NUCLEAR WASTE MANAGEMENT ORGANIZATION
SOCIÉTÉ DE GESTION DES DÉCHETS NUCLÉAIRES

Phase 1 Desktop Assessment, Environment Report

CITY OF ELLIOT LAKE, TOWN OF BLIND RIVER, TOWNSHIP OF THE NORTH SHORE AND TOWN OF SPANISH, ONTARIO

APM-REP-06144-0090

OCTOBER 2014

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1.0 INTRODUCTION

The Communities of Elliot Lake, Blind River, The North Shore and Spanish in northern Ontario expressed interest in continuing to learn more about a facility to manage Canada's Used Nuclear Fuel through the Nuclear Waste Management Organization's (NWMO) Adaptive Phased Management Site Selection Process (NWMO, 2010). This process is seeking to find a site for a deep geological repository that will provide safe long-term containment and isolation within an informed and willing host community. The process is presently at an early stage.

Part of the process is focussed on determining if there are environmental features that would preclude the potential for a facility to be constructed and operated in the vicinity of the area of the four communities. To this end, this report provides a general description of the environment in the area of the four communities. It is complemented by reports prepared in parallel which characterize the geoscientific conditions and community well-being profile of the area. These reports are summarized, with other information, in an integrated Preliminary Assessment Report.

This report is not an environmental assessment. Its purpose is to provide a high level description of the current human and natural environment based on readily available sources of data. Additional detailed information for specific locations would be sought at subsequent phases of the work.

The area considered here is the same as that used for the Phase I Geoscientific Desktop Assessment for the City of Elliot Lake, the Town of Blind River, the Township of The North Shore and the Town of Spanish and Surrounding Area. This area is shown on Figure 1, and includes the area of the four communities, as well as areas to the north, west and east of these communities.

2.0 COMMUNITIES AND INFRASTRUCTURE

2.1 Communities

The area of the four communities is about 14,450 km^2 in size[1], located north of Lake Huron in northern Ontario (LIO, 2013). Highway 17 (Trans-Canada Highway) crosses through the area of the four communities and connects to Sudbury (100 km to the east) and Sault Ste. Marie (145 km to the west), based on road distances to the boundary of the area of the four communities. Figure 2 presents satellite imagery for the area taken in 2006. Table 1 summarizes the total population and population density for the area of the four communities and the District of Algoma.

Table 1: Population Statistics for the Communities of Elliot Lake, Blind River, The North Shore and Spanish

Political Boundary	Population	Population Density per km^2
Town of Blind River	3,549	6.7
Town of Spanish	696	6.4
Township of The North Shore	509	2.1
City of Elliot Lake	11,348	15.9
District of Algoma	115,870	2.4

Source: 2011 Census of Population (Statistics Canada, 2013)

Figure 1 also shows the geographic boundaries for municipalities within the area of the four communities. Each of the four communities maintains a municipal government (MMAH, 2009). Land ownership within the area of the four communities, including areas of Crown land[2], Crown Reserve[3] land, parks and reserves and private lands, is shown on Figure 3.

There are a number of First Nation and Métis communities and organizations in and around the area of the four communities including Whitefish Lake First Nation, Wikwemikong Unceded First Nation, Serpent River First Nation, Mississauga #8 First Nation, Sagamok Anishnawbek First Nation and Whitefish River First Nation. Métis Councils in the area include the Historic Sault Ste. Marie Métis Council, the North Channel Métis Council, the Sudbury Métis Council and the North Bay Métis Council.

Further information on Elliot Lake, Blind River, The North Shore and Spanish and the surrounding area is provided in the Community Well Being Profile Report.

2.2 Infrastructure

Figure 1 shows the location of the primary infrastructure corridors in the area of the four communities. The main transportation routes for the area of the four communities include the Trans-Canada Highway (Highway 17) which passes through the southern part of the area of the four communities in an east-west orientation, through the settlement areas of Blind River, Algoma Mills, Spragge, Serpent River, Spanish and Massey. As well,

[1] Area calculated using Geographic Information System (GIS) municipal boundaries from the Ministry of Municipal Affairs and Housing (MMAH, 2009).

[2] Crown land is divided on the Figure into Crown Leased Land, Non-freehold Disposition Public and Unpatented Public Land. Crown Leased land is acquired by MNR for reasons based on ecological sustainability, including ecosystem health, the protection of natural and cultural assets, recreation, and / or the protection of people and property. Non-freehold Dispositions Public are a tenure holding, usually for a set term and a specific purpose (e.g., Lease, Licence of Occupation, Land Use Permit, Beach Management Agreement and Easement), excluding permanent disposition in the form of a patent. Unpatented Public Land is generally land that has never been granted or sold by the Crown to people or organizations for their private use and are under the mandate or management of the MNR.

[3] Crown Reserves are Crown lands that have been withdrawn from dispositioning under Section 21 of the Crown Minerals Act.

Highway 108 runs north from its intersection with Highway 17 from the community of Serpent River up through Elliot Lake, becoming Highway 639 north of Elliot Lake. Highway 553 runs north from Highway 17 at Massey along the Aux Sables River (Figure 1). Local logging roads cover much of the area of the four communities. A rail corridor, operated by the Huron Central Railway (HCRY) runs approximately parallel to Highway 17 through the area of the four communities.

A number of transmission corridors are located in the area of the four communities. Two 230 kV transmission lines run west to east, one along Highway 17, and the other further north, passing through the northern half of the Town of Blind River and the City of Elliot Lake. Another 230 kV line runs from north to south along the western side of the area of the four communities. Two shorter 115 kV transmission lines are also located in the area of the four communities, one from Highway 17 north to Elliot Lake and a second running west to southeast from Basswood Lake Conservation Reserve towards Blind River. There are two airports in the area of the four communities, including the Elliot Lake Municipal Airport in Elliot Lake. There are also two emergency landing strips and five seaplane bases in the area of the four communities (LIO, 2013). There is a one gas pipeline running westward from Elliot Lake to the southwestern part of the area of the four communities. There are five operating landfills within the area of the four communities (MOE, 2013a). There is one waste water treatment plant located in Blind River and one in Elliot Lake. Spanish operates sewage lagoons, and The North Shore has a waste water service system in place for a number of households in one of its subdivisions.

2.3 Protected Areas

2.3.1 Parks and Reserves

There are 15 provincial parks, 12 conservation reserves and four forest reserves in the area of the four communities. Figure 4 shows the location of these parks and protected areas. The following are located within the municipal boundaries of the four communities: Blind River Provincial Park, Matinenda Provincial Park, Mississagi Delta Provincial Park, Glenn N. Crombie Conservation Reserve and Brennan Harbour Conservation Reserve.

Blind River Provincial Park, a waterway class park, encompasses part of the Blind River and its tributaries, and covers an area of approximately 44 km^2. Downstream of the Blind River Provincial Park is the Matinenda Provincial Park, classed as a natural environment park and covers an area of 294 km^2. The Mississagi Delta Provincial Park is a nature reserve class park approximately 2.4 km^2 in size containing a variety of aquatic and terrestrial vegetation (Ontario Parks, 2013).

Conservation reserves are lands set aside by the government (municipal, provincial or federal) to protect ecosystems that are representative of a natural region, protect significant elements of natural and cultural heritage, and maintain biodiversity. The Glenn N. Crombie Conservation Reserve is partially located in the City of Elliot Lake, and extends beyond the eastern boundary of the City. The reserve has an area of approximately 70 km^2. This conservation reserve protects the best known example of diverse vegetative growth on rugged terrain for the region. The Brennan Harbour Conservation Reserve is the only protected area within the Town of Spanish and occupies an area of approximately 2 km^2.

Other Provincial Parks in the area of the four communities include: The Chutes, La Cloche, Aubinadong River, Wenebegon, Aubrey Falls, Spanish River, Mississagi, Mississagi River, Little White River, North Channel Islands, River au Sables and Rushbrook Provincial Parks. Other conservation reserves in the area of the four communities include: Rawhide Lake, Basswood Lake, Wagony Lake, Mozhabong Lake, Archambeau Lake

Forest, Old Colleagues, Flat Creek Old Pine, Gough Outwash Forest, Shakespeare Forest and La Cloche Ridge. The four forest reserves are: Rawhide Lake, Glen N. Crombie, River aux Sables and Shakespeare. They are located within the conservation reserves of the same names.

2.3.2 Heritage Sites

The cultural heritage screening examined known archaeological and historic sites in the area of the four communities, using the Ontario Archaeological Sites Database, the Ontario Heritage Trust Database, the Parks Canada Database and the National Historic sites Database. There are 85 registered archaeological sites in the area of the four communities (von Bitter, 2013).

Of these 85 archaeological sites, three are located within the municipal boundary for the City of Elliot Lake, four are within the municipal boundary of the Town of Blind River, and five within the Township of The North Shore. Of note, there is a series of registered archaeological sites located along the shores of the Mississagi River, within Mississagi River Provincial Park. Of the 16 sites recorded within the provincial park boundary, all are pre-contact Aboriginal sites with the exception of one being a historic fur trade post (MTCS, 2013). The number and types of sites recorded along the Mississagi River give evidence that this was a major transportation route for both Aboriginal and Euro-Canadians.

There is a second concentration of archaeological sites within the Mississagi Delta Provincial Nature Reserve. These sites were recorded in the 1970s and there is no information on the age of these archaeological sites, their cultural affiliation, or the type of site.

Four sites have been identified as historical Aboriginal cemeteries and one site has been identified as a single burial of a Euro-Canadian squatter. Of the historic Aboriginal cemeteries, two are located along the north shore of Lake Huron and the remaining two are located along the Mississagi River system.

A search on archaeological assessments undertaken within the last 20 years has identified 11 background (Stage 1) or background and property survey (Stage 1 and 2) assessments within the municipal boundary of the City of Elliot Lake (von Bitter, 2013).

A search of Parks Canada's Directory of Federal Heritage Designations revealed that there are no federally recognized heritage designations within the area of the four communities. The closest federal designations are the Former Canadian Pacific Railway Station and the Government of Canada Building in Sudbury. The closest recognized National Historic Sites are in the Sault St. Marie area: Algoma Central Engine House, Ermatinger House, Sault Ste. Marie Canal, Whitefish Island and Fort St. Joseph. Parks Canada also administers a database, the Canadian Register of Historic Places (CRHP), which includes federal, provincial and territorial historic sites. A search of this database indicated that there are no additional designated historic sites in close proximity to the area of the four communities (Parks Canada, 2013). There are no Provincial Historic Sites in the area of the four communities (OHT, 2013).

Archaeological potential is established by determining the likelihood that archaeological resources may be present on a subject property. In archaeological potential modelling, a distance criterion of 300 m is generally employed for known archaeological resources, water sources and early Euro-Canadian settlements (Government of Ontario, 2011). The presence of local heritage sites would need to be further confirmed in discussion with the community and First Nation and Métis communities and organizations in the area.

2.4 Land Use

Land use described in this section refers to commercial land use such as forestry, mining, trapping and agriculture, but not recreation or Aboriginal spiritual use.

Forestry is a major industry in the area and the largest single land-use. The region has more than 60% productive forest and a number of private timber companies are currently managing forestry operations. Forest Management Units[4] (FMU) in the vicinity of the area of the four communities are presented on Figure 5.

The area of the four communities lies within the Great Lakes – St. Lawrence Forest Region. The area of the four communities contains portions of two FMUs: the Northshore Forest (FMU 680) and the Spanish Forest (FMU 210) (MNR, 2013a). The Northshore Forest FMU, managed by Northshore Forest Inc., is located in the western part of the area of the four communities. The Spanish Forest FMU, managed by Domtar Inc., covers the northeastern region of the area of the four communities. The Northshore Forest FMU contains approximately 734,372 ha of crown land, of which 79% is managed for eastern white pine (*Pinus strobus*), red pine *(Pinus resinosa)*, eastern hemlock (*Tsuga canadensis)* and yellow birch (*Betula alleghaniensis*) in the east along with other tolerant hardwoods in the west (Domtar, 2010a). The Spanish Forest FMU contains approximately 994,625 ha of crown land, of which 92% is managed for jack pine (*Pinus banksiana*), black spruce (*Picea mariana*), poplar *(Populus* spp*.)* and white birch *(Betula papyrifera)* (Domtar, 2010b).

Within heavily forested areas, such as those in the area of the four communities, there is a risk of forest fires. Locations where forest fires occurred in the vicinity of the area of the four communities between 1976 and 2010 affecting an area of greater than 200 ha are also shown on Figure 5.

There are currently no active mines in the area of the four communities, but the region has a long history of mining and mineral exploration and development continues there today. In the area of the four communities, there are several areas of active exploration and of metallic mineral production. There is a historic and ongoing interest in the Huronian Supergroup, Whiskey Lake and Benny Lake greenstone belts and the East Bull Lake intrusive suite. As shown on Figure 6, within the area of the four communities, there are 21 past producing mines with no reserves and six past producing mines with reserves. The Huronian Supergroup is known for uranium and thorium mineralization in quartz-pebble conglomerates as well as other metallic minerals (e.g., gold, nickel, copper) typically associated with the intrusion of Nipissing diabase (Reid, 2003). Mineral exploration in the Whiskey Lake and Benny Lake greenstone belts has focused on base metals, sulphide-bearing units of banded iron formations and mafic intrusive rocks (Jensen, 1994). The East Bull Lake intrusive suite has platinum group elements and copper-nickel sulphide mineralization and contains economically significant platinum, palladium and gold (Peck and James, 1991). The mineral potential in the Ramsey-Algoma granitoid complex is relatively low compared to the other rock formations listed above.

As shown on Figure 7, there are numerous sand and gravel pits within the area of the four communities (LIO, 2013). These are typically shallow pits of limited surface extent exploiting glaciofluvial outwash or lacustrine beach deposits. There are two discretionary occurrences for building stone (granite) reported within the Ramsey-Algoma granitoid complex, near the mouth of the Blind River. There is also a building stone quarry, about 20 km east of the City of Elliot Lake.

[4] Ontario's Crown forest is divided into geographic planning areas, known as Forest Management Units. Most of these units are managed by individual forest companies who carry out various activities which are subject to the Ontario Ministry of Natural Resources (MNR) regulations and approvals. Activities include forest management planning, harvest, forest renewal, access road construction, monitoring and reporting.

The area along the Highway 17 corridor north of Lake Huron supports some agricultural activities including raising of livestock and growing of some crops. The Town of Spanish and other communities include agriculture as a permitted use in rural areas (Tunnock, 2010; Tunnock, 2013). The Town of Blind River encourages urban agriculture, including community and rooftop gardens and farmers markets for local produce (Tunnock, 2012a).

As noted in Section 3.3, other land uses include trapping and commercial fisheries.

3.0 DESCRIPTION OF THE ENVIRONMENT

3.1 Physiography

The area of the four communities is located in the Canadian Shield which generally has a low-relief, gently undulating land surface. The area of the four communities lies within the Penokean Hills physiographic region, composed of folded Proterozoic stratified rocks, and the Abitibi Upland physiographic region to the north, which are comprised of broadly rolling surfaces of Canadian Shield bedrock that occupies most of north-central Ontario (NRCan, 1997). The terrains are either exposed at surface or shallowly covered with Quaternary glacial deposits (Thurston, 1991). Terrains in the Penokean Hills and Abitibi Upland contain numerous lakes and the terrain of the area of the four communities is typical in that regard.

The topography in this area is largely bedrock-controlled (Ford, 1991; Henderson and Halstead, 1992), with bedrock hills and ridges and structurally-controlled valleys acting as the main landscape elements. Glacial deposits are predominantly located in bedrock-controlled valleys. The land surface within the area of the four communities varies across the area, with ground surface elevation ranging from 612 metres above sea level (masl), north of the municipal boundaries of Blind River and Elliot Lake, to 176 masl at the shoreline of Lake Huron in the south.

Figure 8 presents the topography of the area of the four communities as a digital elevation model (DEM).

3.2 Geology

3.2.1 Bedrock Geology

The bedrock geology of the area of the four communities is shown on Figure 6. The area of the four communities is underlain by Archean-age rocks of the Superior Province which are, in turn, overlain in the south portion of the area of the four communities by early Proterozoic rocks of the Southern Province. The northern part of the area of the four communities is located within the Abitibi Subprovince which is a granite-greenstone-gneiss terrain that was developed between 2.8 and 2.6 billion years ago (Thurston, 1991). This area is dominated by low-grade metamorphosed volcanic rocks and granitoid plutonic and gneiss-dominated domains consisting of discrete batholiths within the greenstone belts, as well as large areas of plutonic and gneissic rock between the greenstone belts. The Southern Province occupies the area north of Lake Huron and consists of metasedimentary rocks of early Proterozoic age, 2.5 to 2.2 billion years old, named the Huronian Supergroup.

In the area of the four communities, the regional bedrock geology is dominated by the Archean Ramsey-Algoma granitoid complex, which is a large granitic complex that intruded the older metavolcanic and subordinated metasedimentary rocks of the Whiskey and Benny Lake greenstone belts. Smaller intrusions include the granitic Cutler pluton, the Seabrook Lake intrusion, the Parisien Lake syenite and the East Bull Lake intrusive suite. Parts of the greenstone belts and the Ramsey-Algoma granitoid complex are overlain by the metasedimentary rocks of the Huronian Supergroup (Figure 6). All the geological units in the region except the Seabrook Lake intrusion are intruded by dykes of different ages.

3.2.2 Quaternary Geology

The Quaternary geology of the area of the four communities is shown on Figure 7. The area of the four communities is dominated by exposed bedrock or bedrock having only a thin mantle of unconsolidated sediments. Quaternary deposits are predominantly located in bedrock-controlled valleys. The most widely occurring and oldest known stratigraphic unit in the area is a silty sand to sandy silt till found overlying bedrock in

low relief areas and along the flanks of topographic lows. It is typically thin and discontinuous and is coarse-textured, unsorted and boulder-rich, although there are some areas of compact, massive to fissile and gravelly to silty and sandy till (Barnett et al., 1991). Glaciolacustrine sediments have more limited distribution, confined to very small mappable surficial units largely along river valleys (Ford, 1993). These units, typically composed of laminated silt and fine sand and silt-clay rhythmites, may be related to the series of post-glacial lakes of the Lake Huron basin.

Deposits of glaciofluvial outwash and ice-contact stratified drift are commonly encountered along valleys in the area of the four communities. Ice contact deposits are composed of variable quantities of sand, gravel and boulders, locally with minor silt and/or till in the form of small moraines. Glaciofluvial outwash is common in low-lying areas and occasionally in esker ridges with the local formation of terraces related to changing lake levels in the Lake Huron basin. Thick deposits of alluvial sand and gravel are found along many of the rivers in the region. Recent swamp, lake and stream deposits are also common throughout the area.

3.3 Natural Environment

3.3.1 Natural Environment Overview

The natural environment mapping on Figures 9 and 10 shows the terrestrial and aquatic features, respectively, across the area of the four communities. The area of the four communities contains a large number of lakes of various sizes, 24 of which are larger than 10 km^2 and 10 of which are larger than 20 km^2. The many inland lakes and rivers that occur within the area of the four communities are attractive to fishermen and hunters, and the network of logging roads that supports commercial timber harvesting also provides access to some of the more remote areas. The natural environment within the area of the four communities contains an abundance of plant and animal communities, some of which have special status or designations. The following sections describe the protected natural areas, the terrestrial ecology and aquatic ecology, with a focus on rare species that may be most sensitive to impacts from alterations or changes to the landscape.

3.3.2 Natural Areas

As discussed in Section 2.3.1, there are 15 provincial parks, 12 conservation reserves and four forest reserves in the area of the four communities. The area of the four communities also contains 15 Life Science sites, one Earth Science site, eight Candidate Life Science Areas of Natural Interest (ANSIs) and two Provincially Significant Wetlands (PSWs), as shown and numbered on Figure 9 and listed in Table 2. There are also a number of enhanced management areas[5] (EMAs) located within the area of the four communities. Ecologically important areas are also designated through local (i.e., Town) planning documents; these areas include Environmental Protection Areas, green spaces and significant woodlands or forests. Schedule C of the Official Plan of Elliot Lake identifies Environmental Protection Areas (EPA). One EPA is located southeast of the City of Elliot Lake, within the Ecology Area (Planscape, 2006). The Town of Blind River and the Township of The North Shore released Draft Official Plans in November of 2012 and the Town of Spanish release a Draft Official Plan in February 2013; however, environmentally sensitive areas were not included in the Drafts provided for review (Tunnock, 2012a; Tunnock 2012b; Tunnock, 2013). This would require follow-up in the future.

Based on the Land Information Ontario data (LIO, 2013) the area of the four communities contain about 73,800 ha of wetlands (Figure 10). Wetlands account for approximately 5% of the total land area according to the LIO

[5] Enhanced Management Area is a land use designation that permits logging, but places restrictions to accommodate other values and priorities such as wilderness qualities.

data. The Ministry of Natural Resources (MNR) periodically updates their LIO information and wetland areas and boundaries are subject to change. Field studies conducted at the appropriate times are able to provide ground truthing and sensitivity/significance analysis for existing wetlands. If wetlands have the potential to be affected by a proposed activity, they would typically require evaluation of significance according to the Ontario Wetland Evaluation System (OWES).

Table 2: Significant Natural Areas within the Area of the Four Communities

Number (Figure 9)	Area Name	Area Type
1	Tunnel Lake Hemlock	Candidate Life Science ANSI
2	Foul Bight Beach Ridge and Swale	Candidate Life Science ANSI
3	Mississagi Bay Shoreline Marsh	Candidate Life Science ANSI
4	Spanish River Mouth	Candidate Life Science ANSI
5	La Cloche Provincial Park	Candidate Life Science ANSI
6	La Cloche Patterned Peatland	Candidate Life Science ANSI
7	Mississagi Delta Provincial Park	Candidate Life Science ANSI
8	Basswood Lake	Candidate Life Science ANSI
9	Rocky Island-Kindiogami Fores	Life Science Site
10	Flat Creek Forest	Life Science Site
11	Flat Creek Old Pine	Life Science Site
12	Archambeau Lake Forest	Life Science Site
13	Bark Lake Old Growth Forest	Life Science Site
14	Martel Cliffs	Life Science Site
15	Boland River Valley	Life Science Site
16	Whiskey-Quirke Lakes Forest and Outcrops	Life Science Site
17	White Owl-Red Pine Lakes Complex	Life Science Site
18	South Rushbrook Old Pine	Life Science Site
19	Stag Lake Peatland	Life Science Site
20	South Deschamp Lake Forest and Outcrops	Life Science Site
21	Cobre Lake Old Pine	Life Science Site
22	Whiskey Lake Hemlock Stand	Life Science Site
23	Clapperton Island Alvar	Life Science Site
24	Mississagi River	Life Science Site
25	Basswood Lake	Earth Science Site
26	Marsh Bay – Island 9 Wetland	PSW Wetland
27	Spanish River Delta Marsh	PSW Wetland

3.3.3 Terrestrial Features and Wildlife

The area of the four communities lies within the Great Lakes – St. Lawrence Forest Region and this terrain cradles wetlands, lakes and rivers that support a diversity of fish and wildlife. Wetlands, including swamps,

marshes, fens and bogs are often ecologically sensitive. As noted in Section 2.4 and shown on Figure 5, this area contains portions of two FMUs. Approximately 987,646 ha (68%) of the area of the four communities is woodlands (LIO, 2013). Typical forest types in the area of the four communities include eastern white pine, red pine, jack pine, black spruce, eastern hemlock, yellow birch, white birch, poplar and tolerant hardwoods.

The area of the four communities falls primarily within Wildlife Management Units[6] (WMU) 37 and 38, with limited intrusion into portions of WMU 35, 36, 42 and 43 (MNR, 2013b). These areas are considered important for the trapping of furs and hunting of game. Management of moose *(Alces alces)*, marten *(Martes americana)* and pileated woodpecker *(Dryocopus pileatus)* along with other sensitive wildlife populations are a particular concern to the MNR. Documented feeding, wintering and calving sites for moose (*Alces alces*) and white-tailed deer (*Odocoileus virginianus*) are depicted on Figure 9. Concentration and nesting areas for raptors, herons and waterfowl are also considered an important management concern; known locations are also shown on Figure 9.

3.3.4 Aquatic Features and Fish

As discussed in Section 3.5, the area of the four communities spans across four tertiary watersheds and is located within the St. Lawrence drainage basin. Most of the area of the four communities falls under the MNR's designated Fisheries Management Zone[7] (FMZ) 10 (MNR, 2010a,b). FMZ 10 has the highest proportion of lake trout (*Salvelinus namaycush*) and brook trout (*Salvelinus fontinalis*) lakes of any northern zone and it includes several deep, clear inland lakes supporting inland fisheries (MNR, 2013c). Water bodies occurring within the area are a mix of cold, cool and warm thermal classification (Figure 10). Inland water bodies comprise approximately 167,000 ha, which is 11.5% of the area of the four communities, according to the LIO data. The water bodies noted are actively managed and support provincial and federal biodiversity initiatives as well as supporting local sport fishing and tourism.

Fish and fish habitat are managed by the MNR and the Department of Fisheries and Oceans Canada (DFO). General information is available publicly for each FMZ, but more detailed information must be obtained directly from these agencies for further investigations. Publicly available data for each FMZ may not be consistent for each area. Although there is consistency in the types of data collected by MNR for each area, data deemed sensitive within the FMZ may not be reported or shown on mapping. Field verification will be required to determine the actual fish habitat and use by species across the landscape.

3.3.5 Endangered, Threatened and Special Concern Species

The area of the four communities consists of diverse aquatic and terrestrial habitats, and is within many migratory corridors for birds, insects and mammals. The Natural Heritage Information Centre (NHIC) database (NHIC, 2013) shows the occurrence of species that are listed as Endangered (END), Threatened (THR) or Special Concern (SC) either under the provincial *Endangered Species Act* (ESA) (Government of Ontario, 2007), or the Federal *Species at Risk Act* (SARA) (Government of Canada, 2012). The Royal Ontario Museum range maps (ROM, 2013) indicate the potential for Species at Risk (SAR), based on the principles of range mapping.

The Phase 1 Geoscientific Desktop Assessment (Golder, 2014) identified the area of the Ramsey-Algoma granitoid complex (Figure 6) in the northern and eastern part of the area of the four communities as being

[6] Wildlife Management Units are geographic units of land on which the Ontario Ministry of Natural Resources (MNR) bases the sustainable management of species, hunting seasons and harvest limits.

[7] Fisheries Management Zones are the units of management for lakes in Ontario. Fish are monitored and assessed at the zone level and fishing regulations, such as catch limits, are based on these zones.

potentially suitable to host a repository facility, and excluded the Proterozoic rocks of the Huronian Supergroup (Figure 6) in the southwestern part of the area of the four communities as being geoscientifically unsuitable. The environment report therefore focussed specifically on END, THR and SC species and habitats that could occur within the Ramsey-Algoma granitoid complex. There are 30 potentially occurring SAR within this area, as listed in Table 3.

Species listed as provincially or federally END are significant because these species and their habitats receive the highest level of protection afforded under applicable legislation. The six END species potentially occurring within the Ramsey-Algoma granitoid complex include provincially END eastern cougar (*Puma concolor*), little brown myotis (*Myotis lucifugus*) (bat), northern myotis (*Myotis septentrionalis*) (bat), golden eagle (*Aquila chrysaetos*), the federally END (and provincially THR) wood turtle *(Glyptemys insculpta)* and the provincially and federally END shortnose cisco *(Coregonus reighardi)* (fish). An additional nine species are classified as provincially THR (and federally THR, SC or not classified), and 14 species are classified as provincially SC (and federally THR, SC or not classified) within the area.

The ranges of SAR species are generally identified through a reference grid, noting detailed field study is required to confirm the extent that a listed species or its habitat occurs in a specific geographic area. Based on available background information, the range of eastern cougar overlaps the area, but this species is extremely secretive and can cover a very large home range for each individual. Little brown myotis and northern myotis were recently added to the ESA and the natural range of these species suggests that habitat likely occurs within the area. Golden eagles are likely to pass through this area during migration, but typically nest farther north (MNR, 2014). The shortnose cisco prefers deep, clear and cold water and may be present within the area. The wood turtle has a patchy distribution in Ontario, but populations have been identified within the area.

The records identified here represent either known occurrences or are based on range mapping as published by the MNR, noting that the list is typically updated annually. In addition to species that are listed on the ESA and SARA, species of conservation concern including those that are considered regionally rare, uncommon or in significant decline would also be considered in the evaluation of wildlife of the area. Many of these species are not tracked in public databases, and therefore a complete list could be developed in future through specific data requests to agencies and field investigations.

With reference to Table 3, there were no species of plants, mosses or lichens identified as END, THR or SC within the Ramsey-Algoma granitoid complex.

Table 3: Endangered, Threatened and Special Concern Species in the Ramsey-Algoma Granitoid Complex within the Area of the Four Communities

Common Name	Scientific Name	ESA Status[1]	SARA (Schedule)[2]	Source[3]
Mammals				
Eastern cougar	*Puma concolor*	END		ROM
Eastern wolf	*Canis lupus lycaon*	SC	SC	ROM
Little brown myotis	*Myotis lucifugus*	END		BCI
Northern myotis	*Myotis septentrionalis*	END		BCI
Birds				

Common Name	Scientific Name	ESA Status[1]	SARA (Schedule)[2]	Source[3]
Bald eagle	*Haliaeetus leucocephalus*	SC		OBBA; NHIC; ROM
Barn swallow	*Hirundo rustica*	THR		OBBA
Black tern	*Chlidonias niger*	SC		ROM
Bobolink	*Dolichonyx oryzivorus*	THR		OBBA; NHIC
Canada warbler	*Cardellina canadensis*	SC	THR	OBBA
Chimney swift	*Chaetura pelagica*	THR	THR	OBBA
Common nighthawk	*Chordelies minor*	SC	THR	OBBA; ROM
Eastern meadowlark	*Sturnella magna*	THR		OBBA
Golden eagle	*Aquila chrysaetos*	END		NS FMP;
Golden-winged warbler	*Vermivora chrysoptera*	THR	SC	ROM
Least bittern	*Ixobrychus exilis*	THR	THR	ROM
Olive-sided flycatcher	*Contopus cooperi*	SC	THR	OBBA
Peregrine falcon	*Falco peregrinus*	SC	THR	NHIC; ROM
Rusty blackbird	*Euphagus carolinus*	NAR	SC	OBBA; ROM
Short-eared owl	*Asio flammeus*	SC	SC	OBBA; ROM
Eastern whip-poor-will	*Antrostomus vociferus*	THR	THR	OBBA; NHIC
Yellow rail	*Coturnicops noveboracensis*	SC	SC	NS FMP;
Reptiles				
Snapping turtle	*Chelydra serpentina*	SC	SC	NHIC; Herp Atlas
Blanding's turtle	*Emydoidea blandingii*	THR	THR	NHIC; ROM; Herp Atlas
Milksnake	*Lampropeltis triangulum*	SC	SC	NHIC; ROM; Herp Atlas
Wood turtle	*Glyptemys insculpta*	THR	END	ROM; Herp Atlas
Fish and other Aquatic Species				
Lake sturgeon (Northwestern Ontario Population)	*Acipenser fulvescens*	THR		NHIC; ROM
Northern brook lamprey	*Ichthyomyzon fossor*	SC	SC	ROM
Shortnose cisco	*Coregonus reighardi*	END	END	ROM
Invertebrates				
Monarch butterfly	*Danaus plexippus*	SC	SC	ROM; Butterfly Atlas
West Virginia white butterfly	*Pieris virginiensis*	SC		ROM

Notes:

Common Name	Scientific Name	ESA Status[1]	SARA (Schedule)[2]	Source[3]

blank: species not assessed; NAR: species assessed to be not at risk; SC: special concern species; THR: threatened species; END: endangered species

[1] – Status on the Species at Risk of Ontario list of the *Endangered Species Act* (ESA) (Government of Ontario, 2007)

[2] – Status listed on the federal *Species at Risk Act* (SARA) (Government of Canada, 2012)

[3] – Data obtained from the Natural Heritage Information Centre (NHIC, 2013); Royal Ontario Museum (ROM, 2013) rangemaps; Ontario Herpetofaunal Summary Database (Herp Atlas) (Oldham and Weller, 2000); Atlas of the Breeding Birds of Ontario (OBBA) (BSC, 2006); The North Shore Forest Management Plan (NS FMP) (Domtar, 2010a); Bat Conservation International Species Profiles (BCI, 2013a,b); Ontario Butterfly Atlas (Butterfly Atlas) (Jones et al, 2013); Ontario Odonata Atlas (Odonata) (NHIC, 2005); Mammal Atlas of Ontario (Mammal Atlas) (Dobbyn, 1994)

3.3.6 Aboriginal Interests and Traditional Knowledge

Traditional lifestyles, culturally significant wildlife and the extent of sacred and ceremonial locations important to First Nation and Métis communities and organizations are important factors to be considered when identifying potential repository locations for further detailed study.

For this phase of the work, the extent to which such information has been sought is that which can be found in publicly available sources. Known archaeological sites, many of which are Aboriginal, are noted in Section 2.3.2. Trapline License Areas are located over most of the area of the four communities, outside Provincial Parks, Conservation Reserves, communities and Indian Reserves, as shown on Figure 3. Figure 9 presents terrestrial ecology mapping for the area and Figure 10 presents aquatic resource mapping.

It is recognized that this does not fully represent the environmental interests and concerns of First Nation and Métis communities and organizations in the area and that further information and discussion is required before a more complete picture can be developed. Discussions with First Nation and Métis communities and organizations and field investigations would be undertaken in later phases of the work program to further enhance the environmental understanding of specific locations.

3.4 Background Environmental Conditions

3.4.1 Air Quality

Air quality monitors in northern Ontario indicate that ground-level ozone and particulate matter fall within normal values compared to the national average (EC, 2013a). Table 4 provides a list of industrial facilities that reported air and water emissions through Environment Canada's National Pollutant Release Inventory (NPRI) database (EC, 2013b). The list includes sites in Sudbury, Sault Ste. Marie and Blind River, Ontario which have local air emissions. Additional sources that may affect background air quality include rail operations and the Trans-Canada Highway, both of which traverse the area of the four communities.

Table 4: NPRI Regional Sources of Air Emissions

NPRI ID	Facility Name	City
3657	CAMECO - Blind River Refinery	Blind River
10138	Carmeuse Lime Canada - Northern Lime Limited	Blind River

NPRI ID	Facility Name	City
5928	Safety-Kleen Canada Inc. - Chelmsford Branch	Chelmsford
11238	First Nickel Inc. - Lockerby Mine	Chelmsford
444	Vale Canada Limited - Copper Cliff Smelter	Copper Cliff
1465	Vale Canada Limited - Clarabelle Mill	Copper Cliff
1467	Vale Canada Limited - Copper Cliff Nickel Refinery	Copper Cliff
10203	Vale Canada Limited - Copper Cliff Mine (North)	Copper Cliff
10204	Vale Canada Limited - Copper Cliff Mine (South)	Copper Cliff
11227	Fisher Wavy Inc. - Sudbury	Copper Cliff
11877	Vale Canada Limited - Ellen Pit	Denison Township
7361	King Packaged Materials Co. - Onaping Falls	Dowling
1236	Xstrata Canada Corporation - Xstrata Nickel Sudbury Smelter	Falconbridge
10202	Vale Canada Limited - Garson Mine	Garson
11245	Pioneer Construction Inc. - Skead Road Facility	Garson
11561	Dyno Nobel Canada Inc. - Garson	Garson
11289	KJ Beamish Construction Co. Limited - Hanmer Plant and Pit	Hanmer
10199	Vale Canada Limited - Coleman Mine	Levack
11154	FNX Mining Company Inc. - McCreedy West Mine	Levack
11608	FNX Mining Company Inc. - Levack Mine	Levack
10201	Vale Canada Limited - Creighton Mine	Lively
11356	Northern Plating Inc. - Northern Plating	Lively
1233	Xstrata Canada Corporation - Sudbury Operations Mines/Mill - Onaping Area	Onaping
5885	Flakeboard Company Limited - Flakeboard Company Limited	Sault Ste. Marie
6672	Shell Canada Products - Sault Ste. Marie Terminal	Sault Ste. Marie
10697	Lake Superior Power - Lake Superior Power	Sault Ste. Marie
1070	Essar Steel Algoma Inc. - Essar Steel Algoma Inc	Sault Ste. Marie
5859	St. Marys Paper Corporation	Sault Ste. Marie
7265	Sault Ste. Marie Municipal Landfill	Sault Ste. Marie
8086	Jazz Aviation LP - Sault Ste. Marie Airport	Sault Ste. Marie
10231	Imperial Oil - Sault Ste. Marie Terminal	Sault Ste. Marie
10762	Sault Ste. Marie Waste Water Treatment Plant - West End Water Pollution Control Plant	Sault Ste. Marie
11148	Boniferro Mill Works ULC - Boniferro Mill Works ULC	Sault Ste. Marie
11215	Tenaris Algoma Tubes	Sault Ste. Marie
11244	Pioneer Construction Inc. - Sault Ste. Marie Facility	Sault Ste. Marie
11369	Fisher Wavy Inc. - Sault Ste. Marie	Sault Ste. Marie
11400	Lafarge Canada Inc. - Sault Ste. Marie RMC Plants	Sault Ste. Marie
11467	City of Sault Ste. Marie - East Wastewater Treatment Plant	Sault Ste. Marie
11793	Essar Power Canada Ltd.	Sault Ste. Marie
11588	Xstrata Canada Corporation - Nickel Rim South Mine	Skead
11155	KJ Beamish Construction Co. Limited - Spragge Plant and Quarry	Spragge
10044	Pioneer Construction Inc. - 1-311 Portable HMA Plant	Sudbury

NPRI ID	Facility Name	City
5990	City of Greater Sudbury - Sudbury Wastewater Treatment Plant	Sudbury
5991	City of Greater Sudbury - Wanapitei Water Treatment Plant	Sudbury
6541	Jazz Aviation LP - Sudbury Airport	Sudbury
7228	Toromont Energy Ltd. - SDEC Hospital Plant	Sudbury
10043	Pioneer Construction Inc. - 1-312 Portable HMA Plant	Sudbury
10045	Pioneer Construction Inc. - 1-308 Portable HMA Plant	Sudbury
10205	Vale Canada Limited - Frood-Stobie Mine	Sudbury
10233	Imperial Oil – Sudbury Terminal	Sudbury
10562	Weston Bakeries Ltd. - Weston Bakeries Sudbury Plant	Sudbury
11243	Pioneer Construction Inc. - Aztec Portable HMA Plant	Sudbury
11466	FNX Mining Company Inc. - Podolsky Mine	Sudbury
11477	City of Greater Sudbury - Sudbury Landfill Site	Sudbury
25089	Health Sciences North - Ramsey Lake Health Centre (Laurentian Site)	Sudbury
11465	Xstrata Canada Corporation - Sudbury Operations Mines/Mill - Thayer Lindsley Mine	Val Caron
11878	Vale Canada Limited - Totten Mine	Worthington

3.4.2 Background Radiation

Within the area of the four communities there have been a number of past producing uranium mines in the Elliot Lake area, uranium mineral prospects within the Huronian Supergroup, and an operating commercial uranium refinery at Blind River. Additionally, the rocks of the Ramsey–Algoma granitoid complex are generally elevated in potassium, uranium and thorium.

The background radiation levels for the area of the four communities are presented on Figure 11. The highest radiation levels are found proximal to the historic mining uranium operations located northeast and 12 km north of the City of Elliot Lake. The dose rates in these areas average above 200 nGy/h and peak at 2,700 nGy/h and are due to uranium mine tailings. Outside of the former mining areas, radiation levels generally range from approximately 10 to 90 nGy/h, with a few areas to the north and east of the municipal boundaries ranging from 100 to 150 nGy/h. These radiation levels are attributed to naturally occurring radioactive materials (NORM), specifically potassium, uranium and thorium-bearing minerals in the granitic rock.

A recent review of background concentrations of radionuclides in surface waters across Canada has been supplemented by measurements of surface waters sampled at various Canadian sites (NWMO, 2011). There were several sites in Ontario, one of which was at Quirke Lake north of the City of Elliot Lake, where elevated concentrations of uranium and radium were measured. This area is near a number of historic uranium mining operations and associated uranium mineralization. Elevated concentrations of Iodine-129 were also measured and are interpreted to be cosmogenic or geogenic.

In addition, the Canadian Radiological Monitoring Network (CRMN) measures monthly water quality in the Elliot Lake area. They report that all measured concentrations are much less than Drinking Water Quality Guidelines (Health Canada, 2013). While in the past some releases into the watershed from uranium mining activities have exceeded guidelines, a report to the Canadian Nuclear Safety Commission, Minnow (2011) stated that the current environmental releases of radionuclides into the Serpent River Watershed due to former uranium mining

activities are extremely low and there are essentially no measurable impacts outside of the licensed former mine site areas.

With respect to the Blind River Refinery, Cameco (2011) reports in their re-licencing submission that there were no regulatory exceedances of radiation levels or radionuclide releases during the previous licence period 2007-2011.

3.4.3 Soil Quality

A preliminary desktop review indicated that there is no specific information on background soil quality in the area of the four communities available. Outside of mining and industrial areas, soil concentrations are expected to be consistent with Ontario Typical Background ranges, as noted in Table 1 of Ontario Ministry of the Environment (MOE) Regulation 153/04, as amended (Government of Ontario, 2004).

3.4.4 Water Quality

The City of Elliot Lake draws its potable water from Elliot Lake. The 2011 annual report on water quality from the Elliot Lake Drinking Water System compared monitored water quality to the requirements of the Ontario *Safe Drinking Water Act* (O. Reg. 170/03) (Government of Ontario, 2003) and regulations therein (i.e., Ontario Drinking Water Standards, Objectives and Guidelines) (Government of Ontario, 2006). The report indicated that in 2011 there were no exceedances for any measured organic parameter (e.g., pesticides, herbicides, PCBs, volatile organics) or inorganic parameter (i.e., antimony, arsenic, cadmium, mercury, uranium, nitrate or nitrites) for the treated water (MOE, 2011).

The Town of Blind River draws its drinking water from a shallow unconfined sand aquifer, less than 5 m deep that is hydraulically connected to the Blind River (Harden, 2005). Precipitation has the ability to carry surficial contaminants from the ground surface down to the drinking water sources. The town's wells also draw water from the Blind River that is susceptible to contamination. In 2010, Algoma Public Health issued a drinking water advisory for the Town of Blind River, stating that trihalomethane (THM) concentrations in the municipal water system exceeded the Provincial Standard. THM is a by-product that forms when chlorine is added to water with elevated levels of organic materials (APH, 2010). This advisory was removed in January 2012, following 12 months of satisfactory results.

The Town of Spanish draws its water from groundwater wells, whereas the Township of The North Shore draws its potable water from Lake Huron (Pronto East Sub-Division) or from the Serpent River (Settlement of Serpent River). As these communities have small populations they are not required to provide the MOE with annual reports on water quality.

As noted in Section 3.4.2, a recent review of background concentrations of radionuclides in surface waters and soils across Canada has been supplemented by measurements of surface waters sampled at various Canadian sites (NWMO, 2011) including one at Quirke Lake in the area of the four communities and in Spanish River, just east of the area of the four communities. Results included elemental composition.

Surface water hydrology, groundwater and wells are further discussed in Sections 3.5 and 3.6.

3.4.5 Lake Sediment Chemistry

The desktop review did not identify any information related to lake sediment chemistry for the area of the four communities.

3.4.6 Potential Sources of Pollutants

There are a number of potential sources of pollutants in the area of the four communities including landfills, transportation corridors, domestic septic systems and local industries.

There are five operating landfill sites within the area of the four communities (Figure 1); namely, the Elliot Lake Landfill, Elliot Lake Landfill for sewage sludge, Serpent River Landfill, Blind River Landfill and the Quirke Mine Landfill (Table 5). All sites are classified as small landfills. As well there are 12 other small, closed landfills within the area of the four communities (MOE, 2013a).

Table 5: Registered Landfills in the Area of the Four Communities

Certificate of Approval (C of A) Number	Site Name	Location	Status
A560006	Koch Minerals	Lot 1, 2, Concession 2	Closed
	Client: Koch Canada Real Estate and Properties, LLC	Twp of The North Shore	
A560802	Client: Rio Algom Mines	Claim # 66632	Closed
		City of Elliot Lake	
A560803	Elliot Lake Landfill	Mining Claim #S-101389, Plan 5598	Closed
	Client: The City of Elliot Lake	City of Elliot Lake	
A560807	Panel Mine Landfill Site	Box 1500 Elliot Lake	Closed
	Client: Rio Algom Limited	City of Elliot Lake	
A560808	Quirke Mine Landfill		Closed
	Client: Rio Algom Limited	City of Elliot Lake	
A560809	Stanleigh Mine	75 Dieppe Avenue; Plan 5388	Closed
	Client: Rio Algom Limited	City of Elliot Lake	
A560810	Town of Elliot Lake Landfill	1.5 km south of the City of Elliot Lake	Open
	Client: The Corporation of the City of Elliot Lake	City of Elliot Lake	
A560811	Quirke Mine	Manfred Lake Trails Area, Plan 2333	Open
	Client: Rio Algom Limited	City of Elliot Lake	
A560812	Town of Elliot Lake Landfill, Sewage sludge	Part of Mining Claim S-86916	Open
	Client: The City of Elliot Lake	City of Elliot Lake	
A560813	Panel Mine	Part 1 CL 2885	Closed
	Client: Rio Algom Limited	City of Elliot Lake	
A560814	Stanleigh Mine	75 Dieppe Avenue	Closed
	Client: Rio Algom Limited	City of Elliot Lake	
A560815	Denison Mines Ltd Landfill	Mining Claims Nos S-86120, S-86121, S-86116, S-86117	Closed
	Client: Denison Mines Limited	City of Elliot Lake	
A562301	Township of Shedden Landfill	Part of Section 29	Closed

Certificate of Approval (C of A) Number	Site Name	Location	Status
	Client: The Corporation of the Town of Spanish	Town of Spanish	
A562302	Smith Lake Landfill	North ½ of Section 23	Closed
	Client: Town of Spanish	Town of Spanish	
A562303	Serpent River	Lot 8, Concession 2	Open
	Client: The Township of The North Shore	Township of Lewis	
A7138701	Blind River Landfill	South ½ of Lot 7, Concession 1	Open
	Client: The Town of Blind River	Town of Blind River	
A7138702	Striker Township Waste Disposal Site	North ½ of Lot 7, Concession 2	Closed
	Client: Ministry of Natural Resources	Town of Blind River	

Source: Ontario Landfills List (MOE, 2013a)

Transportation corridors, such as Highways 17, 108, 553 and 639, secondary roads, logging roads and rail lines, traverse the area of the four communities, and are considered to be potential sources of pollution, as a result of salt application for de-icing and mobile air emissions from internal combustion. There is also a potential for chemical releases along transportation routes as a result of spills or accidents. Additionally, the area of the four communities contains eight local airports which are also potential sources of pollution due to air emissions and potential chemical spills. Local septic systems are a potential source of pollutants, mainly as a result of septic waste and possibly as a result of chemical disposal into the septic system. Industrial operations in the area may be a source of pollutants, due to the potential release of chemicals as a result of spills or improper chemical handling practices. No specific releases of the above-named pollutants into the environment were identified in this review.

3.5 Surface Water Hydrology

The area of the four communities is located in the St. Lawrence drainage area, which drains into the Atlantic Ocean through the St. Lawrence River. Drainage through the area is generally from the north to the south, into the North Channel of Lake Huron. There are four tertiary watersheds in the area of the four communities; namely, the Upper Mississagi, the Lower Mississagi, the Serpent and the Spanish. Watershed boundaries and surface water drainage for the area of the four communities are shown on Figure 12.

The Mississagi River drains the northwestern and western parts of the area of the four communities. Within the Upper Mississagi watershed, the Aubinadong, Wenebegon, Maskuti and Abinette rivers are the main tributaries to the Mississagi River. Within the Lower Mississagi watershed, the Mississagi River is fed by the Little White, Little Rapid and Sharpsand rivers, of which the Little White River is the major tributary. The Serpent watershed drains the south-central part of the area of the four communities, including the City of Elliot Lake. This watershed is drained by the Blind and Serpent Rivers. The Spanish watershed drains the eastern part of the

area of the four communities. The Spanish River receives flow from the River aux Sables and the Vermillion, Wakonassin, Agnes, Mogo, East Spanish and Mozhabong Rivers.

3.6 Groundwater and Wells

Information concerning groundwater in the area of the four communities was obtained from MOE Water Well Information System (WWIS) database (MOE, 2013b). The locations of known water wells are shown on Figure 12. The majority of wells have been drilled along Highways 17 and 108, with a number of wells located around the City of Elliot Lake and in the area north of La Cloche Provincial Park. Water wells in the area of the four communities obtain water from the overburden or the shallow bedrock.

The WWIS database contains a total of 785 water well records in the area of the four communities (Figure 12), 538 of which provided useful information regarding lithology, well yield and / or depth to static water level as noted in Table 6. The negative value for the depth to water table indicates the water level is 0.9 m above ground surface or under artesian conditions (Golder, 2014).

Table 6: Water Well Record Summary for the Area of the Four Communities

Water Well Type	Number of Wells	Total Well Depth (m)	Static Water Level (m below surface)	Tested Well Yield (L/min)	Depth to Top of Bedrock (m)
Overburden	181	2.4 to 136.8	-0.9 to 44.8	4.5 to 1,137	N/A
Bedrock	357	3 to 216	0.3 to 28.2	4.5 to 341	0 to 137

3.6.1 Overburden Aquifers

There are 181 water well records in the area of the four communities that can be confidently assigned to the overburden aquifer. These wells are generally 2.4 to 136.8 m deep and have pumping rates of 4.5 to 1,137 L/min. These well-yields reflect the maximum pumping rate of the pumps in the wells and do not necessarily reflect the maximum sustained yield that might be available from overburden aquifers.

The overburden well records are concentrated within bedrock controlled valleys and along the main roadways which limits the available information regarding the extent and characteristics of the overburden aquifers in the area of the four communities. However, as several of these water wells are located within glaciolacustrine and glaciofluvial terrains, it is likely that similarly mapped terrains in the area of the four communities would also host overburden aquifers (Golder, 2014).

3.6.2 Bedrock Aquifers

Limited information was found on deep bedrock groundwater conditions in the area of the four communities at a typical repository depth of approximately 500 m. In the area of the four communities there are 357 well records that can be confidently assigned to the shallow bedrock aquifer. These wells range from 3 to 216 m in depth. Measured pumping rates in the bedrock wells are variable and range from 4.5 to 341 L/min. These well yields reflect the purpose of the wells (private residential supply, dewatering, etc.) and do not necessarily reflect the maximum sustained yield that might be available from the aquifers. Long-term groundwater yield in fractured bedrock will depend on the number and size of fractures, their connectivity, transmissivity, storage and on the recharge properties of the fracture network in the wider aquifer (Golder, 2014).

The MOE's WWIS shows no potable water supply wells which exploit aquifers at typical repository depths in the area of the four communities or anywhere else in northern Ontario (MOE, 2013b). Experience from other areas in the Canadian Shield has shown that active groundwater flow is generally confined to shallow fractured localized systems. In these shallow regions, flow tends to be dependent on the secondary permeability created by fractures. In deeper regions, hydraulic conductivity tends to decrease as fractures become less common and less interconnected. Increased vertical and horizontal stresses at depth tend to close or prevent fractures thereby reducing permeability and resulting in diffusion-dominated groundwater movement.

3.7 Climate and Meteorology

The climate assessment for the area of the four communities is based on Environment Canada's Sault Ste. Marie climate station 1971-2000 normals, as this is the closest climate station to the area of the four communities. The station has more than 30 years of continuous data required for establishing reliable climate normal, and the 30 year period from 1971-2000 is the most recent period for which climate normals are available from Environment Canada. Parameters that are measured at the Sault Ste. Marie climate station include temperature, precipitation, wind, atmospheric pressure and relative humidity.

The area of the four communities has a primarily continental climate, with cold winters and mild summers. The major driver for precipitation is weather systems that cross the Canadian prairies, the American Midwest and deep south that move northward into the region; these weather systems are responsible for transporting moisture from the Great Lakes and the Gulf of Mexico. Most precipitation falls in the late spring into early fall in the form of showers and thunderstorms associated with traversing weather systems. In the winter, snowfall amounts can be greater than 60 cm and are associated with strong winter storm weather. Prolonged periods of extreme cold can also be experienced in the region during the winter.

3.7.1 Temperature

Temperature data were obtained from Environment Canada's 1971-2000 climate normals for the Sault Ste. Marie meteorological station (EC, 2013c). Temperature in the area of the four communities can reach highs of 37°C in summer months and lows of -39°C in winter months. The annual average temperature is 4°C, with an average summer temperature of 16°C and an average winter temperature of -8°C (EC, 2013c). Figure 13 shows the monthly temperatures normals for Sault Ste. Marie displaying daily average, maximum, minimum and extreme temperature values over the calendar year. It should also be noted that winter temperatures inland from Lake Huron in the area of the four communities at higher elevations can be significantly colder than the climate normals reported for the Sault Ste. Marie station.

3.7.2 Precipitation

As shown on Figure 14, the annual average of total precipitation is 889 mm, where one cm of snow is equal to one mm of equivalent rainfall. The region received fairly similar precipitation rates on a monthly basis with summer months recording slightly higher precipitation on average. Figure 14 presents monthly precipitation data for the Sault Ste. Marie meteorological station, including total rainfall, rainfall, snowfall and all-time extreme values over the calendar year (EC, 2013c).

3.7.3 Wind

The prevailing wind in the area of the four communities is westerly, as expected for a mid-latitude region of North America. In the fall and winter season the dominant wind direction is an easterly flow. Table 7 presents the

monthly wind data obtained from Environment Canada's 1971-2000 climate normals for the Sault Ste. Marie meteorological station (EC, 2013c). Wind speed and direction are an average for each month over the calendar year.

Table 7: Monthly Wind Normals for Sault Ste. Marie

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Speed (km/hr)	14	13	14.1	15	13.4	12	11	11	13	14	15.6	15	13.3
Prevailing Wind Direction (from)	E	E	W	W	W	W	W	W	NW	E	E	E	W

3.8 Natural Hazards

3.8.1 Earthquakes and Seismicity

The area of the four communities lies within the Canadian Shield, where large parts have remained tectonically stable for the last 2.5 billion years (Percival and Easton, 2007). The area of the four communities has a low seismic hazard rating (NRCan, 2010). According to the National Earthquake Database (NEDB) for the period between 1985 and 2011 (NRCan, 2013) the area of the four communities has recorded only one moderate earthquake with a magnitude m_N of 2.1 in August of 1991.

A significant portion of the seismicity measured in the area of the four communities is due to mining activities near Sudbury. Natural Resources Canada has documented several hundred seismic events of magnitude m_N 2 or smaller, identified as being anthropogenic (man-made), resulting from rock bursts associated with mining activities in the area of the four communities for their period of active monitoring, 1985 through present. Studies of mining associated rock bursts in the area of Denison Mine (Pritchard and Hedley, 1993) and Quirke II Mine (Johnston, 1988) near Elliott Lake confirm the sources of the low magnitude seismic events.

In summary, the available literature and recorded seismic events indicate that the area of the four communities is located within an area of low seismicity.

3.8.2 Tornadoes and Hurricanes

As noted in Table 7, average monthly wind speeds in the area of the four communities are low, ranging from 11 to 16 km/hr. The area of the four communities experiences thunderstorms in the summer months and is located in an area with a low tornado frequency (<0.2 tornadoes per year / 10,000 km^2), but where there is a potential for F2-F5 tornadoes (Sills et al., 2012). The area of the four communities is situated too far away from the Atlantic Ocean to be susceptible to hurricanes. The National Building Code of Canada recommends a design 1/50 maximum[8] hourly wind pressure for the Elliot Lake area of 0.38 kPa, which is a typical value for Ontario (NRC, 2010).

3.8.3 Drought and Flooding

According to precipitation climate normals for the region (Figure 14), the area of the four communities experiences on average between 40 and 96 mm of precipitation each month, and is therefore unlikely to experience drought conditions that would affect the viability of local water sources. The single day extreme rainfall and snowfall events on record at the Sault Ste. Marie station (Figure 15) are 117 mm of rain and 61 cm of

[8] Hourly wind speeds having the annual probability of occurrence of a 1 in 50 year return period.

snow, respectively. In years where there is a high snowpack accumulation, the spring freshet can result in a nominal increase in water levels in local streams and rivers. As noted on Figure 12, the area of the four communities lies at the outflow of four watersheds along the northern shoreline of Lake Huron with moderate sized catchment areas, making for a moderate risk of flooding in some parts of the area. The potential for flooding to affect a repository facility would depend on the specific location.

3.8.4 Snow and Ice

As noted on Figure 14, the area of the four communities receives on average about 303 cm of snowfall per year, primarily between the months of November and April. No single month receives an average snowfall greater than 82 cm. There are usually one or two high snowfall events per year, with accumulations of 30 cm or greater, noting that the highest single day snowfall accumulation on record is 61 cm, recorded on February 10, 1947. The National Building Code of Canada recommends a design 1/50 snow load (S_s + S_r)[9] for the Elliot Lake area of 3.3 kPa, which is a typical value for central and northern Ontario (NRC, 2010). Local lakes and water bodies freeze over in the winter months in the area of the four communities, as average daily temperatures from November to March typically range from -10 to -0^{o}C.

3.8.5 Forest Fires and Lightning

Within forested areas such as the area of the four communities there is a risk of forest fires. Locations where forest fires have occurred in the vicinity of the area of the four communities between 1976 and 2010 affecting an area of greater than 200 ha are shown on Figure 5. These forest fires combine to comprise <1% of the total area of the four communities. Forest fires can be initiated by lightning strikes or human activity, particularly if dry conditions are present in the forest understory. As previously noted, thunderstorms occur in the area of the four communities and lightning strikes are not uncommon in the summer months.

3.8.6 Landslides and Tsunamis

Steep slopes in the area of the four communities, where present, are generally comprised of crystalline rock with a thin veneer of soil cover. The physical nature of these slopes, combined with typically modest precipitation and low seismicity, results in a possible landslide risk for the area of the four communities. There is a low risk of tsunamis in the area of the four communities, along the immediate Lake Huron / North Channel shoreline, owing to the low seismicity.

[9] The combined snow and rain load that has an annual probability of occurrence in a 1 in 50 year period.

4.0 SUMMARY

This report provides a high level description of the environment in the area of the four communities.

Situated in the District of Algoma between Sault Ste. Marie and Sudbury, the area of the four communities is approximately 14,450 km² in size (LIO, 2013), with a total population of 16,102 (Statistics Canada, 2013). The area of the four communities has a primarily continental climate, with cold winters and mild summers with most precipitation falling in the form of summer showers and thunderstorms. Winter snowfall amounts are high and are associated with winter storm events.

There are a number of First Nation and Métis communities and organizations in and around the area of the four communities including Whitefish Lake First Nation, Wikwemikong Unceded First Nation, Serpent River First Nation, Mississauga #8 First Nation, Sagamok Anishnawbek First Nation and Whitefish River First Nation. Métis Councils in the area include the Historic Sault Ste. Marie Métis Council, the North Channel Métis Council, the Sudbury Métis Council and the North Bay Métis Council.

The area of the four communities lies in the Penokean Hills and Abitibi Upland, featuring the broadly rolling surfaces of Canadian Shield bedrock that occupies most of north-central Ontario; either exposed at surface or shallowly covered with Quaternary glacial deposits. Terrains in the area of the four communities contain numerous lakes. Geologically, the area of the four communities is underlain by Archean-age rocks of the Superior Province which are, in turn, overlain in the south portion of the area of the four communities by early Proterozoic rocks of the Southern Province. The regional bedrock geology in the area of the four communities is dominated by the Ramsey-Algoma granitoid complex, a large granitic complex that intruded older greenstone belts.

There are currently no active mines in the area of the four communities, but the region has a long history of mining, and mineral exploration and development continues there today. In the area of the four communities, there are several areas of active exploration and of metallic mineral production including in the Huronian Supergroup, Whiskey Lake and Benny Lake greenstone belts, and the East Bull Lake intrusive suite.

Infrastructure within the area of the four communities includes the Trans-Canada Highway (Highway 17) heading east-west through the area of the four communities and Highway 108 heading north from the community of Serpent River from Highway 17 up through Elliot Lake. A rail corridor runs approximately parallel to Highway 17 through the area of the four communities. Several transmission lines are located in the area of the four communities, two running east to west along the southern half of the area and another running north to south along the western edge of the area. There is a natural gas pipeline running westward from the City of Elliot Lake to the southwestern part of the area of the four communities. The area is serviced by two local airports and has two emergency landing strips and five seaplane bases. There are 15 provincial parks, 12 conservation reserves and four forest reserves in the area of the four communities.

The area of the four communities lies within the Great Lakes – St. Lawrence Forest. The area of the four communities lies within two Forest Management Units: the Northshore Forest (FMU 680), managed by Northshore Forest Incorporated and the Spanish Forest (FMU 210), managed by Domtar Incorporated. In total the area of the four communities contains 987,646 ha of woodlands, which is 68% of the land coverage (LIO, 2013). Typical forests in the area of the four communities include eastern white pine, red pine, jack pine, black spruce, eastern hemlock, yellow birch, white birch, poplar and tolerant hardwoods.

The region's forests provide habitat for wildlife including game, furbearing mammals and fish. Management of moose populations and concentration and nesting areas for raptors, herons and waterfowl are a particular concern to the MNR.

The Natural Heritage Information Centre (NHIC) database (NHIC, 2013) shows the occurrence of species that are listed as Endangered (END), Threatened (THR) or Special Concern (SC) either under the provincial *Endangered Species Act* (ESA) (Government of Ontario, 2007), or the Federal *Species at Risk Act* (SARA) (Government of Canada, 2012). The Royal Ontario Museum range maps (ROM, 2013) indicate the potential for Species at Risk (SAR) to exist within the area of the four communities, based on the principals of range mapping. Habitats within the Ramsey-Algoma granitoid complex of the area of the four communities could directly or indirectly support the needs of 30 designated SAR. These species include six END species: the provincially END eastern cougar, little brown myotis (bat), northern myotis (bat), golden eagle, the federally END wood turtle and the provincially and federally END shortnose cisco (fish).

In the area of the four communities is located in four tertiary watersheds: Upper Mississagi, Lower Mississagi, Spanish and Serpent. Surface water generally flows from north to south, outflowing into Lake Huron and major rivers include the Blind, Wenebegon, Mississagi, Spanish, Sable and Little Serpent Rivers. The area of the four communities has the highest proportion of lake trout and brook trout lakes of any northern zone and it includes several deep, clear inland lakes supporting inland fisheries (MNR, 2013c). Water bodies occurring within the area are a mix of cold, cool and warm thermal classification. Water bodies in the area of the four communities support local sport fishing and tourism.

Water wells in the area of the four communities obtain water from the overburden or the shallow bedrock. The MOE water well database contains 785 water well records in the area of the four communities, 538 of which provided useful information regarding lithology, well yield and / or depth to static water. No potable water supply wells are known to exploit aquifers at typical repository depths in the area of the four communities or anywhere else in northern Ontario.

Outside of mining and industrial areas, air, soil and surface water quality within the area of the four communities are expected to be within the normal range for north-central Ontario. Within the area of the four communities there have been a number of past producing uranium mines in the Elliot Lake area, uranium mineral prospects within the Huronian Supergroup, and an operating commercial uranium refinery at Blind River. Additionally, the rocks of the Ramsey–Algoma granitoid complex are generally elevated in potassium, uranium and thorium.

The Ontario Archaeological Sites Database identified 85 known archaeological sites in the area of the four communities, with 12 of these found within the municipal boundaries of the four communities. Archaeological sites within the area of the four communities also include sites in the Mississagi River Provincial Park and the Mississagi Delta Provincial Nature Reserve (von Bitter, 2013). There are five historic burial sites, no known Federal Heritage Designations and no Provincial historic sites identified in the area of the four communities. The presence of local heritage sites would need to be further confirmed in discussion with the community and First Nation and Métis communities and organizations in the area.

5.0 REFERENCES

Algoma Public Health (APH), 2010. Drinking Water Advisory, dated December 17, 2010. Retrieved from (http://www.algomapublichealth.com). Accessed April 2013.

Barnett, P.J., A.P. Henry and D. Babuin, 1991. Quaternary geology of Ontario, east-central sheet. Ontario Geological Survey, Map 2555, scale 1:1,000,000.

Bat Conservation International (BCI), 2013a. BCI Species Profiles: Myotis lucifugus. Retrieved from (http://www.batcon.org/index.php/all-about-bats/species-profiles.html?task=detail&species=2040&country=43&state=all&family=all&start=25). Accessed April 2013.

Bat Conservation International (BCI), 2013b. BCI Species Profiles: Myotis septentrionalis. Retrieved from (http://www.batcon.org/index.php/all-about-bats/species-profiles.html?task=detail&species=2306&country=43&state=40&family=100&limitstart=0). Accessed April 2013.

Bird Studies Canada (BSC), 2006. Environment Canada's Canadian Wildlife Service, Ontario Nature, Ontario Field Ornithologists and Ontario Ministry of Natural Resources. Ontario Breeding Bird Atlas Website. Retrieved from (http://www.birdsontario.org/atlas/index.jsp). Accessed April 2013.

Cameco Corporation (Cameco), 2011. Written Submission Supporting the Renewal of Blind River Refinery's Class IB Nuclear Fuel Facility Operating Licence Application. Dated November 3, 2011.

Dobbyn, J.S., 1994. Atlas of the Mammals of Ontario. Federation of Ontario Naturalists, Toronto. 120 pp.

Domtar Inc. (Domtar), 2010a. Forest Management Plan for the North Shore Forest, Ministry of Natural Resources Sault Ste. Marie and Sudbury Districts, Northeast Region, for the 10-year period from April 1, 2010 to march 31, 2020.

Domtar Inc. (Domtar), 2010b. Forest Management Plan for the Spanish Forest, Ministry of Natural Resources Sudbury District, Northeast Region, for the 10-year period from April 1, 2010 to march 31, 2020.

Environment Canada (EC), 2013a. National and Regional Air Quality, Air and Climate Indicators. Retrieved from (http://www.ec.gc.ca/indicateurs-indicators/default.asp?lang=En&n=03603FB3-1). Accessed April 2013.

Environment Canada (EC), 2013b. National Pollutant Release Inventory: Facility Reported Data. (Retrieved from http://www.ec.gc.ca/inrp-npri/). Accessed April 2013.

Environment Canada (EC), 2013c. National Climate Data and Information Archive. (Retrieved from http://climate.weatheroffice.gc.ca/climateData/canada_e.html). Accessed April 2013.

Ford, M.J., 1993. The Quaternary Geology of the Rawhide Lake area, District of Algoma; Ontario Geological Survey, Open File Report 5867, 10 p.

Ford, M.J., 1991. The Quaternary geology of the Rawhide Lake area, District of Algoma. Ontario Geological Survey, Miscellaneous Paper 157.026.

Golder Associates Ltd. (Golder), 2014. Phase 1 Desktop Geoscientific Preliminary Assessment of Potential Suitability for Siting a Deep Geological Repository of Canada's Use Nuclear Fuel – Communities of Elliot Lake, Blind River, The North Shore and Spanish, and Surrounding Area, Ontario. NWMO Report Number APM-REP-06144-0092.

Government of Canada, 2012. *Species at Risk Act* (SARA). Retrieved from (http://www.sararegistry.gc.ca/default_e.cfm). Accessed May 2013.

Government of Ontario, 2011. Standards and Guidelines for Consulting Archaeologists. Ministry of Tourism, Culture, and Sport.

Government of Ontario, 2007. *Endangered Species Act* (ESA). Retrieved from (http://www.mnr.gov.on.ca/en/Business/Species/2ColumnSubpage/MNR_SAR_ENDNGR_SPC_TBSCS_EN.html). Accessed April 2013.

Government of Ontario, 2006. Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines. PIBS 4449e01. Revised June 2006.

Government of Ontario, 2004. *Environment Protection Act* (EPA). Ontario Regulation 153/04. Retrieved from (http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_040153_ev001.htm). Accessed May 2013.

Government of Ontario, 2003. *Safe Drinking Water Act*. Ontario Regulation 170/03. Retrieved from (http://www.e-laws.gov.on.ca/html/regs/english/elaws_regs_030170_e.htm). Accessed May 2013.

Harden Environmental Services Ltd. (Harden), 2005. Municipal Groundwater Study – Town of Blind River.

Health Canada, 2013. Canadian Radiological Monitoring Network: Who We Are. Retrieved from (http://www.hc-sc.gc.ca/ewh-semt/contaminants/radiation/crmn-rcsr/who_we_are-qui_sommes_nous-eng.php). Accessed April 2013.

Henderson, P.J. and J.M. Halstead, 1992. The Quaternary Geology of the Elliot Lake Area, District of Algoma. Ontario Geological Survey, Open File Map 193, 1:50,000.

Jensen, L.S., 1994. Geology of the Whiskey Lake Greenstone Belt (West Half), Districts of Sault Ste. Marie and Sudbury, Ontario Geological Survey, Open File Report 5883, 101p.

Johnston, J.C., 1988. A Survey of Mining Associated Rockbursts. Environmental Research Papers, NO. 998.

Jones, C., R Layberry and A. Macnaughton, 2013. Ontario Butterfly Atlas Online. Retrieved from (http://www.ontarioinsects.org/atlas_online.htm). Toronto Entomologists' Association. Accessed March 2013.

Land Information Ontario (LIO), 2013. Ontario Ministry of Natural Resources. Retrieved from (http://www.mnr.gov.on.ca/en/Business/LIO/). Accessed April 2013.

Minnow Environmental Inc. (Minnow), 2011. Serpent River Watershed State of the Environment Report. Prepared for: Rio Algom Limited and Denison Mines Inc., Elliot Lake, ON. July 2011.

Natural Heritage Information Centre (NHIC), 2013. Ontario Ministry of Natural Resources. (Retrieved from http://www.mnr.gov.on.ca/en/Business/NHIC/). Accessed March 2013.

Natural Heritage Information Centre (NHIC), 2005. Ontario Odonata Atlas Natural Heritage Information Centre, Ontario Ministry of Natural Resources. Retrieved from (http://nhic.mnr.gov.on.ca/odonates/about.html)). Accessed March 2013.

National Research Council (NRC), 2010. National Building Code of Canada 2010, Volume 2. 1245p.

Natural Resources Canada (NRCan), 2013. Earthquakes Canada Website. Retrieved from (http://earthquakescanada.nrcan.gc.ca) Accessed April 2013.

Natural Resources Canada (NRCan), 2010. Seismic Hazard Map, Geological Survey of Canada. Retrieved from (http://www.earthquakescanada.nrcan.gc.ca). Accessed April 2013.

Natural Resources Canada (NRCan), 1997. Geological Map of Canada - Map D1860A [CD-ROM].Geological Survey of Canada, Natural Resources Canada, Ottawa.

Nuclear Waste Management Organization (NWMO), 2011. Environmental Radioactivity in Canada - Measurements. NWMO TR-2011-16. May 2011.

Nuclear Waste Management Organization (NWMO), 2010. Moving Forward Together: Process for Selecting a Site for Canada's Deep Geological Repository for Used Nuclear Fuel. May 2010.

Oldham, M.J. and W.F. Weller, 2000. Ontario Herpetofaunal Atlas. Natural Heritage Information Centre, Ontario Ministry of Natural Resources. (Retrieved from http://nhic.mnr.gov.on.ca/MNR/nhic/herps/ohs.html).. Accessed March 2013.

Ontario Heritage Trust (OHT), 2013. Ontario Heritage Trust website. (Retrieved from http://www.heritagetrust.on.ca/Home.aspx). Accessed April 2013.

Ontario Ministry of the Environment (MOE), 2013a. Landfill Inventory Management Ontario (LIMO) List. Retrieved from (http://www.ene.gov.on.ca/environment/en/monitoring_and_reporting/limo/landfills/). Accessed April 2013.

Ontario Ministry of the Environment (MOE), 2013b. Water Well Information System (WWIS) Database. Natural Resources Canada, 2013. Geobase. Accessed September 2013.

Ontario Ministry of the Environment (MOE), 2011. Corporation of the City of Elliot Lake Drinking Water Annual Report. January 1 – December 31, 2011.

Ontario Ministry of Municipal Affairs and Housing (MMAH), 2009. Restructured Municipalities, Ontario Map #4. Retrieved from (http://www.mah.gov.on.ca/Page5383.aspx). Accessed April 2013.

Ontario Ministry of Natural Resources (MNR), 2014. Golden Eagle – Ontario Recovery Strategy Series (Draft). Retrieved from (http://www.mnr.gov.on.ca/en/Business/Species/2ColumnSubPage/MNR_SAR_SPEC_RCVRY_STRAT_EN.html). Accessed February 2014.

Ontario Ministry of Natural Resources (MNR), 2013a. Forest Management Plans. Retrieved from (http://www.efmp.lrc.gov.on.ca/eFMP/home.do?currentFmu=&language=en). Accessed March 2013.

Ontario Ministry of Natural Resources (MNR), 2013b. Wildlife Management Unit Maps. Queen's Printer for Ontario. Retrieved from (http://www.mnr.gov.on.ca/en/Business/FW/2ColumnSubPage/256933.html). Accessed March 2013.

Ontario Ministry of Natural Resources (MNR), 2013c. Fishing Regulations Summary 2013. ISSN 1911-6276.

Ontario Ministry of Natural Resources (MNR), 2010a. Fisheries Management Zone 10 What's new for 2010? Retrieved from (http://www.mnr.gov.on.ca/en/Business/LetsFish/2ColumnSubPage/264844.html). Accessed March 2013.

Ontario Ministry of Natural Resources (MNR), 2010b. Fisheries Management Zone 10: Lake Trout Operational Objectives and Management Strategies. Retrieved from (http://www.mnr.gov.on.ca/en/Business/LetsFish/2ColumnSubPage/264844.html). Accessed April 2013.

Ontario Ministry of Tourism, Culture, and Sport (MTCS), 2013. Heritage Properties Search Form. Retrieved from (http://www.hpd.mcl.gov.on.ca/scripts/hpdsearch/english/default.asp). Accessed April 2013.

Ontario Parks, 2013. Provincial Parks Profiles. Retrieved from (http://www.ontarioparks.com/en). Accessed August 2013.

Parks Canada, 2013. Canada's Historic Places. Retrieved from (http://www.pc.gc.ca/progs/lhn-nhs/index.aspx). Accessed April 2013.

Peck, D.C. and R.S. James, 1991. Geology and Platinum Group Element Sulphide Mineralization, East Bull Lake, Ontario Geological Survey, Open File Report 5813, 65p.

Percival, J.A. and R.M. Easton, 2007. Geology of the Canadian Shield in Ontario: an update. Ontario Geological Survey, Open File Report 6196, Geological Survey of Canada, Open File 5511, Ontario Power Generation, Report No. 06819-REP-01200-10158-R00, 55 p.

Planscape, 2006. Official Plan for the City of Elliot Lake. Retrieved from (http://www.cityofelliotlake.com/en/cityservices/officalplan.asp). Accessed March 2013.

Pritchard, C.J. and D.G.F. Hedley, 1993. Progressive pillar failure and rockbursting at Denison Mine.

Reid, J.L., 2003. Regional modern alluvium sampling survey of the Sault Ste. Marie-Espanola Corridor, Northeastern Ontario: Operation Treasure Hunt, Ontario Geological Survey, Open File Report 6117, 147p.

Royal Ontario Museum (ROM), 2013. Ontario's Biodiversity: Species at Risk. Retrieved from (http://www.rom.on.ca/ontario/risk.php). Accessed March 2013.

Sills, D., V. Cheng, P. McCarthy, B. Rousseau, J. Waller, L. Elliott, J. Klaassen and H. Auld, 2012: Using tornado, lightning and population data to identify tornado prone areas in Canada. *Preprints, 26th AMS Conference on Severe Local Storms, Nashville, TN*, Amer. Meteorol. Soc., Paper P59.

Statistics Canada, 2013. *Census Profile.* Retrieved from (http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/index.cfm?Lang=E). Accessed March 2013.

Thurston, P.C., 1991. Geology of Ontario: Introduction, *In*: Geology of Ontario. Ontario Geological Survey, Special Volume No. 4, Ontario Geological Survey, p.3-26.

Tunnock Consulting Ltd. (Tunnock), 2013. Town of Spanish Official Plan. Dated February 8, 2013.

Tunnock Consulting Ltd. (Tunnock), 2012a. Town of Blind River Draft Official Plan. (Retrieved from http://www.blindriver.com/site/townhall/). Accessed March 2013.

Tunnock Consulting Ltd. (Tunnock), 2012b. Township of The North Shore Draft Official Plan. Dated November 20, 2012.

Tunnock Consulting Ltd. (Tunnock), 2010. Township of Sables-Spanish Rivers Official Plan. (Retrieved from http://www.sables-spanish.ca/page/planning-and-zoning). Accessed January 2014.

von Bitter, R., 2013. Personal Communication on April 26, 2013 re: Archaeological Sites Database. Ministry of Tourism, Culture, and Sport.

Report Signature Page

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FIGURES





LEGEND

- Community
- Airport
- Domestic Waste Site
- Waste Water Treatment Plant
- Main Road
- Local Road
- Railway
- 230 kV Transmission Line
- 115 kV Transmission Line
- Natural Gas Pipeline
- Watercourse, Permanent
- Watercourse, Intermittent
- Waterbody
- Federal Land - Indian Reserve
- Forest Reserve
- Conservation Reserve
- Provincial Park
- Municipal Boundary
- Municipal Boundary (Communities of Elliot Lake, Blind River, The North Shore and Spanish)

REFERENCE

Base Data - MNR LIO, obtained 2009-2012, CANMAP v2006.4
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17N

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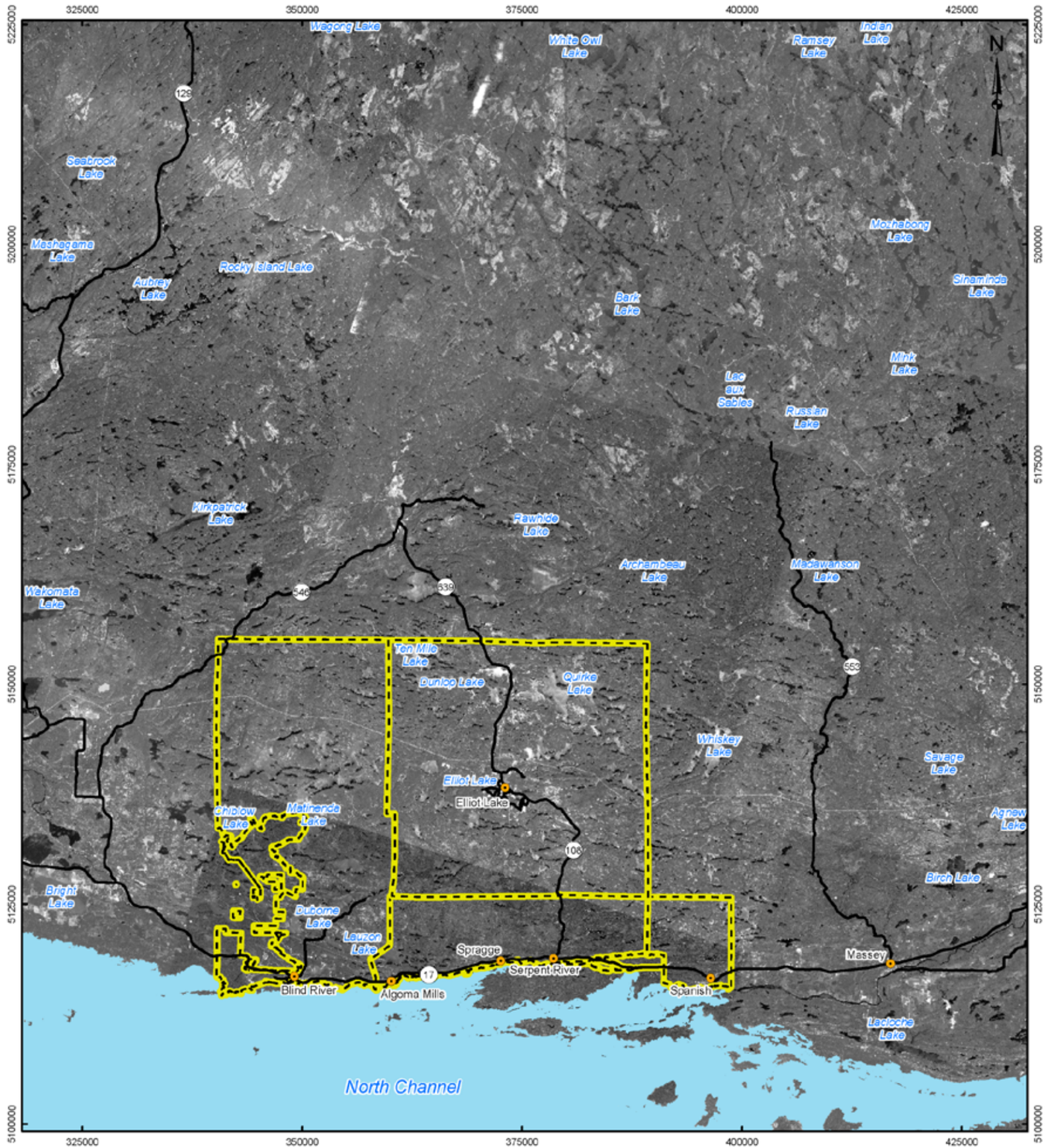
PROJECT
Environment Report
Communities of Elliot Lake, Blind River,
The North Shore and Spanish, Ontario

TITLE
Communities of Elliot Lake, Blind River, The North Shore and Spanish and Surrounding Lands

Golder Associates
Mississauga, Ontario

PROJECT NO. 12-1152-0026			SCALE AS SHOWN	REV. 0.0
DESIGN	PRM	28 Mar. 2012	
GIS	PMJB	28 Nov. 2014	FIGURE: 1
CHECK	JH	28 Nov. 2014	
REVIEW	GWS	28 Nov. 2014	

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LEGEND

- Community
- Main Road
- Waterbody
- Municipal Boundary (Communities of Elliot Lake, Blind River, The North Shore and Spanish)



REFERENCE

Base Data - MNR LIO, obtained 2009-2012. CANMAP v2009.4
Imagery - SPOT 5, Obtained from Geobase (2006. 10 m resolution)
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17N

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PROJECT: Environment Report
Communities of Elliot Lake, Blind River,
The North Shore and Spanish, Ontario

TITLE: **Satellite Imagery of the Communities of Elliot Lake, Blind River, The North Shore and Spanish and Surrounding Area**

Golder Associates
Mississauga, Ontario

PROJECT NO. 12-1152-0026			SCALE AS SHOWN	REV. 0.0
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REVIEW	GWS	13 Mar. 2014		

FIGURE: 2

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LEGEND

- Community
- Main Road
- Local Road
- Railway
- Waterbody
- Forest Reserve
- Conservation Reserve
- Provincial Park
- Private Land
- Federal Land - Indian Reserve
- Crown Leased Land
- Crown Land - Non-Freehold Dispositions Public
- Crown Land - Unpatented Public Land
- Crown Reserves
- Regular Registered Trapline Area License
- Municipal Boundary (Communities of Elliot Lake, Blind River, The North Shore and Spanish)



REFERENCE

Base Data - MNR LIO, obtained 2009-2012, CANMAP v2006.4
Crown Reserves - Ministry of Northern Mines and Development (April 4, 2013)
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17N

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SCALE 1:525,000 KILOMETERS

PROJECT Environment Report
Communities of Elliot Lake, Blind River,
The North Shore and Spanish, Ontario

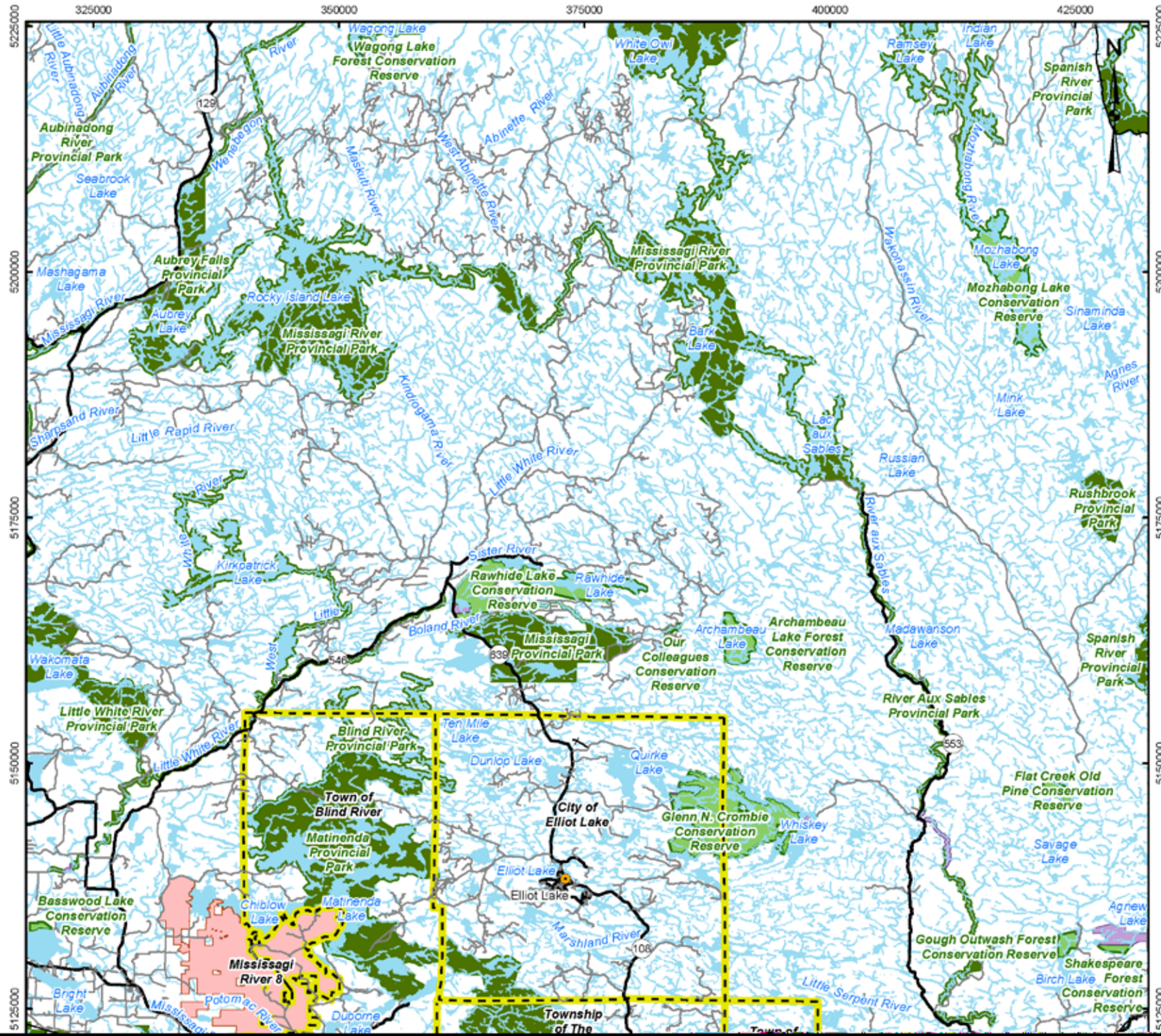
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Golder Associates
Mississauga, Ontario

PROJECT NO. 12-1152-0245			SCALE AS SHOWN	REV. 0.0
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GIS	PMUB	29 May. 2014		
CHECK	JH	29 May. 2014		
REVIEW	GWS	29 May. 2014		

FIGURE: 3

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LEGEND

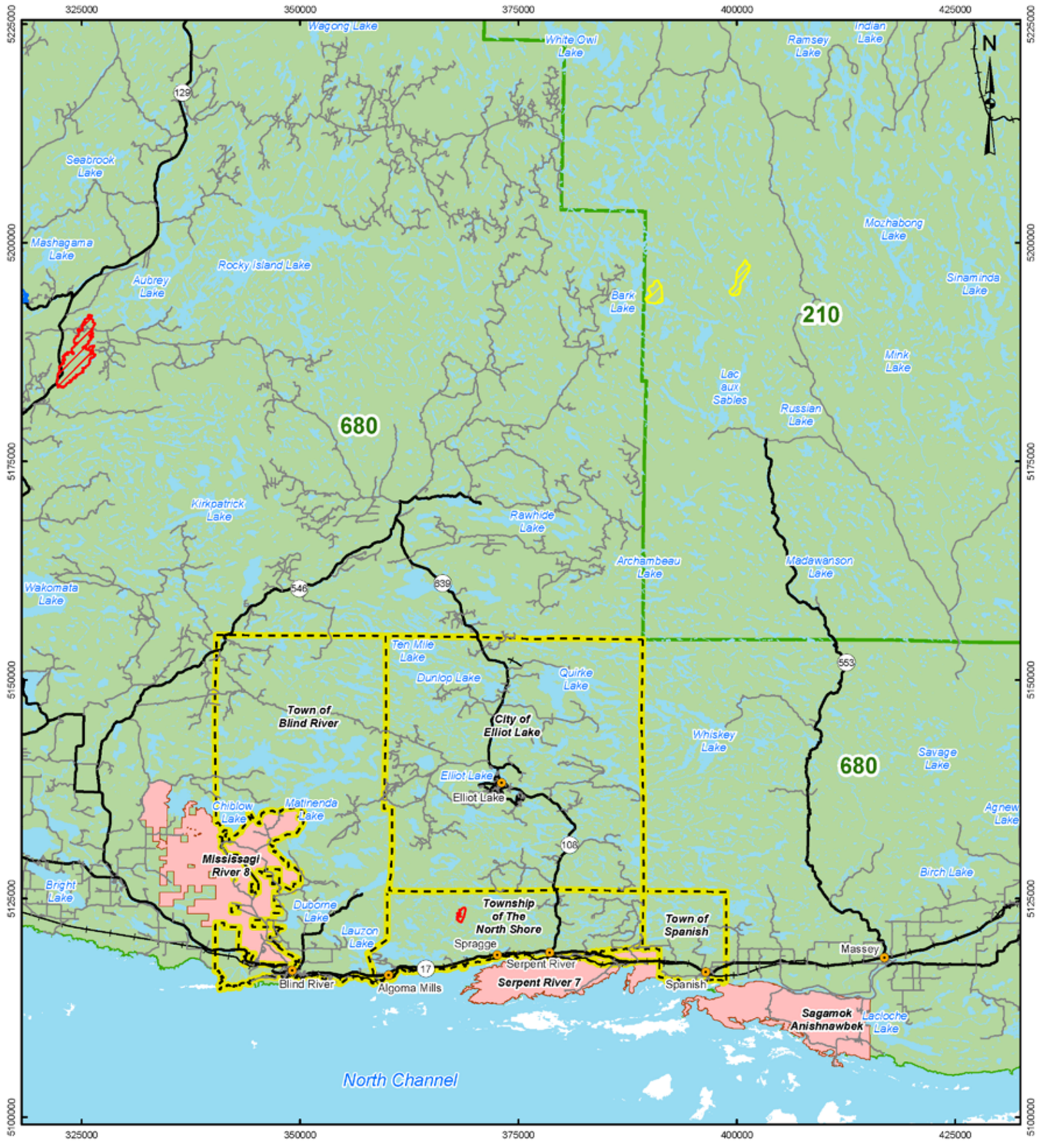
- Community
- Main Road
- Local Road
- Railway
- Watercourse, Permanent
- Watercourse, Intermittent
- Waterbody
- Federal Land - Indian Reserve
- Forest Reserve
- Conservation Reserve
- Provincial Park
- Municipal Boundary (Communities of Elliot Lake, Blind River, The North Shore and Spanish)



REFERENCE

Base Data - MNR LIO, obtained 2009-2012, CANMAP v2006.4
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LEGEND

- Community
- Main Road
- Local Road
- Railway
- Waterbody
- Federal Land - Indian Reserve
- Municipal Boundary (Communities of Elliot Lake, Blind River, The North Shore and Spanish)

Forest Fire Areas (greater than 200 hectares)

- 1976 - 1980
- 1981 - 1990
- 1991 - 2000
- 2001 - 2010

Forest Plan Renewal Year

- 2013
- 2014
- 2015
- 2016
- 2017

FOREST MANAGEMENT UNITS

210 - Spanish Forest
680 - Northshore Forest



REFERENCE

Base Data - MNR LIO, obtained 2009-2012, CANMAP v2006.4
Forest Management Units & Forest Fire Areas - Canadian Forest Service, 2010.
Canadian National Fire Database - Agency Fire Data, Natural Resources Canada, Canadian ForestService, Northern Forestry Centre, Edmonton, Alberta.
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17N

10 5 0 10 20 30
SCALE 1:525,000 KILOMETRES

PROJECT: Environment Report
Communities of Elliot Lake, Blind River,
The North Shore and Spanish, Ontario

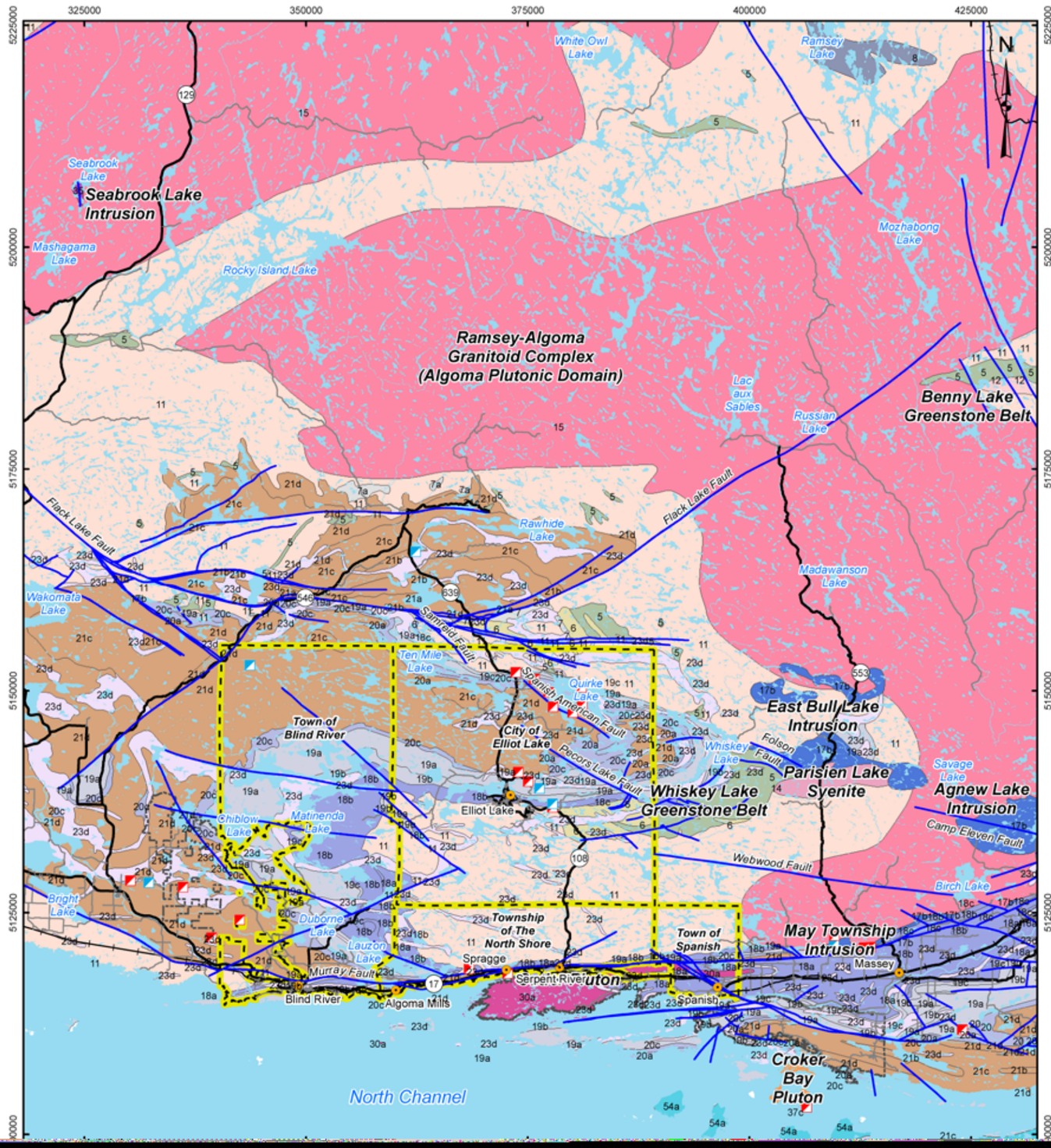
TITLE: **Forest Management Units of the Communities of Elliot Lake, Blind River, The North Shore and Spanish and Surrounding Area**

Golder Associates
Mississauga, Ontario

PROJECT NO. 12-1152-0026			SCALE AS SHOWN	REV. 0.0
DESIGN	PRM	28 Mar. 2012		
GIS	PRM	13 Mar. 2014		
CHECK	JH	13 Mar. 2014		
REVIEW	GWS	13 Mar. 2014		

FIGURE: 5

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LEGEND

- Community
- Past Producing Mine with Reserves
- Past Producing Mine without Reserves
- Main Road
- Local Road
- Railway
- Waterbody
- Municipal Boundary (Communities of Elliot Lake, Blind River, The North Shore and Spanish)
- Geological Fault

Bedrock Geology

Phanerozoic

- 55 Shale, limestone, dolostone, siltstone
  - 55b Georgian Bay Fm.; Blue Mountain Fm.; Billings Fm.; Collingwood Mb.; Eastview Mb. MinStr:
- 54 Limestone, dolostone, shale, arkose, sandstone
  - 54a Ottawa Gp.; Simcoe Gp.; Shadow Lake Fm.

Proterozoic

- 37 Mafic intrusive rocks
  - 37c Gabbro, diorite, ultramafic rocks, granophyre
- 35 Carbonatite-alkalic intrusive suite (1.0 to 1.2 Ga)
- 30 Felsic intrusive rocks
  - 30a Granite, alkali granite, granodiorite, quartz feldspar porphyry; minor related volcanic rocks (1.4 to 1.5 Ga)
- 23 Mafic and related intrusive rocks
  - 23d Nipissing sills (2219 Ma)
- 21 Cobalt Gp.: siltstone,argillite, sandstone, conglomerate
- 20 Quirke Lake Gp.: sandstone, siltstone, conglomerate, limestone, dolostone
- 19 Hough Lake Gp.: siltstone, wacke, argillite, quartz-feldspar sandstone, conglomerate, sandstone
- 18 Elliot Lake Gp.: siltstone, wacke, argillite, quartz-feldspar sandstone, conglomerate, mafic
- 17 Mafic and ultramafic intrusive rocks
  - 17b Gabbro, anorthosite

Archean

- 15 Massive granodiorite to granite
- 14 Diorite-monzodiorite-granodiorite suite
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite
- 8 Migmatized supracrustal rocks
- 7 Metasedimentary rocks
  - 7a Paragneisses and migmatites
- 6 Felsic to intermediate metavolcanic rocks
- 5 Mafic to intermediate metavolcanic rocks

REFERENCE

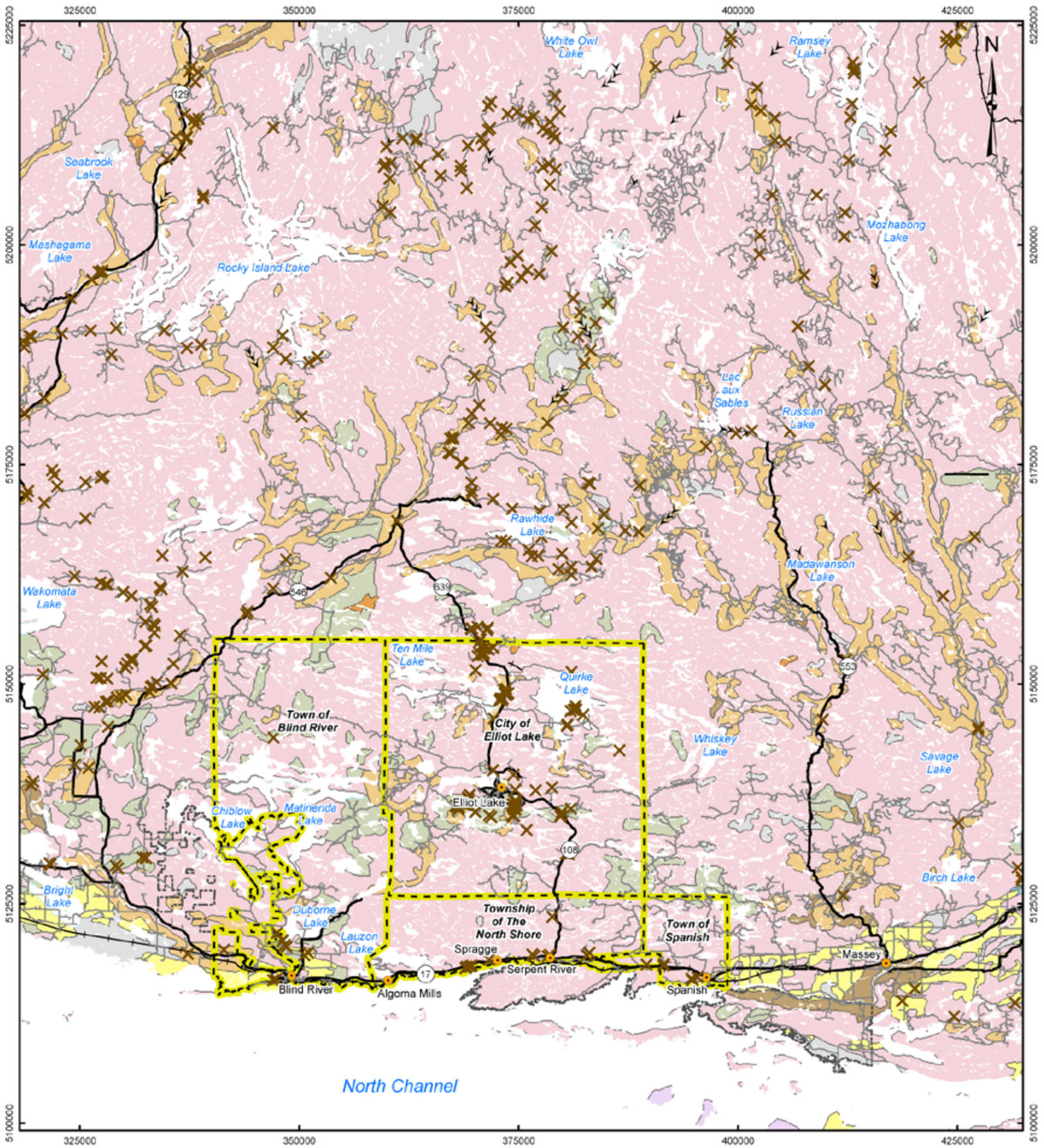
Base Data - MNR LIO, obtained 2009-2013
Geology - MRD126-Bedrock Geology of Ontario, 2011
Mineral Inventory - Mineral Deposit Inventory of Ontario v2, 2004
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17N

10 5 0 10 20 30
SCALE 1:525,000 KILOMETERS

PROJECT: Environment Report
Communities of Elliot Lake, Blind River, The North Shore and Spanish, Ontario

TITLE: **Bedrock Geology of the Communities of Elliot Lake, Blind River, The North Shore and Spanish and Surrounding Area**

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LEGEND

- Community
- Main Road
- Local Road
- Railway
- Pit (Gravel)
- Federal Land - Indian Reserve
- Esker or area of eskers; direction of flow known or assumed
- Trend of end moraine crest

Surficial Geology

- 1: Bedrock
- 2: Bedrock, post-Precambrian
- 18: Till
- 22: Glaciofluvial Ice
- 23: Glaciofluvial Outwash deposits
- 24: Glaciolacustrine deposits (silt and clay)
- 25: Glaciolacustrine deposits (sand and gravel)
- 28: Fluvial deposits
- 31: Fluvial deposits
- 32: Organic deposits
- 33: Waterbody
- Municipal Boundary (Communities of Elliot Lake, Blind River, The North Shore and Spanish)



REFERENCE

Base Data - MNR LIO, obtained 2009-2012, CANMAP v2005.4
Geology - Quaternary geology, Ontario Geological Survey, Data Set 14 (1:1,000,000)
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17N

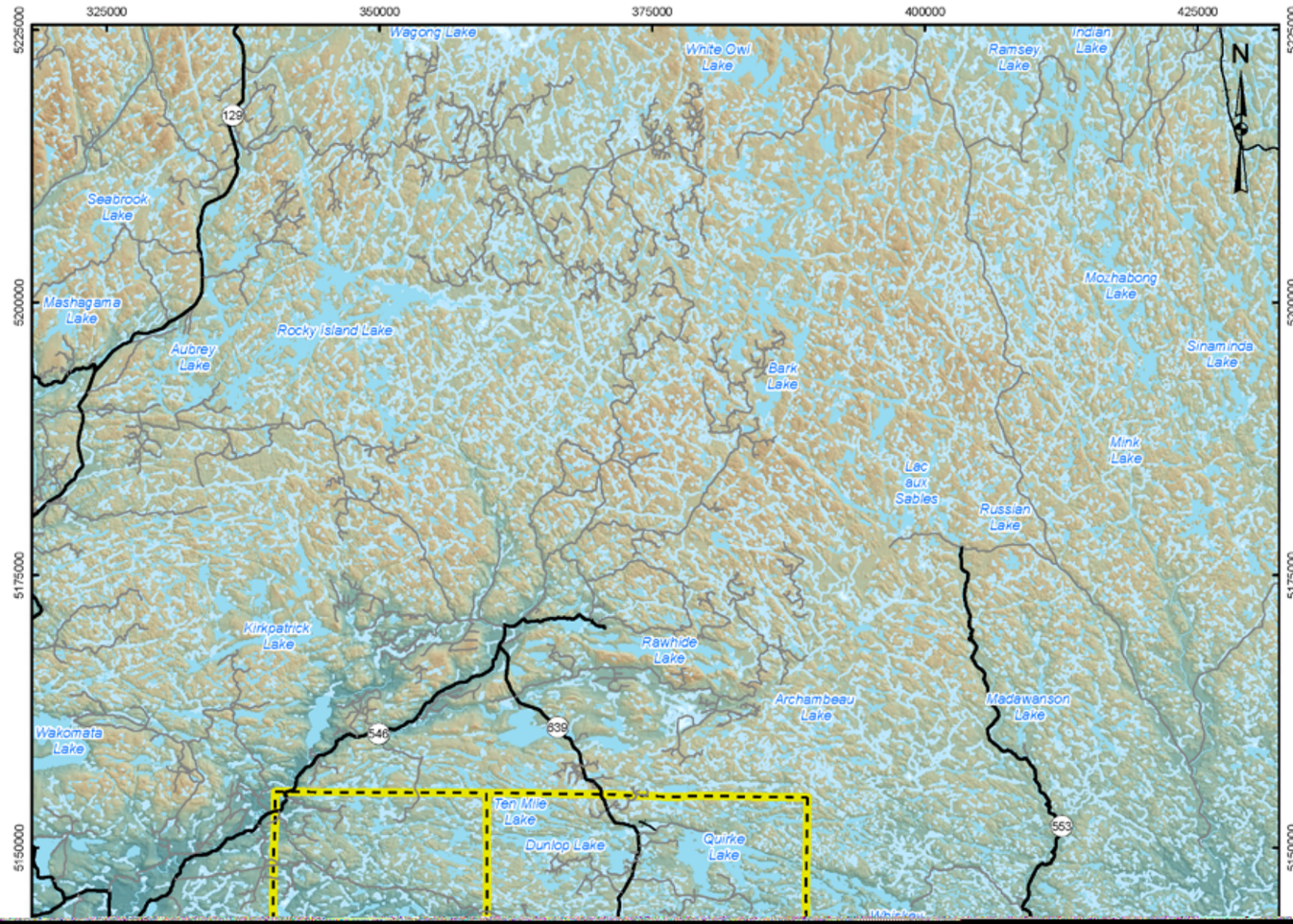
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SCALE 1:525,000 KILOMETERS

PROJECT	Environment Report Communities of Elliot Lake, Blind River, The North Shore and Spanish, Ontario
TITLE	**Quarternary Geology of the Communities of Elliot Lake, Blind River, The North Shore and Spanish and Surrounding Area**

Golder Associates
Mississauga, Ontario

PROJECT NO. 12-1152-0026			SCALE AS SHOWN REV. 0.0
DESIGN	PRM	13 Mar. 2013	
GIS	PRM	13 Mar. 2014	**FIGURE: 7**
CHECK	JH	13 Mar. 2014	
REVIEW	GMS	13 Mar. 2014	

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LEGEND

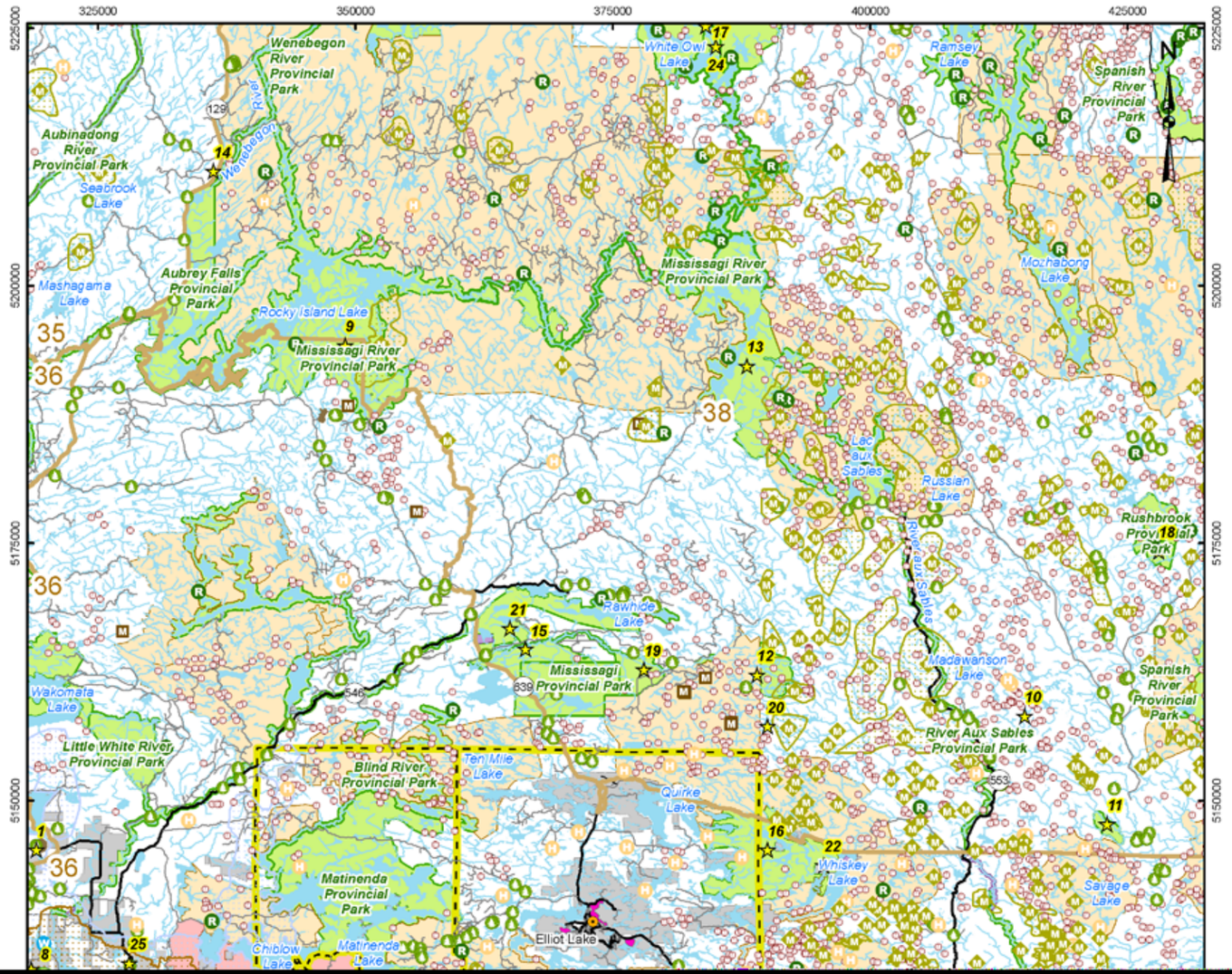
- Community
- Main Road
- Local Road
- Railway
- Waterbody
- Wetland, Permanent
- Municipal Boundary (Communities of Elliot Lake, Blind River, The North Shore and Spanish)

Elevation (masl)

612
568
525
481
438
394
350
307
263
220
176



ELNOS\ElevationTopographicFeaturesELNOS.mxd



LEGEND

- Community
- Main Road
- Local Road
- Railway
- Watercourse
- Waterbody
- Private Land
- Federal Land - Indian Reserve
- Forest Reserve
- Provincial Park / Reserve
- Enhanced Management Area
- Environmental Protection Area
- Municipal Boundary (Communities of Elliot Lake, Blind River, The North Shore and Spanish)
- Earth or Life Science Site

Wildlife and Forestry

- Forest Research Area
- Moose Aquatic Feeding Area
- Wildlife Management Unit

Nesting

- Heron
- Other
- Raptor
- Waterfowl

Significant Ecological Area

- Significant Woodland

Staging Area

- Waterfowl
- Waterfowl

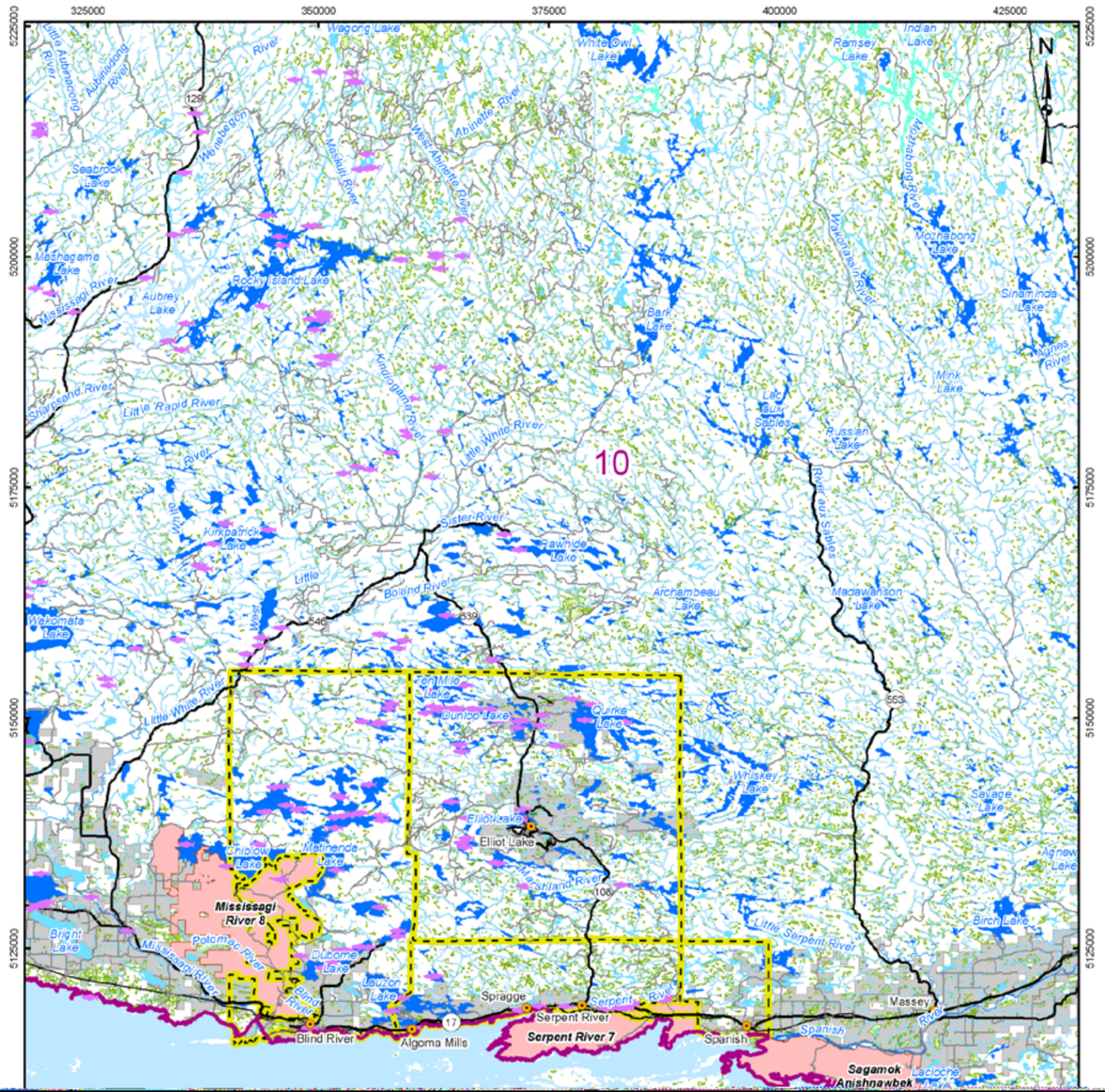
Wintering Area

- Deer Wintering Area
- Deer Yard
- Moose Late Wintering Area
- Deer Wintering Area
- Deer Yard
- Moose Late Wintering Area

Calving/Fawning Sites

- Moose Calving Site

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LEGEND

- Community
- Main Road
- Local Road
- Railway
- Watercourse
- Private Land
- Federal Land - Indian Reserve
- Fisheries Management Zone (10, 14)
- Municipal Boundary (Communities of Elliot Lake, Blind River, The North Shore and Spanish)

Fisheries and Wetlands

- Fish Nursery Area
- Spawning Area
- Wild Rice Stand
- Waterbody (unspecified)
- Cold Water Lake
- Cool Water Lake
- Warm Water Lake

Natural Heritage

- Wetland



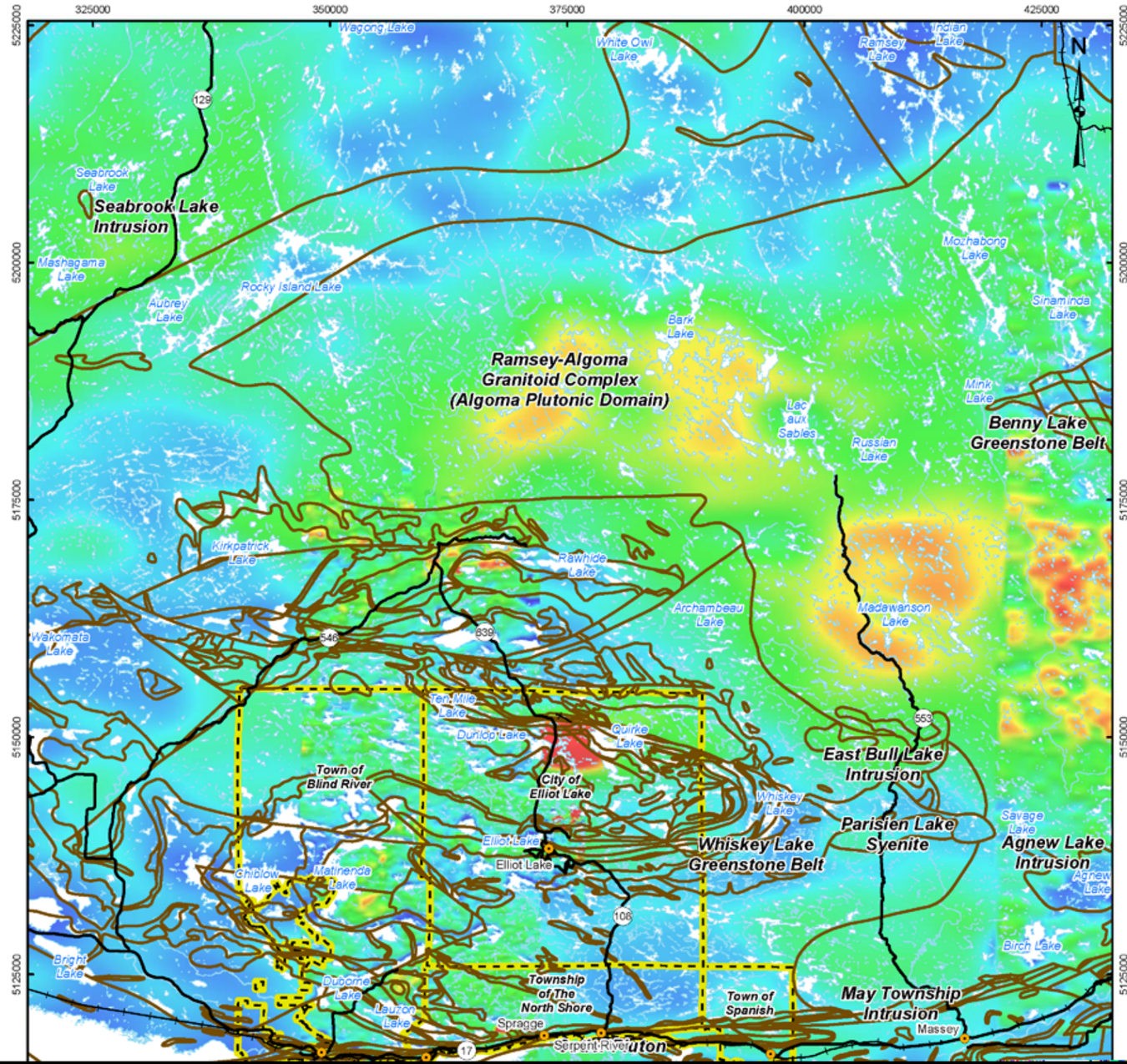
REFERENCE

Base Data - MNR LIO, obtained 2009-2012, CANMAP v2008.4
Fisheries and Wetlands Maps - Northshore Forest FMU and Algoma Forest FMU (2010-2020)
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17N

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SCALE 1:525,000 KILOMETRES

PROJECT
Environment Report
Communities of Elliot Lake, Blind River

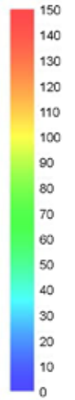
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LEGEND

- Community
- Main Road
- Railway
- Waterbody
- Geological Contact
- Municipal Boundary (Communities of Elliot Lake, Blind River, The North Shore and Spanish)

Air Absorbed Radiation Levels (nGy/h)



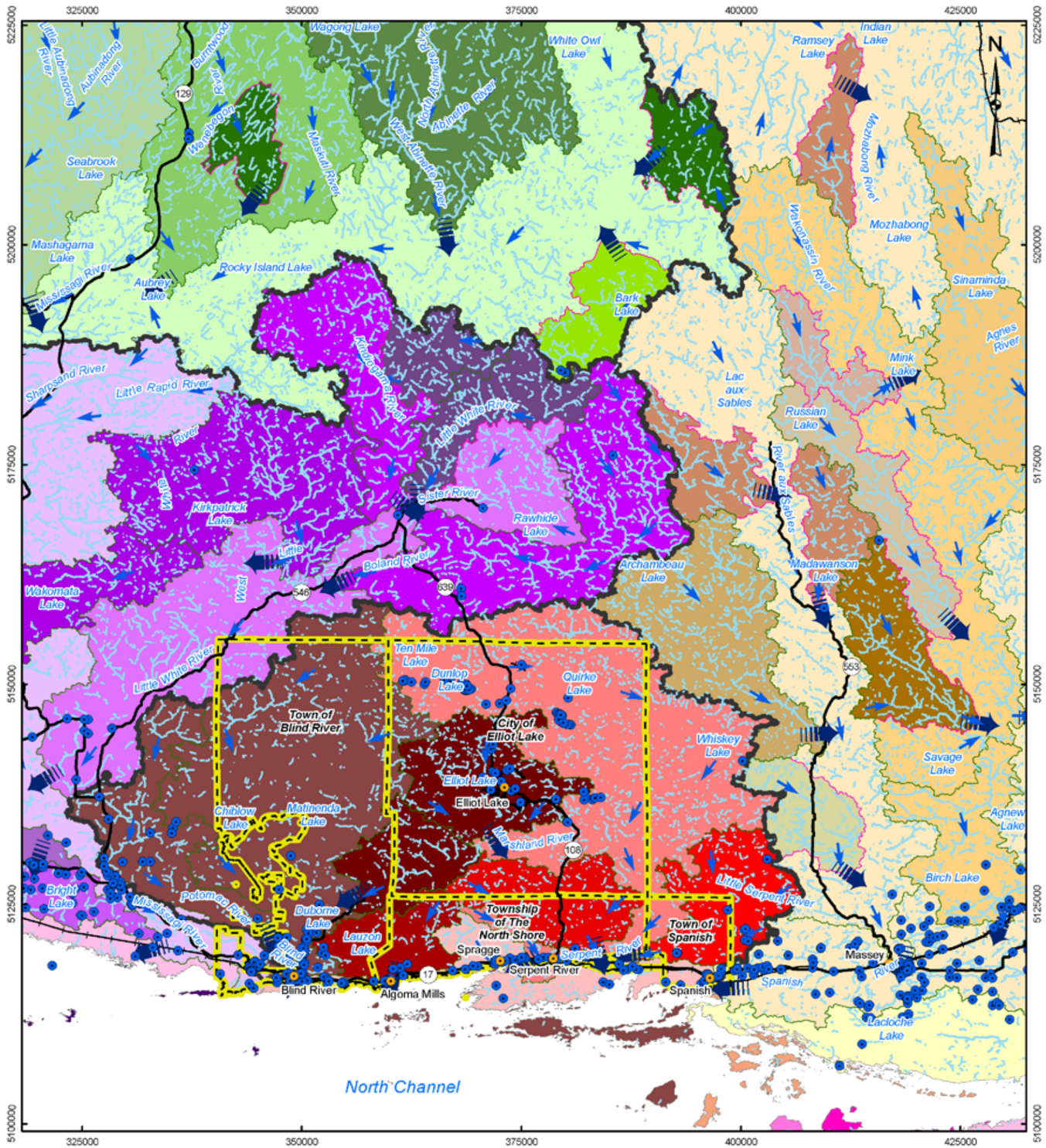


REFERENCE

Base Data - MNR LIO, obtained 2009-2012; CANMAP v2006.4
Radiometrics: GSC Canada - 250m -Natural Air Absorbed Dose Rate, 2012;
National Gamma-Ray Spectrometry Program Data Base, Airborne Geophysics Section,GSC - Central Canada Division, Geological Survey of Canada, Earth Sciences Sector,Natural Resources Canada
Geology: MRD126-Bedrock Geology of Ontario, 2011
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Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17N

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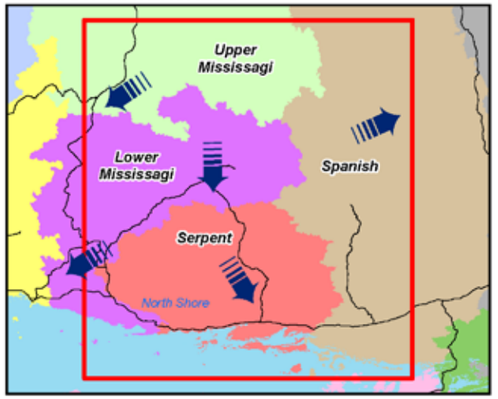
LEGEND

- Community
- MOE Well Location
- Main Road
- Railway
- Watercourse, Permanent
- Watercourse, Intermittent
- Waterbody
- Tertiary Watershed
- Quarternary Watershed
- Flow Direction
- Watershed Outflow Point

Drainage Divide

- Delineated by JDMA
- Delineated by MNR
- Municipal Boundary (Communities of Elliot Lake, Blind River, The North Shore and Spanish)

TERTIARY WATERSHEDS



REFERENCE

Base Data - MNR LIO, obtained 2009-2013
Wells: Ministry of the Environment, 2010
Watersheds - LIO Quaternary Watersheds (Updated JDMA)
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2013
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 17N

10 5 0 10 20 30
SCALE 1:525,000 KILOMETRES

PROJECT
Environment Report
Communities of Elliot Lake, Blind River,
The North Shore and Spanish, Ontario

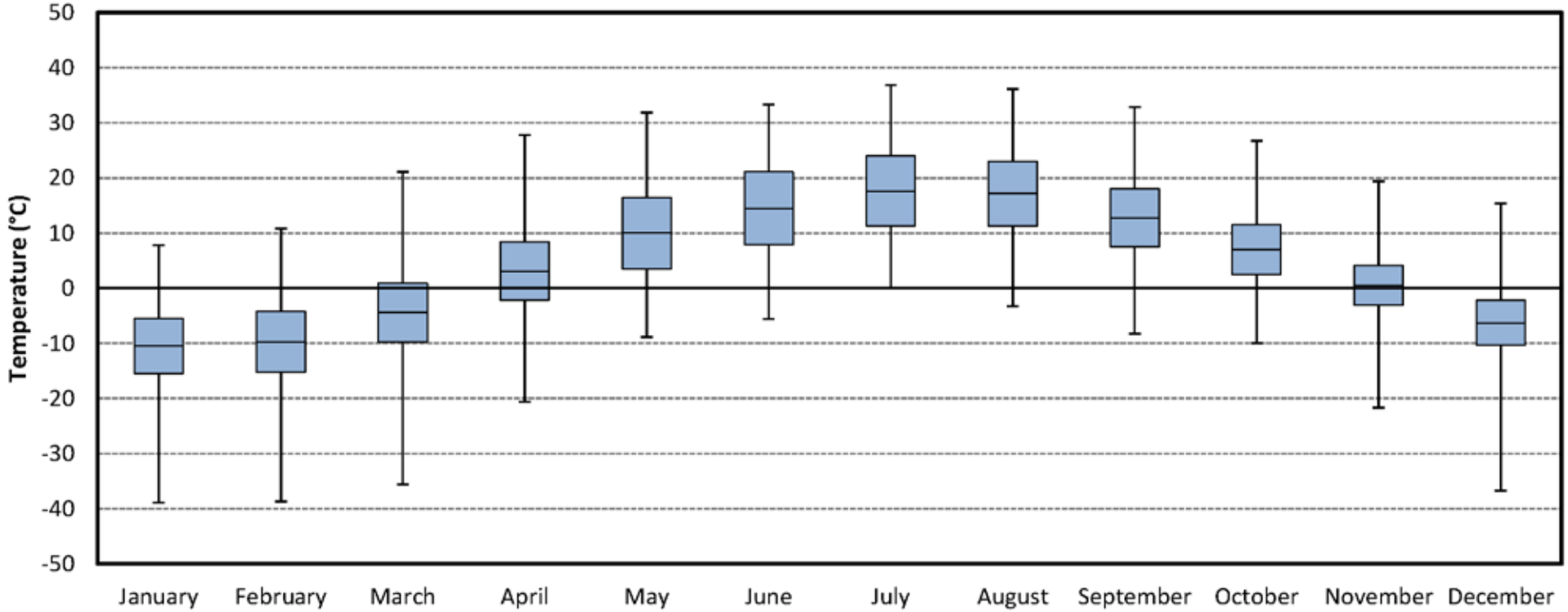
TITLE
Communities of Elliot Lake, Blind River, The North Shore and Spanish - Surface Water Drainage and Water Wells

Golder Associates
Mississauga, Ontario

PROJECT NO. 12-1152-0026			SCALE AS SHOWN REV. 1.0
DESIGN	PRM	29 Mar. 2012	
GIS	PMJB	23 Oct. 2014	
CHECK	JH	23 Oct. 2014	
REVIEW	GWS	23 Oct. 2014	

FIGURE: 12

G:\Projects\2012\12-1152-0026_NWMO_Phase1_Feasibility\GIS\MXDs\Reporting\Env_Safety_Report\ELNOS\SurfaceWaterDrainageAndWaterWells\ELNOS.mxd



LEGEND

- Extreme Maximum (°C)
- Daily Maximum (°C)
- Daily Average (°C)
- Daily Minimum (°C)
- Extreme Minimum (°C)

DATA SOURCE

Environment Canada

PROJECT: Environment Report
Communities of Elliot Lake, Blind River,
The North Shore and Spanish, Ontario

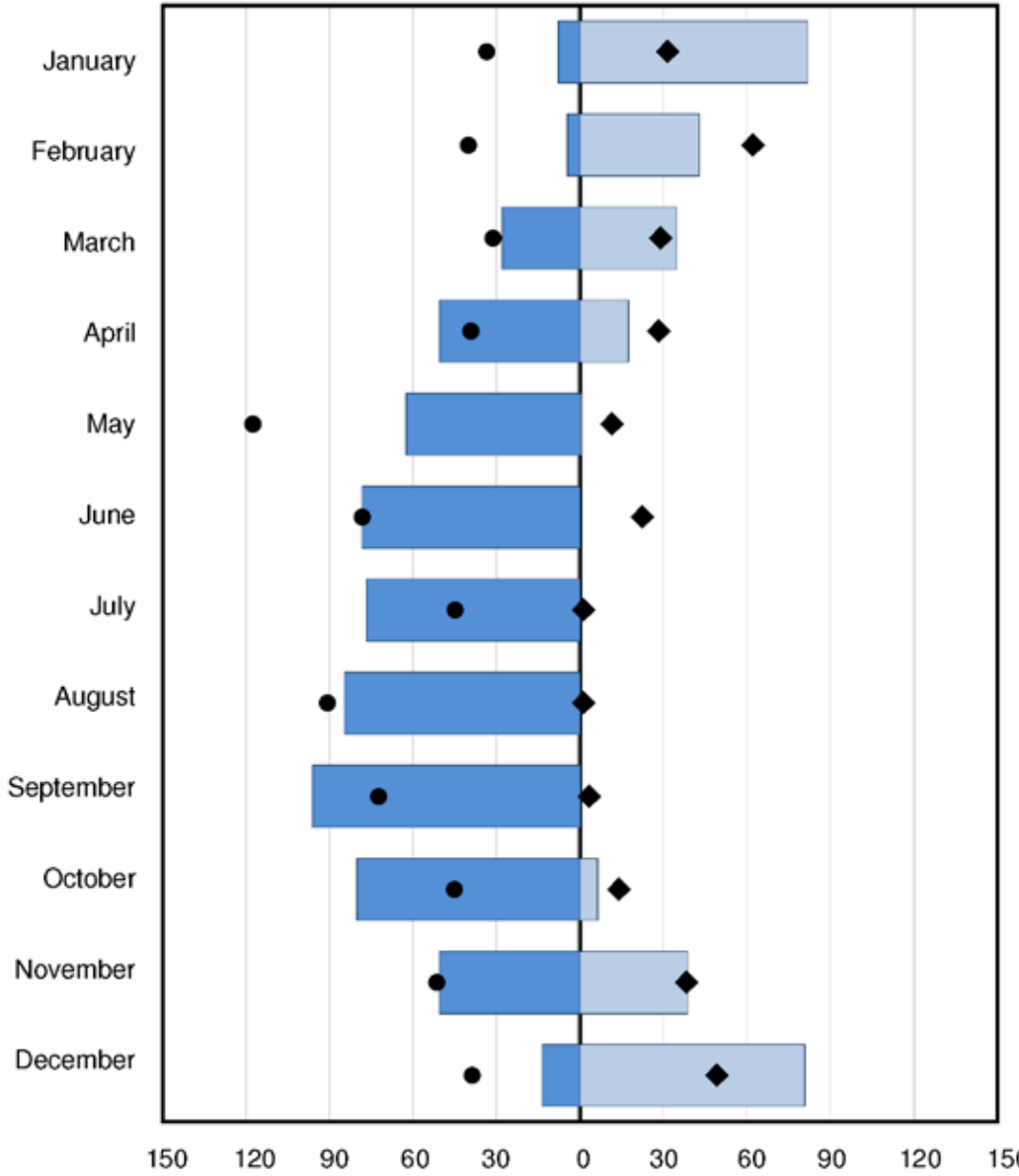
TITLE: **Sault Ste. Marie 1971-2000**
Temperature Data Summary

Golder Associates
Mississauga, Ontario

PROJECT NO. 12-1152-0026			REV. 0.0
DESIGN	PRM	28 Mar. 2011	
GIS	PRM	13 Mar. 2014	
CHECK	JH	13 Mar. 2014	
REVIEW	GMS	13 Mar. 2014	

FIGURE: 13

G:\Projects\2012\12-1152-0026_NWMO_Phase1_Feasibility\GIS\MXDs\Reporting\Env_Safety_Report\ELNOS\TemperatureDataSummaryELNOS.mxd



LEGEND

- Monthly Rainfall (mm eq.)
- Monthly Snowfall (cm or mm eq.)
- Extreme Daily Rainfall (mm eq.)
- Extreme Daily Snowfall (cm or mm eq.)

DATA SOURCE

Environment Canada

PROJECT: Environment Report
Communities of Elliot Lake, Blind River,
The North Shore and Spanish, Ontario

TITLE: **Sault Ste. Marie 1971-2000 Precipitation Data Summary**

Golder Associates
Mississauga, Ontario

PROJECT NO. 12-1152-0026			REV. 0.0
DESIGN	PRM	29 Mar. 2012	FIGURE: 14
GIS	PRM	14 Mar. 2014	
CHECK	JH	14 Mar. 2014	
REVIEW	GWS	14 Mar. 2014	

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