BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Appendix L - Part 1

Hydrogeological Existing Conditions Review Report

BURNSIDE

Hydrogeological Existing Conditions Review for Warden Avenue and Kennedy Road Environmental Assessment Studies between Major Mackenzie Drive East and Elgin Mills Road East

Regional Municipality of York
Markham, Ontario

Hydrogeological Existing Conditions Review for Warden Avenue and Kennedy Road Environmental Assessment Studies between Major Mackenzie Drive East and Elgin Mills Road East

Regional Municipality of York
Markham, Ontario

R.J. Burnside & Associates Limited
292 Speedvale Avenue West Unit 20
Guelph ON N1H 1C4 CANADA

March 2022
300052314.0000

Distribution List

No. of Hard Copies	PDF	Email	Organization Name
-	Yes	Yes	Regional Municipality of York

Record of Revisions

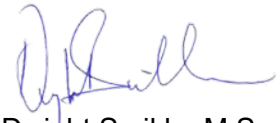
Revision	Date	Description
0	November 15, 2021	Initial Submission to Regional Municipality of York (in memo format)
1	March 8, 2022	Revised Draft Report Submission to Regional Municipality of York

R.J. Burnside & Associates Limited

Report Prepared By:

Stephanie Charity, B.Sc., P.Geo.
Hydrogeologist
SC:cl

Report Reviewed By:



Dwight Smikle, M.Sc., P.Geo.
Senior Hydrogeologist
DS:cl

Table of Contents

Figures

Appendices

Disclaimer

1.0 Introduction

R.J. Burnside & Associates Limited has been retained by the Regional Municipality of York to provide hydrogeological services in support of the Class Environmental Assessment (EA) Studies for the proposed improvements to Warden Avenue and Kennedy Road from Major Mackenzie Drive to Elgin Mills Road. The purpose of this report is to characterize existing groundwater conditions in the area of the proposed work and identify any potential hydrogeological impacts from the proposed improvements to Warden Avenue and Kennedy Road. The hydrogeological impacts associated with the proposed improvements to these road corridors will be further assessed as part of the Hydrogeological Assessment being completed for these EAs. The Study Areas for the studies are illustrated on Figure 1 and include lands within 500 m of the subject roads, but road improvements will be limited to the right-of-way (ROW) along the roads and will not extend into private property. The width of the right-of-way in the areas to be improved is expected to be 41 m mid-block and 43 m at intersections.

2.0 Background Review

This report has been completed based on a review of published geological and hydrogeological information including topography, physiography, surficial geology and bedrock geology mapping as well as existing geotechnical and hydrogeological reports completed within the Study Area.

The main reports used to complete this desktop study of existing hydrogeological conditions are listed below:

- Berczy Glen Master Environmental Servicing Plan, Berczy Glen Landowners Group, Stonybrook Consulting Inc., et al., 2020.
- Angus Glen Master Environmental Servicing Plan, Stonybrook Consulting Inc., et al., October 2017.
- Robinson Glen Master Environmental Servicing Plan, Stonybrook Consulting Inc., et al., 2017.
- Geotechnical Investigation, Schedule C Class EA Study for Improvements to Warden Avenue, From Major Mackenzie Drive to North of Elgin Mills Road, Markham, Ontario. Golder Associates, August 6, 2021.
- Geotechnical Investigation, Schedule C Class EA Study for Improvements to Kennedy Road, From Major Mackenzie Drive to North of Elgin Mills Road, Markham, Ontario. Golder Associates, August 30, 2021.
- Berczy, Bruce, Eckardt and Robinson Creeks Subwatershed Study (AMEC Foster Wheeler, 2019).

Hydrogeological data within these reports include geotechnical information, groundwater level monitoring, surface water monitoring, hydraulic conductivity testing and water quality sampling. The data collected as part of previous studies have been incorporated into the analyses and interpretations conducted as part of the current assessment. A complete list of references used for this report is included in Section 7.0.

3.0 Topography and Drainage

The Study Areas are characterized by rolling to hilly topography with slopes generally being southwards towards the watercourse valleys. Along Warden Avenue the ground elevations range from 229 meters above sea level (masl) at Elgin Mills Road down to 210 masl at Major Mackenzie Drive East. Along Kennedy Road, ground elevations range from 225 masl near Elgin Mills Road down to 205 masl at Major Mackenzie Drive (Figure 1).

The Study Areas are located in the Rouge River watershed within the jurisdiction of the Toronto Region Conservation Authority (TRCA) and occupy portions of the Berczy Creek, Bruce Creek and Robinson Creek subwatersheds. Along Warden Avenue a tributary of Bruce Creek crosses under the ROW approximately 825 m north of Major Mackenzie Drive flowing southeast and the main branch of Berczy Creek flows under Warden Avenue just south of Major Mackenzie Drive. Along Kennedy Road there are no watercourse crossings except for Bruce Creek, which crosses just north of Elgin Mills Road.

Parts of the provincially significant Bruce and Berczy Creek Wetland Complex are mapped within the Study Areas. The wetlands are mostly located along the Bruce and Berczy Creek watercourses and only a small portion of the wetland extends to the ROW. Groundwater monitoring completed within the wetlands as part of MESP studies indicate seasonal discharge of groundwater occurs in the wetlands and along watercourses.

4.0 Geology

The Study Areas are located within the physiographic region known as the Peel Plain (Chapman and Putnam, 1984). The Peel Plain consists of a thin veneer of lacustrine silt and clay deposited over glacial till with a flat to rolling topography with generally more incised slopes in the vicinity of the watercourses.

Regional surficial geology mapping published by the Ontario Geological Survey (2011) show the surficial sediments within the Study Areas include silty sand glacial till, coarse textured glaciolacustrine deposits (sand/silt), fine textured glaciolacustrine deposits (silt/clay) and modern alluvial deposits along Bruce Creek (Figure 2).

Soil information obtained by local drilling was used to refine the surficial geology interpretation in the Subwatershed Study (SWS) (AMEC Foster Wheeler, 2019). The results of the refinement were generally consistent with the published regional mapping with respect to overall soil types however discrepancies with respect to the spatial distribution of various surficial soil types were noted in the SWS (AMEC Foster Wheeler, 2019). The published mapping suggests large areas of sand at surface however based on drilling programs the dominant sediment type found at surface across the area was till.

Bedrock beneath the Study Areas consists of layered grey shale bedrock of the Blue Mountain Formation (OGS, 1991). Bedrock is generally found at an elevation of approximately 120 masl to 130 masl (approximately 100 m below ground surface).

4.1 Local Geology

Local drilling programs completed in the Study Areas as part of previous studies indicate that shallow soils consist generally of till with interbedded layers of sand, silty sand, and silt (Golder, 2021, Stonybrook Consulting Inc., et al., 2017). The locations of boreholes and monitoring wells within the Study Areas are shown on Figures 3 and 4. Borehole logs with soil descriptions are provided in Appendix A.

In 2021, Golder completed a total of 17 boreholes along Warden Avenue within the Study Area ranging in depth from 2 metres below ground surface (mbgs) to 9 mbgs. A total of 24 boreholes were drilled along Kennedy Road within the Study Area by Golder in 2021. The boreholes ranged in depths from 2.0 m to 17.1 mbgs. The geotechnical drilling confirmed that the shallow soils encountered in the Study Areas generally consist of glaciolacustrine silt and clay and sandy silt to silty sand till with interbedded layers of sand, silty sand and silt.

4.2 Stratigraphy

The stratigraphy in the Markham area including the Study Areas was modelled by the TRCA for the Rouge River Watershed Plan (2007) and further refined during the Berczy, Bruce, Eckardt and Robinson Creeks Subwatershed Study (AMEC Foster Wheeler, 2019) and Berczy Glen MESP (Stonybrook et al., 2020), Angus Glen MESP and Robinson Glen MESP (Stonybrook et al., 2017). There are three major overburden aquifer systems identified in the vicinity of the Study Areas. The overburden aquifers are described in order of increasing depth as the:

- Oak Ridges Aquifer Complex (ORAC), formed within the Oak Ridges Moraine (ORM) sediments and sometimes referred to as the Upper Aquifer.
- Thorncliffe Aquifer (or Middle Aquifer), formed by the sandy sediments of the Thorncliffe Formation and generally separated from the overlying ORAC by the Newmarket till aquitard.

- Scarborough Aquifer (Lower Aquifer), formed by sandy sediments of the Scarborough Formation overlying the bedrock, and separated from the Thorncliffe Aquifer by the Sunnybrook aquitard.

In the North Markham area, the ORAC tends to be thin and sporadic as the aquifer is pinching off to the south. Within the Study Areas, the ORAC has been identified as isolated layers and lenses of sand/gravel and silty sand within 5 m to 15 m below ground surface (Angus Glen MESP and Robinson Glen MESP, 2017).

Site-specific geological information obtained from the geotechnical boreholes and groundwater monitoring wells drilled within the Study Area (Appendix A) and local MECP well records (Appendix B) have been used to prepare schematic cross-sections along Warden and Kennedy Road within the Study Areas to illustrate the shallow stratigraphy. The cross-sections location are shown on Figure 3 and 4 and the cross-sections are provided as Figures 5 and 6.

The cross-section along Warden Avenue (Figure 5) shows a thick layer of fine-grained soils (glaciolacustrine silt and clay and glacial till deposits) at surface, interspersed with lenses and layers of sand of variable thickness and extent. The sand layers are interpreted to be discontinuous lenses of ORAC sediments separated by finer-grained layers of silty sand and silty sand till. Because of the discontinuous nature of the occurrence of ORAC sediments, the aquifer is not interpreted to be expressed in this location.

The cross-section along Kennedy Road (Figure 6) also shows a layer of fine grained soils overlying a layer of sand/gravel and silty sand at depths of 1 m to 10 mbgs and a thickness of 5 to 10 m. The coarse grained layer is interpreted to be the ORAC and appears to be continuous in the northern part of the Study Area before becoming discontinuous in the south.

The Thorncliffe aquifer is interpreted to be generally found between elevations 160 masl and 180 masl (i.e., more than 35 mbgs) in the vicinity of the Study Area (Figures 5 and 6). (Stonybrook et al., 2020). The Scarborough aquifer was interpreted to be found between 120 masl and 130 masl (Stonybrook et al., 2020).

5.0 Hydrogeology

5.1 Local Groundwater Use

The Study Areas are situated immediately north of the currently urbanized area of Markham and properties in the Study Areas north of Major Mackenzie Drive still rely on private wells for water supply. The Ministry of the Environment Conservation and Parks (MECP) maintains a database that provides geological records of water supply wells drilled in the province. The locations of MECP well records within 500 m of the Study

Areas are plotted on Figures 7 and 8. It is noted that the well locations listed in the MECP records are approximations only and may not be representative of the precise well locations in the field.

Within 500 m of the Warden Avenue Study Area, 88 well records are listed as water supply wells (Figure 7). The majority of the water supply wells were drilled wells screened in the overburden at depths ranging from 15 mbgs to 97 mbgs. Eight of the wells were bored wells with depths of 4 to 12 mbgs. Three of the wells were in the bedrock at depths of approximately 72 m to 99.7 mbgs. Most of the well records are located south of Major Mackenzie within a rural subdivision (Figure 2).

Within 500 m of the Kennedy Road Study Area, 38 of the well records are listed as water supply wells (Figure 8). The majority of the water supply wells were drilled wells screened in the overburden at depths ranging from 9 mbgs to 177 mbgs. Eleven of the wells were bored wells with depths of 5 to 12 mbgs. Two of the wells were in the bedrock at depths of approximately 53 m to 71 mbgs.

The MECP well records suggest that most of the local private wells tap the Thorncliffe Aquifer (more than 30 m below ground surface) for water supply; however, some shallow wells are completed in the ORAC sediments. The reported well yields are generally considered good and sufficient for typical domestic use with yields ranging from 0.2 L/s to 15 L/s (2 gpm to 200 gpm).

The Study Area is within the North Markham Future Urban Area (FUA) and the majority of the private wells identified will be decommissioned and residents will be connected to municipal water.

Based on review of available MECP data there is only one active Permit to Take Water (PTTW) identified within 500 m of the Study Areas. The permit is associated to irrigation wells located on the Angus Glen Golf Club Ltd.

5.2 Groundwater Levels

The shallow groundwater in the Study Areas has been observed in hydrogeological and geotechnical studies (see Section 2.0). The locations of monitoring wells in or near the Study Areas are shown on Figures 3 and 4 and hydrographs showing groundwater level data are provided in Appendix C.

Groundwater levels were also measured in wells along the road alignments by the Region in May 2021. The Region's groundwater level data is provided in Table C-1, Appendix C.

A review of available groundwater data indicates that along Warden Avenue groundwater elevations range from 212 masl to 227 masl with depths ranging from

<1 mbgs to 5 mbgs (Appendix C). It should be noted that the groundwater levels were measured in wells screened at depths from 6 mbgs to 12 mbgs and shallow groundwater levels may be reflective of an upward gradient in the till. The interpreted depth to groundwater within the Warden Study Area is mapped on Figure 9. The depth to water table varies with topography being shallower in areas of low topography and deeper in areas of high topography. There were no flowing wells identified in the groundwater monitoring data.

A review of available groundwater data indicates that along Kennedy Road groundwater elevations range from 202 masl to 221 masl with depths ranging from <1 mbgs to 9 mbgs (Appendix C). It should be noted that the groundwater levels were measured in wells screened at depths from 4 mbgs to 12 mbgs and shallow groundwater levels are reflective of an upward gradient in the till. Water was not encountered during drilling until depths of a least 4 mbgs (see borehole logs Appendix A). There were no flowing wells identified in the groundwater monitoring data.

The interpreted depth to groundwater within the Kennedy study area is mapped on Figure 10. Most of the land along Kennedy Road is shown as having groundwater levels between 2 m and greater than 4 mbgs. Some shallow levels are mapped on the southern portion of Kennedy Road just north of the Major Mackenzie Drive East intersection (Figure 10).

5.3 Water Quality

A review of groundwater quality reported in the Berczy Glen, Angus Glen and Robinson Glen MESP studies was completed. Impacts from agricultural land use is observed in some wells with reported nitrate concentrations ranging from 0.12 mg/L up to 18.5 mg/L. Elevated sodium and chloride has been observed in monitoring wells located near Warden Avenue and Kennedy Road with chloride concentrations ranging from 55 mg/L to 361 mg/L and sodium concentrations ranging from 7 mg/L up to 227 mg/L.

5.4 Source Protection

The Study Area is located in the Toronto and Region Source Protection Area. Municipal supply for Markham is sourced from Lake Ontario, therefore, there are no well head protection areas in the vicinity of the Study Area. Mapping from the MECP Source Protection Information Atlas indicates that the Study Area include lands mapped as highly vulnerable aquifer (HVA) and significant groundwater recharge areas (SGRA) on Figures 11 and 12.

Aquifer vulnerability refers to the susceptibility of an aquifer to potential contamination. Some degree of protection for groundwater quality from natural and human impacts is provided by the soil above the water table. The degree of protection is dependent upon

the depth to the water table (for unconfined aquifers) or the depth of the aquifer (for confined aquifers) and the type of soil above the water table of aquifer. As these two properties vary over any given area, the degree of protection or vulnerability of the groundwater to contamination also varies. The surficial soils of the Study Area are generally low hydraulic conductivity, fine grained soils, so the shallow depth to the ORAC is the primary reason that the area would be considered to have high vulnerability.

Mapping of HVAs were completed by TRCA on a regional scale and should only be used as a guide, and not site-specific planning decisions. The results of the site-specific geological and hydrogeological work completed for previous studies (see Section 2.0) suggests that there are some areas where aquifer layers are close to surface within the Study Areas however a review of water well indicates that the deeper Thorncliffe Aquifer is the main aquifer used for private well supplies and the shallow sediments of the ORAC are not used extensively.

SGRAs are shown on the MECPs Source Protection Atlas based on analyses completed by the TRCA in 2016. The areas mapped as SGRAs generally correspond to areas shown to have surficial sand on the OGS surficial geology mapping. Site-specific drilling within the Study Area did not encounter surficial sands but rather silt and clay or sandy silt/silty sand glacial till soils which limit significant recharge from occurring.

As part of this assessment, Burnside also reviewed Areas of Concern for York Region based on mapping available on the York Region's Source Water Protection website. Our review indicated that there are no areas of concern for groundwater in the Study Areas and that the closest Area of Concern is located over 3 km northwest of Warden Avenue at Highway 404.

5.5 Hydrogeological Conceptual Model

A hydrogeological conceptual model is not a physical nor a numerical model but is an interpretation of the local and regional hydrogeological conditions and a description of how the various components of the system relate to each other. It can be simplified to be an interpretation of the groundwater flow conditions and directions within an area. In the Study Areas, groundwater is interpreted to infiltrate within the surficial low permeability fine grained sediments and will tend to move vertically to recharge the ORAC sediments. It is expected that in areas where ORAC sediments are not encountered minimal groundwater will occur. As noted above in Section 5.2, water levels measured in the Study Area are reflective of conditions in the vicinity of well screens that are a minimum of 4 m to 6 m below grade and excavations that are shallower than these depths may not encounter groundwater.

Upward gradients that have been identified in the above sections may be due to groundwater being encountered in association with the ORAC sediments or in close proximity to watercourses/low topographic areas where groundwater from shallow sediments is discharged. The above hydrogeological conceptual model therefore indicates that groundwater conditions may only be a concern in areas where road work is deep enough to encounter ORAC sediments or in topographic low spots such as around watercourses.

6.0 Potential Impacts

6.1 Construction Impacts

Road construction may impact shallow groundwater wells that are located in close proximity to the construction. Potential impacts include the cutting off or removal of sand lenses that contribute to the well or damage to the well integrity due to vibrations or heavy machinery use. It is expected that only shallow wells will be impacted in this way and the potential number of wells that may be impacted can be evaluated using information from a well survey. It is noted that the locations for wells listed in the MECP records are approximations only and may not be representative of the precise well locations in the field. To understand the potential for construction impacts, the locations of the wells should be confirmed in a well survey conducted within each Study Area to identify any shallow wells that may in close proximity to the road widening and potentially impacted by the construction. Any wells identified as being potentially impacted should have baseline water quality and water levels collected and be monitored through construction. A well interference and reporting protocol should be established before construction that outlines the actions taken should a complaint from a private well owner be received and ensures that a supply of water is provided for the private resident.

6.2 Construction Dewatering

During road upgrades municipal servicing will be installed including watermain, storm sewer and sanitary sewers. Based on groundwater levels for the Study Area, some dewatering of sediments may be required during the installation of underground infrastructure. An assessment of dewatering requirements will be completed on a project basis to support necessary permits. Dewatering volumes will be determined based on the proposed depth of excavation, dimensions of the excavated area and the hydraulic properties of the soils encountered. Depending on the dewatering volumes predicted, water taking permits will be required such as an Environmental Sector Registry Activity (EASR) or a permit to take water (PTTW) from the MECP. An assessment of potential impacts from dewatering is required to obtain these permits as well as monitoring and mitigation plans to address potential impacts. These impacts should be further evaluated based on more detailed information on service installation depths obtained later in the design process.

Based on the hydrogeological conditions of the Study Areas, potential receptors that could be impacted by short-term construction dewatering include private wells and surface water features. It is assumed that impacts to these receptors would be managed through a monitoring and mitigation plan to ensure that receptors are not negatively impacted or that impacts are suitably mitigated and that the plan would be a condition of any permits for dewatering. It is noted that these impacts are likely to be of short duration and limited to the period during which actual construction is taking place. After construction it is expected that the area should return to pre-construction conditions as no adverse changes are predicted.

6.3 Long-Term Impacts

Runoff from winter maintenance activities on roads can infiltrate into the groundwater resulting in elevated sodium and chloride in the groundwater. Additional lanes on the road will result in greater surface area for application of road salt and therefore a greater loading of sodium and chloride to groundwater.

These impacts may be mitigated in part by the implementation of Low Impact Development (LID) features in the improved road corridors which will be considered as part of the EA studies. Best Management practices for salt management may also help with a reduction in salt loading.

Potential impacts to groundwater discharge in wetlands or watercourses at road crossings are not anticipated but can also be mitigated through the use of LID features. Groundwater flow may occur at increased rates along trenches and excavations constructed as part of the servicing works. Industry best practices for construction of service trenches, including the building of cut off walls will ensure that groundwater flow is not re-directed along trenches.

7.0 References

AMEC Foster Wheeler, 2019. Berczy, Bruce, Eckardt and Robinson Creeks Subwatershed Study, AMEC Foster Wheeler, 2019.

Burnside, 2018. Hydrogeological Assessment, Berczy Warden Holdings Inc. and Berczy Elgin Holdings Inc., R.J. Burnside & Associates Limited, October 2018.

Golder 2021a. Geotechnical Investigation, Option 2 – Kylemore Lands Street 'A', Berczy Glen Externals – Warden Avenue and Street 'A', Proposed New Sanitary Sewer, Markham, Ontario. Golder Associates, July 5, 2021.

Golder, 2021b. Geotechnical Investigation, Schedule C Class EA Study for Improvements to Warden Avenue, From Major Mackenzie Drive to North of Elgin Mills Road, Markham, Ontario. Golder Associates, August 6, 2021.

Golder, 2021c. Geotechnical Investigation, Schedule C Class EA Study for Improvements to Kennedy Road, From Major Mackenzie Drive to North of Elgin Mills Road, Markham, Ontario. Golder Associates, August 30, 2021.

Ontario Geological Survey 1991. Bedrock Geology of Ontario, Southern sheet; Ontario Geological Survey, Map 2544, scale 1:1,000,000.

Ontario Geological Survey. 2010. Surficial Geology of Southern Ontario, Ontario Geological Survey, Miscellaneous Release – Data 128.

Ontario Ministry of the Environment, Parks and Conservation, Water Well Records.

Stonybrook Consulting Inc., et al., 2020. Berczy Glen Final Master Environmental Servicing Plan, Berczy Glen Landowners Group, May 2020.

Stonybrook Consulting Inc., et al., 2017. Angus Glen Master Environmental Servicing Plan, Stonybrook Consulting Inc., et al, October 2017.

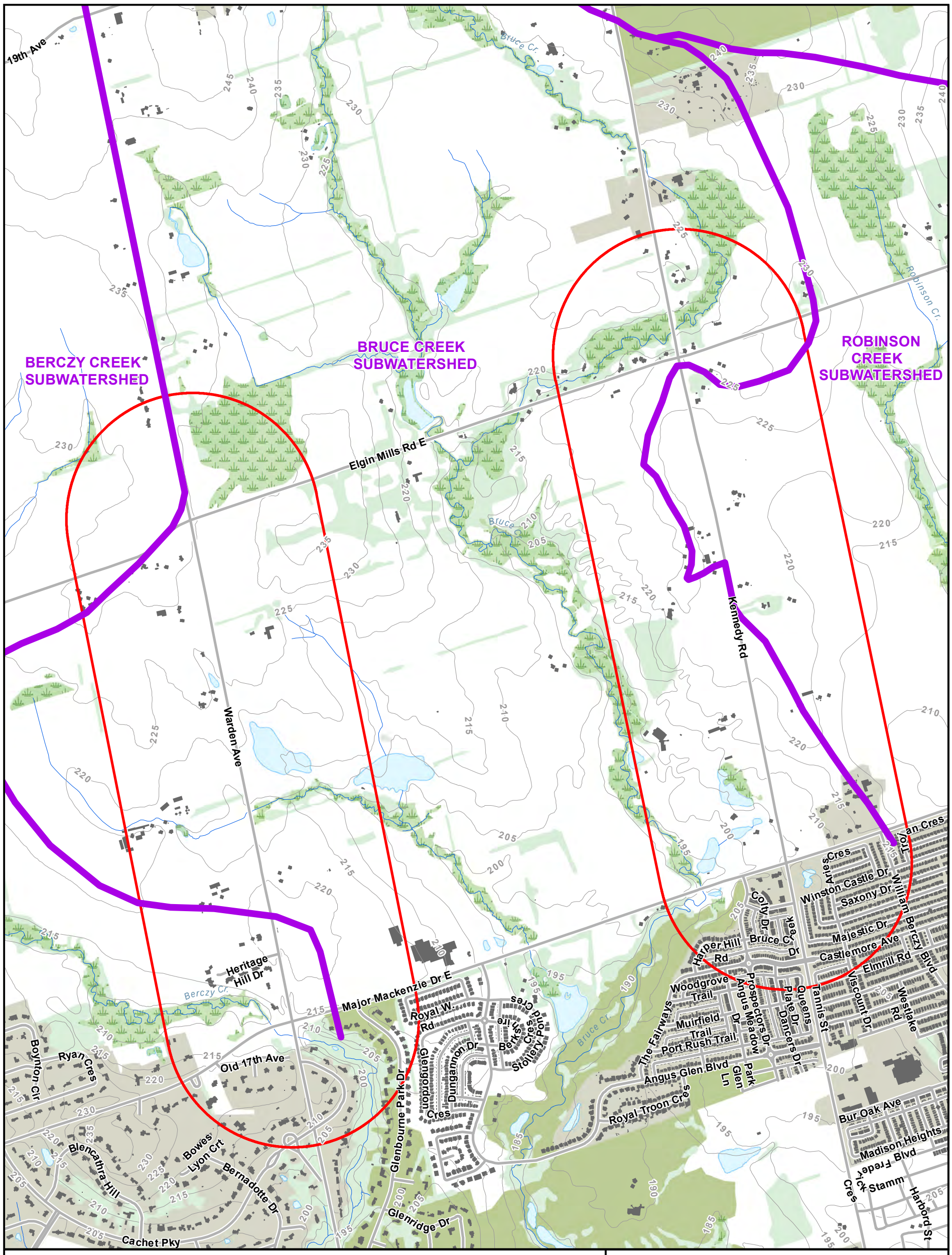
Stonybrook Consulting Inc., et al., 2017. Robinson Glen Master Environmental Servicing Plan, Stonybrook Consulting Inc., et al, October 2017.

Toronto and Region Conservation Authority, 2007. Rouge River Scenario Modelling and Analysis Report.

BURNSIDE

[THE DIFFERENCE IS OUR PEOPLE]

Figures



LEGEND

- STUDY AREAS
- SUBWATERSHED BOUNDARY
- BUILDING
- ROADWAY
- CONTOUR (5m intervals - masl)
- WATERCOURSE
- WETLAND
- OPEN WATER
- WOODED AREA
- BUILT-UP AREA: IMPERVIOUS
- BUILT-UP AREA: PERVIOUS

Sources:
1. Ministry of Natural Resources and Forestry, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.

N

0 100 200 300 400 500 600 700 800 900 1,000
Metres

BURNSIDE

Client / Report

REGIONAL MUNICIPALITY OF YORK

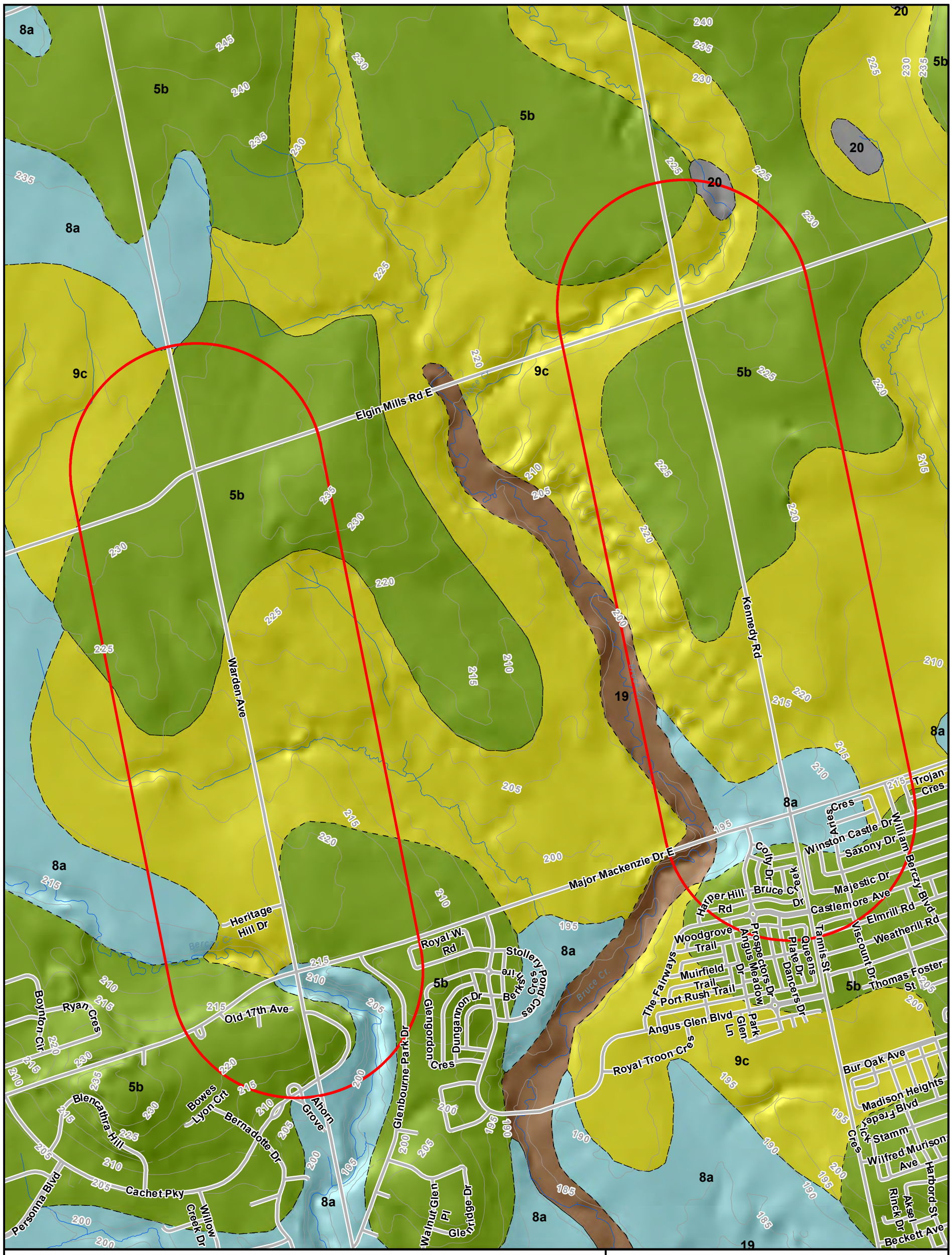
WARDEN AVENUE & KENNEDY ROAD EA STUDIES
HYDROGEOLOGICAL ASSESSMENT

Figure Title

STUDY AREAS

Drawn	Checked	Date	Figure No.
SK	SC	FEBRUARY 2022	1
Scale		Project No.	
1:15,000		300052314	

File Path: Nigel/Shared Work Areas/A:\052314 Warden Kennedy Road Widening\06_GIS\052134 Study Area.mxd Print Date: 2022/02/11 Time: 07:29 AM



LEGEND

- STUDY AREAS
- ROADWAY
- CONTOUR (5m intervals - masl)
- WATERCOURSE
- 5b: Till: Stone-poor, carbonate-derived silty to sandy till
- 8a: Fine-textured glaciolacustrine deposits: Massive-well laminated
- 9c: Coarse-textured glaciolacustrine deposits: Foreshore-basinal deposits
- 19: Modern alluvial deposits
- 20: Organic deposits

Sources:
1. Ministry of Natural Resources and Forestry, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.
3. Ontario Geological Survey 2010. Surficial Geology of Southern Ontario; Ontario Geological Survey, Miscellaneous Release--Data 128.

N

0 100 200 300 400 500 600 700 800 900 1,000
Metres

BURNSIDE

Client / Report

REGIONAL MUNICIPALITY OF YORK

WARDEN AVENUE & KENNEDY ROAD EA STUDIES
HYDROGEOLOGICAL ASSESSMENT

Figure Title

SURFICIAL GEOLOGY

Drawn	Checked	Date	Figure No.
SK	SC	FEBRUARY 2022	2
Scale		Project No.	
1:15,000		300052314	

File Path: Nigel/Shared Work Areas/A:\052314 Warden Kennedy Road Widening\06_GIS\052134 Surficial Geology.mxd Print Date: 2022/02/10 Time: 03:15 PM

LEGEND

- MONITORING WELL (RJB, 2015)
- MONITORING WELL (YORK REGION)
- MONITORING WELL (RJB, 2013)
- MONITORING WELL (EXP, 2020)
- MONITORING WELL (GOLDER, 2021)
- MONITORING WELL (GOLDER, 2020)
- BOREHOLE (GOLDER, 2021)
- BOREHOLE (GOLDER, 2020)
- MECP WELL RECORD LOCATION
- CROSS-SECTION LOCATION KEY (A – A')

0 100 200 400 600
Metres

N

BURNSIDE

Client / Report

REGIONAL MUNICIPALITY OF YORK

WARDEN AVENUE & KENNEDY ROAD EA STUDIES
HYDROGEOLOGICAL ASSESSMENT

Figure Title

BOREHOLE, MONITORING WELL AND CROSS-SECTION LOCATIONS (WARDEN AVENUE)

Drawn	Checked	Date	Figure No.
SK	SC	FEBRUARY 2022	3
Scale		Project No.	
1:7,500		300052314	

File Name:N\gel/Shared Work Areas/035564 Highmark/02_Production/ 052314 Warden Kennedy EA.dwg Date Plotted: February 14, 2022 - 1:56 PM

LEGEND

- MONITORING WELL (RJB, 2015)
- MONITORING WELL (YORK REGION)
- MONITORING WELL (SOIL ENG., 2013)
- MONITORING WELL (GOLDER, 2021)
- MONITORING WELL (NO LOG)
- BOREHOLE (GOLDER, 2021)
- BOREHOLE (SOIL ENG., 2013)
- BOREHOLE (SOIL ENG., 2004)
- BOREHOLE (PML, 2014)
- BOREHOLE (AMEC, 2012)

MECP WELL RECORD LOCATION

A A' CROSS-SECTION LOCATION KEY

0 100 200 400 600
Metres

N

BURNSIDE

Client / Report

REGIONAL MUNICIPALITY OF YORK

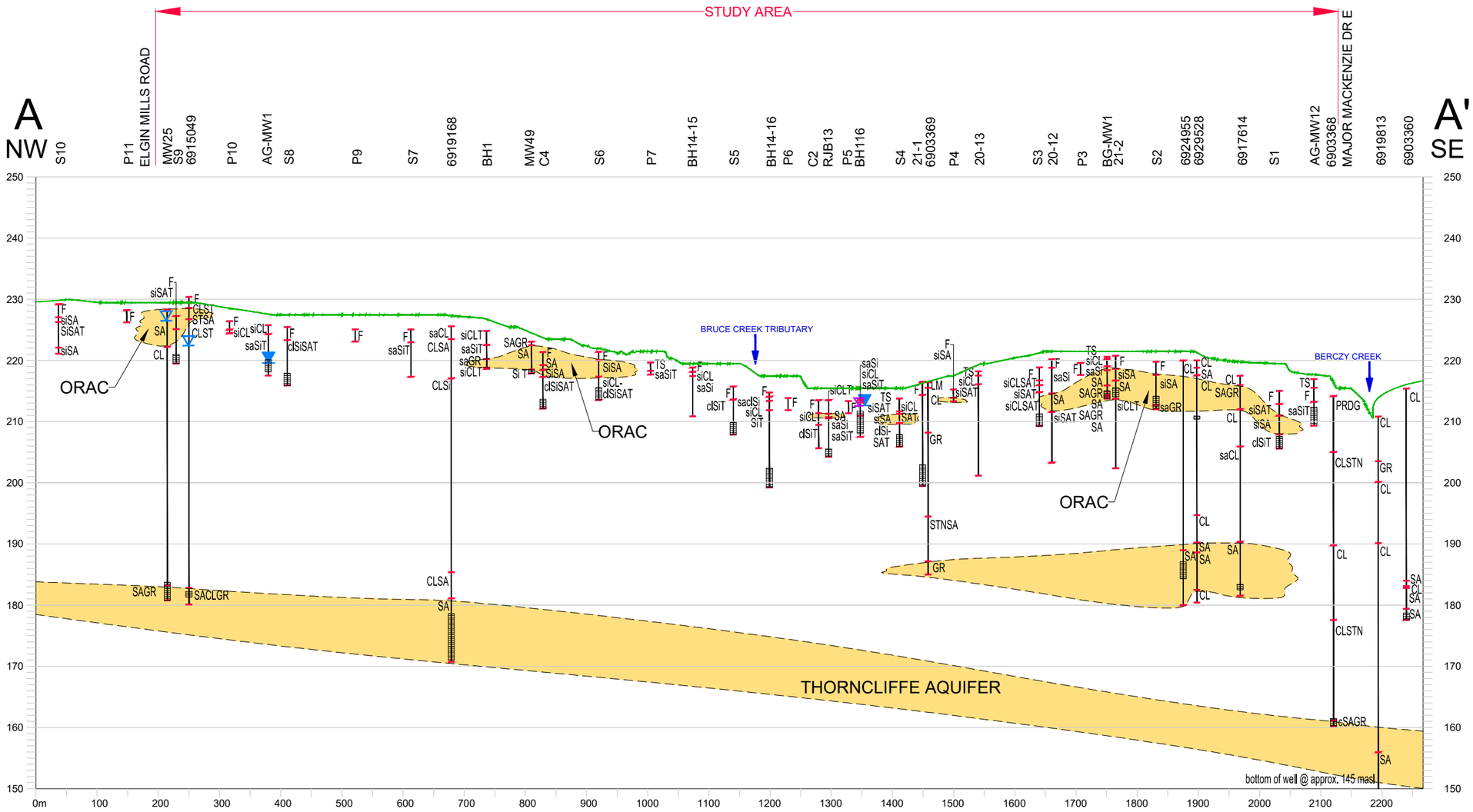
WARDEN AVENUE & KENNEDY ROAD EA STUDIES
HYDROGEOLOGICAL ASSESSMENT

Figure Title

BOREHOLE, MONITORING WELL AND CROSS-SECTION LOCATIONS (KENNEDY ROAD)

Drawn	Checked	Date	Figure No.
SK	SC	FEBRUARY 2022	4
Scale		Project No.	
1:7,500		300052314	

File Name:Nigel/Shared Work Areas/035564 Highmark/02_Production/ 052314 Warden Kennedy EA.dwg Date Plotted: February 14, 2022 - 7:07 AM



LEGEND

MW9 — WELL IDENTIFICATION

EXISTING GROUNDLINE

GEOLOGICAL STRATIGRAPHY CONTACT

STATIC WATER LEVEL (MECP WELL RECORD)

MEASURED WATER LEVEL (APRIL 2016)

WELL SCREEN

INTERPRETED GEOLOGICAL CONTACT

SAND / GRAVEL / SILT

cl	clayey
si	silty
sa	sandy
gr	gravelly
TS	Topsoil
LM	Loam
CL	Clay
Si	Silt
SA	Sand
GR	Gravel
ST	Stones
BLD	Boulder
LMSN	Limestone

BURNSIDE

Client / Report

REGIONAL MUNICIPALITY OF YORK

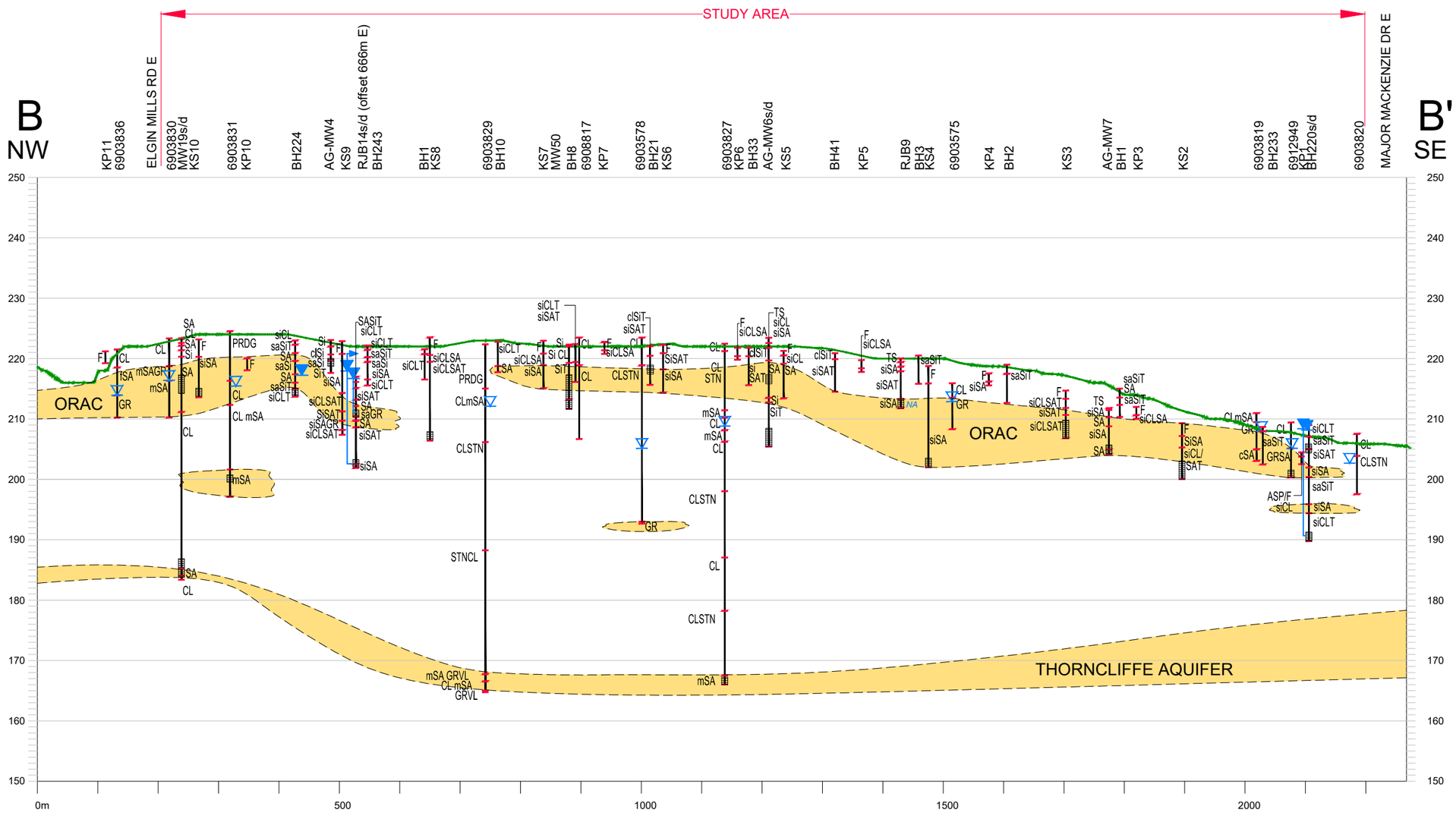
WARDEN AVENUE & KENNEDY ROAD EA STUDIES
HYDROGEOLOGICAL ASSESSMENT

Figure Title

INTERPRETED GEOLOGICAL CROSS-SECTION A-A' (WARDEN AVENUE)

Drawn	Checked	Date	Figure No.
SK	SC	FEBRUARY 2022	5
Scale		Project No.	
1:7,500		300052314	

File Name: 052314 Warden Kennedy EA.dwg Date Plotted: February 11, 2022 - 7:57 AM



LEGEND

MW9
WELL IDENTIFICATION
EXISTING GROUNDLINE
GEOLOGICAL STRATIGRAPHY CONTACT
STATIC WATER LEVEL (MECP WELL RECORD)
MEASURED WATER LEVEL (APRIL 2016)
WELL SCREEN

INTERPRETED GEOLOGICAL CONTACT
SAND / GRAVEL / SILT

cl	clayey
si	silty
sa	sandy
gr	gravelly
TS	Topsoil
LM	Loam
CL	Clay
Si	Silt
SA	Sand
GR	Gravel
ST	Stones
BLD	Boulder
LMSN	Limestone

BURNSIDE

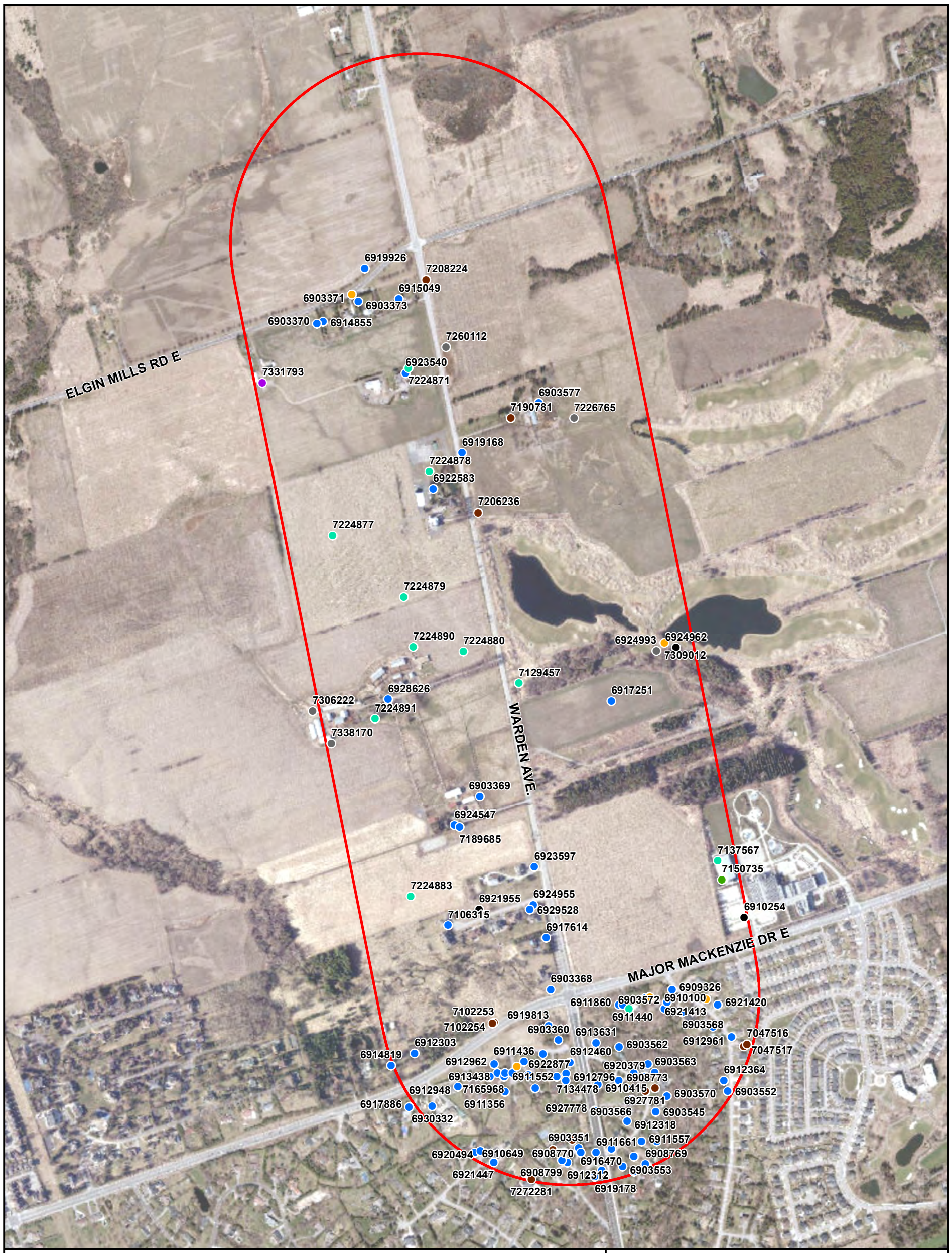
Client / Report
REGIONAL MUNICIPALITY OF YORK

WARDEN AVENUE & KENNEDY ROAD EA STUDIES
HYDROGEOLOGICAL ASSESSMENT

Figure Title
INTERPRETED GEOLOGICAL CROSS-SECTION B-B' (KENNEDY ROAD)

Drawn	Checked	Date	Figure No.
SK	SC	FEBRUARY 2022	6
Scale		Project No.	
1:7,500		300052314	

File Name: 052314 Warden Kennedy EA.dwg Date Plotted: February 14, 2022 - 7:11 AM



LEGEND

STUDY AREA

Well Status:

- Water Supply
- Observation Wells
- Monitoring and Test Hole
- Test Hole
- Abandoned-Supply
- Abandoned-Other
- Abandoned-Quality
- Unknown

Sources:

1. Ministry of Natural Resources and Forestry, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.

N

0 100 200 300 400 500 600

Metres

BURNSIDE

Client / Report

REGIONAL MUNICIPALITY OF YORK

WARDEN AVENUE & KENNEDY ROAD EA STUDIES
HYDROGEOLOGICAL ASSESSMENT

Figure Title

MECP WATER WELL RECORDS (WARDEN AVENUE)

Drawn	Checked	Date	Figure No.
SK	SC	FEBRUARY 2022	7
Scale		Project No.	
1:10,000		300052314	

File Path: Nigel/Shared Work Areas/A:\052314 Warden Kennedy Road Widening\06_GIS\052314 Warden MECP Locations.mxd Print Date: 2022/02/10 Time: 03:25 PM

LEGEND

STUDY AREA

Well Status:

- Water Supply
- Observation Wells
- Test Hole
- Abandoned-Supply
- Abandoned-Other
- Unknown

Sources:

1. Ministry of Natural Resources and Forestry, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.

N

0 100 200 300 400 500 600

Metres

BURNSIDE

Client / Report

REGIONAL MUNICIPALITY OF YORK

WARDEN AVENUE & KENNEDY ROAD EA STUDIES
HYDROGEOLOGICAL ASSESSMENT

Figure Title

MECP WATER WELL RECORDS (KENNEDY ROAD)

Drawn	Checked	Date	Figure No.
SK	SC	FEBRUARY 2022	8
Scale		Project No.	
1:10,000		300052314	

File Path: Nigel/Shared Work Areas/A:\052314 Warden Kennedy Road Widening\06_GIS\052314 Kennedy MECP Locations.mxd Print Date: 2022/02/10 Time: 03:22 PM

LEGEND

- 100m BUFFER AROUND ROW
- WATERCOURSE
- MONITORING WELL (RJB, 2015)
- MONITORING WELL (YORK REGION)
- MONITORING WELL (SOIL ENG., 2013)
- MONITORING WELL (GOLDER, 2021)

DEPTH TO GROUNDWATER:

- 0 TO 1m BELOW GRADE
- 1 TO 2m BELOW GRADE
- 2 TO 4m BELOW GRADE
- >4m BELOW GRADE

0 100 200 400 600
Metres

N

BURNSIDE

Client / Report

REGIONAL MUNICIPALITY OF YORK

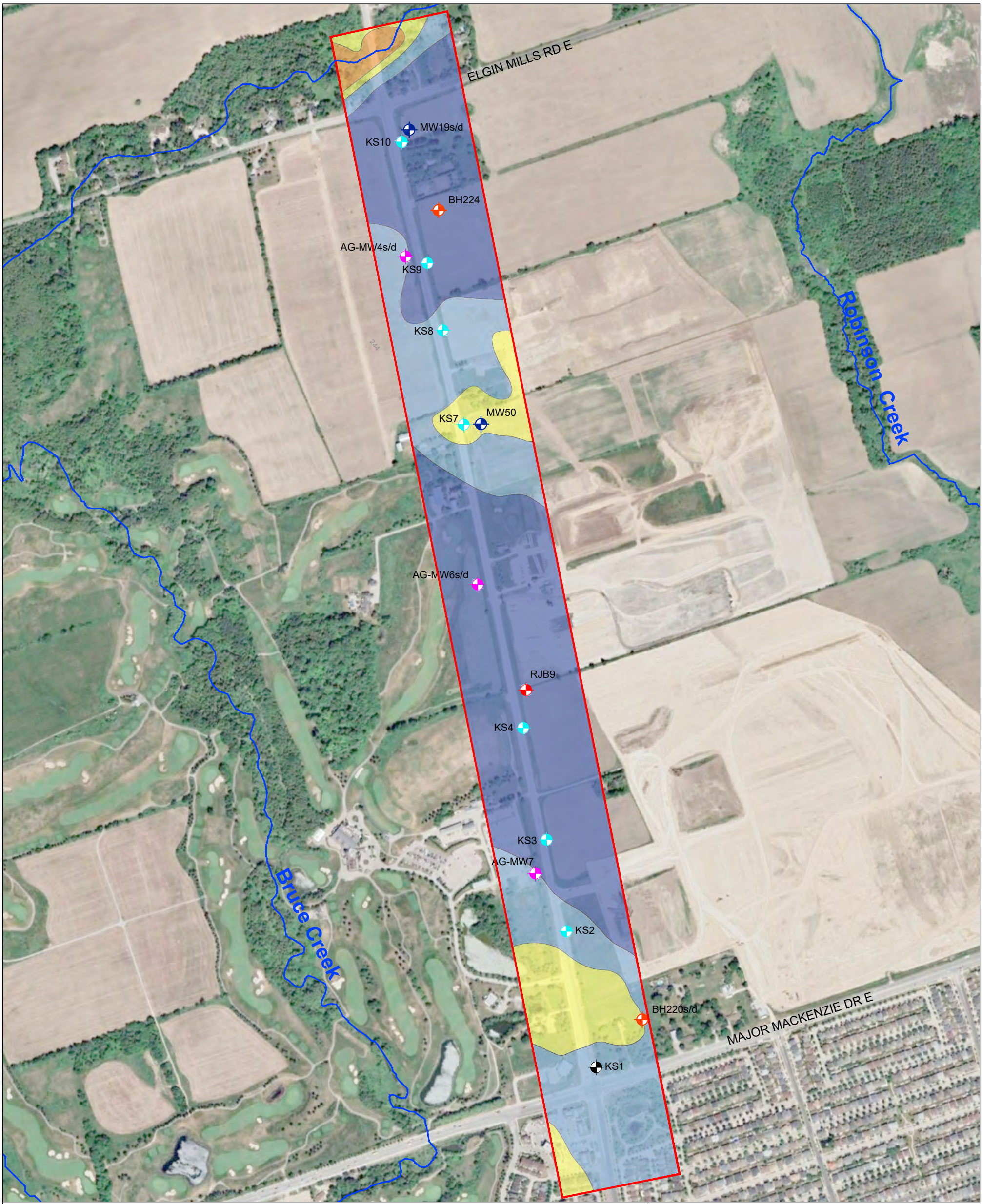
WARDEN AVENUE & KENNEDY ROAD EA STUDIES
HYDROGEOLOGICAL ASSESSMENT

Figure Title

INTERPRETED DEPTH TO GROUNDWATER (WARDEN AVENUE)

Drawn	Checked	Date	Figure No.
SK	SC	FEBRUARY 2022	9
Scale		Project No.	
1:7,500		300052314	

File Name:Nigel/Shared Work Areas/035564 Highmark/02_Production/ 052314 Warden Kennedy EA.dwg Date Plotted: February 14, 2022 - 7:00 AM



LEGEND

- 100m BUFFER AROUND ROW
- MONITORING WELL (RJB, 2015)
- MONITORING WELL (YORK REGION)
- MONITORING WELL (SOIL ENG., 2013)
- MONITORING WELL (GOLDER, 2021)
- MONITORING WELL (NO LOG)

DEPTH TO GROUNDWATER:

- 0 TO 1m BELOW GRADE
- 1 TO 2m BELOW GRADE
- 2 TO 4m BELOW GRADE
- >4m BELOW GRADE

0 100 200 400 600
Metres

N

BURNSIDE

Client / Report

REGIONAL MUNICIPALITY OF YORK

WARDEN AVENUE & KENNEDY ROAD EA STUDIES
HYDROGEOLOGICAL ASSESSMENT

Figure Title

INTERPRETED DEPTH TO GROUNDWATER (KENNEDY ROAD)

Drawn	Checked	Date	Figure No.
SK	SC	FEBRUARY 2022	10
Scale		Project No.	
1:7,500		300052314	

File Name:N\gel/Shared Work Areas/035564 Highmark/02_Production/ 052314 Warden Kennedy EA.dwg Date Plotted: February 14, 2022 - 6:58 AM

ELGIN MILLS RD E

WARDEN AVE.

MAJOR MACKENZIE DR E

LEGEND

- STUDY AREA
- Highly Vulnerable Aquifers
- Significant Groundwater Recharge Areas

Sources:

1. Ministry of Natural Resources and Forestry, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.

N

0 100 200 300 400 500 600

Metres

BURNSIDE

Client / Report

REGIONAL MUNICIPALITY OF YORK

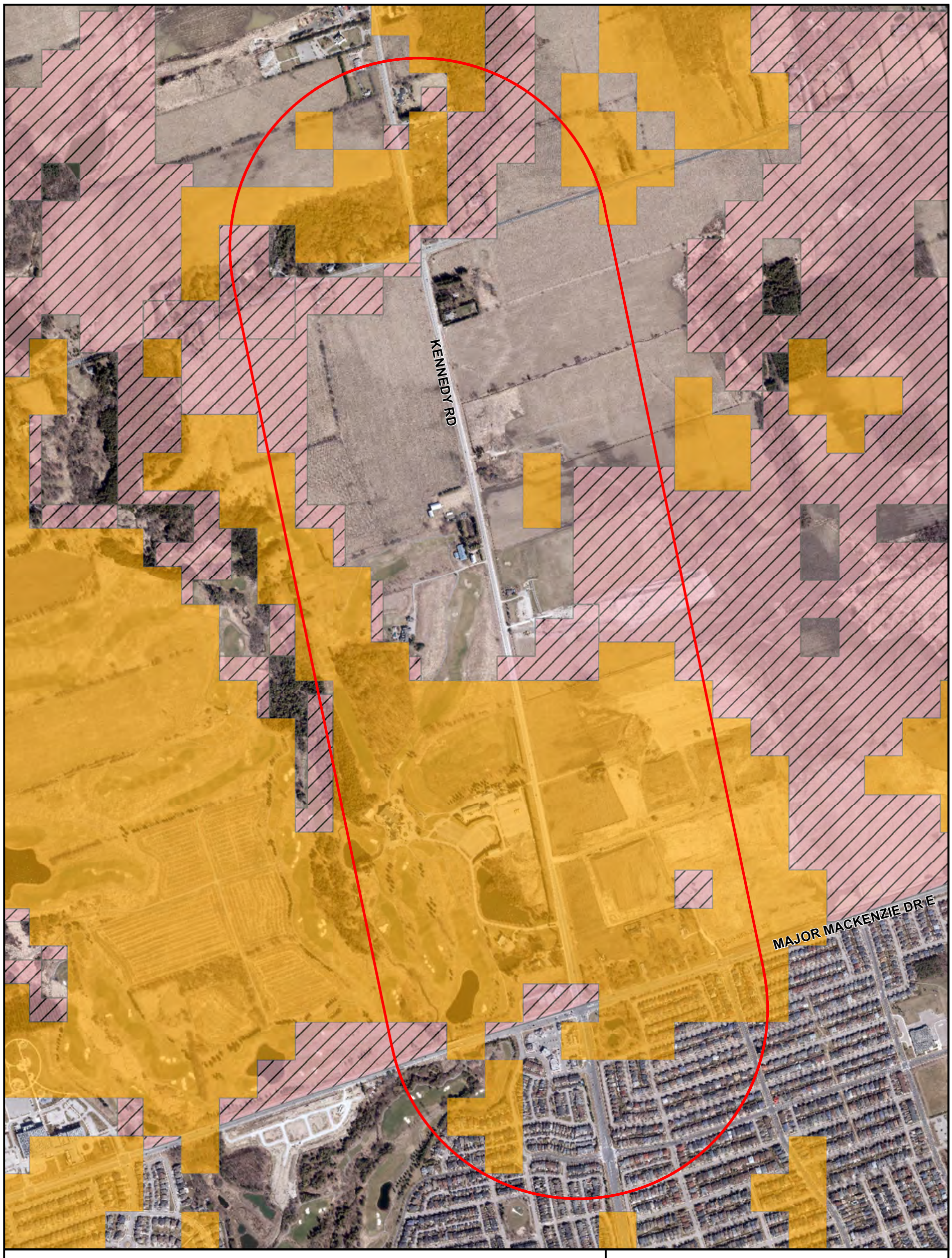
WARDEN AVENUE & KENNEDY ROAD EA STUDIES
HYDROGEOLOGICAL ASSESSMENT

Figure Title

VULNERABLE AREAS (SGRA & HVA) WARDEN AVENUE

Drawn	Checked	Date	Figure No.
SK	SC	FEBRUARY 2022	11
Scale		Project No.	
1:10,000		300052314	

File Path: Nigel/Shared Work Areas/A:\052314 Warden Kennedy Road Widening\06_GIS\052314 Warden Vulnerable Areas.mxd Print Date: 2022/02/11 Time: 02:27 PM



LEGEND

- STUDY AREA
- Highly Vulnerable Aquifers
- Significant Groundwater Recharge Areas

Sources:

1. Ministry of Natural Resources and Forestry, © Queen's Printer for Ontario
2. Natural Resources Canada © Her Majesty the Queen in Right of Canada.

N

0 100 200 300 400 500 600

Metres

BURNSIDE

Client / Report

REGIONAL MUNICIPALITY OF YORK

WARDEN AVENUE & KENNEDY ROAD EA STUDIES
HYDROGEOLOGICAL ASSESSMENT

Figure Title

VULNERABLE AREAS (SGRA & HVA) KENNEDY ROAD

Drawn	Checked	Date	Figure No.
SK	SC	FEBRUARY 2022	12
Scale		Project No.	
1:10,000		300052314	

File Path: Nigel/Shared Work Areas/A:\052314 Warden Kennedy Road Widening\06_GIS\052314 Kennedy Vulnerable Areas.mxd Print Date: 2022/02/11 Time: 02:47 PM