5.0 EXISTING ENVIRONMENT

5.1 Climate and Meteorology

This section provides a description of the existing climate from long-term observed meteorological records. The full study report is presented in Appendix G.

5.1.1 Study Area

The Project site is located in the west-central portion of the Boreal Shield Ecozone, experiencing a continental climate, generally characterized by short mild summers and long cold winters with relatively low precipitation. The terrain is generally flat and absent of orographic features which can block air masses or produce localized increases in precipitation. Climate is described in more detail using long term Environment Canada (EC) regional observations at Dryden and Sioux Lookout and other pertinent climatic references described herein.

Historical meteorological observations recorded at EC stations at Dryden (Dryden and Dryden A) describe the climate for the local study area (LSA) and the regional study area (RSA) (Table 5.1.1). Dryden, located 5 km west of the Project location, sits outside of the LSA, defined by the Wabigoon Lake watershed boundary, but is considered representative. The analysis is augmented by historical observations at EC's Sioux Lookout A station, located 60 km to the northeast to provide analysis of regional variability (Table 5.1.1).

5.1.2 Methods

Climate is described in terms of mean, maximum and minimum air temperature, mean annual precipitation (rain and snow-water equivalency, SWE), precipitation intensity-duration and mean annual lake evaporation and potential evapotranspiration. The EC Dryden station has a meteorological period of record of 82 years (1914 – 1997; two years are partial). EC Dryden A has a period of record of 30 years (1970 – 2005). Sioux Lookout A has a period of record of 70 years (1938 – 2007).

5.1.3 Air Temperature

Air temperature in the region follows an annual sinusoidal pattern typical of northern continental climates at mid-latitude with minimum average daily temperature occurring in January and maximum average daily temperature occurring in July (Figure 5.1.1). Mean daily temperature in July is approximately 19°C with an average daily maximum near 24°C and an average daily minimum near 13°C. Mean daily temperature in January is -18°C with average and daily maximum near -13°C and an average daily minimum near -23°C. Temperatures are typically below freezing between November and March. The diurnal temperature range is similar during spring, summer and winter (approximately 10°C) but is less during the fall (7°C).

Temperatures observed at Dryden and Sioux Lookout show similarity, suggesting that temperature does not vary greatly with geographic location and is relatively homogeneous through the RSA. Furthermore, the absence of significant relief does not allow for distinct localized variability of temperature due to elevation differences.

5.1.4 Precipitation

Based on historical observations at Dryden, mean annual precipitation at the Project site is 705 mm, of which, between 20% to 24% falls as snow (Table 5.1.1). Precipitation recorded at Dryden is considered as representative of the LSA due to the proximity and the lack of significant elevation differences or orographic features. Slightly higher precipitation totals and a higher percentage of precipitation falling at snow at Sioux Lookout may suggest that precipitation is less homogeneous through the RSA.

Table 5.1.1 Mean Annual Precipitation in the LSA/RSA

EC Station	Mean Annual Rainfall (mm)	Mean Annual Snowfall (mm SWE)	% Snowfall	Mean Annual Precipitation (mm)
Dryden	566	140	20%	706
Dryden A	536	170	24%	705
Sioux Lookout A	517	204	28%	721

Source: Environment Canada

*Precipitation data does not include undercatch adjustment

Figure 5.1.2 shows mean rainfall and total precipitation by month through the RSA. The figure shows that the majority of yearly precipitation occurs during the summer (May to September) as rainfall. Precipitation between November and March falls predominantly as snow, although rainfall in November and March is not uncommon (approximately 20% to 25%).

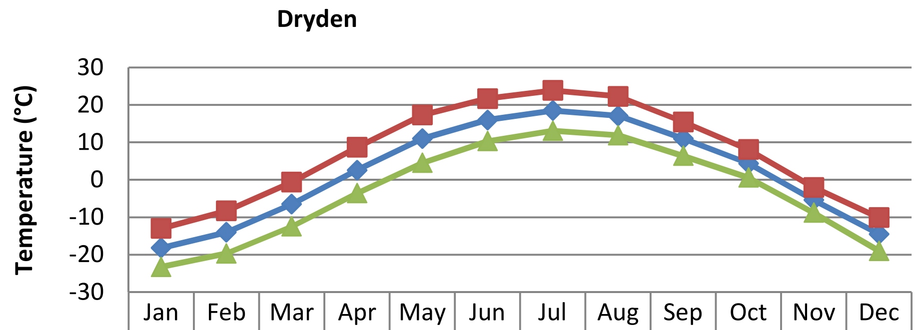
24-hour rainfall depths range from 44 mm for a 2-year return period to 113 mm for a 100-year return period (Table 5.1.2). The maximum 24-hour rainfall depth recorded in 82 years at Dryden was 111.6 mm which is just under the 100-year event.

Table 5.1.2 Extreme 24-Hr Rainfall Depth – LSA (Dryden)

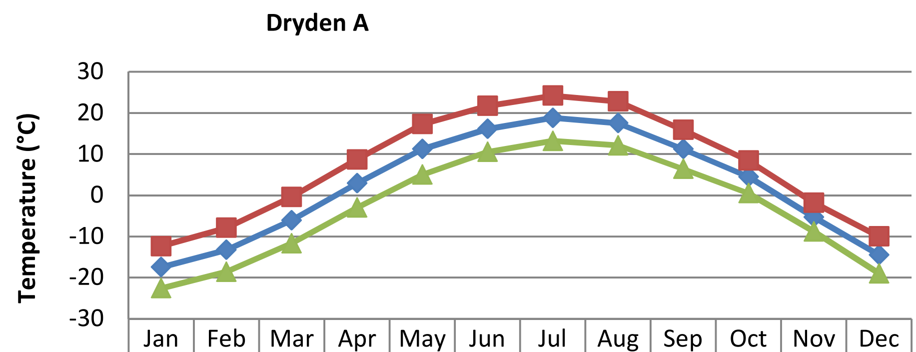
DURATION	RAINFALL DEPTH (mm)						RAINFALL INTENSITY (mm/hr)					
	Return Period (years)						Return Period (years)					
	2	5	10	25	50	100	2	5	10	25	50	100
24-hr	44.1	61.5	73.8	89.6	101.2	112.8	1.8	2.6	3.1	3.7	4.2	4.7

5.1.5 Evaporation

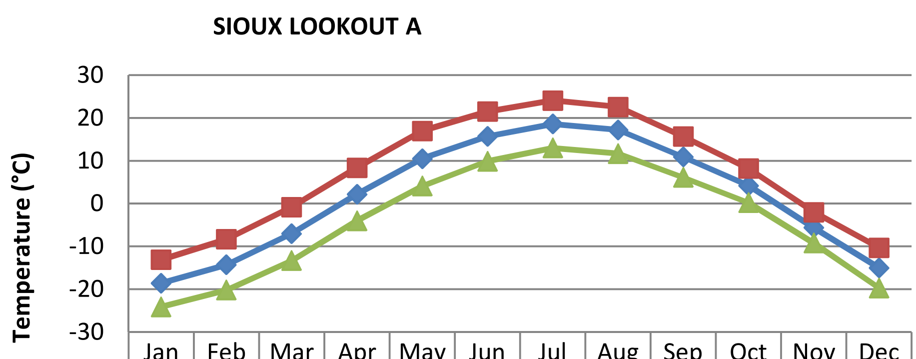
Hydrological Atlas of Canada estimates for lake evaporation in the LSA ranges from 500 mm to 600 mm per year while estimates for potential evapotranspiration are between 510 mm and 560 mm. Lake evaporation and potential evapotranspiration are both upper bounds of actual evaporation and evapotranspiration, respectively. Actual evaporation and evapotranspiration are limited by the availability of moisture stored in the soil or by vegetal water consumption.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Daily Temperature	-18.2	-14	-6.5	2.6	11	16	18.5	17.1	11	4.4	-5.4	-14.5
Maximum Daily Temperature	-13	-8.3	-0.6	8.7	17.3	21.7	23.9	22.3	15.5	8.1	-2	-10.1
Minimum Daily Temperature	-23.3	-19.7	-12.5	-3.6	4.5	10.3	13.1	11.9	6.4	0.6	-8.8	-19

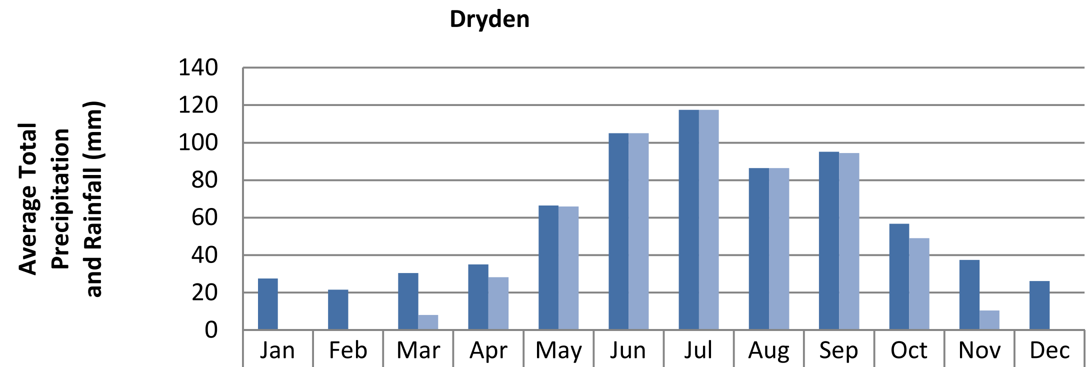


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Daily Temperature	-17.5	-13.3	-6.1	2.9	11.2	16.1	18.8	17.5	11.2	4.5	-5.3	-14.5
Maximum Daily Temperature	-12.4	-7.9	-0.4	8.7	17.3	21.7	24.2	22.8	15.9	8.4	-1.8	-10
Minimum Daily Temperature	-22.6	-18.6	-11.7	-3	5	10.5	13.2	12.1	6.4	0.5	-8.8	-19

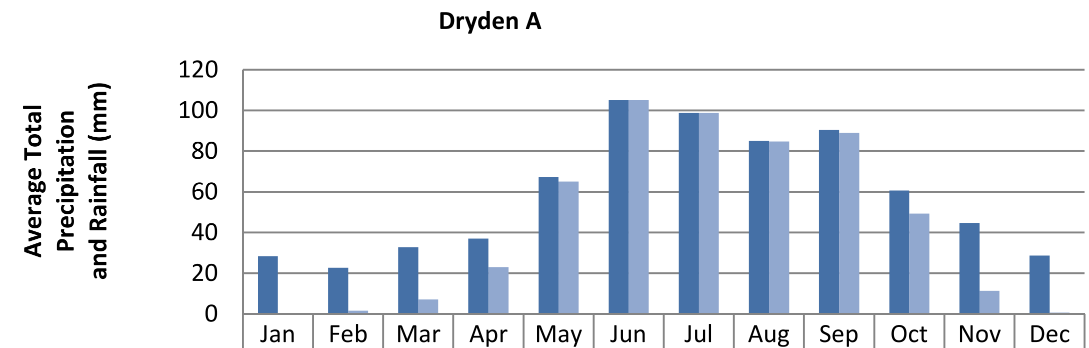


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Daily Temperature	-18.6	-14.3	-7	2.2	10.5	15.7	18.6	17.2	10.9	4.2	-5.6	-15
Maximum Daily Temperature	-13.1	-8.3	-0.8	8.4	17	21.5	24.1	22.6	15.7	8.2	-2	-10.3
Minimum Daily Temperature	-24.1	-20.2	-13.3	-4	4.1	9.9	13	11.7	6.1	0.2	-9.2	-19.7

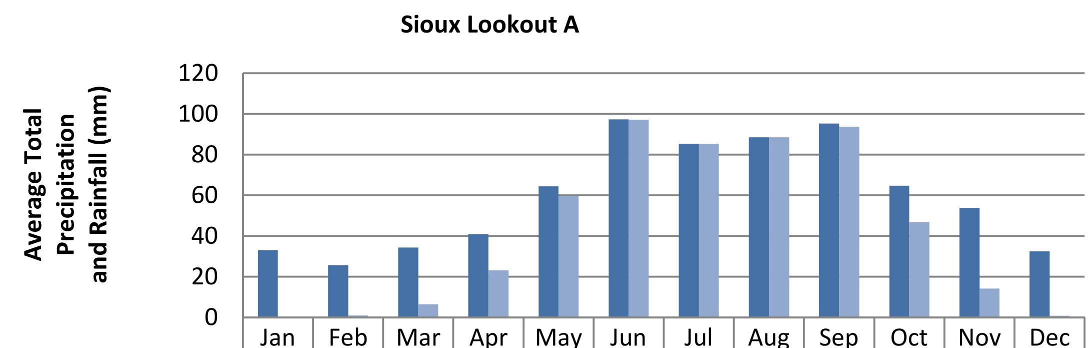
Figure 5.1.1 Mean, Maximum and Minimum Air Temperature – LSA/RSA (Dryden, Dryden A and Sioux Lookout A)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Total Precipitation	27.5	21.6	30.4	35.1	66.4	105	117.5	86.4	95.2	56.8	37.4	26.2
Average Rainfall	0.1	0.6	8	28.2	66	105	117.5	86.4	94.5	49.1	10.5	0



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Total Precipitation	28.4	22.7	32.7	37	67.2	105.1	98.8	85	90.4	60.7	44.8	28.7
Average Rainfall	0.2	1.6	7	23	65	105.1	98.8	84.8	89	49.3	11.3	0.6



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Total Precipitation	33.1	25.6	34.4	40.9	64.4	97.3	85.3	88.5	95.3	64.8	53.8	32.5
Average Rainfall	0.5	0.9	6.5	23.2	59.7	97.2	85.3	88.5	93.7	46.9	14.1	0.8

Figure 5.1.2 Mean Rainfall and Total Precipitation by Month through the Goliath Gold Project Regional Study Area

5.2 Air Quality

This section provides a description of the existing air quality conditions in the Project area.

5.2.1 BASELINE AIR QUALITY LEVELS

As part of the Environmental Air Quality Assessment, completed by RWDI Air Inc., a Baseline Ambient Air Quality assessment was completed (Appendix J). The relevant details have been summarized in the following sections. The full Baseline Ambient Air Quality assessment is presented in Section 3.2 of the Environmental Air Quality Assessment in Appendix J.

5.2.1.1 STUDY AREA

The Project study area is located in a mostly forested area between the communities of Dryden and Wabigoon and north of Highway 17 (Figure 5.2.1). The proposed Project site is at least 10 km from any existing sources of significant air emissions. There are several aggregate operations on the east side of Airport Road in Dryden. The town of Dryden, located approximately 15 km to the west, is home to a Kraft pulp mill operated by Domtar, which would contribute to the background air quality in the area, primarily due to emissions from the natural gas and wood-waste fired boilers, recovery boiler and lime kiln. Due to the distance between sources at the Domtar pulp mill, the aggregate operations and the project site, significant interaction between these sources are expected to be minimal. 44 receptors of interest have been identified in the study area. These include a campground within Aaron Provincial Park, a trailer on otherwise vacant land, and 42 residences, mostly in the developments along Thunder Lake.

5.2.1.2 ASSESSMENT CRITERIA AND METHODS

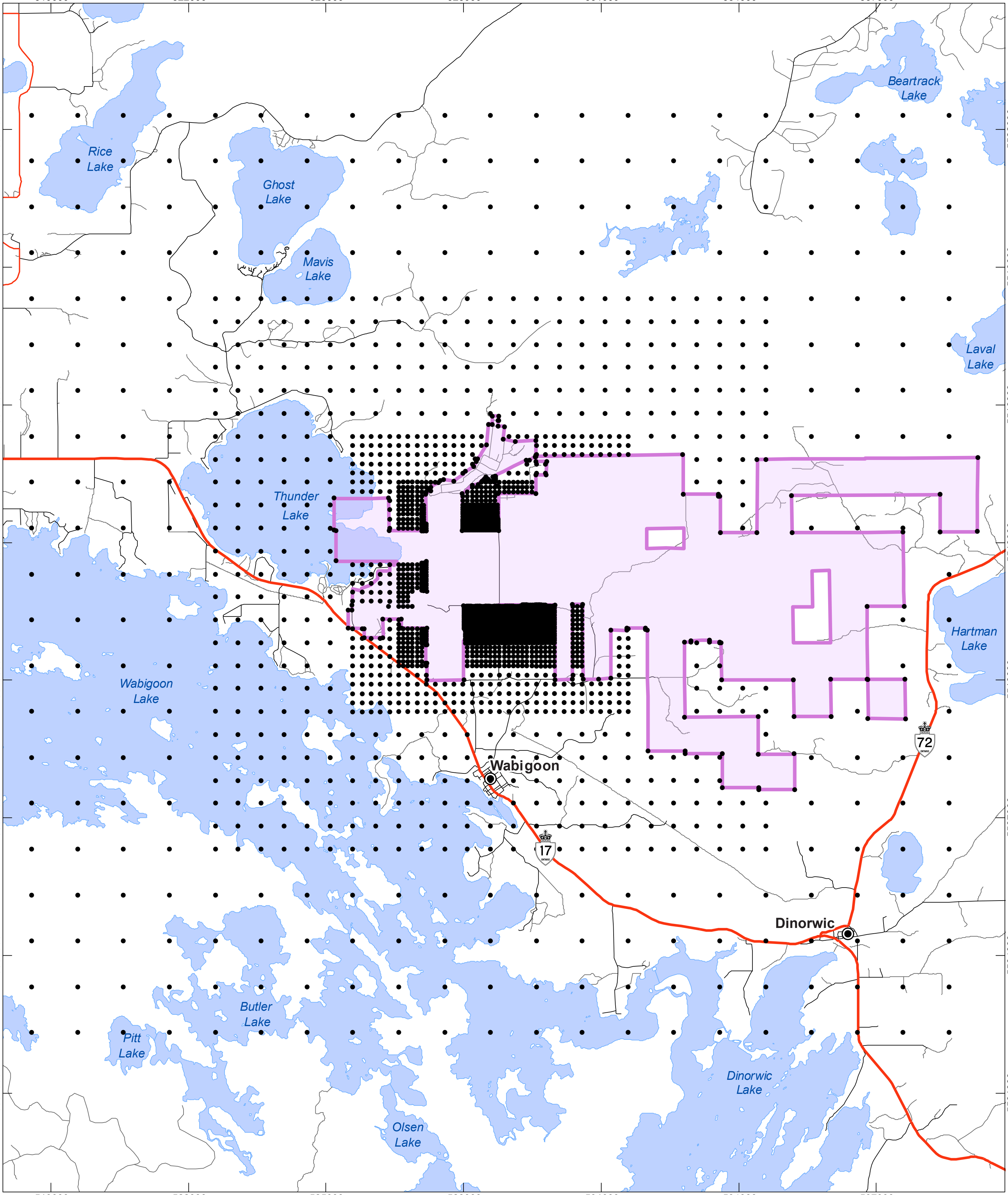
The ambient air quality assessment has been completed based on a combination of Canadian Ambient Air Quality Standards (CAAQSs), National Ambient Air Quality Objectives (NAAQOs) and the Ontario Ministry of the Environments (MOEs) Ontario Ambient Air Quality Criteria (OAAQC) including Schedule 3 Standards, Guidelines, and Jurisdictional Screening Levels (JSL's) as prescribed under Ontario Regulation 419/05 (O.Reg.419/05).

The assessment criteria employed are presented in detail in Table 5.2.1. These criteria are intended to guard against adverse effects including health, odour, vegetation, soiling, visibility, corrosion or other suitable end-points. A number of different averaging periods are required under the relevant regulatory regimes to account for potential short-term acute exposures and long-term chronic exposures. Where more than one criteria is presented, the most stringent criteria were selected as the threshold for each contaminant of concern.

The existing baseline ambient air quality indicator levels at the Project site were estimated based on data from two (2) MOE monitoring stations in the Thunder Bay area (MOE Stations No. 63203 and 63064; Figure 5.2.2). As these stations are located in a more urbanized area than the project site the recorded data is expected to reflect an overestimate of typical concentrations of contaminants of concern. As the maximum measured values represent peak events which occur infrequently, the 90th percentile values (i.e. exceeded <10% of the time), which are more representative of the typical maximum background conditions have been used. These 90th percentile values are more likely to coincide with maximum contributions from the project related emissions. These values are then compared against the relevant criteria.

5.2.1.3 EXISTING AIR QUALITY INDICATOR LEVELS

The measured ambient air quality data from the MOE monitoring stations is presented in Table 5.2.2 along with a comparison of each value to the relevant assessment criteria. The MOE monitoring station results indicate that the existing baseline ambient air quality levels do not exceed the relevant assessment criteria.



GOLIATH GOLD PROJECT
DRYDEN, ONTARIO, CANADA

SCALE: 110 000

TREASURY METALS INC.

ENVIRONMENTAL AIR QUALITY ASSESSMENT LOCAL STUDY AREA

DESIGN: AT 06 FEB. 2014
GIS: AT 20 FEB. 2014
CHECK: AT 09 OCT. 2014

FIGURE: 5.2.1 REV.00

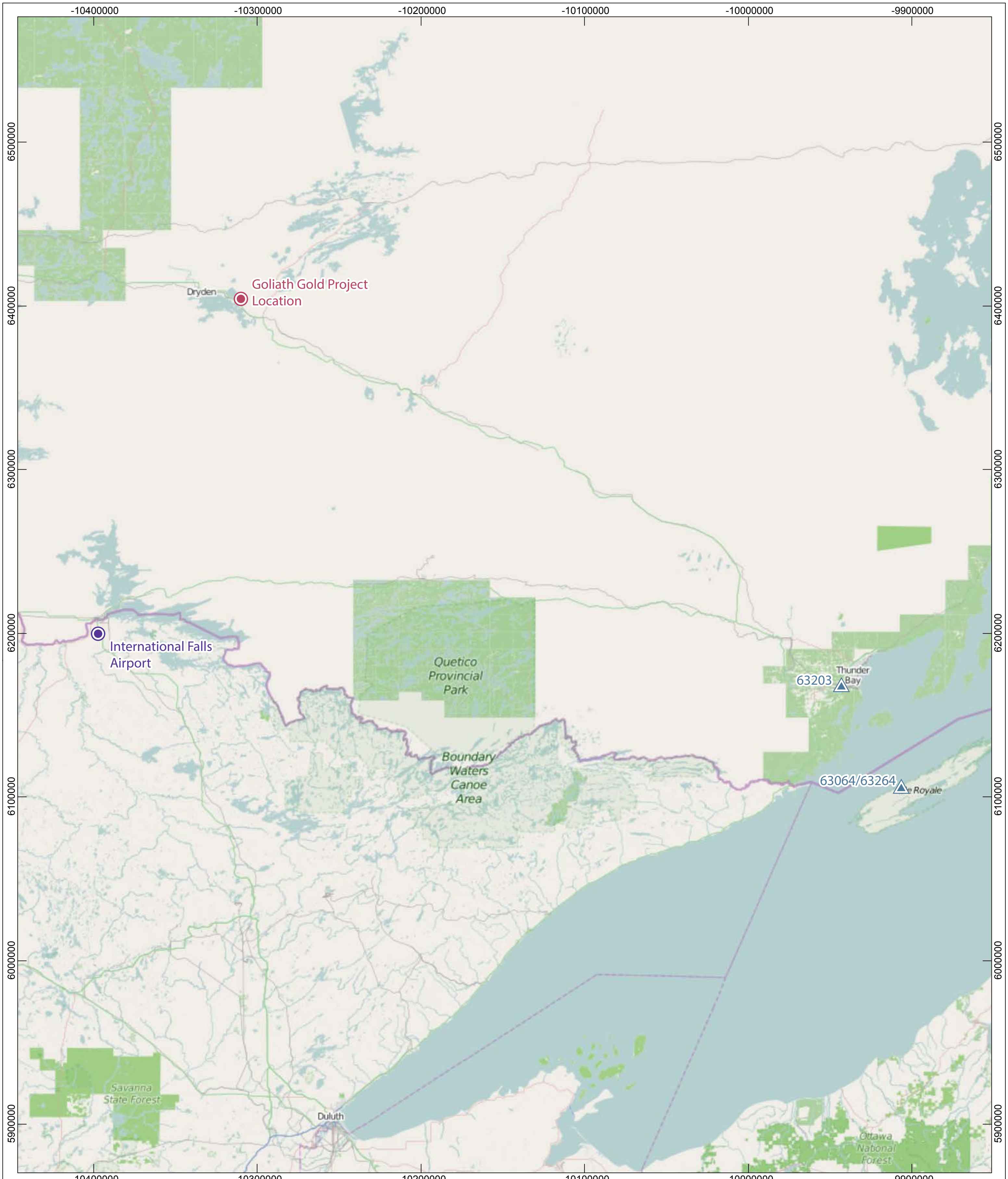
LEGEND

- Air Quality Model Receptor
- Populated Area
- Property Boundary
- Waterbody
- Arterial Road
- Highway
- Local Road
- Recreational Road

0 1,000 2,000 3,000 Meters

N E S W

REFERENCE
Base Data: OBM
Receptors: RWDI
Projection: NAD83 UTM Zone 15N



GOLIATH GOLD PROJECT DRYDEN, ONTARIO, CANADA	SCALE: 3 000 000 TREASURY METALS INC.
ENVIRONMENTAL AIR QUALITYASSESSMENT REGIONAL STATIONS	*DESIGN: AT 06 FEB. 2014* *GIS: AT 10 OCT. 2014* *CHECK: AT 10 OCT. 2014*
FIGURE: 5.2.2 REV.00	

Goliath Gold Project
Environment Canada Monitoring Station
RWDI Meteorological Station

0 50 100
Kilometers

N
W E
S

REFERENCE

Projection: NAD83 UTM Zone 15N
Base Data: OBM
Wells Provided by AMEC
Service Layer Credits: © OpenStreetMap (and) contributors, CC-BY-SA

Table 5.2.1 Air Quality Assessment Criteria

Air Quality Indicator	Averaging Time	National Air Quality Objectives			Canadian Ambient Air Quality Standards ug/m³	Ontario Ambient Air Quality Criteria ug/m³	Threshold ug/m³
		Desirable ug/m³	Acceptable ug/m³	Tolerable ug/m³			
TSP	24 hr	-	120	400	-	120	120
	Annual	60	70	-	-	60	60
PM10	24 hr	-	-	-	-	50	50
PM2.5	24 hr	-	-	-	28 27 [2]	-	27
	Annual	-	-	-	10 8.8 [2]	-	8.8
Dustfall [1]	30 day	-	-	-	-	7	7
	Annual	-	-	-	-	4.6	4.6
SO_2	1 hr	450	900	-	-	690	450
	24 hr	150	300	800	-	275	150
	Annual	30	60	-	-	55	30
NO_2	1 hr	-	400	1000	-	400	400
	24 hr	-	200	300	-	200	200
	Annual	60	100	-	-	-	60
CO	1 hr	15,000	35,000	-	-	36,200	15,000
	8 hr	6,000	15,000	20,000	-	15,700	6,000
Aluminum	24 hr	-	-	-	-	4.8 (JSL)	4.8
Antimony	24 hr	-	-	-	-	25	25
Arsenic	24 hr	-	-	-	-	0.3	0.3
Barium	24 hr	-	-	-	-	10	10
Beryllium	24 hr	-	-	-	-	0.1	0.1
Bismuth	24 hr	-	-	-	-	-	N/A
Cadmium	24 hr	-	-	-	-	0.025	0.025
Calcium	24 hr	-	-	-	-	-	N/A
Chromium	24 hr	-	-	-	-	0.5	0.5
Cobalt	24 hr	-	-	-	-	0.1	0.1
Copper	24 hr	-	-	-	-	4	4
Gallium	24 hr	-	-	-	-	-	N/A
Gold	24 hr	-	-	-	-	-	N/A
Iron	24 hr	-	-	-	-	25	25
Lanthanum	24 hr	-	-	-	-	-	N/A
Lead	24 hr	-	-	-	-	0.5	0.5
Lithium	24 hr	-	-	-	-	20	20

Table 5.2.1 Air Quality Assessment Criteria

Air Quality Indicator	Averaging Time	National Air Quality Objectives			Canadian Ambient Air Quality Standards ug/m³	Ontario Ambient Air Quality Criteria ug/m³	Threshold ug/m³
		Desirable ug/m³	Acceptable ug/m³	Tolerable ug/m³			
Magnesium	24 hr	-	-	-	-	120	120
Manganese	24 hr	-	-	-	-	0.4	0.4
Molybdenum	24 hr	-	-	-	-	120	120
Nickel	24 hr	-	-	-	-	0.04	0.04
Palladium	24 hr	-	-	-	-	10	10
Phosphorous	24 hr	-	-	-	-	0.35 (JSL)	0.35
Platinum	24 hr	-	-	-	-	0.2	0.2
Potassium	24 hr	-	-	-	-	28	28
Rhodium	24 hr	-	-	-	-	0.4 (JSL)	0.4
Scadium	24 hr	-	-	-	-	-	N/A
Selenium	24 hr	-	-	-	-	10	10
Silver	24 hr	-	-	-	-	50	50
Sodium	24 hr	-	-	-	-	10	10
Strontium	24 hr	-	-	-	-	120	120
Sulphur	24 hr	-	-	-	-	20 (JSL)	20
Thallium	24 hr	-	-	-	-	0.24	0.24
Thorium	24 hr	-	-	-	-	-	N/A
Tin	24 hr	-	-	-	-	10	10
Titanium	24 hr	-	-	-	-	120	120
Tungsten	24 hr	-	-	-	-	4 (JSL)	4
Uranium	24 hr	-	-	-	-	0.03	0.03
Vanadium	24 hr	-	-	-	-	2	2
Yttrium	24 hr	-	-	-	-	2.4 (JSL)	2.4
Zinc	24 hr	-	-	-	-	120	120

Table 5.2.2 Measured Ambient Air Quality Data from the MOE Monitoring Stations

Air Quality Indicator	Monitoring Period	Averaging Period	90th Percentile Concentration (ug/m³)	Threshold ug/m³	Percent of Threshold
TSP	2007 - 2011	24 hr	33	120	28%
		Annual	14	60	23%
PM10	2007 - 2011	24 hr	15	50	30%
PM2.5	2007 - 2011	24 hr	10	27	37%
		Annual	4.3	8.8	49%
SO_2	1999 - 2003	1 hr	4	400	1%
		24 hr	4	200	2%
		Annual	1	60	2%
NO_2	2007 - 2011	1 hr	33	450	7%
		24 hr	33	150	22%
CO	2000 - 2003	1 hr	1,248	15,000	8%
		8hr	1,248	6,000	21%

There is very little variation in concentrations over the course of the day, as can be seen by the negligible variation in the 1 hour average and 24 hour average concentrations measured for NO_2 and SO_2. The existing ambient air quality levels near the project site are expected to be typical of other forested areas of Northern Ontario. However; as the only available data near the Project site is from an urban area, this data is expected to be a conservative overestimate of current local conditions.

5.3 Acoustic and Light Environment

This section provides a description of the existing noise and light conditions at the Project.

5.3.1 Baseline Noise Levels

A baseline noise study was conducted in December 2011 and July 2013 and the results have been summarized in the following sections. The full study report is presented in Appendix H.

5.3.1.1 STUDY AREA

The Project study area is in a rural location between the communities of Dryden and Wabigoon and north of Highway 17 with characteristics of a Class 3 area (MOE 1995). Potential receptors include the City of Dryden, the community of Wabigoon, and Aaron Provincial Park and residential developments along Thunder Lake. Potential sources of noise include the above developments as well as Highway 17 and the mainline of the Canadian Pacific Railway. Sampling locations were selected based on the location of the emission sources, potential receptor locations, and the extent of transport, propagation, and dispersion of any air contaminants (Figure 5.3.1).

5.3.1.2 ASSESSMENT CRITERIA AND METHODS

In Class 3 areas, rural, recreational, or wilderness, the applicable MOE "Stationary Source" guidelines are provided in MOE Publication NPC-232 (MOE 1995). The guidelines state that one-hour sound exposures (L_{EQ}, 1-hr dBA values) from stationary noise shall not exceed that of the background, where the background is defined as the sound level present in the environment produced by noise sources other than those associated with the facility under assessment. The MOE Publication NPC-232 sound level limits are as follows:

- The higher of 45 dBA or background noise, during the daytime hours (0700-1900h);
- The higher of 40 dBA or background noise, during the evening hours (1900-2300h); and
- The higher of 40 dBA or background noise, during the night-time hours (2300-0700h).

The applicable guideline limit is the higher of the measured background sound level and the guideline minimum sound level limit. The above sound level limits are the applicable for the receptors surrounding the Project.

The basic procedures for the baseline assessment consists of long-term background sound level measurements of receptors near the Project, validation of measured hourly data based on weather information, and comparing the validated lowest hourly sound level data to the guideline limits. Long-term measurements of background ambient sound levels at one location was conducted from December 5 to December 7, 2011, near the Project site (Table 5.3.1 and Figure 5.3.1). Monitoring was also conducted at three representative locations from July 3 to July 9, 2013 (Figure 5.3.1). All measurements were conducted in accordance with the applicable requirements of MOE Publication NPC-103 (MOE 1977).

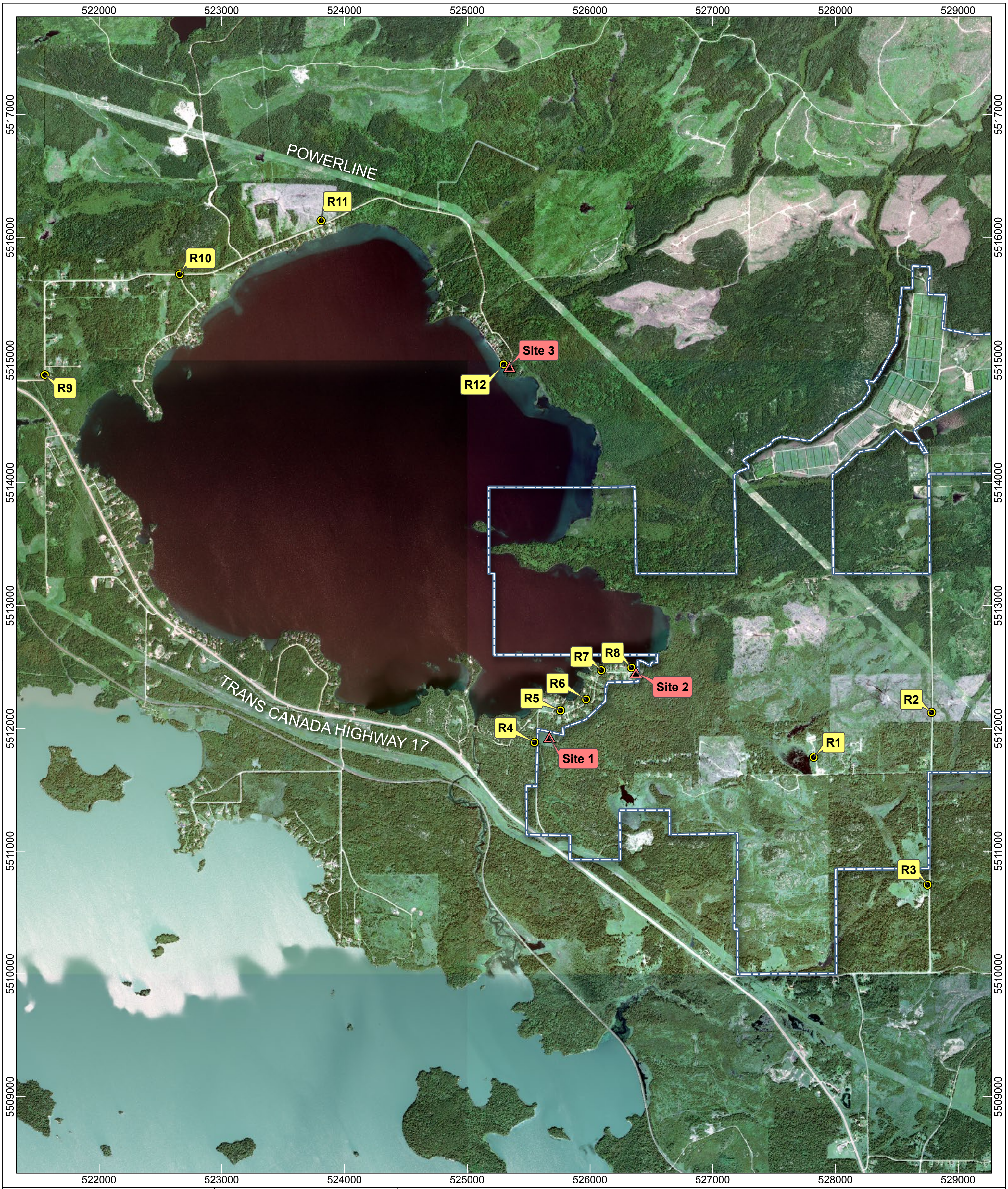
5.3.1.3 EXISTING NOISE LEVELS

The measured ambient sound levels at the Project site were similar to background ambient sound levels characteristic of remote areas (25 to 45 dBA; Tables 5.3.1 and 5.3.2). The sound from these levels would be described as faint. Noise observed during the study consisted mostly of wind, small animals, bird noise and vehicle noise from the TransCanada Highway. The difference between daytime and nighttime sound levels were generally small, and are attributed mainly to very low level of noise from human activity which could not be screened out. The noise measurement results indicate that the existing baseline sound levels did not exceed the guideline sound level limits (MOE 1995). The existing baseline noise levels are typical of northwestern Ontario conditions.

Table 5.3.1 Ambient Sound Levels at the Goliath Gold Project

Location	Time Period	L_{EQ} (1hr)	L_{MIN}	L_{MAX}	NPC-232 Minima[1]	Resultant Limit
Site 1	Day	39	30	70	45	45
	Evening	38	30	66	40	40
	Night	35	29	67	40	40
Site 2	Day	38	20	68	45	45
	Evening	37	27	63	40	40
	Night	32	19	68	40	40
Site 3	Day	32	21	69	45	45
	Evening	35	24	69	40	40
	Night	28	20	62	40	40

[1]MOE (1995)



GOLIATH GOLD PROJECT
DRYDEN, ONTARIO, CANADA

Baseline Noise and Light Monitoring Stations

FIGURE: 5.3.1 REV.00

SCALE: 40000

TREASURY METALS INC.

DESIGN: AT 06 FEB. 2014
GIS: AT 07 MAR. 2014
CHECK: XX ADD DATE
REVIEW: XX ADD DATE

LEGEND

- Noise Monitoring Station
- Light Monitoring Location
- Property Boundary

N

0 500 1,000
Meters

REFERENCE

Data by Treasury Metals Inc.
Projection: NAD83 UTM Zone 15N
Imagery: MNR FRI Orthorectified 40cm (2010)

TREASURY METALS
INCORPORATED

5.3.2 Baseline Light Levels

A baseline light assessment study was conducted in July 2013 and the results have been summarized in the following sections. The full study report is presented in Appendix H.

5.3.2.1 STUDY AREA

The area surrounding the Project site is a mix of mostly forested and some open rural land cover. The topography in the area is generally low, rolling hills, with elevation decreasing along the shoreline of Thunder Lake to the west of the project site, and again along Wabigoon Lake to the west/southwest of the Project site. The closest residences are located along East Thunder Lake Road, which runs along the western edge of the Project property boundary. Additionally, there are other pockets of houses/cottages along the shore of Thunder Lake and Wabigoon Lake further away from the Project site. Generally, the surrounding area is sparsely populated and the land is heavily treed.

Light effects beyond 1 km are typically comparable to general lighting in the vicinity of the receptor (e.g., streetlights, garage lights). A light study area extending 1 km from the Project property boundaries was therefore selected to determine receptors/sampling sites that could be directly affected by the Project. Representative receptors on the far side of Thunder Lake were also sampled since the lake body provides an unobstructed line of sight to the Project property. Therefore, the light study area was therefore conservative as the Project infrastructure will be centrally located on the property and screened from the potential receptors by terrain.

A total of 12 receptor locations were determined for the purpose of the baseline light assessment. Receptors R1 through R3 are located on/within the Project site boundary, while receptors R4 through R8 and R12 are neighbouring residences or cottages within 1 km of the property boundary on the shoreline of Thunder Lake Figure 5.3.1; Table 5.3.3). Receptors R9 through R11 are the representative receptors for clusters of cottages located on the far (west) shoreline of Thunder Lake from the Project Site, and were grouped for reasons of sharing similar viewscapes and topographic features.

5.3.2.2 ASSESSMENT CRITERIA

In Ontario, there are no provincial guidelines or regulations governing light trespass. Therefore, the study relied on information from other sources. Lighting criteria for illuminance are available from the U.S. Green Building Council Leadership in Energy and Environmental Design (LEED; USGBC 2007. The Illuminating Engineering Society (IES) of North America recommends a minimum lighting level of 5.4 lux for safety. The IES also recommends 5 to 22 lux for outdoor pedestrian walkways, and about 100 lux for interior stairways (malls). Interiors of buildings typically measure in the hundreds of lux.

The light that escapes the Project site (known as light trespass) can be regarded as a nuisance by property owners immediately adjacent or in relatively close proximity to the Project. For the baseline light assessment, only measurements of illuminance, the perceived power of light per unit area, were taken, which is the appropriate measurement to assess baseline conditions. Relative brightness, also known as glare, was not measured as the Project has not been constructed or exterior lighting installed.

5.3.2.3 EXISTING LIGHT LEVELS

Existing (baseline) conditions represent the current light levels within the light study area and are presented in Table 5.3.3. Baseline illuminance measurements at the selected receptors were all below the LEED criteria for rural residential areas (1.1 lux) with the exception of sample sites that were directly influenced by a local light source such as a street light or exterior house light near the measurement location. Any areas, including the three sample sites that were on the Project property, that were away from these types of direct sources were generally measured to be 0.0 lux.

Table 5.3.2 Current Light Levels within the Light Study Area

					Illuminance (lux)				
Receptor	**Site**		**UTM**			**Direct**		**Direct**	
ID	**ID**	**Type**	**Northing**	**Easting**	**2-Jul-13**	**2-Jul-13**	**3-Jul-13**	**3-Jul-13**	**Description**
R1	1	Goliath Gold Site	527822	5511764	0.00	0.00	0.00	0.00	Center of Proposed Pit
R2	2	Goliath Gold Site	528782	5512129	0.00	0.00	0.00	0.00	East of Proposed Pit
R3	3	Goliath Gold Site	528751	5510726	0.00	0.00	0.01	0.00	Nystrom House on Tree Nursery Road
R4	4	Receptor	525549	5511888	0.00	0.00	0.01	0.00	Field to east of E Thunder Lake Road (Noise Site #1)
R5	5	Receptor	525760	5512145	2.40	4.00	2.70	4.30	249 E. Thunder Lake Road, next to street light on road, edge of pavement and gravel
R6	6	Receptor	525969	5512235	0.21	3.00	0.21	3.20	Measured ~14m from road near the hydro station (SW2), next to street light near location 1A
R7	7	Receptor	526092	5512473	0.00	0.00	0.00	0.03	352 E. Thunder Lake Road
R8	8	Receptor	526338	5512493	0.00	0.50	0.00	0.00	At Noise Site # 2, light from resident, front door light on house
R9	9	Receptor	521559	5514880	0.00	15.20	0.00	15.10	65 Thunder Lake Road. Edge of road pavement to gravel. Pointed at streetlight.
R10	10	Receptor	522658	5515699	1.40	0.00	4.10	0.00	Taken under street light corner of North Shore and Thunder Lake Road (Stop sign)
R11	11	Receptor	523810	5516134	0.03	0.22	0.02	0.19	North side of Thunder Lake, pointed at residence, measured from edge of road, approximately 12m from light source
R12	12	Receptor	525296	5514963	0.05	0.19	0.02	0.17	Johnsons Beach (by Noise Site 3)

5.4 Geology

5.4.1 Geological Setting

The Project area is located within the volcano-plutonic Eagle-Wabigoon-Manitou Greenstone Belt in the Wabigoon Subprovince of the Archaean Superior Province, and is on the north side of the regional Wabigoon fault. This Greenstone Belt consists of a 150 km-wide domain that has an exposed strike extent of 700 km. The full strike length of the Greenstone Belt is unknown since it is overlain by Palaeozoic strata on both ends.

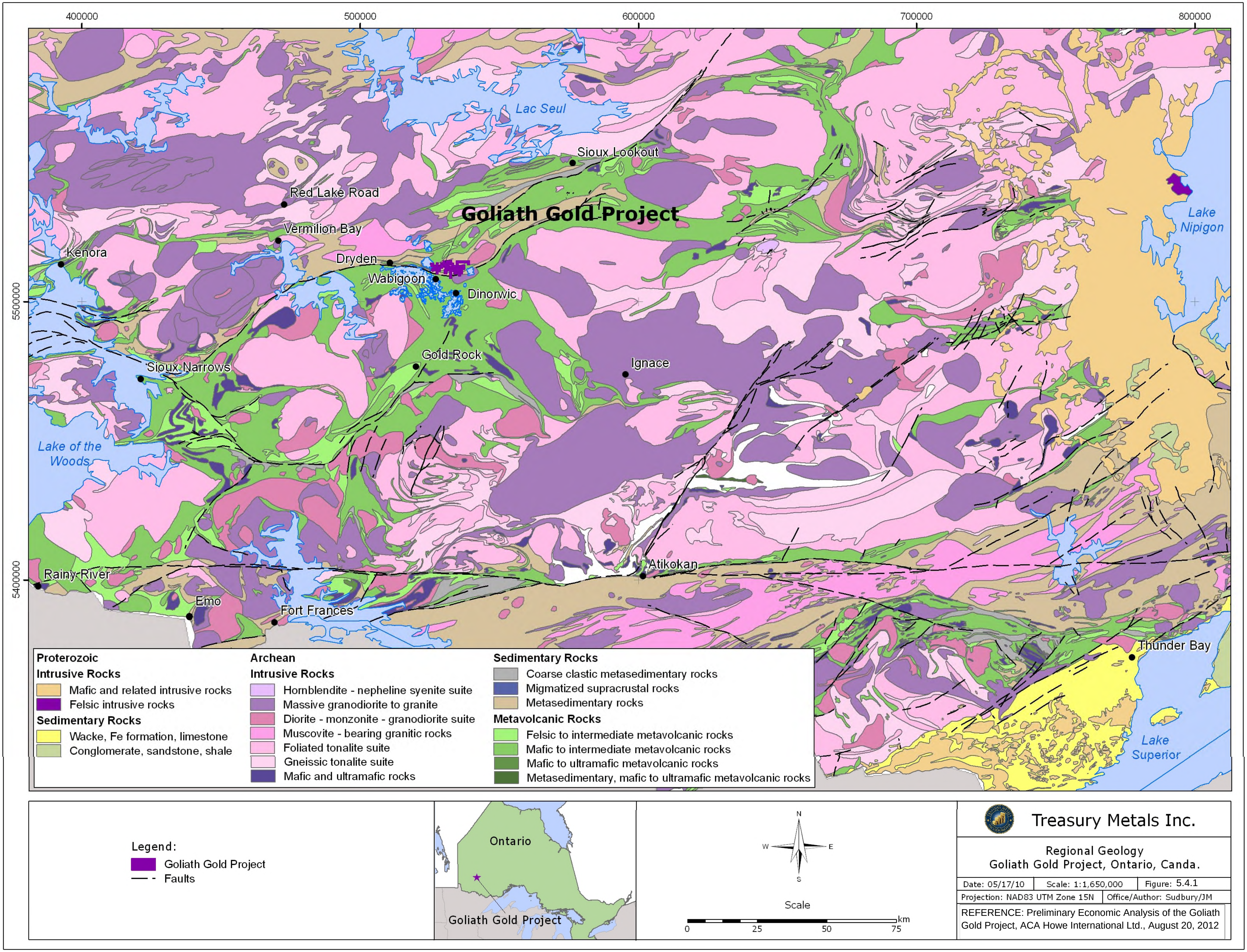
The geology on the northern side of the Wabigoon Fault is characterized by generally southward-facing, alternating panels of metavolcanic and metasedimentary rock.

Geohazards (e.g., landslides, avalanches) associated with mountainous environments are not expected due to the topographic characteristics of the Project site which is located in a relatively flat area within low relief surroundings with a 140 m vertical variability within 20 km of the site (Appendix G, Section 2.4.3 and Figure 1.1). In addition, the Project site is located within the Interior Platform Seismic Zone which is defined as a "Low" relative hazard region by Natural Resources Canada (Appendix D, Section 2.8 and Figure 2.3).

There are no known sites of paleontological or palaeobotanical significance in the Project area.

5.4.2 Deposit Geology

Major lithological units within the project area were identified on the basis of visual examination of rock type in outcrops, drill core, and trenches. These rocks have been grouped into the Thunder Lake Assemblage; a volcanogenic-sedimentary complex of felsic metavolcanic rocks and clastic metasedimentary rocks that underlies much of the Project area, and the Thunder River Mafic metavolcanic rocks, which are generally massive but are pillowed locally and include amphibolite and mafic dykes, characterized as chlorite schists, and underlie the south part of the project area (Figure 5.4.1).



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Lake Nipigon
Gold Rock
Ignace
Sioux Narrows
Lake of the Woods
Atikokan
Rainy River
Emo
Fort Frances
Thunder Bay
Lake Superior
Proterozoic
Intrusive Rocks
Mafic and related intrusive rocks
Felsic intrusive rocks
Sedimentary Rocks
Wacke, Fe formation, limestone
Conglomerate, sandstone, shale
Archean
Intrusive Rocks
Hornblendite - nepheline syenite suite
Massive granodiorite to granite
Diorite - monzonite - granodiorite suite
Muscovite - bearing granitic rocks
Foliated tonalite suite
Gneissic tonalite suite
Mafic and ultramafic rocks
Sedimentary Rocks
Coarse clastic metasedimentary rocks
Migmatized supracrustal rocks
Metasedimentary rocks
Metavolcanic Rocks
Felsic to intermediate metavolcanic rocks
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Regional Geology
Goliath Gold Project, Ontario, Canda.
Date: 05/17/10
Scale: 1:1,650,000
Figure: 5.4.1
Projection: NAD83 UTM Zone 15N
Office/Author: Sudbury/JM
REFERENCE: Preliminary Economic Analysis of the Goliath Gold Project, ACA Howe International Ltd., August 20, 2012

5.4.2.1 THUNDER LAKE ASSEMBLAGE

The main sedimentary unit within the Thunder Lake Assemblage is described as being dominated by biotite-muscovite and biotite schist (greywackes) with subordinate inter-layered metasediment (probably pyroclastic siltstone and arkose sandstone) which exhibits highly strained and well-preserved primary sedimentary structures such as graded bedding, scour, rip-up clasts etc. This unit also includes ink blue magnetite layers that are closely associated with distinctive garnet-rich layers and calc-silicate rock. The felsic metavolcanic rocks within the Thunder Lake Assemblage comprise quartz-porphyritic felsic to intermediate metavolcanic rosk represented by biotite gneiss, mica schist and quartz-porphyritic mica schist, which are conformably inter-layered with wacke-siltstone, and with lenses of metasedimentary rocks, which are similar in composition to the main sedimentary unit.

All of the rocks have been subjected to folding and moderate to intense shearing with local hydrothermal alteration, quartz veining, and sulphide mineralization. Schistosity is commonly developed within both the metasedimentary rocks and volcanic rocks, exhibiting a similar orientation with a strikes of around 90° and dips from 70° to 80° south-southeast.

The primary components of the Thunder Lake Assemblage are described as follows:

- Biotite muscovite schist: Dark grey to grey, fine to medium grained mica schist. Usually it consists of intercalated leucocratic and melanocratic bands. This unit contains a high number of grey to milky white quartz veins. Most of the veins are 1 to 15 cm wide, parallel or crosscutting the foliation. Some veins are associated with highly chloritized and silicified intervals with tourmaline and sulphides.
- Muscovite sericite schist: Light grey to beige grey, fine to medium grained quartz- sericite schist. It is variably siliceous, commonly contains interbedded, dark grey biotite-muscovite bands and grey to milky white quartz veins. It is characterized by the presence of moderate to strong pervasive sericite alteration and gold and silver bearing disseminated sulphides.
- Iron formation: Dark greenish grey calc-silicate metamorphic rocks, which include coarse to medium grained gneiss, biotite schist, 10 to 15 cm wide distinctive layers enriched with garnet, chlorite and narrow ink blue magnetite bands. The rock unit is magnetic and contains disseminated pyrite.
- Metasediment: Grey to dark grey-green medium grained massive unit, which consists of biotite, feldspar, quartz, muscovite with a weak patchy potassium and sericite alteration and rare hematite (rusty brown) alteration. Foliation is poorly developed but more prominent in contact and altered areas. Quartz veins, parallel or crosscutting the foliation are very common. This unit can be distinguished by presence of numerous “quartz eyes” or quartz porphyroblast. This unit may contain 1 to 5% bleb-finely disseminated pyrite and chalcopyrite.
- Biotite schist: Dark grey to black, fine to medium grained, slightly to well-foliated schist. Locally contains disseminated pyrite in the foliation planes and fractures.
- Chloritic-Biotite schist: Dark grey to greenish grey medium grained, slightly to well-foliated schist. Locally it contains disseminated pyrite along foliation planes and fractures.

5.4.2.2 THUNDER RIVER MAFIC METAVOLCANICS

The Thunder River Mafic Metavolcanic rocks are described as follows:

- Mafic dyke: Usually narrow dark green to almost black massive or slightly foliated fine to medium grained biotite-chlorite schist. The width of the layers can reach up to 5 m. The dykes can be either parallel to or crosscut the foliation.
- Amphibolite: Coarse to medium-grained, dark green to black to green units, which consist mainly of 30% to 50% amphibole (hornblende and actinolite), 30% to 40% feldspar and pyroxene with rare post genetic

quartz veins and layers of chlorite schist. It has typical “salt and pepper” appearance and nematoblastic texture.

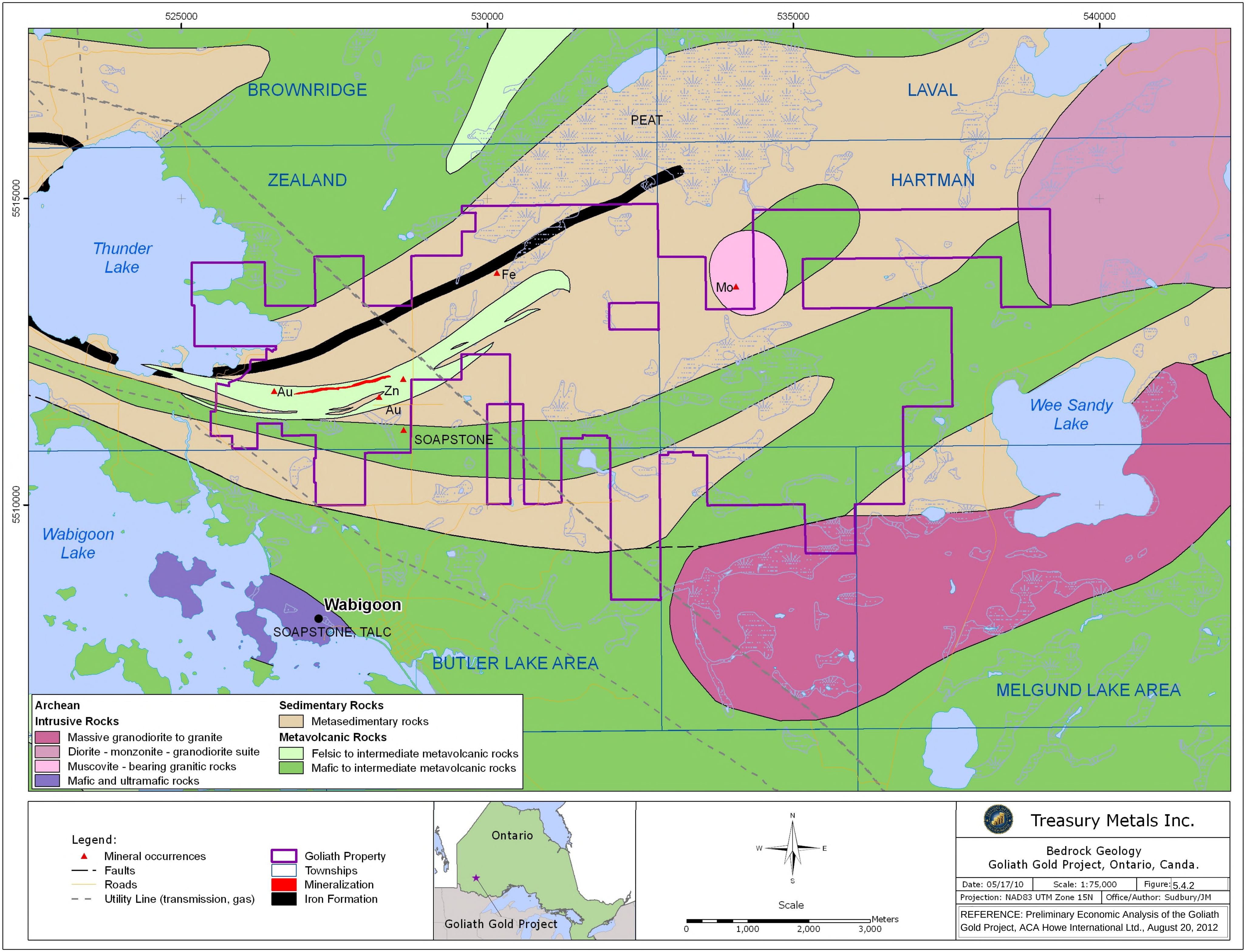
- Green schist: Usually dark green to almost black foliated fine to medium grained schist, which consists mainly of chlorite, biotite, feldspar, amphibole. The width of the layers can reach up to 5 m.

5.4.2.3 DEPOSIT AREA GEOLOGY

Three major rock groupings are consistently recognized from south to north at the Project site, and consist of the following (Figure 5.4.2):

- A hanging-wall unit of altered felsic metavolcanic rocks (sericite schist, biotite-muscovite schist) and metasedimentary rocks.
- A central unit of approximately 100 m to 150 m true thickness, which hosts the most significant gold concentrations and consists of intensely deformed and variably altered felsic, fine to medium grained, quartz-feldspar-sericite schist and biotite-quartzfeldspar-sericite schist (BMS) with minor metasedimentary rocks.
- A footwall unit of predominantly metasedimentary rocks with some porphyritic units and minor felsic gneiss and schist.

The gold mineralization is located primarily in the central unit, and is concentrated in a pyritic (phyllic) alteration zone, consisting of the muscovite sericite schist, quartz-eye gneiss and quartz-feldspar geniss. This area of mineralization appears to extend to a maximum drill-tested depth of 805 m below grade, over a strike length of approximately 2,300 m, with the possibility of this strike length extending to greater than 5,000 m (Figure 5.4.3).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Wabigoon Lake
Wabigoon
SOAPSTONE, TALC
BUTLER LAKE AREA
MELGUND LAKE AREA
Archean
Intrusive Rocks
Massive granodiorite to granite
Diorite - monzonite - granodiorite suite
Muscovite - bearing granitic rocks
Mafic and ultramafic rocks
Sedimentary Rocks
Metasedimentary rocks
Metavolcanic Rocks
Felsic to intermediate metavolcanic rocks
Mafic to intermediate metavolcanic rocks
Legend:
Mineral occurrences
Faults
Roads
Utility Line (transmission, gas)
Goliath Property
Townships
Mineralization
Iron Formation
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Treasury Metals Inc.
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Date: 05/17/10
Scale: 1:75,000
Figure: 5.4.2
Projection: NAD83 UTM Zone 15N
Office/Author: Sudbury/JM
REFERENCE: Preliminary Economic Analysis of the Goliath Gold Project, ACA Howe International Ltd., August 20, 2012

Figure 5.4.3

Cross-sectional view of the eastern high-grade shoot within the main zone

5.4.3 Geochemistry

5.4.3.1 ACID ROCK DRAINAGE AND METAL LEACHING

Acid-rock drainage (ARD) is a natural process whereby sulphuric acid is produced when sulphides present in rocks are exposed to air and water. Metal leaching (ML) is the release of dissolved metal concentrations in rock leachate. The evaluation and control of these two items is vital to maintaining a clean environment during construction, operation and post-closure around the mining activities. An ARD/ML geochemical characterization was undertaken for the Goliath Gold Project mine rock components with the potential to leach acid and metals during mining. These data and information have been used in the development of the overall mine plan and applicable environmental management plans, as well as in the predictive water quality assessments to assist in predicting possible effects and mitigation requirements for the Project.

The ARD/ML characterization and prediction studies were completed by EcoMetrix Inc. (EcoMetrix) in accordance with recommendations presented in the Mine Environment Neutral Drainage (MEND) “Prediction Manual for Drainage Chemistry from Sulphidic Geologic Materials, MEND Report 1.20.1 (MEND, 2009). This document represents an update to the “Draft Guidelines and Recommended Methods for the Prediction of Metal Leaching and Acid Rock Drainage at Mine Sites in British Columbia” prepared for the British Columbia Ministry of Energy and Mines (Price, 1997), and referenced in Regulation 240/00 of the Ontario Mining Act.

History of Geochemical Characterization Studies

The first record of geochemical characterization for the Project site is from 1997 when NAR Environmental collected five rock samples for acid-base accounting (ABA) analyses as part of their closure plan (NAR, 1997). The preliminary results from these five samples triggered the collection of an additional 25 samples for ABA analyses. There was limited activity on the Project between 1999 and 2008. Treasury assumed ownership of the Project in 2008, and initiated additional geochemical characterization analyses in 2012 as part of the environmental baseline studies.

As part of these baseline studies, 54 drill core samples were selected and submitted for ABA and whole rock metals analysis (KCB, 2012). These studies subsequently led to the ongoing geochemical characterization work being completed by EcoMetrix which is outlined in the following sections. Samples collected and analyzed prior to 2012 have not been considered in the ongoing geochemical characterization program. The information presented in this EIS references the “Geochemical Evaluation of the Goliath Gold Project (Draft)” (EcoMetrix, 2014).

5.4.3.2 DEPOSIT GEOLOGY AND GEOCHEMICAL SETTING

The deposit mineralized zones are tabular composite units defined on the basis of anomalous to strongly elevated gold concentrations, increased sulphide content and distinctive altered rock units and are concordant to the local stratigraphic units. Stratigraphically, gold mineralization is contained in an approximately 100 m to 150 m wide central zone composed of intensely altered felsic metavolcanic rocks (quartz-sericite and biotite-muscovite schist) with minor metasedimentary rocks. Overlying hanging-wall rocks consist of altered felsic metavolcanic rocks (sericite schist, biotite-muscovite schist and metasedimentary rocks) with the footwall comprising metasedimentary rocks with minor porphyries, felsic gneiss and schist. Gold within the central unit is concentrated in a pyritic (phyllic) alteration zone, consisting of quartz-sericite schist (MSS), quartz-eye gneiss, and quartz-feldspar gneiss.

5.4.3.3 PROJECT COMPONENTS

The proposed open pit will produce ore and four primary types of mine waste rock. The ore processing component of the Project will generate tailings. Additional quarry sources have been identified to supply construction material needed for the Project. The geochemical characterization considers the range of rock materials generated over the life of the mine. Estimate volumes of mined materials are presented in Table 5.4.1.

Table 5.4.1 Estimated Volumes of Mined Materials

Mined Material		Relative Proportions of Each Mined Material Type	
		Tonnage (Millions of Metric Tonnes)	**Proportion of Total (%)**
Waste Material	Biotite Muscovite Schist (BMS) and Biotite Schist (BS)	17.50	38%
Waste Material	Muscovite Sericite Schist (MSS)	3.75	8%
Waste Material	Meta-Sediment (MSED)	3.75	8%
Waste Material	Tailings	11.82	26%
Ore	Open Pit Mill Feed	2.98	7%
Ore	Low-grade Stockpile	2.29	5%
Ore	Underground Mill Feed	3.70	8%
Total		**45.79**	**100%**

Mine Waste Rock

Mine waste rock is defined as rock that will be excavated from the active mining areas, and does not have sufficient ore grades to process for mineral extraction. It is estimated that approximately 25 million tonnes of mine waste rock will be generated from both underground and open pit operations over the over the life of the mine.

The mine waste rock (Table 5.4.2) has been subdivided into three primary rock types, which include Biotite Muscovite Schist (BMS), Muscovite Sericite Schist (MSS), and Meta-Sediment (MSED). A fourth unit, Biotite Schist (BS), was used in the geochemical characterization program to characterize samples. The BMS and BS are now grouped together because of geological similarity.

Table 5.4.2 Estimated Volumes of Mine Waste Rock

Waste Rock Type	Relative Proportions of Each Waste Rock Type	
	Tonnage (Millions of Metric Tonnes)	**Proportion of Total (%)**
Biotite Muscovite Schist (BMS) and Biotite Schist (BS)	17.5	70%
Muscovite Sericite Schist (MSS)	3.75	15%
Meta-Sediment (MSED)	3.75	15%
Total	**25**	**100%**

Tailings

Lycopodium Minerals Canada Ltd. (Lycopodium) produced a Process Optimization Study (Lycopodium, March 2014) for the Project, identifying the Project as a free-milling gold deposit with ore material containing coarse gold that is readily amenable to conventional processing options. The ore processing plant will process approximately 2,700 tonnes per day over the mine life using gravity concentration of free gold, followed by carbon-in-leach (CIL) cyanidation. Process tailings will be placed and stored in an engineered TSF.

Low-grade Ore

A low-grade ore stockpile (LGO) will be maintained over the mine life to allow blending of lower grade and higher grade ores to ensure a more consistent grade of ore to the processing plant. The LGO will be maintained throughout the initial years of mining and will be used to blend with the underground material until it is wholly consumed and fed to the process plant at the end of the mine life. It is expected that the ore stockpiles will be temporary, and that there will be ongoing replacement and turnover as the stockpiled ore is processed, and new ore from mining is placed in the stockpile.

Geochemical characterization of the low grade ore has not yet been completed. For the purposes of geochemical characterization, the MSS host rock has been used as a surrogate for the low grade ore as a preliminary approximation Up to three separate stockpiles of varying grade will be used to feed the process plant.

Other Project Components

Geochemical characterization for quarry, excavation, and other potential construction materials has not yet been carried out, and will be done as the Project design advances.

5.4.3.4 MATERIALS CHARACTERIZATION AND MANAGEMENT STUDIES

The geochemical characterization program has been an iterative process consisting of several sampling and analysis programs. The programs have served to obtain ARD/ML prediction information to be used for the water quality effects assessment and to determine mitigation requirements for the Project.

A preliminary geochemical assessment was completed in 2011 as part of the baseline studies for the site and involved the characterization of 54 drill core samples. An additional 112 drill core samples of potential mine rock material were selected and characterized in June 2012.

A summary of the characterization programs completed to date, including methodologies, analyses, and conclusions, are presented in Appendix K. The geochemical characterization programs are ongoing with the intent and purpose of further refining the geochemical predictions and informing the mine rock management and handling strategies.

Methodology

The geochemical characterization program has included a suite of static and kinetic tests to evaluate short term static conditions and long term potential for acid generation and metal leaching. Characterization methods for the various Project components included static and kinetic geochemical characterization tests. This includes acid-base accounting (ABA), whole rock metals (ICP-MS), shake flask extraction (SFE), humidity cell tests (HCT) and field cell tests (Table 5.4.3). A complete summary of the geochemical characterization program and methodology for ARD/ML prediction is provided in Appendix K.

ABA testing included paste pH, total sulphur, sulphate-sulphur, sulphide-sulphur, Modified Sobek NP, total carbon, total organic carbon, and total carbonate analyses. The results from these analyses were utilized to calculate the carbonate NP (Carb-NP), acid generating potential (AP), net neutralization potential (NNP), and Sobek NPR (ratio of Sobek NP to AP) and Carbonate NPR (Carb-NPR).

Elemental analysis was completed to quantify the concentration of elements in the rock samples. An aqua regia digestion process was followed by an Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) scan. Shake flask extraction (SFE) metal leaching tests were used to assess the presence of potentially soluble elements and to understand their release during the initial stages of weathering. The shake flask extraction leachate was evaluated for pH, conductivity, hardness, sulphate and dissolved metals. SFE tests were run using both deionized water and a 0.1M HCl acid dissolution.

Table 5.4.3 Sample Numbers for Static Tests on Waste Rock Material

Waste Rock Type	Number of Samples			
	Acid Base Accounting	Whole Rock Metals Analysis	Shake Flask Extraction	
			Deionized Water	0.1M HCl Acid
Biotite Muscovite Schist (BMS)	52	67	13	5
Biotite Schist (BS)	16	20	4	2
Muscovite Sericite Schist (MSS)	35	59	8	3
Meta-sediment (MSED)	9	15	3	1
Total	**112**	**161**	**28**	**11**

Three humidity cell tests (HCT) with different sulphur content ranges were initiated for each of the BMS, MSS, and BS materials, respectively. Drill core samples were selected to create composite samples representing humidity cell samples with sulphur ranges of less than 0.25 %S, 0.25 %S to 1.00 %S, and greater than 1.00 %S for each of the three rock types. For the MSED material, two columns were initiated, less than 0.60 %S and greater than 0.60 %S. These ranges allow for appropriate evaluation of potential metal leaching from mine rock material and were designed to be suitable for water quality modeling required as part of a feasibility study and Environmental Assessment.

Four barrel tests were initiated in September 2012 at the Goliath Gold site. The barrels were constructed using one-half of a clean 170 L plastic barrel. Selected drill core segments (50 cm to 100 cm long), including both half cores and full cores, were placed in each barrel to represent mine rock material from each of the four material types. Approximately 78, 87, 90, and 88 kg of core samples were placed in the BMS, BS, MSS, and MSED barrels, respectively. The top of each barrel remained open so that mine rock samples were exposed to air and precipitation falling as rain or snow. Each barrel has a bottom drain spout connected with tubing to pails where water collects between sampling events. Leachates from the barrel tests were analyzed at an accredited lab for general chemistry (pH, hardness, conductivity, total dissolved solids, alkalinity, acidity, chloride, sulphate, phosphorus, nitrate/nitrate, and ammonium), cyanide (total, weak acid dissociable (WAD), and free), and total and dissolved trace metals.

Tailings samples were produced by metallurgical bench scale testing. Two duplicate HCTs were set-up using a prepared composite tailings sample. A single composite tailings sample was submitted for ICP-MS (1 test), ABA (1 test) and SFE analysis (3 tests with deionized water, 2 tests with 0.1M HCl acid).

Classification Method and Screening Criteria

ARD classification criteria are as documented in the MEND guidelines (Price, 2009) stipulating that material with an NPR value of less than 1 (i.e., NPR<1) is classified as potentially acid generating (PAG). Material with an NPR value of greater than 2 (i.e., NPR>2) is classified as non-acid generating (NAG). And material with an NPR value of between 1 and 2 (i.e., 1<NPR<2) is classified as Uncertain.

Shake flask and humidity cell results were compared against the Ontario Provincial Water Quality Objectives (PWQO; MOEE, 1994) to evaluate constituents of potential concern (COPCs).

Material Characterization for ARD/ML Potential

Waste Rock

All rock types were characterized by carbonate NPR (Carb-NPR) geomean values below 1.0. Similarly, with the exception of the BS samples, all mine rock samples had geomean values for Sobek-NPR below 1.0. Therefore, all four mine rock types were classified as potentially acid generating (PAG), as per the MEND guidelines (Price, 2009).

The average sulphide-sulphur contents amongst all the samples ranged between 0.01 and 8.58 percent sulphur (%S), whereas the average sulphate-sulphur contents ranged between 0.01 and 1.00 %S. The geomean sulphide-sulfur contents of BMS, BS, MSS, and MSED were 0.0.44, 0.40, 0.78, and 0.52 %S, respectively, while sulphate-sulphur values were 0.24, 0.22, 0.23, and 0.16 %S, respectively. For all four mine rock types, the high sulphide-sulphur content standard deviation (0.43, 0.38, 1.24 and 0.53 %S) relative to the geomean values demonstrates the broad range of sulphide contents.

The total carbonate values for all four rock types, measured as percent carbon (%C), ranged between 0.01 and 0.71 %C. Total carbonate values were higher in BS and MSED samples with geomean values of 0.09 and 0.08 %C. Conversely, BMS and MSS samples both had geomean values of 0.03 %C.

The measured Sobek-NP values were relatively low, ranging from 2.10 to 20.8 kg $CaCO_3$/t with geomeans of 7.19, 8.57, 5.69, and 8.90 kg $CaCO_3$/t for BMS, BS, MSS, and MSED, respectively. Typically, Carb-NP values were lower than and only represent less than one-half of the Sobek-NP values, ranging from 0.08 to 16.7 kg $CaCO_3$/t with geomean values for BMS, BS, MSS, and MSED of 0.74, 1.37, 0.72, and 1.87 kg $CaCO_3$/t, respectively.

As expected, higher soluble concentrations were generally observed in samples for all four mine rock types in the acid extractions compared to those in the deionized water extractions. Deionized water extraction values exceeded acid-wash values for antimony and sulphate for the BMS samples; cadmium, zinc, and sulphate for the MSS sample; and sulphate for the MSED samples. The screening values were exceeded for aluminum (BS, MSED), copper (MSED), and lead (BMS, BS, MSED) in the acid-wash SFEs. Conversely, no screening values were exceeded for any of the deionized-water SFE for all four mine rock types.

Tailings

The tailings material was classified as PAG, as per the MEND guidelines (Price, 2009), with an NPR ratio of well below one in the composite tailings sample (Appendix K). The tailings sample was analyzed with a total-sulphur content of 1.53 %S, occurring dominantly as sulphide sulphur (1.23 %S). All carbon in the sample was in the form of carbonate at a concentration of 0.02 %C.

Mineralogy information for material reported in the Lycopodium report (Appendix B) indicate that total sulphide accounts for ~2.1% of the sample mass, with 10% of the sulphide minerals occurring as pyrrhotite The dominant non-sulphide gangue minerals present were quartz (56%), micas (22%), and feldspars (22%).

Time for Onset of Acidic Conditions

A range of times to onset of acid conditions in waste rock stockpiled on surface can be estimated from the HCT results and calculated loading rates. The BMS, BS, MSS, and MSED rock samples, used for the HCTs, reached acidic conditions (pH values less than 5.5) after approximately 60 weeks. These HCT results can be considered as conservative estimates for the onset of acidic conditions, as they incorporate smaller grain size distributions, higher average temperatures, and higher precipitation infiltration rates than those anticipated for mine rock during mining operations. Therefore the higher rates of oxidation in the HCT tests than those expected in the WRSF will result in shorter times to the onset of acid drainage. Acidic drainage in the WRSA is expected to be delayed to a greater extent than was observed in the HCTs.

It is conservatively estimated that the time to acid onset for the PAG rock, based on the samples examined in this investigation, will potentially range between a few tens of years to many tens of years. However, the low Carb-NP values, relative to the calculated AP values, observed for a large majority of the mine rock samples selected for this investigation suggest that any mine rock management methods take a conservative approach to the onset of acid production. If segregation of PAG and non-PAG mine rock is completed, any material used for construction purposes should be evaluated for acid generation potential and metal leaching prior to use.

5.4.3.5 Mine Material Management and Storage Strategy

All (100%) mined materials, including waste rock, tailings, and low-grade ore, have been classified as PAG. The following sections document the proposed management, material handling and disposal plans for mine rock and related materials. Mitigation strategies and contingency plans are identified in the context of mine material management and strategies.

Waste Rock Material Management

Approximately 12.9 million tonnes of waste rock will be permanently stored in the dedicated WRSA, while the remaining 12.1 million tonnes will be backfilled to the main pit as part of site reclamation. All waste rock has been classified as PAG; therefore there will be no segregation of materials. All waste rock material will be handled appropriately to minimize potential impacts of ARD/ML. As all waste rock has been found to be unsuitable for road aggregate, the necessary aggregate for construction purposes will need to be obtained from an approved outside source.

Waste Rock Storage Area

A WRSA will be constructed for the permanent storage of waste rock generated throughout the life of the mine. The WRSA is expected to be constructed on the north side of the proposed open pit. The WRSA will have a capacity of approximately 12.8 million m^3 or 26 million tonnes. It will have a footprint area of approximately 675,000 m^2 and a maximum vertical stack height of 20 m. Current design criteria suggest that the slopes will be set at a 3:1 ratio, and that vertical stack height will be limited to reduce the potential visual impact for neighbouring residents. Prior to commissioning, the WRSA site will be cleared and perimeter ditching installed to collect all WRSA runoff. Collected water will be directed to the water management system for treatment.

Tailings Storage

A TSF will be constructed for the permanent storage of all tailings material generated during the life of the mine. The facility is proposed for construction within the watershed of the Blackwater Creek Tributary #2.

The TSF will have a capacity of approximately 10 million m^3 and a total final footprint area of approximately 600,000 m^2. Due to the flat terrain, a compound-style dam will be constructed. In the current design, the primary dam structure is located on the downstream side and a secondary dam is constructed to contain potential upstream flooding, effectively creating a deeper TSF with a smaller lateral footprint. In accordance with the water management strategy (Lycopodium, June 2014), all tailings will be deposited sub-aqueously.

A fence may be installed around the TSF to limit possible interactions with wildlife, particularly large mammals such as moose, deer and wolves. The fence will be constructed in consultation with the Ministry of Natural Resources.

Low Grade Ore Stockpiles

The low grade ore will be stockpiled in a location adjacent to the processing plant site to facilitate transport to the processing plant. The low grade stockpile will have a maximum volume of 900,000 m^3 or 1.8 million tonnes, and occupy a footprint of approximately 62,500 m^2.

At the end of mining operations, the LGO will be depleted and no material will be left behind. Treasury understands that conditions may change over the life of the mine. For this reason, a contingency plan is presented in Section 3.14.3 to address potential for a low grade stockpile at closure.

Mitigation and Contingency Plans

Mitigation strategies will be required to manage mine rock and tailings at the site to prevent potential negative effects on water quality at the site in post closure and during operation. The following mitigation measures may be used: prevention, sub-aqueous disposal, capping of PAG rock material, engineered barriers, and liners. Best practices and handling of materials guidelines will be incorporated into site management plans. Contingency plans will be in place to minimize the impacts of ARD/ML if they should occur. Based on the monitoring program, the schedule of capping or flooding could be amended as soon as possible to reduce the impact time.

5.5 Terrain & Soil

The terrain and soil of the project area, as described below, has been adapted from Klohn Crippen Berger's Environmental Baseline Study (September 2012).

5.5.1 Regional Soil Classification

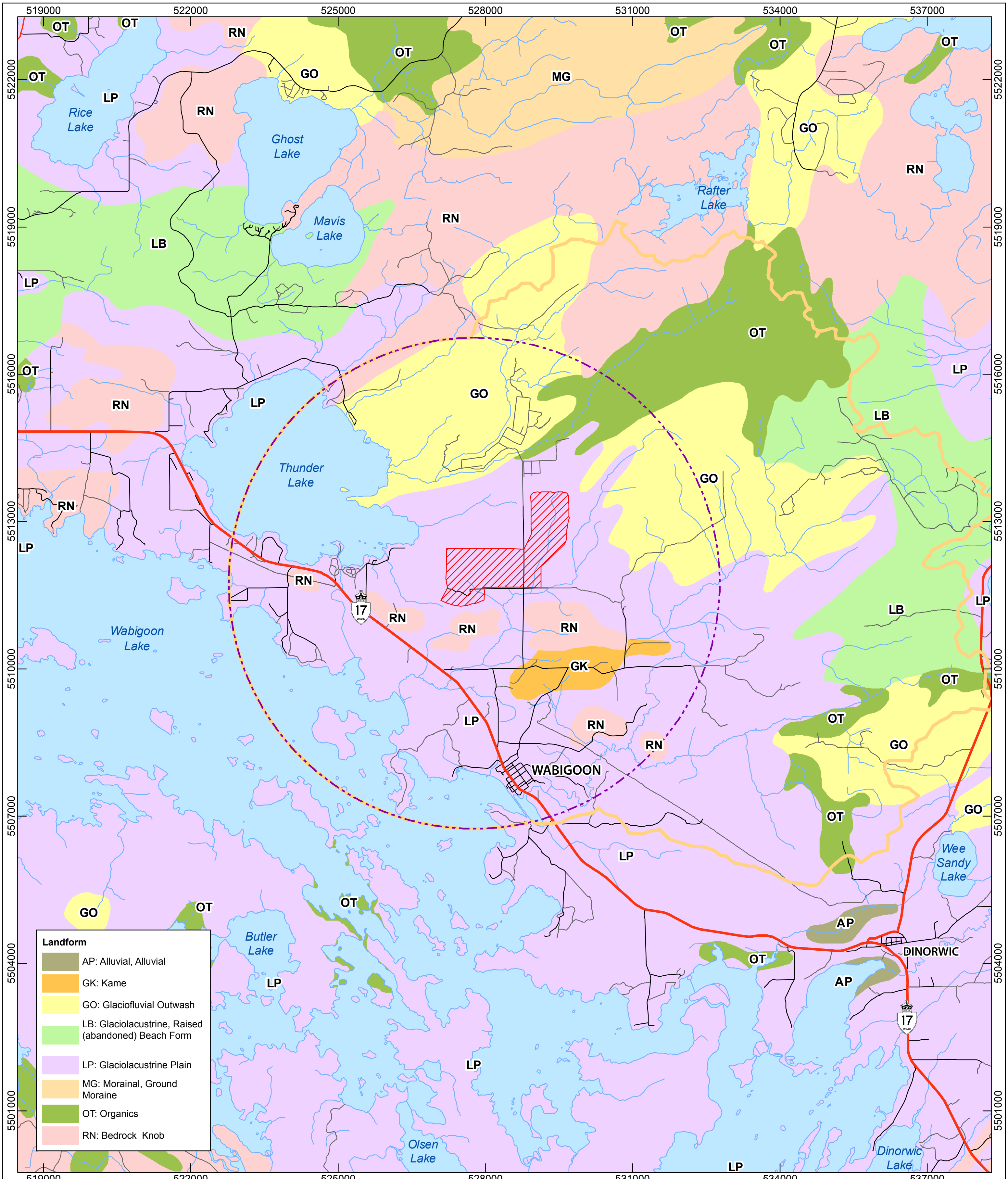
The dominant regional landform within the LSA is predominately Glaciolacustrine Plain (Figure 5.5.1). The regional soils were categorized based on visual observations by Klohn Crippen Berger (Appendix G) and by mapping available from the Ontario Institute of Pedology (OIP 1984) for the Dryden-Kenora Area. The three major soil classifications found in the regional study area (RSA) that will play a role in Project development, land use, reclamation, and water management are:

- Gray Luvisols: characterized by an illuviated Bt horizon (i.e., subsoil with accumulation of silicate clays). The typical gray luvisol in the Dryden-Kenora area has clay, clay loam, sand loam, or silt loam texture. They are well drained and have a moderate agricultural capability;
- Gleysols: characterized by their saturated nature and reducing conditions that occur either continuously or seasonally. Gleysols can be identified by hue and mottling in the lower horizons, which is an indication of reducing conditions, associated with saturation. The Gleysols of the Dryden-Kenora area are poorly drained and are silt loam to medium-coarse in texture. They are underlain by outwash that is calcareous and lacustrine in origin; and
- Podzols: Soils of the Podzolic order have B horizons (i.e., subsoil) in which the dominant accumulation product is amorphous material composed mainly of humified organic matter combined in varying degrees of aluminum and iron. Typically these soils occur in coarse- to medium-textured, acid parent materials, under forest or heath vegetation in cool to very cold humid to perhumid climates (Soil Classification Working Group (SCWG) 1998). The podzols of the Dryden-Kenora area are well drained and overlay fine outwash material that is non-calcareous in origin.

5.5.2 Local Soil Classification

The soils found in the RSA and the LSA are fairly similar with a slight variation related to micro scale changes in ground elevation during the soil investigation by Klohn Crippen Berger in 2010. The LSA is characterized regionally by the Broadtail and Deception humo-ferric Podzols, the Minnitaki orthic Gleysol, and the Sioux grey Luvisol (Figures 5.5.2 and 5.5.3). All soil types were determined to be present locally; however, the difference in drainage and variable elevation allow for more local variation in soil type. An area of marshland was identified in the local survey and is evident in the topography surrounding Blackwater Creek and a beaver pond on the northwestern section of the LSA. The soils in the Broadtail group are limited in agricultural capability due to low fertility and moisture limitations with stoniness and bedrock. The Deception group is also limited in agricultural capability with an additional limitation due to topography. More capable land use areas are found in areas where the soil is less stony and the soils are less limited such as the Minnitaki group. The Minnitaki group has moderate capability and a limitation due to excess water. The Sioux soil group is limited in agricultural capability due to undesirable soil structure, topography, and erosion.

The soil type in the LSA ranges from loamy sand to silty clays. The soils with coarser textures are generally moderately to well-drained, and finer textures have poorer drainage due to hydraulic conductivities. The soil type in the LSA was confirmed during a drilling investigation by TBT Engineering Ltd. in March 2014 (Figures 5.5.4 and 5.5.5). The O horizon (i.e., organic material) was generally encountered to approximately 0.2 m below grade to a maximum depth of 1.4 m in some areas. The O horizon is underlain by B horizon (i.e., subsoil) of predominantly clay and/or silt to bedrock, which was encountered at depths ranging from 1.05 m to 18.6 m below grade.



GOLIATH GOLD PROJECT
DRYDEN, ONTARIO, CANADA

Baseline Regional Landforms in the Goliath Gold Project Area

FIGURE: 5.5.1 REV.00

SCALE: 100 000

TREASURY METALS INC.

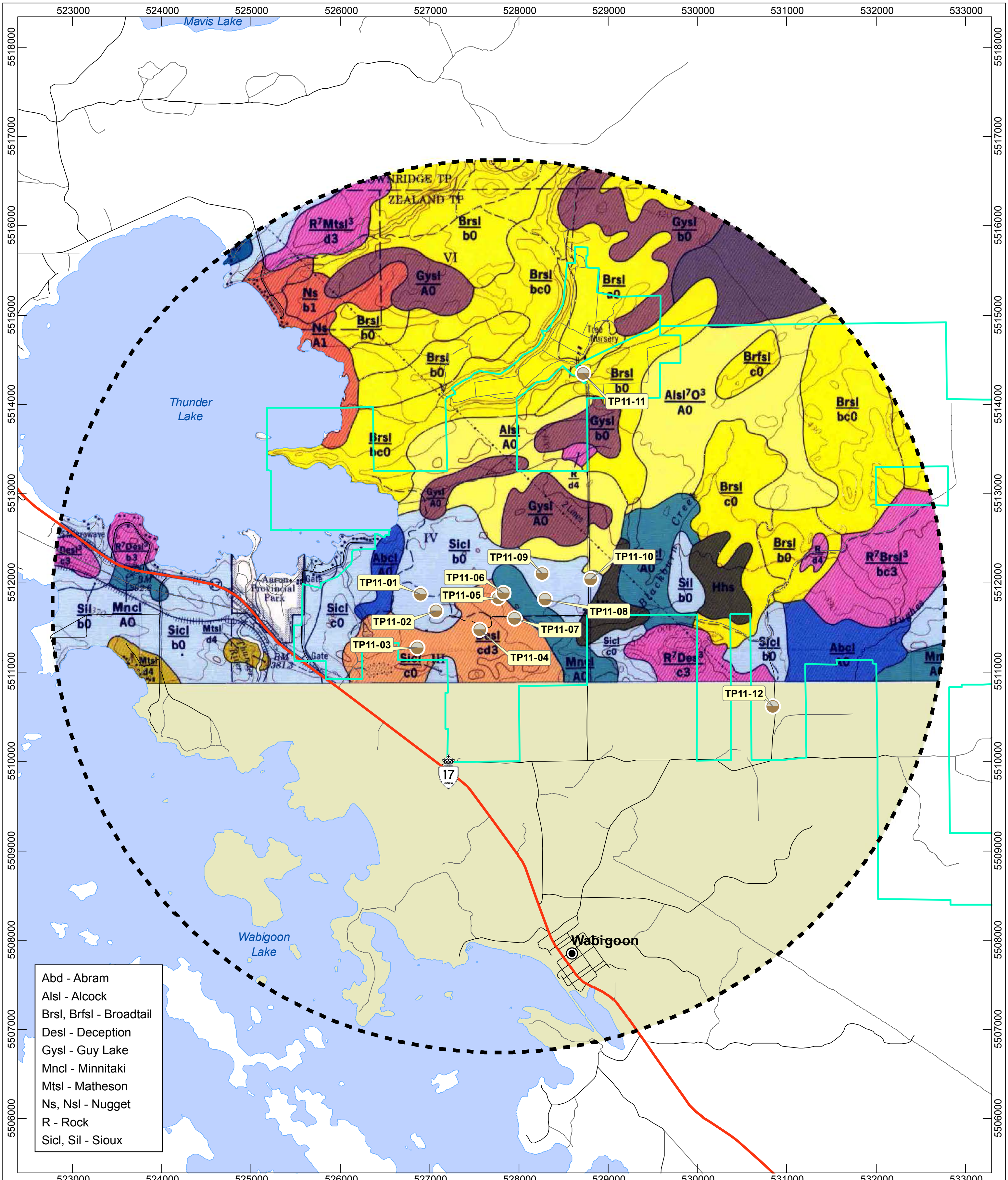
DESIGN: AT 06 FEB. 2014
GIS: AT 14 NOV. 2014
CHECK: AT 14 NOV. 2014

Study Area (Local)
Study Area (Regional)
Immediate Project Extents
Arterial Road
Highway
Local Road
Recreational Road
Waterbody
Watercourse

N W E S

0 1,000 2,000 3,000
Meters

REFERENCE
Projection: NAD83 UTM Zone 15N
Base Data: OBM
Landform Data/Classification by AMEC



GOLIATH GOLD PROJECT DRYDEN, ONTARIO, CANADA	SCALE: 55 000 TREASURY METALS INC.
SOIL SAMPLING TEST PIT LOCATION AND LOCAL SOIL CLASSIFICATION	*DESIGN: AT 06 FEB. 2014* *GIS: AT 20 FEB. 2014* *CHECK: AT 09 OCT. 2014*
FIGURE: 5.5.2 REV.00	

LEGEND

- Soil Sampling Location
- Local Study Area
- Property Boundary
- Populated Area
- Arterial Road
- Highway
- Local Road
- Recreational Road
- Waterbody

0 500 1,000 1,500
Meters

N E S W

REFERENCE

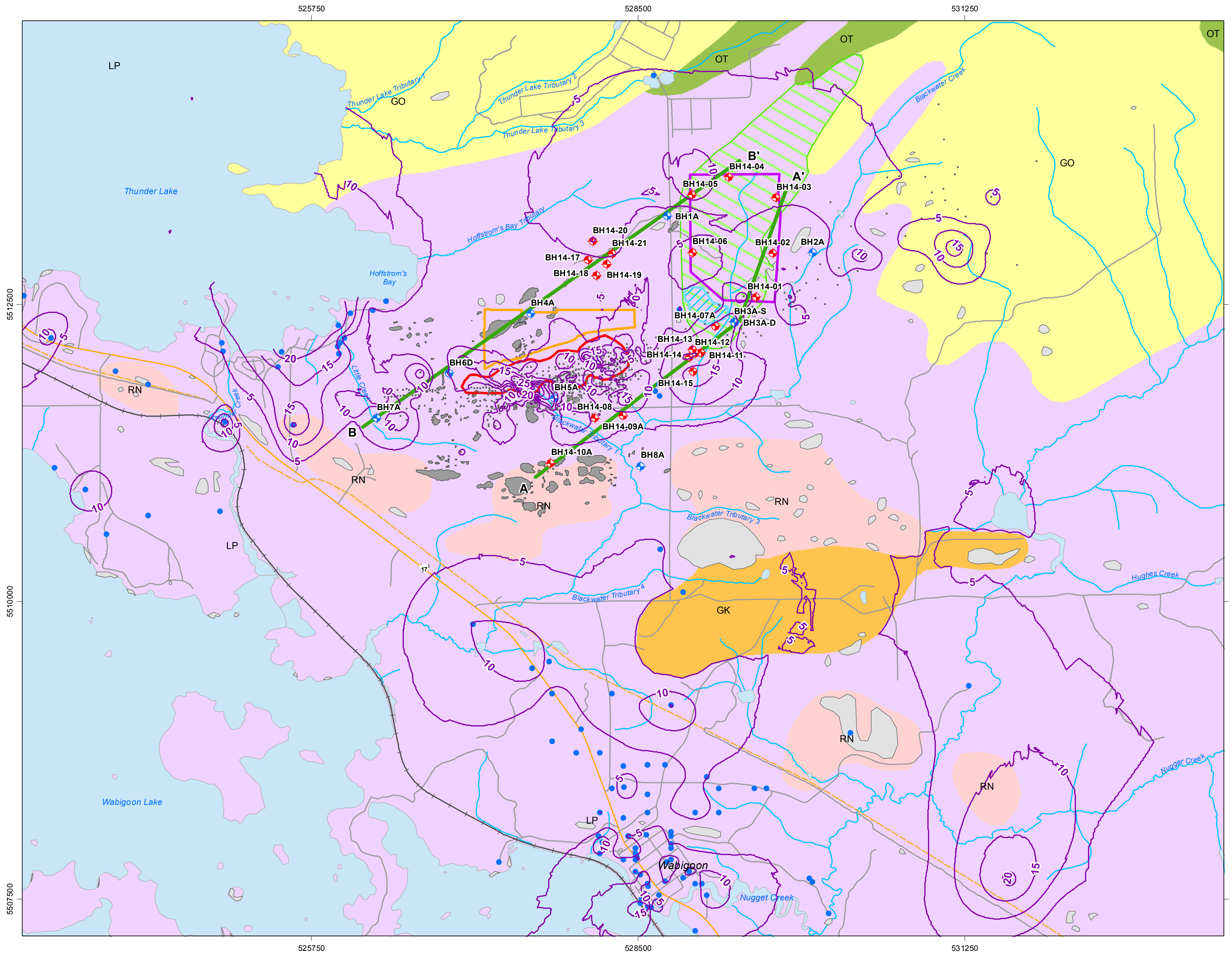
Projection: NAD83 UTM Zone 15N
Base Data: OBM
Soil classification: Ontario Institute of Pedology. Ontario Ministry of Agriculture and Food, 1987.

HYDROGEOLOGICAL PRE-FEASIBILITY / EA SUPPORT STUDY

Goliath Project

Figure 5.5.3

Project Site Overburden Geology and Soil Profile Location



Legend

- Overburden Thickness (meters below ground surface)
- Proposed Open Pit
- Waste Rock Storage Area
- Tailings Management Area
- Tailings Management Pond
- Cross Section Location
- Railway
- Pipeline

Surficial Geology

- Sand - Clay / Silt - Sand Boundary

Landform

- GK: Kame
- GO: Glaciofluvial Outwash
- LP: Glaciolacustrine Plain
- OT: Organics
- RN: Bedrock Knob

Bedrock Outcrop Mapping

- Beakhouse and Pigeon, 2003
- Treasury Metals

Source: National Topographic Database, 052F09, 052F10, 052F15, and 052F16, 1:10 000 nominal scale.
Source: Ontario Geological Survey, Ministry of Northern Development and Mines, and Northeast Science and Information Section, Ministry of Natural Resources 2005. Digital Northern Ontario Engineering Geology Terrain Study (NOEGTS); Ontario Geological Survey, Miscellaneous Release--Data 160. 1:100,000 scale

Conditions encountered in the field may be different from the interpreted information presented on this figure.

Project #: TB124004
Date: July, 2014
Client: Ontario Infrastructure & Lands

Drawn by: DF
Checked by: MS
Revision No.: 2

UTM NAD 83
Zone 15N
1:30,000

Meters 0 200 400 600 800 1,000

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5.5.3 Soil Nutrient Baseline

The purpose of the soil nutrient baseline by Klohn Crippen Berger (Appendix G) was to determine the productivity level of current surface soils and to predict the potential productivity of the soils for reclamation.

5.5.3.1 SOIL ORGANIC MATTER

Soil organic matter (SOM) improves both physical and chemical properties of the soil. SOM improves soil structure and particle stability, increase water retention capacity, increases aeration, and stores and supplies nutrients for plants and micro-organisms.

The SOM content correlates with the sampling horizon. The O horizon (i.e., organic matter) has the highest organic matter content at an average of 35%, followed by the Ah horizon (i.e., topsoil with illuvial accumulation of organic matter) at an average of 7%, and minimal to no organic matter in the mineral (B) horizons. Although there is an abundance of organic matter in the O horizons, the poor drainage often associated with the soil formation minimizes agricultural capability. The potential for use of these materials in reclamation is high because of the elevated organic matter and the ability of the SOM to improve the chemical and physical properties of soil.

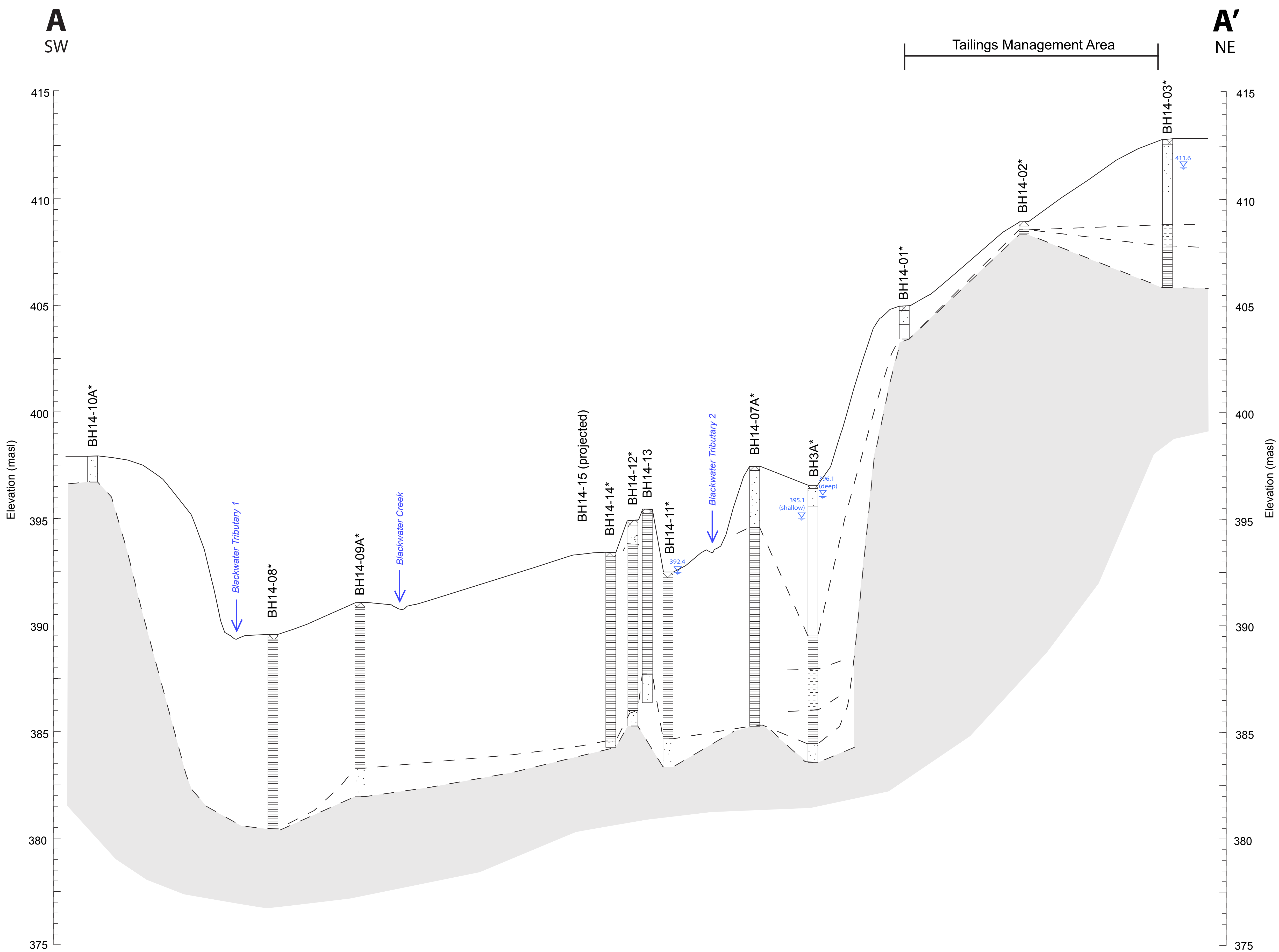
5.5.3.2 MAJOR NUTRIENTS (N, P AND K)

Available nitrogen (N) in the LSA is low and is typically less than the method of detection limit of 2 mg/kg. Nitrogen has only been detected in the Om soil horizon due to the high organic matter content. The low nitrogen content in the LSA indicates little to no amendment done and/or low microbial activity. An increase in spring precipitation and runoff has also been known to decrease soil available nitrogen through leaching.

The available phosphorous (P) in the LSA ranges from below the detection limit of 2 mg/kg to 20 mg/kg. The higher available phosphorous levels are generally associated with the higher organic matter horizons. Soil phosphorous levels are relevant for soil fertility in relation to the crops produced. Excess phosphorous is a concern in terms of entry into surrounding water bodies. The relatively low concentration in these soils indicates that there should not be a concern of excess phosphorous entering the watershed. Phosphorous is generally most available in soil with a pH between 5.5 and 7.0.

The potassium (K) content was measured to be below the method of detection limit of 2 mg/kg.

Generally, the nutrient content of the soils is low with the highest measureable nutrients found in the organic containing O and Ah horizons.



HYDROGEOLOGICAL PRE-FEASIBILITY / EA SUPPORT STUDY

Goliath Project

Figure 5.5.4

South-west to North-east Cross-section through Overburden (a) South-east of Proposed Open Pit

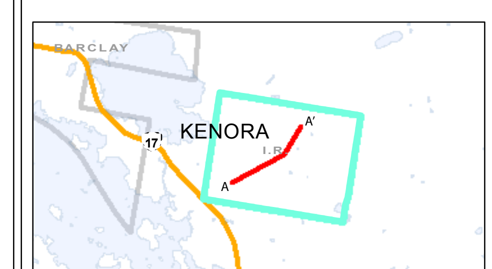
Legend

- Organics
- Sand
- Silty Sand
- Silt
- Clay
- Bedrock
- Waterlevel (masl)

Notes: "Clay" indicates lithology of predominantly clay but also includes silty clay and layered clay and silt.

Borehole with * indicates auger refusal (assumed bedrock).

BH14 water levels from May 2014, BH 2013 (BH1A - BH8A) water levels from July 2013.



Source: Treasury Metals Borehole Logs

Conditions encountered in the field may be different from the interpreted information presented on this figure.

Project #: TB124004
Date: June, 2014
Client: Ontario Infrastructure & Lands

Drawn by: DF
Checked by: MS
Revision No.: 1

0 100 200 300 400 500 Meters

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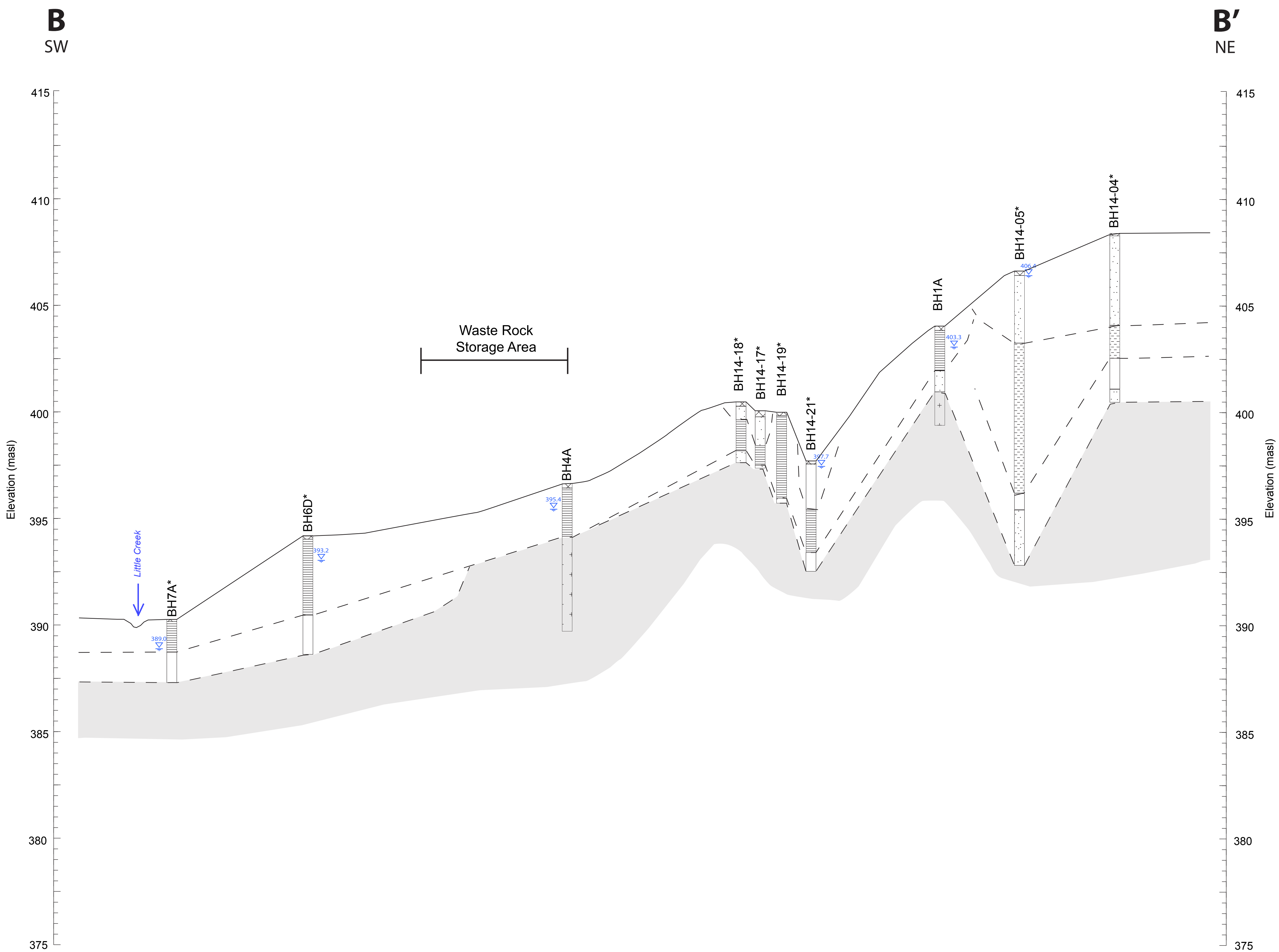


HYDROGEOLOGICAL PRE-FEASIBILITY / EA SUPPORT STUDY
Goliath Project

Figure 5.5.5

South-west to North-east Cross-section through Overburden (b) North-west of Proposed Open Pit

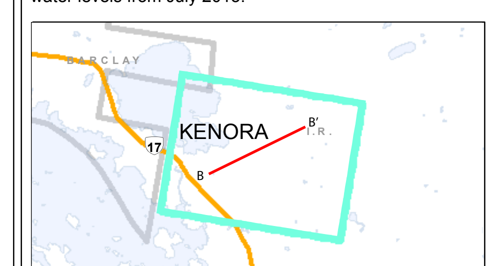
Legend

- Organics
- Sand
- Silty Sand
- Silt
- Clay
- Bedrock
- 400.0 Waterlevel (masl)

Notes: "Clay" indicates lithology of predominantly clay but also includes silty clay and layered clay and silt.

Borehole with * indicates auger refusal (assumed bedrock).

BH14 water levels from May 2014, BH 2013 (BH1A - BH8A) water levels from July 2013.



Source: Treasury Metals Borehole Logs

Conditions encountered in the field may be different from the interpreted information presented on this figure.

Project #: TB124004
Date: July 2014
Client: Ontario Infrastructure & Lands
Drawn by: DF
Checked by: MS
Revision No.: 2

0 100 200 300 400 500 Meters

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5.5.3.3 CATION EXCHANGE CAPACITY

The cation exchange capacity (CEC) is a measure of the nutrient or cation buffering capacity of the soil and is an important function of soil fertility as it is a measure of the capacity of the soil to adsorb and exchange nutrients (i.e., K^+, Ca^{2+}, Mg^{2+}, NH_4^+). The CEC of soil is primarily driven by organic matter content and secondarily by clay content. Plant available nutrients will only exist in soil pore water at minimal concentrations; therefore, it is important for the soil to have a reservoir of these nutrients to exchange when required by the plant.

The CEC of the soil ranges from 4.5 meq/100g to 82 meq/100g. Organic soils have a good degree of CEC for reclamation purposes; however, the deeper mineral horizons (i.e., the sandy loam soils) have a much lower CEC due to the low organic matter. The clay content of the LSA soils is low and therefore does not contribute significantly to CEC.

The optimal concentrations of calcium, magnesium, and sodium should have a higher proportion of Ca, followed by Mg, with smaller amounts (~5%) of Na. The exchangeable calcium (Ca) in the soil ranges from less than 2 meq/100g to greater than 103 meq/100g. Soils are considered to be Ca deficient if the exchangeable Ca value is less than 1 meq/100g. The highest Ca contents were found in the C horizons (i.e., parent rock), which is likely related to the presence of carbonates in the parent material.

The soils in the LSA have exchangeable Mg ranging from less than 2 meq/100g to 27 meq/100g. Soils are considered to be Mg deficient if the exchangeable Mg value is less than 0.2 meq/100g.

The exchangeable sodium in the soil ranges from 5.2 meq/100 g to 18 meq/100g.These values are generally low indicating that these soils are not sodic in nature, which is expected in the region, and beneficial for reclamation.

Overall, the exchangeable cations are moderate throughout the soil profile in the LSA. The Ca:Mg ratios are predominantly greater than 1, indicating a generally healthy soil.

5.5.4 Soil Chemical Baseline

The purpose of the soil chemical baseline was intended to measure the baseline metal concentrations and measure the potential for large stockpiled volumes of soil to produce metal leaching. It is not common for soils to leach large quantities of metals, and the reducing nature of gleysols and the soils of the poorly drained areas on the LSA tend to keep metals and metalloids relatively immobile in their reduced forms. Some metals are mobile in this reduced state; however, the natural state of the soils maintains a balance in metal mobility/immobility. The stockpiling and draining of the soils will allow for oxidation and may alter the potential mobility of elements into the receiving environment.

5.5.4.1 SOIL PH

The pH of the soils in the LSA ranges from 5.0 to 8.1 The more acidic pHs are typically related to the organic acid content of the soils, while the more alkaline pHs are related to the higher clay content and calcareous material present in some of the soil horizons. More acidic conditions are also found to be present in the Bf horizons (i.e., subsoil).

The pH of the soils are rarely low or high enough to present significant impacts of H^+ and OH^- ions on roots and microorganisms (McBride, 1994). Soil pH below 5.5 will generally encourage an increase in the solubility levels of aluminum and manganese to the point of being biologically toxic. A pH value greater than 7 is often associated with low solubility of micronutrient cations, and pH higher than 8.5 is associated with high soluble and exchangeable Na^+ (McBride, 1994). However, the relationship between soil pH and exchangeable nutrients (i.e., Ca^{2+}, Mg^{2+}, NH_4^+) in the LSA show no apparent trend.

5.5.4.2 SOIL METAL CONTENT (SOLID PHASE)

The soil metal concentrations in the LSA are generally low and consistent with the parent material and underlying bedrock of the area. Trace elements, such as silver, antimony, molybdenum, mercury, selenium, and thallium are present in some locations at low levels but are generally below the method of detection limits.

Elements that have a low cause for concern for phytotoxicity include Cd, Hg, and Zn based on the total metal contents and potential for metal leaching. Other metals, including Cu, Ni, Fe, Mn, and Pb are present in the solid phase at higher levels; however, the potential for these metals to leach and become bioavailable is low.

The maximum Cd concentration in the area was found to be 1.4 ug/g. Cadmium concentrations greater than 0.5 ug/g are considered to be evidence of soil influences from anthropogenic sources; however, the association of Cd with the peaty organic matter in the Om horizon indicates that the precipitation of sulphide minerals in the poorly drained soil may be contributing to the concentration of Cd. Similar mechanisms can influence the concentration of mercury in surface horizons, as mercury accumulations correlate with organic matter levels. It is unlikely that these forms of mercury will become soluble and mobile; however, the complex nature of this parameter makes predication difficult (McBride, 1994).

The maximum recorded zinc level in the LSA exceeds the worldwide mean soil concentration. However, the Zn mobility in neutral soils is generally very low (McBride, 1994) and it is unlikely that the higher Zn concentrations associated with the O horizons will become bioavailable.

5.5.4.3 SOIL METAL CONTENT IN SOIL SOLUTION

The potential for metals to leach into solution is the more distinguishing factor for the potential for metal toxicity. Plants will take up metals from the soils through the soil solution and an accumulation of metals in the root zone.

The concentrations of all metals analyzed were below the limit of detection in the soil solution. The cadmium concentration was also very low with only one measurable concentration above the detection limit, which is associated with the Om horizon. As discussed above, the precipitation of sulphide minerals in the poorly drained soil may contribute to the increased concentration of cadmium. Zinc concentrations were detected but were generally below 1 mg/L, which is well below the applicable water quality guidelines for the protection of agriculture.

5.5.5 Summary of Soils in the LSA

The potential for the soils in the LSA to be used as material in reclamation is good. Soil management would be required for stockpiling to maintain the nutrient content and the physical and chemical stability of the organic material. Mixing the organic topsoil with the finer textured subsoils would be beneficial for soil structure and provide optimal rooting conditions and water holding capacity.

The soil testing indicates the presence of some metals at higher, potentially phytotoxic levels, although the metal leaching testing indicates that the potential for the higher solid phase metal contents to leach into the soil solution and become bioavailable is low.

There were no unexpected land conditions or soil characteristics identified in the LSA. The potential for metal leaching is low and the nutrient content of the soils is moderate.

5.5.6 Sediment

Sediment quality in the LSA was assessed by analyzing the following: grain size, nutrients (total organic carbon), metals, and polycyclic aromatic hydrocarbons (PAHs). Metals are the constituents expected to have the highest potential to be introduced to or mobilized in the environment as a result of the Project. PAHs could also potentially be introduced to the environment as a result of the Project, due to the use and disposal of hydrocarbon-based fuels and solvents during Project construction and operations.

Based on the Project understanding at the time the sediment samples were collected during Klohn Crippen Berger's field program in 2011, the sediment sample locations were as follows:

- At a crossing of Norman's Road on Blackwater Creek,
- Downstream of a roadway and beaver dam downstream of the unnamed tributary of Blackwater Creek south of the Project portal,
- At the crossing of Blackwater Creek and Anderson Road,
- At the confluence of Blackwater Creek and the unnamed tributary immediately south of the Project portal, and
- At the outlet of Blackwater Creek at Wabigoon Lake.

The Blackwater Creek watershed consists mainly of glaciolacustrine silt and fine sand substrates with a large peat deposit upstream of the Norman's Road crossing on Blackwater Creek. Sediment at all locations were described as having a slight sulphur odour.

5.5.6.1 GRAIN SIZE

Sediment in the area is predominantly fine-grained. Fine-grained sediments, such as silts and clays, facilitate the transport of certain constituents since their surface area to volume ratio is greater than coarse-grained sediments (Ongley 1996).

5.5.6.2 NUTRIENTS – TOTAL ORGANIC CARBON

The total organic carbon (TOC) ranged from 2.32% to 16.4%, which all exceed the low effect limit (LEL) of 1%. The TOC at the outlet of Blackwater Creek at Wabigoon Lake also exceeded the severe effect limit (SEL) of 10%. Higher TOC levels are commonly associated with wetlands. Fine-grained sediments (i.e., silts and clays) are also known to have generally higher levels of nutrients, such as TOC, than coarse-grained sediments (Gascon et al. 2006).

5.5.6.3 METALS

Concentrations of 32 metals were determined in the sediment; however, only nine of the metals listed in the *Ontario Provincial Sediment Quality Guidelines (OPSQGB) for Metals and Nutrients* (i.e., arsenic, cadmium, chromium, copper, lead, manganese, nickel, zinc and iron) are discussed.

Levels of arsenic, cadmium, and lead did not exceed the LEL or SEL in any of the locations. The following parameters exceeded the LEL at the identified locations:

- Chromium: exceeded at all sample locations;
- Copper: exceeded downstream of the unnamed tributary of Blackwater Creek south of the Project portal, at the crossing of Blackwater Creek and Anderson Road, and at the outlet of Blackwater Creek at Wabigoon Lake;
- Iron: exceeded at all sites except at the crossing of Norman's Road on Blackwater Creek;
- Nickel: exceeded at all sites except at the crossing of Norman's Road on Blackwater Creek;
- Manganese: exceeded downstream of the unnamed tributary of Blackwater Creek south of the Project portal, at the crossing of Blackwater Creek and Anderson Road, and at the confluence of Blackwater Creek and the unnamed tributary immediately south of the Project portal; and
- Zinc: exceeded at the outlet of Blackwater Creek at Wabigoon Lake.

The only parameter determined to exceed the SEL was manganese at the confluence of Blackwater Creek and the unnamed tributary immediately south of the Project portal.

The reason for the higher levels of some metals at the outlet of Blackwater Creek at Wabigoon Lake are likely related to the wetland environment surrounding the area, the influence of backwaters from Wabigoon Lake, and its proximity to the railroad tracks.

5.5.6.4 POLYCYCLIC AROMATIC HYDROCARBONS

Sediment samples from each location were analyzed for twenty-four PAHs. Benzo[b]fluoranthene and naphthalene were detected at the outlet of Blackwater Creek at Wabigoon Lake. Benzo[k]fluoranthene was detected at all locations.

Baseline concentrations of PAHs are generally below concentrations considered protective of benthic organisms (i.e., both LEL and SEL), with the exception of benzo[k]fluoranthene, with a concentration of 0.25 mg/kg, which slightly exceeds the LEL of 0.24 mg/kg.

There is the potential for additional exceedances at the outlet of Blackwater Creek at Wabigoon Lake based on the fact that the detection limit of 0.25 mg/kg exceeded LEL values of anthracene, perylene, dibenzo[a,h] anthracene, fluorene, and andindeno[1,2,3-cd]pyrene. High organic carbon content of the sediment at the outlet of Blackwater Creek at Wabigoon Lake may have led to instrument interferences that resulted in elevated detection limits at this location.

Therefore, PAHs, were generally not detected at the site, and those which were detected are not present at levels of concern for benthic organisms. Overall, PAHs are not expected to be currently affecting the health or survival of benthic organisms at the site.

5.5.6.5 SEDIMENT SAMPLING QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

The water depth at each sampling location ranged between 20 cm and 30 cm. Surficial sediment was sampled from the surface to a depth of between 10 cm to 15 cm. Sediment samples were consistently collected from pools at each site.

A petite ponar grab was used to sample surficial sediments at all sampling locations. Three subsamples were randomly collected within a 10 m x 10 m area at each location and pooled to comprise each site's sediment sample. The petite ponar grab was manually cleaned of residual sediment after each sample and then rinsed in stream water. At each new sampling site, the petite ponar grab was rinsed again before the next sample was collected. New disposable nitrile gloves were also worn during each sediment sample collection to minimize the possibility of cross-contamination.

Samples were placed in jars provided by the laboratory, field-labelled, and kept cool (between 0°C and 8°C) before being submitted to the laboratory for analysis. None of the samples were frozen before being submitted. All sediment samples were provided to the laboratory within the recommended hold time for sediment analyses and were documented by a chain of custody.

The laboratory followed its own QA/QC procedures that are required in order to maintain its accredited status.

5.6 Hydrogeology

The hydrogeology of the project area, as described below, has been adapted from the August 2014 report entitled *Hydrogeological Pre-Feasibility/EA Support Study Goliath Project*, AMEC Environment & Infrastructure, August, 2014. This report described the various initial hydrogeological investigations undertaken at the site, primarily in 2013, with limited site work done in 2012 and 2014. Supplementary work has been proposed to further develop and refine the understanding of the local hydrogeological conditions including the installation of additional groundwater monitoring wells in the basal sand unit and the shallow bedrock, continued groundwater elevation monitoring with both manual and automated methods, and quarterly groundwater quality sample analyses.

5.6.1 HYDROGEOLOGICAL SETTING

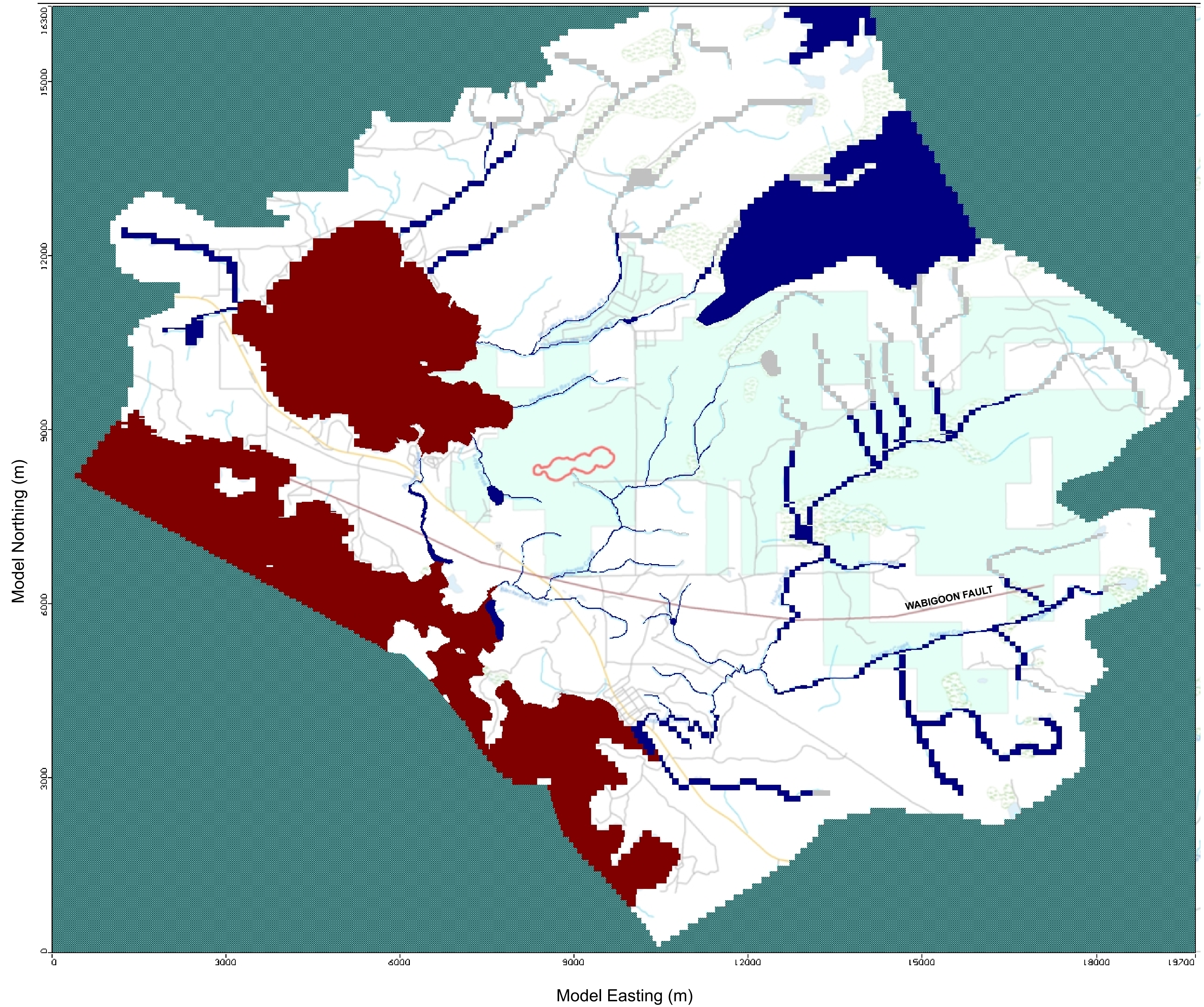
The proposed mine site is located in the west-central portion of a hydrological basin containing low to moderate relief topographic features, including low lying marsh type lands and exposed bedrock ridges. This basin has been defined by inferred groundwater divides associated with topographic watersheds, and is bordered by upland areas to the east, in the vicinity of Hartman Lake, and to the north, part of which is occupied by a significant wetland area; the Thunder Lake Tributary drainage basin to the west; and Wabigoon Lake to the south. This basin contains the Thunder Lake drainage area to the west, Blackwater Creek drainage area through the central region, and the Hughes and Nugget Creek drainage areas in the east. Blackwater Creek and Hughes Creek both drain southerly into Wabigoon Lake. The extent of this area is shown in Figure 5.6.1.

The regional hydrogeology of this study area reportedly consists of relatively shallow (less than 10 m), localized overburden aquifers, as well as fractured metamorphic bedrock aquifer conditions.

HYDROGEOLOGICAL PRE-FEASIBILITY / EA SUPPORT STUDY
Goliath Project

Figure 5.6.1

Model Domain and Boundary Conditions



Legend

- Constant Head Nodes
- River Nodes
- Drain Nodes

Conditions encountered in the field may be different from the interpreted information presented on this figure.

Project #: TB124004
Date: June 2014
Client: Ontario Infrastructure & Lands

Drawn by: DF
Checked by: MS
Revision No.: 1

UTM NAD 83
Zone 15N

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505 Woodward Ave.
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5.6.2 OVERBURDEN AQUIFER CONDITIONS

As described in the 2014 study report, the hydrogeological investigations conducted to date for this area were based on the following infrastructure:

- Nine monitoring wells/groundwater quality wells were constructed in the overburden and bedrock contact in May 2013.
- 20 geotechnical boreholes were drilled in March/April 2014 with four of these completed with shallow stand pipes for groundwater monitoring.
- Groundwater elevations were manually recorded in the water quality wells on near monthly intervals between June 2013 and January 2014, and in the standpipes on one occasion in May 2014.
- Hydraulic conductivity testing of the overburden soils was performed on six of the water quality wells in February 2014.

Borehole logs and well construction details for these monitoring wells are provided in the AMEC report.

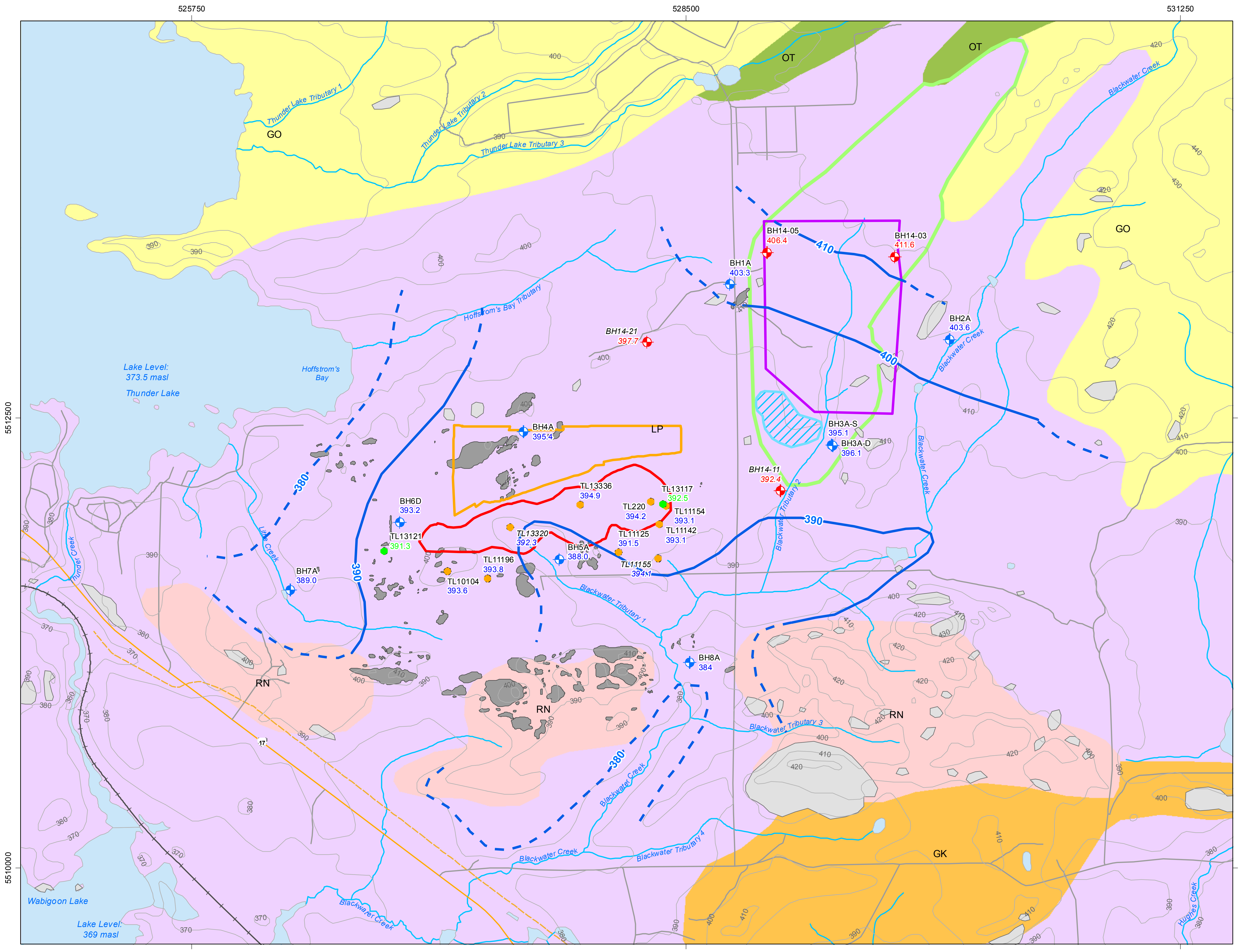
5.6.2.1 OVERBURDEN GEOLOGY

Overburden throughout the area consists of fine grained lacustrine deposits and coarser grained glaciofluvial outwash deposits, distributed over shallow, irregular bedrock. This overburden has an average thickness of around 7.5 m, but does vary from non-existent where bedrock outcrops at surface in various locations in the vicinity of the project site, as well as to the north and south, to depths of around 15 m in limited areas, with a maximum depth of 40 m below grade. The distribution of this surficial geology is shown in Figure 5.6.2. For additional details relating to the surficial geology, including cross section through the study area, please refer to Section 5.5.

For the most part, the lacustrine deposits of clay, silt and sand-clay or silt-sand, have a low hydraulic conductivity (10^{-8} m/s), and are expected to act as an aquitard. These deposits are generally not expected to provide any significant base flow to the local creeks or streams, or to be suitable for development as a groundwater resource through use of private wells.

Through portions of this area (exploratory drilling suggest 40% of borehole locations), there is a basal sand of variable but generally limited thickness (3 to 4 m maximum), underlying the lacustrine clay-rich unit. Hydraulic conductivities of the basal sand unit are in the order of 10^{-6} m/s, so there is the potential for development of this water bearing zone as a localized groundwater resource. These deposits generally infill the low areas of the variable bedrock surface.

Across the northeastern portion of the study area, the overburden geology is dominated by sand and sand and gravel glacial deposits, associated with the Hartman Moraine, a northwest to southeast trending feature running parallel to the shoreline of Thunder Lake. These outwash deposits are expected to provide base flow to various tributaries draining into Thunder Lake, and are suitable for development as a groundwater resource. A second area of deeper sand and gravel deposits is present in the southeast portion of the study area in the form of a Kame deposit.



HYDROGEOLOGICAL PRE-FEASIBILITY / EA SUPPORT STUDY

Goliath Project

Figure 5.6.2

Groundwater Level Contours Representing Groundwater Conditions at the Overburden/Bedrock Contact

Legend

- 2013 Monitoring Well (July 2013 water level labelled in blue)
- 2014 Geotechnical Hole (May 2014 water level labelled in red)
- 2013 Shallow Vibrating Wire Pezometer (July 2013 water level labelled in green)
- Exploration Borehole (July 2013 water level labelled in blue)
- Water Level Contour (masl)
- Inferred Water Level Contour (masl)
- Proposed Open Pit
- Waste Rock Storage Area
- Tailings Management Area
- Tailings Management Pond
- Elevation Contour (masl, 10 m intervals)

Surficial Geology

- Sand - Clay / Silt - Sand Boundary

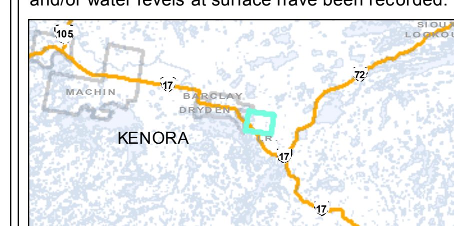
Landform

- GK: Kame
- GO: Glaciofluvial Outwash
- LP: Glaciolacustrine Plain
- OT: Organics
- RN: Bedrock Knob

Bedrock Outcrop Mapping

- Beakhouse and Pigeon, 2003
- Treasury Metals

Note: holes in italics are where flowing conditions and/or water levels at surface have been recorded.



Source: National Topographic Database, 052F09, 052F10, 052F15, and 052F16, 1:10 000 nominal scale.
Source: Ontario Geological Survey, Ministry of Northern Development and Mines, and Northeast Science and Information Section, Ministry of Natural Resources 2005. Digital Northern Ontario Engineering Geology Terrain Study (NOEGTS); Ontario Geological Survey, Miscellaneous Release--Data 160. 1:100,000 scale

Conditions encountered in the field may be different from the interpreted information presented on this figure.

Project #: TB124004	Drawn by: DF
Date: July, 2014	Checked by: MS
Client: Ontario Infrastructure & Lands	Revision No.: 2

UTM NAD 83
Zone 15N
1:20,000

Meters
0 100 200 300 400 500

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5.6.2.2 AQUIFER CHARACTERISTICS

In February 2014, rising head slug tests were conducted by Treasury on six of the groundwater quality wells installed in the overburden and overburden/ bedrock interface. Hydraulic conductivities ranged from 4.6E-07 m/s to 1.3E-06 m/s with a geometric mean of 9.2E-0.7 m/s and arithmetic mean of 9.8E-07 m/s. In most of the wells in which rising head slug tests were conducted, the screened portion of the well extended through a mixture of clay and sand immediately above the contact with the bedrock surface (location of auger refusal) or the screen straddled the basal sand and bedrock contact surface. Details relating to the well construction, stratigraphy and conductivity values are summarized below. The resulting hydraulic conductivity values are generally representative of silty sand conditions.

Table 5.6.1 Overburden Hydraulic Conductivity Testing Summary

Well ID	Screened Depth (m below grade)	Screened Stratigraphy	Depth to Water (m below grade)	Hydraulic Conductivity (m/s)
1A	3.1 – 4.6	Basal sand and bedrock	1.06	1.3×10^{-6}
3AS	3.1 – 6.1	Sand	1.66	7.1×10^{-7}
3AD	10.9 – 12.9	Clay and basal sand	1.20	4.6×10^{-7}
5A	6.6 – 9.6	Clay	2.0	1.0×10^{-6}
6D	3.0 – 6.0	Clay and basal sand	1.91	1.1×10^{-6}
7A	4.0 – 7.0	Clay and Silt & sand	1.43	1.2×10^{-6}

5.6.2.3 GROUNDWATER FLOW

During the limited period of groundwater elevation monitoring (June 2013 to January 2014), the depth to groundwater ranged from 0.14 m to 1.9 m below grade. Seasonal fluctuations of the water table were noted as a slight rise in the fall and then a decrease in the winter, with the range of fluctuation in the individual wells being 0.5 m to 1.7 m. The groundwater elevations recorded are summarized in Table 5.6.2.

Based on limited monitoring of various wells (water quality monitoring and geotechnical boreholes) installed throughout the area, groundwater flow in the basal sand feature appears to be southwesterly, from the elevated wetland to the north, then splitting off in the general vicinity of the project site to the south towards Wabigoon Lake and to the west towards Thunder Lake, suggesting that this flow is largely controlled by local topography. The groundwater contours and apparent flow direction is shown in Figure 5.6.3 of the Hydrogeological Pre-Feasibility/EA Support Study Goliath Project, AMEC Environment & Infrastructure, August, 2014, report.

Based on this flow system, the recharge area for the basal sand aquifer is expected to be in higher elevation, outwash areas to the north, and the Kame deposit to the southeast, or along the edges of the localized bedrock outcrops.

Monitoring of stream flows in Blackwater and Little Creek during the regional dry/low precipitation year of 2011 found that these creeks had no flow or not enough flow for accurate measurement beyond the spring freshet. This was considered to be an indication that there was no significant groundwater discharge to these creeks, as otherwise some baseflow could be expected during very dry conditions. In 2012 and 2013, precipitation was again below the 30 year average, but near continuous flow was noted in both of these creeks, which was then assumed to account for part of the recharge to the overburden aquifer system.

Table 5.6.2 2013/2014 Groundwater Monitoring Data

2013/2014 Groundwater Quality Monitoring Wells								Groundwater Levels[2][3]														
	Easting [1]	Northing [1]	Screened Units			Surface Elevation	Stick Up						10-11/06/13	9/7/13	14/8/13	16/10/13	27/11/13	28/11/13	19/12/13	30/1/14	3/2/14	1/5/14
						masl	m						masl	masl	masl	masl	masl	masl	masl	masl	masl	masl
BH1A	528705	5513251	Basal Sand/Bedrock			404.20	0.92						404.06	403.33	403.27	403.89			403.61		403.14	
BH2A	529978	5512931	Clay/Basal Sand/Bedrock			403.91	0.99						403.79	403.57	403.00		403.77		403.57			
BH3A - S	529283	5512359	Sand (top Sand-Clay/Silt-Sand)			396.77	0.78						395.51	395.12	395.15	395.31		395.01	395.12	395.11		
BH3A - D	529281	5512360	Clay/Sand (bottom Sand-Clay/Silt-Sand)			397.00	0.86						396.26	396.11	395.95	396.23		395.73	395.09	395.80		
BH4A	527699	5512263	Clay/Bedrock			396.38	1.02						396.22	395.42	395.03	395.94		396.27	395.99	394.53		
BH5A	527800	5511717	Clay			389.07	0.87						388.31	387.98	387.87				387.97	387.07		
BH6D	526905	5511901	Clay/Basal Sand			394.25	0.88						393.93	393.24	393.14	393.20		392.95	392.81	392.34		
BH7A	526307	5511546	Clay/Basal Sand			390.28	0.64						389.64	388.99	388.73	389.02		388.38	389.01	388.85		
BH8A	528560	5511072	Basal Sand/Bedrock			388.63	0.85						384.73	384.03	383.91	383.94	383.63		383.33		382.81	
2014 Geotechnical Holes Shallow Standpipes																						
BH14-03	529660	5513406	Silty Sand (top Sand-Clay/Silt-Sand)			411.87	0.17															411.57
BH14-05	528946	5513426	Silty Sand (top Sand-Clay/Silt-Sand)			406.64	0.31															406.41
BH14-11	529025	5512091	Clay			392.35																*392.35*
BH14-21	528280	5512927	Clay			397.65																*397.65*
Exploration Boreholes (all in bedrock)																						
	Easting [1]	Northing [1]	BH Length m	BH Dip Degrees[4]	Azimuth Degrees[5]			21/3/12	25/3/13	12/4/13	6/5/13	27/5/13	17/6/13	5/7/13								
								masl	masl	masl	masl	masl	masl	masl								
TL10,104	527173	5511648	321	-70	360	396.00	0.2		395.63	395.65	395.72	394.98	394.74	393.62								
TL11,125	528124	5511753	411	-64	309	394.74	0.5		390.75	390.81	392.41	392.16	392.02	391.52								
TL11,142	528352	5511909	447	-69	360	394.87	1.0	392.93	392.26	392.30	393.52	393.38	393.38	393.06								
TL11,154	528389	5512010	249	-64	360	396.32	1.1	394.62	392.87	392.96	394.52	394.48	394.49	393.11								
TL11,155	528342	5511720	585	-67	311	393.00	1.1		*394.13*	393.76	*394.13*	*394.13*	*394.13*	*394.13*								
TL11,196	527396	5511608	429	-65	350	395.89	0.2		391.86	392.10	394.37	394.71	394.58	393.83								
TL13,320	527521	5511892	123	-44	360	390.90	1.4		391.87	391.78	*392.27*	*392.27*	*392.27*	*392.27*								
TL13,336	527910	5512018	105	-44	360	396.10	1.1		393.54	393.70		395.51	395.53	394.86								
TL220	528302	5512035	66	-45	360	396.09	0.8		393.77	393.59	394.63	394.71	394.58	394.21								

Notes:

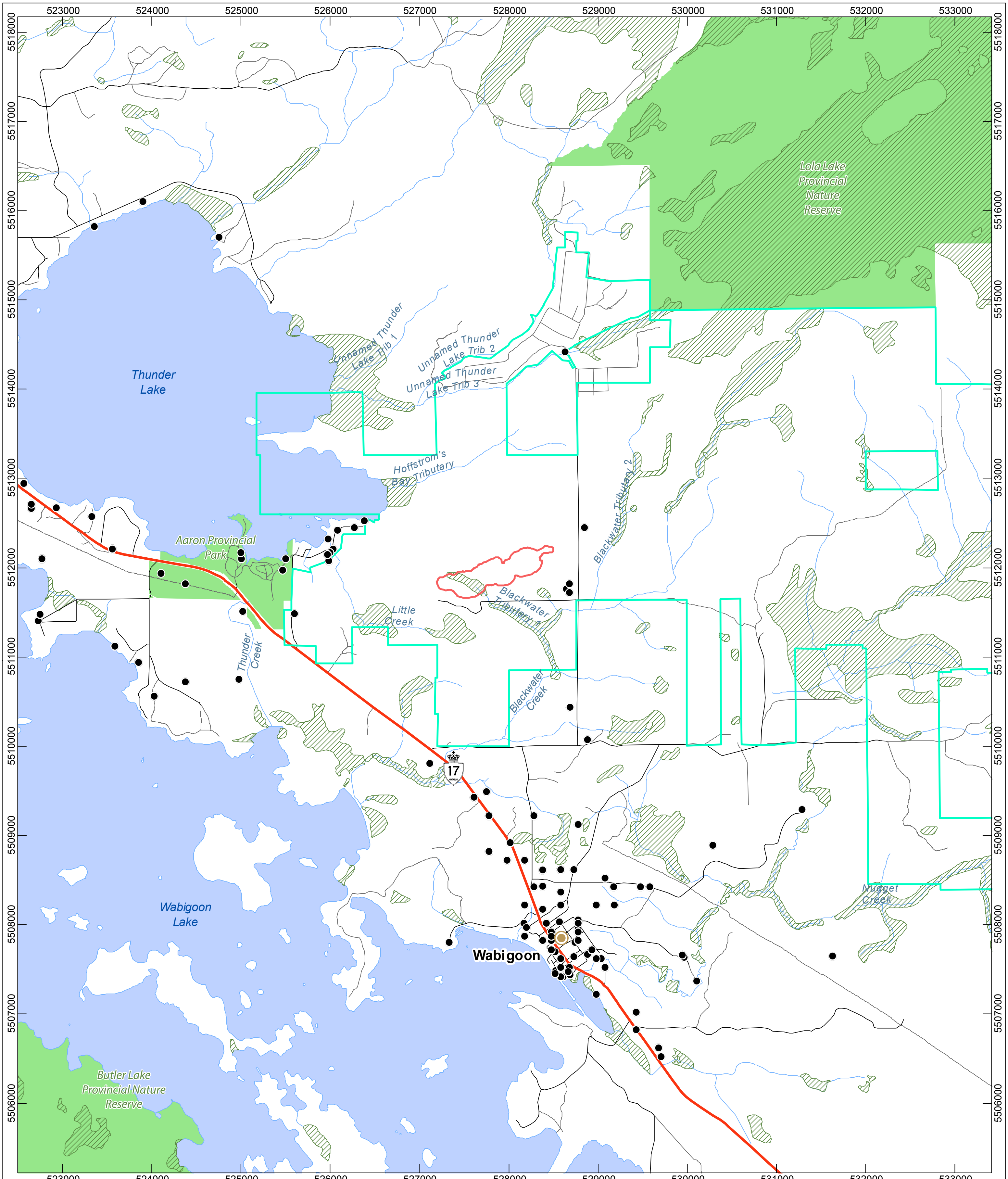
1.Coordinates in NAD 83, UTM Zone 15N;

2.Groundwater levels shaded in grey used for groundwater model calibration;

3.Groundwater levels italicized when water is at surface/hole is flowing;

4.Measured from ground surface; and

5.Measured from north.



GOLIATH GOLD PROJECT
DRYDEN, ONTARIO, CANADA

PRIVATE WATER WELLS AND SURFACE WATER FEATURES

FIGURE: 5.6.3 | REV.00

SCALE: 55 000

TREASURY METALS INC.

DESIGN: AT 06 FEB. 2014
GIS: AT 10 OCT. 2014
CHECK: AT 10 OCT. 2014

Populated Area
Private MOE Water Well
Proposed Open Pit Shell
Property Boundary
Wetland
Arterial Road
Highway
Local Road
Recreational Road
Waterbody
Provincial Park
Watercourse

N S E W

0 500 1,000 1,500
Meters

REFERENCE
Projection: NAD83 UTM Zone 15N
Base Data: OBM
Wells Provided by AMEC

5.6.2.4 GROUNDWATER QUALITY

Groundwater quality was monitored through sampling conducted on six occasions during 2013 from the groundwater quality wells which were screened within the basal sand and bedrock contact. These results indicated that the groundwater was typically calcium-magnesium-bicarbonate type water. Dissolved metal concentrations were found to exceed the Ontario PWQO for the Protection of Aquatic Life at one or more of the eight monitoring wells during one or more of the sampling events as follows: Aluminum (BH3A, BH6D, and BH7A), Arsenic (BH3A) Chromium (BH3A, BH6D), Cobalt (BH1A, BH2A, BH3A, BH4A, BH6D), Copper (BH3A, BH6D, BH8A), Iron (BH2A, BH3A, BH4A, BH5A, BH6D, BH7A), Tungsten (BH8A), Vanadium (BH3A, BH6D) and Zinc (BH3A, BH6D).

A summary of the groundwater quality is provided in Table 5.6.3.

Table 5.6.3 2013 Groundwater Quality

			Parameters	pH	Conductivity	Total Ammonia	Dissolved Chloride	Nitrate	Nitrite	Nitrate + Nitrite	Sulphate	Alkalinity	Acidity	Total Cyanide	Hardness
			Units		µS/cm	As N mg/L	mg/L	As N mg/L	As N mg/L	As N mg/L	mg/L	mg/L as $CaCO_3$	mg/L as $CaCO_3$	mg/L	mg/L as $CaCO_3$
			ODWS	6.5-8.5			250	10[d]	1[d]	1[d]		30-500		0.2	
			PWQO	6.5-8.5										0.005	
	UTM 15		**CEQG**	6.5-9											
Station Name	Easting	Northing	Date												
BH1A	528742	5513247	11-Jun-13	6.88	319	< 0.020	48	0.33	< 0.020	0.33	18.3	63	24.8	< 0.0020	124
BH1A			10-Jul-13	6.84	339	< 0.020	49.6	0.304	< 0.020	0.304	21.5	73.1	15	< 0.0020	122
BH1A			14-Aug-13	7.14	321	< 0.020	48	0.22	< 0.020	0.22	20.1	61.2	11	< 0.0020	121
BH1A			17-Oct-13	6.79	321	< 0.020	46.6	0.153	< 0.020	0.153	21.7	66.9	19	< 0.0020	105
BH1A			28-Nov-13	6.79	306	< 0.020	46.5	0.104	< 0.020	0.104	18.8	60	15	< 0.0020	117
BH1A			19-Dec-13	6.8	316	< 0.020	46.2	0.066	< 0.050	0.066	14.7	65	12	< 0.0020	114
BH2A	529967	5512940	11-Jun-13	7.38	475	0.288	26.2	0.065	< 0.020	0.065	51.4	160	21.2	< 0.0020	231
BH2A			10-Jul-13	6.83	475	0.105	34.5	< 0.030	< 0.020	< 0.030	57.2	138	18.0	< 0.0020	219
BH2A			14-Aug-13	7.14	451	0.327	36.5	< 0.030	< 0.020	< 0.030	58	114	9	< 0.0020	203
BH2A			17-Oct-13	6.97	487	0.0999	45.9	< 0.030	< 0.020	< 0.030	75.1	98.9	22	< 0.0020	199
BH2A			28-Nov-13	6.84	494	0.195	51.7	< 0.030	< 0.020	< 0.030	86.6	94	18	< 0.0020	222
BH2A			19-Dec-13	6.95	555	0.106	59.6	< 0.050	< 0.050	< 0.050	101	77	8	< 0.0020	224
BH3 A-D	529308	5512354	11-Jun-13	8.11	356	0.237	6.33	< 0.030	< 0.020	< 0.030	30.2	*1270*	3.4	< 0.0020	314
BH3 A-D			10-Jul-13	7.59	379	0.209	0.33	0.128	< 0.020	0.128	4.76	239	10	< 0.0020	203
BH3 A-D			14-Aug-13	8.19	359	0.181	6.87	< 0.030	< 0.020	< 0.030	29.6	156	3	< 0.0020	172
BH3 A-D			17-Oct-13	8	353	0.309	6.76	< 0.030	< 0.020	< 0.030	29.8	160	4	< 0.0020	154
BH3 A-D			28-Nov-13	8.02	334	0.349	6.33	< 0.030	< 0.020	< 0.030	27.7	158	6.0	< 0.0020	178
BH3 A-D			19-Dec-13	8	376	0.042	6.8	< 0.050	< 0.050	< 0.050	27.7	160	2	< 0.0020	177
BH3 A-S	529308	5512354	11-Jun-13	7.8	323	0.051	0.37	0.151	< 0.020	0.151	3.8	174	11.2	< 0.0020	169
BH3 A-S			10-Jul-13	8.03	371	0.257	7.15	< 0.030	< 0.020	< 0.030	30.4	309	3	< 0.0020	186
BH3 A-S			14-Aug-13	7.81	294	0.024	0.49	0.165	< 0.020	0.165	3.34	152	3.0	< 0.0020	156
BH3 A-S			17-Oct-13	7.65	371	0.111	0.24	0.14	< 0.020	0.14	4.14	190	10.0	< 0.0020	175
BH3 A-S			28-Nov-13	7.45	341	0.084	1.11	0.185	< 0.020	0.185	4.07	217	6	< 0.0020	200
BH3 A-S			19-Dec-13	7.7	500	< 0.020	< 2 .0	< 0.105	< 0.050	< 0.105	4.7	251	7.0	< 0.0020	220
BH4A	527596	5512426	11-Jun-13	7.48	376	0.030	0.56	0.177	< 0.020	0.177	35.3	161	5	< 0.0020	159
BH4A			10-Jul-13	7.22	347	0.262	0.91	0.031	< 0.020	0.031	35	155	15	< 0.0020	168
BH4A			14-Aug-13	7.63	343	0.049	0.3	< 0.030	< 0.020	< 0.030	33.9	146	15	< 0.0020	170
BH4A			17-Oct-13	7.54	326	0.096	0.27	< 0.030	< 0.020	< 0.030	28	149	10	< 0.0020	140
BH4A			28-Nov-13	7.21	313	0.058	0.33	< 0.030	< 0.020	< 0.030	34.9	141	15	< 0.0020	143
BH4A			19-Dec-13	7.39	359	0.027	< 2 .0	< 0.050	< 0.050	< 0.050	34.2	152	9	< 0.0020	155
BH5A	527794	5511715	11-Jun-13	7.71	486	0.346	0.91	< 0.030	< 0.020	< 0.030	17	430	15.2	< 0.0020	255
BH5A			10-Jul-13	7.70	517	0.362	3.54	< 0.030	< 0.020	< 0.030	18.1	*593*	12	< 0.0020	269
BH5A			14-Aug-13	7.82	503	0.322	0.76	< 0.030	< 0.020	< 0.030	17.5	264	11	< 0.0020	258
BH5A			17-Oct-13	7.6	506	0.42	0.52	< 0.030	< 0.020	< 0.030	19.4	276	12	< 0.0020	252
BH5A			28-Nov-13	7.57	499	0.394	0.52	< 0.030	< 0.020	< 0.030	19.9	274	10	< 0.0020	264
BH5A			19-Dec-13	7.67	538	0.326	< 2 .0	< 0.050	< 0.050	< 0.050	19.6	286	9	< 0.0020	267

Table 5.6.3 2013 Groundwater Quality

			Parameters	pH	Conductivity	Total Ammonia	Dissolved Chloride	Nitrate	Nitrite	Nitrate + Nitrite	Sulphate	Alkalinity	Acidity	Total Cyanide	Hardness
			Units		µS/cm	As N mg/L	mg/L	As N mg/L	As N mg/L	As N mg/L	mg/L	mg/L as $CaCO_3$	mg/L as $CaCO_3$	mg/L	mg/L as $CaCO_3$
			ODWS	6.5-8.5			250	10[d]	1[d]	1[d]		30-500		0.2	
			PWQO	6.5-8.5										0.005	
	UTM 15		**CEQG**	6.5-9											
Station Name	Easting	Northing	Date												
BH6 D	526907	5511924	11-Jun-13	7.77	393	0.119	0.94	0.619	< 0.020	0.619	24.2	*2160*	25	< 0.0020	301
BH6 D			10-Jul-13	7.77	254	0.197	0.69	0.087	< 0.020	0.087	4.68	313	6	< 0.0020	116
BH6 D			14-Aug-13	7.98	331	0.246	0.51	0.114	< 0.020	0.114	5.24	175	6.0	< 0.0020	133
BH6 D			17-Oct-13	7.90	225	0.115	0.41	0.1	< 0.020	0.1	4.58	99.3	15.0	< 0.0020	89.8
BH6 D			28-Nov-13	7.25	228	0.098	0.53	0.205	< 0.020	0.205	6.99	100	14.0	< 0.0020	201
BH6 D			19-Dec-13	7.43	255	0.17	< 2.0	0.244	< 0.050	0.244	7.8	158	5.0	< 0.0020	109
BH7A	526298	5511547	11-Jun-13	8.14	540	0.255	0.29	0.037	< 0.020	0.037	8.57	*671*	11.8	< 0.0020	304
BH7A			10-Jul-13	7.77	457	0.203	0.64	< 0.030	< 0.020	< 0.030	12.2	*1810*	11	< 0.0020	245
BH7A			14-Aug-13	7.98	434	0.203	0.44	0.099	< 0.020	0.099	11.4	228	7.0	< 0.0020	175
BH7A			17-Oct-13	7.89	393	0.317	0.41	0.056	< 0.020	0.056	13.5	237	7.0	< 0.0020	222
BH7A			28-Nov-13	7.77	311	0.266	0.47	< 0.030	< 0.020	< 0.030	13.6	167	6.0	< 0.0020	182
BH7A			19-Dec-13	7.75	338	0.314	< 2 .0	< 0.050	< 0.050	< 0.050	14.1	169	4.0	< 0.0020	161
BH8A	528520	5511143	11-Jun-13	7.76	561	0.054	< 0.10	0.061	< 0.020	0.061	1.01	335	19.0	< 0.0020	318
BH8A			10-Jul-13	7.42	593	0.026	0.18	0.049	< 0.020	0.049	1.76	324	22.0	< 0.0020	327
BH8A			14-Aug-13	7.73	572	0.026	0.17	0.045	< 0.020	0.045	0.94	313	24	< 0.0020	334
BH8A			17-Oct-13	7.39	568	0.083	< 0.10	0.041	< 0.020	0.041	0.83	340	47	< 0.0020	301
BH8A			28-Nov-13	7.27	535	0.022	0.15	0.033	< 0.020	0.033	0.81	329	23	< 0.0020	313
BH8A			19-Dec-13	7.36	603	< 0.020	< 2.0	< 0.050	< 0.050	< 0.050	< 2.0	354	16	< 0.0020	302

Notes: PWQO: Provincial Water Quality Objective (provided for information purposes only) — **bold** Concentration is above the PWQO

CEQG: Canadian Environmental Quality Guidelines (Protection of Aquatic Freshwater Life) — [box] Concentration is above the CEQG

ODWS: Ontario Drinking Water Standard as per O.Reg 169/03 — *italic* Concentration is above the ODWS

^^ PWQO and/or CEQG is an interim value

a Aesthetic Objective

b Aesthetic Objective for sodium in drinking water is 200 mg/L

c When sulphate levels exceed 500 mg/L, water may have a laxative effect on some people

d Where both nitrate and nitrite are present, the total of the two should not exceed 10 mg/L (as nitrogen)

e Applies to water at point of consumption. Since lead is a component in some plumbing systems, first flush water may contain higher concentrations of lead than water that has been flushed for five minutes

f 0.005 mg/L if pH < 6.5 or 0.1 mg/L if pH > 6.5

g For hardness of 350 mg/L CaCO3

i For hardness > 75 mg/L CaCO3

o Operational Guideline

5.6.3 BEDROCK AQUIFER CONDITIONS

As described in the 2014 AMEC study report, the hydrogeological investigations conducted to date for the bedrock system were based on the following infrastructure.

- Records for available geological exploration boreholes were initially reviewed and six of these were incorporated in to the hydrogeological assessment program.
- Three additional boreholes were drilled into the bedrock in February 2013 to assess hydrogeological conditions.
- All nine of these hydrogeological purposes bedrock boreholes are located in the immediate vicinity of the proposed mine development site.
- In February 2014, multi-level hydraulic conductivity testing was conducted on three existing geological exploration boreholes and in the three bedrock boreholes drilled for hydrogeological assessment.
- The three drilled boreholes were equipped with vibrating wire piezometers to allow for continuous water level fluctuation monitoring through 2013.

5.6.3.1 GEOLOGY

Bedrock throughout the area consists of metasedimentary rock, with mafic to intermediate metavolcanic rock to the north and south. Groundwater availability and flow through these units is dependent on fracture frequency and fracture interconnectivity which allows for groundwater storage movement from the recharge areas. The areas of higher conductivity in the metasedimentary unit are most commonly in the upper portion, which has been subjected to historical weathering, and in a central unit of more highly altered rock (e.g. schists) which shows an east –west structural trend. Please refer to Section 5.4 for additional details relating to the bedrock geology.

For the most part, the rocks outside of the surficial portion and the central unit are fairly competent with fracture frequency decreasing with depth, as indicated by Rock Quality Designation (RQD) recovery values of around 90%, and therefore are unlikely to produce any significant amount of groundwater. The central unit, although more conductive as a result of the higher fracturing rate, still shows a limited potential for groundwater flow (RQD value of 83%), typical of Canadian Shield bedrock environments.

5.6.3.2 AQUIFER CHARACTERISTICS

Hydraulic conductivity testing was conducted in three existing exploration boreholes and in three boreholes drilled in part for hydrogeological purposes, to estimate the hydraulic conductivity in the bedrock along the east-west structural trend. This conductivity testing involved the use of packers to isolate a limited portion of the borehole, either starting at the base of existing exploration boreholes and moving upward to increase the length of exposed fractured zone, or moving downward as drilling progressed in new boreholes. The groundwater within the isolated zone was pumped out and a rising head slug test performed.

A total of six boreholes were tested in this way, with each borehole being tested over between 5 to 9 intervals. The estimated bedrock hydraulic conductivities that resulted from the packer testing in the existing exploration boreholes ranged from 2E-06 m/s near the surface due to weathering and fracturing of the bedrock, down to 1E-08 m/s, decreasing with depth. The exception was within the central mineralized zone where hydraulic conductivity values were in the order of 1E-07 m/s. This coincided with anecdotal information from the construction of the portal which indicated that groundwater flow was associated with the mineralized zones.

A summary of the packer test results averaged over the length of the individual boreholes is provided below:

Table 5.6.4 Hydraulic Conductivity Summary of Bedrock Units

Well ID	Tested Zone (m below grade)	Geological Unit Penetration Sequence	Average Depth to Water (m below grade)	Average Hydraulic Conductivity (m/s)
TL13321	18 – 254	Hanging-wall – Central – Foot-wall	5.0	1.3×10^{-7}
TL13317	17 – 210	Hanging-wall – Central	3.4	6.5×10^{-7}
TL13315	15 – 225	Foot-wall – Central	1.7	3.9×10^{-7}
TL0855	27 – 237	Hanging-wall – Central	3.0	2.2×10^{-8}
TL10111	27 – 168	Hanging-wall – Central	3.2	4.8×10^{-7}
TL11195	45 – 224	Hanging-wall – Central (intercepts NW Fault at 130m downhole)	0.6	1.8×10^{-8}

The locations of the boreholes in which packer testing was conducted is shown in Figure 5.6.2 displays. The Table in Appendix D of the *Hydrogeological Pre-Feasibility/EA Support Study Goliath Project, AMEC Environment & Infrastructure,* August, 2014 provides additional details relating to the individual rising head tests performed.

5.6.3.3 GROUNDWATER FLOW

Between March and July 2013, groundwater levels were measured on seven occasions in the nine bedrock boreholes identified for hydrogeological purposes. During this period, groundwater was found to show flowing well conditions in two boreholes, with water heights of 0.8 m to over 1.4 m above grade (the height of the casing). Groundwater levels in the remaining seven wells ranged from 0.3 m to 4.0 m below grade, and generally showed an increase in the spring (April to June) and then either stabilized or decreased, with a total range of fluctuation of 0.4 m to 2.9 m. A summary of groundwater monitoring results is provided in Table 5.6.2. Review of the vibrating wire piezometer levels reportedly indicated a groundwater elevation rise following the spring freshet, followed by a gradual decline through to the winter of 2013/2014. Total water level fluctuations in these wells was reported to be between 1.0 m and 1.5 m.

Based on limited monitoring of these bedrock boreholes situated in the immediate vicinity of the proposed mine site, the groundwater flow appears to be suggest an outward radial flow to the east and southwest. These elevations also suggest an upward vertical flow gradient within the bedrock, and from the bedrock into the overburden units, which may then result in some groundwater discharge to the adjacent Blackwater Creek.

During excavation of the exploration ramp at the proposed mine site, few seeps were encountered, most of which contained a limited volume of water which drained out in 24 to 48 hours. Within the mineralized zone, increased groundwater inflow was noted; however this was readily controlled through pumping to small (20 m^2) on-site settling ponds.

5.6.3.4 GROUNDWATER QUALITY

Groundwater samples have not been collected from any of the bedrock exploration wells for laboratory analysis so no information is available relating to water quality in the bedrock unit at the site.

5.6.4 GROUNDWATER DEVELOPMENT

Groundwater development has occurred in the western and southern portions of the study area, primarily for private residential use, with approximately 140 well records identified for the area within 5 km of the proposed mine site. This development is concentrated to the south, in the vicinity of the community of Wabigoon, and to the east, along the shoreline of Thunder Lake. There are also a few wells are located in the central portions of the study area, as shown in Figure 5.6.3. These wells are completed in each of the potential water bearing zones, with the majority of the well development (70%) being in the shallow bedrock, to depths of up to 25 m below grade, and the remaining wells being completed in the overburden units with depths ranging from 7 m to 15 m below grade. Most of these overburden wells have been completed in the outwash sand and gravel deposits in the area around Thunder Lake.

5.6.5 CONCEPTUAL HYDROGEOLOGICAL MODEL

Based on data collected during 2012 to 2014, it appears that there is limited groundwater flow that provides a minimal contribution to creeks in the vicinity of the project site and across much of the project area.

There have been five hydro stratigraphic units identified during the investigation that contribute to the surface water interaction in the watershed and the shallow groundwater flow patterns in the project area. These five units are described in the following:

1. A clay unit consisting of fine grained glaciolacustrine deposits of dominantly clay composition (clay, silty clay, layered clay and silt) that is located around the project site and creating the main unit of the southern project area. This clay unit acts as an aquitard that provides little to no flow to creeks in the area.
2. A Basal sand unit which is a relatively thin discontinuous sand layer beneath the clay unit approximately 3 m to 4 m thick where present. This unit acts as a minor aquifer with a hydraulic conductivity of approximately 1E-06 m/s that provides limited groundwater flow.
3. Bedrock knolls where bedrock outcrops at the surface or has a very thin sand cover and therefore contains no overburden groundwater.
4. A sand-clay/silt-sand unit consisting mainly of silty sand overlying a mainly continuous silty clay above the basal sand unit. This unit is mainly found in the northwestern portion of the Blackwater Creek Watershed (near the top of Blackwater Tributary #2). This silty sand does provide some groundwater flow to Blackwater Creek and likely has a hydraulic conductivity similar to the basal sand.
5. A sand and gravel unit consisting of coarse glacial deposits located on the northern and northeastern edge of the project area. This unit provides the most groundwater flow to the unnamed tributaries leading to Thunder Lake.

The data collected from 2012 to 2014, appears to indicate that most of the groundwater flow with the project site follows the topography with greatest flow rates present along the contact between the upper weathered/fractured bedrock and basal san units with groundwater flow rates being much lower in the deeper bedrock. There were four hydro stratigraphic units identified during the investigation in the bedrock:

1. The shallow bedrock unit occurring within the initial 10 m from the bedrock surface where a bulk hydraulic conductivity of 1E-06 m/s was recorded due to the near surface fractures and weathering.
2. The intermediate bedrock unit present from approximately 10 mbg to around 400 mbg where a range of bulk hydraulic conductivity of 1E-07 m/s to 1E-08 m/s was recorded.
3. The deep bedrock unit present below 400 mbg where there are very few fractures and low hydraulic conductivities of approximately 1E-09 m/s.

4. The deformation zone of the central unit – this unit is a steeply inclined zone occurring in all of the shallow, intermediate and deep bedrock units and likely has hydraulic conductivities up to an order of magnitude higher in the units that are not affected by near surface weather - the intermediate and deep bedrock.

5.7 Surface Hydrology

Two environmental baseline studies that include hydrology baseline studies have been conducted for the Project (Appendix G and Appendix N). Appendix G includes the complete KCB 2012 report and Appendix N includes the complete DST 2014 report. Detailed methodologies used to assess the hydrology of the project area can be found in each of the previous two hydrology baseline studies conducted. In addition to the field studies, a hydrologic modeling study was conducted for watercourses in the LSA (Appendix O). The purpose of the study was fill information gaps present in the baseline studies.

The project is located near two lakes in which the watersheds affected by the project flow into. Wabigoon Lake is located to the south of the properties affected by the project and Thunder Lake is located to the west of the properties affected by the Project (Figure 5.7.1).

Hydrological baseline studies conducted included hydrological monitoring measurements of stream flow at up to eight locations (hydrometric stations) within the local study area (LSA) dating back to November 2010. Four automatic stream water level logging devises were installed in March 2011 and an additional three were installed in 2012 in order to record stream (Figure 5.7.2).

- Hydrometric monitoring stations were located within the project area watersheds as shown follows:
- The largest sub-watershed within the study area which discharges into Wabigoon Lake was monitoring by hydrometric stations TL1A, JCTA and TL3 located on Blackwater Creek.
- Hydrometric station HS4 was installed contributed monitoring data from the second largest sub-watershed located on unnamed tributary 2 of Thunder Lake.
- Hydrometric station HS7 was installed on the north branch of unnamed tributary to Thunder Lake.
- Hydrometric station HS5 was installed on Hoffstrom Bay Tributary in the fourth largest sub-watershed.
- Hydrometric station HS6 was installed on unnamed tributary 3 of Thunder Lake in the smallest of the sub-watersheds in the project area.

A summary of the average daily during 2012 and 2013 from each of the hydrometric stations can be found in Table 5.7.1.

Table 5.7.1 Average Daily Discharge, 2012 to 2013

	2012			2013		
Site	**Min**	**Max**	**Mean**	**Min**	**Max**	**Mean**
TL1A	0.1	173.3	27.0	9.6	356.3	53.0
TL3	2.7	81.4	17.2	19.9	100.6	66.2
HS4	13.1	77.2	26.8	26.5	569.2	111.6
HS5	0.4	6.2	1.9	0.003	46.6	1.9
HS6	9.2	12.5	10.6	0.1	22.0	3.6
HS7	19.7	127.7	53.0	15.2	791.6	91.0
JCTA				16.1	930.9	85.1

Average daily discharges are reported in L/s.

Dryden Airport weather station recorded precipitation data and indicated significant amounts of rainfall in July, August and October 2012 and May, July, September and October in 2013 which generally corresponds to the maximum average daily discharges at several of the hydrometric stations.

Discharge data obtained from Environment Canada that was recorded at the Wabigoon River hydrometric monitoring station indicated the spring freshet occurring in April 2013.

Discharge yields from each of the sub-watersheds were compared and the higher discharge yields were observed at hydrometric stations TL1A, TL3, HS6 in 2012 and at JCTA and TL3 in 2013. The highest discharge yields observed were as follows:

- In 2012 were 26 L/s/km^2 (TL1A), 26 L/s/km^2 (TL3) and 12 L/s/km^2 (HS6);
- In 2013 were 567 L/s/km^2 (JCTA) and 36 L/s/km^2 (TL3).

GOLIATH GOLD PROJECT
DRYDEN, ONTARIO, CANADA

Hydrographic Network in the Goliath Gold Project Area

FIGURE: 5.7.1 | REV.00

SCALE: 100 000

TREASURY METALS INC.

DESIGN: AT 06 FEB. 2014
GIS: AT 18 NOV. 2014
CHECK: AT 18 NOV. 2014

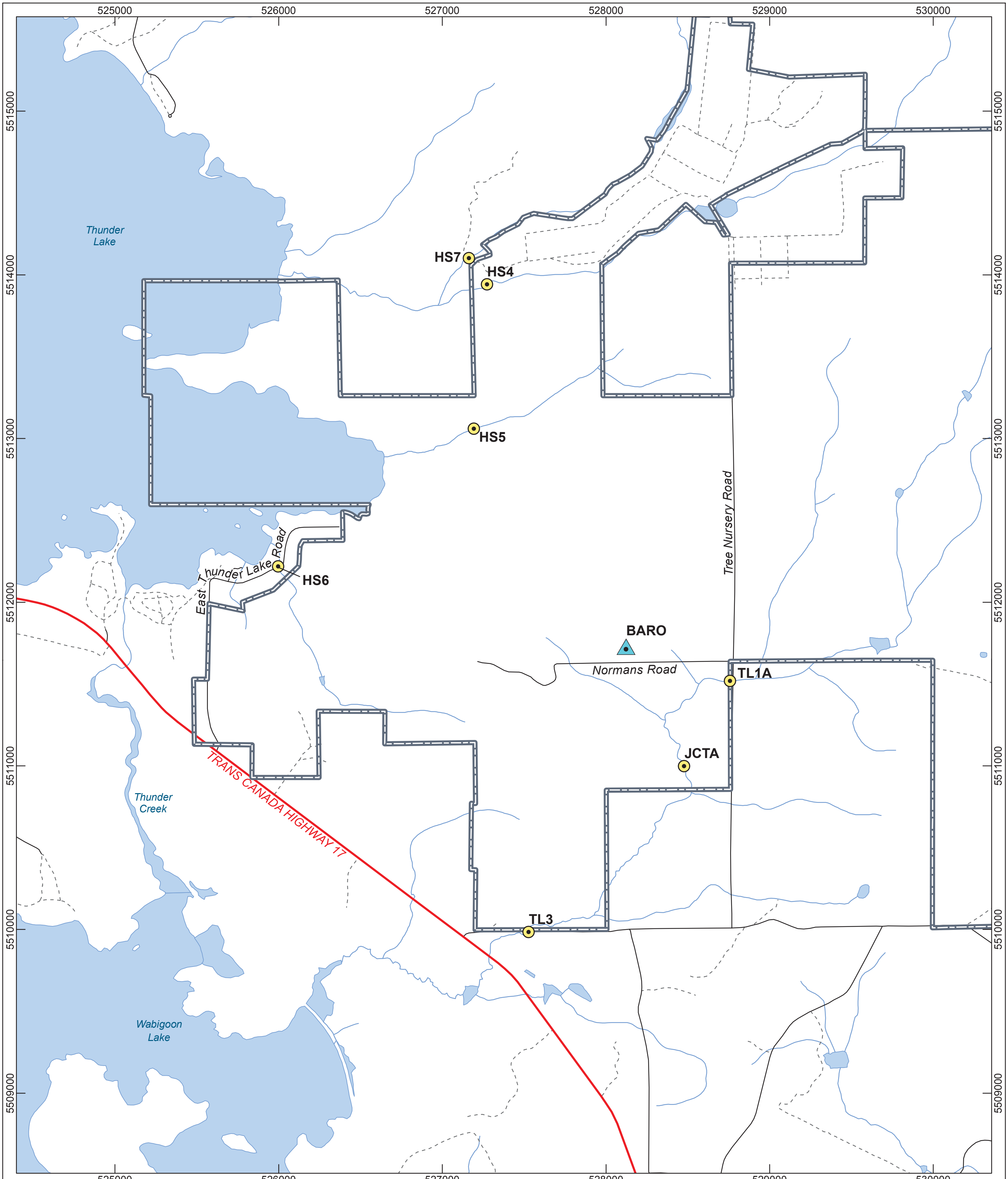
Study Area (Local)
Study Area (Regional)
Immediate Project Extents
Arterial Road
Highway
Local Road
Recreational Road
Wetland
Waterbody
Watercourse

Tertiary Watershed
Wabigoon Watershed
Upper English Watershed

N E S W

0 1,000 2,000 3,000
Meters

REFERENCE
Projection: NAD83 UTM Zone 15N
Base Data: OBM
Watershed Data: MNR



GOLIATH GOLD PROJECT
DRYDEN, ONTARIO, CANADA

Hydrostation and Barometer Locations

FIGURE: 5.7.2 | REV.01

SCALE: 30000

TREASURY METALS INC.

DESIGN: AT 06 FEB. 2014
GIS: AT 26 FEB. 2014
CHECK: MP 14 MAR. 2014
REVIEW: KB 14 MAR 2014

LEGEND

- Barometer Location
- Hydrostation Location
- Local Study Area
- Property Boundary
- Expressway / Highway
- Local
- Resource / Recreation
- Waterbody
- Watercourse

N

0 250 500 750
Meters

REFERENCE
Data by Treasury Metals Inc.
and DST Consuting Engineers
Projection: NAD83 UTM Zone 15N

DST consulting engineers

5.8 Aquatic Resources

The water resources of the Project area, as described below, have been adapted from reports prepared by others, in particular KCB (2012) and DST (2014), as listed in the References Section and provided as Appendix G and Appendix Q. Environmental baseline studies, such as the one completed herein, establish background site conditions representative of the site at the time of sample collection and provide a framework for conducting environmental effects monitoring (EEM) following Project completion.

5.8.1 Surface Water Quality

More than two years of surface water quality samples have been collected in or near the Project area beginning November 2010 (KCB 2012) and again in 2012/2013. Sites were initially selected to capture pre-development site conditions and, during the planning process, considered the distribution of catchments, creeks, rivers, and other waterbodies to characterize the spatial and/or temporal variability in water chemistry (KCB 2012). The 2010/2011 survey identified sample locations in the local study area (LSA) that included Blackwater Creek, which is of concern because it is the primary watercourse draining the proposed Project. Blackwater Creek drains into the Wabigoon Lake Watershed. The larger regional study area (RSA) also included areas of Blackwater Creek, Hughes Creek, and Thunder Lake sub-catchment and their associated tributaries. Also during the 2010/2011 survey, a far-field station (SW3 at McHugh Creek and Highway 17) was sampled to capture information in a catchment that will not likely be impacted by mining developments as planned at the time of study.

Following the 2010/2011 survey, the specific location of sampling sites evolved as additional information about the Project footprint was developed. Nine locations were added and three locations were discontinued during the 2012/2013 sampling program. Additional sites include tributaries to Thunder Lake and locations along Blackwater Creek. A summary of water quality sampling locations and for all sample years is provided in Table 5.8.1 and Figure 5.8.1.

At each surface water sampling site, in situ field measurements included: water and air temperature, pH, conductivity, total dissolved solids, dissolved oxygen, and turbidity. Oxidation reduction potential was measured during 2012/2013 only. Samples were also collected and analyzed for physical and inorganic parameters, as well as total and dissolved metals (Table 5.8.2). Detailed sampling protocols and analytical methods are provided in Appendix G and Appendix P.

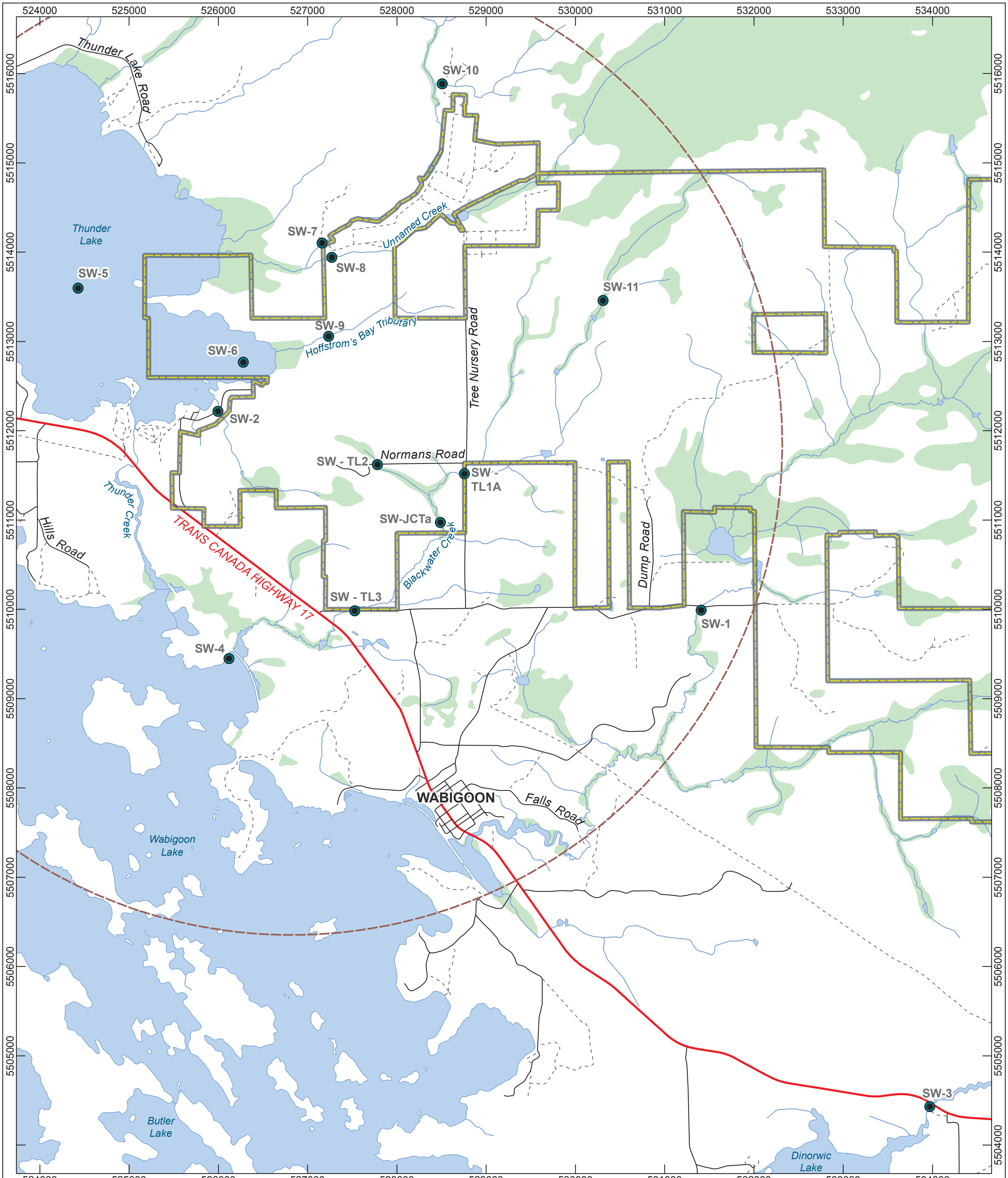
There are two surface waterbodies in the LSA/RSA that are known to be sources for potable water: Wabigoon Lake and Thunder Lake. Wabigoon Lake provides raw water for the City of Dryden and some residences along the shore. The City of Dryden provides water treatment prior to distribution. Some residences along the shore of Thunder Lake draw water for residential use. As these are private dwellings it is unknown whether secondary treatment is conducted.

Table 5.8.1 Location and Dates for Surface Water Sample Collection

Station	Description and Purpose	Sample Year	
		2010/2011	2012/2013
TL1*	Located at a crossing of Norman's Road on Blackwater Creek and captures runoff upstream of the project site on Blackwater Creek	x	
TL1a	Located below the confluence of Blackwater Tributary 2 and Blackwater Creek		x
TL2*	Located downstream of a roadway and beaver dam downstream of the unnamed tributary of Blackwater Creek south of the Project site. This station collects runoff from the Project site which drains southward	x	x
TL2a	Located downstream of Station TL2 is a stand of poplar trees. This Station was established to collect runoff from the Project Site	x	
TL3*	Located at the crossing of Blackwater Creek and Anderson Road and captures runoff from the Project site including potential upstream influences to the east	x	x
JCT*	Located at confluence of Blackwater Creek and the unnamed tributary immediately south of the Project site	x	
JCTa	Located downstream of the confluence of Blackwater Creek and the unnamed tributary south of the Project site	x	x
SW1	Located on Hughes Creek at the Anderson Road crossing. This was established as a local reference station	x	x
SW2	Located at the culvert crossing under Thunder Lake Road on the unnamed tributary to Thunder Lake southwest of the Project site. This location captures sample runoff from the LSA to the west	x	x
SW3	Located on McHughes Creek at the Hwy 17 crossing was established as a regional reference site. Samples are taken downstream of the box culvert	x	x
SW4	SW4 is the field duplicate station and rotates locations with the schedule **	x	x
SW5	Located in the eastern end of Thunder Lake		x
SW6	Located in the southeast end of Thunder Lake. This area captures water coming into the lake from Hoffstrom's Bay Tributary		x
SW7	Located along Thunder Lake Tributary 2		x
SW8	Located along Thunder Lake Tributary 3		x
SW9	Located along Hoffstram's Bay Tributary prior to confluence with Thunder Lake.		x
SW10	Located along an unnamed tributary to Thunder Lake Tributary 2		x
SW11	Located along Blackwater Creek, upstream from Norman's Road		x

Table 5.8.2 Water Quality Parameters Measured

Analysis	Parameter	Sample Year	
		2010/2011	2012/2013
Conventionals	pH	x	x
	Temperature	x	x
	Dissolved oxygen	x	x
	Conductivity	x	x
	Alkalinity	x	x
	Hardness (as $CaCO_3$)	x	x
	Oxidation-reduction Potential		x
	Total Suspended Solids (TSS)	x	x
Anions and Nutrients	Acidity (as $CaCO_3$)	x	x
	Ammonia, total (as N)	x	x
	Chloride (Cl)	x	x
	Nitrate-N (NO_3-N)	x	x
	Nitrite-N (NO_2-N)	x	x
	Phosphorus, total (TP)	x	x
	Sulphate (SO_4)	x	x
Other	Oil and Grease	x	
Cyanides	Cyanide, weak acid dissociable	x	x
	Cyanide, total	x	x
	Cyanide, free	x	x
Metals, total and dissolved	Ag, Al, As, B, Ba, Be, Bi, Ca, Cd, Ce, Co, Cr, Cu, Fe, Hg, K, Li, Mg, Mn, Mo, Na, Ni, Pb, Rb, Sb, Se, Si, Sn, Sr, Te, Ti, Tl, U, V, W, Zn, Zr	x; See note 1	x



GOLIATH GOLD PROJECT DRYDEN, ONTARIO, CANADA	SCALE: 55000 TREASURY METALS INC.
SURFACE WATER QUALITY SAMPLING LOCATIONS	*DESIGN: AT 06 FEB. 2014* *GIS: AT 25 FEB. 2014* *CHECK: AT 17 OCT. 2014*
FIGURE: 5.8.1 REV.01	

LEGEND

- Surface Water Quality Sampling Location
- Local Study Area
- Property Boundary
- Waterbody
- Watercourse
- Arterial
- Expressway / Highway
- Local
- Resource / Recreation
- Wetland

N

0 500 1,000
Meters

REFERENCE

Data by Treasury Metals Inc.
Projection: NAD83 UTM Zone 15N

5.8.1.1 QUALITY ASSURANCE/QUALITY CONTROL

Details on blind field duplicate, trip blanks and field blanks were collected during each sampling event and submitted to the laboratory as part of a quality assurance/quality control (QA/QC) program and are further described in Appendix G and Appendix N.

5.8.1.2 WATER QUALITY REGULATORY INFORMATION

The results of inorganics and dissolved and total metals surface water analyses were compared to the Ministry of Environment and Energy Provincial Water Quality Objectives (PWQO) for the protection of aquatic life and recreation in freshwater (MOEE 1994) (Table 5.8.3). A firm objective for total phosphorus in surface water is not provided in the PWQOs; however, general guidelines are provided to avoid nuisance concentrations of algae in lakes, excessive plant growth, and general aesthetic deterioration. Water quality results were also compared to the Metal Mining Effluent Regulations (MMER) for deleterious substances, provided in Schedule 4 of the MMER and Table 5.8.4 of this document.

5.8.1.3 WATER QUALITY RESULTS

Detailed results of the 2010/2011 and the 2012/2013 sampling events are provided in KCB (2012) and DST (2014). In general, surface water samples had water temperatures that ranged from -0.8°C in the winter months to 28°C in the summer months. Field-measured pH was generally neutral with the occasional pH value below the PWQO for pH of 6.5 at TL1 (at 6.2) measured during the 2010/2011 survey. During the 2012/2013 survey, pH measurements were similarly neutral with several measurements below the PWQO at SW7 (one occurrence) and SW11 (eight occurrences). Measurements of pH at SW11 were below the MMER of 6.0 on six occurrences. Mean conductivity measured during the 2010/2011 survey ranged from 131 µS/cm at JCTa to 264 µS/cm at SW3 and from 23.6 µS/cm at SW7 to 450 µS/cm at SW3 in 2012/2013. Conductivity is a measurement of water's capacity to conduct electrical current which is positively correlated with increases in metal and salt content in water. Increased conductivity is common during spring runoff events as road salts applied during winter are washed away. Sites associated with the Project area with higher conductivity are more closely associated with or downstream roadways or infrastructure.

Laboratory results of samples collected during both surveys that exceeded PWQO and MMER are provided in Table 5.8.5 and Table 5.8.6, respectively. In general, PWQO exceedances were measured on at least one occasion for dissolved aluminum and total silver, cobalt, copper, iron, lead, selenium, zinc, and vanadium. Dissolved aluminum exceedances were found at TL1, TL2, TL3, JCTa, and SW2. Total cobalt exceedances were found at SW3, SW10, SW11, TL1a, TL2, TL2a, TL3, JCTa, and SW3. Total silver was exceeded in two of eight samples from TL2a. Dissolved aluminum exceeded PWQO at TL1, TL2, TL3, JCTa, and SW2. Total copper exceedances were found at TL1 (2010/2011) and SW1 (2012/2013); however, the measurement at TL1 is believed to be an outlier and the result from SW1 has a detection limit above the PWQO. Total iron exceedances were found at SW1, SW2, SW4, SW6, SW7, SW9, SW10, SW11, TL1, TL1a, TL2, TL2a, and JCTa. Total iron is often elevated in the Canadian Shield region of Ontario due to high iron presence in the bedrock and soils. One exceedance of total lead was found at TL2a as well as one exceedance of total selenium at JCTa. Exceedances of total zinc were found at SW3, SW7, SW9, SW10, SW11, and JCTa. One exceedance of vanadium was found at SW10.

Based on general guidelines provided in the interim PWQO for total phosphorus, nearly all samples from both survey years were in exceedance of the most conservative guidance (0.01 mg/L or less during the ice-free period to provide a high level of protection against aesthetic deterioration). Notable exceptions included SW1 which had the fewest exceedances during both survey periods and SW5 which had no exceedances in 2012/2013. Overall, the highest total phosphorus concentrations were measured from TL2 during 2011/2012 (average of 0.08 mg/L) and from SW2 during 2012/2013 (average 0.07 mg/L).

Of the eight deleterious substances identified by MMER, total suspended solids (TSS) was the only parameter exceeded during the survey periods (Table 5.8.6). TSS exceedances were measured from numerous sites during both sample periods. The lowest exceedance was measured from SW1 in (19.8 mg/L; just above the maximum authorized monthly concentration); however, the highest exceedance was measured from TL2 (347 mg/L; well above the maximum authorized concentration in a grab sample). In fact, most of the exceedances were greater than the maximum concentration in a grab sample.

5.8.2 Sediment Samples

Sediment samples were collected from five locations in 2011 (KCP 2012) and 19 locations in 2012 (DST 2014) (Figure 5.8.2). In general, the 2011 sites were restricted to Blackwater Creek and tributaries, though there was one site at the outlet of Blackwater Creek at Wabigoon Lake. Sites in 2012 were far more widespread and often with multiple sample locations within the same waterbodies. Specific analyses varied between studies with more metals analysis and PAHs in 2011 and more nutrient analyses were performed in 2012 (Table 5.8.7). Sediment size classification was determined in both studies. Detailed sampling protocols and analytical methods, including method detection limits, are provided in KCB (2012) and DST (2014).

Table 5.8.3 PWQO for Freshwater

Analysis	Parameter	Unit	PWQO
Inorganics	pH	n/a	6.5 – 8.5
	Phosphorus, total	mg/L	See note 1
	Cyanide, free	mg/L	0.002
Dissolved Metals	Aluminum (Al)	mg/L	0.075
	Mercury (Hg	mg/L	0.0002
Total Metals	Antimony (Sb)	mg/L	0.02
	Arsenic (As)	mg/L	0.005
	Beryllium (Be)	mg/L	0.011 – 1.1 (see note 2)
	Boron (B)	mg/L	0.2
	Cadmium (Cd)	mg/L	0.0001 – 0.0005 (see note 3)
	Cobalt (Co)	mg/L	0.0009
	Copper (Cu)	mg/L	0.005
	Iron (Fe)	mg/L	0.3
	Lead (Pb)	mg/L	0.001 – 0.005 (see note 4)
	Molybdenum (Mo)	mg/L	0.04
	Nickel (Ni)	mg/L	0.025
	Selenium (Se)	mg/L	0.1
	Silver (Ag)	mg/L	0.0001
	Thallium (Ti)	mg/L	0.0003
	Tungsten (W)	mg/L	0.03
	Uranium (U)	mg/L	0.005
	Vanadium (V)	mg/L	0.006
	Zinc (Zn)	mg/L	0.02
Notes:			
1. For the ice-free period should not exceed 0.02 mg/L; a high level of protection against aesthetic deterioration will be provided by a total phosphorus concentration for the ice-free period of 0.01 mg/L or less. This should apply to all lakes naturally below this value; Excessive plant growth in rivers and streams should be eliminated at a total phosphorus concentration below 0.03 mg/L.			
2. Criteria is 0.011mg/L if Hardness as CaCO3 is = 75mg/L; criteria is 1.1 mg/L if the sample hardness is >75mg/L			
3. Criteria is 0.0001mg/L if the sample hardness is = 0-100 mg/L; criteria is 0.0005 mg/L if the sample hardness is >100 mg/L			
4. Criteria is 0.001 mg/L if the sample hardness is 30mg/L; criteria is 0.003 mg/L if the sample hardness is = 30-80mg/L; criteria is 0.005 µg/L if the sample hardness is = >30-80mg/L			

Table 5.8.4 MMER Authorized Limits of Deleterious Substances

Deleterious Substance	Maximum Authorized Monthly Mean Concentration	Maximum Authorized Concentration in a Composite Sample	Maximum Authorized Concentration in a Grab Sample
Arsenic	0.50 mg/L	0.75 mg/L	1.00 mg/L
Copper	0.30 mg/L	0.45 mg/L	0.60 mg/L
Cyanide	1.00 mg/L	1.50 mg/L	2.00 mg/L
Lead	0.20 mg/L	0.30 mg/L	0.40 mg/L
Nickel	0.50 mg/L	0.75 mg/L	1.00 mg/L
Zinc	0.50 mg/L	0.75 mg/L	1.00 mg/L
Total Suspended Solids (TSS)	15.00 mg/L	22.50 mg/L	30.00 mg/L
Radium 226	0.37 Bq/L	0.74 Bq/L	1.11 Bq/L
Source: Metal Mining Effluent Regulations SOR/2002-222. Fisheries Act.			
Note: All concentrations are total values.			
pH values should be equal or greater than 6.0 but less than 9.5			

Table 5.8.5 Surface Water PWQO Exceedances

		Description of PWQO Exceedance (Range of Measurements)	
Parameter	**Station**	**2010/2011**	**2012/2013**
pH	SW7	-	1 of 15 (6.24 - 7.95)
	SW11	-	8 of 9 (5.06 - 6.61)
	TL1	3 of 13 (6.2 - 7.41)	-
Total Phosphorus		See note 1	See note 2
Total Ag	TL2a	-	2 of 8 samples (0.00072 mg/L - 0.00083 mg/L)
Dissolved Al	**TL1**	12 of 13 samples (0.072 mg/L - 0.24 mg/L)	-
	TL2	5 of 13 (0.050 mg/L to 0.19 mg/L)	-
	TL3	1 of 13 samples (0.0050 mg/L - 0.11 mg/L)	-
	JCTa	2 of 13 samples (0.0098 mg/L - 0.11 mg/L)	-
	SW2	5 of 13 samples (0.033 mg/L - 0.15 mg/L)	-
Total Co	SW10	-	1 of 15 samples (0.00162 mg/L)
	SW11	-	1 of 9 samples (0.0011 mg/L)
	TL1	8 of 13 samples (0.00025 mg/L - 0.0030 mg/L)	-
	TL1a	-	8 of 16 samples (0.00216 mg/L - 0.00723 mg/L)
	TL2	6 of 13 samples (0.00025 mg/L - 0.0060 mg/L)	-
	TL2a	-	2 of 8 samples (0.00095 mg/L - 0.00103 mg/L)
	TL3	1 of 13 samples (0.00025 mg/L - 0.0016 mg/L)	-
	JCTa	3 of 13 samples (0.00025 mg/L - 0.0018 mg/L)	4 of 14 samples (0.0096 mg/L - 0.00314 mg/L)
	SW2	1 of 13 samples (0.00025 mg/L - 0.0015 mg/L)	-
	SW3	1 of 13 samples (0.00025 mg/L - 0.0016 mg/L)	-
Total Cu	TL2a	-	2 of 8 samples (0.0075 mg/L - 0.0087 mg/L)
	TL1	1 of 13 samples (0.00050 mg/L - 0.015 mg/L)	-
Total Fe	SW1	9 of 13 samples (0.21 mg/L - 1.3 mg/L)	11 of 16 samples (0.333 mg/L - 1.71 mg/L)
	SW2	11 of 13 samples (0.62 mg/L - 3.4 mg/L)	13 of 13 samples (0.658 mg/L - 2.34 mg/L)
	SW3	6 of 13 samples (0.064 mg/L - 3.0 mg/L)	4 of 14 samples (0.323 mg/L - 1.23 mg/L)

Table 5.8.5 Surface Water PWQO Exceedances

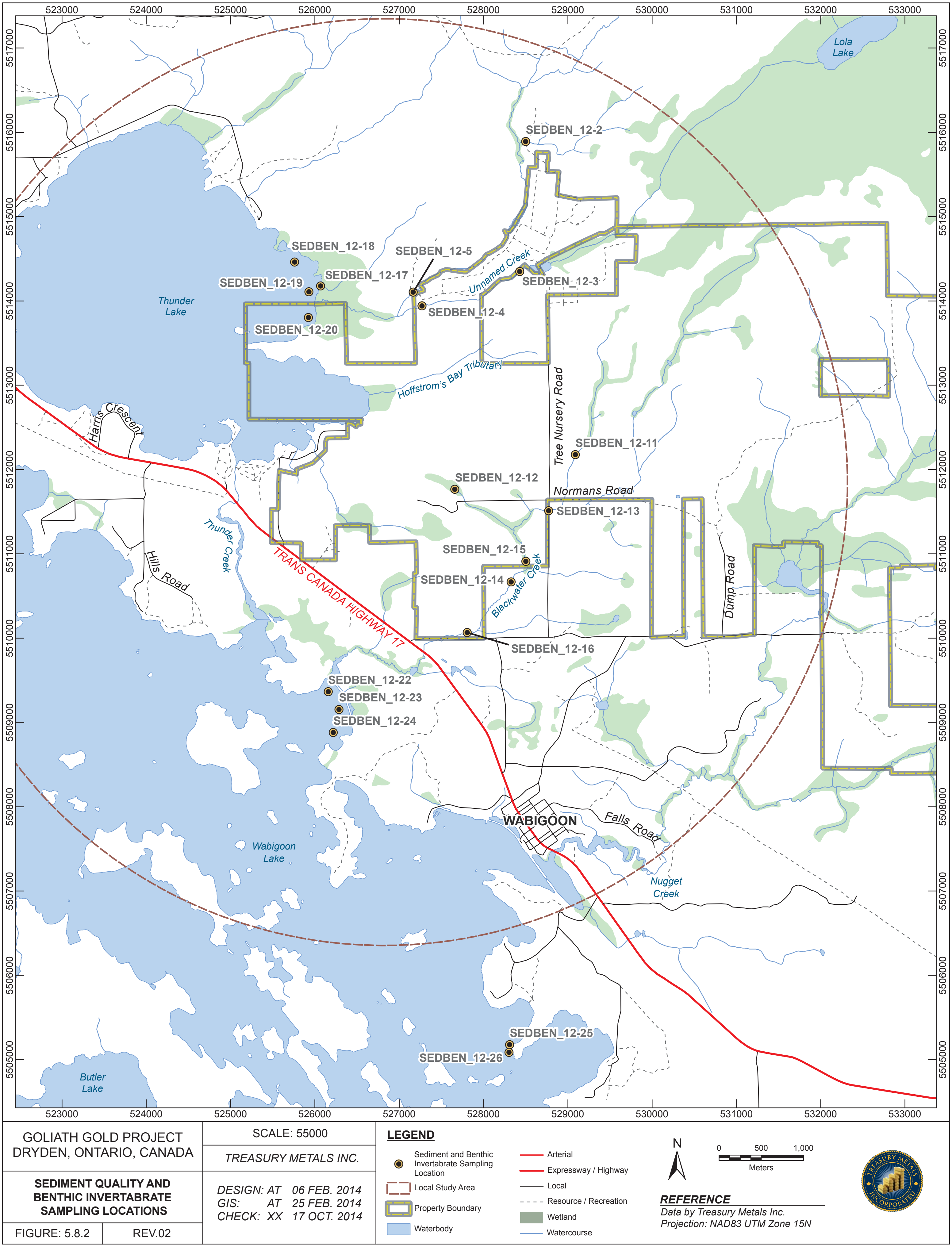
		Description of PWQO Exceedance (Range of Measurements)	
Parameter	**Station**	**2010/2011**	**2012/2013**
	SW4	-	8 of 10 samples (0.440 mg/L - 0.788 mg/L)
	SW6	-	1 of 9 samples (0.734 mg/L)
	SW7	-	14 of 15 samples (0.350 mg/L - 1.03 mg/L)
	SW9	-	9 of 14 samples (0.315 mg/L - 0.797 mg/L)
	SW10	-	15 of 15 samples (0.685 mg/L - 8.71 mg/L)
	SW11	-	9 of 9 samples (1.17 mg/L - 2.82 mg/L)
	TL1	13 of 13 samples (0.90 mg/L - 6.1 mg/L)	-
	TL1a	-	14 of 16 samples (0.353 mg/L - 10.40 mg/L)
	TL2	12 of 13 samples (0.23 mg/L - 2.9 mg/L)	-
	TL2a	-	8 of 8 samples (0.615 mg/L - 2.0 mg/L)
	TL3	13 of 13 samples (0.57 mg/L - 3.0 mg/L)	14 of 15 samples (0.301 mg/L - 6.47 mg/L)
	JCTa	3 of 13 samples (0.59 mg/L - 3.7 mg/L)	14 of 14 samples (0.305 mg/L - 9.11 mg/L)
Total Pb	TL2a	-	2 of 8 samples (0.0018 mg/L - 0.0043 mg/L)
Total Se	**JCTa**	-	1 of 14 samples (1.1 mg/L)
Total Zn	SW3	-	1 of 14 samples (0.0267 mg/L)
	SW7	-	1 of 14 samples (0.158 mg/L)
	SW9	-	1 of 14 samples (0.0267 mg/L)
	SW10	-	1 of 14 samples (0.0267 mg/L)
	SW11	-	1 of 9 samples (0.051 mg/L)
	JCTa	-	1 of 14 samples (0.024 mg/L)
Total V	SW 10	-	1 of 15 samples (0.0096 mg/L)
Notes:			
Stations in **bold** are associated with Blackwater Creek			
1. All sample locations in 2010/2011 exceeded the interim PWQO guidance of 0.01 mg/L on nearly all sample occasions except SW1 which has the fewest exceedances.			
2. All sample locations in 2012/2013 exceeded the interim PWQO guidance of 0.01 mg/L on nearly all sample occasions except SW5 which had no exceedances. SW1 had exceedances in less than half the samples collected.			

Table 5.8.6 Surface Water MMER Exceedances

		Description of MMER Exceedance (Range of Measurements)	
Parameter	**Station**	**2010/2011**	**2012/2013**
pH	**SW11**	-	6 of 9 (5.06 - 6.61)
Total Suspended Solids (TSS)	**JCTa**	2 of 13 (<2.0 mg/L - 268 mg/L)	1 of 14 (2.2 mg/L - 40.2 mg/L)
	SW1	1 of 13 (<2.0 mg/L - 19.8 mg/L)	3 of 6 (2.3 mg/L - 84 mg/L)
	SW2	2 of 13 (,2.0 mg/L - 41.4 mg/L)	8 of 13 (59. mg/L - 92.7 mg/L)
	SW4	1 of 13 (<2.0 mg/L - 122 mg/L)	-
	SW7	-	2 of 15 (2.5 mg/L - 33 mg/L)
	SW8	-	5 of 16 (2.4 mg/L - 137 mg/L)
	SW9	-	3 of 14 (2.0 mg/L - 40.4 mg/L)
	SW10	-	6 of 15 (4.8 mg/L - 403 mg/L)
	SW11	-	3 of 9 (2.4 mg/L - 88.4 mg/L)
	TL1	7 of 13 (4.1 mg/L - 83.3 mg/L)	-
	TL2	3 of 13 (3.1 mg/L - 347 mg/L)	-
	TL2A	-	3 of 8 (2.8 mg/L - 252 mg/L)
	TL3	3 of 13 (2.7 mg/L - 123 mg/L)	4 of 15 (2.2 mg/L - 40.2 mg/L)
Notes:			
Stations in **bold** are associated with Blackwater Creek			

Table 5.8.7 Sediment Parameters Measured

Parameter		Sample Year	
		2010/2011	2012/2013
Organics	PAH	x	
Metals	Al, Sb, As, Ba, Be, Bi, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mb, Ni, K, Se, Ag, Na, Sr, S, Tl, Sn, Ti, U, V, Zn	x	
	Br, Cl, F, S, Hg, Zr		x
Nutrients	Ammonia, total (as N)		x
	Nitrate-N (NO_3-N)		x
	Nitrite (NO_2-N)		x
	Phosphorus, total (TP)	x	x
	Nitrate + Nitrite (TN)		x
	Total Kjeldahl Nitrogen (TKN)		x
	TOC	x	



GOLIATH GOLD PROJECT
DRYDEN, ONTARIO, CANADA

SCALE: 55000

TREASURY METALS INC.

SEDIMENT QUALITY AND BENTHIC INVERTABRATE SAMPLING LOCATIONS

DESIGN: AT 06 FEB. 2014
GIS: AT 25 FEB. 2014
CHECK: XX 17 OCT. 2014

FIGURE: 5.8.2 REV.02

REFERENCE
Data by Treasury Metals Inc.
Projection: NAD83 UTM Zone 15N

5.8.2.1 SEDIMENT QUALITY REGULATORY INFORMATION

Sediment samples (metals) were compared to the Ontario Provincial Sediment Quality Guidelines (PSQG) (MOE 1993). The guidelines have established three levels of effect – No Effect Level (NEL), Lowest Effect Level (LEL) and Severe Effect Level (SEL). The LEL and SEL are based on long-term effects which contaminants may have on sediment dwelling organisms (Table 5.8.8). The purpose of the PSQG is to protect the aquatic environment by setting safe levels for metals, nutrients and organic compounds (Fletcher et al. 2008). Metal contaminants examined in the 2011 study level (KCB 2012) and two of the nutrients analyzed in the 2012 study correspond to parameters that have established provincial sediment quality guideline level (Fletcher et al. 2008).

5.8.2.2 SEDIMENT QUALITY RESULTS

Sediment Particle size

Sediment particle size can confound interpretation of sediment chemistry data (Lapota et al. 2000). That is, due to the high surface area to volume ratio of fine grain sediments, silts and clays are capable of transporting certain constituents compared to coarser grain sediments (Ongley 1996) and there is a strong positive correlation between decreased grain size and increased trace metal concentrations (Horowitz 1985). Sediments collected from three of the five sites in 2011 were dominated by silt, particularly TL2 and, to lesser degrees, JCTa and BC. Stream sites monitored in 2012 were typically dominated by sand; however, SB12-11a and SB12-12 were dominated by silt. Conversely, all sediments collected Wabigoon Lake were dominated by silt and clay while sediments from Thunder Bay were dominated by sand.

Nutrients

Total organic carbon (TOC) was measured from sediment samples collected in 2011. All samples exceeded the LEL of 1%, and one site, BC (located at the outlet of Blackwater Creek at Wabigoon Lake) also exceed the SEL of 10% (Table 5.8.9). During the 2012 study, three samples (SB12-3, SB12-25, and SB12-26) exceeded the total phosphorus (TP) LEL of 600 mg/kg (Table 5.8.9).

Sediment samples collected in 2012 which were submitted for analysis of anions and nutrients were not compared to Sediment Quality Guidelines as the leachable anions and nutrients requested by Treasury Personnel cannot be compared to those guidelines.

Metals

Of the 32 metals analyzed in sediment samples collected in 2011, nine are listed in the PSQG (Arsenic, cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc). With the exception of the following, all other constituents were detected below the LEL in sediments. Chromium concentrations at all 2011 sample sites was above the LEL of 26 µg/g but below the SEL guideline of 110 µg/g. Copper concentrations from sediments collected in 2011 from TL2, TL3 and BC were above the LEL of 16 µg/g but below the LEL of 110 µg/g. Manganese concentrations in sediments from sites TL2 and TL3 were above the LEL of 460 µg/g but below the SEL of 1100 µg/g. Nickel concentrations in sediments from sites TL2, TL3, and JCTa were above the LEL of 16 µg/g but below the SEL of 75 µg/g. The concentration of zinc collected from BC was above the LEL of 120 µg/g. The percentage of iron in samples collected from all sites except TL1 were above the LEL of 2%; however, all samples were below the SEL of 4%.

Of the two metals analyzed in sediment samples collected in 2012, one (mercury) is listed in the PSQS. None of the sediment samples collected from any site in 2012 exceeded the LEL of 0.2 µg/g for mercury.

Table 5.8.8 MOE Sediment Effects Levels

Effect Level	Description
No Effect Level (NEL)	This is the level at which the chemicals in the sediment do not affect fish of the sediment-dwelling organisms. At this level no transfer of chemicals through the food chain and no effect on water quality is expected.
	Sediment at the NEL rating is considered clean and no management decisions are required. Furthermore, it may be placed in rivers and lakes provided it does not physically affect the fish habitat or existing water uses.
Lowest Effect Level (LEL)	This indicates a level of contamination which has no effect on the majority of sediment-dwelling organisms. The sediment is deemed to be marginally polluted. Dredged sediments containing concentrations of organic contaminants - PCBs or pesticides, for example - that fall between the NEL and LEL may not be disposed of in an area where the sediment at the proposed disposal site has been rates at the NEL or better.
	Contamination in sediment that exceeds the LEL may require further testing and a management plan.
Severe Effect Level (SEL)	At this level, the sediment is considered heavily polluted and likely to affect the health of sediment-dwelling organisms. If the level of contamination exceeds the SEL then testing is required to determine whether or not the sediment is acutely toxic.
	At the SEL a management plan may be required. The plan may include controlling the source for the contamination and removing the sediment.
Source: MOE (1993)	

Table 5.8.9 PSQG Exceedances

Parameter	Waterbody	Site(s)	Sample Year	Units	Analytical Result(s)	LEL	SEL
TOC	Blackwater Creek at Norman's Road	TL1	2011	%	2.32	1	10
TOC	Blackwater Creek below unnamed tributary	Tl2	2011	%	3.97	1	10
TOC	Blackwater Creek at Anderson Road	TL3	2011	%	2.62	1	10
TOC	Blackwater Creek below unnamed tributary; south of Project	JCTa	2011	%	3.7	1	10
TOC	Blackwater Creek at Wabigoon Lake	BC	2011	%	16.4	1	10
TP	Unnamed Creek	SB12-3	2012	mg/kg	680	600	2000
TP	Wabigoon Lake	SB12-24	2012	mg/kg	644	600	2000
TP	Wabigoon Lake Reference	SB12-25	2012	mg/kg	853	600	2000
TP	Wabigoon Lake Reference	SB12-26	2012	mg/kg	793	600	2000
Cr	Various creeks	TL1, TL2, TL2, JCTa, and BC	2011	µg/g	27.7 - 54.0	26	110
Cu	Various creeks	TL3 and BC	2011	µg/g	19.0 - 51.6	16	110
Mn	Various creeks	TL2 and TL3	2011	µg/g	616 - 637	460	1100
Ni	Various creeks	TL2, TL2 and JCTa	2011	µg/g	20.8 - 30.8	16	75
Zn	Outlet of Blackwater Creek to Wabigoon Lake	BC	2011	µg/g	268	120	820
Fe	Various creeks	TL2, TL2, JCTa, and BC	2011	%	2.38 - 2.94	2	4

5.8.3 BENTHIC INVERTEBRATE COMMUNITY

Benthic invertebrate community samples were collected in October of 2011 and 2012. Samples from 2011 were only collected from areas associated with Blackwater Creek; however, 2012 samples included areas associated with Blackwater Creek as well as Wabigoon Lake, Thunder Bay, and throughout the creek located at either side of a former Tree Nursery which is located within the Project area (Figure 5.8.2 and Table 5.8.10). A number of parameters were determined for the benthic invertebrate samples including: taxon richness, relative abundance, percent Ephemeroptera, Plecoptera, Trichoptera (EPT), percent Diptera, Simpson's diversity index, Bray-Curtis Index, and evenness. Specific sampling methods are summarized in KCB (2012) and DST (2014).

5.8.3.1 BENTHIC INVERTEBRATE QUALITY ASSURANCE/QUALITY CONTROL

Identification to Family level was completed by ALS, where possible. The QA/QC process for invertebrate identification involves periodic testing of Senior Taxonomists with voucher samples, and resampling by third parties.

5.8.3.2 BENTHIC INVERTEBRATE RESULTS

Results of benthic invertebrate sampling from Blackwater Creek in 2011 indicated a general increase in mean number of taxa and taxa richness from upstream to downstream sites with mean number of taxa ranging from approximately four to 14. Additionally, approximately 61% of the total specimens within all samples consisted of chironomids (family Diptera) which is typical of slow moving streams with silt and clay substrates or where oxygen availability is limiting to many other taxa (Hynes 1970). Percentages of Diptera greater than 40% are indicative of poor water quality. EPT ratios in 2011 were highest at the mouth of Blackwater Creek (13.57%) but less than 2% in all other sample locations. EPT ratios of 50% or greater are typically considered indicators of good biodiversity. The Simpson Index, which considers abundance patterns and taxonomic richness on a scale of 0 to 1, ranged from 0.537 to 0.588 in Blackwater Creek during the 2011 sampling. Results of benthic invertebrate sampling from Blackwater Creek in 2012 were somewhat similar to 2011 in that a higher percentage of EPT families were observed in downstream samples compared to upstream samples. Simpson’s index, which ranged from 0.4 to 0.9 further suggests moderate to high species diversity in Blackwater Creek.

Samples from Wabigoon Lake (SB12-22, SB12-23, and SB12-24) in 2012 were dominated by Diptera (ranging from 52.3% to 80.1%), again suggesting poor water quality. EPT in Wabigoon Lake was similarly low and ranged from 2.7% to 27%, suggesting poor to moderate biodiversity. The Simpson’s diversity index ranged from 0.3 to 0.7, indicating low to rather high species diversity, depending upon sample location in the lake. Additionally, though chironomids were quite high, their numbers declined while numbers of other species (e.g., Ephemeridae) increased further away from the mouth of Blackwater Creek. Invertebrates collected from the Wabigoon Reference sites (SB12-25 and SB12-26) were dominated by Ephmeroptera (roughly 60%) followed by Diptera (between 15 and 20%) as a percentage of all taxa. EPT was near 60% for both locations indicating moderate water quality and Simpson’s Index was 0.6 at both sites indicating moderate species diversity.

Samples from Thunder Lake in 2012 indicate a higher abundance of taxa compared to Wabigoon Lake; however, evenness indicated that there is still a skewed dominance of most samples by the Chironomids (23% to 58% depending on location). Combined with the generally low EPT (0.22% to 51%), data suggest relatively poor water quality in Thunder Lake.

The unnamed tributary (i.e., Tree Nursery Creek) that runs along either side of the former tree nursery had the highest EPT ratio of all waterbodies sampled (ranging from 2.8% to 51%), indicating a range in water quality. While the Simpson’s index indicated that diversity was high, evenness indicates that samples were commonly dominated by one or two families.

In general, the lake samples were characterized by invertebrate species resistant to poor water quality (e.g., Chironomidae) and associated with fine grain sediments. Conversely, stream samples had more EPT members which increased in the downstream direction.

Table 5.8.10 Benthic Invertebrate Sample Locations

Site No.	Description and Purpose	Sample Year	
		2010/2011	2012/2013
13	Blackwater Creek upstream of the Project site	x	
6	Blackwater Creek downstream of the Project site	x	
65	Confluence of the portald tributary and Blackwater Creek	x	
28	Blackwater Creek downstream of the Project site at Anderson Rd	x	
23	Outlet of Blackwater Creek into Wabigoon Lake	x	
SB12-11A	Blackwater Creek		x
SB12-12	Blackwater Creek		x
SB12-13	Blackwater Creek		x
SB12-14	Blackwater Creek		x
SB12-15A	Blackwater Creek		x
SB12-16	Blackwater Creek		x
SB12-2A	Tree Nursery Creek		x
SB-3	Tree Nursery Creek		x
SB-4	Tree Nursery Creek		x
SB-5A	Tree Nursery Creek		x
SB12-22	Wabigoon Lake		x
SB12-23	Wabigoon Lake		x
SB12-24	Wabigoon Lake		x
SB12-25	Wabigoon Lake Reference		x
SB12-26	Wabigoon Lake Reference		x
SB12-17	Thunder Bay		x
SB12-18	Thunder Bay		x
SB12-19	Thunder Bay		x
SB12-20	Thunder Bay		x

5.8.4 FISH AND FISH HABITAT

Two environmental baseline studies that include fish and fish habitat have been conducted for the Project (Appendix G and Appendix Q). The reports contain the methodologies each used to assess fish and fish habitat for the Project.

5.8.4.1 STUDY AREAS & INCLUDED WATERBODIES

The Project is located within the Lake Wabigoon Ecoregion (Ecoregion 4S) within the Lower English River Section of the Boreal Forest Region (see Figure 5.7.1 for a representation of the hydrographic network in the Ecoregion). It is also within the northern limits of the OMNRF Fisheries Management Zone (FMZ) 5. This zone covers 44,360 km^2 from the Manitoba border east to Quetico Provincial Park and the United States border north to the Wabigoon River Watershed. KCB 2012 and DST 2014(b) assessed multiple waterbodies in the RSA and LSA (Table 5.8.11).

Table 5.8.11 Waterbodies Assessed in the RSA and LSA

Waterbody	KCB 2012	DST 2014(b)
Thunder Lake	bay near outlet of Unnamed Thunder Lake Tributary 1 and 2, Hoffstrom's Bay	Hoffstrom's Bay
Wabigoon Lake	Keplyn Bay and channel east of Christie's Island	Keplyn Bay
Thunder Creek	Main channel	Main channel
Blackwater Creek	main channel, tributaries, ponds	Main channel, some tributaries
Hughes Creek	main channel, tributaries, ponds	Not assessed
Thunder Creek Tributaries	ponds and tributaries west of the Tree Nursery and ponds west of the Portal	DST 2014(b) assessed only "Unnamed Thunder Lake Tributary" which is analogous to "Unnamed Thunder Lake Tributary 2" in KCB 2012 For the purpose of this EIS, it is referred to as *Unnamed Thunder Lake Tributary 2*.
RSA	The larger RSA includes the watershed boundaries of Nugget Creek, Hughes Creek, Blackwater Creek, and the unnamed tributaries flowing into the eastern edge of Thunder Lake.	Not assessed

5.8.4.2 FISH PRESENCE

Appendix G and Appendix Q contain a lists of all fish species identified within the Project area, including those identified in historical records and those caught in field surveys.

A total of 10,236 fish were captured at 130 sample sites: 8,265 fish were captured in 2012 at 66 sample sites and 1,971 fish over 68 sites (Appendix G and Appendix Q, respectively; Table 5.8.12). Thirty six fish species were identified during a review of historical records while presence of only thirty one fish species, including two identified to the genus level, was confirmed by field sampling. Fish indicated in historical reviews but not confirmed by field surveys include: Cisco, Lake Trout, Lake Whitefish, Longnose Sucker, Muskellunge and

Ninespine Stickleback. Fish captured in field surveys but not included in the historical records include Brassy Minnow.

Table 5.8.12 Summary of Fish Species Confirmed by Field Surveys

Species	Waterbody					
	Blackwater Creek	**Hughes Creek**	**Thunder Lake Tributaries***	**Thunder Creek**	**Wabigoon Lake**	**Thunder Lake**
Black Crappie					x	
Blacknose Shiner		x	o			
Brassy Minnow			o			
Brook Stickleback	b	x	b	o		
Burbot	b					
Central Mudminnow			b			
Centrarchid Sp.	x	x	x			
Common Shiner		x				
Creek Chub			o			
Cyprinid sp.	x	x	x			
Emerald Shiner					x	
Fathead Minnow	b		b			
Finescale Dace	b	x	b			
Iowa Darter			b			
Johnny Darter		x				
Logperch					x	
Mimic Shiner		x		x		
Mottled Sculpin			x			
Northern Pearl Dace	b	x	b			
Northern Pike	x		x	b	x	x
Northern Redbelly Dace	o		o			
Pumpkin Seed	x					
Rock Bass			x		x	
Sauger					o	
Shiner Sp.	x	x	x			
Shorthead Redhorse					x	

Table 5.8.12 Summary of Fish Species Confirmed by Field Surveys

Species	Waterbody					
	Blackwater Creek	**Hughes Creek**	**Thunder Lake Tributaries***	**Thunder Creek**	**Wabigoon Lake**	**Thunder Lake**
Smallmouth Bass					x	
Trout-Perch			x			
Walleye		x			o	o
White Sucker	b	x	b			x
Yellow Perch	x		x	x	x	
*Includes "Unnamed Thunder Lake Tributary" from DST 2014(b)						
b= fish captured by both KCB 2012 and DST 2014(b) x=fish captured by KCB 2012 o=fish captured by DST 2014(b)						

5.8.4.3 FISH TISSUE SAMPLING

A total of 57 fish tissue samples (43 muscle tissue samples and 14 batch samples) were submitted for laboratory analysis of Mercury concentrations (Table 5.8.13). Results were compared to the guidelines provided in Ontario Ministry of Environment (MOE) *Guide to Eating Ontario Sport Fish 2013-2014* ("MOE Guidelines") and to Canadian Council of Ministers of the Environment (CCME) *Tissue Residue Guideline Values for the Protection of Wildlife Consumers of Aquatic Biota: Methylmercury* (2000) ("CCME Guidelines"). MOE guidelines consider two populations: sensitive (includes children under 15 and women of childbearing age) and general. Two restriction categories were applied within each population: minimum levels and "do not eat" advisory levels.

Table 5.8.13 Summary of Mercury Concentrations in Fish Tissue Samples

Waterbody	Species/Sample ID	# Submitted	Mercury Concentration (mg/kg)
Thunder Lake	Walleye	11	
	F31		**0.143**
	F32		***0.331***
	F33		**0.143**
	F34		**0.142**
	F35		**0.102**
	F36		**0.157**
	F37		***0.272***

Table 5.8.13 Summary of Mercury Concentrations in Fish Tissue Samples

Waterbody	Species/Sample ID	# Submitted	Mercury Concentration (mg/kg)
	F38		**0.195**
	F39		***0.261***
	F40		**0.191**
	F41		***0.503***
Wabigoon Lake	**Walleye**	**30**	
	F1		**0.228**
	F16		***0.335***
	F18		**0.245**
	F19		**0.24**
	F2		**0.194**
	F20		**0.0865**
	F21		***0.473***
	F22		**0.117**
	F23		**0.176**
	F3		**0.149**
	F4		**0.165**
	F5		**0.241**
	F6		**0.196**
	F7		***0.442***
	F8		**0.18**
	F10		**0.195**
	F11		**0.173**
	F12		**0.245**
	F13		**0.206**
	F14		**0.207**
	F24		**0.23**
	F25		**0.14**
	F26		**0.108**
	F27		**0.121**

Table 5.8.13 Summary of Mercury Concentrations in Fish Tissue Samples

Waterbody	Species/Sample ID	# Submitted	Mercury Concentration (mg/kg)
	F28		**0.155**
	F29		**0.0975**
	F30		**0.105**
	F9		**0.0978**
	GN1		**0.136**
	GN3		**0.114**
	Sauger	1	
	F17		**0.184**
Blackwater Creek			
(Site 12)	White Sucker	2	**0.078**
(Site 6)	Pearl Dace*	10	**0.082**
	Finescale Dace*	10	**0.105**
(Site 28)	Fathead Minnow*	10	**0.043**
	Pearl Dace*	10	0.025
Thunder Lake Tributaries	Pearl Dace*	10	0.027
	Finescale Dace*	10	0.033
DST "Streams"			
TS15	species unknown*	13	0.0295
TS7	species unknown*	12	**0.0451**
TS21	species unknown*	9	**0.0569**
TS22	species unknown*	5	**0.067**
TS5	species unknown*	8	**0.088**
TS13	species unknown*	3	**0.0983**
TS2	species unknown*	5	**0.111**
TS16	species unknown*	5	**0.123**
Guidelines:			
Ontario MOE	Guide To Eating Ontario Sport Fish		
	Sensitive Population	Minimum Level	0.26 mg/kg

Table 5.8.13 Summary of Mercury Concentrations in Fish Tissue Samples

Waterbody	Species/Sample ID	# Submitted	Mercury Concentration (mg/kg)
		"Do Not Eat" Advisory	0.52 mg/kg
	General Population	Minimum Level	0.61 mg/kg
		"Do Not Eat" Advisory	1.84 mg/kg
CCME	Values for the Protection of Wildlife Consumers of Aquatic Biota (Methylmercury)		0.033 mg/kg
Legend:			
BOLD	Result exceeds CCME Guideline		
Italic/shaded	Result exceeds MOE Guideline (Minimum Level in a Sensitive Population)		

Mercury concentrations generally exceed the CCME Guideline; 53 of the 57 samples (93%) were greater than 0.033 mg/kg. Seven samples (12%) also exceeded the MOE Guideline Minimum Level of 0.25 mg/kg for a sensitive population. All seven samples that exceeded the MOE Guideline Minimum Level in a Sensitive Population were Walleye caught in either Thunder Lake or Wabigoon Lake. Elevated mercury levels are known throughout the region. Mercury occurs naturally (at low levels) and historical industrial effluents were introduced to the Wabigoon River System between 1962 and 1970 (Kinghorn et al 2006 in DST 2014b) but the point of discharge has been attributed to the Dryden pulp mill and chemical plants downstream of Wabigoon Lake. Since it is bioaccumulative concentrations of mercury are predictably higher in large, predatory fish such as Walleye. However, the Dryden dam prevents the upstream movement of fish into Wabigoon Lake.

5.8.4.4 FISH HABITAT

Fish habitat was assessed by both KCB 2012 and DST 2014(b). Under the Federal *Fisheries Act 2012* fish habitat is defined as "spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes."

Habitat values, as defined by FPTWG 2011, are described as:

> **High** – presence of high-value spawning or rearing habitat, including an abundance of suitably sized gravels, deep pools, undercut banks or stable debris.
>
> **Medium** – important migration corridor; presence of suitable spawning habitats (gravels, aquatic vegetation); habitat with moderate rearing potential for the species present.
>
> **Low** – absence of suitable spawning habitat (gravels, aquatic vegetation) and low rearing potential (absence of deep pools, undercut banks, stable debris).

Habitat within the LSA appears to generally be of *low* to *moderate* value. In both lakes and streams substrates are primarily dominated by fines (silts and clays) while spawning gravels required for some species (i.e., Walleye, Sucker, Lake Whitefish) are limited. The aquatic vegetation required for Northern Pike and Muskellunge spawning is more abundant. In-stream cover is available mostly in the form of pools, woody debris and vegetation (overhanging, emergent and submergent).

Both Thunder Lake and Wabigoon Lake are known to support diverse fish populations that include large predatory fish like Walleye and Northern Pike therefore these waterbodies must contain suitable spawning and rearing habitat. Appendix Q, Figures 3.1.3 and 3.2.3, illustrate potential spawning areas. Section 5.8.4.5 below describes the habitat assessment each assessed lake.

Fish capture in the assessed streams indicates that suitable habitat is present for small baitfish species. Nursery habitat was observed by KCB 2012 at the outlet of several streams. Spawning habitat for Walleye and/or White Sucker was identified on Hughes Creek, Blackwater Creek and the North Branch of Unnamed Thunder Lake Tributary 2. Potential Northern Pike spawning habitat was identified on Hughes Creek, Blackwater Creek, Thunder Creek and the North Branch of Unnamed Thunder Lake Tributary 2. Section 5.8.4.6 below describes the habitat assessment of each stream.

Appendix G, Figure 10.9, illustrates areas of important fish habitat within the LSA.

5.8.4.5 LAKE HABITAT SUMMARY

Thunder Lake

Thunder Lake is considered a coldwater lake with low productivity, deep, clear water and relatively low temperatures year-round (DST 2014b). Water levels are controlled by a small dam at the head of Thunder Creek in Aaron Provincial Park. The East shore is mostly undeveloped but the rest of the lake is dominated by private homes, seasonal camps and public campgrounds.

Habitat mapping was focused on the Hoffstrom's Bay area of Thunder Lake. A mixture of sand/silt substrates with sandy shorelines and bedrock/boulder/cobble substrate with rocky shorelines habitat was identified by DST 2014(b). Aquatic vegetation was generally sparse in Thunder Lake, except for three small areas on the south side of the lake, near East Thunder Lake Road and one small area near the northwestern tip of Hoffstrom's Bay (DST 2014(b)). KCB 2012 identified two marsh/shore fen communities near the outlets of Hoffstrom's Bay Creek and Unnamed Thunder Lake Tributary 1.

The marsh/fen communities provide potential Northern Pike spawning habitat and likely serve as nursery habitat. Cobble shoals observed between the bedrock point and island on the northeast corner of Hoffstrom's Bay could provide spawning habitat for Lake Trout, Lake Whitefish and Walleye. No fish were observed during the Spring Spawning survey on Thunder Lake, however DST 2014(b) identified potential Whitefish spawning habitat in several areas on the south side of Hoffstrom's Bay in addition to the cobble shoals at the bedrock point (Appendix Q Figure 3.1.3).

Wabigoon Lake

Wabigoon Lake is a cool water lake with moderate to high productivity and shallow, turbid water which is uncharacteristic of lakes in FMZ 5 (DST 2014b). It is surrounded by boreal mixed wood forest with extensive wetlands in sheltered bays (KCB 2012). Water levels in this lake are controlled by a dam in Dryden, Ontario at the outfall of Wabigoon River. The changing water levels cause shoreline erosion which contributes to the lake's turbidity. Wabigoon Lake is proximate to the communities of Wabigoon and Dryden as well as the Trans-Canada Highway and other roads. Walleye and Muskellunge angling support high recreation and commercial tourism use on this lake. Private homes and seasonal camps, as well as eight active tourist outfitters are present along its shorelines.

Habitat surveys were focuses on Keplyn's Bay area of Wabigoon Lake. Sand, silt and gravel comprise most of the north and south sides of the bay. Areas of aquatic vegetation are present intermittently on the north shore while a large area is present on the southwest tip of the bay entrance. The eastern edge of the bay is composed of rip-rap and boulder cobble a result of the rail causeway that is present.

The calm littoral waters of Keplyn's Bay has could provide rearing habitat for juvenile fish. No spawning Northern Pike or Muskellunge were observed on Wabigoon Lake during DST 2014(b) Spring Spawning Surveys, although areas with suitable aquatic vegetation were noted. Potential Northern Pike and Muskellunge spawning areas are noted in Appendix Q Figure 3.2.3. No Walleye were observed spawning and it is unlikely that they spawn in Keplyn's Bay as no suitable rocky shoals were found (DST 2014(b)). The mouth of Nugget Creek at Wabigoon Lake is designated a Provincial Fish Sanctuary to protect spawning Walleye.

5.8.4.6 STREAM HABITAT SUMMARY

Table 5.8.14 Stream Habitat Summary

Waterbody		Notes	Habitat
Blackwater Creek		Channel narrows towards headwaters. No permanent barriers to fish passage observed. Substrates dominated by fines (clay and silt) with some cobbles present. Cover includes vegetation, pools, woody debris and undercut banks.	Northern Pike spawning habitat common in all reaches. Evidence of Walleye and Sucker spawning observed in Reach 3, although their spawning habitat appeared very limited. DST 2014(b) caught juvenile White Suckers in minnow traps during a Spring Spawning survey, suggesting they use this stream for spawning. Rearing and overwintering habitat for Northern Pike also available in beaver ponds and deep pools.
Reach 1	Outlet of creek into Wabigoon Lake	Railway infrastructure likely inhibits fish passage though extent of exclusion is unknown. Low DO recorded at 2 m depth. Substrates dominated by organics. Cover includes dense submergent and emergent vegetation.	Overall habitat suitable for rearing, potential northern pike spawning habitat. Many juveniles and minnows observed.
Reach 2	500 m upstream of outlet to Keplyn Bay to Highway 17 crossing	Tortuous meander channel with vertical banks. Run/glide morphology with deep pools and one gravel riffle. Beaver ponds present on tributaries. No obstructions to fish passage noted. Substrates dominated by fines. Cover includes deep pools.	Good rearing habitat. Potential over wintering habitat. Potential northern pike spawning habitat (flooded grass and sedge) during high water and early spring.

Table 5.8.14 Stream Habitat Summary

Waterbody		Notes	Habitat
Reach 3	upstream of Highway 17 crossing to portal location and east along Willow Ave to Norman Road	Meander to tortuous meander channel. Run/glide morphology with deep pools. Low DO recorded at 1.3 m depth. Beaver activity present throughout reach - may inhibit fish passage. No permanent obstructions to fish passage noted. Substrates dominated by fines. Cover includes overhanging vegetation, deep pools and woody debris.	Spawning habitat noted in several areas (where gravel was deposited from construction activity). Low DO levels at beaver pond make that area unsuitable for fish except at shallow (0.3 m) depth.
Reach 4	upstream of Norman Road to headwaters	Series of beaver dams extending 2.5 km upstream of Norman Road. Riparian vegetation alternates between dense alder and sedge meadows. Peatlands are present near headwaters.	"Suitable habitat" present (KCB 2012).
Hughes Creek			
	Nugget Creek: outlet to Barrett Bay in Wabigoon Lake to confluence with Hughes Creek	Railway along lake shoreline, allows fish passage but impedes wave action. Lower 1.5 km of Nugget Creek is slow moving and meandering. Substrates dominated by fines. Road crossing contributes gravels. Dense emergent and submergent vegetation present at outlet to Barrett Bay.	Outlet provides good fish nursery habitat.
	1 km upstream of Nugget Creek confluence	Sinuous, riffle-pool morphology. Beaver dams present. Set of rapids present at bedrock outcropping near outlet. Substrates include bedrock outcropping with cobbles and boulders. Cover includes woody debris, boulders, pools and overhanging vegetation.	Walleye spawning habitat available at the rapids.

Table 5.8.14 Stream Habitat Summary

Waterbody		Notes	Habitat
	Rapids to Hughes Pond	Meandering. Creek widens to a shallow, marshy channel from Hughes Pond to ~1.3 km downstream. Beaver dams may limit fish passage at certain times, but White Suckers above the dams suggests periodic migration. Substrates are primarily silt and clay with a short reach of bedrock. Gravel and cobble present near a road/hydro line crossing. Organics comprise more of the substrate further upstream.	Walleye and White Sucker spawning habitat present near road/hydro line crossing). Areas of emergent vegetation provide potential Northern Pike spawning habitat.
Unnamed Thunder Lake Tributaries			
Unnamed Thunder Lake Tributary 1		Flows through sandy soils of an outwash plain. Iron precipitates observed (indicates groundwater discharge).	Provides protective rearing habitat for lake fish
Unnamed Thunder Lake Tributary 2 (*=DST "Unnamed Thunder Lake Tributary")			
	N/S branch confluence to Thunder Lake outlet	Juvenile fish observed at outlet. Iron precipitates observed in several locations (indicates groundwater discharge). Dense marsh vegetation present at outlet.	Provides protective rearing habitat for lake fish at outlet as well as potential spawning habitat for Northern Pike.
	North Branch	Deeply incised valley walls with silty, very fine sandy banks in some areas. Constructed dam at North Tree Nursery Pond is a permanent barrier to fish passage. Substrates dominated by fines. No gravel, cobble or boulder observed. Cover includes woody debris, pools and overhanging vegetation.	Provides good rearing habitat (1YO White Suckers caught) and overwintering habitat in deep pools. No Walleye or Sucker spawning habitat observed but may be available in fast-moving sections. Potential Northern Pike spawning habitat available in flood plain.
	South Branch	Irregular meander, unconfined channel morphology near confluence with North Branch. Channel splits into two channels	

Table 5.8.14 Stream Habitat Summary

Waterbody		Notes	Habitat
		and braids near South Tree Nursery Pond, which has a constructed dam. Natural bedrock falls present 30 m downstream of dam with a boulder filled channel. Bedrock falls and constructed dam are a permanent barrier to fish passage. Dominated by fines. No gravel, cobble or boulders present in lower reaches. Bedrock falls and boulders in channel near pond.	
Unnamed Thunder Lake Tributary 3		Heavy beaver activity just upstream of the outlet. Beaver pond had low DO (4.48 mg/L) suggesting it is anoxic at +0.3 m.	
Unnamed Thunder Lake Tributary 4		Heavy beaver activity and stagnant water near outlet.	
Hoffstrom's Bay Tributary		Outlet is densely vegetated.	Outlet provides rearing for lake fish and potential spawning habitat for Northern Pike.
Thunder Creek		Dam upstream of Hwy 17 excludes upstream migration of fish from Wabigoon Lake into Thunder Lake. Substrates are dominated by fines (silt/clay). Inlet and outlet densely vegetated with emergent and submergent vegetation.	Rapids near Hwy 17 are potential spawning habitat for Walleye, Sucker and Lake Whitefish. Outlet is suitable nursery habitat. Good Northern Pike spawning habitat (dense submergent vegetation).

5.8.4.7 HABITAT REHABILITATION OPPORTUNITIES

Wabigoon Lake in its present form occurred when the Wabigoon River was impounded at Dryden. This raised the surface water elevation by 3 m and has resulted in ongoing erosion and significant slumping of the shoreline materials into Wabigoon Lake. The Ontario Ministry of Natural Resources and Forestry has identified Crown shore stabilization on Wabigoon Lake as an effective way to benefit fish and fish habitat and offset potential losses from the Project development.

5.8.4.8 SPECIES AT RISK & SPECIES OF MANAGEMENT CONCERN

Species at Risk

KCB 2012 searched the OMNRF Natural Heritage Information Centre (NHIC) and Committee on the Status of Endangered Wildlife in Canada (COSEWIC) databases to determine Species at Risk (SAR) presence within the RSA. No records of fish SAR were found within the RSA and none were encountered during field surveys.

Species of Management Concern

Seven (7) fish Species of Management Concern were considered for this EIS (Table 5.8.15).

Table 5.8.15 Fish Species of Management Concern in the RSA

Species	Rationale for Inclusion	Results
Northern Pike	Sport fish Potential economic value	• Captured in most lake and stream locations (all except Hughes Creek). • Spawn in densely vegetated marshes of Wabigoon Lake bays, downstream of the Project.
Smallmouth Bass	Sport fish Potential economic value	• Captured in Wabigoon Lake. • Known to occur in Thunder Lake. • May use densely vegetated bays as a nursery.
Walleye	Sport fish Potential economic value	• Identified in Hughes Creek, Wabigoon Lake and Thunder Lake. • Potential to occur in Blackwater Creek (because of presence of spawning White Suckers). • Beaver dams may block access in some years. • Marshes at creek mouth in bays of Wabigoon and Thunder Lakes likely provide nursery and feeding habitat. • Important to recreational and commercial use.
Muskellunge	Sport fish Potential economic value	• None were captured in field surveys but are known to occur in Wabigoon Lake. • Potential spawning and nursery habitat available in the marshes at the mouths of Blackwater Creek, Thunder Creek and Nugget Creek.
Lake Whitefish	Sport fish Potential economic value	• None were captured in field surveys but are known to occur in Wabigoon Lake and Thunder Lake. • Have potential to use occur in LSA streams for spawning. • Potential spawning shoals present on east side of Thunder Lake. • Most valuable commercial freshwater fish in Canada (KCB 2012).
Lake Trout	Sport Fish	• None were captured during field surveys although they are known to occur in Thunder Lake. • Only Ontario sport fish adapted to oligotrophic lakes. • Preferred species among anglers. • Potential spawning shoals on east side of Thunder Lake.
White Sucker	Food source for predatory fish	• Identified in all locations except Thunder Creek and Wabigoon Lake, although database information indicates presence in Wabigoon Lake. • Marshes at creek mouth in bays of Wabigoon and Thunder Lakes likely provide nursery and feeding habitat.

5.9 Terrestrial Resources

Two terrestrial environmental baseline studies have been conducted for the Project:

- Baseline Study: November 2010 to November 2011 (Klohn Crippen Berger, September 2012; hereafter KCB 2012).
- 2013 Terrestrial Wildlife Baseline Study (DST Consulting Engineers, February 2014; hereafter DST 2014).

Refer to Appendix G and Appendix R for detailed treatments of methods and results.

5.9.1 Natural Heritage Areas

No internationally recognized areas (e.g., UNESCO Biosphere Reserve) or nationally protected sites (e.g., National Park) are located in the vicinity of the RSA. Two provincial parks are found within the LSA. Aaron Provincial Park is a relatively (117 ha), recreation-class park situated at the Thunder Lake outflow (approximately 2.5 km west of the existing mine portal). Lola Lake Provincial Park is a large (6,572 ha) Class 1 Strict Nature Reserve/Scientific Reserve-classed park that serves to protect an extensive peatland. This park partially overlaps the LSA to the northeast of the existing portal. Allowable activities are strictly regulated in parks with this classification.

5.9.2 Vegetation

5.9.2.1 ENVIRONMENTAL SETTING

The Project is located within the Ontario Shield Ecozone, the largest ecozone in Ontario. This ecozone is typified by extensive wetlands and boreal forests. Within the ecozone, the Project is situated within the Lake Wabigppm Ecoregion (Ecoregion 4S), within the Lower English River Section of the Boreal Forest Region. This ecoregion is characterized by a range of forest types (mixed forest 25%, sparse forest 24%, and coniferous forest 14%) and open water (24%) (Crins et al. 2009). Typical tree species include trembling aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), spruces (*Picea glauca*, *Picea marina*), white birch (*Betula papyrifera*) and willows (*Salix* spp.).

Landcover in the RSA is 61% forest, 20% wetland, 14% water, 5% development land and <1% barren land. Landcover in the LSA is 62% forest, 21 % water, 9% developed land, 8% wetland, and <1% barren land. The diversity of underlying landforms within Ecoregion 4S has resulted in a wide diversity of ecosites (common groupings of abiotic and biotic components) within the RSA (Table 5.9.1; Figure 5.9.1; see Appendix G and Appendix R for a full description of ecosite characteristics).

Table 5.9.1 Ecosites of the RSA And LSA (Based On Table 9.5 KCB 2012)

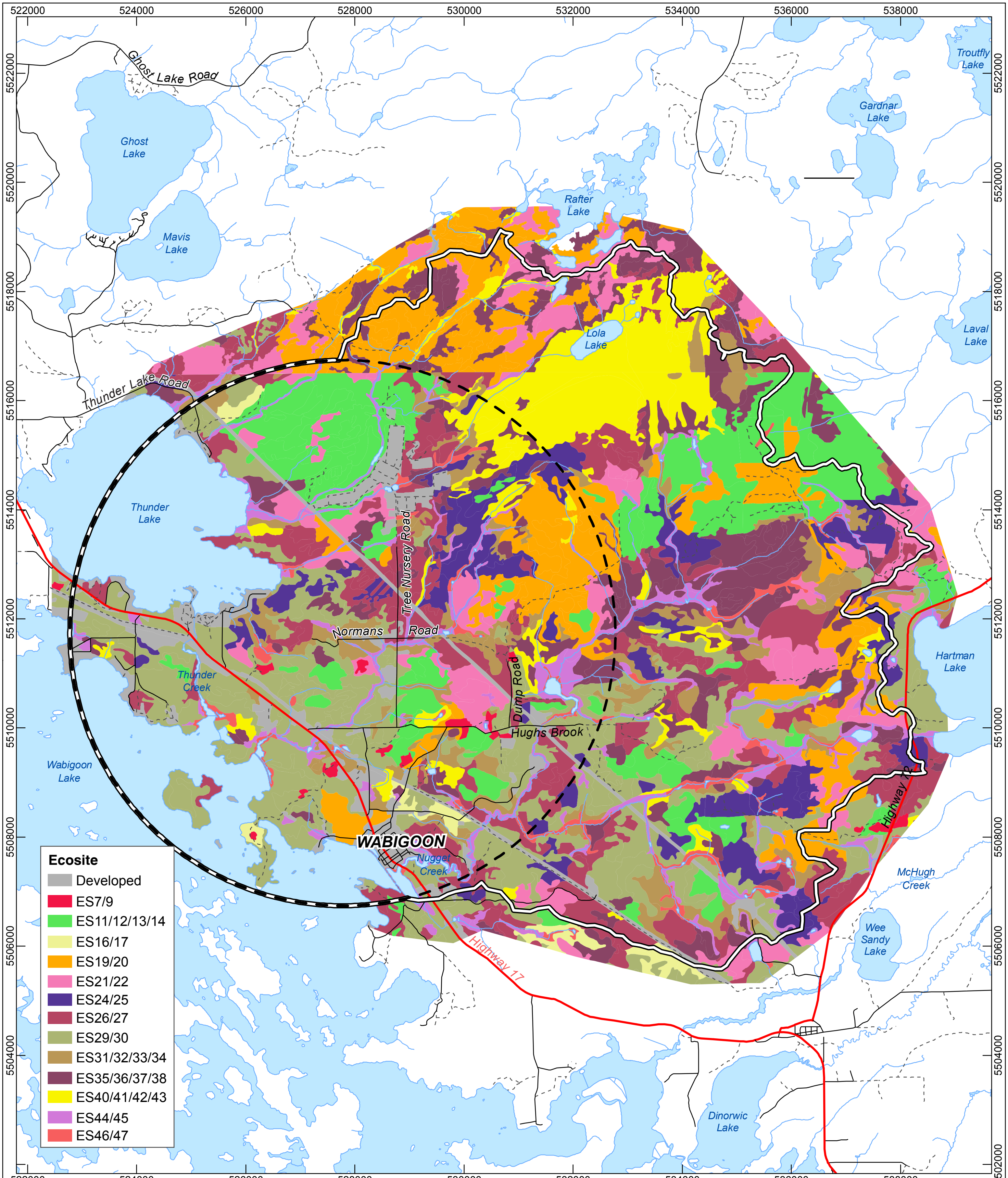
ECOSITE	RSA		LSA	
	(km^2)	%	(km^2)	%
Agricultural / Developed	7.6	5	6.81	9
Open Water	19.97	14	16.13	21
ES7 Rock Barren	0.06	<1	0.06	<1
ES9 Sand Barren	0.38	<1	0.38	<1
ES11 Red Pine-White Pine-Jack Pine: Very Shallow Soil	0.18	<1	-	-
ES12 Black SpruceJack Pine: Very Shallow Soil	2.63	2	1.9	2
ES13 Jack Pine-Conifer: DryModerately Fresh, Sandy Soil	9.95	7	4.92	6
ES14 Pine-Spruce Mixedwood: Sandy Soil	1.26	1	0.81	1
ES16 Hardwood-FrSpruce Mixedwood: Sandy Soil	0.51	<1	0.51	1
ES17 White Cedar: FreshMoist, Coarse-Fine Loamy Soil	0.18	<1	0.12	<1
ES19 HardwoodFirSpruce Mixedwood: Fresh, Sandy-Coarse Loamy Soil	2.75	2	1.05	1
ES20 Spruce-Pine / Feathermoss: Fresh, SandyCoarse Loamy Soil	11.13	8	4.17	5
ES21 FrSpruce Mixedwood: Fresh, Coarse Loamy Soil	6.14	4	1.78	2
ES22 SprucePine/Ledum/Feathermoss: Most, SandyCoarse Loamy Soil	1.72	1	1.27	2

Table 5.9.1 Ecosites of the RSA And LSA (Based On Table 9.5 KCB 2012)

ECOSITE	RSA		LSA	
	(km²)	%	(km²)	%
ES24 Red Pine-Whie Pine: Fresh, Fine Loamy Soil	0.05	<1	0.05	<1
ES25 PineSpruce / Feathermoss: Fresh, Silty Soil	8.1	6	3.03	4
ES26 Spruce-Pine / Feathermoss: Fresh, Fine Loamy-Clayey Soil	12.34	8	5.95	8
ES27 FirSpruce Mixedwood: Fresh, Fine Loamy Soil	1.69	1	1.19	2
ES29 Hardwood-FirSpruce Mxedwood: Fresh, Fine Loamy-Clayey Soil	22.12	15	14.34	18
ES30 Black Ash Hardwood: Fresh, Silty-Clayey Soil	0.41	<1	0.41	1
ES31 Spruce-Pine / Feathermoss: Moist, Silty-Clayey Soil	2.59	2	1.32	2
ES32 FirSpruce Mixedwood: Moist, SiltyClayey Soil	1.73	1	0.94	1
ES33 Hardwood-FirSpruce Mixedwood: Moist, Silty-Clayey Soil	3.28	2	1.71	2
ES34 Treed Bog: Black Spruce: Organic Soil	0.54	<1	0.09	<1
ES35 Poor Swamp: Black Spruce: Organic Soil	35	2	0.4	1
ES36 Intermediate Swamp: Black Spruce (Tamarack): Organic Soil	7.82	5	2.19	3
ES37 Rich Swamp: Cedar (Other Conifer): Organic Soil	1.55	1	0.46	1

Table 5.9.1 Ecosites of the RSA And LSA (Based On Table 9.5 KCB 2012)

ECOSITE	RSA		LSA	
	(km²)	**%**	**(km²)**	**%**
ES38 Rich Swamp: Black Ash (Other Hardwood): OrganicMineral Soil	0.32	<1	0.24	<1
ES40 Treed Fen: TamarackBlack Spruce / Sphagnum: Organic Soil	2.86	2	1.69	2
ES41 Open Poor Fen Ercaceous Shrub / Sedge / Sphagnum: Organic Soil	0.08	<1	0.05	<1
ES42 Open Mod. Rich Fen: Eric. Shrub / Sedge / Sphagnum: Organic	3.33	2	0.26	<1
ES43 Open Extr. Rich Fen: Eric. Shrub / Sedge/ Brown Moss: Organic	1.19	1	0.41	1
ES44 Thicket Swamp: Mineral Soil	3.62	2	1.83	2
ES45 Shore Fen: Organic Soil	1.94	1	1.01	1
ES46 Meadow Marsh: Organic-Mineral Soil	2.17	2	0.84	1
ES47 Sheltered Marsh: Emergent: Sedimentary Peat Substrate	0.04	<1	0.04	<1
Ecosites Identified in 2011 Fieldwork				
ES48 Exposed Marsh: Emergent: Mineral Substrate	+	<1	+	<1
ES49 Open Water Marsh: Subm. / Floating-leaved: Sed. Peat Substr.	+	<1	+	<1
ES50 Open Water Marsh: Submergent: Mineral Substrate	+	<1	+	<1
TOTAL	**145.73**	**100**	**79.17**	**100**



GOLIATH GOLD PROJECT
DRYDEN, ONTARIO, CANADA

Ecosites of the LSA and RSA

FIGURE: 5.9.1 REV.00

NOT FOR CONSTRUCTION

TREASURY METALS INC.

DESIGN: AT 06 FEB. 2014
GIS: AT 22 Jul. 2014
CHECK: XX ADD DATE
REVIEW: XX ADD DATE

LEGEND

- Regional Study Area
- Local Study Area
- Highway
- Local Road
- Recreational Road
- Waterbody
- Watercourse

0 500 1,000
Meters

N

NOTES:

1. UTM Zone 15N, NAD83
2. Base Data Source: OBM
3. 1:90 000 scale NTS
4. Ecosites from FRI data by MNR. Combined from the Wabigoon and the Dryden Forest Ecosites

TREASURY METALS INCORPORATED

5.9.2.2 FOREST COMPOSITION

The LSA (and most of the RSA) falls within the Dryden Forest Management Unit (hereafter Dryden Forest). Dryden Forest is comprised of coniferous (53%), mixed wood (42%), and broadleaf (5%) forests, 29% of which is considered mature and late stage forest (DFMC 2010). The forest composition of the RSA and LSA match that of the larger Dryden Forest (Figure 5.9.2).

5.9.2.3 OTHER TERRESTRIAL LAND COVER

The non-forested areas within the RSA and LSA are primarily agricultural (i.e., pasture or hayfield dominated by introduced species. A defunct tree nursery is located at the north edge of the LSA. In addition to the two provincial parks, other developed areas within the LSA include the Town of Wabigoon (south LSA) and the local garbage dump (central-east LSA).

5.9.2.4 FIELD SURVEYS

Vegetation field surveys were restricted to the LSA and included 60 person days of effort in 2010 and 2011 across over 300 individual field stations. Methods were based on the OMNRF Ontario Parks Inventory and Monitoring Program (McCaul et al. 2008).

Biologists detected 270 vascular plant species in the LSA during the course of field survey activities (Appendix G), 25 of which were introduced species commonly associate with disturbed habitats. Most of the remaining species are typical of Ontario’s southern boreal forest.

5.9.3 Wetlands

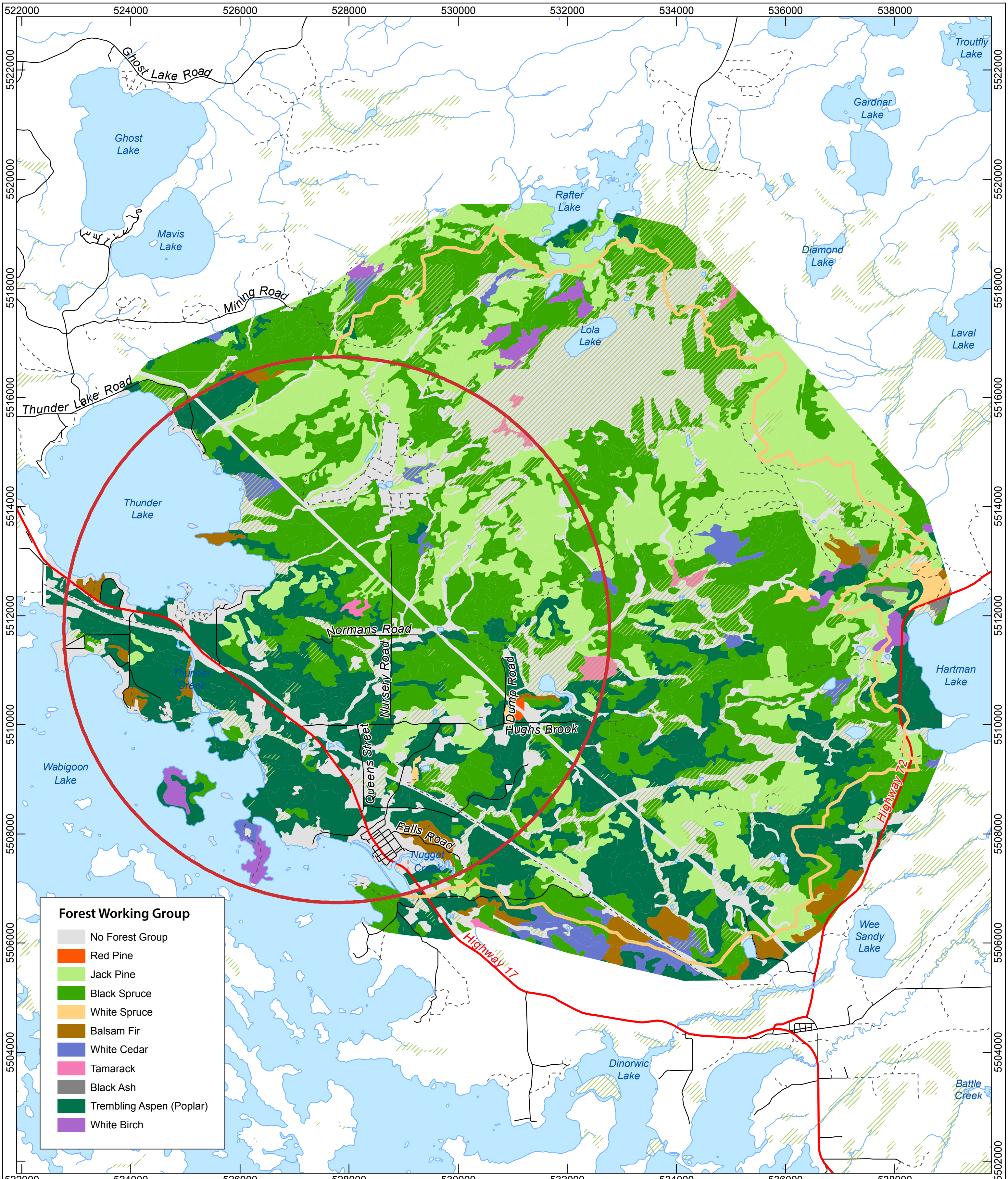
5.9.3.1 ENVIRONMENTAL SETTING

The majority of the Project area lies within the Dryden Forest Management Unit (FMU), but also extends into the adjacent Wabigoon FMU (OMNRF 2014). Both FMUs fall within the boundaries of the Wabigoon Ecoregion and are located on the Precambrian Shield. The bedrock in the area is primarily granite and greenstone comprised of metavolcanic and metasedimentary rocks, with granitoid intrusions. The landscape of the Wabigoon Ecoregion is a gently sloping plain of shallow tills over bedrock in conjunction with moraine of varying depths. Sediments consist of sandy-silt, sand and gravel deposits overlain by lacustrine sand, silt and varved clays. Localized pockets of clay and silt are scattered in low-lying areas. Vegetation conditions are described in Section 5.9.2, and descriptions of wildlife and associated habitat are presented in subsequent sections.

5.9.3.2 ASSESSMENT METHODS

A wetland survey was conducted during the summer of 2012 (Appendix S). The purpose of the survey was to gain baseline knowledge of wetlands located within the proposed Project area, with emphasis placed on wetlands located in areas of potential mining infrastructure development. The specific objectives, as provided by the Ontario Wetland Evaluation System (OWES) (OMNRF 1993) were as follows:

- Characterize all riparian/wetland vegetation communities within the proposed project area according to the appropriate classification guides provided by OWES.
- Describe individual wetland vegetation community distribution, structure, and diversity; and, identify any provincially significant wetlands.



GOLIATH GOLD PROJECT
DRYDEN, ONTARIO, CANADA

Forest Working Groups of the LSA and RSA

FIGURE: 5.9.2 REV.00

NOT FOR CONSTRUCTION

TREASURY METALS INC.

DESIGN: AT 06 FEB. 2014
GIS: AT 23 Jul. 2014
CHECK: XX ADD DATE
REVIEW: XX ADD DATE

Local Study Area
Regional Study Area
Waterbody
Wetland Area
Highway
Local Road
Recreational Road
Watercourse

0 500 1,000 Meters

N

Notes:
1. UTM Zone 15N, NAD83
2. Base Data Source: OBM
3. 1:90 000 scale NTS
4. Forest Groups from FRI data provided by MNR.

A wetland can be comprised of multiple types of ecosystems including bogs, fens, swamps, and marshes. The OWES refers to these classifications as “wetland types”. Wetland types differ in their appearance and species composition and therefore have different rates of productivity. Wetland types are determined based on major plant associations, substrate, and hydrological information obtained in the wetland. A wetland may be comprised of one or more wetland types.

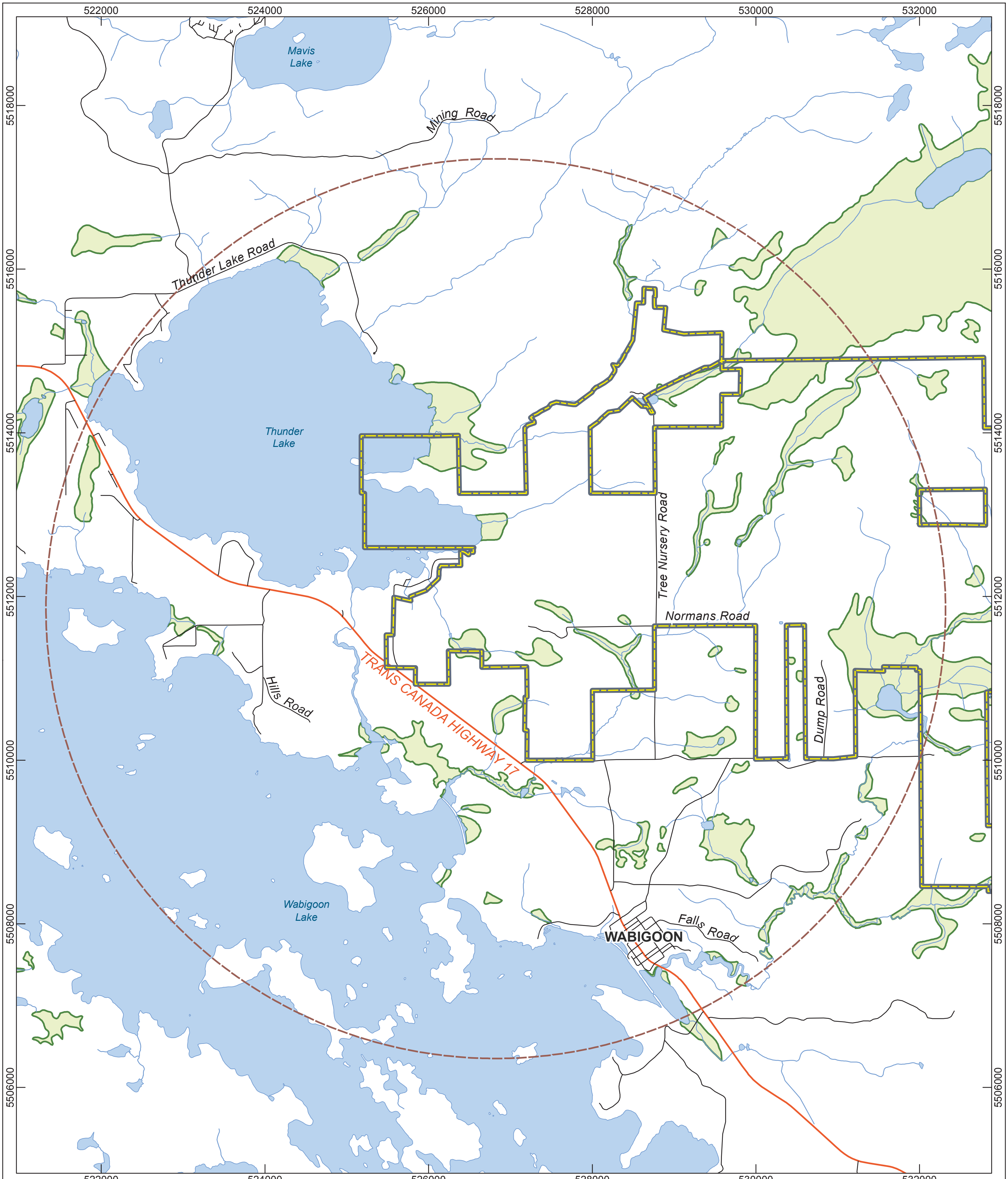
A wetland biologist applied the OWES protocol to assess and score wetlands within the proposed project area. The OWES evaluation procedure involves assigning points to the different features of a wetland, based on four components: social, hydrological, biological, and special features. As the score for each component is capped at 250 points, a wetland can score a maximum of 1,000 points. Wetlands which achieve a total score of 600 or more points, or a score 200 or more points in either the biological or special features components, are considered to be provincially significant.

The NHIC compiles, maintains, and distributes information on native species, plant communities and areas of conservation concern in Ontario. They also provide a provincial designation prioritizing protection efforts for each applicable species. Prior to conducting the field survey, records were compiled from the NHIC (NHIC 2012) and used to guide the wetland assessment.

For the purposes of this assessment, the survey area was delineated to include Treasury Metals Inc. patented land and the areas immediately adjacent that could be physically impacted by the proposed project. Adjacent areas included Thunder Lake to the east, and Hughes Creek, Black Water Creek, Thunder Creek, and Wabigoon Lake to the south. Wetlands with an area greater than 0.5 ha, as identified through Forest Resource Inventory maps, were considered for field assessment.

5.9.3.3 FINDINGS

Nine wetlands were identified as being potentially impacted by future development (Figure 5.9.3) and were assessed in the field using the OWES protocol. Marsh wetland types (wetlands dominated by emergent vegetation) were the most frequently encountered, and swamp wetland types (wooded wetlands with 25% or more tree/woody shrub cover) composed the largest area (49.7% of total area assessed) (detailed survey results are presented in Table 5.9.2; summary of wetland types are presented in Table 5.9.3; dominant plant species are presented in Table 5.9.4). Fen wetlands (peatlands characterized by surface layers of poorly to moderately decomposed peat) were also documented in the survey area. Small areas of marsh dominated by emergent vegetation and shrubs were prominent throughout the study area. A total of 23.1% of the wetlands assessed were lacustrine (i.e., related to an open, freshwater body) located on Thunder Lake and Wabigoon Lake, and 73.9% were palustrine (i.e., emergent marsh wetlands with little or no open water). No component score for any wetland exceeded the maximum value for being provincially significant. No threatened, endangered, or provincially significant plant species were observed during the field survey; however, three provincially significant avian species were identified in five of the assessed wetlands (Table 5.9.5).



GOLIATH GOLD PROJECT
DRYDEN, ONTARIO, CANADA

SCALE: 60000

TREASURY METALS INC.

WETLAND AREAS WITHINPROJECT STUDYAREA

DESIGN: AT 06 FEB. 2014
GIS: AT 03 MAR. 2014
CHECK: AT 09 OCT. 2014

FIGURE: 5.9.3 | REV.01

LEGEND

- Wetland Area
- Local Study Area
- Property Boundary
- Waterbody
- Watercourse
- Highway
- Local Road

REFERENCE
Base Data: OBM & TML
Projection: NAD83 UTM Zone 15N

Table 5.9.2 Summary Of OWES Scores for Each Wetland Evaluated

Wetland ID:		WLD1	WLD2	WLD3	WLD4	WLD5	WLD6	WLD7	WLD8	WLD9
BIOLOGICAL COMPONENT										
Productivity	Growing Degree-Day/soils (max 30)	8	7	10	9	8	8	13	9	8
	Wetland Type (max 15)	7	8	9	13	7	15	11	8	9
	Site Type (max 5)	2	2	2	2	2	5	2	2	2
Biodiversity	Number of Wetland types (max 30)	20	13	13	13	13	9	13	20	20
	Vegetation Communities (max 45)	5	5	3	5	5	3	5	5	7
	Diversity of Surrounding Habitat (max 7)	6	7	6	7	7	7	7	7	6
	Proximity to other wetlands (max 8)	8	8	8	8	8	8	8	8	8
	Interspersion (max 30)	9	6	9	12	12	15	12	18	6
	Open water type (max 30)	8	0	14	20	8	30	30	14	14
	Size (max 50)	10	7	9	17	8	25	25	21	9
Total Biological	**Component (not to exceed 250)**	**83**	**63**	**83**	**106**	**78**	**125**	**126**	**112**	**89**
SOCIAL COMPONENT										
Economically Valuable Products	Wood products (max 14)	0	0	0	0	0	0	0	6	4
	Low Bush Cranberry (max 2)	2	2	0	0	2	0	0	0	2
	Wild rice (max 10)	0	0	0	0	0	10	0	0	0
	Commercial fish (max 12)	0	12	12	12	0	12	12	12	12
	Furbearers (max 12)	3	0	3	3	0	3	6	0	3
Recreational Activities	Hunting/Fishing/Nature (max 80)	0	0	0	0	0	8	0	0	0
	Landscape Distinctness (max 3)	3	3	3	3	3	3	3	3	3
	Absence of human disturbance (max 7)	7	4	4	4	7	4	7	7	4
	Educational Uses (max 20)	0	0	0	0	0	0	0	0	0
	Facilities and Programs (8)	0	0	0	0	0	0	0	0	0
	Research and Studies (max 12)	8	5	5	5	0	5	5	5	5
	Proximity to human settlement (max 40)	10	10	10	10	10	10	10	10	10
	Ownership (max 10)	8	5	4	8	4	4	8	8	4
	Size (max 20)	7	2	2	2	3	5	5	11	7
	Aboriginal and cultural (max 30)	0	0	0	0	0		0	0	0
Total for Social	**Component (not to exceed 250)**	**48**	**43**	**43**	**47**	**29**	**64**	**56**	**62**	**54**
HYDROLOGICAL COMPONENT										
	Flood attenuation (max 100)	59	35	10	14	34	0	0	0	30
Ground Water Recharge	Site type (20)	20	20	20	20	20	0	0	0	20
	Hydrological Soils (max 10)	7	7	4	4	4	0	0	0	7
Downstream Water Quality	Watershed Improvement (max 30)	30	30	30	30	21	30	30	30	30
Improvement	Adjacent Watershed Land Use (max 60)	4	4	4	4	14	29	14	29	4
	Vegetation form (max 10)	8	8	8	10	8	10	10	8	8
	Carbon Sink (max 15)	15	9	9	9	0	9	9	9	9
	Shoreline erosion control (max 15)	0	0	0	0	0	8	15	8	0
	Groundwater Discharge (max 30)	22	21	18	17	12	22	17	17	21
Total for Hydrological	**Component (not to exceed 250)**	**165**	**134**	**103**	**108**	**113**	**108**	**95**	**101**	**129**
SPECIAL FEATURES										
Rarity	Wetlands (max 70)	50	30	30	30	40	20	30	50	50
	Endangered/Threatened spp. breeding habitat (no max)	0	0	0	0	0	0	0	0	0

Table 5.9.3 Proportional Distribution of Wetland Types and Dominant Vegetation for Evaluated Wetlands in the Goliath Gold Project Study Area (2012)

Wetland type	Total % of area of wetlands surveyed	% Dominant Vegetative Forms										
		Conifer (C)	Tall Shrubs (TS)	Low Shrubs (LS)	Narrow Emergents (NE)	Robust Emergents (RE)	Broad-leaved Emergents (BE)	Floating Plants (F)	Subemergents (SU)	Mosses and Lichens (M)	Herbs and Ground Cover (GC)	Unvegetated (U)
Fen	34	0	22.0	7.0	3.5	0	0	0	0	1.5	0	0
Marsh	1	0	0	0	7.2	6.1	0	1	2.3	0	0	
Swamp	4	22.88	26.9	0	0	0	0	0	0	0	0	0

Table 5.9.4 Dominant Plant Species in All Assessed Wetlands

Dominant Species		% Occurrence	Vegetation Form
Common Name	**Scientific Name**		
Canada bluejoint	*Calamagrostis canadensis*	65.2	Narrow-leaved Emergents (NE)
Sphagnum spp.	*Sphagnum spp.*	39.1	Mosses and Lichens (M)
Speckled alder	*Alnus incana*	60.1	Tall Shrubs (TS)
Labrador Tea	*Rhododendron*	26.1	Low Shrubs (LS)
Lance-leaved Aster	*Aster lanceolatus*	34.8	
Dwarf Raspberry	*Rubus pubescens*	34.8	Herbs and Graminoides (GC)
Viola Species	*Viola spp.*	34.8	
Tape grass	*Vallisneria amaericana*	13.0	Submerged Plants (SU)
Common cattail	*Typha latifolia*	43.5	Robust Emergents (RE)
Buckbean	*Menyanthes trifoliata*	13.0	Broad-leaved Emergents (BE)
Floating-Leaved pondweed	*Potamogeton natans*	13.0	Floating Plants (F)
Eastern White Cedar	*Thuja occidentalis*	17.4	Conifer (C)
White Birch Balsam Poplar	*Betula papyrifera* *Populus balsamifera*	4.3 4.3	Hardwood (H)
Duckweed	*Lemna minor*	4.3	Free Floating Plants (FF)

Table 5.9.5 Provincially Significant Species Identified During the Wetland Survey

Wetland ID	Scientific Name	Common Name
WLD9	*Contopus cooperi*	Olive Sided Flycatcher
WLD4, WLD7, WLD6, WLD 8	*Haliaeetus leucocephalus*	Bald Eagle
WLD 8	*Wilsonia canadensis*	Canada Warbler

A search of the NHIC database indicated a number of vascular wetland plants identified as provincially rare are found within the Dryden District. Habitat for these plants has been described as including ditches, shorelines, rocky outcrops, disturbed areas, damp thickets, meadows, seasonally flooded swales, and other wet ground and wetland type areas. None of these species; however, were encountered during the 2012 wetland field assessment.

5.9.4 Mammals

A number of mammal-focused survey efforts have been conducted within the LSA and RSA:

- Encounter surveys (i.e., meandering transects through potential habitat) focused on key ungulate habitats (e.g., winter deer yards) and SAR habitats (e.g., grasslands for American Badger (Taxidea taxus) (2010-2013);
- Passive presence/absence acoustic monitoring for bats (2011 and 2012); and
- Small mammal trapping (2013 only).

Twenty-one mammal species were detected during the baseline survey efforts. Several large mammals were regularly observed (Moose *Alces alces*, White-tailed Deer *Odocoileus virginianus*, Black Bear *Ursus americanus*, and Gray Wolf *Canis lupus lupus*) as were several furbearer species (Beaver *Castor canadensis*, Mink *Mustela vison*, River Otter *Lontra canadensis*, Red Fox *Vulpes vulpes*, Muskrat *Ondantra zibethicus*, Woodchuck *Marmota monax*, and Snowshoe Hare *Lepus americanus*). Small mammal trapping surveys in October 2013 captured four species over a four-night period: Red-backed Vole *Clethrionomys gapperri*, Deer Mouse *Peromyscus manculatus*, Northern Short-tailed Shrew *Blarina brevicauda*, and Red Squirrel *Tamiasciurus hudsonicus*.

Passive acoustic monitoring of bat activity in 2011 and 2012 detected five species: Hoary Bat *Lasiurus cinereus*, Silver-haired Bat *Lasionycteris noctivagans*, Little Brown Myotis *Myotis lucifugus*, Northern Myotis *Myotis septentrionalis* and Big Brown Bat *Eptesicus fuscus*.

5.9.5 Birds

A number of bird-focused survey efforts have been conducted within the LSA and RSA:

- Breeding Bird Surveys (Forest Bird Monitoring Program protocol; Konze and McLaren 1997);
- Migration Surveys (Hawk Migration Association of North America protocol; HMANA 2011);
- Marshbird and Waterfowl Survey (Marsh Bird Monitoring Program; Konze and McLaren 1997);
- Bobolink Survey (Forest Bird Monitoring Program protocol; Konze and McLaren 1997); and
- Whip-poor-will and Common Nighthawk Surveys (Whip-poor-will Roadside Survey Protocol; Bird Studies Canada 2011).

Over 140 bird species have been detected within the LSA over the course of environmental baseline surveys (Appendix G and Appendix R), of which over 100 breed (or probably breed) within the LSA (based on existing data from the Ontario Breeding Bird Atlas and on habitat availability and range overlap). Intensive nest searches were not conducted during the baseline survey efforts. No active stick nests were detected within the LSA; however, active nests were detected for several species:

- Common Loon (Gavia immer): active nest on Thunder Lake;
- Barn Swallow (Hirundo rustica): active nests on buildings on the grounds of the former tree nursery;
- Common Grackle (Quiscalus quiscala): nest in the central LSA (grackle nests are not protected by the Migratory Birds Convention Act).

The species detected during the environmental baseline surveys are typical of Ontario's southern boreal forest. The majority of the birds detected during field efforts are protected under the federal *Migratory Birds Convention Act*.

5.9.6 Amphibians and Reptiles

Call count surveys have been conducted on site (21 sites in each of 2011 and 2012) in accordance with established protocols (e.g., Amphibian Road Call Count; Konze and McLaren 1997). In addition, passive acoustic monitors were deployed in 2011 to record calls from birds, frogs, and bats (33 recorder location-nights). Six amphibian species have been recorded within the LSA: Spring Peeper *Pseudacris crucifer*, Boreal Chorus Frog *Psuedacris maculata*, Grey Treefrog *Hyla versicolor*, Wood Frog *Lithobates sylvaticus*, American Toad *Anazyrus americanus*, and Blue-spotted Salamander *Ambystoma jeffersonianum-laterale* "complex".

Visual encounter surveys for reptiles were conducted in appropriate habitats (e.g., basking logs, soil banks) as they were encountered during other field survey efforts during the 2011 field program. Western Painted Turtle (*Chrysemys picta belli*) and Eastern Garter Snake (*Thamnophis sirtalis sirtalis*) were regularly detected within the LSA.

5.9.7 Invertebrates

No systematic surveys of terrestrial invertebrates have been conducted within the LSA. Incidental observations gathered during the 2011 field efforts (KCB 2012) included four butterflies (*Papilo glaucus candensis*, *Colias eurytheme*, *Celastrina ladon*, *Nymphalis antiopa*), two damselflies (*Calopteryx aequabilis*, *Nehalennia irene*) and 16 dragonflies (*Aeshna canadensis*, *Aeshna interrupta*, *Arigomphus cornutus*, *Boyeria grafiana*, *Dorocordulia libera*, *Dromogomphus spinosus*, *Epitheca cynosura*, *Gomphus graslinellus*, *Gomphus lividus*, *Hagenius brevistylus*, *Leucorrhinia hudsonica*, *Libbellula lydia*, *Libellula pulchella*, *Libellula quadrimaculata*, *Macromia illinoiensis*, *Sympetrum danae*).

5.9.8 Significant Wildlife Habitat

In accordance with the OMNRF guidance (OMNRF 2000) the occurrence of significant wildlife habitat and the potential for seasonal wildlife concentrations was evaluated (Appendix G; Tables 5.9.6 to 5.9.7).

Table 5.9.6 Assessment of Seasonal Concentrations of Wildlife in the LSA (Modified from Table 8.12 in KCB 2012)

Type of Seasonal Concentration	Likelihood of Occurrence in the LSA	Comments
White-tailed deer winter yard	Possible	Not documented or observed in field investigation. Potential habitat present.
Moose late winter habitat	Possible	Not documented or observed in field investigation. Potential habitat present.
Waterfowl stopover and staging areas	Confirmed	Marshes at Blackwater, Nugget, and Thunder Creek supported significant numbers of migrating waterfowl in October 2011. There are fairly extensive areas of wild rice (important duck food) at these sites.
Waterfowl nesting areas	Confirmed	Eight waterfowl species observed during the nesting season. Marshes at Blackwater, Nugget, and Thunder Creek may be significant nesting habitat.
Colonial bird nesting sites	Possible	No evidence of heronries or nesting of other colonial species documented or observed in site investigation. Potential habitat present for Great Blue Heron.
Shorebird migratory stopover areas	Possible	No significant numbers of shorebirds observed during site investigation. Stopover of some species may occur in fields and marshes in some years.
Landbird migratory stopover area	Unlikely	Not documented. Stopover of some species may occur, but unlikely to be significant at more than the local scale given the absence of large lakes, ravines, and other landforms likely to concentrate migrants.
Raptor wintering areas	Possible	None documented or observed in site investigation. Some potential habitat is present but wintering raptors are generally uncommon in northwestern Ontario.
Bald Eagle winter, feeding and roosting sites	Possible	Bald Eagles observed in May to October 2011. Wintering not documented. No open water present in most winters, but the dump is a potential source of food.
Wild turkey winter range	No	Wild Turkeys do not occur in the area.
Turkey vulture summer roost	Unlikely	None documented or observed in site investigation.
Reptile hibernacula	Possible	None documented or observed in site investigation. Potential habitat present.
Bat hibernacula	Unlikely	None documented. No suitable habitat present.
Butterfly migratory stopover areas	Unlikely	None documented or observed in site investigation. Suitable habitat present on Wabigoon Lake shoreline, but significant butterfly migration has apparently not been documented in northwestern Ontario.
Bullfrog concentration areas	No	Bullfrogs do not occur in the area.

Table 5.9.7 Assessment of Specialized Wildlife Habitat in the LSA (Modified From Table 8.13 in KCB 2012)

Natural Feature	Likelihood of Occurrence in the LSA	Comments
Habitat for Area Sensitive Species	Confirmed	Twenty-nine area sensitive species observed in site investigation.
Forest providing high diversity of habitats	Confirmed	Relatively large, old, and undisturbed forest stands present.
Amphibian Woodland Breeding Pools	Confirmed	Suitable habitat noted during site investigation. Seven amphibian species observed.
Foraging Areas with Abundant Mast	Possible	No oaks or other nut-bearing trees. Fruit bearing shrubs (blueberries, June berries, pin cherries) common.
Osprey, Bald Eagle nesting habitat	Possible	None documented or observed in site investigation but Bald Eagles observed during nesting season and suitable habitat present.
Turtle Nesting Habitat	Yes	None documented or observed in site investigation but Western painted turtle is present.
Moose aquatic feeding areas	Possible	None documented or observed in site investigation. Suitable habitat present.
Mink and otter feeding/denning sites	Possible	Dens not observed or documented, but both species present in the LSA.
Marten and fisher denning sites	Possible	Dens not observed or documented, but suitable habitat present and both species present in surrounding area.
Areas of High Diversity (e.g., seeps, springs, cliffs, and caves)	Unlikely	None documented or observed in site investigation.

5.10 Species at Risk

5.10.1 Definition

For the purposes of this EIS, Species at Risk (SAR) are defined as:

- Any species listed as Special Concern, Threatened or Endangered by the Committee on the Status of Species at Risk in Ontario (COSSARO) under the auspices of the provincial Endangered Species Act.
- Any plant species identified as provincially rare by the OMNRF Natural Heritage Information Centre (NHIC)
- Any species listed as Special Concern, Threatened or Endangered on Schedule 1 of the federal Species at Risk Act.
- Any species listed as Special Concern, Threatened or Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

5.10.2 Potential Species at Risk

The potential occurrence of plant SAR was evaluated (KCB 2012) by searching the NHIC (2012) database for the Dryden District and all 10 km x 10 km grid squares that intersected with the LSA and RSA (15WR10-12, 15WR20-22, 15WR30-32, 15WR40-42). This search was augmented by species lists in the Dryden Forest Management Plan (DFMC 2010). Twenty potentially occurring SAR were highlighted in this search (Table 5.10.1) and were the focus of targeted rare plant surveys conducted in July 2011 within the LSA. Based on existing data sources (e.g., Ontario Breeding Bird Atlas [OBBA]), 24 terrestrial SAR are known to occur or have the potential to occur within the LSA and RSA (Table 5.10.2).

Table 5.10.1 Plant Species at Risk Potentially Occurring within the LSA and RSA

Species				
English Name	**Scientific Name**	**Status**	**Habitat**	**Location**
yellow birch	*Betula alleghaniensis*	Locally Rare	deciduous and mixed forest	record in Dryden Forest
floating marsh marigold	*Caltha natans*	S1	shallow water	Thunder Creek at Wabigoon Lake
Parry's sedge	*Carex parryana*	S1	ditches	record in Dryden District
northern meadow sedge	*Carex praticola*	S2	various	record in Dryden District
water pygmyweed	*Crassula aquatica*	S2	aquatic	record in Dryden District
Vasey's rush	*Juncus vaseyi*	Rare	aquatic	record in Dryden Forest
large-flowered ground herry	*Leucophysalis grandiflora*	S3	disturbed habitat	record in Dryden District
northern mudwort	*Limosella aquatica*	S2	aquatic	record in Dryden District
large-leaved sandwort	*Moehringia macrophylla*	S2	rocky outcrops	record in Dryden District
brittle prickly pear	*Opuntia fragilis*	S3	rocky outcrops	record in Dryden District
western wheat grass	*Pascopyrum smithii*	S2	prairies	record in Dryden District
Braun's holly fern	*Polystichum braunii*	S3	moist woods	record in Dryden District
brook cinquefoil	*Potentilla rivalis*	SH	various	record in Dryden District
bur oak	*Quercus macrocarpa*	Locally Rare	deciduous and mixed forest	Record in Dryden Forest
slender bulrush	*Schoenoplectus heterochaetus*	S3	aquatic	record in Dryden District
water awlwort	*Subularia aquatica*	S3	aquatic	record in Dryden District
prairie white heath aster	*Symphyotrichum ericoides var. pansum*	S2	rocky outcrops	record in Dryden District
western silvery aster	*Symphytrichum sericeum*	S1	rocky outcrops	record in Dryden District
white elm	*Ulmus laevis*	Locally Rare	deciduous and mixed forest	record in Dryden Forest
heart-leaved Alexander	*Zizia aptera*	S2	rrairies and rail lines	record in Dryden Forest

Table 5.10.2 Wildlife Species at Risk Potentially Occurring or Known to Occur within the LSA and RSA

Species		Status			Local or Recent Records
English Name	**Scientific Name**	**SARA**	**COSEWIC**	**SARO**	
Birds					
American White Pelican	*Pelecanus erythrorhynchus*	-	NAR	T	Lake of the Woods
Least Bittern	*Ixobrychus exilis*	T	T	T	Within local OBBA square
Bald Eagle	*Haliaeetus leucocephalus*	NAR	SC	SC	Recorded in LSA
Golden Eagle	*Aquila chrysaetos*	-	NAR	E	Records to north and south of LSA. Possible migrant
Yellow Rail	*Coturnicops noveboracensis*	SC	SC	SC	Dryden Forest
Black Tern	*Chlidonias niger*	-	NAR	SC	Recorded in LSA
Short-eared Owl	*Asio flammeus*	SC	SC	SC	Dryden Forest
Common Nighthawk	*Chordeiles minor*	T	T	T	Recorded in LSA
Eastern Whip-poor-will	*Caprimulgus vociferous*	T	T	T	Northern range limit. Closest records is west of Dryden
Chimney Swift	*Chaetura pelagica*	T	T	T	None but within range.
Peregrine Falcon	*Falco peregrinus*	SC	T	T	Recorded in LSA
Olive-sided Flycatcher	*Contopus cooperi*	T	T	T	Recorded in LSA
Barn Swallow	*Hirundo rustica*	-	T	-	Active nests in LSA
Canada Warbler	*Cardellina canadensis*	T	T	T	Recorded in LSA

Table 5.10.2 Wildlife Species at Risk Potentially Occurring or Known to Occur within the LSA and RSA

Species		Status			Local or Recent Records
English Name	**Scientific Name**	**SARA**	**COSEWIC**	**SARO**	
Bobolink	*Dolichonyx oryzivorus*	-	T	T	Within local OBBA square
Rusty Blackbird	*Euphagus carolinus*	SC	NAR	SC	Within local OBBA square
Amphibians and Reptiles					
Snapping Turtle	*Chelydra serpentina*	SC	SC	SC	Dryden Forest
Mammals					
American Badger	*Taxida taxus*	E	E	E	Most recent records from 1960s
Grey Fox	*Urocyon cinereoargenteus*	T	T	T	Known from Rainy River District
Cougar	*Puma concolor*	-	-	E	No confirmed records but occasional reports
Eastern Timber Wolf	*Canis lupus lycaon*	SC	SC	SC	Unknown
Little Brown Myotis	*Myotis lucifugus*	E	E	E	Recorded in LSA
Northern Myotis	*Myotis septentrionalis*	E	E	E	Recorded in LSA
Invertebrates					
Monarch	Danaus plexippus	SC	SC	SC	Relatively common in Ontario

SARA – Federal *Species at Risk* Act, COSEWIC – Committee on the Status of Endangered Wildlife in Canada; SARO – Species at Risk Ontario; NAR – Not at Risk; T – Threatened; E – Endangered; OBBA – Ontario Breeding Bird Atlas; LSA – Local Study Area; RSA – Regional Study Area

5.10.3 Observed Species at Risk

5.10.3.1 PLANTS

In addition to the general vegetation survey efforts (Section 5.9.2.4), targeted rare plant surveys were conducted in areas with suitable habitats for identified potential SAR (Section 5.10.2). The only plant SAR observed within the LSA (during all field work activities) was the floating marsh marigold observed in the Thunder Creek wetland near the mouth of Thunder Creek.

Wild rice (*Zizania palustris*) communities were detected at the mouths of Thunder, Blackwater, and Nugget creeks and at Hughes Pond. These communities occupy an estimated area of 12.8 ha within the LSA. Wild rice is a traditional food source for many First Nations.

During the course of field work, no provincially rare plant communities were documented within either the LSA or RSA, nor were any prairie or savannah communities observed. However, the LSA and RSA both contain stands of relatively large, old, and undisturbed forest.

5.10.3.2 ANIMALS

Two terrestrial mammalian SAR were observed within the LSA during field survey efforts: Little Brown Myotis (2011 and 2012) and Northern Myotis (2012). However, the selected survey methodology only allows for the determination of presence; it does not allow for the estimation of abundance, seasonal activity, or spatial distribution.

Seven bird SAR were observed within the LSA during the field survey efforts. Bald Eagle, Peregrine Falcon, Black Tern, Common Nighthawk, Barn Swallow, Canada Warbler, Olive-sided Flycatcher. Based on range overlap and habitat availability, seven additional bird SAR are likely present (at least in some years) but have not yet been reported from the LSA: American White Pelican, Bobolink, Eastern Whip-poor-will, Golden Eagle, Least Bittern, Short-eared Owl, and Yellow Rail. The 2013 marshbird surveys were conducted in accordance with Bird Studies Canada protocols. However, the choice of evening surveys, though allowable in the protocol, will result in lower detection probability of target species. In addition, the Bird Studies Canada protocol does not do a good job of surveying one of the target species (Least Bittern), which is why a new national Least Bittern survey protocol has been developed as part of the proposed Least Bittern Recovery Plan (Environment Canada 2011).

Snapping Turtles, Northern Leopard Frog, and Green Frog are known to occur in the Dryden vicinity (Oldham and Weller 2000) but were not observed during field survey efforts within the LSA.

No terrestrial invertebrate SAR were observed within the LSA during field survey efforts.

5.11 Human Environment

Two baseline studies have been conducted for the Project relevant to the human environment:

- Socioeconomic Baseline Report: Conditions in Northwestern Ontario (gck Consulting Ltd., May 2014; hereafter GCK 2014).
- Stage One and Two Archaeological and Heritage Assessment (Boreal Heritage Consulting, December 2012; hereafter BHC 2012).

Refer to Appendix T and Appendix U for a detailed treatment of methods and results.

5.11.1 LAND USE

The Project is located between the City of Thunder Bay and The City of Kenora. Both Cities are recognized for its natural resources and outdoor characteristics making them tourist destinations. The City of Thunder Bay is the region's commercial, administrative and medical hub; a strategically located service and transportation centre in Northwestern Ontario. The City of Kenora is a tourists and cottagers destination; where leisure industry, tourism-related services, recreation and cottage building and services are the main sources of income.

The Project area includes the following towns and communities within the Kenora and Thunder Bay Districts:

- City of Dryden
- Village of Wabigoon
- Township of Ignace
- Municipality of Sioux Lookout
- Municipality of Machin
- Wabigoon Lake Ojibway Nation
- Eagle Lake First Nation
- Lac Seul First Nation

All of the above locations are characterized by being situated in natural beauty and spectacular scenery that provide significant outdoor recreational opportunities all year-round. In addition most of the localities are in close proximity to the TransCanada Highway making them important transportation and service hubs that support the local industry. The beautiful parks, hiking trails and sandy beaches provide a variety of outdoor recreational and sporting opportunities in the area; and recent announcements from the forestry and mining sectors indicate opportunities for growth. The Canadian Pacific Railway also passes through or near several of the communities with specific use for the forestry industry in the manufacturing and product handling areas. In particular, the City of Dryden rail yard would be the most likely receiving point for freight destined for the Project.

5.11.2 SOCIAL FACTORS

5.11.2.1 POPULATION

According to the Statistics Canada 2011 census data the City of Thunder Bay represents the highest concentration of population (108,359), the City of Kenora, the second largest (15,345) followed by the City of Dryden (7,617) and Sioux Lookout (5,053) for the project. The other locations have smaller populations but in general all are roughly equally divided based on gender with more marked difference in the age class distribution. For most populations the median age is over the provincial and Canadian national median. This along with a percentage decrease on the 20 to 24 age group in comparison with 2006 points to an outmigration of young adult population. In most cases this patter is due to the pursuit of school and work opportunities outside of their work communities due to the reduction of the mining and forest industry in the area.

5.11.2.2 EDUCATION

Most education facilities in the Study Area are at the elementary level (Table 5.11.1). The population of Ontario is highly educated. In Ontario, 24.7% of the population aged 15 years and older has a university degree, higher than any other province or territory in Canada. In addition, 29.2% of its population has obtained College or Trade certification.

Table 5.11.1 Education Facilities in the Study Area

Community	Elementary School	Middle School	High School	Secondary Institution	Post-Secondary Institution	Private School	Adult Education Institution
Thunder Bay	38	3		8		2	1
Kenora	9		2				
Dryden	4		1				
Ignace	1		1				
Sioux Lookout	1		1		2		
Machin	1						

Approximately 78 percent of the population in Thunder Bay and 77 percent of the population in Kenora aged 15 and over has attained education or training at or beyond the high school level (Table 5.11.2).

Table 5.11.2 Level of Education In Thunder Bay And Kenora

Community	High School Certificate or Equivalent	Apprenticeship or Trade Certificate	College Equivalent Certificate	University Diploma or Degree
Thunder Bay	25%	10%	22%	21%
Kenora	29%	11%	19%	15%

5.11.2.3 HEALTH SERVICES AND PROGRAMS

A range of health-care services and programs are available in the Study Area (Table 5.11.3).

Table 5.11.3 Health Services and Programs in the Study Area

Community	Primary Health Care Facility	Services Offered
Thunder Bay	Thunder Bay Regional Health Sciences Centre	Thunder Bay Regional Health Sciences Centre (THRHSC) is state-of-the-art acute care facility with 375 acute care beds serving the healthcare needs of people living in Thunder Bay and Northwestern Ontario. The THRHSC Emergency Department has approximately 95,000 annual visits. THRHSC has 12 OR theatres, a 28-bed Post Anesthetic Recovery Unit, and a 40-bed Day Surgery Recovery Area.
Kenora	Lake of the Woods District Hospital	Lake of the Woods District Hospital treats about 30,000 people per year, and is a fully accredited hospital under the national standards of the Canadian Council on Health Services Accreditation. It is the largest hospital in Northwestern Ontario outside of Thunder Bay.
Dryden	Dryden Regional Health Centre	Dryden Regional Health Centre is a fully modern 41 bed acute care hospital. There are thirty-one acute and ten chronic/rehabilitation beds in the hospital. The centre provides a full range of inpatient services, including medical, surgical, obstetrical, chronic and critical care.
Ignace	Mary Berglund Community Health Centre	Health care services are provided by physicians, nurse practitioners and registered nurses. Other services available include physiotherapy, chiropody, lab specimen collection, screening programs for blood sugar and blood pressure.
Sioux Lookout	Meno-Ya-Win Health Centre	The health centre includes a hospital, long term care facility, community services, patient hostel and other related services, and is characterized by its unique blending of mainstream and traditional Aboriginal healing. It has been designated Ontario's Center of Excellence for First Nation Health Care.
Machin	Community Health Centre	Health Services are available through the Machin Family Health Team. Dr. Yvon-Rene Gagnon is the doctor. Further care, as well as home care, may be sought in the nearby City of Dryden.

5.11.2.4 HOUSING

Traditionally Sioux lookout has maintained a relatively high number of owned dwellings compared to the number of apartments and duplexes in the area (Table 5.11.4). This trend has consistently been higher than the provincial average and could partially be attributed to the higher median incomes in Sioux Lookout than the provincial median, allowing more people the ability to buy rather than rent.

Table 5.11.4 Housing Supply in the Study Area

Community	Total Private Dwellings	Owned Dwellings	Rented Dwellings	Average Value of Owned Dwelling
Dryden	3417	2310	900	$162,551.00
Wabigoon	204	N/A	N/A	N/A
Ignace	680	515	55	$83,976.00
Sioux Lookout	2080	1250	655	$189,919.00
Machin	560	335*	60*	$145,600.00*

Source: Statistics Canada, 2011 Census Community Profiles
*2006 data used where 2011 data was unavailable

5.11.2.5 CRIME AND JUSTICE

Most local communities have experience some increase in criminal activity in recent years (Table 5.11.5).

5.11.2.6 POVERTY AND SOCIAL ISSUES

The median household income for Dryden families dropped by 7% from 2006 to 2011 as result of the continued economic depression of the community from the downturn of the Domtar pulp mill.

Between 2006 and 2011, median household incomes also decreased by 10% in Ignace. This decrease over a five-year period generally corresponds to the economic downturn in Canada during that period.

Several community-based organizations serving low income households (food banks, second-hand shops, free recovery and counselling programs, temporary shelter and financial assistance programs, etc.) operate in the Study Area to serve community needs.

Table 5.11.5 Police Services and Crime in the Study Area

Community	Police Service	Crime
Dryden	Dryden Police Services	From 2010-2012, reported violent crimes in Dryden have increased slightly by 3.73 percent. Overall major crime activity remained consistent with a significant increase in impaired driving charges. Also notable is the significant decrease in drug-related charges.
Ignace	Ontario Provincial Police	The period from 2010-2012, reported violent crimes in Ignace have increased slightly by 3.73 percent. Most notably, Ignace has experienced a significant increase in alcohol and drug related crimes, which contribute to impaired driving charges.
Sioux Lookout	Ontario Provincial Police	From 2010 to 2012, major crimes in Sioux lookout increased significantly by 10 percent. In contrast to the increase in major crimes, drug-related offenses have reduced by 30.77 percent since their height in 2011. This was due to the oxycodone epidemic, which is no longer available in the same format in 2012. The largest contributors to major crimes in the community are attributed to sexual offences and domestic assaults, which constitute 43 percent of total crimes.
Machin	Ontario Provincial Police	The single most significant threat to public safety within the Machin area remains travelling to and from communities on area roadways. Severe weather patterns and wildlife contribute significantly to motor vehicle collisions in the area; however, the main cause can still be attributed to apparent driver action (speeding, aggressive driving, following too closely, speed too fast for conditions).

5.11.3 ECONOMIC FACTORS

5.11.3.1 LABOUR FORCE, LABOUR PARTICIPATION AND EMPLOYMENT

Ontario

On the provincial level, Ontario's unemployment rate was 7.4% in April 2014, up from 7.3% in March. By comparison, in April 2014 the Canadian unemployment held steady at 6.9%. Employment in Ontario relies heavily on the Service sector, which accounted for 79.6% of Ontario jobs in April 2014. Unemployment rates in the Study Area ranges from 4 to 20% (Table 5.11.6).

Table 5.11.6 Labour Force, Labour Participation and Employment in the Study Area

Community	Total Labour Force (individuals)	Labour Force Participation (%)	Employment Rate (percent)	Unemployment Rate (%)
Thunder Bay	55115	61	56.4	8
Kenora	8375	66	61.4	7.6
Dryden	3935	63	58.1	7.6
Ignace	640	58	46	20
Sioux Lookout	2920	74	70	5
Machin	535	66	63	4

Source: Statistics Canada, 2011 and 2006 Census Community Profiles

Historically, northwestern Ontario's economy has been tied to its landscape and the abundant natural resources contained therein, particularly in forestry and mining as well as tourism. In Thunder Bay the largest amount of labour force participation is in the Sales and Services category. The lowest participation in the labour force is in Natural Resources and Manufacturing occupations.

The main sources of income in Kenora come from different industries that include tourism and tourism-related service businesses, recreation businesses, cottage building and services, value-added forestry, mining and mining services. The two largest private employers in Kenora are the Trus Joist Weyerhaeuser TimberStrand mill and the Canadian Pacific Railway.

5.11.3.2 INCOME LEVELS

Lower median household incomes in some communities in the Study Area (Table 5.11.7) may be attributed to an aging population reaching or entering into retirement. Pension or retirement income is considerably lower than working income, which may partially contribute to lower median incomes.

Table 5.11.7 Income Levels in the Study Area Compared to Provincial Average

	Median Household Income	Median Family Income
Ontario	$60,455	$72,734
Dryden	$60,058	$79,977
Ignace	$51,601	$57,064
Sioux Lookout	$67,034	$86,347
Machin	$55,616	N/A

Source: Statistics Canada, 2011 and 2006 Census Community Profiles

5.11.3.3 ECONOMIC DEVELOPMENT

Historically, northwestern Ontario's economy has been tied to its landscape and the abundant natural resources contained therein, particularly in forestry and mining as well as tourism. Prior to 2006, northwestern Ontario's primary economic driver was the forestry sector. However, the global recession combined with recent falling lumber prices resulted in devastating impacts on forestry sector. Many local mills were closed or significantly downsized as a result of falling demand. Recently, the forestry sector has seen increased activity, such as the re-opening of the Eacom Forest Products (Ear Falls) and Mckenzie Forest Products (Hudson) sawmills in 2014, but it seems unlikely the industry will return to its previous levels of activity. Many communities are now struggling to diversify their economies to keep dollars circulating locally, meanwhile many workers and families continue to migrate out of the region in search of employment opportunities.

The rich mineral deposits of the Canadian Shield have attracted many mining companies to the region for exploration and extraction. In the wake of the recent recession of the forestry sector, mining activity in the region has received increased attention as major employer in the region. Speculation regarding the Ring of Fire has also lead to increased political interest in current mining infrastructure and development projects. There are currently six active mines in the region, with many more exploration activities ongoing.

Dryden

Economic development has been a primary focus of City of Dryden staff and leadership for over a decade. As the pulp and paper mill began reducing operations and downsizing its workforce, the City recognized the imperative need to diversify its economic base and attract new industry. The City is currently focusing its industry expansion efforts in the areas of Exploration and Mining, Renewable Energy, Manufacturing, Tourism, Agriculture and Retail/Distribution.

Village of Wabigoon

Inhabitants in the Village of Wabigoon can pursue a number of economic development opportunities mainly concentrating on the tourism and services sectors. Business owners in the community focus on the tourism and retail/service sectors offering hospitality and service employment to residents.

One of the most important economic contributors to the community is the tourism industry and the Village of Wabigoon has a number of businesses to capture the demand for northern adventure.

Township of Ignace

The economy of Ignace is based largely on transportation and tourism, but forestry is recovering and on the rise. The forestry industry has been a major employer in Ignace since the 1940s. Although there have been significant losses of employment in this sector in the last decade, there is renewed optimism with the announcement of the planned reopening of the Resolute Forest Products Ignace Sawmill, which was idled in 2006.

Municipality of Sioux Lookout

Sioux Lookout has an economic development plan that was approved in 2011 with targeted sectors as follows:

- Health care and service industries;
- Manufacturing, specifically value-added forestry;
- Arts, culture and heritage tourism; and,
- First Nation government and economic development.

Sioux Lookout completed over $250 million dollars in capital projects over the last five years. These projects include:

- The Sioux Lookout Meno Ya Win Health Centre;
- An extension of water and sewer infrastructure along Highway 72;
- New downtown revitalization initiatives.

Sioux Lookout has a great selection of commercial, industrial and residential land with development opportunities in the rural, urban, lakefront and beautiful lake view settings.

Municipality of Machin

Machin boasts a variety of successful businesses. Many of the businesses and economics in Machin depend on seasonal tourism dollars, so they benefit from its location on the TransCanada Highway and its proximity to several excellent fishing lakes. Beyond the current businesses available in Machin, many residents access the businesses and services available in the City of Dryden 45 km east of Vermillion Bay.

5.11.4 HERITAGE RESOURCES

A Stage 1 and Stage 2 archaeological and cultural heritage assessment was completed for the Project area (Appendix U).

5.11.4.1 ARCHAEOLOGICAL CONTEXT

Several cultural traditions are represented in the prehistory of Northwestern Ontario extending from about 10,000 years ago to the present.

Palaeo-Indian Period (ca. 10.000 B.P. — 7,000 B.P.): Colonization of the northern part of Ontario by vegetation and animals was later than the south due to the northward retreat of the glaciers and subsequent flooding of the glacially depressed landscape by pro- and post-glacial lakes. As a result, it appears that people may have not entered the Thunder Bay area until about 10,000 years ago while archaeological work in the Hudson's Bay Lowland suggests that human occupation maybe limited to about the last 7,000 years.

The first inhabitants of the area most likely arrived by following herds of caribou across the tundra/parkland environment of newly opened lands left by the retreating glaciers. Within a few hundred years succession to a boreal forest environment led to the concentration of peoples along lakes and river systems. Several types of spear points, made of different types of material indicate that different groups of early hunters moved in at various times.

Archaic Period (ca. 7,000 B.P. — 2,500 B.P.): About 7,000 B.P. the environment in the area became warmer and drier which brought about changes in plant and animal communities and in the subsistence patterns of humans. The changes are reflected in the artifact assemblages where the hunting of smaller game resulted in smaller notched projectile points and stone knives replacing large spear points. A new technology involving the production of stone tools by grinding rather that chipping was also utilized.

About 5,000 years ago people started making use of cold-hammered copper to form spear points, knives, and gaff hooks. One of the most complete copper artifact assemblages for Northwestern Ontario was found at a burial site south of Lake Nipigon that dated to about 3,500 years ago. The Lac Seul area has produced an abundance of copper artifacts reflecting many tool types.

Initial Woodland Period (ca. 2,500 B.P. — 900 A.D.): This tradition is marked by the introduction of fired-clay pottery vessels with conical bases made using the coil method. The vessels were smooth with the exception of the neck and rim which were decorated with distinctive toothed or sinuous edged tools. The makers of these vessels are known as the Laurel people who practiced a way of life similar to the region's Archaic people — fishing, hunting, and collecting wild plants on the major waterways. There are two major theories concerning the origin of the Laurel culture in the area. One is that it arose out of an Archaic base differing only by the adoption of pottery. The other is that the people of the Laurel culture moved into the area following the expansion of wild rice into the area about 2,500 B.P.

Terminal Woodland Period (ca.900 A.D. — 1,600 A.D.): Two distinctive cultures, both of which appear to have developed from a Laurel base are present in the Terminal Woodland Period. The Black Duck culture is characterized by globular pottery vessels textured by cord-wrapped paddle and rims decorated with cord wrapped object impressions. Most Archaeologists believe the Black Duck culture to be ancestral to the modem day Ojibway or Anishnabeg Aboriginal Peoples and First Nations.

The Selkirk tradition is found farther north and is characterized by fabric-impressed vessels. These people are thought to be ancestral to the Cree Aboriginal Peoples and First Nations.

Contact Period (ca. 1,650 A.D. — Present): This tradition starts with the arrival of Non-Aboriginal Peoples into the area, first the French then English traders bringing with them trade goods such as axes, guns, beads and metal and woolen goods.

5.11.4.2 HISTORICAL CONTEXT

Zealand Geographic Township has been divided into lots and concessions but is largely undeveloped. A former Ministry of Natural Resources tree nursery was located on the property but is not a historic feature. No historic settlements or historic transportation routes have been identified on or in proximity to the property. No historic atlas of the area is available.

5.11.4.3 LOCAL STUDY AREA

The Project is located in the DgJc Borden block. A site registration database information request made through the Ministry of Tourism, Culture and Sport resulted in no reported archaeological sites within two kilometers of the Project.

Archaeological sites are most often associated with well-drained, sandy soils. The soils in the LSA are silt and wet clay over bedrock which suggests low archaeological potential. Site inspection of the LSA disturbances and access roads with disturbed exposures found no cultural material. The several small areas of elevated topography were observed to have been disturbed by past wood harvesting activities. The LSA therefore does not have topological, surface water, or soil characteristics that would indicate any archaeological potential.

5.11.5 ABORIGINAL PEOPLES

Treasury evaluated the use of the Project area by Aboriginal peoples using pre-existing reports and publically available information and the results of engagement with local communities (Appendix EE). People that harvest country foods from the study area may include:

- Local residents (i.e., residents of the local area, Wabigoon, Dryden), including both Aboriginal and non-Aboriginal peoples; and
- Residents from other communities that have travelled to the area to engage in hunting or fishing activities.

Hunting and gathering activities conducted in the vicinity of the Project include:

- Gathering of vegetation: blueberries, raspberries, pin cherries, wild cranberries, chanterelle mushrooms and wild rice.
- Hunting: moose, deer, grouse, and waterfowl.
- Trapping: Fur-bearing species identified within the RSA include: beaver, muskrat, marten, fisher, otter, fox, lynx, and rabbit; and
- Fishing: no large-bodied fish occur in Project waterbodies. However, Wabigoon Lake supports a number of large-bodied fish species of value to the public and First Nations: Walleye, Muskellunge, and Northern Pike.

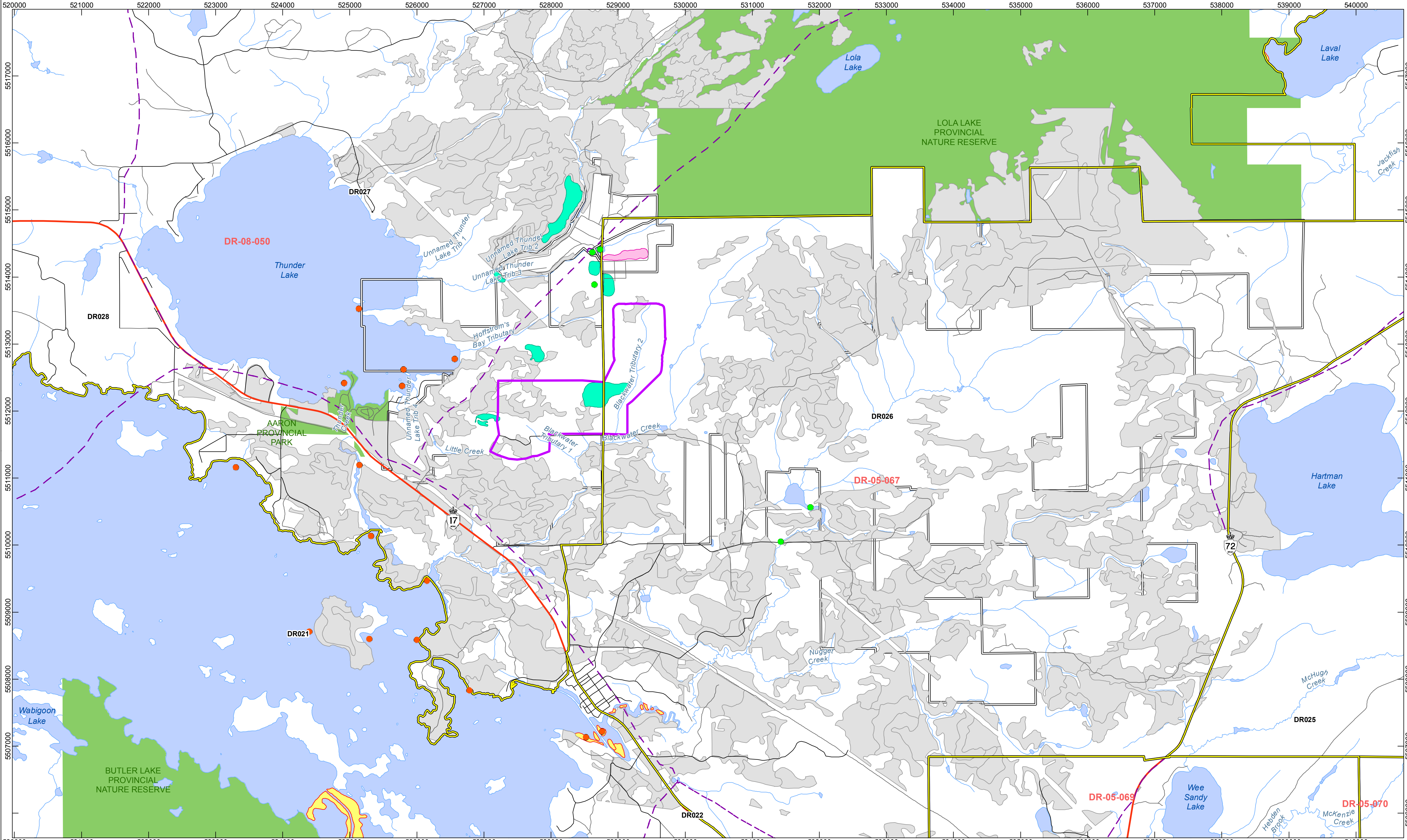
5.11.5.1 VEGETATION

First Nation communities and the public have not identified any specific plants or berries which may be negatively affected by the development of the Project, nor have any locations been identified within the Project area from which plants and berries are being gathered been identified**.** Treasury recognizes that the gathering of plants and berries by Aboriginal people is part of a traditional life style which continues to this day. However, it must also be recognized that while the gathering of plants and berries is a part of a traditional lifestyle, the presence of the plants and berries to be gathered is dependent on a wide variety of factors including: forest ecotype; Soil type; moisture regime; and stage of forest succession. Consequently, although the gathering of plants and berries may be ongoing from year to year, the specific area where gathering may take place can change within a very short time.

Blueberries have been identified as a country food that is commonly used though the RSA and LSA (Figures 5.11.1 and 5.11.2). Blueberries are common to the boreal forest but not on all sites. Blueberries prefer the sandy or rocky soils associated with jack pine forests but also occasionally can be found on clays rich soils. Blueberries are an early succession species and thrive for a few years following disturbance such as fire or logging, but decline rapidly as the newly regenerating forest reaches crown closure. Generally the period in which blueberry crops proliferate on a site is approximately 4 to 6 years. Blueberries are also very dependent on an absence of late spring frost and rely on adequate sunshine and moisture during growing season to allow berries to mature. Consequently, even on ideal sites and at the right stage of forest development, there is no guarantee that blueberries will be available. It is not realistic to expect blueberry crops to be available for picking on the same specific location over an extended period of time. However, disturbance and change within the boreal forest is common and blueberry crops can usually be found at similar sites which are at an earlier stage of forest development. Such sites can frequently be found in close proximity to sites where blueberries have previously been picked.

Chanterelle mushroom picking activity has been documented within the LSA.

A wild rice harvesting and processing business known as Kawiosa Manomin was established by Wabigoon Lake Ojibway Nation in 1987. Several locations of wild rice are documented with the RSA (Section 5.10.3.1).



Cultural Foods and Interests in Goliath Gold Project Area (Regional Scale)

FIGURE: 5.11.1 REV.00

SCALE: 50 000

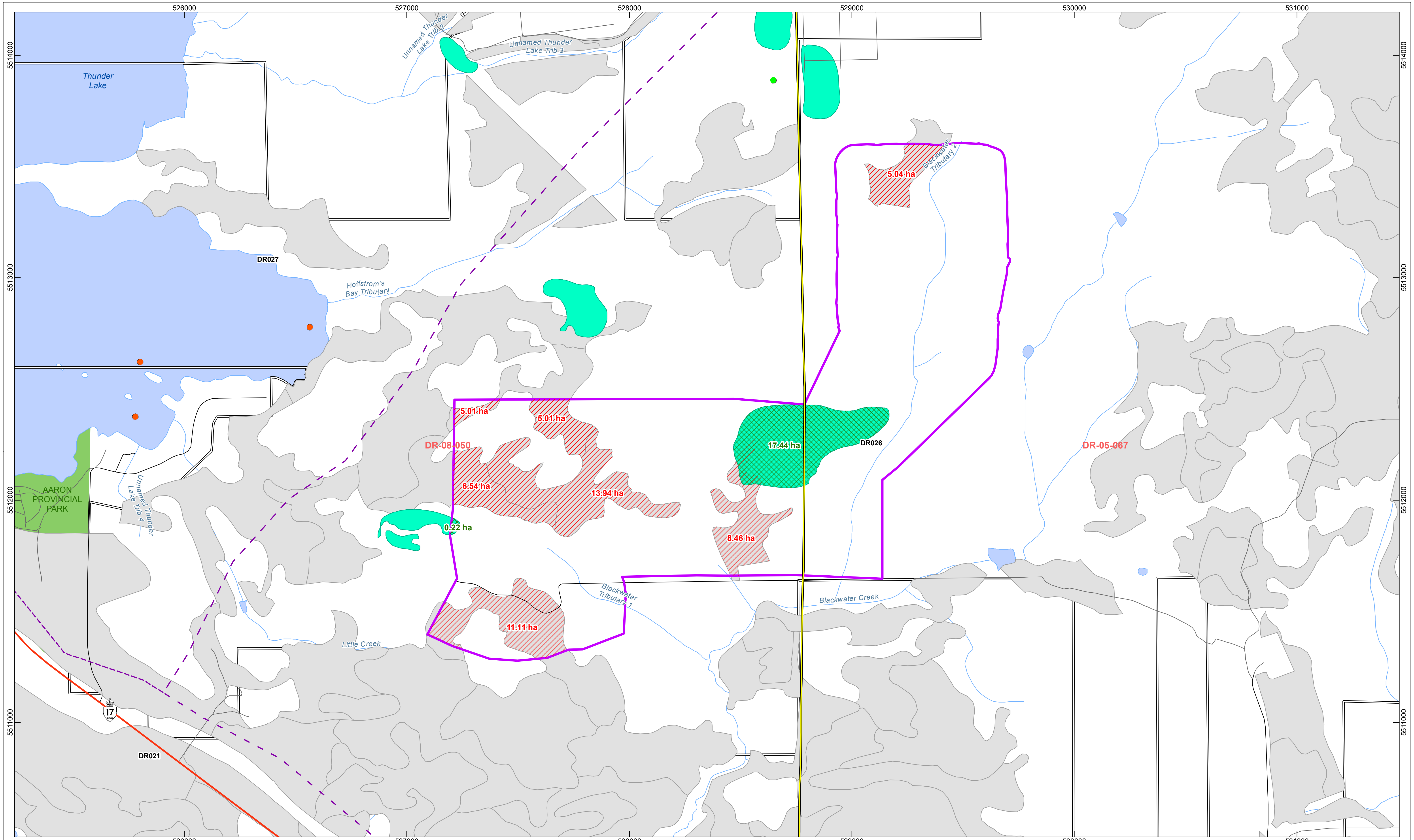
DESIGN: AT 06 FEB. 2014
GIS: AT 03 NOV. 2014
CHECK: – Not Checked

- Known Fishing Area
- Known Minnow Trapping Area
- Bear Management Area
- Immediate Project Extents
- Trapline Boundary
- Known Blueberry Harvest Area
- Potential Blueberry Habitat
- Known Chantrelle Mushroom Harvest Area
- Property Boundary
- Wildrice Area
- Provincial Park

0 500 1,000 1,500 Meters

REFERENCE

Projection: NAD83 UTM Zone 15N
Base Data: OBM, Potential Blueberry Habitat based off MNRF Ecosite Data
FMZ ID: 5



Cultural Foods and Interests in Goliath Gold Project Area
(Local Scale)

FIGURE: 5.11.2 | REV.00

SCALE: 15 000

DESIGN: AT 06 FEB. 2014
GIS: AT 03 NOV. 2014
CHECK: -- Not Checked

Known Fishing Area
Known Minnow Trapping Area
Bear Management Area
Known Blueberry Harvest Area Removed
Potential Blueberry Harvest Area Removed
Immediate Project Extents
Trapline Boundary
Known Blueberry Harvest Area
Potential Blueberry Habitat
Known Chantrelle Mushroom Harvest Area
Property Boundary
Wildrice Area
Provincial Park

N E S W

0 100 200 300
Meters

REFERENCE
Projection: NAD83 UTM Zone 15N
Base Data: OBM, Potential Blueberry Habitat based off MNRF Ecosite Data
FMZ ID: 5

5.11.5.2 HUNTING AND TRAPPING

Game species that have been identified as valued components as part of hunting community include:

- Moose;
- White-tailed Deer;
- Waterfowl;
- Fur-bearing species; and
- Ruffed Grouse.

The mine site area is fully enclosed within Wildlife Management Unit (WMU) 8; WMU 5 and WMU 9A are within the LSA. Trapping locations within the LSA include Trap lines DR026, DR027, and DR021. Current numbers for active hunters within the region are detailed in Table 5.11.8 and Table 5.11.9.

Table 5.11.8 White-Tailed Deer Hunting Activity

Year	Estimates for Resident Hunters	
	Estimated # of Active Hunters	Estimated Total Harvest
2008	1394	1206
2009	1352	1055
2010	1394	1216
2011	1475	1148
2012	1552	1304

Source: OMNRF, 2013 and Tetra Tech, 2014

Table 5.11.9 Moose Hunting Activity

Year	Estimates for Resident Hunters	
	Estimated # of Active Hunters	Estimated Total Harvest
2006	1398	218
2007	1485	166
2008	1184	166
2009	1261	110
2010	1145	123
2011	975	106
2012	809	89

Source: OMNRF, 2013 and Tetra Tech, 2014

5.11.5.3 FISHING

The Project is located within the Lower English River Section of the Boreal Forest Region, of the Lake Wabigoon Ecoregion (Ecoregion 4S). It is also within the northern limits of the OMNRF FMZ 5. Ranging from the Manitoba border east to Quetico Provincial Park and the United States border north to the Wabigoon River Watershed, the total area covers 44,360 km^2 (KCB 2012, DST 2014).

Aquatic habitat surrounding the Project site is generally of low to moderate value (KCB 2012, DST 2014). Substrates of lakes and streams are primarily dominated by fines (silts and clays), spawning gravels required for some species (i.e., Walleye, White Sucker, Lake Whitefish) are limited. The aquatic vegetation required for Northern Pike and Muskellunge spawning is more abundant. In-stream cover is available mostly in the form of pools, woody debris and vegetation (overhanging, emergent and submergent). Additional areas that have been considered include the spawning areas associated with Thunder Creek, and Nugget Creek. The mouth of Nugget Creek at Wabigoon Lake is designated a Provincial Fish Sanctuary to protect spawning Walleye and fishing is prohibited in this area during the Walleye spawning season; therefore it is seen as a culturally important and relevant to country food harvesters as a valued component.

Additionally Naotkamegwanning First Nation holds commercial fishing licenses on both Thunder and Wabigoon Lakes. Eagle Lake First Nation, the Métis Nation of Ontario, and the Aboriginal People of Wabigoon have all expressed an interest in the fishery of Wabigoon Lake.

Thunder Lake and Wabigoon Lake support diverse fish populations that include large predatory fish such as Walleye and Northern Pike; therefore these water bodies must contain suitable spawning and rearing habitat. Assessed streams indicate that suitable habitat is present for small forage fish species (KCB 2012, DST 2014).