thicknesses of peat below ground surface overlying soft clayey silt, overlying layers of sand / silt and clay. Groundwater levels were found to be at ground surface within the wetlands. The peat and other compressible soils were seen as a considerable challenge in the construction of the road.

## 4.4 Shop Drawings

During road construction, the base of the peat layer was generally found to be about 5 m bgs, although in places it was identified to be almost 15 m bgs. Due to the instability and thickness of the peat, dewatering methods were not used during the construction of the road. Instead, a large number of caissons were installed to support the road and prevent significant settling. Based on this information, it is expected that the conditions in the vicinity of the wetlands are going to be similar to those encountered during the current widening of the road, and that significant thicknesses of peat will be encountered. This is particularly true on the north side of the road.

# 5. Receptors

The two types of receptors identified in this report are private water wells and natural environmental features. These items are discussed below. A discussion of contaminated soils and groundwater is provided under separate cover.

## 5.1 Private Wells

Approximately 150 water well records were identified within 500 m of the study alignment (Figure 4). Of these records, it is likely that there are a much lower number of water wells still in use due to increased development. It is estimated that residential wells may still be in use in the rural part of the alignment west of McLaughlin Road. There are also several properties in the serviced areas east of this that may still utilize water wells for their source of supply. Based on existing mapping, there could be anywhere between 12-15 properties with wells potentially still in use.

## 5.2 Natural Environment

Several types of environmental features were identified along the study alignment, including watercourses, wetlands, woodlots and areas of natural and scientific interest (ANSIs). These features are discussed briefly in the following sections. A more thorough discussion of environmental features is provided under separate cover.

### 5.2.1 Watercourses

As discussed in section 2.2, the study area falls within two watersheds. The western portion of the alignment is within the Fletcher's Creek watershed. As shown in Figure 1, ten tributaries of Fletcher's Creek cross Mayfield Road. These tributaries arise from the Kelso Moraine just north of Mayfield Road and drain south. However, most of these are intermittent. Groundwater discharge has not been observed in these tributaries (Philips Engineering, 2008). It should be noted that downstream of the study area, Fletcher's Creek provides habitat for Redside Dace. As such, these crossings must be considered with caution.

The eastern portion of the alignment is within the Etobicoke Creek watershed. The main branch of Etobicoke Creek crosses Mayfield Road just east of Hurontario Street. Two other tributaries cross nearby. Two additional potential crossings occur in the wetland complex between Kennedy Road and Heart Lake Road. These discharge into Spring Creek, which is a tributary to Etobicoke Creek. Significant groundwater discharge was noted within the main branch of the creek north of the Kelso Moraine (Philips Engineering, 2008).

### 5.2.2 Wetlands

Several wetlands were identified along the project alignment (Figure 1). Of these wetlands, the ones of greatest concern are found between Kennedy Road and Heart Lake Road. The wetlands are within the Heart Lake Conservation Area and are known to contain significant thicknesses of peat (see Section 4.3). The wetlands in this system located south of Mayfield Road near Heart Lake Road are within an earth science and life science ANSI, and are protected.

### 5.2.3 Woodlots

Several woodlots were identified along the project alignment (Figure 1). Most of them are associated with Etobicoke Creek or the Heart Lake Conservation Area. However, one large woodlot is located south of Mayfield Road between Chinguacousy Road and McLaughlin Road.

# 6. Evaluation of Alternatives and Mitigation

For the purposes of evaluating alternatives for Mayfield Road, the study area was divided into the following sections:

- Chinguacousy Road to McLaughlin Road
- McLaughlin Road to Orangeville Rail
- Orangeville Rail to Hurontario Street
- Hurontario Street to Snelgrove Bridge
- Snelgrove Bridge to Kennedy Road
- Kennedy Road to Stonegate Drive
- Stonegate Drive to Heart Lake Road

For each of the sections, the following general design alternatives were provided for further evaluation:

- Widening to the North Side Only
- Widening to the South Side Only
- Widening to both the North and South Sides

From a hydrogeological perspective, there is generally little difference between any of the alternatives, since the subsurface conditions typically don't change substantially over short distances. However, there are two particular items to consider:

- Wetlands to the north of Mayfield Road between Heart Lake Road and Kennedy Road
- Residential wells and septic systems along the study alignment

These are discussed in more detail in the following sections.

## 6.1 Wetlands between Heart Lake Road and Kennedy Road

There is a large wetland area north of Mayfield Road between Heart Lake Road and Kennedy Road as discussed in Sections 4.3 and 5.2.2. . Previous investigations showed varying thicknesses of peat below ground surface overlying soft clayey silt, overlying layers of sand / silt and clay. Groundwater levels were found to be at ground surface within the wetlands. These compressible soils have been a considerable challenge in the construction of the existing road, which included numerous geotechnical investigations and the use of caissons as a road base. As such, any additional widening outside of the existing allowance to the north is expected to require extensive work and thus would not be preferred from a hydrogeological perspective. However, should the preferred alternative require some expansion to the north, a detailed hydrogeological assessment should be undertaken during the detailed design phase, including:

- Additional boreholes / monitoring wells in the affected area(s).
- Single well hydraulic testing of monitoring wells (slug tests).
- Assessment of whether additional hydraulic testing is required (pumping tests).
- Assessment of impacts to the wetlands.
- Provide input into the design process.

- Discussion of potential dewatering requirements and the need for a Permit to Take Water (PTTW).
- Preparation of a monitoring and mitigation plan during construction.

## 6.2 Residential Wells and Septic Systems

Based on existing aerial photography, there are several areas remaining that may be serviced by residential wells and septic systems. The first is west of McLaughlin Road, which is still rural. For this area, the following measures are recommended during the design phase:

- A residential well survey should be conducted to determine the location and use of private water wells and septic systems.
- Baseline water quality sampling and groundwater levels should be taken as part of the survey.
- Recommendations should be provided as to the potential for decommissioning / replacement of any infrastructure that is located within the proposed new road allowance.
- Recommendations should also be provided as to the potential for well interference during construction and mitigative measures to be implemented, including provision of a temporary water supply.

Over the remainder of the route, there may be scattered water wells present even though most of the area is municipally serviced by water and sewer. A well survey should be undertaken to identify any homes that may still have wells and / or septic systems. This should include water quality sampling, groundwater levels, recommendations for decommissioning / replacement of infrastructure within the proposed new road allowance, and recommendations for dealing with well interference complaints, including provision of a temporary water supply or hookup to the municipal system.

# 7. Conclusions and Recommendations

## 7.1 Conclusions

The study area is located in the South Slope Physiographic Region, which consists of undulating till plains with limited relief. The major surface material is Halton till, which is up to 10 m thick. Recent alluvium consisting of gravel, sand, silt and clay is expected in the vicinity of Little Etobicoke Creek, and organic deposits of muck and peat are found in the wetland complex on the north side of Mayfield Road between Heart Lake Road and Kennedy Road. Groundwater was noted to be near ground surface in the vicinity of the wetlands, and some upwelling into Spring Creek north of Mayfield Road. Private wells are expected to be in use west of McLaughlin Road, which is a rural area. There may be some residences on private wells east of this, however.

The study area was divided into seven segments for the purposes of the EA, and the proposed alternatives for each included widening to the north, to the south, or a combination of the two. Generally, there is little difference between any of the alternatives from a hydrogeological perspective, since the subsurface conditions typically don't change substantially over short distances. However, the south side of Mayfield Road between Kennedy Road and Heart Lake Road is preferred due to the presence of peat in the subsurface on the north side. Also, residences that use private well and septic systems may be impacted by construction.

## 7.2 Recommendations

Based on the conclusions above, the following recommendations are provided:

- Additional widening outside of the existing allowance into the wetlands is expected to require extensive effort, so a detailed hydrogeological assessment should be undertaken during the design phase if the preferred alternative includes expansion to the north. This assessment should include additional boreholes, slug testing, assessment of pumping test requirements (if any), assessment of impacts to the wetlands, input to the design, potential for dewatering and a PTTW, and preparation of a monitoring and mitigation plan.
- A residential well survey should be conducted to determine the location and use of private water wells and septic systems in the study area. The survey should include baseline water quality sampling and groundwater levels, recommendations for the potential decommissioning / replacement of any infrastructure that is located within the proposed new road allowance, and recommendations for potential well interference during construction and mitigative measures to be implemented.

# 8. References

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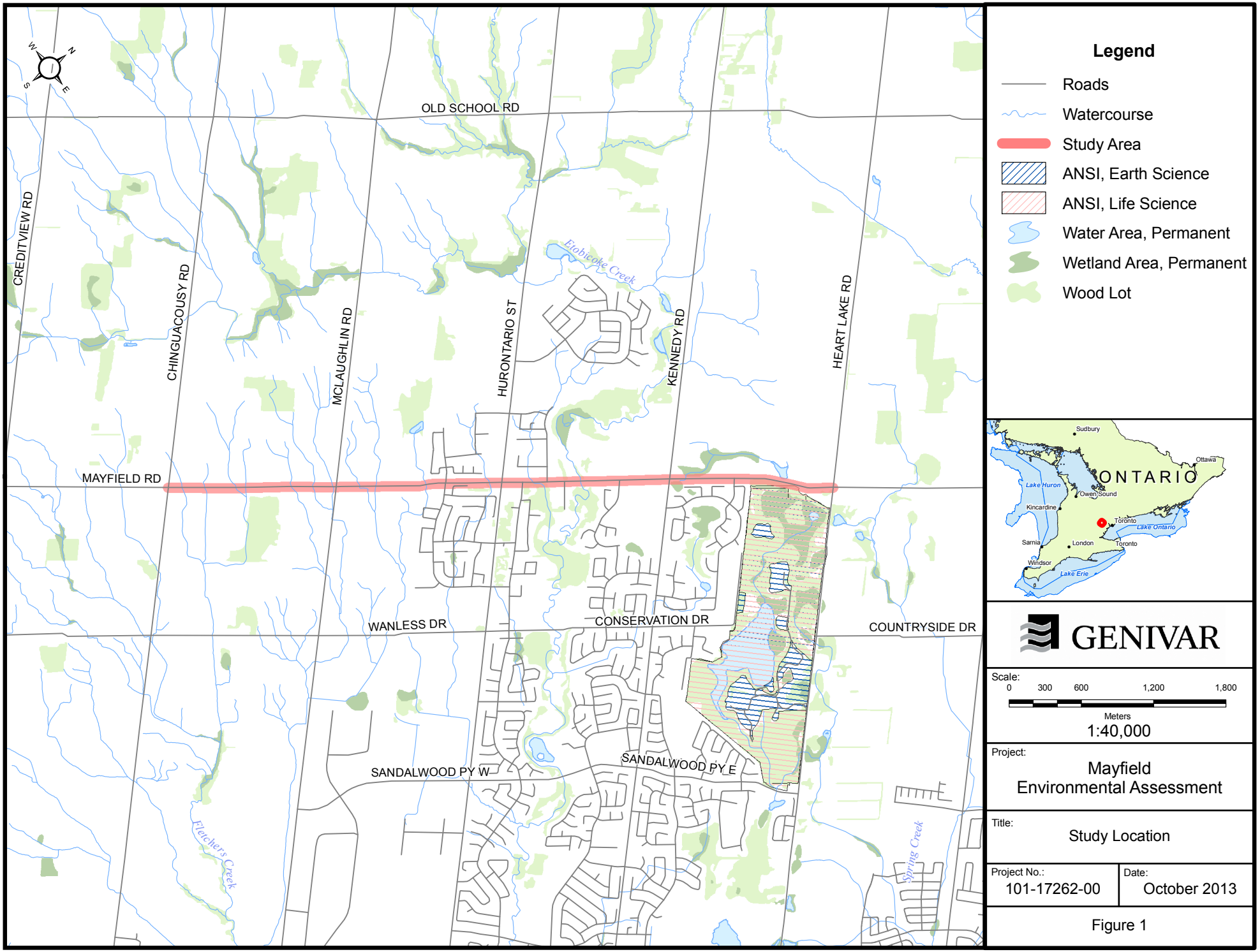
# Figures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MAYFIELD RD
WANLESS DR
CONSERVATION DR
COUNTRYSIDE DR
SANDALWOOD PY W
SANDALWOOD PY E
Fletchers Creek
Spring Creek
Legend
Roads
Watercourse
Study Area
ANSI, Earth Science
ANSI, Life Science
Water Area, Permanent
Wetland Area, Permanent
Wood Lot
Sudbury
Ottawa
ONTARIO
Lake Huron
Owen Sound
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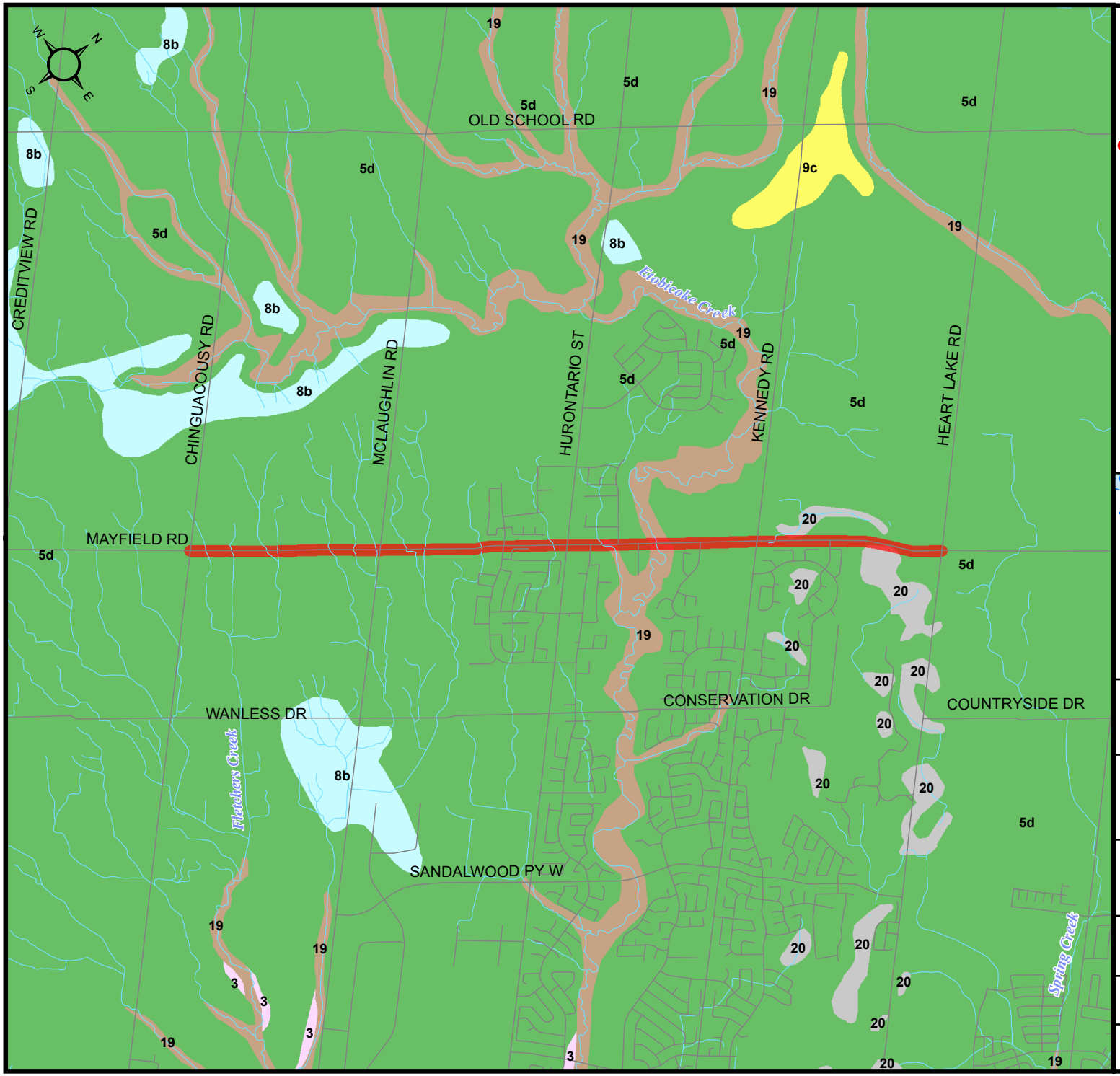
Study Location
Project No.:
101-17262-00
Date:
October 2013
Figure 1




## Legend

- Roads
- Watercourse
- Study Area

**Surficial Geology**

- 3: Paleozoic bedrock
- 5d: Glaciolacustrine-derived silty to clayey till
- 8b: Interbedded flow till, rainout deposits and silt and clay
- 9c: Foreshore-basinal deposits
- 19: Modern alluvial deposits
- 20: Organic deposits


GENIVAR

Scale:
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Meters
1:40,000

Project:
Mayfield
Environmental Assessment

Title:
Surficial Geology

| Project No.: | Date: |
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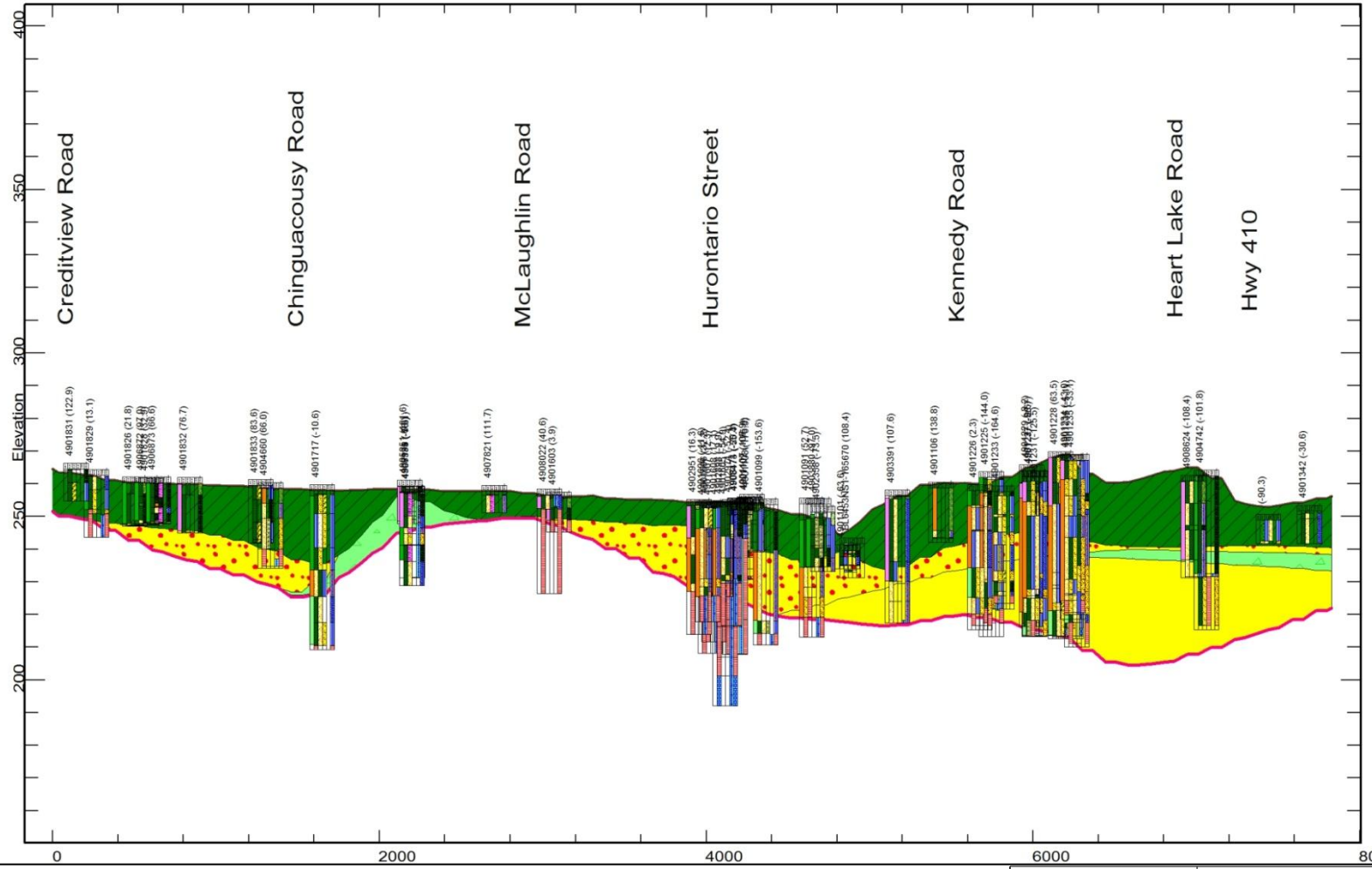
| 101-17262-00 | October 2013 |

Figure 2




LEGEND

- BH Locations (SQL)
- Recent Deposits
- Halton Till (2004)
- Oak Ridges (or Equivalent) (2004)
- Newmarket Till (2004)
- Thorncliffe Fm. (2004)
- Sunnybrook Drift (2004)
- Scarborough Fm. (2004)
- Top of Bedrock (2004)

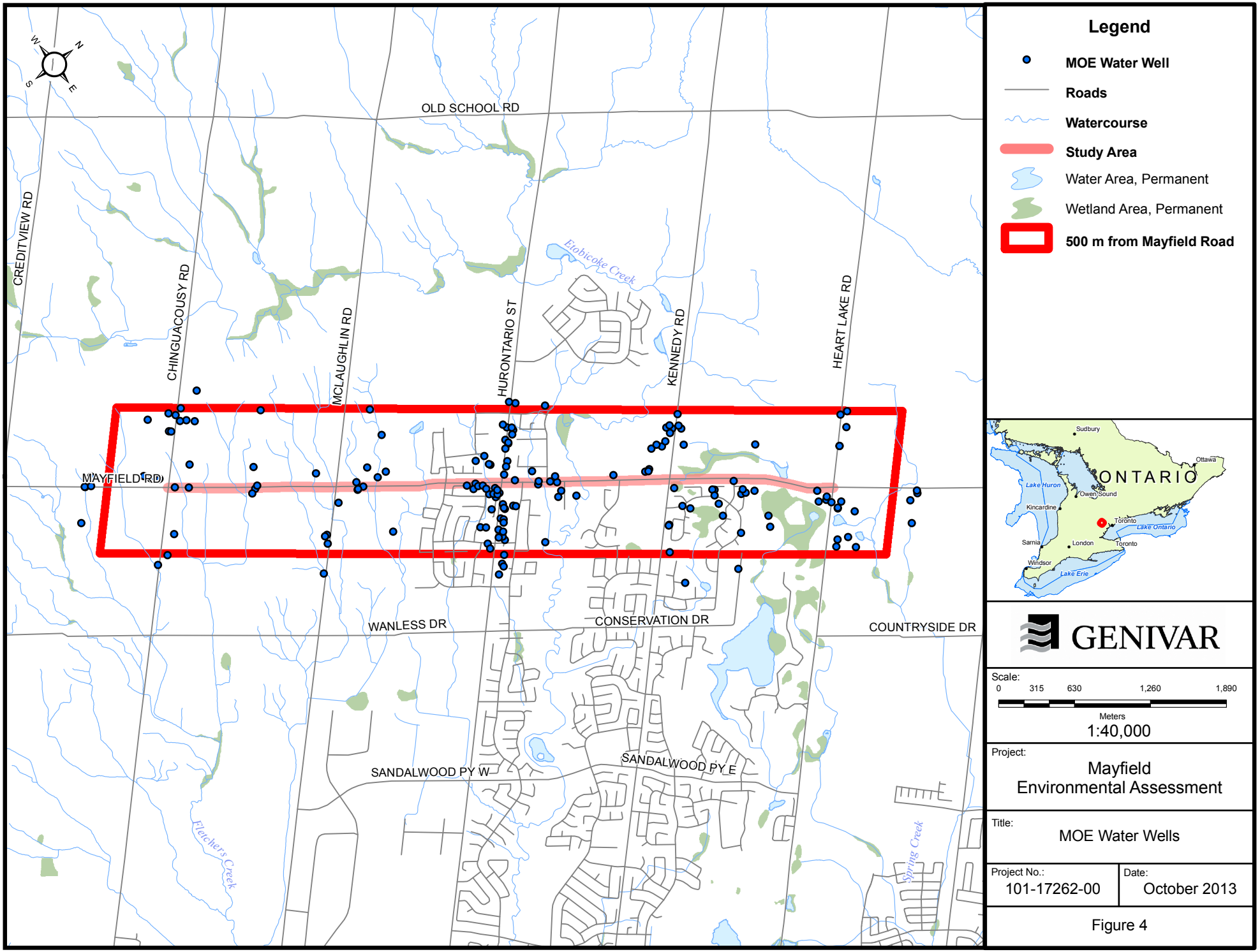
Map Scale (in metres)

0 1000 2000

vertical exaggeration: 20X

Notes:
- Projection: UTM NAD83 Zone 17
- All elevations in metres above sea level
- Date: 3/15/2011

| | |
|---|---|
| CLIENT | CONSULTANT(S) GENIVAR |
| PROJECT TITLE | MAYFIELD ROAD EA |
| DRAWING TITLE | YPDT CONCEPTUAL CROSS-SECTION |
| SCALE | DATE OCTOBER 2013 |
| PROJECT NO. 101-17262-00 | DRAWING NO. FIGURE 3 |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HEART LAKE RD
MAYFIELD RD
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CONSERVATION DR
COUNTRYSIDE DR
SANDALWOOD PY W
SANDALWOOD PY E
Etobicoke Creek
Fletchers Creek
Spring Creek
Legend
MOE Water Well
Roads
Watercourse
Study Area
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Ottawa
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Lake Huron
Owen Sound
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Title:
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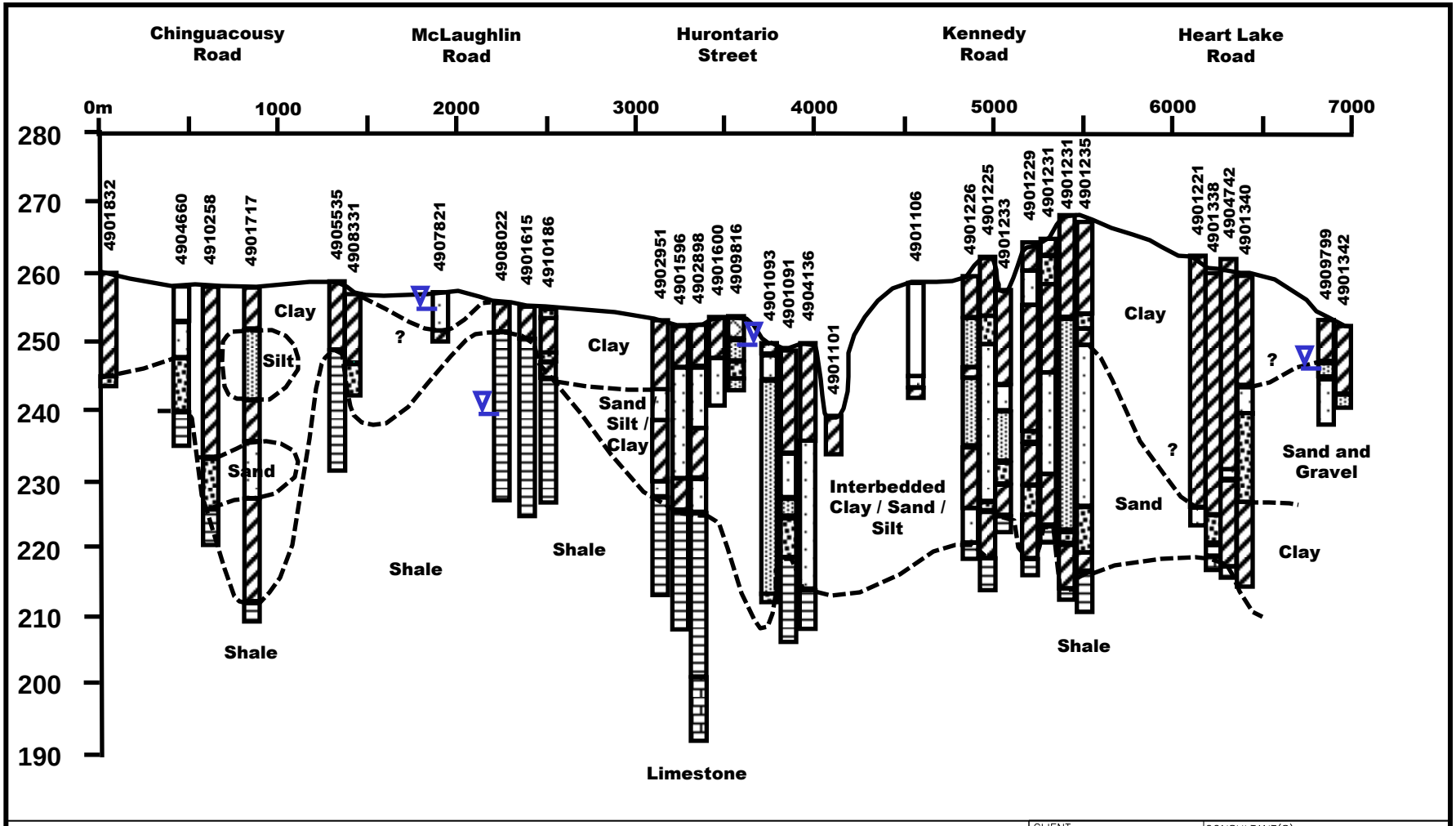
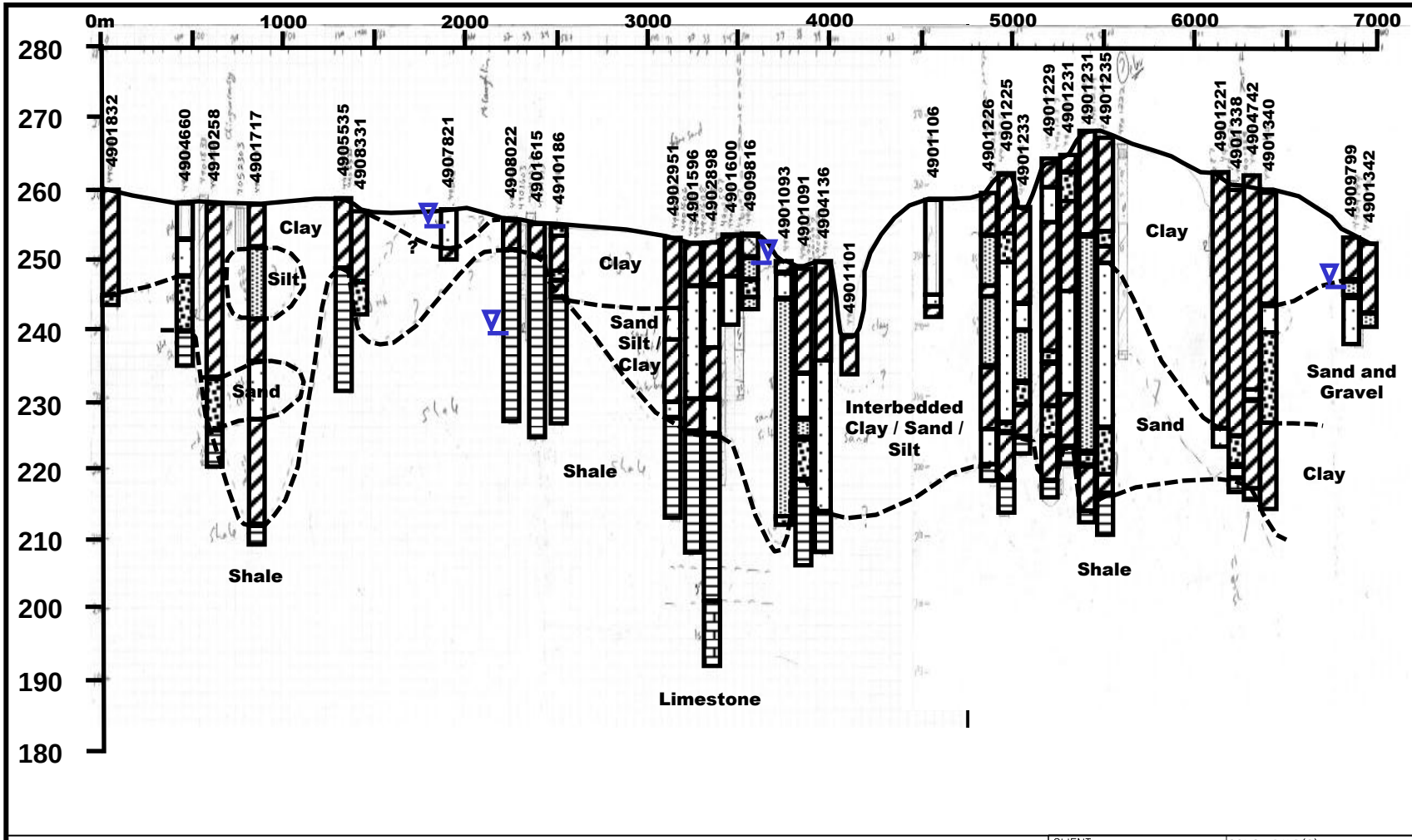
Project No.:
101-17262-00
Date:
October 2013
Figure 4




## Legend

- Fill
- Sand and Gravel
- Sand
- Silt
- Clay / Till
- Shale
- Limestone
- Water Level

| | |
|---|---|
| CLIENT | CONSULTANT(S) GENIVAR |
| PROJECT TITLE | MAYFIELD ROAD EA |
| DRAWING TITLE | CONCEPTUAL CROSS-SECTION FROM MOE WATER WELL RECORDS |
| SCALE | DATE OCTOBER 2013 |
| PROJECT NO. 101-17262-00 | DRAWING NO. FIGURE 5 |




# Legend

- Fill
- Sand and Gravel
- Sand
- Silt
- Clay / Till
- Shale
- Limestone
- Water Level

| | |
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| CLIENT | CONSULTANT(S) GENIVAR |
| PROJECT TITLE | MAYFIELD ROAD EA |
| DRAWING TITLE | CONCEPTUAL CROSS-SECTION FROM MOE WATER WELL RECORDS |
| SCALE | DATE MARCH 2011 |
| PROJECT NO. 101-17262-00 | DRAWING NO. FIG. 4 |