



NUCLEAR WASTE SOCIÉTÉ DE GESTION
MANAGEMENT DES DÉCHETS
ORGANIZATION NUCLÉAIRES

Phase 1 Desktop Assessment Environment Report

MUNICIPALITY OF WAWA, ONTARIO



APM-REP-06144-0026

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PHASE 1 DESKTOP ASSESSMENT

Environment Report Municipality of Wawa, Ontario

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1.0 INTRODUCTION

The Municipality of Wawa in north-central Ontario is considering hosting 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 with 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 in the vicinity of Wawa. To this end, this report provides a general description of the environment in the Municipality of Wawa and surrounding area. It is complemented by reports prepared in parallel which characterize the geoscientific conditions and community well-being profile of this 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 will be sought at subsequent phases of the work.

The area considered here is similar to that used for the Phase I Geoscientific Desktop Assessment for Wawa. This area is shown on Figure 1, and includes the Municipality of Wawa and surrounding area.



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2.0 COMMUNITIES AND INFRASTRUCTURE

2.1 Communities

The Municipality of Wawa is approximately 420 km² in size¹ and is located along the northeast shore of Lake Superior at Michipicoten Bay approximately 227 km (kilometres) north of Sault Ste. Marie (LIO, 2012). The settlement area of Wawa is shown on Figure 1 at the south end of Wawa Lake, approximately 7 km northeast of the Lake Superior shoreline. The Municipality also includes the settlement areas of Michipicoten River Village, and Michipicoten Harbour, both on the shore of Lake Superior. The Municipality of Wawa is bordered on the west by the Michipicoten First Nation (Gros Cap 49 Indian Reserve), on the south by protected park areas, and on the east, north and southeast by unorganized territory. Other settlement areas within the Wawa area include Hawk Junction which is 20 km to the northeast, Limer which is 20 km to the east and Anjigami which is 20 km to the southeast of Wawa. Figure 2 presents satellite imagery for the area taken in 2006. Table 1 summarizes the total population and population density for the Municipality of Wawa and District of Algoma.

Table 1: Population Statistics for the Wawa Area

Political Boundary	Population	Population Density per km ²
Municipality of Wawa	2,975	7.1
District of Algoma	115,870	2.4

Source: 2011 Census of Population (Statistics Canada, 2012)

The Municipality of Wawa maintains a municipal government (MMAH, 2009). Land ownership within the Wawa area, including areas of Crown land², Crown Reserve³ lands, parks and reserves and private lands, is shown on Figure 3. Figure 3 shows areas of private land, including large areas of patented land for mining representing full geographic townships (CFMI, 2005).

There are a number of Aboriginal communities and organizations in the Wawa area including the Brunswick House First Nation, Chapleau Cree First Nation, Chapleau Ojibway First Nation, Michipicoten First Nation and Missanabie Cree First Nation. Métis Councils in the area include Greenstone Métis Council, Superior North Shore Métis Council and Thunder Bay Métis Council and Chapleau Métis Council, Métis Nation of Ontario Timmins Council, Northern Lights Métis Council and Temiskaming Métis Council as represented by Abitibi/Temiskamingue and James Bay Traditional Territory Consultation Committee and the Métis Nation of Ontario.

Further information on Wawa and its surrounding communities, including First Nations and Métis communities, is provided in the Community Profile Report for Wawa.

2.2 Infrastructure

Figure 1 shows the location of the primary infrastructure corridors in the Wawa area. The main transportation routes include the Trans-Canada Highway (Highway 17) which passes north-south through the Wawa area and

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 101 which passes through the Municipality of Wawa from the east and then travels south through the center of the municipality. The railway in the Wawa area is owned by the Canadian National Railway (CN). This includes the north-south line from Sault Ste. Marie to Hearst and the now removed branch from Michipicoten Harbour past Wawa to Hawk Junction. Two 230kV electrical transmission lines meet at the Wawa Transformer Station from the south. One 230 kV line, the East-West Tie, heads northwest through the Wawa area from the Wawa Transformer Station. As well, a 115 kV transmission line heads north, then east from Anjigami. The Wawa airport is located just south of the town, as shown on Figure 1 (NRCan, 2008). There are no gas pipelines recorded in the Wawa area (NRCan, 2009). There are two operating landfills and a wastewater treatment plant within the Wawa area.

2.3 Protected Areas

2.3.1 Parks and Reserves

There are four provincial parks, three conservation reserves and a forest reserve in the Wawa area. Figure 4 shows the location of these seven areas. The largest provincial park in the Wawa area is Lake Superior Provincial Park, which covers approximately 155,000 ha (hectares) and 120 km of Lake Superior shoreline south of the Municipality of Wawa; it is classed as a natural environment park (Ontario Parks, 2013). This park includes a visitor's centre and camping facilities. Potholes Provincial Nature Reserve is a provincial park located on Highway 101 approximately 40 km east of the settlement area of Wawa, and is 347 ha in size (Ontario Parks, 2008a). Its walkways follow the glacial potholes in the bedrock of the Kiniwabi River riverbed. Michipicoten Post Provincial Park, a historical park, occupies 289 ha of land on the south shore of the Michipicoten River at its outlet into Lake Superior, approximately 7 km southwest of the settlement area of Wawa (Ontario Parks, 2008b). It marks the ruins of an early 1700s French trading post, used for hiking and beach access, but does not have visitor facilities. Nimoosh Provincial Park is a waterway class park approximately 3,500 ha in size, located approximately 30 km west of the settlement area of Wawa. It contains the post-glacial University River Terraces and reaches of the Dog River and Jimmy Kash River. There are no visitor services at this park (non-operating). None of the provincial parks lie within the boundaries of the Municipality of Wawa.

Conservation and forest 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 three conservation reserves in the Wawa area are the Magpie River Terraces Conservation Reserve, the South Michipicoten River-Superior Shoreline Conservation Reserve and the Lake Superior Highlands Conservation Reserve (proposed). The Magpie River Terraces Conservation Reserve protects 2,088 ha of land centered approximately 7 km north of the settlement area of Wawa, entirely within the municipal boundary. The Michipicoten River-Superior Shoreline Conservation Reserve protects approximately 2,219 ha of land between the south bank of the Michipicoten River and the northern boundary of Lake Superior Provincial Park, approximately 10 km south of the settlement area of Wawa. A few hectares of this conservation reserve lie within the municipality boundaries. The proposed Lake Superior Highlands Conservation Reserve is located about 20 km west of Wawa and covers an area of 46,734 ha. The 390 ha South Michipicoten River Forest Reserve is located between the Michipicoten River-Superior Shoreline Conservation Reserve and Michipicoten Post Provincial Park, straddling Highway 17 (MNR, 2008). This reserve includes areas of active mining dispositions (not shown on Figure 4).



2.3.2 Heritage Sites

The cultural heritage screening examined known archaeological and historic sites in the Wawa area, using the Ontario Archaeological Sites Database; the Ontario Heritage Trust Database; the National Historic Sites Database; and the Municipality of Wawa Official Plan. There are 37 known archaeological sites in the Wawa area (von Bitter, 2012). Of the 37 sites, 11 are historical sites with seven identified as Euro-Canadian and four as historical Aboriginal. Nine sites are identified as pre-contact Aboriginal and, of these sites, two are Late Woodland, two are Middle Woodland, four are Shield Archaic and one is unknown. The remaining 17 sites have no information as to their culture or time period.

There are also 30 municipally designated heritage sites but no national or provincial heritage sites in the Wawa area (Meridian, 2010; Ontario Heritage Trust, 2011; Parks Canada, 2012). One of the municipal heritage sites is a cemetery, located within the settlement area of Wawa. Archaeological potential is established by determining the likelihood that archaeological resources may be present on a subject property. In archaeological potential modelling, a distance to water criterion of 300 m is generally employed for primary water courses, including lakeshores, rivers and large creeks, as well as secondary water sources, including swamps and small creeks (Government of Ontario, 2011). The potential for archaeological and historical sites within the Wawa area is considered to be high, given the sites already documented and the proximity to the Lake Superior shoreline. The presence of local heritage sites would need to be further confirmed in discussion with the community and Aboriginal peoples 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 Wawa area. Forest Management Units (FMU) in the Wawa area are presented on Figure 5. The Municipality of Wawa and much of the remaining Wawa area is within the Algoma FMU (Algoma District), which is managed by Clergue Forest Management Inc. (CFMI). The northeast portion of the Wawa area is within the Martel Forest, managed by Tembec Enterprises Inc. and the northwestern corner of the Wawa area is within the White River Forest, managed by Domtar Inc.

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

There has been a long history of iron and gold mining in the Wawa area, starting in approximately 1897. The locations of all past producing mines in the Wawa area are shown on Figure 6. For over 100 years, iron ore was extracted at three sites in the Michipicoten greenstone belt⁴ (Sault Ste. Marie Public Library, 2008). There is no current production of iron ore in the Wawa area, although there are still identified reserves. For example, the Ontario Ministry of Northern Development and Mines estimates that approximately 44 million tonnes of iron ore exists that is not currently being mined in Michipicoten greenstone belt (MNDM, 2010).

⁴ A greenstone belt is a zone of volcanic and sedimentary rocks that have undergone metamorphic alteration. The name comes from the green hue imparted by the colour of the dominant minerals within the rocks.



Gold exploration and mining have a similarly long history in the Wawa area, from both the Michipicoten and Mishibishu greenstone belts, although there are currently no operating gold mines in the Wawa area. Gold exploration continues in the region, but at present there are no operating mines in the Wawa area. The mining claims in the vicinity of the Jubilee stock, southeast of the settlement area of Wawa, are predominantly held by the Citadel Gold Mines Inc., and there has been a historical resource estimate of 525,000 ounces of gold (Delta, 2009). The closest operating gold mines are the Island Gold mine located approximately 40 km northeast of Wawa on the northern margins of the Michipicoten greenstone belt, and the Eagle River mine located approximately 50 km west of Wawa in the Mishibishu greenstone belt, outside of the Wawa area.

No record of past or current base metal mining in the Wawa area was found. There is an active mining claim and occurrence of molybdenum within the Western batholith⁵, west of the Michipicoten greenstone belt. The molybdenum occurs in association with a fault and zone of quartz veins. There is also an occurrence of tungsten (as wolframite) in the Western batholith on the shore of Lake Superior. In addition, there is no known past or current mining for rare metals in the Wawa area. According to Wilson (1990) rare earth metals have some potential for discovery and development in the Wawa area. Pegmatites within the external granitoid terrane and the Firesand Creek carbonatite complex have been identified as targets for rare earth element exploration.

The Firesand Creek carbonatite complex, located approximately 10 km southeast of the settlement area of Wawa, was identified in an inventory of Ontario uranium and thorium deposits (Robertson and Gould, 1983), and is known to contain low concentrations of uranium and thorium (Wilson, 1990). However, no economic deposits of uranium have been identified in the Wawa area. The closest known economic uranium mineralization is approximately 100 km south, in the Montreal River area.

Sand and gravel pits in the Wawa area are shown on Figure 3, although it cannot be confirmed which of these pits are currently operational.

As noted in Section 3.3.1, other land uses include trapping, fishing, berry harvesting and collection of forest materials for medicinal use.

⁵ Batholiths are made of multiple masses, or plutons, of igneous rock that have melted and intruded surrounding strata at great depths.



3.0 DESCRIPTION OF THE ENVIRONMENT

3.1 Physiography

The Municipality of Wawa lies in the Abitibi Uplands, a broadly rolling surface of Canadian Shield bedrock that occupies most of north-central Ontario (NRCan, 2011). Within this area, bedrock is typically either exposed at surface or shallowly covered with Quaternary⁶ glacial deposits or post-glacial organic soils (Thurston, 1991). The land surface ranges from around 607 masl (metres above sea level) in the southeast corner of the Wawa area to 183 masl along the shore of the Lake Superior. The lowest ground surface elevations occur in the river valleys, notably the Michipicoten, Magpie and Old Woman rivers, which empty into Lake Superior. The settlement area of Wawa is located within the Magpie River valley at approximately 290 masl elevation.

The highest elevations exist in upland areas surrounding the municipality, typically in association with exposed granitic rocks. Very steep slopes are common in the area, including near vertical 200 m high cliffs at Old Woman Bay. Figure 7 presents the topography of the Wawa area as a digital elevation model (DEM).

3.2 Geology

3.2.1 Bedrock Geology

The bedrock geology of the Wawa area is shown on Figure 6. The main geological features of the area are groups of rocks known as the Michipicoten, Gamitagama and Mishibishu greenstone belts, and the granitoid terranes (Williams et al., 1991) surrounding them. Geologically, the Municipality of Wawa is situated in the southeastern portion of the Wawa Subprovince, which is part of the western region of the Superior Province of the Canadian Shield – 3 to 2.6 billion year old rocks that form the core of the North American continent. The Wawa Subprovince is about 900 km long and 150 km wide, extending from central Minnesota in the United States to the Kapuskasing area in northeastern Ontario. It is composed primarily of Archean greenstone belts and granitic intrusions, with smaller mafic intrusive rocks locally present. Diabase dikes, largely of Proterozoic age, occur in “swarms” throughout most of the Superior Province.

Approximately 75% of the Municipality of Wawa is underlain by the supracrustal rocks of the Michipicoten greenstone belt, which extends beyond the boundaries of the municipality to the north, northwest and southwest, surrounded by granitoid terrane. The Michipicoten greenstone belt is comprised of Archean volcanic rocks which have been subjected to repeated folding and faulting, sedimentation, granitic intrusion and regional metamorphism. The rocks of the Michipicoten greenstone belt are highly heterogeneous and fractured. South of the Michipicoten greenstone belt lies the Wawa gneiss domain, which is a mosaic of granitoid plutons with slivers of metavolcanic rocks, all of Archean age. The Wawa gneiss domain is predominantly tonalitic gneiss, with intrusions of massive granodiorite to granite, including the 60 km long Whitefish Lake - Brule Bay batholith, and another unnamed 20 km long intrusion. Relative to the greenstone belts, the Wawa gneiss domain is less heterogeneous in structure, and is cut by a sparse network of faults associated with discrete tectonic events that occurred in the Late Archean/Early Proterozoic, Paleoproterozoic and Mesoproterozoic eras. West of the Michipicoten greenstone belt is the Western batholith, with properties similar to the Wawa gneiss domain.

⁶ Quaternary refers to the last 2.6 million years of Earth's history.



3.2.2 Quaternary Geology

The Quaternary geology of the Wawa area is shown on Figure 8. All Quaternary sediments within the Wawa area were deposited during the Late Wisconsin by the Labrador sector of the Laurentide ice sheet. During ice retreat, ice-contact stratified drift was deposited as recessional moraine, eskers and dead ice topography, leaving a thin (less than 1 m thick) till veneer on the bedrock surface. This till veneer, when present, is the uppermost deposit across most of the Wawa area. Glaciofluvial outwash was deposited primarily within bedrock-controlled valleys directly from the ice margin or from wasting ice detached from the ice sheet. Also during retreat, the ice sheet was fronted by glacial meltwaters associated with the Lake Superior basin or by glacial meltwater impounded by the ice sheet and topographically higher ground. Glaciolacustrine materials were deposited in these waters, filling the deeper bedrock valleys (Morris, 2001).

According to the water well records (MOE, 2012) and the diamond drillhole database (OGS, 2005) overburden thicknesses of up to 86 m exist in the bedrock valleys of the Michipicoten and Magpie rivers, as they approach Lake Superior.

3.3 Natural Environment

3.3.1 Natural Environment Overview

The location of the Municipality of Wawa along the Trans-Canada Highway and near the shore of Lake Superior, have influenced the role of tourism and natural resources development industries as important economic drivers for the community. Mining and forestry have been key industries in Wawa's recent past. The environment of the area has been affected in a few localized areas by historical industrial practices, as evidenced by the "Wawa Treeless Area" described in Section 3.3.3 and depicted on Figure 9.

The extensive open space and natural features including lakes and rivers are primary tourist attractions for citizens and visitors (Meridian, 2010). As well, Wawa is particularly known for its Canada Goose monument and is the closest community to the popular Lake Superior Provincial Park. Some members of the local communities, including First Nations communities and Métis, engage in non-industrial practices such as berry picking, fishing, hunting and gathering of forest products for medicinal and cultural purposes (CFMI, 2005). The natural environment of the Wawa area 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 and focus on rare species that may be most sensitive to impacts from alterations or changes to the landscape.

3.3.2 Natural Areas

There are several known Areas of Natural and Scientific Interest (ANSI), Provincially Significant Wetlands (PSW) or other Natural Areas within the Wawa area, as shown and numbered on Figure 9.

The Magpie River Wetland Terraces (1) is the only Life Science Site located within the Wawa municipal boundary. There are three Earth Science Sites located within the Wawa municipal boundary also, including the Wawa Lake spherulitic and flamme structures (2), McLeod Mine Hill (3) and Magpie River Terraces (4). Another feature within the municipal boundary is the Wawa Treeless Area (5). High Falls and McPhail Reservoirs (6) are wetland areas located on the eastern border of the Wawa municipal boundary.



Lake Superior Provincial Park (7) is located south of the Municipality of Wawa (Figure 9). Lake Superior Provincial Park is divided into a number of provincial park zones referred to as nature reserves. Provincial Park Zones 1, 2, 3 and 8 (8, 9, 10 and 11 on Figure 9, respectively) are all within the Wawa area. To the south, adjacent to the municipal boundary, is Michipicoten Provincial Park (12). Potholes Provincial Park (13) and Nimoosh Provincial Park, a waterway class park (14) are also located within the Wawa area.

Life Science sites located within the Wawa area include Jimmy Kash and Makwa rivers (15), Michipicoten Wilderness Area (16) and Pothole Reserve (17), which is within Potholes Provincial Park. Makwa River Forest (18) and Jackpine River (19) are Candidate Life Science Sites within the Wawa area. Arrow Lake Park - Cuesta (20) is an Earth Science Site located in the northeastern corner of the Wawa area. Kinniwabi River Scour Holes (21) is an International Biological Program Site located within Potholes Provincial Park. The Official Plan of the Municipality of Wawa also describes two Environmentally Sensitive Areas and the Wawa Treeless Area, shown on Figure 9.

Wetlands identified in the Land Information Ontario (LIO) natural resources data layers (LIO, 2012) have been depicted on Figure 10. The Wawa area contains a total of 14,539 ha of wetlands, representing 4% of the surface area according to the LIO data. Ground investigations are likely to reveal additional wetland areas that have not been identified by LIO data. If wetlands are to be impacted by a proposed activity, they may require evaluation of significance according to the Ontario Wetland Evaluation System (OWES).

3.3.3 Terrestrial Features and Wildlife

The Wawa area lies at the boundary between the Boreal and the Great Lakes-St. Lawrence Forest Regions and primarily in the Algoma FMU 615 as depicted on Figure 5 (MNR, 2012a). The Algoma FMU is approximately 1,561,874 ha of which 49% is managed by CFMI.

The most notable impact on the forest landscape attributable to human activity near Wawa is the area known as the “fume kill” or Wawa Treeless Area. The fume kill zone covers an area of about 10,000 ha stretching northeast from the Town of Wawa. It is the result of the fallout of sulphur dioxide emissions from sintering plant operations over a 50-year period. Sintering operations ceased in 1998 with the closing of the Algoma Ore Division. The core area of 10,000 ha is essentially devoid of trees, while another 20,000 ha of forest surrounding the core area has been heavily damaged (CFMI, 2005).

The remainder of the unit is comprised of maples (*Acer spp.*), yellow birch (*Betula alleghaniensis*), balsam fir (*Abies balsamea*), white spruce (*Picea glauca*), white pine (*Pinus strobus*) and red oak (*Quercus rubra*). The Wawa area is also partly within FMU 509, the Martel Forest and FMU 60, the White River Forest. The Martel Forest is approximately 1,191,274 ha, of which 85% is classified as productive forest, comprised of 15 forest unit types (Tembec, 2011). The White River Forest covers a total of 612,567 ha of which 73% is production forestland comprised primarily of seven forest types (Domtar Inc., 2008). Overall, the Wawa area contains 305,822 ha of woodlands, which is 72% of the surface area according to LIO data.

Portions of Wildlife Management Units (WMU) 32, 33, 34 and 35 are all found within the Wawa area (Figure 9). Trapping of fur bearing species including marten (*Martes americana*), beaver (*Castor canadensis*), mink (*Neovison vison*), otter (*Lontra canadensis*), fisher (*Martes pennanti*), lynx (*Lynx canadensis*), bobcat (*Lynx rufus*), muskrat (*Ondatra zibethicus*), racoon (*Procyon lotor*), red squirrel (*Tamiasciurus hudsonicus*), red fox (*Vulpes vulpes*), weasel (*Mustela spp.*), coyote (*Canis latrans*), striped skunk (*Mephitis mephitis*), wolf (*Canis lupus*) and gray fox (*Urocyon cinereoargenteus*) has been, and still is, an important employment and commercial



activity in the Algoma Forest (CFMI, 2005). Plans for management of woodland caribou (*Rangifer tarandus*), moose (*Alces alces*) and black bear (*Ursus americanus*) populations are required by the Ontario Ministry of Natural Resources (MNR) in overall planning for the Algoma Forest. These species, as well as pileated woodpecker (*Dryocopus pileatus*), white tailed deer (*Odocoileus virginianus*), red-shouldered hawk (*Buteo lineatus*), black-backed woodpecker (*Picoides arcticus*), lynx (*Lynx canadensis*), red-breasted nuthatch (*Sitta canadensis*), ruby crowned kinglet (*Regulus calendula*), northern flying squirrel (*Glaucomys sabrinus*), great gray owl (*Strix nebulosa*), red-headed woodpecker (*Melanerpes erythrocephalus*), bay-breasted warbler (*Setophaga castanea*), ruffed grouse (*Bonasa umbellus*) and boreal chickadee (*Poecile hudsonicus*) are species identified by the MNR as important for management within the Algoma Forest (CFMI, 2005). The western portion of the Wawa area is part of both continuous and discontinuous woodland caribou habitat as identified in Ontario's Woodland Caribou Conservation Plan (MNR, 2009). These areas are shown on Figure 9. Known feeding, wintering and calving sites for moose are also depicted on Figure 9. Nesting areas for raptors, herons and waterfowl are also a management concern for MNR; known locations within the Wawa area are depicted on Figure 9.

3.3.4 Aquatic Features and Fish

The Wawa area is located within the Lake Superior drainage basin where the terrain includes wetlands, lakes and rivers that support a diversity of fish and wildlife. Wetlands, including swamps, marshes and peatlands, are often ecologically sensitive. The Wawa area lies within Fisheries Management Zones (FMZ) 7, 9 and 10 (Fish and Wildlife Service Branch, 2011) (Figure 10). Wawa, Black Trout, Deep and Reed lakes are all considered "lake trout" lakes and identified by the MNR as sensitive. The MNR has identified seven objectives for the management and preservation of lake trout (*Salvelinus namaycush*) populations in Ontario (MNR, 2012b). There is no Fisheries Management plan available for FMZ 7 or 10. FMZ 9 is Lake Superior, within which there are a diverse variety of fish species. Inland lakes within the Wawa area include warm, cool and cold water temperature regimes. Wawa Lake is the largest inland coldwater lake within the Wawa area. Coldwater fisheries in this area typically support natural brook trout (*Salvelinus fontinalis*) populations and the main sport fish are walleye (*Sander vitreus*), northern pike (*Esox lucius*), brook trout and lake trout. These fish populations are managed to maintain and maximize their size and availability to both locals and tourists. Lake sturgeon (*Acipenser fulvescens*) is a species that is classified as threatened in the *Species at Risk Act* (SARA) (Government of Canada, 2012), and can be found within this FMZ (Kerr, 2002). The Wawa area has 26,766 ha of area defined as waterbodies (excluding Lake Superior) by LIO, comprising 7% of the surface area. Spawning areas for fish have been identified by the MNR, and are reported separately for each FMU. This information is available publicly through the Forest Resource Inventory maps, but cannot be reproduced due to its sensitive nature for specific FMUs. Fish and fish habitat are managed by the MNR and the Department of Fisheries and Oceans (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 Natural Heritage Information Centre (NHIC, 2012) records showed six species that are listed as Endangered (END), Threatened (THR) or Special Concern (SC) either under the Ontario *Endangered Species Act* (ESA) (Government of Ontario, 2007) or the Federal *Species at Risk Act* (SARA) (Government of Canada, 2012) within the Wawa area. These species include: woodland caribou, bald eagle (*Haliaeetus leucocephalus*), peregrine falcon (*Falco peregrinus*), kiyi (*Coregonus kiyi*), shortjaw cisco (*Coregonus zenithicus*) and flooded jellyskin (*Leptogium rivulare*) and are listed in Table 2. The Royal Ontario Museum range maps (ROM, 2012) were queried, which provide general areas where species at risk may occur, including those of listed species. The Ontario Herpetofaunal Summary Data (Oldham and Weller, 2000), Atlas of the Breeding Birds of Ontario (Cadman et al., 2007), Atlas of the Mammals of Ontario (Dobbyn, 1994), the Ontario Odonata Atlas (2005) and the Ontario Butterfly Atlas (Holmes et al., 1991) were also queried for listed species. END, THR or SC species identified from these sources to have a range that overlaps the Wawa area are listed in Table 2, although habitat for these species may be confined to specific locations within the area.

Woodland caribou range is described in Section 3.3.3. Although the eastern portion of the Wawa area is not considered continuous or discontinuous woodland caribou habitat, this species may occur anywhere within the boreal forest which extends throughout much of the Wawa area. The range of eastern cougar (*Puma concolor*) extends to the Wawa area, but this species is extremely secretive and can cover a very large home range for each individual. Eastern wolf is a population of wolves that are distinct from the more common gray wolf. Their range extends from Sault Ste. Marie into northwestern Quebec.

Twelve END, THR or SC bird species are listed in Table 2, eight of which were identified in the OBBA. The ROM range maps for black tern (*Chlidonias niger*), chimney swift (*Chaetura pelagica*), short-eared owl (*Asio flammeus*) and golden eagle (*Aquila chrysaetos*) overlap the area although there are no known local records.

Three aquatic species were identified from ROM and NHIC, of which kiyi is likely a resident of Lake Superior only, while shortjaw cisco may also be found in inland lakes. Lake sturgeon is present in Lake Superior and may be present in some inland lakes as identified by Kerr (2002).

No END, THR or SC amphibian or reptile species are known to occur within the Wawa area from these sources. The ranges of two invertebrates, monarch butterfly (*Danaus plexippus*) and West Virginia white butterfly (*Pieris virginiensis*), were reported to overlap with the Wawa area according to ROM, and a record for one Lichen species, the flooded jellyskin, was reported on NHIC. No other species of plants, mosses or lichens were identified as END, THR or SC within the Wawa area.

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 flora and fauna of the area. Many of these species are not tracked in public databases, and therefore a complete list would be obtained as part of the data requests to agencies which would complement the results of field investigations conducted at the site.



Table 2: Potential Endangered, Threatened and Special Concern Species in the Wawa Area

Common Name	Scientific Name	ESA Status ^a	SARA Status (Schedule) ^b	Source ^c
Mammals				
Eastern cougar	<i>Puma concolor</i>	END		ROM
Eastern wolf	<i>Canis lupus lycaon</i>	SC	SC (1)	ROM
Woodland caribou (Forest-dwelling boreal population)	<i>Rangifer tarandus caribou</i>	THR	THR (1)	NHIC, ROM
Birds				
Bald eagle	<i>Haliaeetus leucocephalus</i>	SC		NHIC, OBBA
Barn swallow	<i>Hirundo rustica</i>	THR		OBBA
Black tern	<i>Chlidonias niger</i>	SC		ROM
Canada warbler	<i>Cardellina canadensis</i>	SC	THR (1)	OBBA
Chimney swift	<i>Chaetura pelagic</i>	THR	THR (1)	ROM
Common nighthawk	<i>Chordeiles minor</i>	SC	THR (1)	ROM, OBBA
Eastern meadowlark	<i>Sturnella magna</i>	THR		OBBA
Golden eagle	<i>Aquila chrysaetos</i>	END		ROM
Olive-sided flycatcher	<i>Contopus cooperi</i>	SC	THR (1)	OBBA
Peregrine falcon	<i>Falco peregrinus</i>	THR	THR (1)	NHIC, ROM, OBBA
Rusty blackbird	<i>Euphagus carolinus</i>	Not at risk	SC (1)	ROM, OBBA
Short-eared owl	<i>Asio flammeus</i>	SC	SC (3)	ROM
Fish and other Aquatic Species				
Kiyi (Upper Great Lakes population)	<i>Coregonus kiyi</i>	SC	SC (3)	NHIC, ROM
Lake sturgeon (Northwestern Ontario Population)	<i>Acipenser fulvescens</i>	THR		ROM
Shortjaw cisco	<i>Coregonus zenithicus</i>	THR	THR (2)	NHIC
Invertebrates				
Monarch butterfly	<i>Danaus plexippus</i>	SC	SC(1)	ROM
West Virginia white butterfly	<i>Pieris virginiensis</i>	SC		ROM
Plants				
Flooded jellyskin	<i>Leptogium rivulare</i>	THR	THR (1)	NHIC

Notes:

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

^a Status on the Species at Risk of Ontario list of the *Endangered Species Act* (ESA), (Government of Ontario, 2007)

^b Status listed on the federal *Species at Risk Act* (SARA) (Government of Canada, 2012)

^c Data obtained from the Natural Heritage Information Centre (NHIC) (NHIC, 2012), Royal Ontario Museum (ROM) range maps (ROM, 2012), Ontario Herpetofaunal Summary Database (Herp Atlas) (Oldham and Weller, 2000), Atlas of the Breeding Birds of Ontario (OBBA) (Cadman et al., 2007), or the Ontario Butterfly Atlas (Holmes et al., 1991)



3.3.6 Aboriginal Interests and Traditional Knowledge

Traditional lifestyles, culturally significant wildlife and the extent of sacred and ceremonial locations important to Aboriginal communities 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 literature. The regional rights-bearing Métis community in the Lakehead/Nipigon/Michipicoten Traditional Territory is currently undergoing a Métis traditional knowledge study in the region that will be used to inform ongoing engagement, consultation, accommodation and monitoring on specific projects in the region that have the potential to affect the regional Métis community’s rights, interests and way of life. Additionally, the Anishinabek/Ontario Fisheries Resource Centre were undertaking a lake sturgeon research project on the Michipicoten River in partnership with Michipicoten First Nation, the MNR, Brookfield Renewable Power, the Municipality of Wawa and Buck’s Marina in 2012. This project aims to identify any harmful impacts that these facilities may have on lake sturgeon recruitment. Michipicoten First Nation and the Anishinabek/Ontario Fisheries Resource Centre will also be conducting a survey with elders and anglers from Michipicoten First Nation to identify and compile traditional ecological knowledge about lake sturgeon, and more broadly, the Michipicoten River (The Algoma News, 2012).

Known archaeological sites, many of which are Aboriginal, are noted in Section 2.3.2. Trapline License Areas, which cover much of the Wawa area are shown on Figure 3. Figure 9 presents terrestrial ecology mapping and Figure 10 aquatic resource mapping.

It is recognized that this does not fully represent the environmental issues and concerns of Aboriginal communities in the area and that further information and discussion is required before a more complete picture can be developed. Discussions with Aboriginal groups, community members 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 north-central Ontario indicate that ground-level ozone and particulate matter fall within normal values compared to the national average (EC, 2011a). Table 3 provides a list of industrial facilities that reported air and water emissions through Environment Canada’s National Pollutant Release Inventory (NPRI) database within the same postal code range as the Municipality of Wawa (EC, 2012). The list includes sites in Dubreuilville and Wawa, 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.

Table 3: NPRI Regional Sources of Air Emissions

Table with 3 columns: NPRI ID, Facility Name, City. Rows include Richmond Mines Inc. - Island Gold Mine (Dubreuilville), Wesdome Gold Mines Ltd. - Eagle River Mill (Wawa), and Wesdome Gold Mines Ltd. - Eagle River Mine Site (Wawa).



3.4.2 Background Radiation

The source of background radiation in the Wawa area is attributed to naturally occurring radioactive materials (NORM), specifically potassium, uranium and thorium-bearing minerals. The background radiation for the Wawa area is presented on Figure 11. Statistically, the majority of the dose rate in the Wawa area ranges from approximately 10 to 35 nGy/h, with an average of approximately 20 nGy/h. This range of dose rates and average are consistent with regional dose rates for north-central Ontario. NORM minerals are typically elevated in granitic geology and local dose rate highs are attributed to granitic batholiths, such as the Whitefish Lake batholith. These highs are consistent with dose rate highs in other areas of north-central Ontario. Additional detailed information is available in the geophysical interpretation report (PGW, 2013).

3.4.3 Soil Quality

A soil quality study, in relation to historic iron ore sintering, from the perspective of phytotoxicity was reported by the Ontario Ministry of the Environment (MOE) in 1999. The study reported results from 1976 through 1998 and showed that arsenic, iron, sulphur and manganese were elevated northeast of Wawa and above the Ontario Typical Range (OTR) Soil Guideline (MOE, 1999). The study determined this was a result of the sinter plant located in the northwest part of Wawa. The study also showed that other elements including copper, molybdenum, nickel and magnesium, exceeded OTR Guidelines, however they are of environmentally inconsequential levels (MOE, 1999). It is expected that soil concentrations of other parameters would be within typical OTR, as noted in Table 1 of Ontario MOE Regulation 153/04 (Government of Ontario, 2004).

3.4.4 Water Quality

The Municipality of Wawa obtains its municipal water supply from Wawa Lake for people who live within the town of Wawa. Outside of the town of Wawa, many people rely on private drilled wells for their drinking water. The 2010 annual report on water quality from the Wawa Water Supply System compared monitored water quality to the requirements of the Ontario *Safe Drinking Water Act* (O. Reg. 170/03) (Government of Ontario, 2002) and regulations therein (i.e., Ontario Drinking Water Standards, Objectives and Guidelines [ODWS] (Government of Ontario, 2006)). The report indicated that in 2010 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) (Municipality of Wawa, 2011). Notification of, and corrective actions for, adverse water quality incidents (e.g., exceedance of a Maximum Acceptable Concentration or where observations indicate safety of water cannot be guaranteed) are required under O. Reg. 170//03. Three such incidents were recorded in 2011 including the presence of total coliforms recorded at two locations and exceedance of turbidity limits over a 15 minute period (Municipality of Wawa, 2011). In each of these incidents, corrective actions were taken by flushing out the affected watermain and increasing the chlorine dosage.

As part of a study by Greenaway (2009), water quality measurements were taken to investigate the diatom response to water quality improvements in the Wawa area. The study showed few changes in the measured parameters when compared with measurements taken in lakes interpreted to be not affected by the sinter plant. However, it was found that increases in pH and alkalinity and decreases in specific conductivity, sulphate, calcium, magnesium, chlorine, potassium, aluminium, copper, iron and manganese have occurred since the 1970s in lakes, interpreted to be affected by the sinter plant.

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



3.4.5 Lake Sediment Chemistry

Lake sediments in the Murray Lake area, east of Wawa, were collected at 933 sites during a study by Hamilton et al. (1995). Interpretation of the geochemical patterns indicated that concentrations of some elements were elevated above the typical crustal abundance. These elements include: silver, arsenic, gold, cadmium, copper, chromium, molybdenum, nickel, lead, tungsten and zinc. Digital geochemical data for this survey is available as Miscellaneous Release Data (MRD) 033 (Hamilton et al., 1995). The anomalous geochemical patterns observed in the lake sediment chemistry, relative to typical abundances, are a result of natural mineralization.

Greenaway (2009) looked at the diatom response to water quality improvements in the Wawa area. As part of this study, lake sediment quality measurements were taken. This study shows similar elevated levels of arsenic, iron and magnesium.

3.4.6 Potential Sources of Pollutants

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

There are two operating landfill sites within the Wawa area, the Tiernan Landfill and the Michipicoten Landfill (Table 4), shown on Figure 1. Both sites are classified as small landfills. The Tiernan Landfill site is within Lake Superior Provincial Park and is shown in available data as three locations. In addition, there are also four other small, now closed, landfills within the Wawa area (MOE, 2010). Three were owned and operated by Algoma Ore Division/Algoma Steel Inc.

Table 4: Registered Landfills in the Wawa Area

Certificate of Approval (C of A) Number	Site Name	Location	Status
A561401	Client: The Corporation of the Township of Michipicoten	Township 29, Range 23 Municipality of Wawa	Closed
A7180702	Tiernan Landfill Site Client: Ministry of Natural Resources	Peat lake Road Tiernan Twp MNR Wawa POS 1C0 Twp of Tiernan	Open
A7266501	Michipicoten Landfill Site Client: The Corporation of the Municipality of Wawa	High Falls Rd; Lot MS54 Municipality of Wawa	Open
A770144	Client: Algoma Ore Division/Algoma Steel Inc.	Southern Part of Twp 29 Municipality of Wawa	Closed
A770148	Client: Algoma Ore Division/Algoma Steel Inc.	Southern Part of Twp 29 Municipality of Wawa	Closed
A770152	Client: Algoma Ore Division/Algoma Steel Inc.	Southern Part of Twp 29 Municipality of Wawa	Closed

Source: Ontario Landfill List (MOE, 2010)

Transportation corridors, such as Highway 17, secondary roads, logging roads and rail lines, traverse the Wawa area, 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 Municipality of Wawa contains a local airport which is also a potential source of pollution, due to air emissions and fuel handling. Local septic systems are a potential source of the release 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 Municipality of Wawa is located within the Lake Superior drainage basin of the Atlantic Ocean Watershed. Surface water drainage for the Wawa area is shown on Figure 12. Drainage is generally southwesterly into Lake Superior from the height of land between the Lake Superior drainage and that of the Hudson Bay system located approximately 50 km to the northeast of the Wawa area.

In the Michipicoten-Magpie tertiary watershed, the main drainage is carried by the Michipicoten River, which flows approximately 110 km from Dog Lake just northeast of the Wawa area into Manitowik Lake, Whitefish Lake and finally into Lake Superior. Tributaries of the Michipicoten River include the Shikwamkwa River which drains the east-central part of the Wawa area, the Anjigami River which drains Anjigami Lake and the south-central part of the Wawa area, and the Magpie River which drains the north-central part of the Wawa area including the northern half of the Municipality. The western part of the Wawa area is drained by smaller south-flowing rivers, the largest of which are the Doré River and the Dog River.

The south-central part of the Wawa area is within the Agawa tertiary watershed including Mishewawa Lake which is drained by the Old Woman River which discharges to Lake Superior at Old Woman Bay. The southeast part of the Wawa area including Gould Lake is drained by the Agawa River which flows south through the Agawa Canyon (Agawa River Fault) prior to discharging into Lake Superior at Agawa Bay, 90 km south of the settlement area of Wawa. Given the generally rugged terrain, modest precipitation and relatively large size of some catchment areas, there is a possibility of flash flooding in some areas.

3.6 Groundwater and Wells

Information concerning groundwater in the Wawa area was obtained from the MOE Water Well Record (WWR) database (MOE, 2012). The locations of known water wells are shown on Figure 12. The Municipality of Wawa obtains its municipal water supply from Wawa Lake. Water wells in the Wawa area obtain water from the overburden or the shallow bedrock. The MOE water well database contains 77 water well records in the Wawa area, 41 of which provided useful information regarding well yield and other parameters noted in Table 5.

Table 5: Water Well Record Summary for the Wawa Area

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	31	3.3 to 101	0.9 to 28	4 to 227	N/A
Bedrock	10	38 to 117	1 to 113	4 to 68	0 to 86

3.6.1 Overburden Aquifers

There are 31 water well records in the Wawa area that can be confidently assigned to the overburden aquifer, ranging in depth from 3 to 101 m. These wells are completed in overburden materials within the bedrock valleys



of the Magpie, Michipicoten and Doré rivers, as they approach Lake Superior. Well yields are variable with recorded values of 4 to 227 L/min, with the range being explained by the diversity of materials encountered during drilling: from clay to gravel. These well yields reflect the purpose of the wells (private residential supply) and do not necessarily reflect the maximum sustained yield that might be available from overburden aquifers.

The review of the water well information indicates that competent overburden aquifers exist where thick overburden deposits occur, and within bedrock valleys particularly in proximity to Lake Superior (Morris, 2001). It is notable that overburden is thin to non-existent over much of the Wawa area.

3.6.2 Bedrock Aquifers

No information was found on deep bedrock groundwater conditions in the Wawa area at a typical repository depth of approximately 500 m. In the Wawa area there are eight well records that can be confidently assigned to the shallow bedrock aquifer, ranging from 38 to 117 m in depth. Measured pumping rates in the bedrock wells range from 4 to 68 L/min, with an average yield of 34 L/min. These well yields reflect the purpose of the wells (i.e., private residential supply) and do not necessarily reflect the maximum sustained yield that might be available from the shallow bedrock aquifers.

The MOE WWRs indicate that no potable water supply wells are known to exploit aquifers at typical repository depths in the Wawa area or anywhere else in Northern Ontario (MOE, 2010). 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 Wawa area has a boreal climate and is characterized by long, cold winters, and short, cool to mild summers. Most precipitation falls between May and October and is associated with continental weather systems moving eastward from the Pacific crossing the prairies into northern Ontario or moving southward from the Arctic. In winter and spring, flow of air masses is dominated by Arctic airstreams. In summer and fall, the Arctic air masses are usually replaced by westerly air currents of Pacific origin. The overall yearly mean temperature is a just a degree or so above zero Celsius, reflecting the dominant Arctic air flow over the region.

Climatological information presented in this section is based on meteorological data from Environment Canada's meteorological station located in Wawa. It has more than 30 years of continuous data required for climate analysis. Parameters that are measured at the Wawa station include temperature, precipitation and wind.

3.7.1 Temperature

Temperature data was obtained from Environment Canada's 1971-2000 climate normals for the Wawa meteorological station (EC, 2011b). Figure 13 presents monthly temperatures for Wawa, displaying daily average, maximum and minimum and extreme values over the calendar year.



3.7.2 Precipitation

Figure 14 presents monthly precipitation data obtained from Environment Canada’s 1971-2000 climate normals for the Wawa meteorological station, including total precipitation, rainfall, snowfall and all-time extreme values over the calendar year (EC, 2011b).

3.7.3 Wind

Table 6 presents monthly wind data obtained from Environment Canada’s 1971-2000 climate normals for the Wawa meteorological station (EC, 2011b). Average wind speed and direction are average for each month over the calendar year. The dominant wind direction is from the north, with winds from the southwest and south dominant during the summer months.

Table 6: Monthly Wind Normals for Wawa, Ontario

Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Speed (km/h)	9.6	9.3	10	10	8.9	7.8	6.9	7.9	9.6	9.9	11	9.4	9.2
Most Prevalent Direction	N	N	N	N	N	S	S	SW	SW	SW	N	N	N

3.8 Natural Hazards

3.8.1 Earthquakes and Seismicity

The Wawa area lies within the Canadian Shield, where large parts have remained tectonically stable for the last 2.5 billion years (Percival and Easton, 2007). The Wawa area has a low seismic hazard rating (NRCan, 2010). Since 1627, no earthquakes exceeding a magnitude m_N 6 have been known to occur within 1,000 km of the Wawa area. According to the National Earthquake Database (NEDB) for the period between 1985 and 2011 (NRCan, 2012) all recorded seismic events in the Wawa area had magnitudes m_N ranging from less than 1 to 3.0.

In summary, available literature and recorded seismic events indicate that the Wawa area is located within a region of low seismicity.

3.8.2 Tornadoes and Hurricanes

As noted in Table 6, average monthly wind speeds in the Wawa area are low, ranging from 7 to 11 km/hr. The Wawa area experiences thunderstorms in the summer months and is located in an area with a low tornado frequency (<0.1 tornadoes per year / 10,000 km²), but where there is a potential for F0-F1 tornadoes (Sills et al., 2012). The Wawa area 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 hourly wind pressure for the Wawa area of 0.39 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 Wawa area experiences on average between 50 and 120 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 Wawa station (Figure 14) are 102 mm of rain and 41 cm of 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 Wawa area lies at the outflow of two watersheds, making the size of the upstream catchments areas moderately large. This, in combination with the rugged terrain, makes for a possible risk of flash flooding in the Wawa area, such as that which occurred in the area on October 25, 2012. The potential risk of drought or flooding affecting the facility will also depend to some degree on the specific location selected.

3.8.4 Snow and Ice

As noted on Figure 14, the Wawa area receives on average about 320 cm of snowfall per year, primarily between the months of October and April. No single month receives an average snowfall greater than 85 cm. The highest single day snowfall accumulation on record is 41 cm, recorded on October 20, 1989. The National Building Code of Canada recommends a design 1/50 snow load ($S_s + S_r$) for the Wawa area of 4.5 kPa, which is a typical value for northern Ontario (NRC, 2010). Local lakes and waterbodies freeze over in the winter months in the Wawa area, as average daily temperatures from November to March typically range from -15 to -2°C. Lake Superior partially freezes each year and freezes over completely approximately once every 20 years.

3.8.5 Forest Fires and Lightning

Within heavily forested areas such as the Wawa area there is a risk of forest fires. Locations where forest fires have occurred in the vicinity of the Wawa area between 1976 and 2010 affecting an area of greater than 200 ha are shown on Figure 5. These forest fires combine to comprise approximately less than 1% of the total Wawa area. 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 do occur in the Wawa area and lightning strikes are not uncommon in the summer months.

3.8.6 Landslides and Tsunamis

There are significant areas of steep slopes in the Wawa area, which are generally comprised of crystalline rock with only a thin veneer of soil cover. The physical nature of these slopes, combined with typically modest precipitation and very low seismicity, results in a possible landslide risk for some areas. There is a low risk of tsunamis in the Wawa area along the immediate Lake Superior shoreline, owing to the very low seismicity.





4.0 SUMMARY

This report provides a high level description of the environment in the Municipality of Wawa and surrounding area.

Situated in the District of Algoma along the north shore of Lake Superior, the Municipality of Wawa is approximately 420 km² in size, with a population of 2,975 (Statistics Canada, 2012). The Municipality of Wawa is bordered on the west by the Michipicoten First Nation (Gros Cap 49 Indian Reserve), on the south by protected areas, and on the east, north and southeast by unorganized territory. The climate in Wawa is typical boreal climate and is characterized by long, usually cold winters, and short, cool to mild summers. Wawa receives most of its yearly precipitation between May and October.

There are a number of Aboriginal communities and organizations in the Wawa area including the Brunswick House First Nation, Chapleau Cree First Nation, Chapleau Ojibway First Nation, Michipicoten First Nation and Missanabie Cree First Nation. Métis Councils in the area include Greenstone Métis Council, Superior North Shore Métis Council and Thunder Bay Métis Council and Chapleau Métis Council, Métis Nation of Ontario Timmins Council, Northern Lights Métis Council and Temiskaming Métis Council as represented by Abitibi/Temiskamingue and James Bay Traditional Territory Consultation Committee and the Métis Nation of Ontario.

Geologically, the Municipality of Wawa is situated in the southeastern portion of the Wawa Subprovince, which is part of the western region of the Superior Province of the Canadian Shield. Approximately 75% of the Municipality of Wawa is underlain by the supracrustal rocks of the Michipicoten greenstone belt, which extends beyond the Municipality boundaries to the north, northwest and southwest. The southern part and the northwestern part of the Municipality are underlain by granitoid rocks that are external to the greenstone belt, specifically the Wawa gneiss domain and the Western batholith. The Wawa gneiss domain is composed of gneissic tonalite, the granite to granodiorite Whitefish Lake batholith, migmatized supracrustal rocks and diabase dikes (Williams et al., 1991). The Western batholith extends between the Michipicoten and the Mishibishu greenstone belts and is composed of three different granitic suites. These batholiths extend well beyond the boundaries of the municipality. During ice retreat, ice-contact stratified drift was deposited, leaving a thin (less than 1 m thick) till veneer on the bedrock surface. This till veneer, when present, is the uppermost deposit across most of the Wawa area.

There has been a long history of iron and gold mining in the Wawa area. For over 100 years, iron was extracted at three principal mine sites in the Michipicoten greenstone belt. There is no current production of iron ore in the Wawa area, although there are still identified reserves. Gold exploration and mining has similarly been ongoing in the Wawa area, from both the Michipicoten and Mishibishu greenstone belts, but there are currently no operating gold mines in the Wawa area, although the Island Gold Mine and Eagle River Mine are located nearby. Gold exploration continues in the region, but at present there are no active mines in the Wawa area. In addition, no active mines for base metals, rare metals or uranium exist in the Wawa area.

Infrastructure within the Wawa area includes the Trans-Canada Highway (Highway 17) which passes through the southwest end of the Wawa area and Highway 101 which enters the area from the east and then travels south through the center of the municipality. The railway in the Wawa area is owned by the Canadian National Railway (CN). This includes the north-south line from Sault Ste. Marie to Hearst and the now removed branch from Michipicoten Harbour past Wawa to Hawk Junction. One 230 kV line, the East-West Tie, heads northwest



through the Wawa area from the Wawa Transformer Station. As well, a 115 kV transmission line heads north, then east from Anjigami. The Wawa airport is located just south of the town, as shown on Figure 1 (NRCan, 2008). There are no gas pipelines recorded in the Wawa area (NRCan, 2009).

There are four provincial parks, three conservation reserves and a forest reserve within the Wawa area. The largest provincial park in the Wawa area is Lake Superior Provincial Park, which covers approximately 155,000 ha and 120 km of Lake Superior shoreline south of the Municipality of Wawa.

The Wawa area lies in the southern portion of the Boreal Forest Region where it meets the Great Lakes-St. Lawrence Forest (Hoffman, 2011). The Algoma Forest Management Unit (FMU 350) managed by Clergue Forest Management Inc. (CFMI) extends over most of the Wawa area. A notable impact on the forest landscape attributable to human activity near Wawa is the area known as the “fume kill” or Wawa Treeless Area. The fume kill zone covers an area of about 10,000 ha stretching northeast from the Town of Wawa, resulting from the fallout of sulphur dioxide emissions from sintering plant operations that persisted over a 50-year period. The remainder of the unit is comprised of maples, yellow birch, balsam fir, white spruce, white pine and red oak.

Trapping of fur bearing species has been, and still is, an important employment and commercial activity in the Algoma Forest (CFMI, 2005). Plans for management of woodland caribou, moose and black bear populations are required by the Ontario Ministry of Natural Resources (MNR) in overall planning for the Algoma Forest. These species, as well as pileated woodpecker, white tailed deer, red-shouldered hawk, black-backed woodpecker, lynx, red-breasted nuthatch, ruby crowned kinglet, northern flying squirrel, great gray owl, red-headed woodpecker, bay-breasted warbler, ruffed grouse and boreal chickadee are species identified by the MNR as important for management within the Algoma Forest (CFMI, 2005). The western portion of the Wawa area is part of both continuous and discontinuous woodland caribou habitat as identified in Ontario’s Woodland Caribou Conservation Plan (MNR, 2009). There are several known Areas of Natural and Scientific Interest (ANSI), Provincially Significant Wetlands (PSW) or other Natural Areas within the Wawa area.

The Natural Heritage Information Centre (NHIC, 2012) records showed six species that are listed as Endangered, Threatened or of Special Concern either under the Ontario *Endangered Species Act* (Government of Ontario, 2007) or the Federal *Species at Risk Act* (Government of Canada, 2012) within the Wawa area. These species include: woodland caribou, bald eagle, peregrine falcon, kiyi, shortjaw cisco and flooded jellyskin. Two additional mammals were identified from Royal Ontario Museum (ROM) range maps: provincially endangered eastern cougar and provincially and federally of special concern eastern wolf. Ten additional endangered, threatened or special concern bird species may be located within the Wawa area based on information from the Ontario Breeding Bird Atlas and ROM range maps, including provincially endangered golden eagle. ROM range maps identified that provincially threatened lake sturgeon may be present either in Lake Superior or some inland lakes. The ranges of two invertebrates, monarch butterfly and west Virginia white butterfly, were reported to overlap with the Wawa area according to ROM. No endangered, threatened or special concern amphibian or reptile species are known to occur within the Wawa area based on available sources.

The Wawa area is located within the Lake Superior drainage basin where the terrain including wetlands, lakes and rivers that support a diversity of fish and wildlife. The main drainage, in the Michipicoten-Magpie tertiary watershed, is carried by the Michipicoten River, which flows approximately 110 km from Dog Lake just northeast of the Wawa area into Manitowik Lake, Whitefish Lake and finally into Lake Superior. Wetlands, including swamps, marshes and peatlands, are often ecologically sensitive. Wawa, Black Trout, Deep and Reed Lakes



are all considered "lake trout" lakes and identified by the MNR as sensitive. Wawa Lake is the largest inland coldwater lake within the Wawa area. Coldwater fisheries in this area typically support natural brook trout populations and the main sport fish are walleye, northern pike, brook trout and lake trout.

Water wells in the Wawa area obtain water from the overburden or the shallow bedrock. The Ontario Ministry of the Environment water well database contains 71 water well records in the Wawa area, 41 of which provided useful information regarding well yield and other parameters. There are no records of water wells sourcing potable water aquifers at repository depths in the Wawa area or elsewhere in the Ontario part of the Canadian Shield. The Municipality of Wawa obtains its municipal water supply from Wawa Lake.

Air, soil and surface water quality within the Wawa area are expected to be within the normal range for north-central Ontario. Sources of background radioactivity in the Wawa area are attributed to naturally occurring radioactive materials, specifically potassium, uranium and thorium-bearing minerals. The range of dose rates and average are consistent with regional dose rates for north-central Ontario.

There are 37 known archaeological sites in the Wawa area (von Bitter, 2012). Of the 37 sites, 11 are historical sites with seven identified as Euro-Canadian and four as historical Aboriginal. Nine sites are identified as pre-contact Aboriginal. The remaining 17 sites have no information as to their culture or time period. There are also 30 municipally designated heritage sites but no national or provincial heritage sites in the Wawa area (Meridian, 2010; Ontario Heritage Trust, 2011; Parks Canada, 2012).





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Report Signature Page

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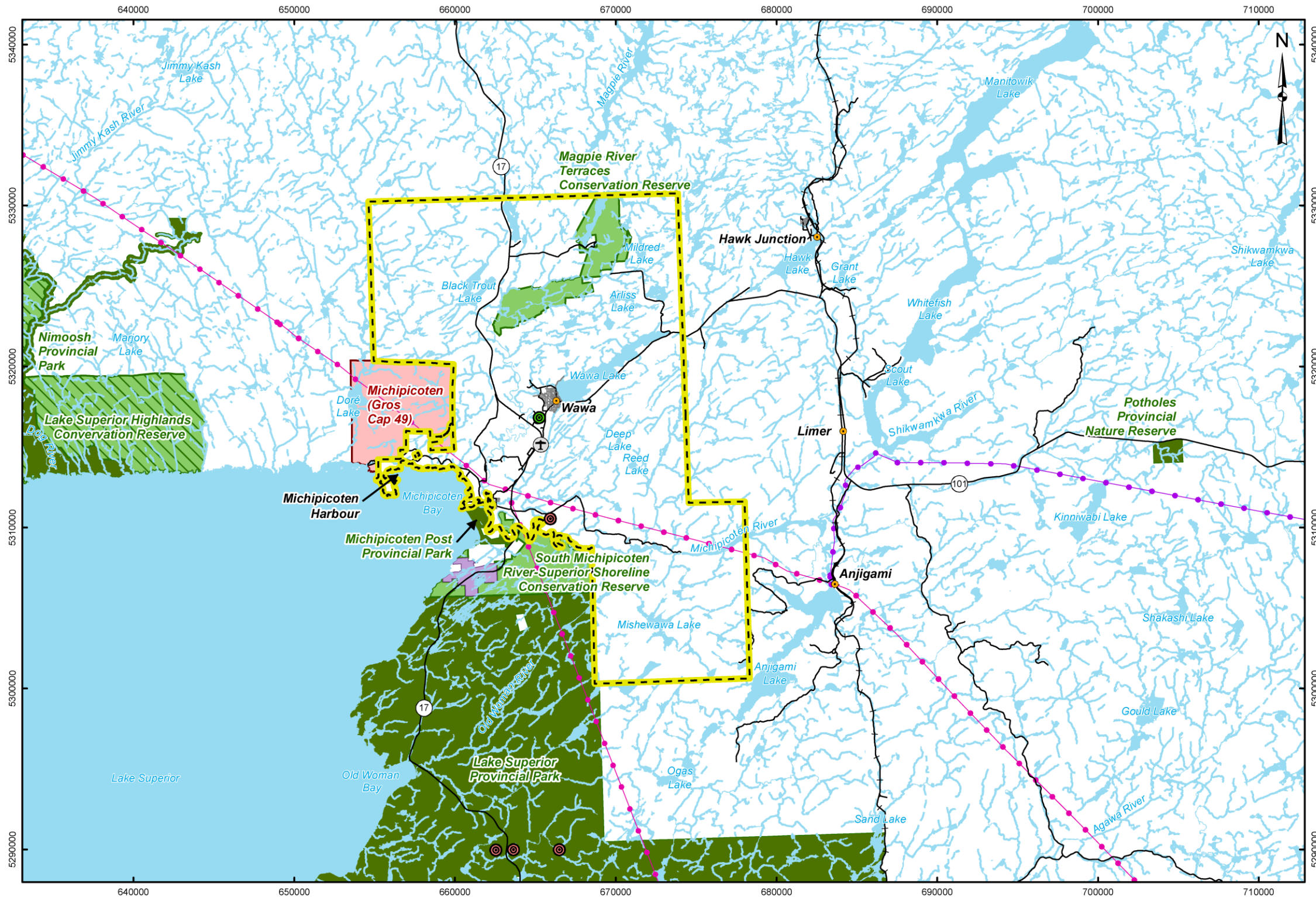


FIGURES



ENVIRONMENT REPORT - MUNICIPALITY OF WAWA, ONTARIO

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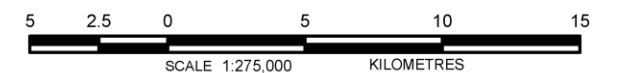
LEGEND


- Community
- ⊕ Airport
- ⊙ Domestic Waste Site
- ⊙ Waste Water Treatment Plant
- Main Road
- Local Road
- Railway
- 230 kV Transmission Line
- 115 kV Transmission Line
- Watercourse, Permanent
- Watercourse, Intermittent
- Water Area, Permanent
- Forest Reserve
- Conservation Reserve
- Conservation Reserve (Recommended)
- Provincial Park
- Federal Land - Indian Reserve
- Municipal Boundary (Municipality of Wawa)



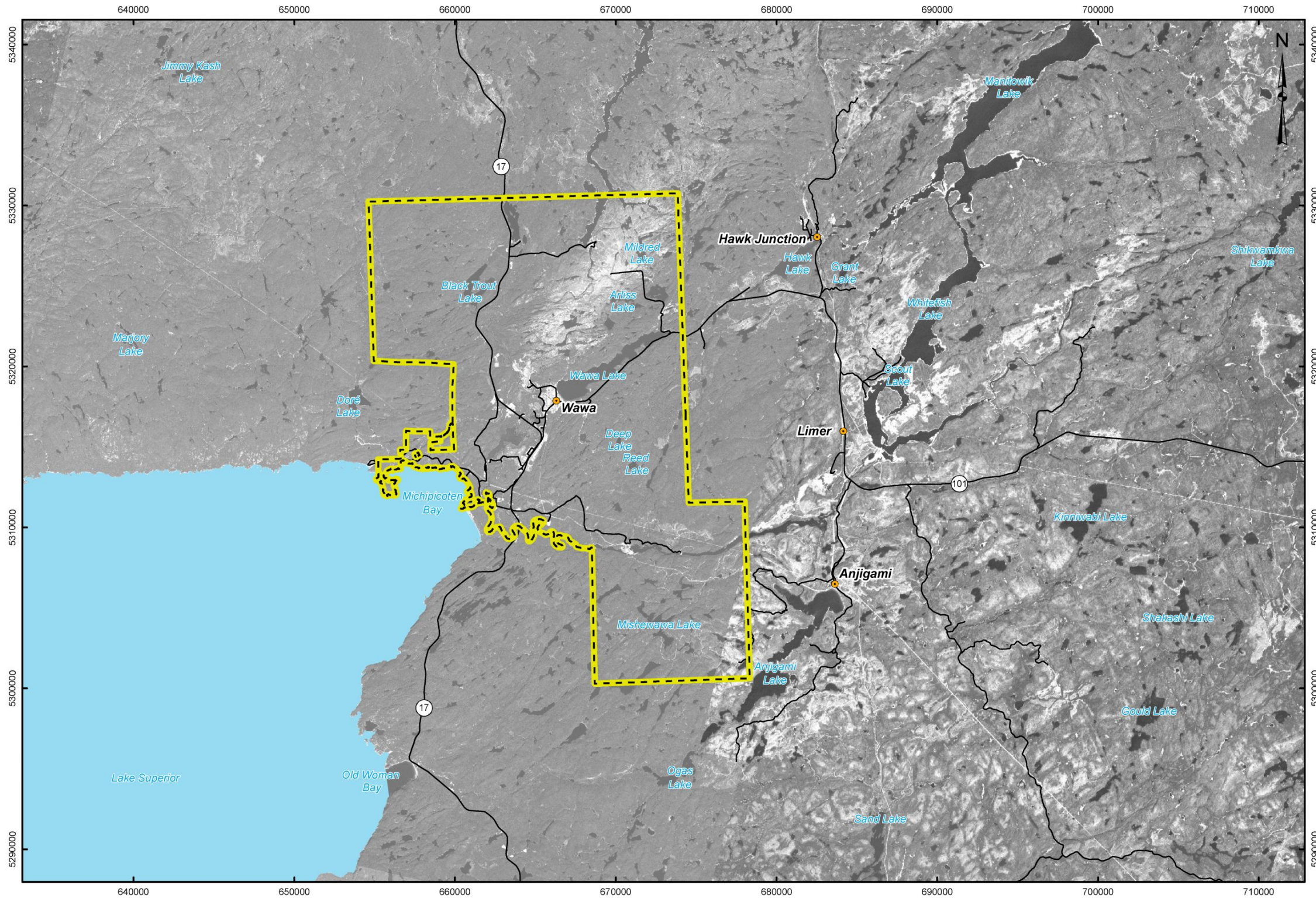
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PROJECT		Environment Report Municipality of Wawa, Ontario	
TITLE			
Wawa and Surrounding Lands			
 Golder Associates Mississauga, Ontario	PROJECT NO.	12-1152-0026	SCALE AS SHOWN
	DESIGN	PRM 27 Jun. 2012	REV. 0.0
	GIS	PM/JB 7 Nov. 2013	FIGURE: 1
	CHECK	JH 7 Nov. 2013	
REVIEW	GWS 7 Nov. 2013		

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LEGEND


- Community
- Main Road
- Water Area, Permanent
- Municipal Boundary (Municipality of Wawa)



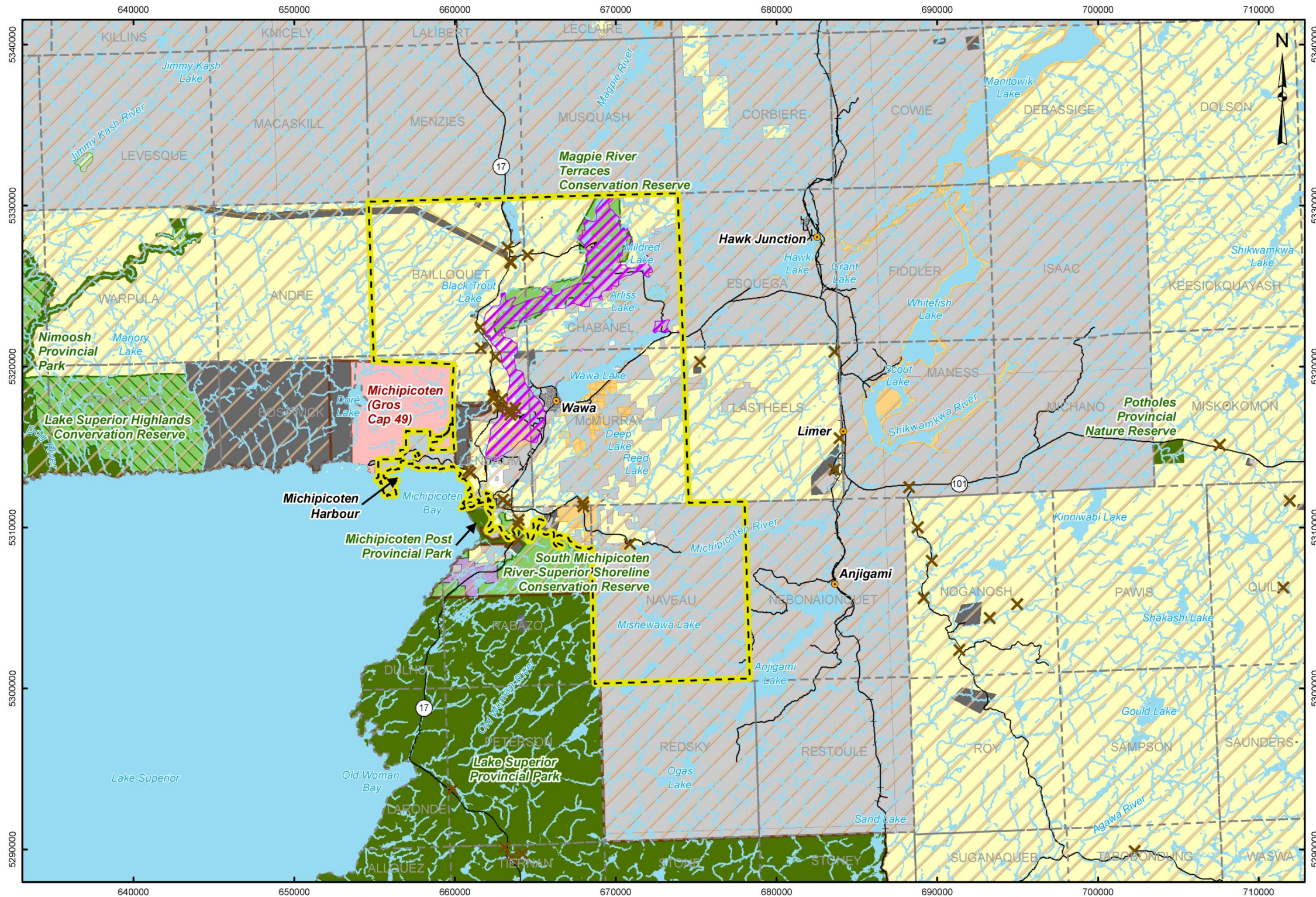
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 Imagery - Spot 5, Obtained from Geobase 2011, (data 2005-2010, 10m resolution)
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 Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 16N



PROJECT		Environment Report Municipality of Wawa, Ontario	
TITLE		Satellite Imagery of the Wawa Area	
 Golder Associates Mississauga, Ontario	PROJECT NO.	12-1152-0026	SCALE AS SHOWN
	DESIGN	PRM 27 Jun. 2012	REV. 3.0
	GIS	PMJB 7 Nov. 2013	FIGURE: 2
	CHECK	JH 7 Nov. 2013	
REVIEW	GWS 7 Nov. 2013		

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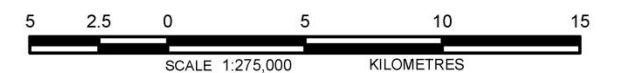
LEGEND


- Community
- Main Road
- Local Road
- + Railway
- Watercourse, Permanent
- - - Watercourse, Intermittent
- Water Area, Permanent
- ✕ Pit (Gravel)
- ANSI, Earth Science
- Candidate ANSI, Earth Science
- Candidate ANSI, Life Science
- Forest Reserve
- Conservation Reserve
- Conservation Reserve (Recommended)
- 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
- - - Geographic Township Boundary
- Municipal Boundary (Municipality of Wawa)



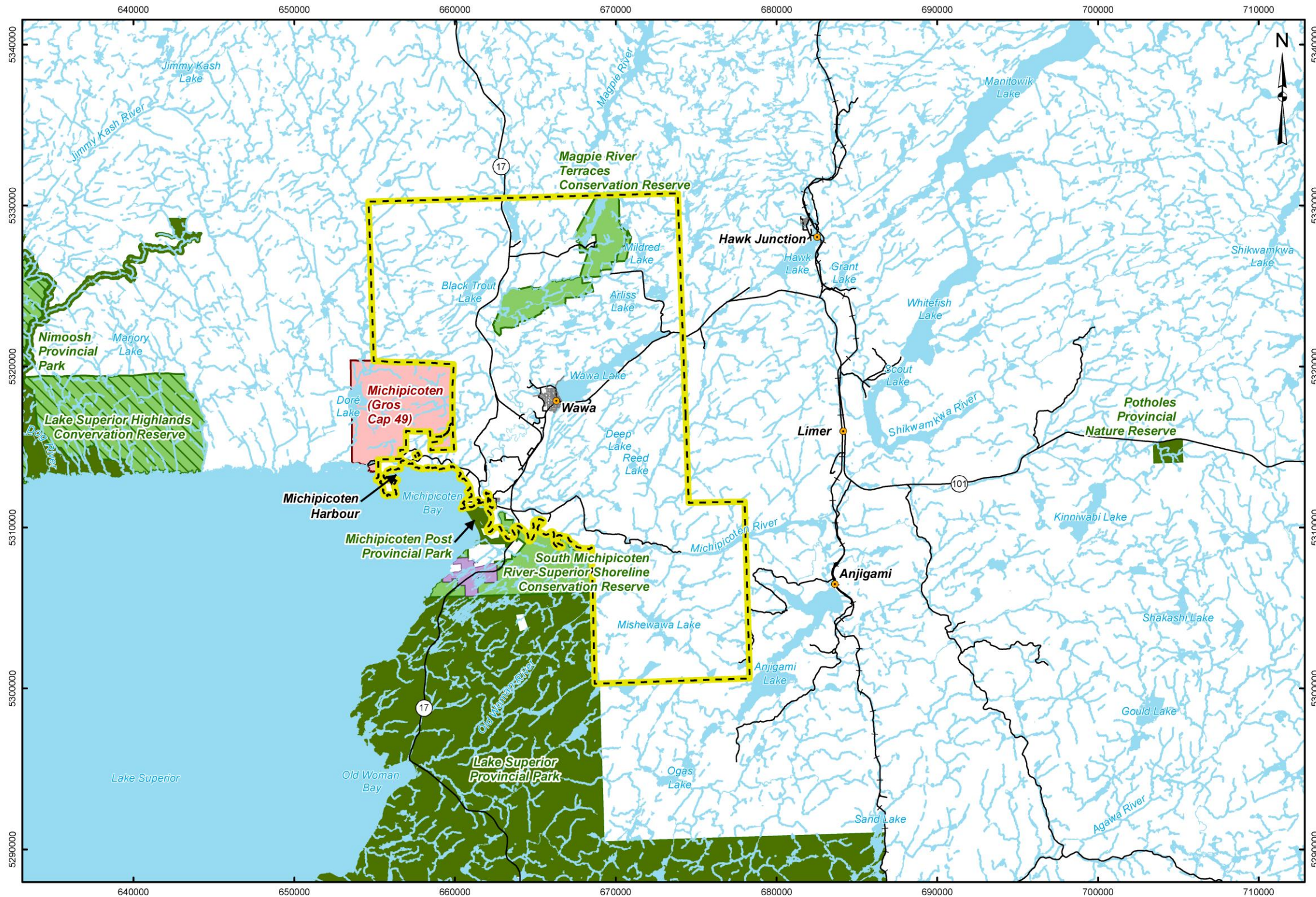
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 Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 16N



PROJECT	Environment Report Municipality of Wawa, Ontario		
TITLE	Wawa Area Land Ownership		
 Golder Associates Mississauga, Ontario	PROJECT NO.	12-1152-0026	SCALE AS SHOWN
	DESIGN	PRM 27 Jun. 2012	REV. 0.0
	GIS	PM/JB 7 Nov. 2013	FIGURE: 3
	CHECK	JH 7 Nov. 2013	
REVIEW	GWS 7 Nov. 2013		

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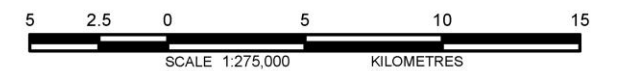
LEGEND

- Community
- Main Road
- Local Road
- Railway
- Watercourse, Permanent
- Watercourse, Intermittent
- Water Area, Permanent
- Forest Reserve
- Conservation Reserve
- Conservation Reserve (Recommended)
- Provincial Park
- Federal Land - Indian Reserve
- Municipal Boundary (Municipality of Wawa)

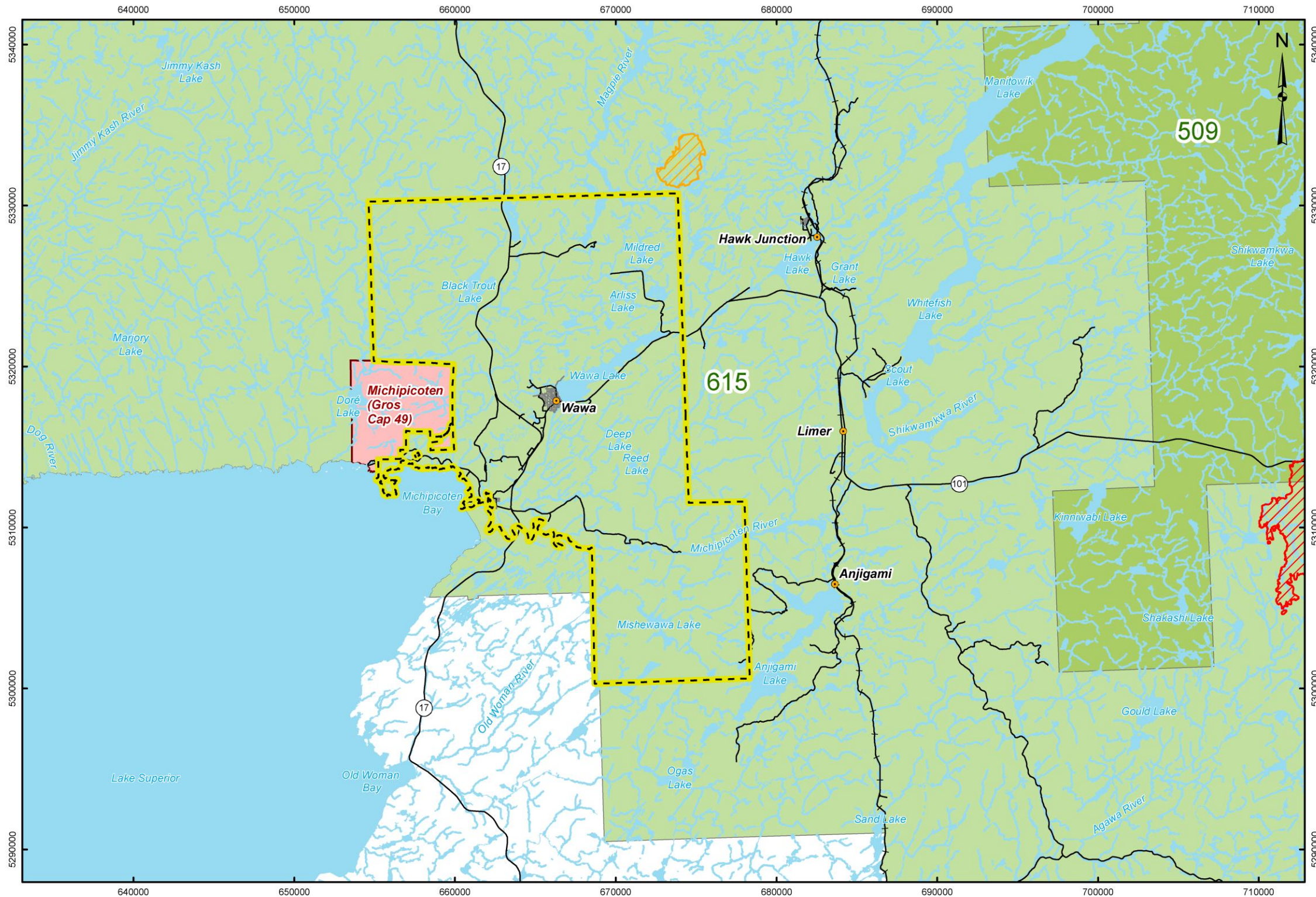


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 Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 16N



PROJECT		Environment Report Municipality of Wawa, Ontario	
TITLE		Wawa - Parks and Protected Lands	
	PROJECT NO.	12-1152-0026	SCALE AS SHOWN
	DESIGN	PRM 27 Jun. 2012	REV. 0.0
	GIS	PM/JB 7 Nov. 2013	FIGURE: 4
	CHECK	JH 7 Nov. 2013	
REVIEW	GWS 7 Nov. 2013		



LEGEND

- Community
- Main Road
- Local Road
- Railway
- Watercourse, Permanent
- Watercourse, Intermittent
- Water Area, Permanent
- Federal Land - Indian Reserve
- Municipal Boundary (Municipality of Wawa)
- 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

- 509 - Martel Forest
- 615 - Algoma Forest



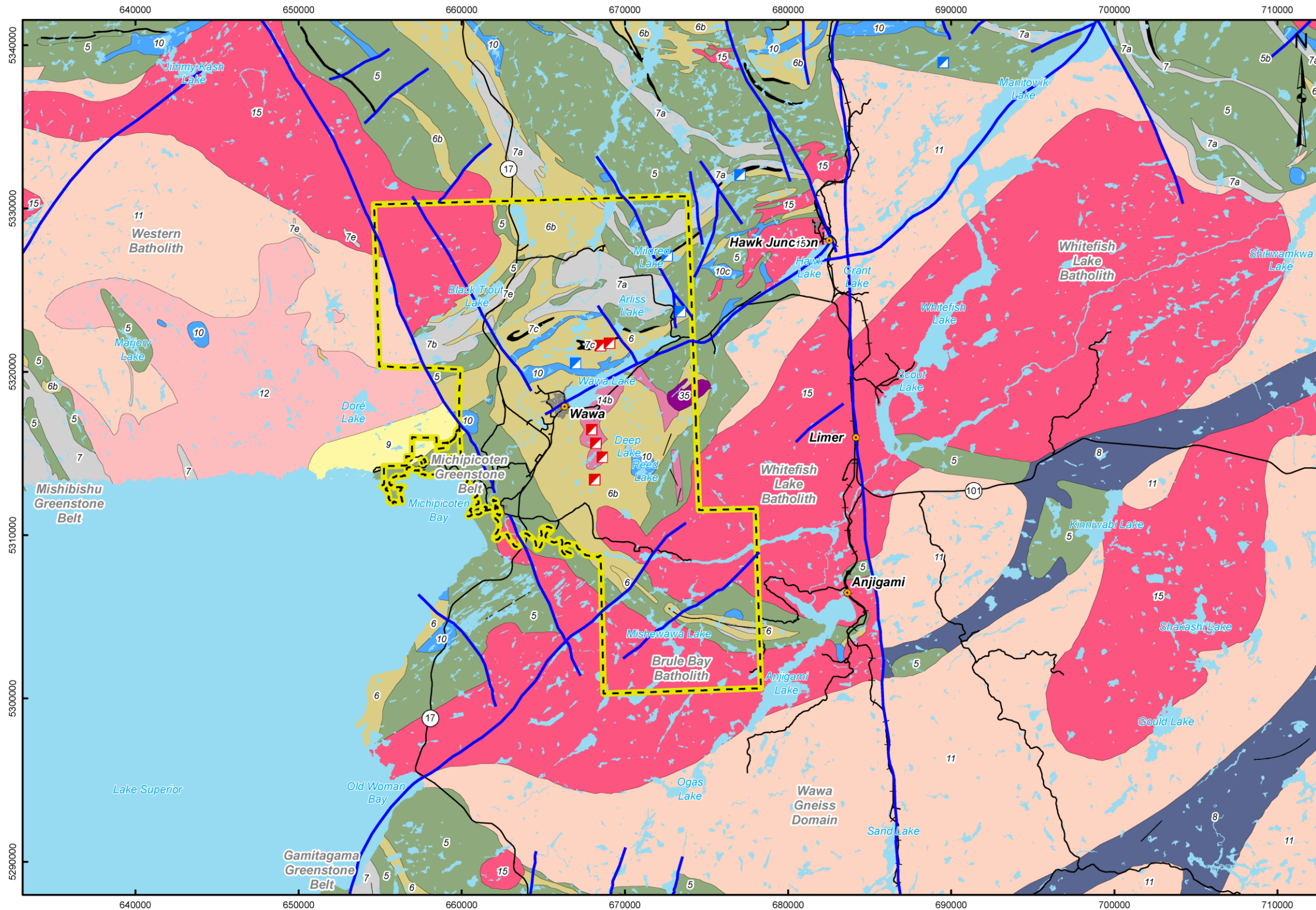
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Base Data - MNR LIO, obtained 2009-2012, CANMAP v2006.4
 Forest Management Units & Forest Fire Areas - Canadian Forest Service, 2010.
 Canadian National Fire Database-Agency Fire Data. Natural Resources Canada,
 Canadian Forest Service, Northern Forestry Centre, Edmonton, Alberta.
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 Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 16N



PROJECT		Environment Report Municipality of Wawa, Ontario	
TITLE		Forest Management Units of the Wawa Area	
Golder Associates Mississauga, Ontario	PROJECT NO.	12-1152-0026	SCALE AS SHOWN
	DESIGN	PRM 27 Jun. 2012	REV. 0.0
	CHECK	JH 7 Nov. 2013	FIGURE: 5
	REVIEW	GWS 7 Nov. 2013	

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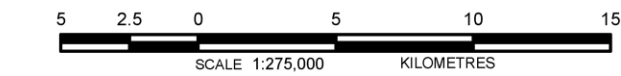
LEGEND

- Community
- ▣ Past Producing Mine with Reserves
- ▣ Past Producing Mine without Reserves
- Main Road
- Local Road
- + Railway
- Water Area, Permanent
- Geological Fault
- Iron Formation
- 35 Carbonatite-alkalic intrusive suite (1.0 to 1.2 Ga)
- 15 Massive granodiorite to granite
- 14-Diorite-monzodiorite-granodiorite suite
- 14b Granodiorite, granite
- 12 Foliated tonalite suite
- 11 Gneissic tonalite suite
- 10 Mafic and ultramafic rocks
- 10c Ultramafic rocks
- 9 Coarse clastic metasedimentary rocks
- 8 Migmatized supracrustal rocks
- 7 Metasedimentary rocks
- 7a Paragneisses and migmatites
- 7b Conglomerate and arenite
- 7c Marble, chert, iron formation, minor metavolcanic rocks
- 7e Paragneiss and migmatites
- 6 Felsic to intermediate metavolcanic rocks
- 6b Rhyolitic, rhyodacitic flows, tuffs and breccias
- 5 Mafic to intermediate metavolcanic rocks
- 5b Basaltic and andesitic flows, tuffs and breccias
- Municipal Boundary (Municipality of Wawa)



REFERENCE

Base Data - MNR LIO, obtained 2009-2012, CANMAP v2006.4
 Mineral Inventory - Mineral Deposit Inventory, 2010
 Geology - MRD126-Bedrock Geology of Ontario, 2011
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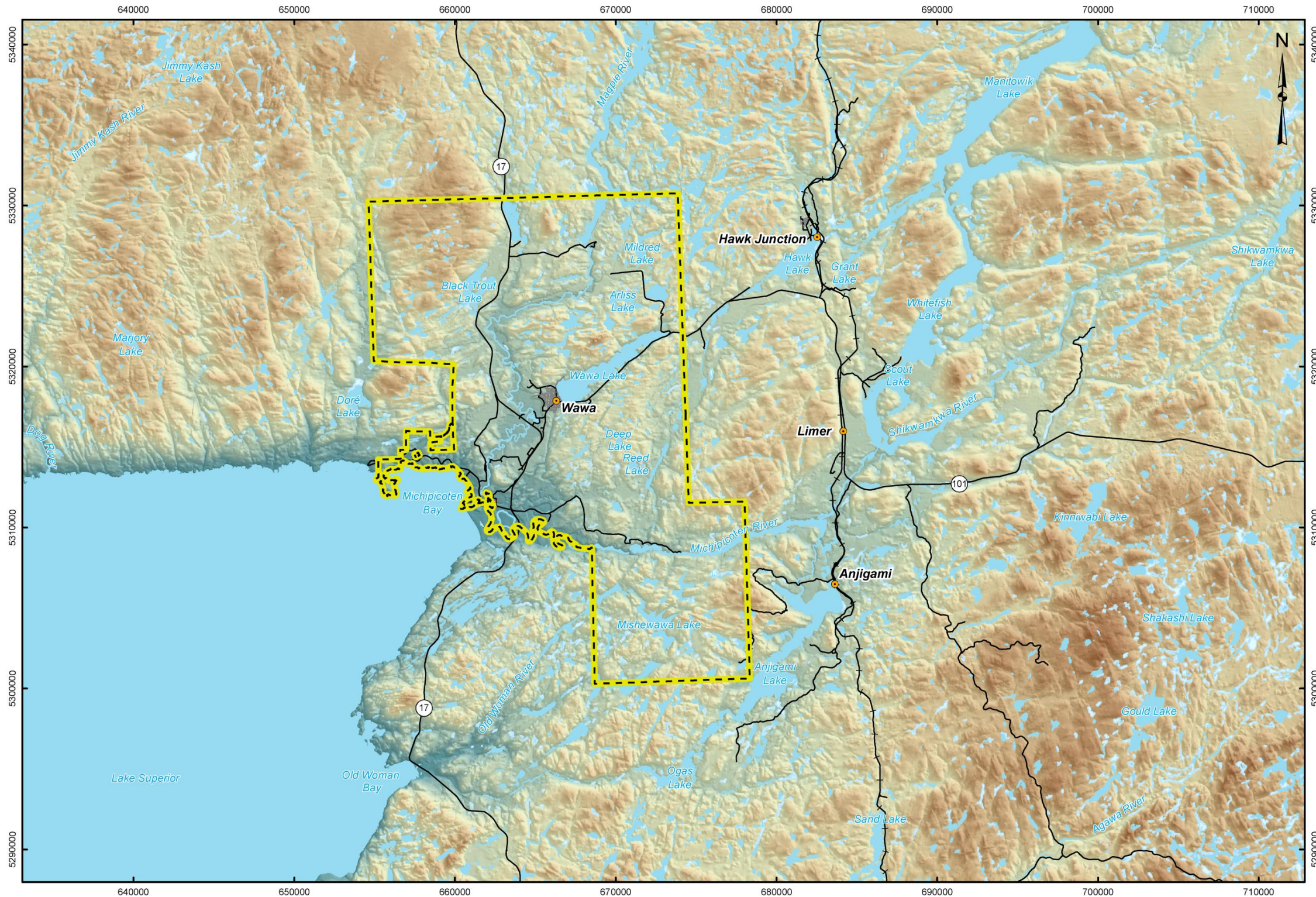


PROJECT
 Environment Report
 Municipality of Wawa, Ontario

TITLE
Bedrock Geology of the Wawa Area

 Golder Associates Mississauga, Ontario	PROJECT NO. 12-1152-0026	SCALE AS SHOWN	REV. 3.0
	DESIGN PRM 27 Jun. 2012	FIGURE: 6	
	GIS PM/JB 7 Nov. 2013		
	CHECK JH 7 Nov. 2013		
REVIEW GWS 7 Nov. 2013			

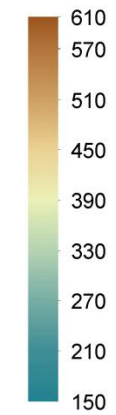
G:\Projects\2012\12-1152-0026_NWMO_Phase1_Feasibility\GIS\MXDs\Reporting\Env_Safety_Report\Wawa\WawaDigitalElevationModel.mxd



LEGEND

- Community
- Main Road
- Local Road
- + Railway
- Water Area, Permanent
- Wetland, Permanent
- Municipal Boundary (Municipality of Wawa)

Elevation (masl)



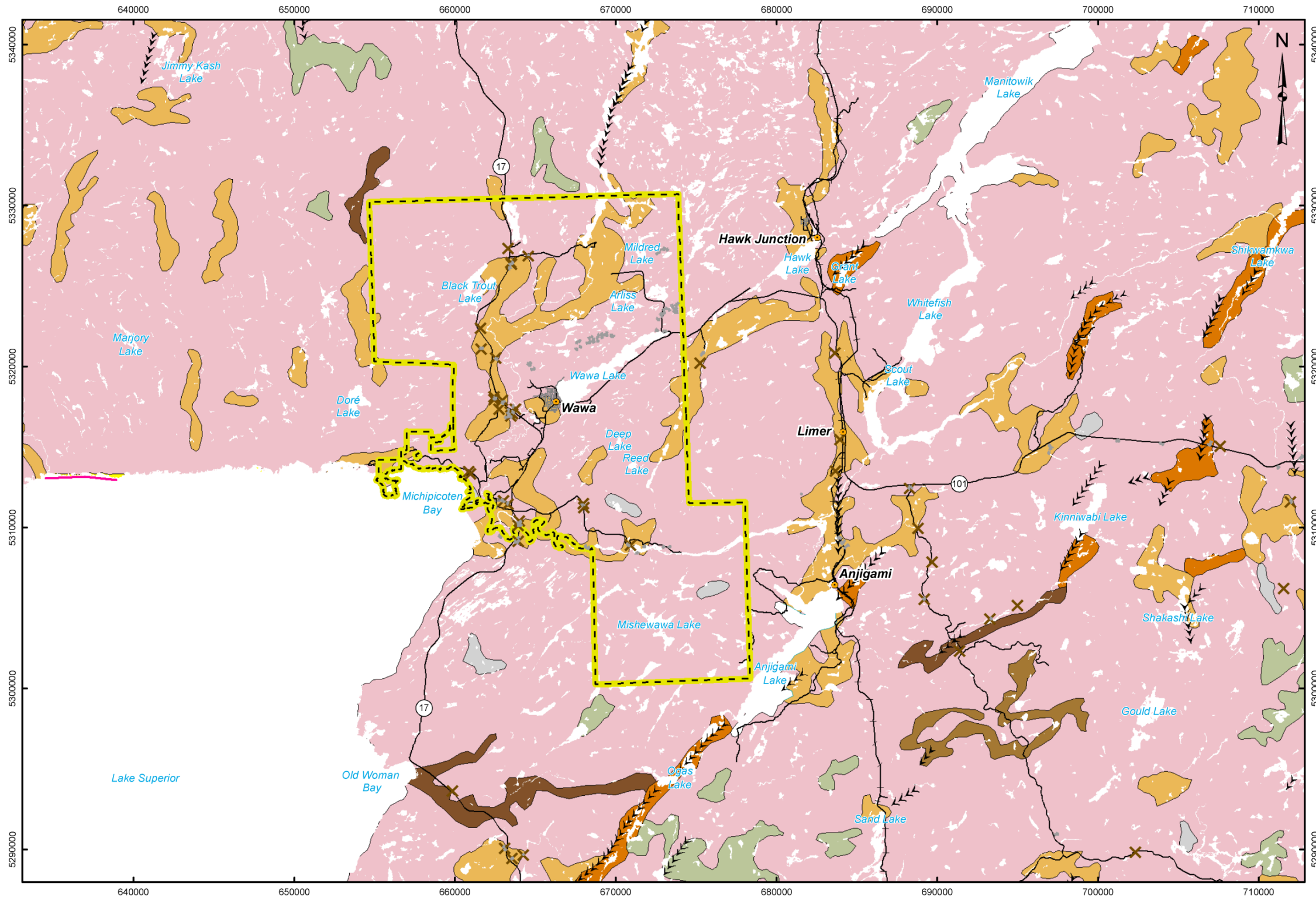
REFERENCE

Base Data - MNR LIO, obtained 2009-2012, CANMAP v2006.4
 Digital Elevation Model - CDED slope raster: Geobase.ca (1:50,000)
 Produced by Golder Associates Ltd under licence from
 Ontario Ministry of Natural Resources, © Queens Printer 2012
 Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 16N



PROJECT	Environment Report Municipality of Wawa, Ontario		
TITLE	Digital Elevation Model (DEM) of the Wawa Area		
 Golder Associates Mississauga, Ontario	PROJECT NO.	12-1152-0026	SCALE AS SHOWN
	DESIGN	PRM 27 Jun. 2012	REV. 0.0
	CHECK	JH 7 Nov. 2013	FIGURE: 7
	REVIEW	GWS 7 Nov. 2013	

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



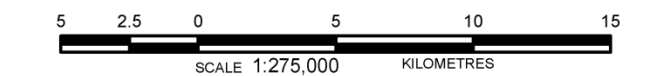
LEGEND


- Community
- Main Road
- Local Road
- Railway
- ✕ Pit (Gravel)
- Esker or Area of Eskers;
Direction of Flow Known or Assumed
- Beach, Bar or Spit
- Terrace Escarpment (abandoned shore bluff)
- 1: Bedrock
- 18: Till
- 22: Glaciofluvial Ice
- 23: Glaciofluvial Outwash deposits
- 25: Glaciolacustrine deposits
- 28: Fluvial Deposits on Abandoned Flood Plains,
Terrace Remnants
- 31: Fluvial Deposits on Modern Flood Plains
- 32: Organic deposits
- 33: Water Area
- ▭ Municipal Boundary (Municipality of Wawa)



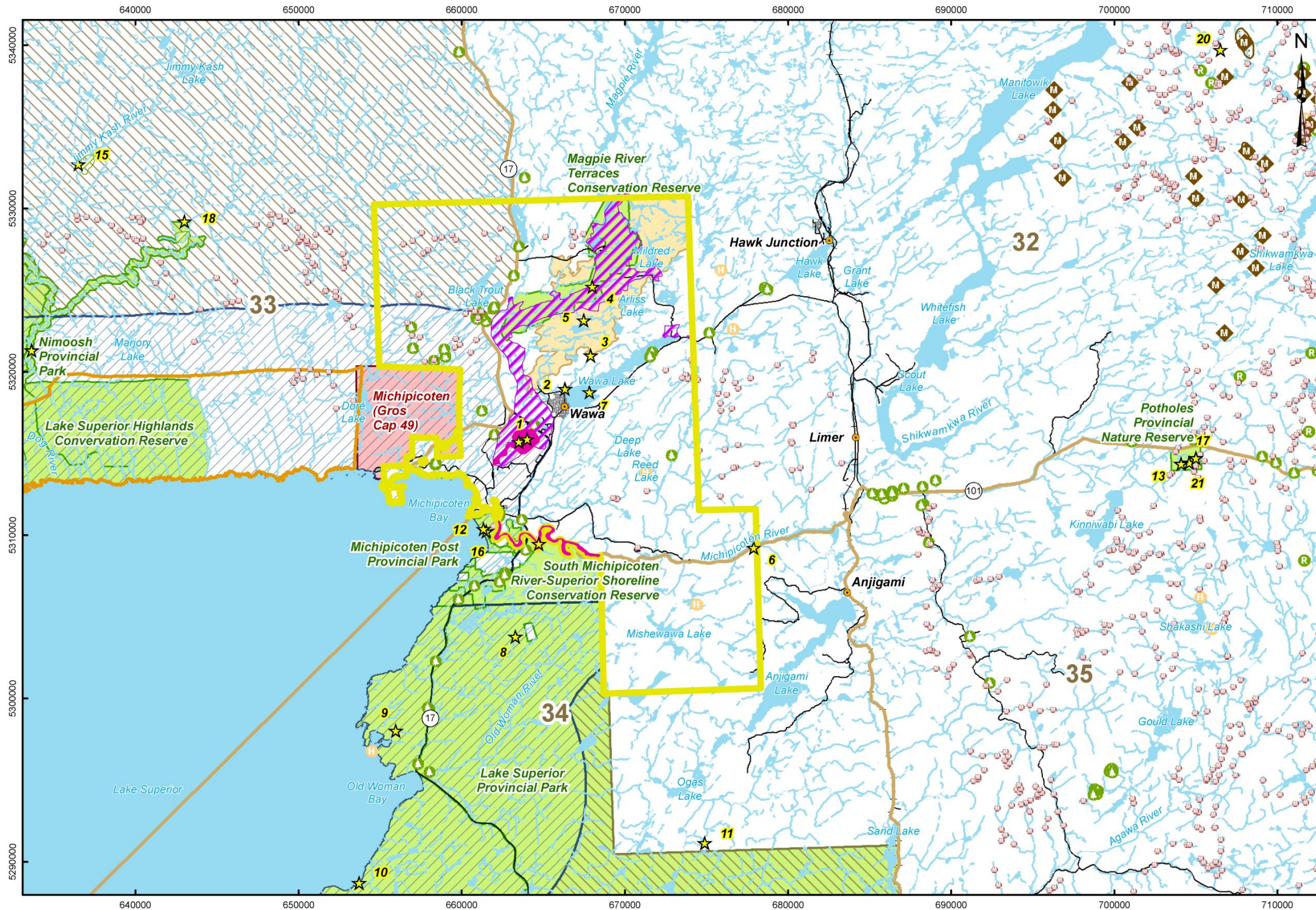
REFERENCE

Base Data - MNR LIO, obtained 2009-2012, CANMAP v2006.4
 Geology - EDS014-Surficial Geology of Ontario 1:1,000,000, 2000
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 Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 16N



PROJECT		Environment Report Municipality of Wawa, Ontario	
TITLE		Quaternary Geology of the Wawa Area	
 Golder Associates Mississauga, Ontario	PROJECT NO.	12-1152-0026	SCALE AS SHOWN
	DESIGN	PRM 27 Jun. 2012	REV. 0.0
	GIS	PMJB 7 Nov. 2013	FIGURE: 8
	CHECK	JH 7 Nov. 2013	
REVIEW	GWS 7 Nov. 2013		

G:\Projects\2012\12-1152-0026_NWMO_Phase1_Feasibility\GIS\MXDs\Reporting\Env_Safety_Report\Wawa\Wawa Terrestrial Ecology.mxd



LEGEND

- Community
 - Main Road
 - Local Road
 - + Railway
 - Watercourse, Permanent
 - - - Watercourse, Intermittent
 - Water Area, Permanent
 - Treeless Area
 - Environmentally Sensitive Area
 - ANSI, Earth Science
 - Candidate ANSI, Earth Science
 - Candidate ANSI, Life Science
 - Provincial Park / Reserve
 - Caribou Migration Route
 - Continuous Coastal Caribou Habitat
 - Discontinuous Caribou Habitat
 - Wildlife Management Unit (32, 33, 34, 35)
 - Municipal Boundary (Municipality of Wawa)
 - ★ Earth or Life Science Site
- Wildlife and Forestry**
- Forest Research Area
 - Moose Aquatic Feeding Area
- Nesting**
- Heron
 - Raptor
- Wintering Area**
- Moose
 - Moose



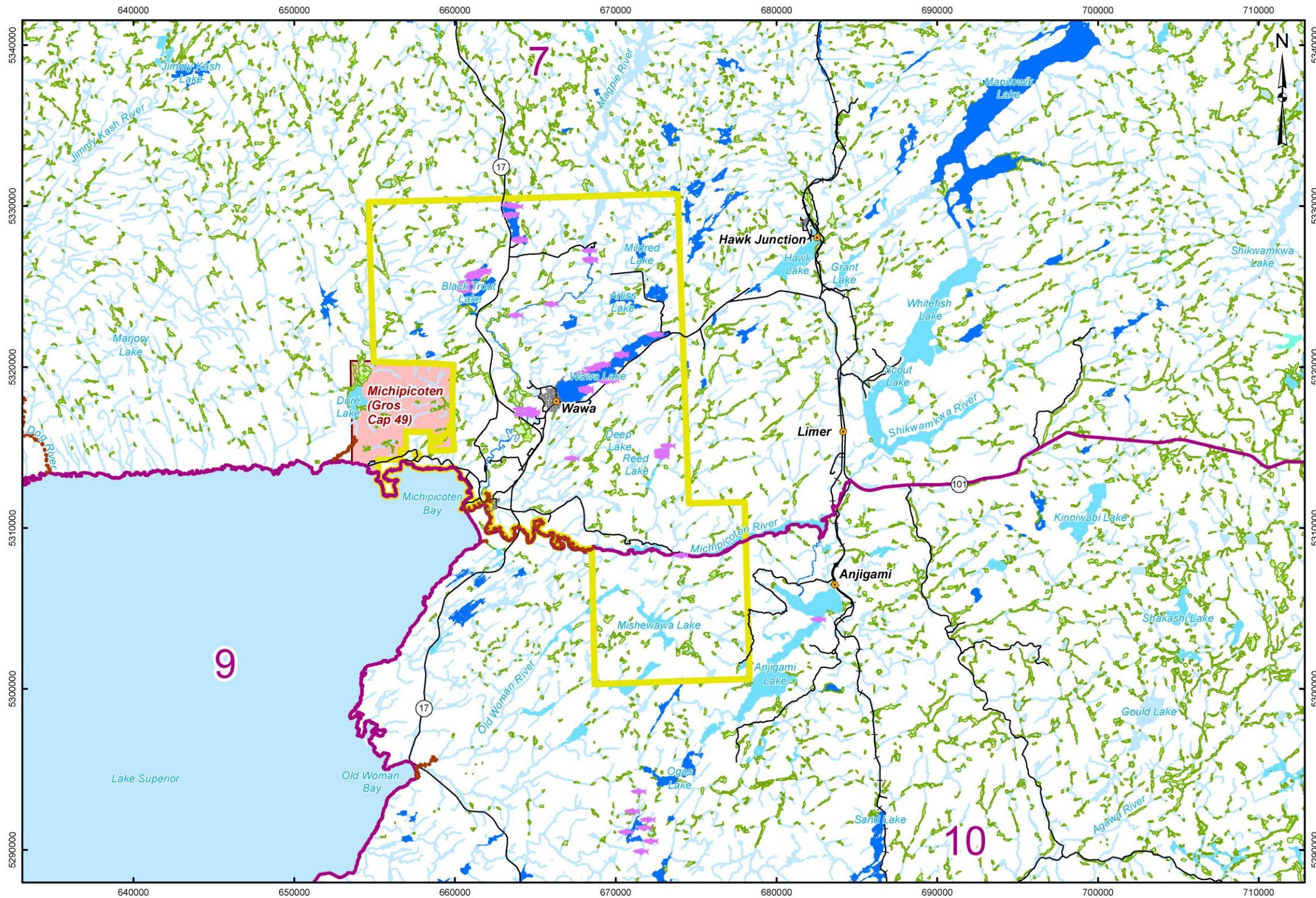
REFERENCE

Base Data - MNR LIO, obtained 2009-2012, CANMAP v2006.4
 ESA and Treeless Area - Municipality of Wawa, Official Plan, Schedule 'B', Natural Heritage Features, June 2010
 Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2009
 Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 16N



PROJECT		Environment Report Municipality of Wawa, Ontario	
TITLE		Wawa - Terrestrial Ecology	
Golder Associates Mississauga, Ontario	PROJECT NO.	12-1152-0026	SCALE AS SHOWN
	DESIGN	PRM 27 Jun. 2012	REV. 0.0
	CHECK	JH 7 Nov. 2013	FIGURE: 9
	REVIEW	GWS 7 Nov. 2013	

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LEGEND

- Community
- Main Road
- Local Road
- + Railway
- Watercourse
- Federal Land - Indian Reserve
- ▨ Fish Migration Route
- ▭ Fisheries Management Zone
- ▭ Municipal Boundary (Municipality of Wawa)

Fisheries and Wetlands

- ◆ Spawning Area
- Waterbody (unspecified)
- Cold
- Cool
- Warm

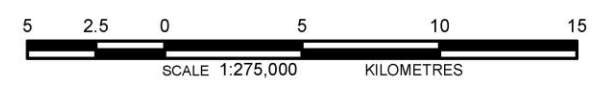
Natural Heritage


- Wetland



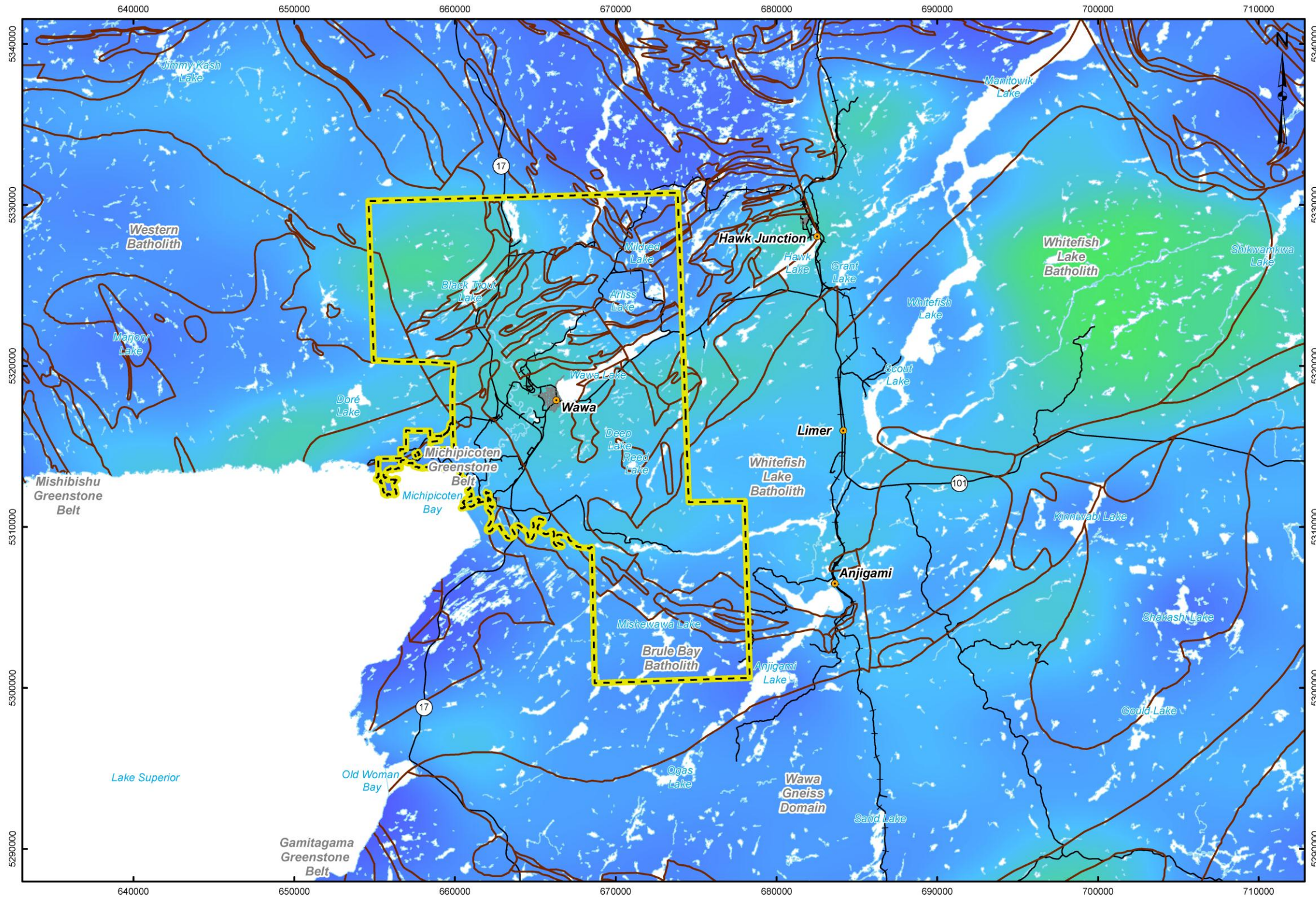
REFERENCE

Base Data - MNR LIO, obtained 2009-2012, CANMAP v2006.4
 Fisheries and Wetlands Maps - Algoma Forest FMU (2010) and White River (2008-2018)
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PROJECT		Environment Report Municipality of Wawa, Ontario	
TITLE		Wawa - Aquatic Ecology	
 Golder Associates Mississauga, Ontario	PROJECT NO.	12-1152-0026	SCALE AS SHOWN
	DESIGN	PRM 27 Jun. 2012	REV. 0.0
	GIS	PMJB 7 Nov. 2013	FIGURE: 10
	CHECK	JH 7 Nov. 2013	
REVIEW	GWS 7 Nov. 2013		

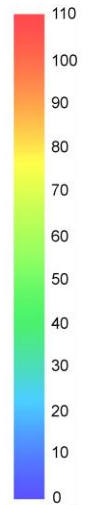
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LEGEND

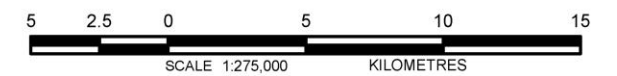
- Community
- Main Road
- Local Road
- Railway
- Water Area, Permanent
- Geological Contact
- Municipal Boundary (Municipality of Wawa)

Air Absorbed Radiation Levels (nGy/h)



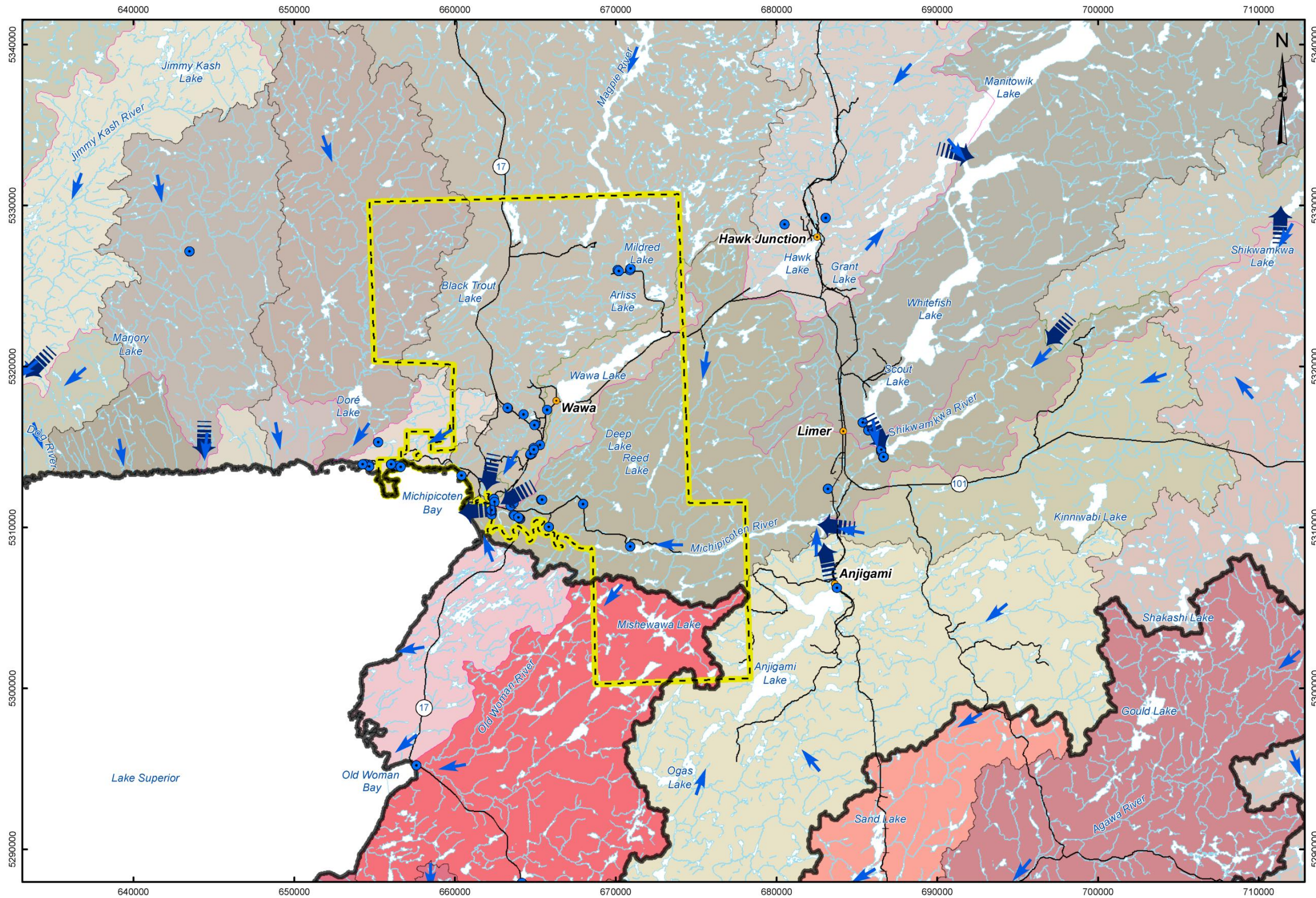
REFERENCE

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
 Produced by Golder Associates Ltd under licence from
 Ontario Ministry of Natural Resources, © Queens Printer 2009
 Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 16N



PROJECT		Environment Report Municipality of Wawa, Ontario	
TITLE		Wawa - Background Radiation Levels	
 Golder Associates Mississauga, Ontario	PROJECT NO.	12-1152-0026	SCALE AS SHOWN
	DESIGN	PRM 27 Jun. 2012	REV. 3.0
	GIS	PRM 7 Nov. 2013	FIGURE: 11
	CHECK	JH 7 Nov. 2013	
REVIEW	GWS 7 Nov. 2013		

G:\Projects\2012\12-1152-0026_NWMO_Phase1_GIS\MXDs\Reporting\Env_Safety_Report\Wawa\WawaSurfaceWater\DrainageAndWaterWells.mxd

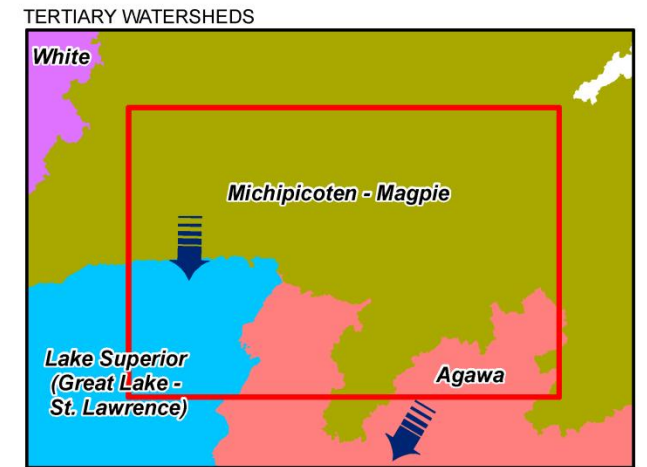


LEGEND

- Community
- MOE Well Location
- Main Road
- + Railway
- Watercourse, Permanent
- - - Watercourse, Intermittent
- Water Area, Permanent
- ➔ Surface Water Flow Direction
- ▬ Watershed Outflow Point

Drainage Divide


- Delineated by JDMA/MNR
- Delineated by JDMA
- Delineated by MNR
- ▭ Municipal Boundary (Municipality of Wawa)

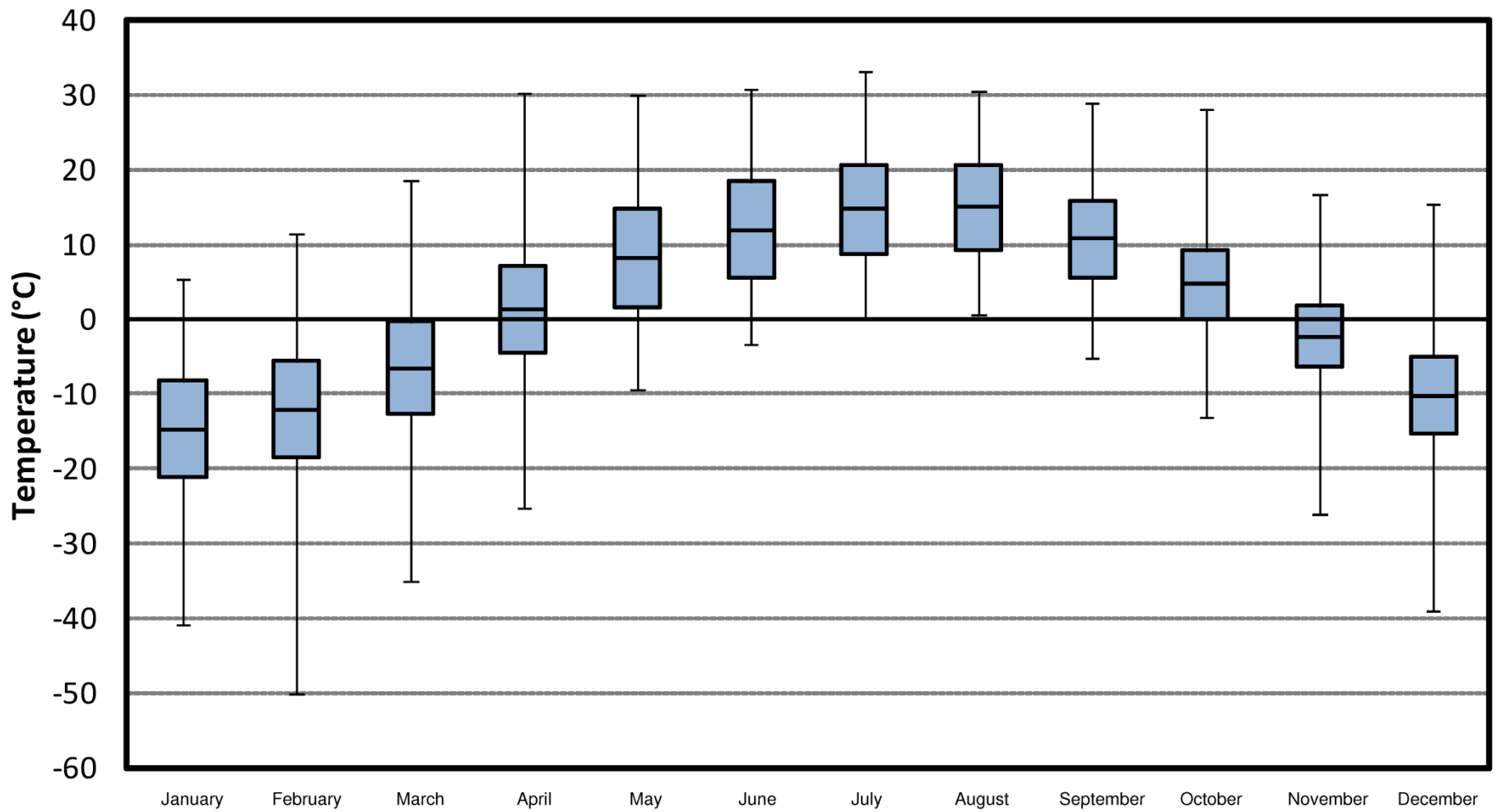


REFERENCE

Base Data - MNR LIO, obtained 2009-2012, CANMAP v2006.4
 Wells - Ministry of the Environment, 2010
 Watershed - LIO Quaternary watershed (updated by JDMA)
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 Ontario Ministry of Natural Resources, © Queens Printer 2012
 Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 16N



PROJECT		Environment Report Municipality of Wawa, Ontario	
TITLE		Wawa Surface Water Drainage and Water Wells	
 Golder Associates Mississauga, Ontario	PROJECT NO.	12-1152-0026	SCALE AS SHOWN
	DESIGN	PM 27 Jun. 2012	REV. 3.0
	CHECK	JH 7 Nov. 2013	FIGURE: 12
	REVIEW	GWS 7 Nov. 2013	




LEGEND

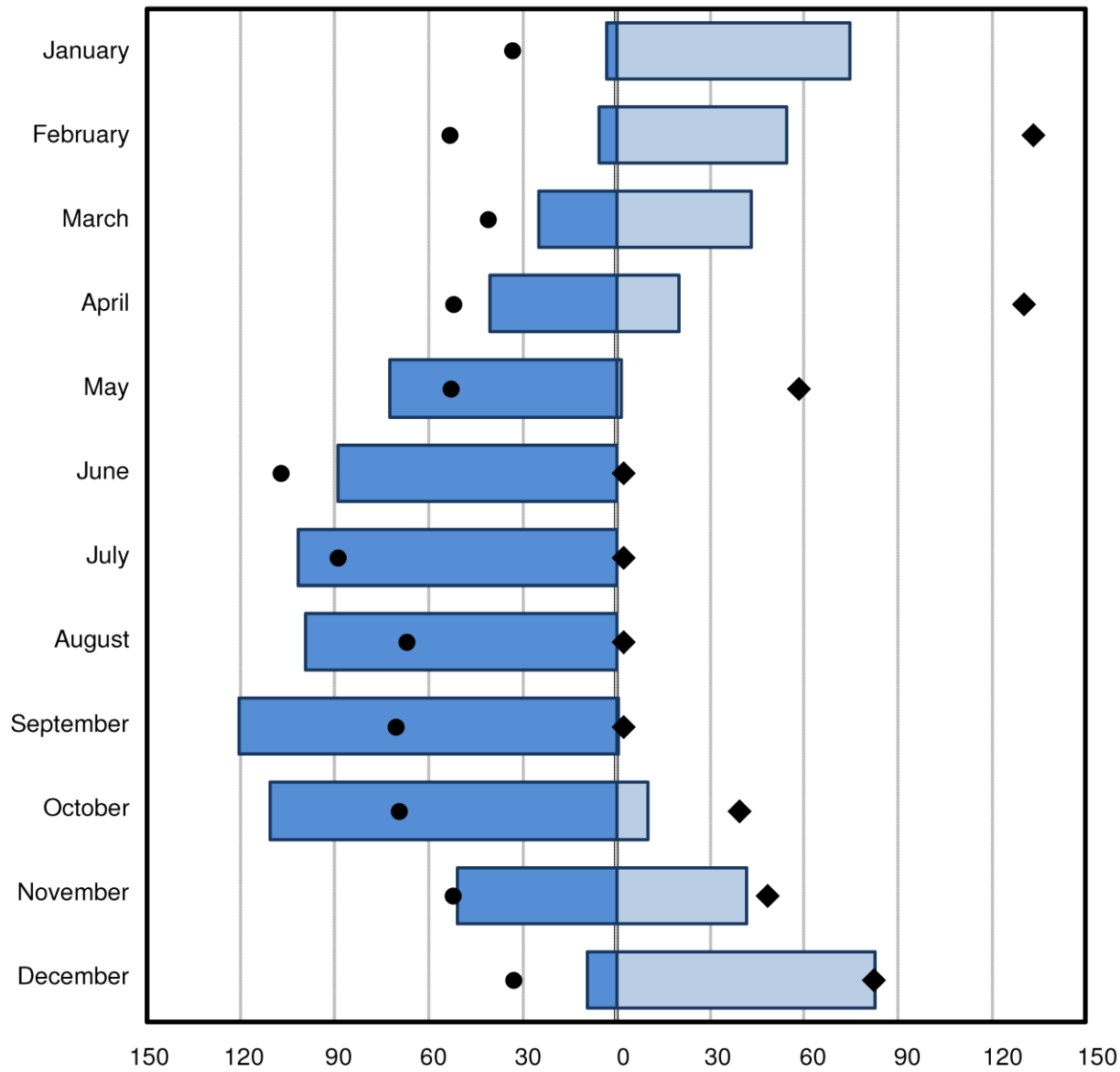
- Extreme Maximum (°C)
- Daily Maximum (°C)
- Daily Average (°C)
- Daily Minimum (°C)
- Extreme Minimum (°C)

DATA SOURCE

Environment Canada

PROJECT		Environment Report Township of Wawa, Ontario	
TITLE		Wawa 1971-2000 Temperature Data Summary	
 Golder Associates Mississauga, Ontario	PROJECT NO. 12-1152-0026	SCALE AS SHOWN	REV. 1.0
	DESIGN PRM 7 Jun. 2012	FIGURE: 13	
	GIS PRM 7 Nov. 2013		
	CHECK JH 7 Nov. 2013		
REVIEW GWS 7 Nov. 2013			

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



LEGEND

- Monthly Rainfall (mm eq.)
- Monthly Snowfall (mm eq.)
- Extreme Daily Rainfall (mm eq.)
- ◆ Extreme Daily snowfall (mm eq.)

DATA SOURCE

Environment Canada


PROJECT		Environment Report Township of Wawa, Ontario	
TITLE		Wawa 1971-2000 Precipitation Data Summary	
 Golder Associates Mississauga, Ontario	PROJECT NO.	12-1152-0026	SCALE AS SHOWN
	DESIGN	PRM 7 Jun. 2012	REV. 2.0
	GIS	PRM 7 Nov. 2013	
	CHECK	JH 7 Nov. 2013	
	REVIEW	GWS 7 Nov. 2013	

FIGURE: 14

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