



April 26, 2010  
MTE File: 33867-100

Mr. S. Greenwood  
Greenwood Construction  
R.R. 2  
Orangeville, ON L9W 2Y9

Dear Mr. Greenwood:

**Re: Level I Hydrogeological Investigation  
Greenwood Construction – East Pit  
East ½ Lot 1, Concession 18, Township of East Garafraxa  
County of Dufferin**

MTE Consultants (MTE) is pleased to provide the following Level 1 Hydrogeological Investigation for a proposed Category 3, Class 'A' pit above water located on the East ½ Lot 1, Concession 18 in the Township of East Garafraxa, County of Dufferin (hereby referred to as the "Site" or East Pit). The Site is located southwest of Orangeville (Figure 1). There is an additional proposed Category 3, Class 'A' pit above water located on West ½ Lot 2, Concession 17, in Township of East Garafraxa, County of Dufferin (hereby referred to as the "West Pit") is owned by Greenwood Construction. The study of the West Pit is presented in a separate report.

### **SCOPE OF WORK**

This report is a preliminary hydrogeological investigation for the purpose of determining:

- the final extraction elevation relative to the established groundwater table; and
- potential impacts to an on-Site wetland and to propose mitigation measures to identified impacts (if required).

### **SITE DESCRIPTION**

The Site covers an area of approximately 40 hectares (ha). The Site is roughly divided from East to West by a ridge that rises to 490 metres above mean sea level (mAMSL). Site topography (Figure 2) falls away from this ridge to the southern corners of the Site reaching an elevation of 480 mAMSL. Site topography generally gently rises north of the ridge that bisects the Site reaching a spot elevation of 498 mAMSL (Figure 2) before falling slightly towards the northern corner of the Site.

Ontario base mapping shows a wetland complex along the south-eastern property boundary that represents the closest surface water body to the Site. Figure 2 also shows two further wetland complexes approximately 200 to 400 metres southeast of the Site. OBM mapping shows an intermittent surface water course crossing the northeastern corner of the Site.

The on-Site wetland is bordered to the southeast by the East Garafraxa – Erin Townline Road (Townline Road) with a culvert that connects the on-Site wetland to the south side of the Townline Road. On March 25, 2010, an elevation survey of the culvert inverts was conducted by Greenwood Construction. The elevations of the culvert inverts were determined as follows:

- South Invert – 476.998 mAMSL; and
- North Invert – 476.581 mAMSL.

The culvert invert elevations indicate that the culvert beneath the Townline Road drains the lands south of the Townline Road into the on-Site wetland, and along with local topography suggests that on-Site wetland does not have a drainage outlet.

### **SITE GEOLOGY AND HYDROGEOLOGY**

The Site is located on unsubdivided ice contact stratified drift (Figure 3) that is comprised of sand and gravel including some till or silt (Cowan, 1976). The drift complex, on which the Site resides, is mapped as the Orangeville Moraine and “generally comprises a hummocky to dissected flat topped positive feature” (Cowan, 1976, p. 33). The Orangeville Moraine is described as having two distinct units; a lower glaciofluvial unit consisting of gravel and an upper glaciolacustrine unit of fine sand, silt, and some varved sand and clay (Cowan, 1976). Stratified drift may exceed 30 metres (100 ft) (Cowan, 1976, p. 33).

Three (3) monitoring wells (MW), MW9-09, MW10-09, and MW11-09, were constructed on the Site to explore the thickness of the aggregate resources by Canadian Soil Drilling. Boreholes (BH1 to BH7) have been installed on the neighbouring existing extraction operated by Greenwood Construction. BH8 has yet to be installed but this well identifier has been reserved, at the request of Greenwood Construction, for a future borehole to be installed on the neighbouring existing pit. MW12-09 through MW13-09 were installed on the West Pit as part of a separate Category 3, Class ‘A’ pit above-water-table proposal.

The monitoring wells were equipped with 5 cm diameter PVC groundwater monitoring wells to allow for the collection of groundwater levels and determination of the elevation of the water table. An elevation survey was completed by Van Harten Surveying Inc. to determine the elevation of the top of the casing at each of the monitoring wells.

The geological materials have been described by Canadian Soil Drilling as between 4.57 metres and 7.60 metres of till overlying a sand and gravel sequence in excess of 7.60 metres thick. Wet conditions were observed to occur between 7.60 metres below ground surface (mbgs) and 12.2 mbgs. The location of MW9-09, MW10-09, and MW11-09 are illustrated on Figure 2. Borehole logs are presented in Appendix A.

A mini-piezometer was hand augured, by MTE, into the wetland along the southeastern property boundary to a depth of 1.75 metres below the wetland floor. A thin layer of organic material was observed to overlie a sequence of grey clay in excess of 1.45 metres thick. A 0.45 metre hand slotted screen was constructed at the bottom of the mini-piezometer.

## GROUNDWATER LEVELS AND ELEVATIONS

Following installation, the groundwater monitoring wells and mini-piezometer were developed to remove fine materials introduced during the installation process, allowing representative groundwater levels to be obtained from the wells. Following well development, groundwater levels were obtained by MTE staff on three occasions between May and July 2009 in order to determine the groundwater elevation at the Site. An additional set of measurements was taken on May 11, 2009 by Greenwood Construction and provided to MTE. Groundwater levels and corresponding elevations for MW9-09, MW10-09, and MW11-09 are summarized in Table 1a. Groundwater and surface water levels and elevations for MP1 are summarized in Table 1b

**TABLE 1A: GROUNDWATER LEVELS AND ELEVATIONS – EAST PIT – MONITORING WELLS**

DATE	MW9-09		MW10-09		MW11-09	
	Groundwater Level (mBTOC)	Groundwater Elevation (mAMSL)	Groundwater Level (mBTOC)	Groundwater Elevation (mAMSL)	Groundwater Level (mBTOC)	Groundwater Elevation (mAMSL)
May 11	9.34	477.06	7.68	472.17	13.12	466.21
May 20	9.32	477.08	7.72	472.14	13.16	466.18
June 5	9.39	477.01	7.68	472.17	13.18	466.15
July 10	9.58	476.82	7.79	472.06	13.25	466.09

*mBTOC = metres below top of casing; mAMSL = metres above mean sea level*

**TABLE 1B: GROUNDWATER AND SURFACE WATER LEVELS AND ELEVATIONS – EAST PIT – MP1**

DATE	MP1			
	Groundwater Level (mBTOC)	Groundwater Elevation (mAMSL)	Surface Water Level (mBTOC)	Surface Water Elevation (mAMSL)
May 11	*	*	*	*
May 20	1.57	476.91	0.87	477.60
June 5	1.49	476.98	0.88	477.59
July 10	1.48	476.99	1.02	477.45

*mBTOC = metres below top of casing; mAMSL = metres above mean sea level; \* = MP1 not yet installed*

Greenwood Construction has obtained groundwater levels from BH1 through BH7 since 2006. Groundwater elevation from BH1 through BH7, MW9-09 through MW13-09, and MP1 are illustrated in Figure 4.

## PRIVATE WELLS

A review of water well records on file with Ontario Ministry of the Environment (MOE) revealed 13 private wells adjacent to the Site. The records indicate that 12 of these wells are constructed into the underlying bedrock. The remaining well in the records (MOE Number 17-04276) obtains water from the overburden. Well 17-04276 is owned by Greenwood Construction and is not currently used as a domestic well. A summary of the private well details obtained from the MOE well data sheets is provided in Table 2. MOE well data sheets are provided in Appendix B.

A private well inventory conducted in 2001 by Gartner Lee Limited (GLL) as part of a Hydrogeological Assessment for the Greenwood Construction - Oliver/White Pit Expansion identified an additional well not in the MOE well records. This well is located on Lot 1, Concession 18 in the Township of East Garafraxa, County of Dufferin, and is a large diameter dug well. The well is approximately 400 metres from the Site and adjacent to a currently licensed above-water-table operation.

**TABLE 2: MOE WELL DATA SHEET SUMMARY**

MOE WELL NUMBER	WELL DEPTH (MBGS)	WELL DEPTH (MAMSL)	WATER FOUND (MAMSL)	BEDROCK SURFACE (MAMSL)
17-00176	128.02	382.52	386.18	426.72
17-04672	67.67	412.39	412.70	413.61
17-00180	63.40	416.66	417.27	418.49
17-01495	63.09	420.01	420.62	422.76
17-02059	76.50	417.27	417.58	417.27
17-03107	105.77	397.15	397.46	420.62
17-04276 <sup>†</sup>	13.11	466.95	466.95	*
17-00181	88.39	406.91	408.13	414.53
17-01805	71.63	414.53	414.53	419.71
17-04443	48.77	430.38	436.78	437.08
17-00182	57.61	428.55	428.85	430.68
17-02115	92.96	387.10	387.10	405.69
17-00188	58.83	419.71	422.15	436.47

*mBTOC = metres below top of casing; mAMSL = metres above mean sea level; † = well is owned by Greenwood Construction;  
\* = well is installed into overburden*

## POTENTIAL SOURCES OF CONTAMINATION

The Site will be operated by machinery, so there is a remote chance that a spill (fuel, hydraulic fluid) could occur. This type of spill will be relatively small and readily observed. Greenwood Construction has a comprehensive plan, as implemented on its current sites, for dealing with this type of problem. Containment of the spill would be undertaken immediately, followed by a call to the Spills Action Line (Ministry of the Environment).

The contaminated soils will be removed from the Site. If there is any suspicion of hydrocarbon contamination into the groundwater, then a detailed hydrogeological investigation will be implemented immediately. This investigation will include, but not be limited to, the installation of observation wells around the location of the spill and the sampling of all private wells within 300 metres and down gradient of the spill.

## **IMPACT ASSESSMENT**

### **Private Wells**

The proposed operation will have no interaction with the water table, so there is no risk of interference with existing supply wells. In addition, 12 of the 13 drilled wells adjacent to the Site are installed into the bedrock aquifer system. The bedrock surface occurs between 405.69 mAMSL and 436.47 mAMSL which equates to a separation distance of between 67.98 metres and 42.18 metres from the proposed pit floor elevations (discussed below). The remaining drilled well is owned by Greenwood Construction and is not currently used as a domestic water supply.

The one dug well is approximately 400 metres from the proposed above-water-table operation. As indicated above, the proposed operation must remain 1.5 metres above the established water table and therefore, will have no interaction with water table so there is no risk of an interference with this well.

### **On-Site Wetland**

MW10-09, MW11-09, and MP1 were constructed adjacent to or in the on-Site wetland to ascertain if there is a connection between shallow groundwater and the wetland. MW10-09 provides the most conservative estimate of shallow groundwater elevations (472.17mAMSL) immediately adjacent to the wetland. The most conservative groundwater elevation at MP1 is 476.99mAMSL. There is a 4.82 metre difference between the most conservative groundwater elevations at MW10-09 and MP1. This large difference between the groundwater levels, combined with the thickness of clay encountered beneath the wetland during the installation of MP1, indicates that the wetland, along the southeastern Site boundary, is perched from shallow groundwater. There does not appear to be any measurable interaction between the shallow groundwater encountered at the Site and the on-Site wetland. The lack of connection between shallow groundwater and the on-Site wetland suggests that the on-Site wetland is supplied by runoff.

The removal of the till overburden will expose the more permeable sands and gravel beneath, thereby increasing infiltration to the shallow groundwater, which has the potential to reduce the amount of runoff available to recharge the on-Site wetland. Additionally, the construction of berms adjacent to the wetland also has the potential to reduce runoff to the wetland.



In order to determine how much water was lost from the wetland during 2009 and to determine mitigation measures (i.e. buffer zone), MTE conducted a water balance for the on-Site wetland. As part of the water balance, the following parameters were used:

- Surface area of the wetland (as determined by Rollings Hyland Consulting – Site Plan preparers) = 9,163 m<sup>2</sup>;
- Elevation of highest recorded surface water level at MP1 = 477.60 mAMSL (May 20, 2009);
- Elevation of lowest recorded surface water level at MP1 = 477.45 mAMSL (July 10, 2009); and
- 30 year average annual precipitation as recorded at the Orangeville MOE weather station = 891.7 mm/annum or 0.8971m/annum.

The observed decline in the on-Site wetland in 2009 was 0.15 metres (477.60mAMSL – 477.45 mAMSL = 0.15m). In the water balance calculations, the observed decline was increased by 20% to 0.18 metres in order to provide a greater decline that may occur in later summer months (August or September). Using this more conservative decline, a total of 1,649m<sup>3</sup> of water (9,163 m<sup>2</sup> x 0.18 m = 1,649 m<sup>3</sup>) was calculated to have been lost from the wetland in 2009. This loss calculation assumes that the pond has vertical sides which would overestimate the actual volume of water lost.

A total of 8,171 m<sup>3</sup> of precipitation (rain and snow) falls directly on the wetland in an average year (9,163m<sup>2</sup> x 0.8971m = 8,171m<sup>3</sup>). According to the water balance calculations, there is a 6,522m<sup>3</sup> surplus of water in an average year that falls directly on the on-Site wetland.

### **Post Extraction Infiltration**

The pit activities will always be above the water table.

The proposed East Pit is topographically higher, so that this area acts as a groundwater recharge zone. As an active gravel pit, this function will be maintained, and rates of infiltration are expected to increase in comparison to historical values, which mean enhanced quantities to the shallow groundwater system. The shallow groundwater will continue to flow to the south and southwest, mimicking the topography. Some of this water is expected to express itself as seepage along the headwaters of creeks to the south of the Site.

### **RECOMMENDATIONS FOR EXTRACTION**

Under the *Aggregate Resources Act (ARA)*, a Category 3 pit must remain a minimum 1.5 metres above the water table. MTE recommends that the ridge that bisects the Site be used to divide the Site into north and south halves. The groundwater elevation in the northern half is established through groundwater elevations at MW9-09 at 477.2mAMSL. The groundwater elevation in the southern half is established through MW10-09 at 472.2mAMSL. MTE recommends that the proposed pit floor be graded between 478.7mAMSL in the north to

473.7mAMSL in the south so that the pit floor is sloped from north to south. Should groundwater (other than perched water) be encountered at an unexpected elevation, then excavation activities should cease until a revised pit floor elevation is established.

Once the currently recommended pit floor elevation is reached, further extraction should be preceded by test pitting to probe for water table to ensure that the 1.5 metre separation distance is maintained. Indications of the water table will include saturated conditions and/or a change in the colour of the aggregate from brown to grey. The elevation for a revised pit floor can be determined from this test pitting investigation.

Under the ARA, a 30 metre buffer is the minimum required distance from an open water body and provided that this buffer is maintained around the on-Site wetland, MTE expects that in addition to amount of precipitation that falls directly on the on-Site wetland that this buffer will allow the on-Site wetland to be able to maintain its existing functions.

## **CONCLUSIONS AND RECOMMENDATIONS**

Since the proposed operation is to remain 1.5 metres above the established water table, there will be no interaction with the water table. No impacts the shallow groundwater system or its users are expected.

Based on the geology encountered and difference in groundwater elevations, the on-Site wetland is perched and isolated from the shallow groundwater which suggests that it is supplied by run-off. The water balance performed by MTE indicates that, in an average year, there is a surplus of water that falls directly on the wetland. The 30 metre buffer required by the ARA is expected to more than adequately ensure that the on-Site wetland receives enough runoff to maintain its existing functions.

Provided that the recommendations for extraction are implemented, MTE is confident that a minimum separation of 1.5 m above the water table will be maintained at the Site and the existing function of the on-Site wetland will be maintained.

## LIMITATIONS

Services provided by **MTE Consultants Inc.** (MTE) were conducted in a manner consistent with the level of care and skill ordinarily exercised by members of the Environmental Engineering & Consulting profession. No other warranty or representation, expressed or implied, as to the accuracy of the information, conclusions or recommendations is included or intended in this report.

This report was completed for the sole use of MTE and their client. It was completed in accordance with the Scope of Work referred in the text. As such, this report may not deal with all issues potentially applicable to the Site and may omit issues, which are, or may be, of interest to the reader. MTE makes no representation that the present report has dealt with any and all of the important features, including any or all important environmental features, except as provided in the Scope of Work. All findings and conclusions presented in this report are based on site conditions, as they existed during the time period of the investigation. This report is not intended to be exhaustive in scope or to imply a risk-free facility.

We trust this meets your current requirements. If you have any questions or comments, please do not hesitate to contact the undersigned directly at (519) 743-6500.

All of which is respectively submitted,

**MTE CONSULTANTS INC.**



W.S. Clarke, M.Sc., P.Ge.  
Technical Director



MDE:plw

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## REFERENCES

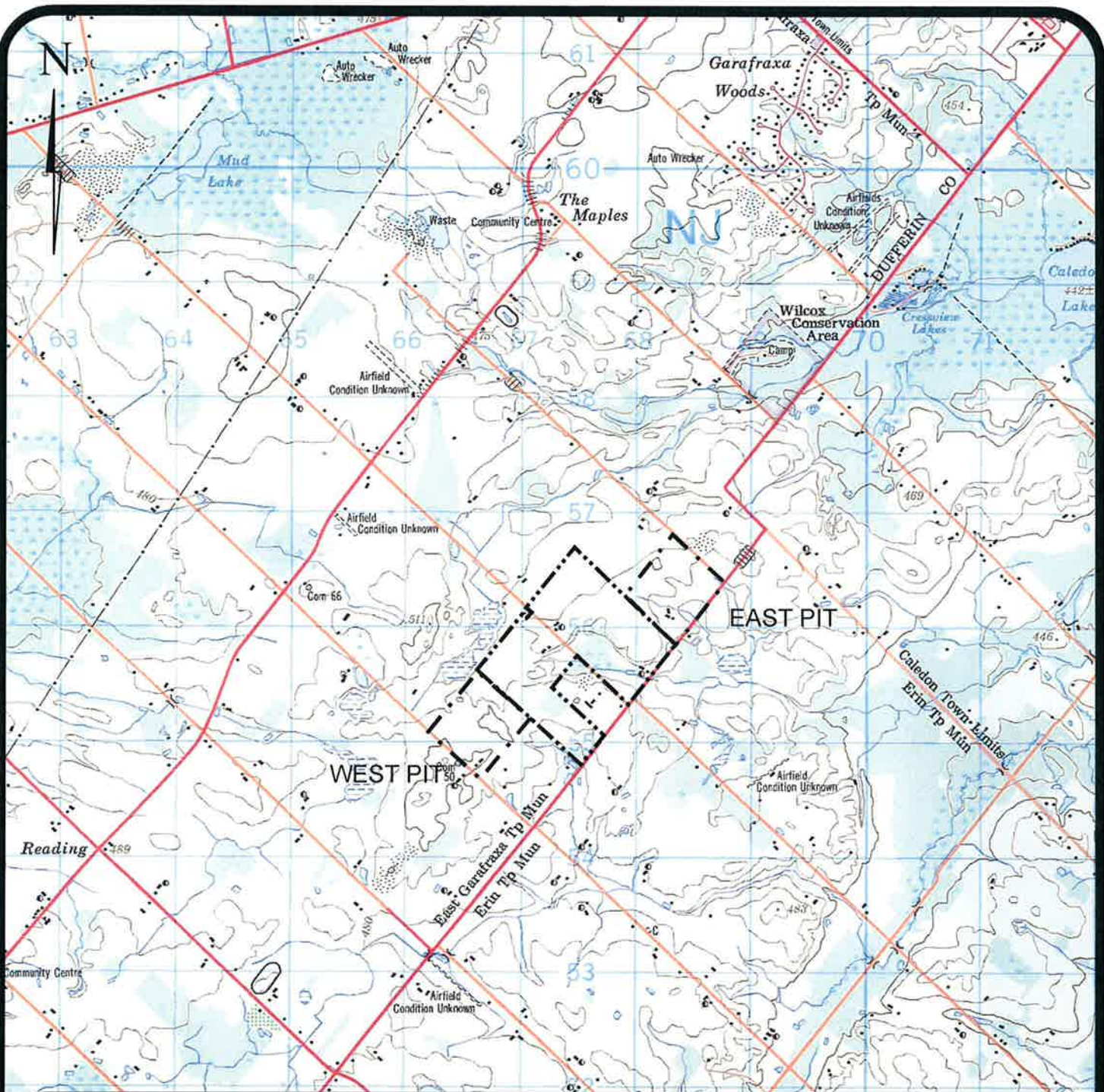
Cowan, W.R., 1976: Quaternary Geology of the Orangeville Area, Southern Ontario; Ontario Div. of Mines, GR141, 98p. Accompanied by Maps 2326, 2327, and 2328, scale 1:50,000.

Gartner Lee Limited, November 29, 2001: Hydrogeological Assessment – Oliver/White Pit Expansion, Part Lots 1 and 2, Concession 17 and 18, Township of East Garafraxa, Dufferin County, 11p.

Environment Canada, March 2010, *National Climate Data and Information Archive, Canadian Climate Normals – 1971 – 2000 – Orangeville MOE*



# FIGURES



**LEGEND** Map Reference: 41P/16

- - - - - Proposed Site Boundary
- - - - - Existing Site Boundary

**FIGURE 1: KEY MAP**

**Project Name**

Greenwood Construction - East Pit

**Site**

E. 1/2 Lot 1, Con, 18, Township of E. Garafraxa

**Client**

Greenwood Construction

**Scale**

1:50 000

**MTE Project No:**

33867-100

**Date**

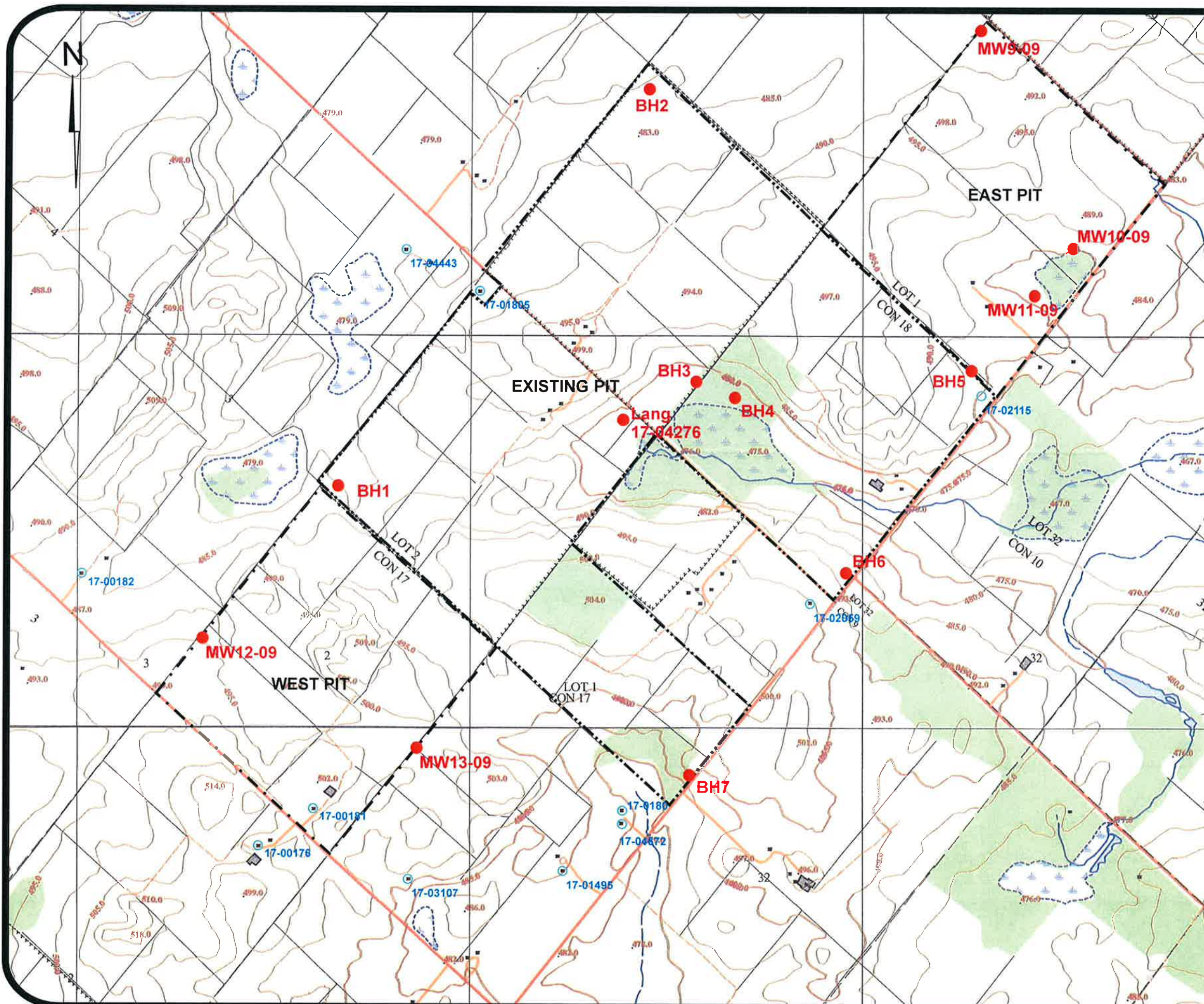
April 2010

**Layout File**



**Environmental  
Division**

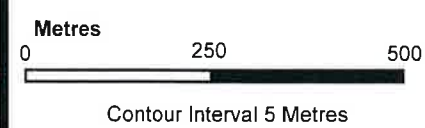




**LEGEND**

- - - - Proposed Site Boundary
- - - Existing Site Boundary
- Private Well Location and MOE Well Number  
68-10945
- Monitoring Well Location  
BH1/MW9-09

OBM: 10 17 5650 48500  
10 17 5650 48550



**FIGURE 2: STUDY AREA MAP**

Project Name			
<b>Greenwood Construction - East Pit</b>			
Site		Client	
E. 1/2 Lot 1, Con. 18, Twmsp E. Garafraxa		Greenwood Construction	
Scale	MTE Project No:	Date	Layout File
1:10 000	33867-100	April 2010	

