

**GIFFELS ASSOCIATES LIMITED
HYDROGEOLOGICAL SCREENING
PROPOSED HIGHWAY 28 REALIGNMENT
TOWNSHIP OF DOURO-DUMMER, LAKEFIELD, ONTARIO**

PROJECT NO. ONO62825



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Environment Canada
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FINAL REPORT TO

GIFFELS ASSOCIATES LIMITED

ON

HYDROGEOLOGICAL SCREENING

PROPOSED HIGHWAY 28 REALIGNMENT

TOWNSHIP OF DOURO-DUMMER, LAKEFIELD, ONTARIO

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September 9, 2003



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1.0 INTRODUCTION

Jacques Whitford Environment Limited (JWEL) was retained by Giffels Associates Limited (Giffels) on behalf of the Ontario Ministry of Transportation (MTO) to perform a two-step hydrogeological investigation consisting of a hydrogeological screening step, followed up by a detailed hydrogeological investigation in support of the proposed Highway 28 realignment (realignment) within the area of Douro-Dummer Township municipal limits (Drawing No. 1), Ontario. This report presents the results of the hydrogeological screening phase of the project. The objective of the hydrogeological screening is to determine the possible impacts in the excavation cut between stations 22+570 and 22+850 on groundwater quality and quantity of existing domestic water wells and pond in the area of realignment. The hydrogeological screening phase consisted of a site history review and a site reconnaissance. JWEL carried out the hydrogeological screening in accordance with Giffels Request For Proposal (RFP) dated May 5, 2003.

This report is organized in seven sections. Section 1 presents background information about the site and outlines the scope of the current study. Section 2 describes the site history review process. Section 3 discusses the results of the site history review and site reconnaissance for physical setting of the realignment, and Section 4 discusses the results of the site history review and site reconnaissance for geology and hydrogeology of the realignment. Section 5 provides an assessment of the vulnerability of local surface and groundwater resources with respect to potential impact from the excavation cut. Section 6 summarizes and presents conclusions. Section 7 provides recommendations. Supporting information is provided in the appendices at the end of this report.

1.1 Scope of Work

The scope of work detailed in the Terms of Reference for the hydrogeological screening of the realignment is outlined as follows:

- A site history review of existing information relating to the area of realignment.
- Undertake a domestic well survey to visually inspect wells and obtain information regarding physical conditions and current usage of water wells.
- Verification of the existing land use and presence of municipal piped water to the areas immediately adjacent to the realignment.



- Visual inspection of significant landforms, geologic features, exposed bedrock outcrop, and location of all permanent surface water bodies including wetlands, tributaries, ponds and lakes.
- Prepare a hydrogeological screening report based on the background information and site inspection. The report will provide an assessment of the vulnerability of local surface and groundwater resources with respect to potential impact from the proposed excavation cut.

2.0 SITE HISTORY REVIEW

The site history review consisted of reviewing existing information relating to the area of the realignment and data sources included the following:

- Ministry of the Environment (MOE) Water Well Records
 - Source of geologic and hydrogeologic information
 - Location and elevation of all water wells
 - Lithology information along the depth of the well (i.e., 5 m of gravel and 3 m of clay)
 - Static water levels for groundwater head (pressure)
 - Well details including depth of water bearing zones
 - Well construction details such as depth of casing and recommended pumping rate
- Reports and Geology maps from Ontario Geological Survey and Ministry of Natural Resources
 - Geology maps and reports fill gaps in stratigraphic cross sections created from MOE water well records
 - Physiography inferred from various geologic maps provide additional geologic data on landforms to aid in the interpretation of recharge and discharge
- GIS (Geographic Information System) maps and databases from the Ministry of Natural Resources
 - Source of information on surface water bodies and wetlands in the area of realignment and also used for verification of site reconnaissance data
- Topographic Maps from the Natural Resources Canada
 - Source of information on roads, town names, county and municipal boundaries, and surface water features and wetlands
- Aerial photographs
 - Source of information on surface water bodies, past and current land use, and structures



Other data sources used in this report are specifically referenced throughout. The results of the site history review were combined with the results of the site reconnaissance to provide a comprehensive summary of physical, geological, and hydrogeological setting of the realignment which is presented in Sections 3 and 4 of this report.

The preliminary design profile of the alignment provided by Giffels was used in conjunction with the data from the site history review to complete the hydrogeological screening.

2.1 Limitations of Data (MOE Water Well Records)

For any particular water well, the quality of the reported data may be suspect in terms of:

- Overall data reporting quality
- Reported location and elevation of the well
- Consistency of terms used to describe geology
- Static water level, which, being measured after a well-yield pumping test, may not have fully recovered to a static level. In addition, static water levels may be affected by year to year variations in water levels and longer-term trends since the database contains records from 1930 to 2000.

During the site reconnaissance, many of the wells could not be located using the coordinate data provided in MOE water well records. The domestic wells that are currently in use were located during the site reconnaissance and are labeled with their property address location (Drawing No. 2).

3.0 PHYSICAL SETTING

3.1 Site Description

The proposed realignment (Drawing No. 1, **Appendix 1**) is located on the south side of Highway 28, the east side of Highway 134 and the west side of County Road 6. The surrounding landscape is predominantly rural consisting of agricultural and residential properties. A golf driving range is located approximately 300 metres to the west of the proposed realignment at the SE corner of the intersection of Highway 28 and Highway 134. Residential properties are located between Highway 28 and the realignment, and agricultural properties are located to the south of the realignment. A small wood lot consisting of coniferous trees is located near the intersection of Highway 28 and County Road 6.



3.2 Soil, Topography and Surface Drainage

The topography of areas adjacent to the realignment is characterized by till plains and drumlinized terrain exhibiting variable relief. The size and shape of the drumlins can vary widely, drumlins located in areas within and adjacent to the realignment appear to be small, scattered, and often imperfectly formed. The surficial soils within northern and southern portions of the realignment consist of moderately drained soils with few stones over a very gently sloping landscape. The surficial soils in the rest of the area of realignment consists of well-drained soils over a gently sloping landscape towards the northwest. The soil material generally consists of calcareous glacial till and occurring primarily in the drumlinized landform east of the Otonabee River.

The natural drainage within one kilometre of the realignment is part of the Trent Canal System and the Otonabee River. This chain of interconnected lakes and rivers traverses the Peterborough County through Buckhorn, Clear, Katchewanooka, Pidgeon, Stony and Rice Lakes connected by the Otonabee River. All streams and creeks located west of the realignment apparently drain into this system. The Katchewanooka Lake, which is part of Otonabee River and Trent Canal system, is located to the west and north of the realignment. Buckley Lake is located to the southeast of the realignment. The realignment is approximately 600 m southeast of Katchewanooka Lake (Drawing No. 2).

3.3 Surface Water Bodies

The location of surface water bodies such as ponds and reservoirs identified within the one (1) kilometre (km) range of the realignment during site inspection are shown in Drawing No. 2. The pond identified within the area of realignment appears to be man-made and is located at 3501 Highway 28. During the site reconnaissance, Mrs. Dawn Hiscocks indicated that the pond (constructed pond) was excavated to the bedrock interface to obtain adequate quantity of water during construction of the constructed pond. The past and current usage of the constructed pond appears to be for aesthetic purposes. The constructed pond is clearly visible in an aerial photograph dating back to the year 1981 and the exact age of the pond is not clearly known. The pond water appeared clear with no apparent turbidity or algae growth. At the time of site visit: the constructed pond is surrounded by growths of cattails, bulrushes, and sedges indicating prolonged saturation of nearby soils. The areal dimensions of the constructed pond at the time of site reconnaissance were approximately 30 m in width and 10 m in length.



A watering hole was identified at 3501 Highway 28, approximately 50 metres southwest of the constructed pond. During the site reconnaissance, the watering hole did not appear to be used for potable purposes and the field adjacent to the watering hole was apparently being used for crop cultivation, not cattle grazing. No apparent kettle holes, drainage ditches, and closed depressions were noticed either at 3501 Highway 28 or in the adjacent areas.

The wetland located along 3446 Highway 134 did not appear to be used for irrigation, agricultural or potable purposes. The wetland is located in a low-lying area, and appears to collect surface water from the surrounding area.

3.4 Surrounding Land Use

Aerial photographs of the realignment area from the years 1929, 1965, 1966, 1976, and 1981 were reviewed to infer the past and current land use. Further, the information inferred from the examination of aerial photographs was verified with the results of site reconnaissance and information provided by the Township of Douro-Dummer and the Township of Lakefield. The current and past land use in the area of realignment is predominately rural with some residential land uses, with the exception of a driving range located southeast of the intersection of Highway 28 and Highway 134 (Drawing No.2 and 5). The utilization of drumlinized areas for general agricultural use appears to be handicapped by stoniness of surficial soils.

Structures and buildings within 500 m of the realignment area are generally few and predominately consists of barns and country houses (Drawing Nos. 2, 5, and 6). The majority of the other buildings and structures outside the 500 m of the realignment area are generally located near the junction of Highway 28 and County Road 6.

4.0 GEOLOGY AND HYDROGEOLOGY

4.1 Geologic Setting

The geologic setting for the area of realignment was inferred based on a review of available technical literature and lithologic information from MOE water well records.

4.1.1 Surficial Geology

The surficial geology around the realignment area generally consists of till plains and till moraines (Drawing No.3). The predominantly drumlinized landform is noted on the eastern and



southeastern side of the proposed realignment. The drumlins throughout Peterborough County are generally composed of non-stratified highly calcareous glacial till. The glacial till overlying the Paleozoic bedrock is thick, moderately stony, calcitic limestone till, with strongly drumlinized landform. The Peterborough County is noted for its many drumlins and contains approximately 3000 drumlins, in addition to other drumlinoid-hills and surface flutings of the glacial drift¹. The northern edge of the realignment is characterized by till plains. The composition of glacial till within the area of realignment ranges from predominately sandy silt to silt, commonly rich in clay and calcareous material². The thickness of surficial deposits (overburden) is less than 10 metres over many areas of the realignment.

4.1.2 Bedrock Geology

The bedrock in the area of realignment is part of Paleozoic sedimentary rocks comprising middle Ordovician Simcoe Group (Drawing No.4). The bedrock comprises sandstones, limestones, dolostones, shale, and arkose. Lithologic analysis of MOE water well data indicates that the area of Highway 28 realignment is generally composed of Paleozoic limestone. It should be noted that MOE water well data is not available for all areas of the realignment. Outcrops of Paleozoic bedrock were not found within the area of realignment. Outcrops of Paleozoic sandstones were identified at a road cut 3 kms south of the realignment on Highway 134 (Drawing No. 6).

4.2 Hydrogeology

The hydrogeology in the area of realignment has been inferred primarily based on site reconnaissance, MOE water well records, and relevant geologic/ hydrogeologic information from the surrounding area.

4.2.1 Regional Aquifer

One of Peterborough County's primary sources of water is groundwater. Groundwater is obtained from dug or drilled wells, which extract water from an aquifer. An aquifer is any

¹ Chapman, L.J. and D.F. Putnam, 1984. *The Physiography of Southern Ontario*, Ontario Geological Survey, Ministry of Natural Resources, Ontario. Volume 2 PP. 169-170.

² Barnett, P.J., Cowan, W.R., and A.P. Henry, 1991. *Quaternary Geology of Ontario*, Ontario Geological Survey, Ministry of Natural Resources, Ontario. Map 2556. *Southern Sheet*.



geologic material such as sand, gravel, or limestone that is permeable enough to yield a significant amount of water to a well or spring. Water quality within aquifers can vary significantly depending on the natural setting or human induced impacts.

Surficial and bedrock aquifers are present in the area of realignment. Surficial aquifers are shallow and generally found in unconsolidated surficial materials of overburden. Surficial aquifers are generally unconfined and receive recharge mainly through precipitation. Bedrock aquifers usually exist at greater depths in fractured bedrock and overburden contact zones depending on fracturing and connectivity of bedrock fractures. The portions of the bedrock aquifer can be either confined or unconfined depending on the presence or absence of low-permeable to impermeable layers, respectively.

4.2.1.1 Surficial Aquifer

Surficial aquifers in the area of realignment are generally unconfined and occur in till plains. The presence of surficial aquifer also depends on the thickness of permeable sand and gravel deposits within glacial till. The extents and connectivity of surficial aquifers in the area of realignment is not clearly known. The shallow groundwater flow direction in the area of the excavation cut appears to be in the northwestern direction towards the constructed pond and consistent with the topographic elevations of the area.

4.2.1.2 Bedrock Aquifer

Potable groundwater is typically obtained from fractures in the bedded Paleozoic sandstone, limestone, dolomite, and shale in the upper portion of these deposits in the Peterborough County³. Faulting and fracturing within these units controls the amount of water that can be extracted and conducted through these units. Where fracturing is intensive, large quantities of water suitable to supply communal systems can be extracted.

The primary aquifer in the area of realignment consists of the upper portion of the fractured Paleozoic bedrock and sand and gravel deposits, which directly overlie the bedrock in the lower portion of the overburden. This aquifer system is often referred to as the Contact Zone Aquifer. The clay and fine-grained deposits in the region can act as a confining layer for the Contact Zone Aquifer. Groundwater can exist at pressures greater than that of the atmosphere in confined

³ Singer, S.N., Cheng, C.K., and M.G. Scafe, 1997. *Hydrogeology of Southern Ontario*, Ministry of the Environment, Ontario. Volume 1, Hydrogeology of Ontario Series (Report 1).



portions of the Contact Zone Aquifer. Groundwater in confined portions of the Contact Zone Aquifer would rise above the top of the aquifer in a penetrating well. Measured groundwater elevation in a well screened in the confined portions of Contact Zone Aquifer is generally commensurate with the pressure in the aquifer and also known as potentiometric surface.

MOE water well records indicate that the water found elevations of the wells screened in the bedrock range from 234.7 to 247.8 metres above mean sea level (m AMSL). The static water elevations which are usually measured after the installation of the water well, range from 5 to 18 m above the water found elevations, indicating the possible presence of a semi-confined aquifer in bedrock in the area of excavation cut.

The low vertical and horizontal hydraulic conductivity of the confining layer is instrumental in preserving the quality of water in the bedrock aquifer as it significantly decreases the downward migration of recharge from the surface to the aquifer. In areas where the glacial till is absent or thin, the bedrock aquifer is more exposed to contamination.

4.2.2 Groundwater Wells and Water Supply

Surficial aquifers in the area of realignment do not appear to be a significant source of water supply. Glacial till is normally known as a poor source of groundwater. The rate of production or capacity of a well is called the well yield and is described in terms of litres per minute. The yield of wells completed in sands and gravels of the surficial aquifer in the area of realignment is less than 12 Litres/minute (L/m)⁴. The well yields further indicate that the most of sand and gravel deposits are not extensive and/or poorly sorted.

A review of MOE water well records for the area of realignment indicates over 80 percent of the wells are bedrock wells. The well water yield is a function of the number and size of fractures and joints encountered by a well. Since these openings could begin and end abruptly, follow complex trends, and possess strong directional orientation, well yields could vary considerably from place to place in the area of realignment. The Paleozoic limestones of the Simcoe Group are the most common source of groundwater in the area of realignment. Water is obtained from a variety of depths in bedrock but most wells seem to obtain suitable supplies from the upper 10 to

⁴ Water Quantity Management Branch, 1973. *Overburden Well Yields*, Lake Ontario Drainage Basin, Ministry of the Environment, Ontario. Map 5926-2.



15 m of bedrock. The yields from wells drilled in the limestones are variable and ranging from 6 to 200 L/m⁵. Greater well yields apparently correspond to areas with thicker overburden.

4.2.2.1 Current and Future Use of Groundwater

Groundwater in the area of the proposed excavation cut is apparently used for rural domestic purposes. Most of rural population resides in the areas adjacent to the junction of the realignment, Highway 28, and County Road 6. Based on the interviews with property owners, it appears that most of rural population's water needs is obtained from groundwater sources. At least one residence uses bottled water for drinking. Water use in southern parts of the realignment is apparently small since rural settlement is sparse. Almost all of domestic water supplies are obtained from bedrock wells that supply adequate amounts of water for domestic use.

Based on conversations with Mr. Ken Currie, Chief Building Official, By-Law Enforcement Officer for the Township of Douro-Dummer. There are no municipal communal supply wells in the area of the realignment and the area is completely serviced by private wells. This was further confirmed during the water well survey. It appears that the water requirements in the area of realignment will continue to be serviced by private wells. Future use of groundwater within the area of realignment might increase after the construction of the realignment.

4.2.2.2 Water Well Survey

Water wells surveyed during the site reconnaissance are shown in Drawing No.2. The water well survey included in this step of the investigation consisted of a visual inspection of the wells to obtain data on physical condition, water levels, current usage of wells within the area of realignment. Depth to groundwater ranged from 2 to 6.4 m below grade surface. Several homeowners also reported bacteriological problem with their wells until they raised the well standpipe at least 30 centimetres (cm) above the ground surface. Almost all of the wells are drilled and bedrock wells, except the dug well at 3501 Highway 28. Groundwater elevations from many of the water wells could not be measured due to the presence of pumps, pipes, sealed well covers, and other obstructions. Locations of water wells currently in use were measured using a Magellan[®] Global Positioning System receiver with sub-centimetre accuracy.

⁵ Water Quantity Management Branch, 1970. *Bedrock Well yields*, Lake Ontario Drainage Basin, Ministry of the Environment, Ontario. Map 5926-1.



Geographic coordinates contained in the MOE water well records were found to be not very reliable. Water well survey data summarized is in Table 4.1.

Table 4.1 Summary of Water Well Survey

Address	MOE Water Well No.	Depth to Water	Current Usage	Type	Comments
3501 Highway 28	51-00691	3	Potable	Dug	One well dug in barn. There may be other disused dug wells.
3450 Highway 28	51-00702		Potable	Drilled	No problems reported
3414 Highway 28			Potable	Drilled	No problems reported
3993 Highway 28			Potable	Drilled	Iron bacteria problem, uses chlorine to disinfect.
3433 Highway 28	51-08321	5.45		Drilled	Well open to the surface. Water is not used for potable purposes
3514 Highway 28		4.5	Potable	Drilled	The well is open to the surface, and the house is abandoned.
3342 Highway 28		5.3	Potable	Drilled	High chloride and sodium reportedly due to road salt.
4429 Highway 29			Potable	Drilled	No problems reported
4435 Highway 29		5.2	Potable	Drilled	No problems reported
114 Stoney Creek	51-00694	6.09	Potable	Drilled	New well installed in 2002 produces 30 L/min. No problems reported with the new well.
102 Stoney Creek			Potable	Drilled	Iron bacteria and other associated odour problems reported
4423 Highway 29			Potable	Drilled	No problems reported
4425 Highway 29			Potable	Drilled	Well brought above grade in 2003. Historical bacterial problem.
3339 Highway 28		2.33	Potable	Drilled	Well runs dry occasionally in August with high use
3454 Highway 28	51-00701	6.4	Potable	Drilled	Former well located on drive-way produced 13 L/min, and had been sealed. New well produces 24 L/min.
3458 Highway 28	51-04520		Potable	Drilled	Historical bacteriological contamination reported
3460 Highway 28	51-09527		Potable	Drilled	Sulphur odour reported



Address	MOE Water Well No.	Depth to Water	Current Usage	Type	Comments
3464 Highway 28	51-05995		Potable	Drilled	Water had been tested, no E.coli reported. Sulphur odour reported.
3476 Highway 28			Potable	Drilled	Owner not present
3446 Highway 28	51-07724	6.09	Potable	Drilled	High chloride and sodium content in groundwater reported
3363 Highway 28			Potable	Drilled	No problems reported

*metres below ground surface

MOE water well records indicate that the water found elevations of the wells screened in the bedrock ranged from 234.7 metres to 247.8 m AMSL. The static water elevations which are usually measured after the installation of water well ranged from 5 to 18 m above the water found elevations, indicating the possible presence of a semi-confined aquifer in bedrock in the area of the excavation cut and underneath the constructed pond. A selected list of wells possibly indicating artesian conditions is summarized in Table 4.2.

Table 4.2 Indicators of Artesian Conditions

MOE Water Well No. ¹	Address	Water Found Elevation ¹ (m AMSL)	Static Water Elevation ¹ (m AMSL)	Possible Artesian Condition? ²
51-08321	3433 Highway 28	236.2	246.9	Y
51-08705	-	235.3	245.4	Y
51-00728	-	230.1	246.9	Y
51-00727	-	237.7	247.8	Y
51-00691	3501 Highway 28	244.1	251.8	Y
51-00694	114 Stoney Lake	243.2	249.3	Y
51-00696	-	237.7	244.5	Y

Notes:

- 1 Data from MOE Water Well Records
- 2 Groundwater in confined portions of bedrock aquifer would rise above the top of the aquifer in a penetrating well.



5.0 VULNERABILITY ASSESSMENT

A grade change within the realignment necessitates an excavation cut with a maximum depth of 7.7 metres between Stations 22+570 and 22+850 (Drawing No. 7). This section provides an assessment of the vulnerability of local surface and groundwater resources with respect to potential impact from the proposed excavation cut.

5.1 Complicating Factors

In the vulnerability assessment of domestic water wells in the vicinity of the excavation cut and the constructed pond at 3501 Highway 28 there are few complicating factors that influence the interpretation of the data obtained during this investigation. These factors are listed as follows:

- Limited hydrogeologic information available in the area of excavation cut. Some hydrogeologic data from the only dug well (MOE Well No. 51-00691/3501 Highway 28) located immediately adjacent to the area of the excavation cut is available. The lack of detailed information complicates the interpretation of site reconnaissance data.
- Limited geologic/soils information in the area of excavation cut to effectively characterize the nature and type of the aquifers present in the area. The aquifer type (unconfined/confined/semi-confined) effectively determines the extent of quality and quantity impacts on groundwater from excavation cut.

5.2 Aquifer Vulnerability

Aquifer vulnerability in terms of groundwater quality and quantity is primarily a function of factors such as aquifer type, aquifer extent, surface water bodies, hydraulic connection between aquifers, overburden thickness, aquifer media, and depth to groundwater. Some of these factors are more applicable to either groundwater quality or quantity.

5.2.1 Impacts to Groundwater Quantity

Impacts to groundwater quantity are influenced by the significance of the following factors:

Aquifer type: There is a possibility of presence of two different aquifers in the area of excavation cut (Drawing No.7 and cross section B-B'). MOE water well records indicate that the water found elevations of the wells screened in the bedrock ranged from 234.7 metres to 247.8 m



AMSL. The static water elevations which are usually measured after the installation of water well ranged from 5 to 18 m above the water found elevations, indicating the possible presence of a semi-confined aquifer in bedrock in the area of the excavation cut and underneath the constructed pond. A surficial unconfined or water table aquifer may exist in the area between the centerline of the realignment and the constructed pond. The water table elevation of the surficial aquifer in the area of the constructed pond is assumed to be coincident with the water level elevation in pond and also assumed to follow the topography in other areas of the excavation cut. Surficial or semi-confined bedrock aquifers may not present in all areas of the excavation cut. The possible presence of a surficial aquifer is further influenced by the thickness and permeability of the surficial deposits or overburden.

Depth to groundwater: The water level elevation in the constructed pond is 254.6 m AMSL and assuming the watertable elevation of the surficial aquifer is coincident with the pond water elevation, the proposed construction elevation at the nearest Station (22+700) is 253.4 m AMSL. The proposed construction elevation is lower than the pond elevation for the area and indicates possible impacts to the constructed pond and surficial aquifer ((Drawing No.7 and cross section B-B'). Assuming that there are no surficial aquifers and the bedrock aquifer is confined in the area of excavation cut, the removal of upper confining layer (low permeability till consisting of clay and other fine grained deposits) in the area between the centerline of the realignment and constructed pond might reduce the confining pressure in the bedrock aquifer and result in lowered potentiometric surface in bedrock wells.

Significance of surface water bodies: Based on the site reconnaissance data, it appears that the constructed pond in the area of the excavation cut was dug to the top of the bedrock. Groundwater may be rising upwards from the confined portions of bedrock aquifer in the area of the constructed pond. It is not clearly known to what extent the constructed pond gains water from bedrock aquifer and other sources.

Based on the available information, there is a possibility that water wells and the constructed pond might be impacted by the road cut excavation between Stations 22+570 and 22+850 of the realignment.

5.2.2 Impacts to Groundwater Quality

Impacts to groundwater quality are influenced by the significance of following factors:



Aquifer type: Unconfined surficial aquifer may exist in the area of excavation cut. Watertable elevations are generally shallower in the surficial aquifers. Thus, the shallower the depth to groundwater, the more vulnerable the surficial aquifer is to contamination from surface sources. The confined portions of the bedrock aquifer are less susceptible to contamination from surface sources. The low vertical and horizontal hydraulic conductivity of the confining layer is instrumental in preserving the quality of water in the bedrock aquifer as it significantly decreases the downward migration of recharge from the surface to the aquifer. In areas where the glacial till is thin (Drawing No.7 and cross section A-A'), the bedrock aquifer is generally more exposed to contamination. The extent and thickness of overburden in the area of the proposed excavation cut is not fully known.

Significance of surface water bodies: There may be a hydraulic connection between the pond and bedrock aquifer. Given the general sloping towards the northwest from the realignment centerline to the constructed pond, there is a possibility that contamination from surface sources may reach the pond through the storm water runoff and contamination may be transmitted to the bedrock aquifer. It is not clearly known whether the constructed pond is a fully functioning wetland. Fully functioning wetlands could filter and reduce the contaminant load reaching the pond water (Drawing No. 6).

Aquifer media: Aquifer media or soil has a significant impact on the amount of recharge that can infiltrate into the ground. In general, the less the clay shrinks and swells and the smaller the grain size of the soil, the less likely contaminants will reach the water table. The extent and nature of different soil layers in the area of excavation cut is not fully known.

Based on the available information, there is a possibility that the water quality in the constructed pond may be impacted by the road cut excavation between Stations 22+570 and 22+850 of the realignment in the near term and hydraulically connected bedrock aquifer in the long term. Further site characterization is required to estimate the contaminant travel times.

6.0 CONCLUSIONS

Based on the available information, we conclude that there is a possibility that water wells and constructed pond in the area of the excavation cut between Stations 22+570 and 22+850 of the realignment might be affected by the proposed road construction.

The water level elevation in the constructed pond is 254.6 m AMSL and assuming the water table elevation of the surficial aquifer is coincident with the pond water elevation, the proposed



construction elevation at the nearest Station (22+700) is 253.4 m AMSL. The proposed construction elevation is lower than the pond elevation for the area, and indicating possible impacts to the constructed pond and surficial aquifer.

There may be a hydraulic connection between the pond and bedrock aquifer. There is a possibility that contamination from surface sources may reach the pond through the storm water runoff and contamination may be transmitted to the bedrock aquifer.

According to the available data in the water well records reviewed, some portions of the bedrock aquifer in the area of the realignment may be confined and exist in semi-artesian conditions.

Based on the information from site reconnaissance, it appears that the majority of homeowners rely on water wells for potable water. Water from the dug well located at 3501 Highway 28, the nearest well to the proposed excavation cut, is used for potable purposes.

7.0 RECOMMENDATIONS

Based on the above, JWEL makes the following recommendations:

- Conduct the detailed hydrogeologic investigation to characterize the area adjacent to the excavation cut according to the Terms of Reference contained in the RFP dated May 5, 2003. The proposed locations of monitoring wells are shown in Drawing No.5. The proposed monitoring well locations were selected based on the results of hydrogeological screening.
- Obtain one surface water sample from the constructed pond (currently not included in the terms of reference) to understand the baseline quality of the surface water and analyze the sample for general inorganic and microbiological parameters listed in MOE *Provincial Water Quality Objectives*, 1994.
- Install and screen monitoring wells in appropriate aquifer media to distinguish different aquifer types that may be present in the area.

8.0 CLOSURE

This report has been prepared for the sole benefit of the Giffels Associates Limited (Giffels) and the Ontario Ministry of Transportation (MTO). The report may not be used by any other person or entity without the express written consent of Jacques Whitford Environment Limited (JWEL), Giffels, and the MTO. Any use that a third party makes of this report, or any reliance on



decisions made based on it, are the responsibility of such third parties. Jacques Whitford Environment Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken based on this report.

The information and conclusions contained in this report are based upon work undertaken by trained professional and technical staff in accordance with generally accepted engineering and scientific practices current at the time the work was performed. Conclusions and recommendations presented in this report should not be construed as legal advice.


The conclusions presented in this report represent the best technical judgement of JWEL and based on the information gathered during site history and site reconnaissance. Due to the nature of the investigation and the limited data available, Jacques Whitford Environment Limited cannot warrant against undiscovered environmental liabilities.

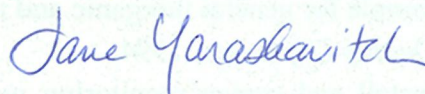
If any conditions become apparent that differ significantly from our understanding of conditions as presented in this report, we request that we be notified immediately to reassess the conclusions provided herein.

This report was prepared by Sonny Sundaram, PhD, and reviewed by Jane Yaraskavitch, M.Eng., P.Eng.

Respectfully submitted,

JACQUES WHITFORD ENVIRONMENT LIMITED


Sonny Sundaram, PhD
Senior Hydrogeologist


Jane Yaraskavitch, M.Eng., P.Eng.
Senior Technical Reviewer

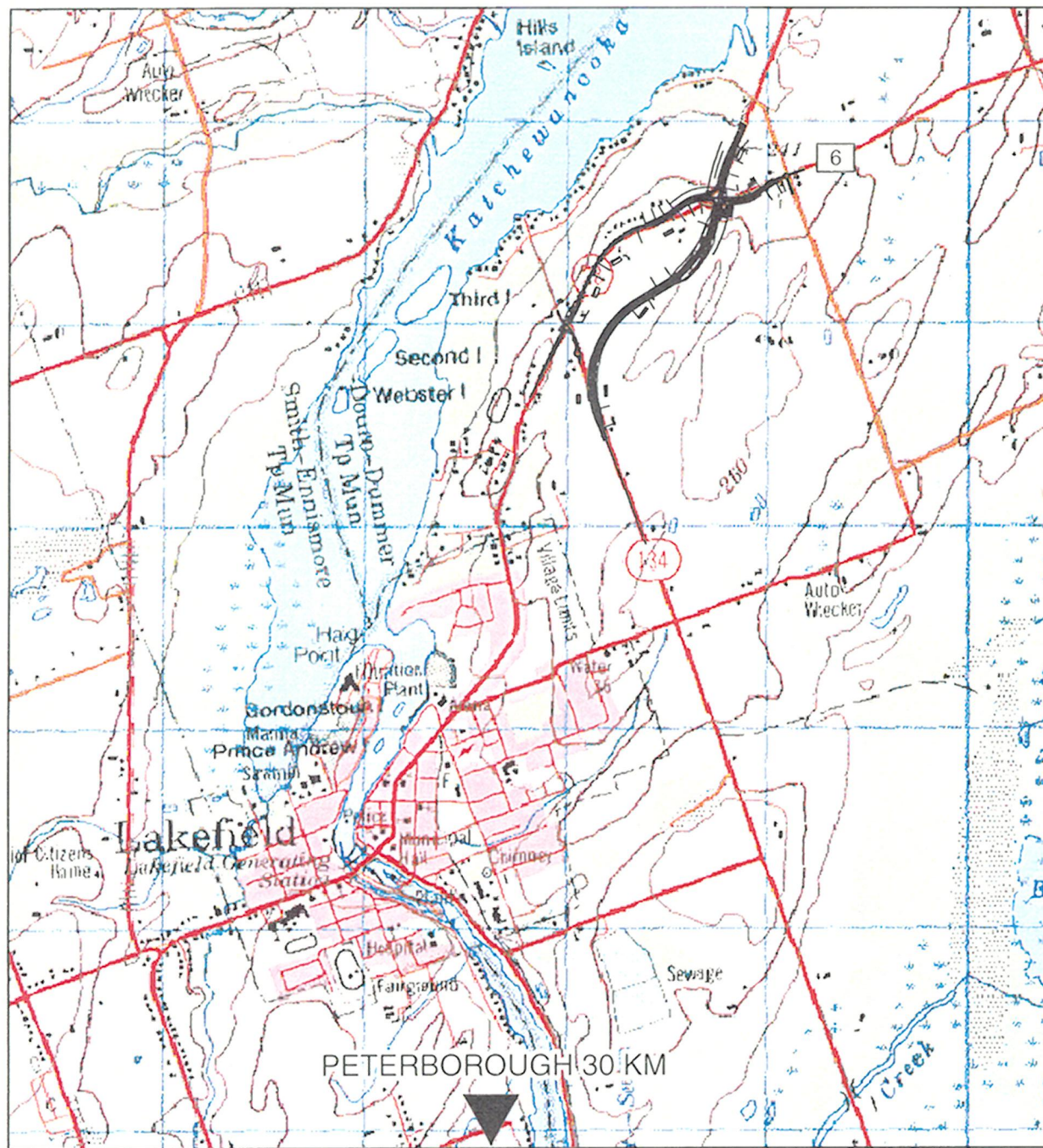
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SS:llm

P:\2003\60000\62825\Hydrogeology Phase 1\Reports\Final Hydrogeological Screening Report 2003-09-8.doc



**APPENDIX 1
DRAWINGS**



Legend

— HWY 28 Re-alignment



Site Location

Project No. ONO 62825
HWY 28

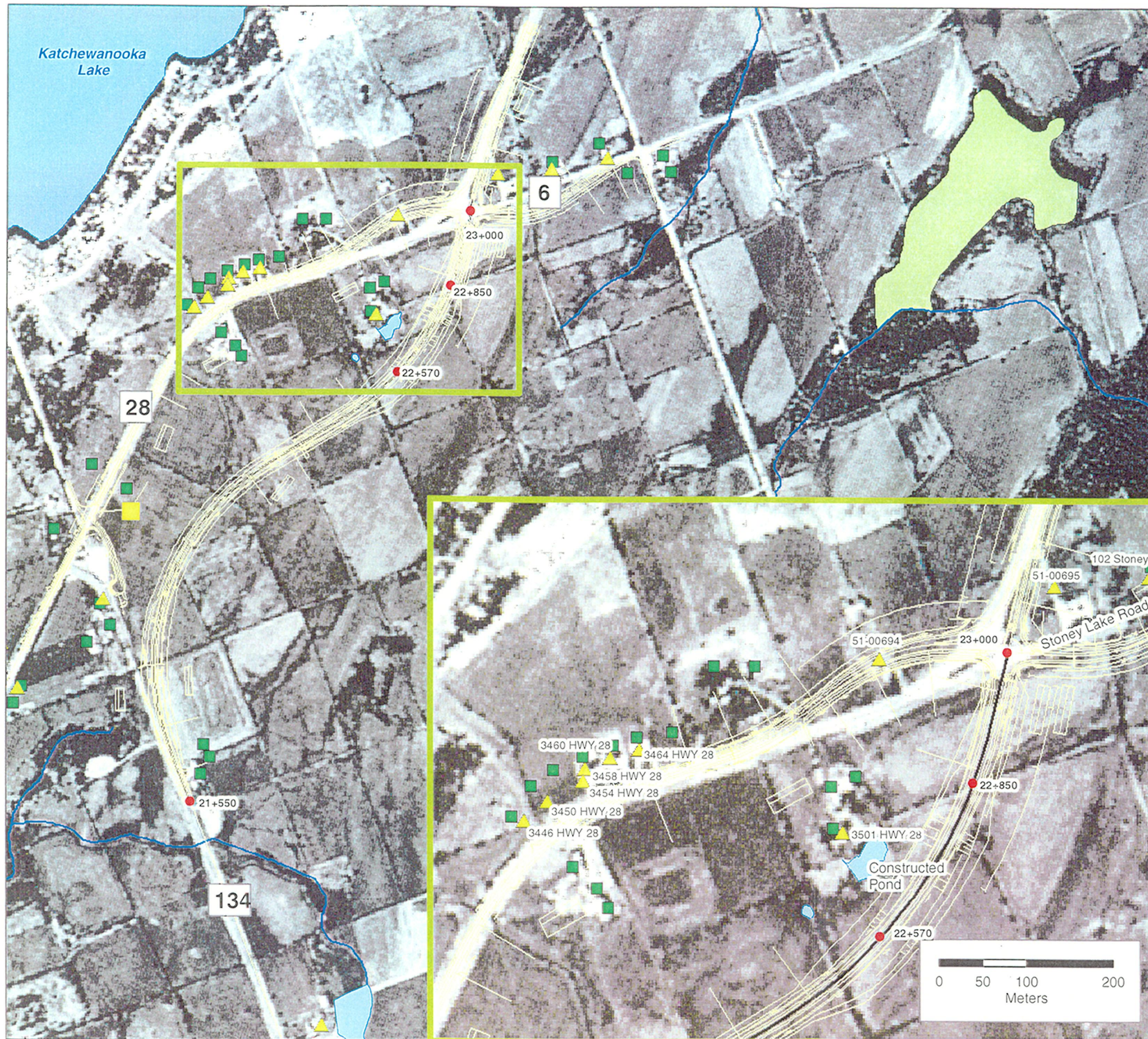
Drawn By: Pam Whyte
Reviewed By: Sonny Sundaram

Date:
August 19, 2003

Drawing No.: 1



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Whitford**

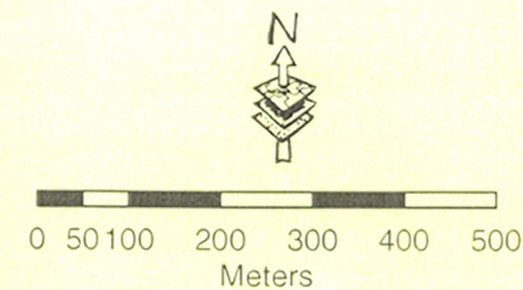


Legend

- Station
- Driving Range
- ▲ Surveyed Water Well
- Building
- HWY 28 Re-alignment
- Centre Line Re-alignment

Water Body

- Lake or Pond
- Wetland
- Flowing Water



Water Wells and Surface Water Bodies

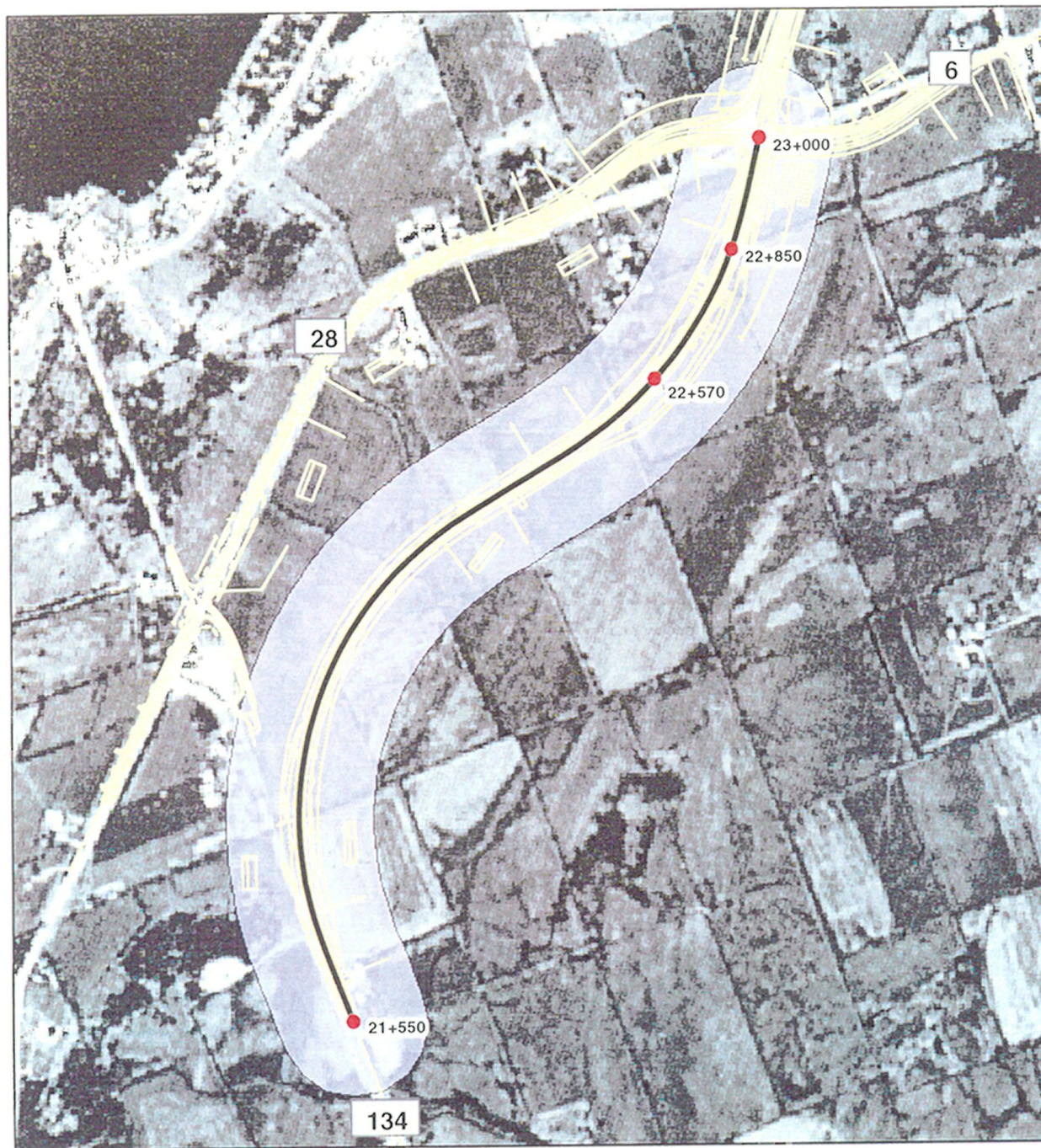
Project No. ONO 62825
HWY 28

Drawn By: Pam Whyte
Reviewed By: Sonny Sundaram

Date:
August 19, 2003

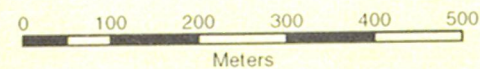
Drawing No.: 2





Legend

- Station
- HWY 28 Re-alignment
- Centre Line Re-alignment
- Till: Undifferentiated



Source: 1:1,000,000
Quaternary Geology of Ontario
Ontario Geological Survey, 1991
Ministry of Northern Mines and Development
Southern Sheet Map 2556

Surficial Geology

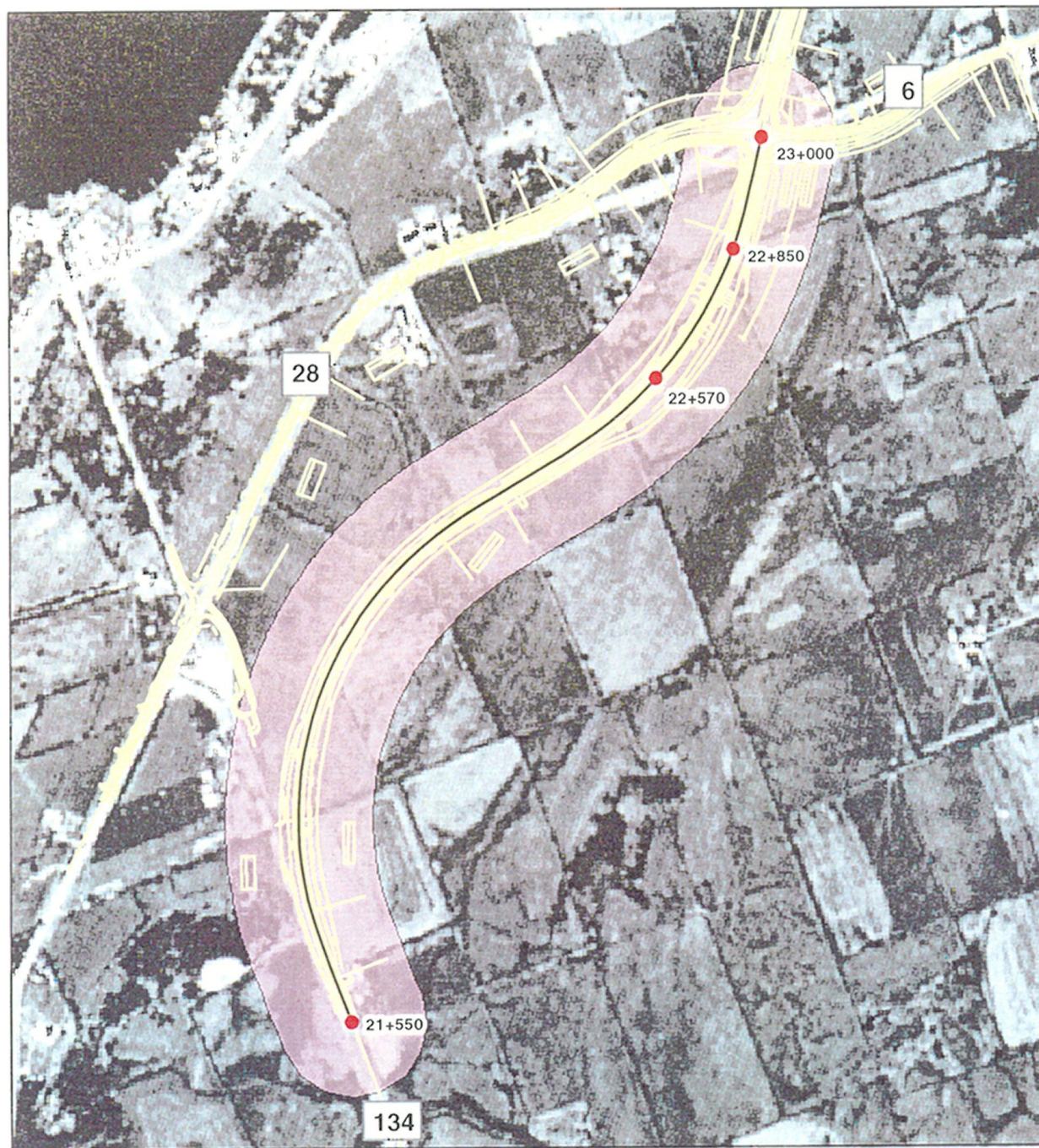
Project No. ONO 62825
HWY 28

Drawn By: Pam Whyte
Reviewed By: Sonny Sundaram

Date:
August 19, 2003

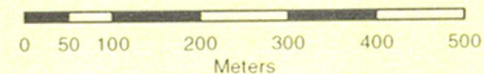
Drawing No.: 3





Legend

- Station
- Centre Line Re-alignment
- HWY 28 Re-alignment
- Limestone, dolostone
Shale, Arkose, Sandstone



Bedrock Geology of Ontario - 1:1,000,000
Southern Sheet
Ministry of Northern Development and Mines, 1991

Bedrock Geology

Project No. ONO 62825
HWY 28

Drawn By: Pam Whyte
Reviewed By: Sonny Sundaram

Date:
August 19, 2003

Drawing No.: 4



**Jacques
Whitford**

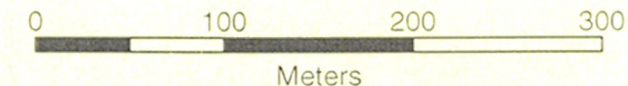


Legend

- Station
- Proposed Monitoring Well Location
- HWY 28 Re-alignment
- Centre Line Re-alignment

Lots

- Residential Property
- Commercial Property
- Unspecified Property
- Surveyed Water Well
- Building



Proposed Monitoring Well Locations

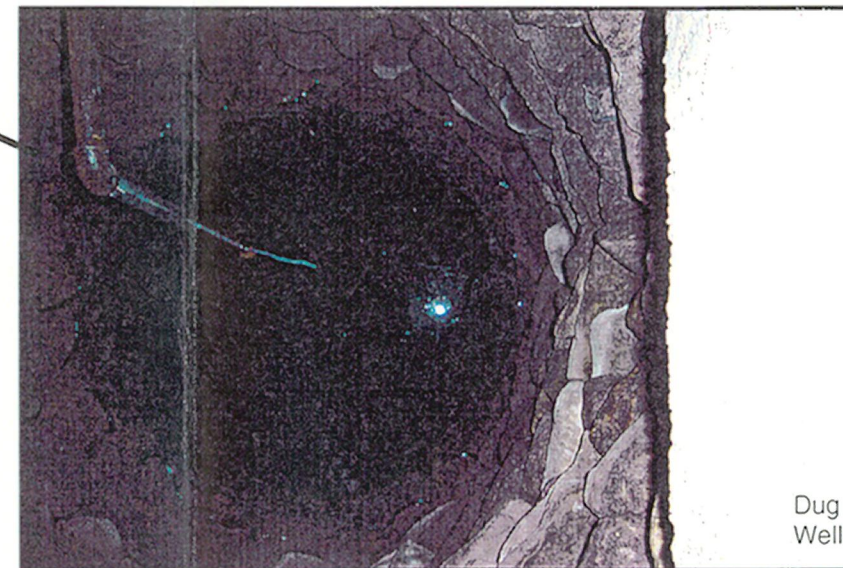
Project No. ONO 62825
HWY 28

Drawn By: Pam Whyte
Reviewed By: Sonny Sundaram

Date:
August 19, 2003

Drawing No.: 5





Legend

- Station
- ▲ Surveyed Water Well
- HWY 28 Re-alignment
- Centre Line Re-alignment
- Building



0 90 180 270 360 450
Meters

Field Photographs

Project No. ONO 62825
HWY 28

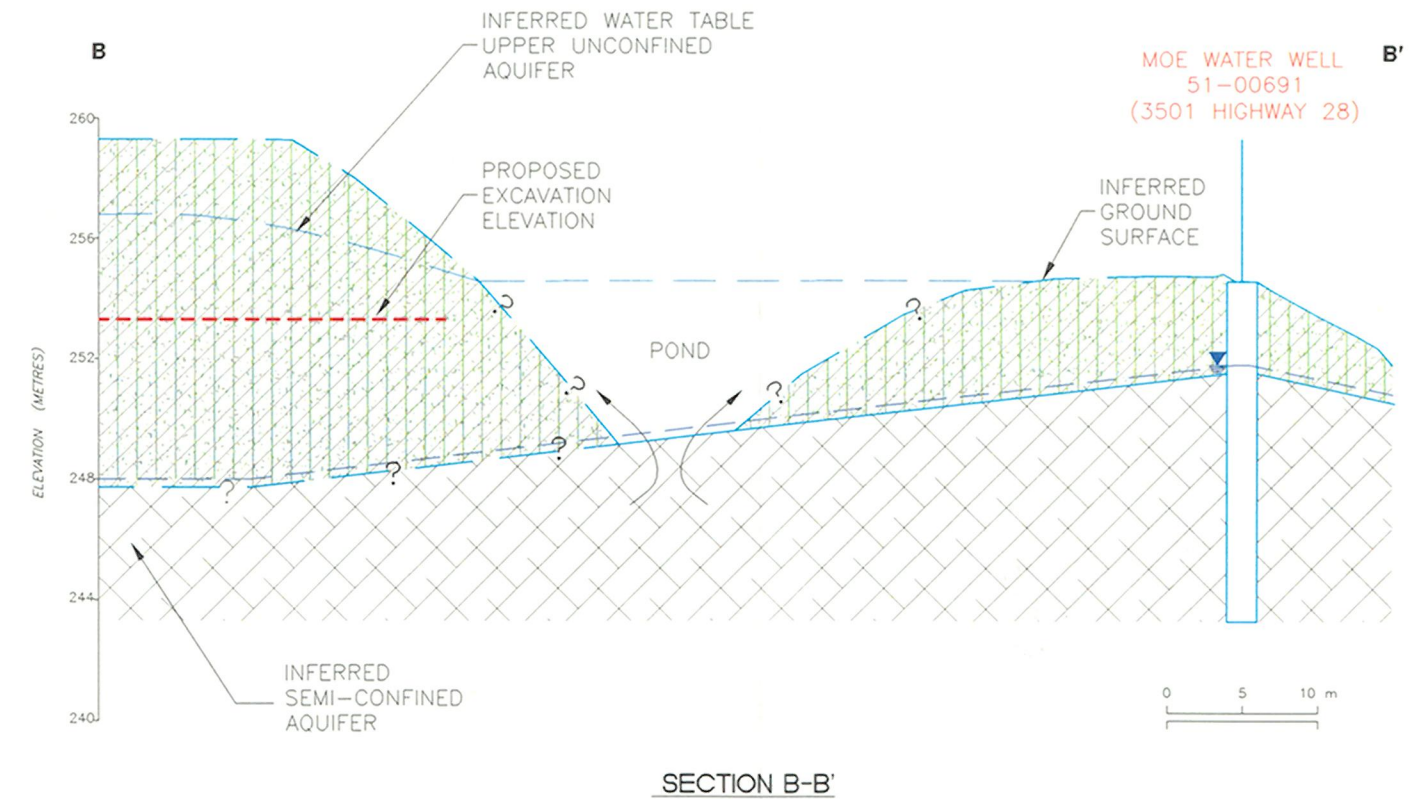
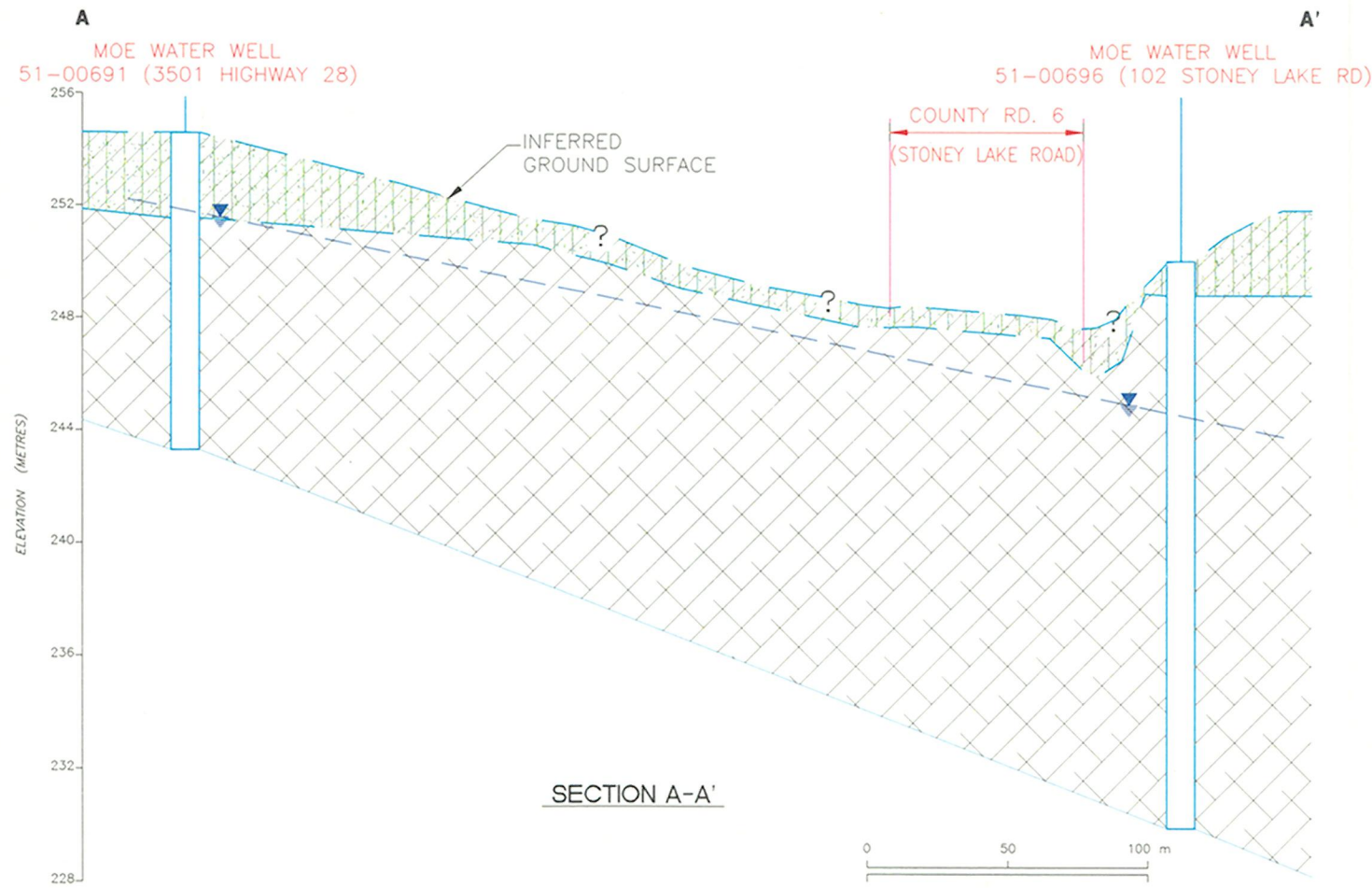
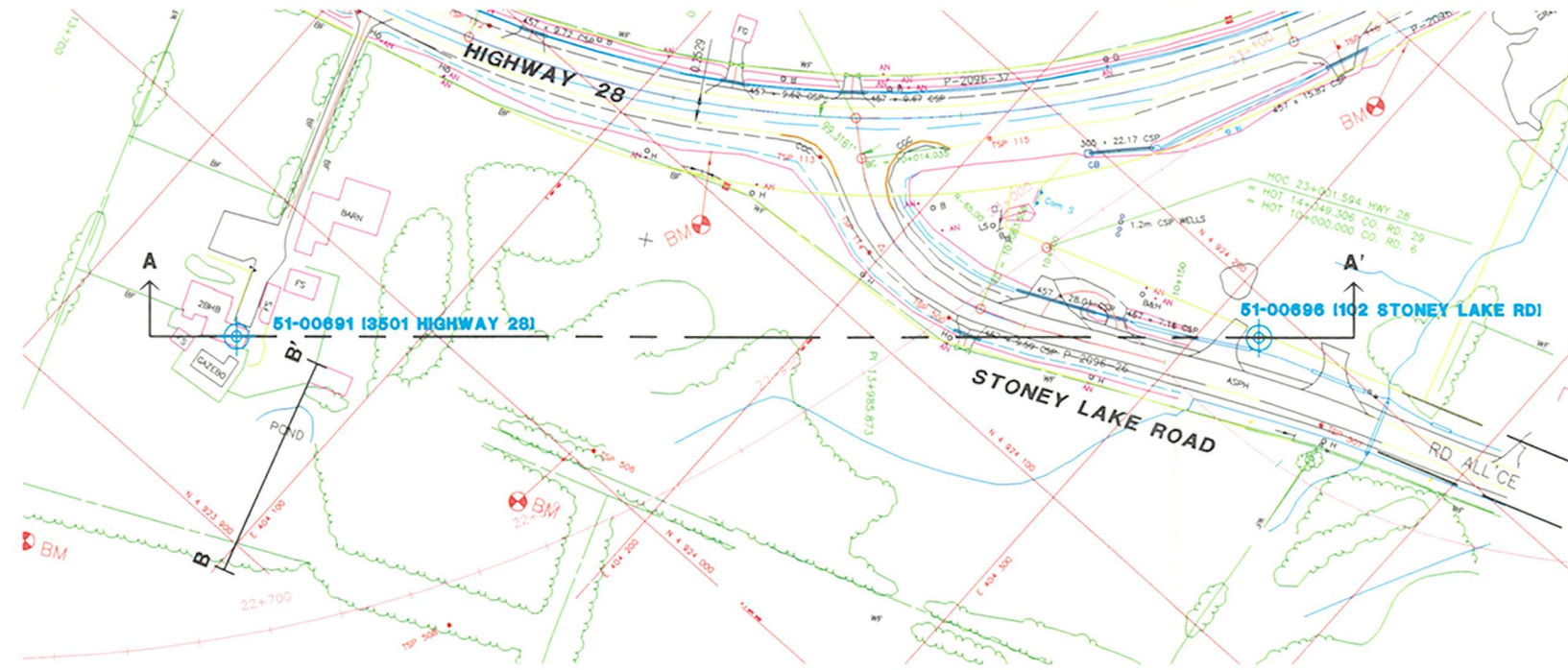
Drawn By: Pam Whyte
Reviewed By: Sonny Sundaram

Date:
August 19, 2003

Drawing No.: 6



PLAN
1:250



Jacques
Whitford

REFERENCE :

INFERRED GROUND SURFACE AND
GROUNDWATER ELEVATIONS BASED ON
ON MOE WELL RECORDS.
BASE PLAN PROVIDED BY GIFFELS.

SCALE : AS SHOWN

DATE : 03/08/18

DWN. BY : GBB

APP'D BY : SS

GIFFELS ASSOCIATES LTD.

HYDROGEOLOGICAL SCREENING
HIGHWAY 28

LAKEFIELD,

ONTARIO

GEOLOGIC
CROSS-SECTION

PROJECT No.:

ONO62825

DRAWING No.:

7