NBMCA Integrated Watershed Management Strategy

Technical Background Report

Stantec

August 28, 2013

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1.0 Introduction

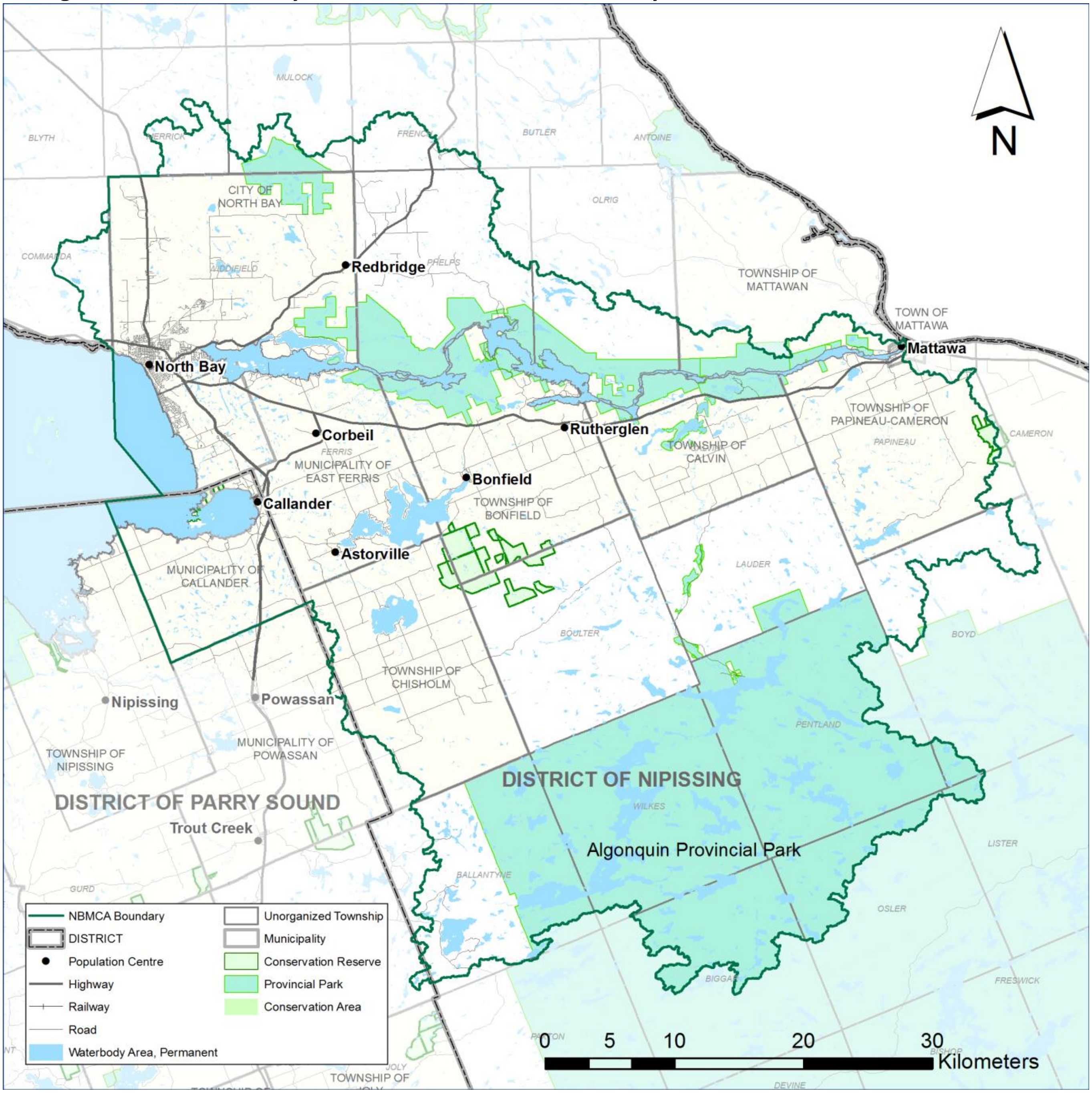
The North Bay-Mattawa Conservation Authority was formed in 1972 pursuant to Ontario's Conservation Authorities Act. Its core area of jurisdiction is founded on drainage systems as illustrated in Figure 1.1. The NBMCA is 1 of 36 Conservation Authorities in Ontario and 1 of 5 in Northern Ontario. As well as its core mandate, the NBMCA conducts sewage system inspections and approvals under the Ontario Building Code and coordinates municipal drinking water source protection under the Clean Water Act in an expanded area within Nipissing and Parry Sound Districts. Its core mandate is to establish and undertake, within the area over which it has jurisdiction, programs designed to further the conservation, restoration, development and management of natural resources other than gas, oil, coal and minerals. The NBMCA has various powers which it uses to fulfill its mandate and it works collaboratively with stakeholders and its member municipalities to identify and administer policies and to carry out programs. The NBMCA has 10 actively participating "member" municipalities plus another 15 unorganized townships which are mainly uninhabited.

The NBMCA's area of jurisdiction is defined as the watersheds of the Mattawa River and all lands flowing to Lake Nipissing within the City of North Bay and the Municipality of Callander. The Mattawa River is part of the Ottawa River drainage system and Lake Nipissing is part of the Great Lakes drainage system. The NBMCA area of jurisdiction has been divided into 20 subwatersheds for the purposes of Watershed Planning as defined in Figure 1.2 and Table 1.1.

1.1 Purpose

This Technical Background Report has been prepared to support an Integrated Watershed Management Strategy for the North Bay-Mattawa Conservation Authority. Background information has been summarized in this Technical Background Report and in a supporting atlas. An Integrated Watershed Management Strategy is a guidance document used to assess management needs at a full watershed scale and at a subwatershed scale. Watershed management needs are developed by exploring natural watershed features and characteristics; by identifying watershed synergies within the living environment; by understanding watershed demographic and economic trends; by assessing stakeholder interests; and by reviewing existing management frameworks to determine if water and resource features are known, used, appreciated and/or adequately protected. An Integrated Watershed Management Strategy not only helps the NBMCA to identify and prioritize its management opportunities but it has implications for all stakeholders including municipalities, agencies, the business community and the general public. Stakeholders share a common responsibility to cooperatively manage water and related resource features in fulfillment of riparian responsibilities shared by everyone.

Figure 1.1 North Bay-Mattawa Conservation Authority Area of Jurisdiction



This is the second overarching Watershed Planning exercise that the North Bay-Mattawa Conservation Authority has embarked on to guide its programs and management activities. The first Watershed Plan was completed in the early 1980's. The first watershed planning initiative was a desk top exercise that assembled and evaluated resource management information in a comprehensive manner. That planning process did not include public participation or seek to gather feedback from stakeholders. That plan was also supported by a Background Watershed

Figure 1.2 North Bay-Mattawa Conservation Authority Subwatershed Planning Areas

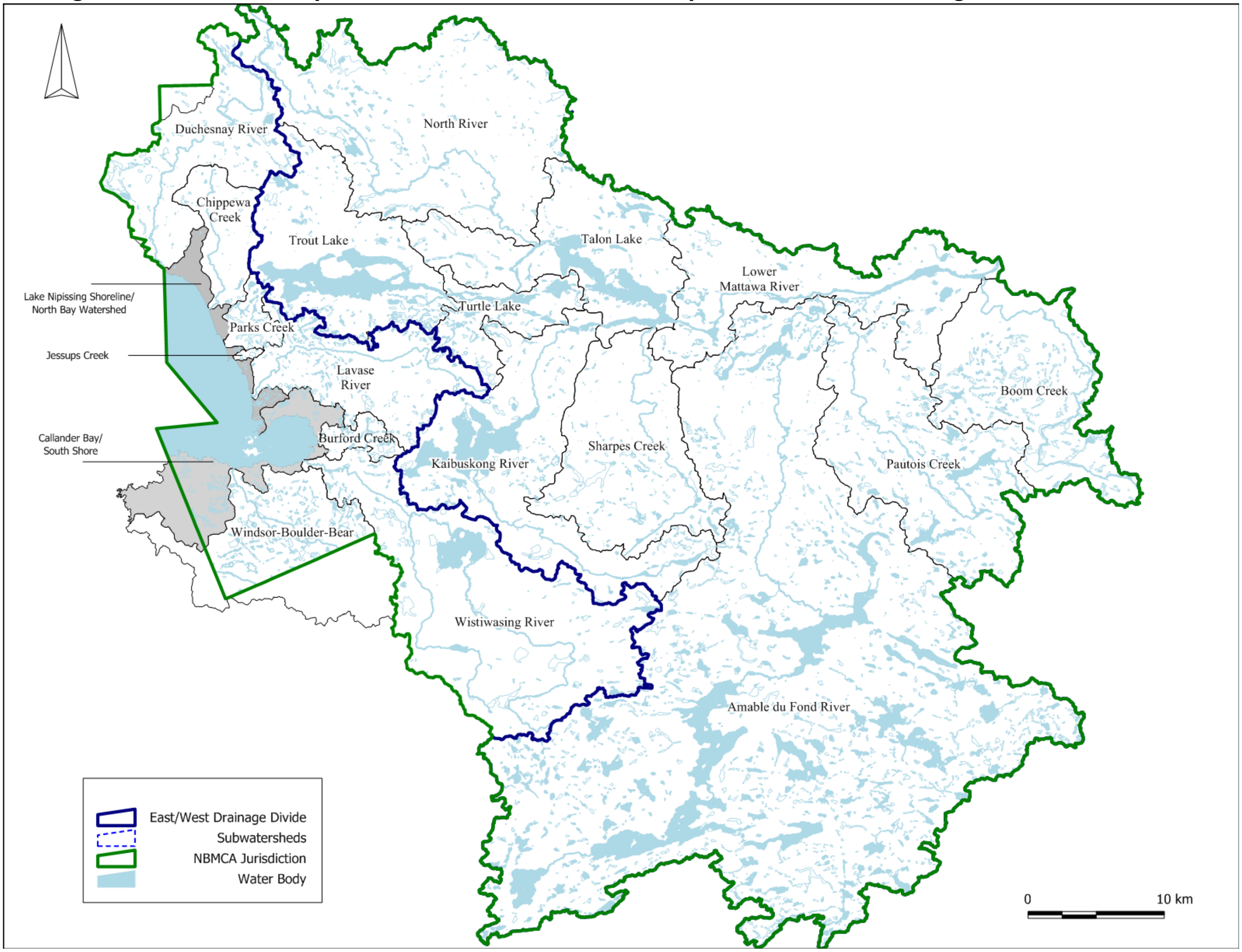


Table 1.1 Subwatershed Planning Units

#	Name	Km^2	#	Name	Km^2
1	Duchesnay Creek Watershed	101.65	11	North River Watershed	247.77
2	Chippewa Creek Watershed	39.90	12	Trout Lake Watershed	124.90
3	Parks Creek Watershed	13.84	13	Turtle Lake Watershed	51.85
4	Jessups Creek Watershed	1.31	14	Kaibuskong River Watershed	181.88
5	La Vase River Watershed	87.20	15	Lake Talon Watershed	130.09
6	Lake Nipissing Shoreline/North Bay	17.50	16	Sharpes Creek Watershed	136.88
7	Windsor/Boulder/Bear Cr Watershed	170.45	17	Amable du Fond River Watershed	964.41
8	Burford Creek Watershed	11.86	18	Pautois Creek Watershed	175.78
9	Callander Bay/South Shore	23.17	19	Boom Creek Watershed	137.86
10	Wistiwasing River Watershed	234.38	20	Lower Mattawa River Watershed	143.39

Inventory Document. That original inventory is now outdated in most categories as new data and updated studies are available. Data collection and research is a continuous process being undertaken for the study area by the Conservation Authority, its partners and through academic or applied government research. This document updates the status and character of the NBMCA watershed as a whole and focuses on subwatersheds in the final section.

1.2 Areas of Focus and New Research

This report mainly consolidates information from reports, studies and data sources of the NBMCA, regional agencies and senior levels of government. Applied reports and studies are referenced throughout this work and full references are provided in the bibliography at the end of the report. Stantec has worked within time and budget constraints to update as much information as possible. Efforts have focused on subject areas most pertinent to the NBMCA core mandate. Greater effort has been placed on updating and interpreting subject areas such as hydrologic and water balance features or integrating new resource characterization and management philosophies espoused through Ontario's Provincial Policy Statements. In some cases Stantec has generated watershed specific statistics and in other instances general regional trends have been used when precise watershed information has been difficult to extract.

Within its scope of work Stantec has focused on two new areas of information to facilitate subwatershed stress assessment. To develop an understanding of potential future subwatershed management risks Stantec has examined regional climate change trends (found in Section 7) as well as regional growth and land use patterns (found in Section 12). Trends in NBMCA climate have been developed by examining climate records from the North Bay Airport Climatic Station. Regional variations have been determined by comparing North Bay Airport climatic data to other selected climatic stations. Severe weather risks have been interpreted from local climatic data and from provincial and national reports. Growth and land use change assessment has been developed by reviewing municipal planning documents, obtaining input from municipal planning staff and applying information outlined in demographic and economic sections of this report. In this latter effort Stantec interviewed staff from each member municipalities to obtain local insight and interpretations of recent land use changes and trends including changes in vegetative cover observed over a 20 year period.

1.3 Data Quality and Availability

Increasingly data collection and interpretation relies on provincial GIS data bases and application of remote sensing techniques. Data quality in provincial GIS data bases are difficult to assess and generally data has declining accuracy with declining scale. Data interpretation in remote areas is often crude due to extensive forest cover and lack of accessibility for ground trothing. Stantec has attempted to consider data quality and to weight interpretations based on perceived reliability of the information provided.

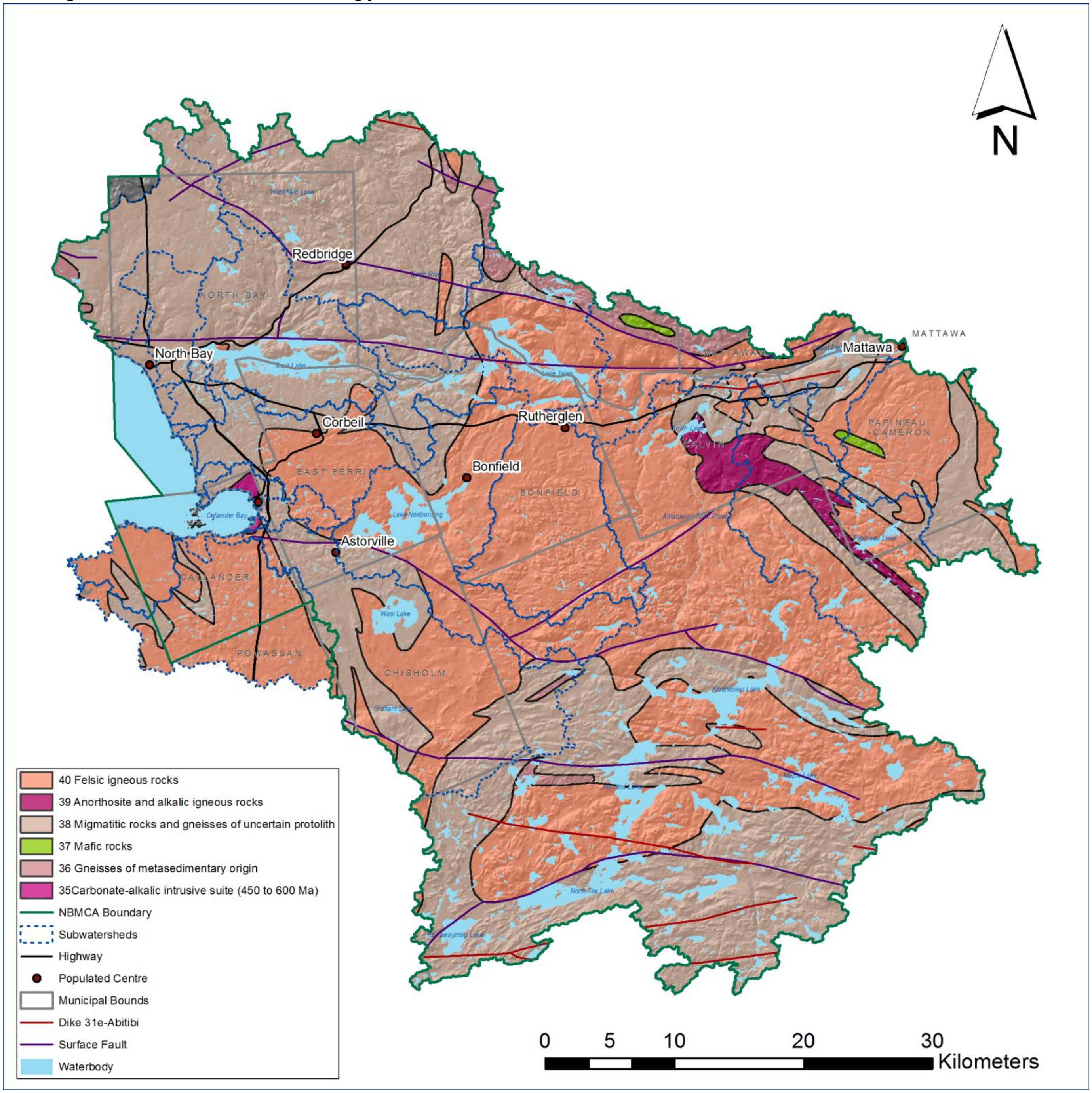
In preparing this background report Stantec has reviewed and synthesized a substantial amount of information. Data has been sourced from many different public sources as well as from academic research. Data gathering within the NBMCA was largely initiated in the early 1970's; it peaked in the mid to late 1980's and has declined in recent years. Monitoring and data interpretation by senior governments continues to be scaled back as funding constraints impact public program delivery. This has caused the NBMCA to reestablish historic monitoring or to initiate new monitoring to meet new objectives. Overall, however, data availability is on the decline. Declining data availability has made the interpretation of recent trends more difficult and some midterm trends are obscure due to data gaps. Data gaps or issues with data quality are evaluated at the end of each section.

2.0 Bedrock Geology

Original bedrock geology field reconnaissance and mapping was completed by Harding (1944) for the Mattawa-Olrig area and by Lumbers (1971) for the western end of the watershed. Bedrock geology was assessed in the first Watershed Plan Inventory Document (1982) and has also been examined in the NBMCA Groundwater Study Report (2006) and in the Drinking Water Source Protection - Watershed Characterization Assessment Report (2008). The understanding of processes that resulted in bedrock formation and deformation has also recently been advanced through a number of tectonic, metamorphic and geochronological studies. Government and academic research are knitting together a comprehensive understanding of the age, structure and characteristics of the bedrock underlying the area of study. The Bedrock Geology of the NBMCA, shown in Figure 2.1, illustrates that the NBMCA is mainly underlain by Precambrian migmatitic rocks and gneisses that are cut by felsic igneous intrusive formations.

The NBMCA's watershed is situated within the Central Gneiss Belt of Grenville Province of Canadian Shield. The Grenville is the youngest of the Canadian Shield Provinces (Holmdem and Dickin 1994). Within the study area bedrock ages range between 0.98 and 2.69 Ga (billion years). Rocks older than 1.2 Ga have pre-Grenvillian origins but, because of metamorphism during the Grenville period, formations are considered part of the Grenville Province. The fact that bedrock older than the Grenville period is considered part of this province is controversial (Moore 1986). Prior to 1.2 Ga the igneous formations of Laurentia (the tectonic plate that existed when the Grenville Province was forming) formed, eroded, reconsolidated as sedimentary rock, were thrusts into mountain ranges in a continental collision and became intruded with new igneous formation. When the Grenville period ended (between 1.08 and

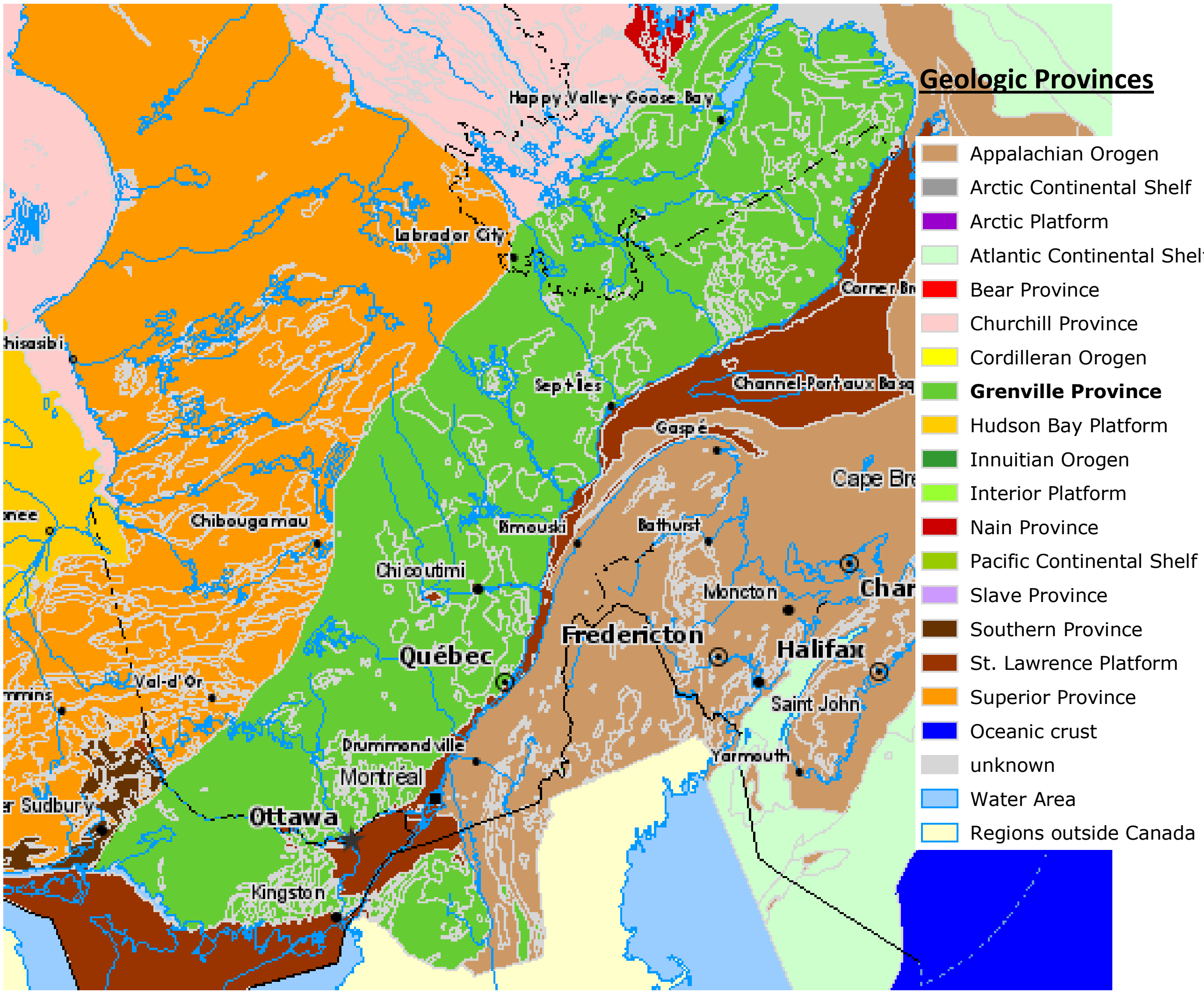
Figure 2.1 Bedrock Geology of the NBMCA



Source: NBMCA Groundwater Report, 2006

0.98 Ga) an intense thermal event deformed these formations to imprint a Grenvillian signature. In Canada the Grenville Province extends from Labrador to Lake Huron and continues under younger deposits for 1000's of kilometers into the US and breaks surface in Texas (Hynes and Rivers 2010). The location of the Grenville Province in eastern Canada is illustrated in Figure 2.2.

Figure 2.2 Location of the Grenville Province Geologic Region in Eastern Canada

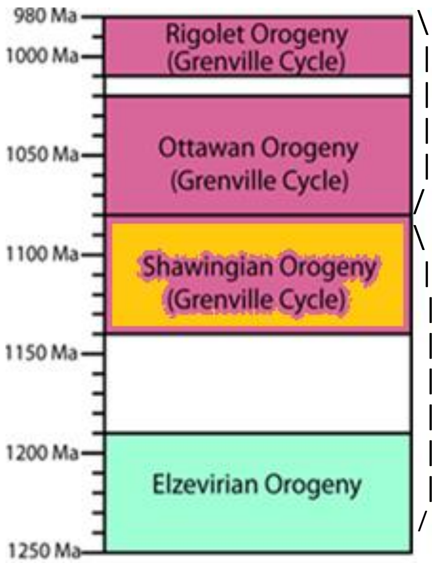


Source: Atlas of Canada, Natural Resource Canada, www.nrcan.gc.ca (2012)

2.1 Grenville Formation

The Grenville epoch includes two and possibly three mountain building episodes that are thought to have started as early as 1.2 billion years ago (the date of the start of the Grenville is currently under debate). The tectonically active southeastern edge of Laurentia, preceding the continental collision, formed arc islands in the central Grenville Province (in Quebec) and implanted plutons (granitoid batholiths) within the study area (Hynes and Rivers 2010). Batholiths, identified as Powassan, Bonfield and Mulock (shown in Figure 2.5) have been dated by Davidson at 1.24 Ga (Davidson, 2001). During the ensuing Grenvillian period two or three orogenic cycles are interpreted to have occurred – the most recent interpretation places the first (Shawingian Orogeny) as preceding the Grenville orogenic period (Hynes and Rivers 2010). These mountain building cycles are depicted in Figure 2.3.

Figure 2.3 Orogenic Cycles/Periods that led to the Formation of the Grenville Province



Continent to Continent convergence causing tectonic delamination and stacking in a Himalayan style orogeny culminating in a major thermal event causing Grenville overprinting

Continent to Arc convergence causing arc island formations in the middle Grenville Province and which formed deep plutons in the Central Gneiss Belt

Source: Adapted from Grenville Orogeny, Wikipedia, September 2012

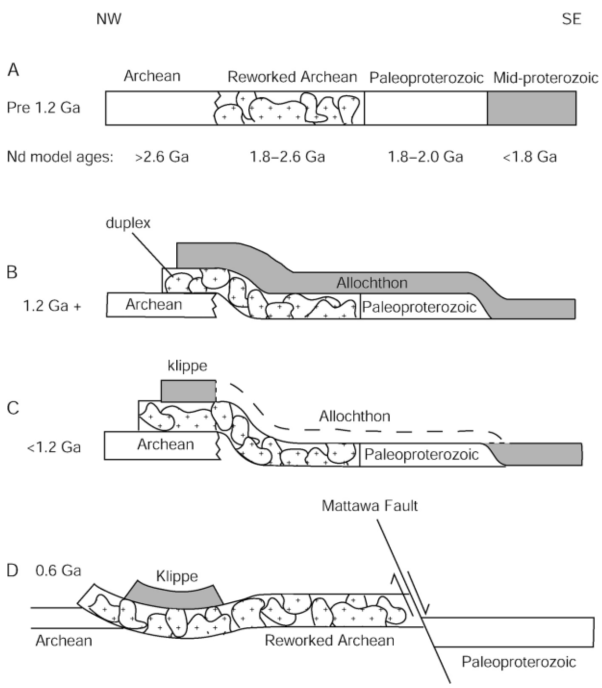
The Grenville period began when two drifting continents collided. A continent, thought to be Amazonia (now South America), converged on Laurentia (now the Superior craton) as earlier as 1.2 Ga. The collision may not have been fully observed until 1.09 Ga (Hynes and Rivers, 2010). The collision, which lasted for up to 100 million years, created crustal compression, thickening and delamination. By 1.0 Ga an impressive mountain range resembling the Himalayas had formed (Hynes and Rivers, 2010). At the height of the collision study area bedrock was embedded deep within the mountainous formations. High pressure deformations observed in southern portions of the study area could only occur at depth exceeding 60 kilometers (interpreted from mapping from Hynes and Rivers, 2010). During the remaining Precambrian era, the thickened continental crust collapsed and mountainous terrain eroded to a peneplain.

At a regional scale Herrell et al. (2004) has studied the sequences of events that led to geologic formations near Mattawa. He examined bedrock formations between Kipawa and Papineau/Cameron Township. His observations have implications for the entire NBMCA area.

Herrell depicts the orderly pre-collision formations of Laurentia in Profile“A” of Figure 2.4 (below) which shows the oldest formations (2.6 Ga) to the northwest and the youngest formations (< 1.8 Ga) to the southeast. Reworked Archean and Paleoproterozoic formations create a *“Parautochthon”* once displaced in Profile “B”. This term is used in the Figure 2.5 inset map to signify that formations only moved a slight distance from where they were formed.

In Profile “B” at 1.2 Ga, when the continental collision is assumed to be underway, the Mid-Proterozoic plate detaches and is thrust over older formations. The Mid-Proterozoic formation, shown as an *"Allochthon"* in Profile "B", signifies that this plate was thrust a considerable distance (more than 100 kilometers) from where it formed. As noted above, thrusting also slightly repositioned the deeper Parautochthon. The current Grenville Front, located north of the study area, marks the final extent of Grenvillian plate advancement at the edge of the (Archean) Southern Province. Archean rock may extend further under the Parautochthon than shown in Figure 2.4 and may exist under the study area at depth (Hynes and Rivers 2010).

Figure 2.4 Theorized Formation of Bedrock Terranes near Mattawa

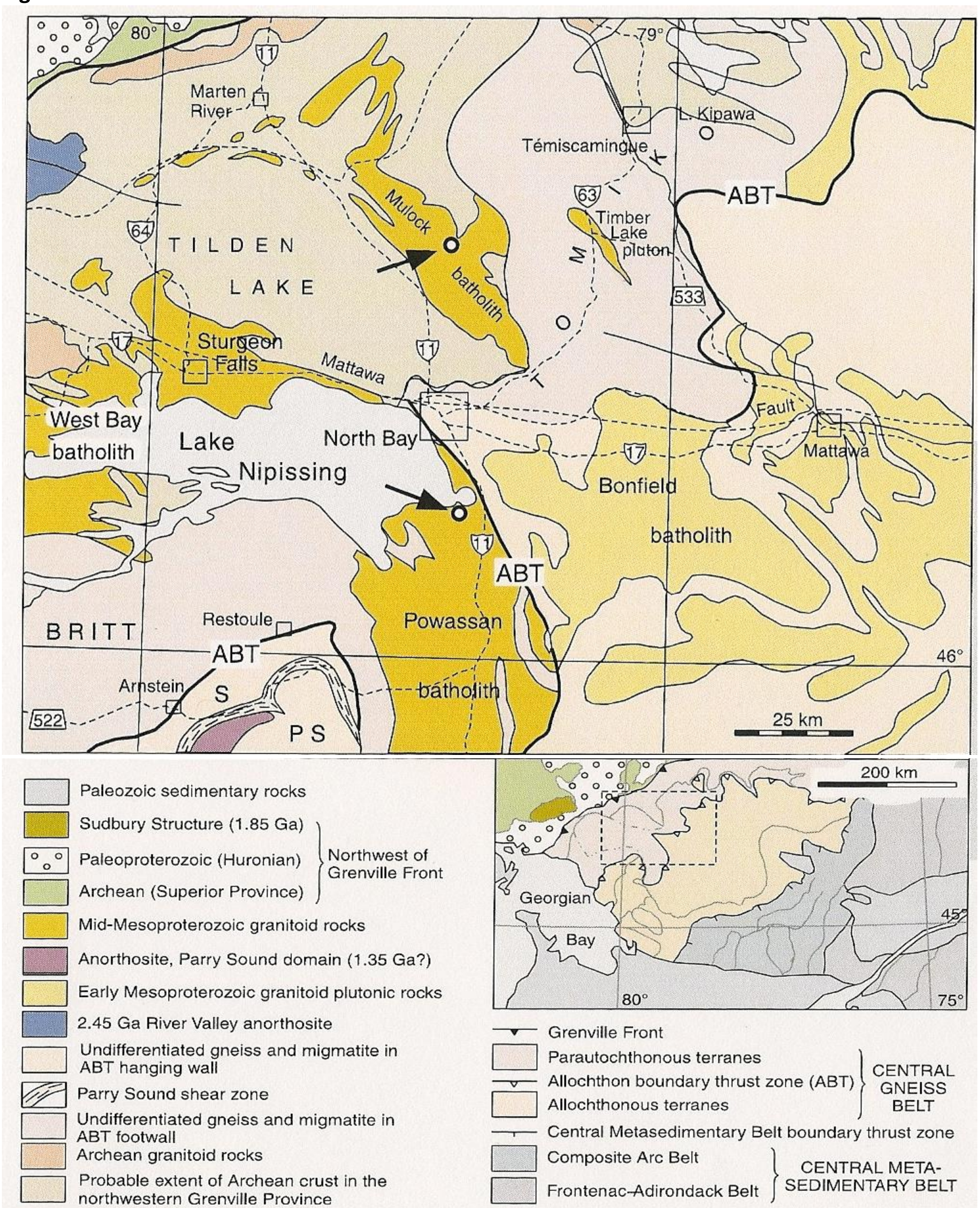


Herrell depicts the re-exposure of the Parautochthon in Profile "C". The Parautochthon/ Allochthon boundary is referred to as the Allochthon Boundary Thrust (ABT) zone which is shown in Figure 2.5. Herrell interprets the ABT boundary further south than what is shown in Figure 2.5 and work continues to identify its exact location through the NBMCA watershed.

"D" represents the formation of the Ottawa-Bonnechere Graben about 600 million years ago. The fault is shown at the reworked Archean and Paleoproterozoic boundary which Herrell speculates may have reopened to create the fault. The positioning of the ABT line in Figure 2.5 does not support this theory.

Major faulting created the Mattawa lowlands at the start of the Cambrian era approximately 680 million years ago (NBMCA 1982). This lowland is part of the larger Ottawa-Bonnechere Graben which extends down the Ottawa valley to the St. Lawrence Rift systems as illustrated in Figure 2.6. A fault branch extends north of Mattawa. At the time of faulting it is thought that coincidental volcanic eruptions occurred near major fault lines to emplace magmatic pipe formations (Callander Bay, Manitou Island, Burritt Island and Iron Island in Lake Nipissing). During this period lamprophyre (kimberlite) dykes and sills were also intruded into Precambrian formations within the study area (Ferguson and Currie, 1972). Lamprophyre dykes and sills can be observed throughout the NBMCA's area of jurisdiction in rock cuts and are more common in the vicinity Callander Bay. Cambrian pipes are of interest for mineral exploration due to the presences of rare earth minerals including columbium, (also called niobium) and uranium (Lumbers, 1971) and may have a high phosphorous content (Ferguson, 1971).

Figure 2.5 Bedrock Features within the NBMCA Watershed



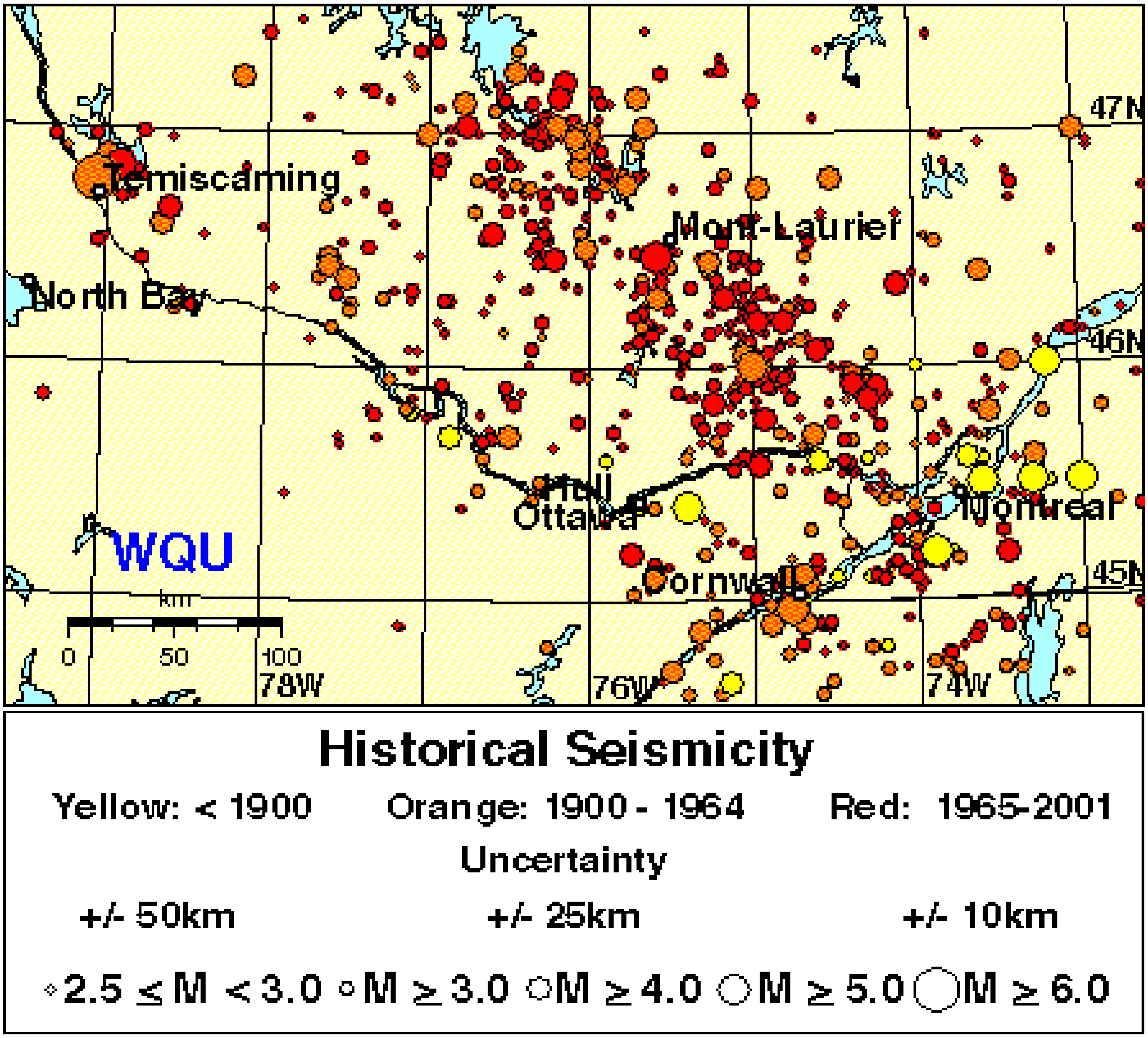
From: Davidson (2001)

Figure 2.6 Ottawa-Bonnechere Graben

Map Source: Wikipedia

Seismic reflection mapping reveals that the upper crust of the NBMCA is approximately 40 km thick and that major faults and boundaries between major bedrock formations extend fully through the mantle (Mereu, Wang and Kuhn, 1986). The area experiences regular minor seismic activity, mainly near fault lines as the mantle continues to readjusts from glacial depression (see Figure 2.7). Large seismic events are rare within the region. A seismic monitoring station exists in Eldee, Ontario. Isostatic rebound is further discussed in the Quaternary Geology section below.

Figure 2.7 Historical Seismic Activity in Eastern Ontario and Southwestern Quebec



Source: Earthquakes Canada, NRC, Background of Earthquakes in Eastern Canada.

2.2 Significance of Bedrock Geology and Data Gaps

Within the NBMCA highly deformed mountain roots exposed by a billion years of erosion now form the watershed's foundation. Metamorphic alteration has made this foundation structurally sound, highly resistant to erosion and, unless fractured, a barrier to water movement. This bedrock foundation is responsible for abundant lakes and wetlands that dominate the landscape. Bedrock is separated into uplands and lowlands by major faulting. Bedrock, not concealed by surficial deposits, lakes or wetland, is exposed as rounded knobs and sheets. Where concealed the bedrock surface is difficult to predict with certainty. Mineralization and economic exploitation are further explored in subsequent sections.

Processes that led to watershed bedrock formations continue to be studied through academic research. The refinement of the understanding of the geologic history of the area can assist with the understanding of watershed features and the movement of water. The chemical composition of some geologic features may also help to explain trophic status levels of lakes and streams within the area.

3.0 Quaternary Geology

Quaternary geology has principally been investigated by Harrison (1971) and supplemented by the Northern Ontario Engineering Terrain Study 101: North Bay Area (Gartner 1980) and Northern Ontario Engineering Terrain Study 102: Mattawa Area (Gartner and VanDine 1980). Quaternary geology has been interpreted within the NBMCA Watershed Plan Background Inventory completed (1982) as well as the NBMCA Ground Water Study (2006) and Drinking Water Source Protection NBMCA Watershed Characterization Report (2008). Work has also been carried out by the NBMCA through the Draft Parks Creek Environmental Assessment Management Report (Totten Sims Hubicki 1990) to examine rebound rates and to identify final outlet connections between Lake Nipissing and Trout Lake during the Holocene.

As documented in past studies, surficial features within the NBMCA's area of jurisdiction are extremely young compared to the underlying bedrock, having formed during the final stages of the Pleistocene (glacial period) and Holocene (post glacial) Epochs. Overburden thicknesses range from nearly absent (> 1 m thickness) near Lake Nipissing to thick deposits of sand and gravel (more than 100 m thick) in glacial fluvial deposits (Waterloo Hydrogeologics Inc 2006). Surficial geology has largely been shaped by the Laurentide ice sheet as it vacated the study area approximately 11,000 years ago and in many cases (especially in the Mattawa lowlands) features have been altered by subsequent fluvial and lacustrine erosional and depositional forces (NBMCA 1982).

3.1 Quaternary Processes that Shaped Watershed Features

The last continental ice mass to cover the northeastern portion of the northern North America continent, known as the Laurentide Ice Sheet, is estimated to have attained a thickness of 4,000 meters over Hudson Bay at its glacial maximum 20,000 years ago (Marshall, et al. 2000). The massive weight depressed the underlying bedrock by hundreds of meters, obliterated all former surficial unconsolidated formations and abraded the bedrock surface. As the continental glacier melted and retreated, the NBMCA watershed was exposed between 10,000 and 11,000 years ago and caused the underlying bedrock mantle to rebound. The disappearance of glacial ice from the study area left behind unconsolidated ice contact and glaciofluvial features (Harrison 1971). As the study area was exposed, melt water trapped at the glacial margins found new outlets through the Mattawa lowlands. The Mattawa lowland corridor served as the main outlet for the upper Great Lakes for many millennia (NBMCA 1982). The rebounding land surface over the past 11,000 years has significantly influenced the evolution of the Great Lakes and affected regional drainage patterns. Post-glacial isostatic adjustment, albeit at a slowing rate, continues to this day.

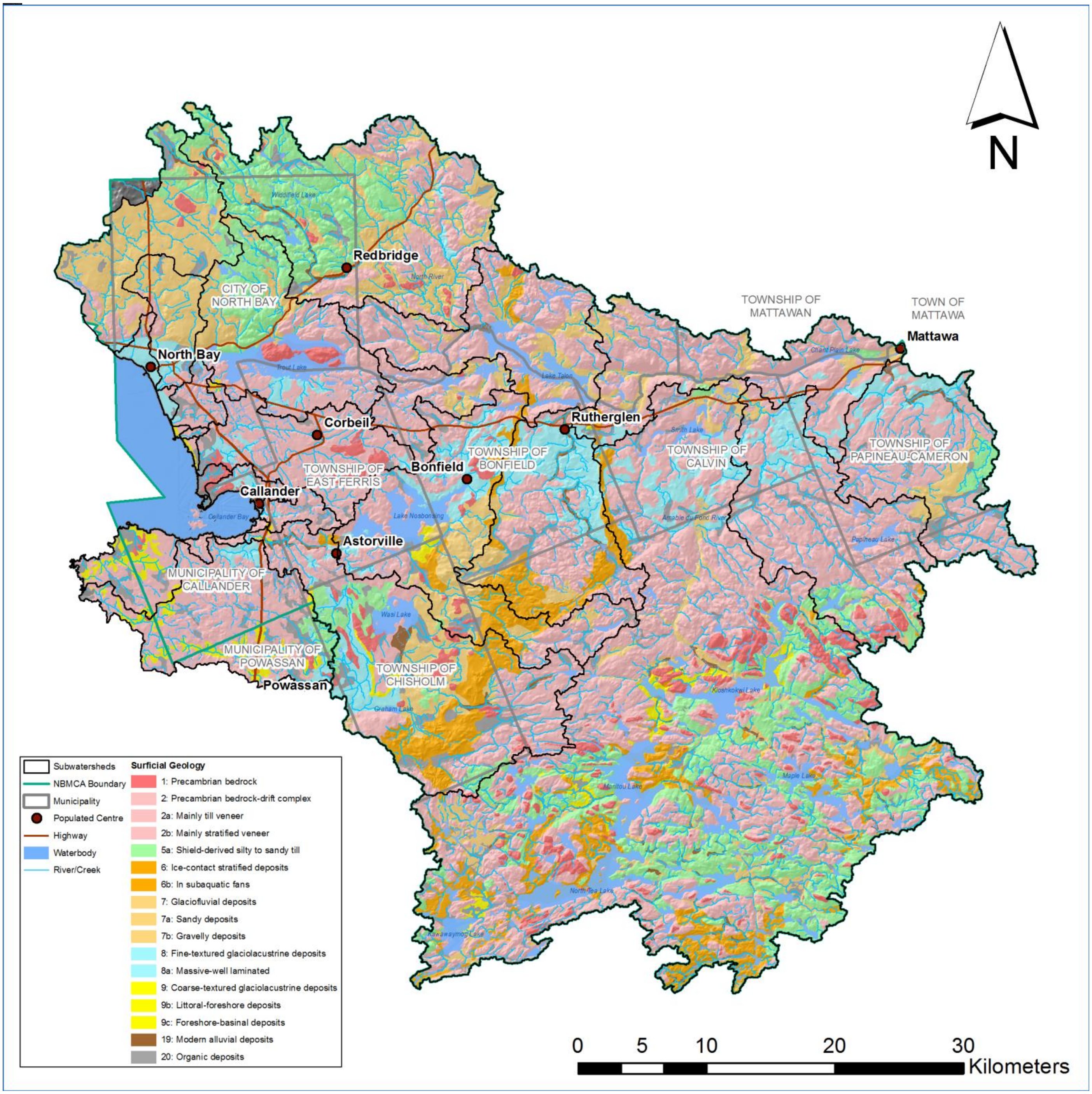
As glacial ice ablated to expose the study area, ponded melt water at the glacial front flooded the study area from the west and discharged through a series of channels that opened in succession to the east (NBMCA 1982). Each successive channel lowered the upper Great Lakes in stages and released significant quantities of melt water which drained through the Mattawa corridor. During these events, the study area was flooded and/or scoured by significant drainage systems. Early landscapes evolved rapidly as melt water drained away and ground elevations rebounded. The surface of the Mattawa lowland was at or below current ocean levels when ice finally vacated the area (NBMCA 1982). Since glaciation the Mattawa lowlands have ascended more than 200 meters. Differential uplift cut off Great Lakes drainage through the North Bay-Mattawa corridor about 5,000 years ago and subsequently has influenced regional drainage (NBMCA 1990). Rebound currently averages about 4 cm per decade across the study area (Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data 2001).

Quaternary deposits within the NBMCA's area of jurisdiction are illustrated in Figure 3.1. Mapping indicates the NBMCA is dominated by bedrock/bedrock with shallow drift. Bedrock is exposed as knobs and sheets which are sometimes covered with a thin veneer of glacial rubble. Undulating bedrock is often interspersed with open water and organic deposits trapped in dips and valleys. Glacial till, in some cases thickened into moraines by late glacial advances, can be found in upland areas and underlie surficial formations in the Mattawa lowlands. Linear north-south trending glacial fluvial features, of considerable thickness in places and in other areas pinching out or absent from post glacial erosion, cut across the watershed at several locations. Linear glaciofluvial formations extend over a much broader area demarking a network of river channels that drained through and from ice fields during ablation. Glacial fluvial deposits originally formed obstructions that were down cut by drainage through the Mattawa lowlands. These formation and down cutting can explaining early Great Lakes water level phases and are also the likely source of alluvial deposit near Mattawa. Glacial lacustrine deposits mainly within the Mattawa lowlands were deposited in post glacial lakes. For brief periods lacustrine wave action worked the western edges of intact glacial fluvial formations to create near shore beach ridges and settled out finer material at depth. Quaternary deposits have and continue to influence surface drainage patterns and thick glaciofluvial formations harbour significant aggregate reserves and overburden aquifers. Surficial deposits within the study area have had a large influence on watershed settlement and land use patterns.

3.2 Glaciofluvial Features

Glaciofluvial esker/kame and deltaic features form thick overburden deposits within the study area. North-south trending esker/kame complexes, formed by rivers that drained from the ice fields, display ice contact feature such as kettles and kettle lakes. The most prominent

Figure 3.1 Surficial Geology of the NBMCA



complexes are known as the Rutherglen Esker/Kame Complex in Bonfield which connects to the Genesee Esker/Kame Complex through Boulter and Chisholm. North of the Almaguin Ridge in Chisholm and Boulter thick sand deposits suggests that drainage from the ice fields were interrupted by the underlying ridge causing deposition. On the opposite Mattawa scarp deposits are largely absent suggesting a zone of scouring by rivers flowing quickly from the ice fields or deposits have been washed away by post glacial drainage. Deltaic deposits above and below the North Bay escarpment suggest that a large river once discharged to a swollen glacial lake at the glacial margin during early exposure of the Mattawa lowlands. Overburden thickness in mapped portions of the NBMCA is illustrated in Figure 3.2 and is further discussed in the Groundwater section.

3.3 Glaciolacustrine Features

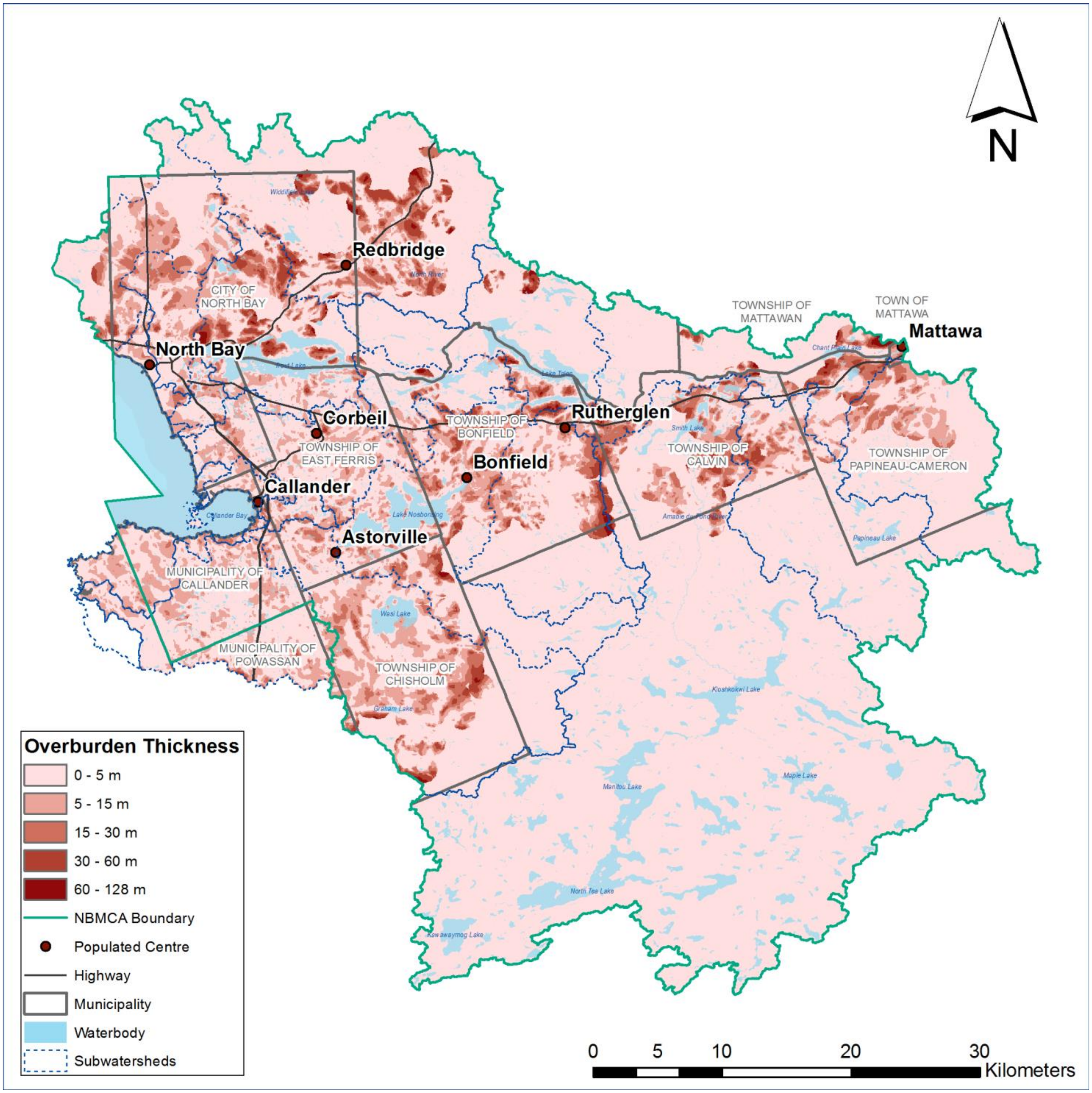
Glaciolacustrine deposits, formed at the bottom of post glacial lakes, are mainly found in the Mattawa lowlands. They are characteristically underlain by layered fine sands, silts, and clays. Early lake formations are evident by beach ridges along the western fringes of esker/kames within the lowlands. Corresponding beach formations follow the face of escarpments to the west of North Bay (Karrow, 2004). These waterlines mark the shores of prominent water bodies that lingered after glaciation, many are Great Lake shorelines. Water bodies or embayments acted as detention basins to settle out finer materials eroded from surrounding deposits. Finer glacial lacustrine deposits have some of the highest agricultural ranking in the region. Glaciolacustrine deposits are the most agriculturally productive lands within the study area.

3.4 Post-Glacial Souring

During a 6,000 year period after glaciation a major river system drained the northern Great Lakes through the Mattawa lowlands (NBMCA, 1982). This period is complex and experienced both extreme high and low flow conditions, a rapidly changing regional climate, rapidly rising land surface elevations and evolving control points which significantly affected water levels and drainage characteristics (Lewis et al. 2005). Significant events include both significant floods from upstream breaches to a period of significant low water (Lewis et al. 2005). Numerous abandoned channels and related drainage features can be observed within the Mattawa lowlands.

Applied research to identify, date and connect drainage features to geologic periods and events is generally lacking. It is evident from existing research that, as land emerged from the Great Lakes, it was scoured by a flowing river system that cut through overburden deposits and carried materials downstream. In Mattawa scoured materials were trapped in what Lumbers describes as an incised valley (Mattawa fault). Alluvial deposits under Mattawa are estimated to extend as much as 35 m below the ground surface and are described as highly permeable sands and gravels. These deposits have been evaluated to contain considerable groundwater reserves. The Town of Mattawa draws their municipal drinking water from this high yielding aquifer as further discussed in the Groundwater section.

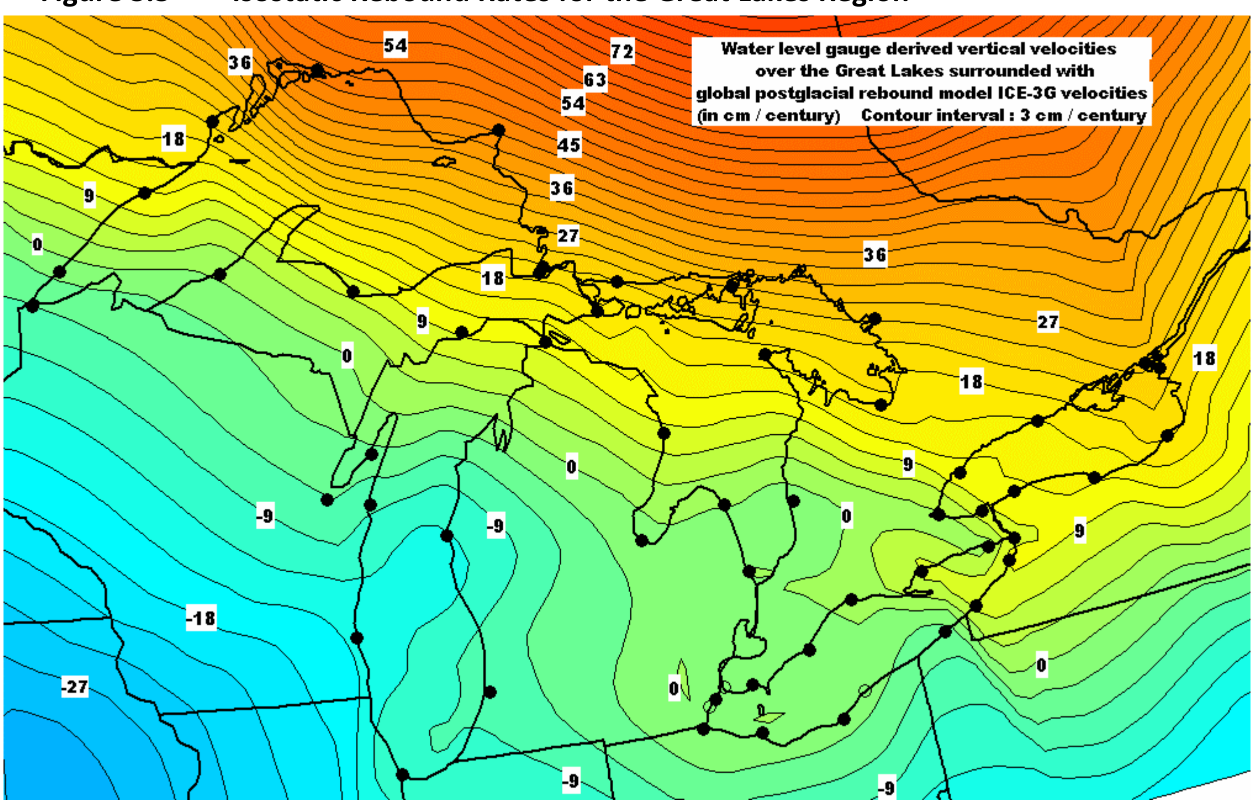
Figure 3.2 Overburden Thickness



3.5 Isostatic Rebound and Variability

As the land continues to respond to glacial deweighting, isostatic readjustment variability across the watershed continues to affect drainage. Figure 3.3 illustrated the current variation in uplift rates across the Great Lakes basin. Uplift within the NBMCA average approximately 40 cm/century and ranges between 36 cm/century near the southwestern watershed boundary to 45 cm/century near Mattawa (Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data 2001). The earth's surface is differentially rolling in a southwest direction causing lakes northern and eastern shores to recede (most noticeable on lakes such as Lake Nipissing) and lakes southern and western shores to drown (most noticeable on Lake Talon – the upper Mattawa River mouth into Lake Talon is drowning). The affects are more pronounced on long narrow water systems such as Trout/Turtle Lake or Lake Talon. Streams flowing east or north such as the Mattawa River or the Amable du Fond are gradually flattening with time and streams flowing west or south are subtly steepening. The impacts are imperceptible on a human time scale. In the longer term watershed boundaries may be affected and subtle impacts to geologic process can be realized. For example the Lake Nipissing shoreline in North Bay is emerging out of Lake Nipissing at a rate of approximately 5 cm/100 years which is affecting beach dynamics over time (NBMCA 1990).

Figure 3.3 Isostatic Rebound Rates for the Great Lakes Region



Source: Coordinating Committee on Great Lakes Basic Hydraulic and Hydrologic Data, Natural Resources Canada, 2001.

3.6 Erosion Potential and Septic Capability

Glacial fluvial deposits can be highly erosive if destabilized and may require lengthy recovery periods. Depot Creek cuts through glacial fluvial deposits south of Lake Nosbonsing. This watercourse was significantly affected by Hurricane Hazel in 1954 and creek erosion contributed significant sedimentation in Lake Nosbonsing (reported by Ward Smith, former Chair of the NBMCA). In the 1980's the NBMCA installed natural channel deflectors at major stream bank erosion sites in an attempt to help with stabilization (the success of this work is unknown). Another example includes Hogan's Creek, a small stream that flows into One Mile Bay of Trout Lake. In the early 1980's this creek was washed out and a small delta formed in One Mile Bay. Also severe erosion at the north end of the Hamlet of Bonfield has occurred on several occasions from heavy rain/failed beaver dams. Active stream bank erosion in the upper Chippewa Creek watershed, in deltaic deposits north of the North Bay Airport, destabilize by runway vegetation removal, continues to load sediment to this stream during high flows. Bluffs along the Lake Nipissing shoreline west of the North Bay waterfront also displays signs of historic erosion which may have contributed significant quantities of sediment to the North Bay shoreline and created the dynamic beach environment. The Lake Nipissing deposits have deltaic and glacial fluvial origins but have been reworked and are mapped as glacial lacustrine deposits.

Surficial features have been interpreted for their septic capabilities in the Northern Ontario Engineering Geology Terrain Study on the North Bay Area map sheet (Map 5044). This mapping indicates where raised beds or extensive engineering support is required to establish a properly functioning tile field. Septic capability mapping is not available for the entire watershed.

3.7 Quaternary Significance and Data Gaps

Glacial deposits and post glacial reworking of those deposits within the study area have greatly influenced localized drainage patterns and often define subwatershed boundaries. These features are significant to groundwater recharge and discharge, they have resource extraction value and their distribution has influenced settlement and land use patterns. Areas with thicker overburden contain aquifers which are further assessed in the Groundwater section. Glaciofluvial deposits including sorted sands and gravels have been a source of construction aggregates and fill and continue to harbour sand and aggregate reserves that may be exploited in the future. Glaciolacustrine deposits, mainly in the Mattawa lowlands contain finer grained mineral content that creates highly valued agricultural lands.

The NBMCAs rich quaternary history has not only left behind surficial deposits that have resource and economic value but has left watershed features that may be of natural or scientific interest. The NBMCA harbours surficial features have the potential for broad interpretations that may explain northern Great Lake's developments during their formative years. Within the Mattawa lowlands abandoned basins, outlets, channels and dry waterfall features are present without proper demarcation or interpretation of their significance. The location of major controlling sills, the scouring of eskers in the Lake Talon area and isostatic rebound history can be interpreted to explain water level changes in Great Lakes basins that are currently listed as unknown in the scientific literature.

Waterways through the Mattawa lowlands also have a human prehistoric context. Archaeological evidence suggests that Lake Talon was a significant occupational area at late stages in Great Lakes drainage through the Mattawa lowlands. Rivers flowing through the Mattawa lowland may well have been favoured as a prehistoric water transportation and trade corridor that lingered for thousands of years after Great Lakes drainage ended.

4.0 Soil

Soil formations within the NBMCA's area of jurisdiction have previously been interpreted in the last Watershed Plan Background Inventory (1982). In 1986 a series of Soil Maps for the area was released by the Ontario Institute of Pedology which covers the central and northern portions of the watershed. Detailed maps are available online from Agricultural Canada at:

http://sis.agr.gc.ca/cansis/publications/surveys/on/on54/index.html

Soil mapping for the study area identifies unit soil types, soil surface texture, soil classification, soil materials (and geologic origin), drainage moisture regime, slope, stoniness or rockiness and agricultural capability.

Soil patterns within the study area largely reflect the underlying parent materials which have evolved into soil types based on slope, drainage regimes and type of vegetative cover. In upland areas soils have developed over a 12,000 year period while soil development in the Mattawa lowlands are over a much shorter period. The classification of different soil textures within the NBMCA are presented in Figure 4.1. The use of soil texture information to calibrate watershed and subwatershed water balance characteristics is discussed below.

4.1 General Soil Orders

4.1.1 Podsols

Based on soil mapping for the area, the dominant soil order in the region is ortho humo-ferric podsolic soils (Ontario Institute of Pedology, 1986). These soils have generally developed in upland, well drained environments under hardwood, mixed and coniferous forests where sufficient overburden is present. These soils have largely been mapped as fine sandy loams to moderately coarse sandy loams. Soils are derived from metamorphic parent bedrocks and glacial sediments and have slightly acidic characteristics derived from their mineralogy (Soils of Canada, University of Saskatchewan, sourced online in 2012). The acidity of the upper soil is increased by the decomposition of coniferous leaf cover. Podsolic soils typically have a dark nutritionally stripped organic A horizon formed by the breakdown of leaves and plant materials. Acidity chemically leaches minerals and nutrients from upper layers. Minerals such as aluminum and iron leach into the B horizon. Aluminum forms a thin whitish B horizon and iron oxidizes beneath to form a reddish brown layer that is a distinguishing podsolic feature from other soil types. Oxidization of iron gradually depletes with depth and soil colour fades from ochre to yellowish orange to yellow.

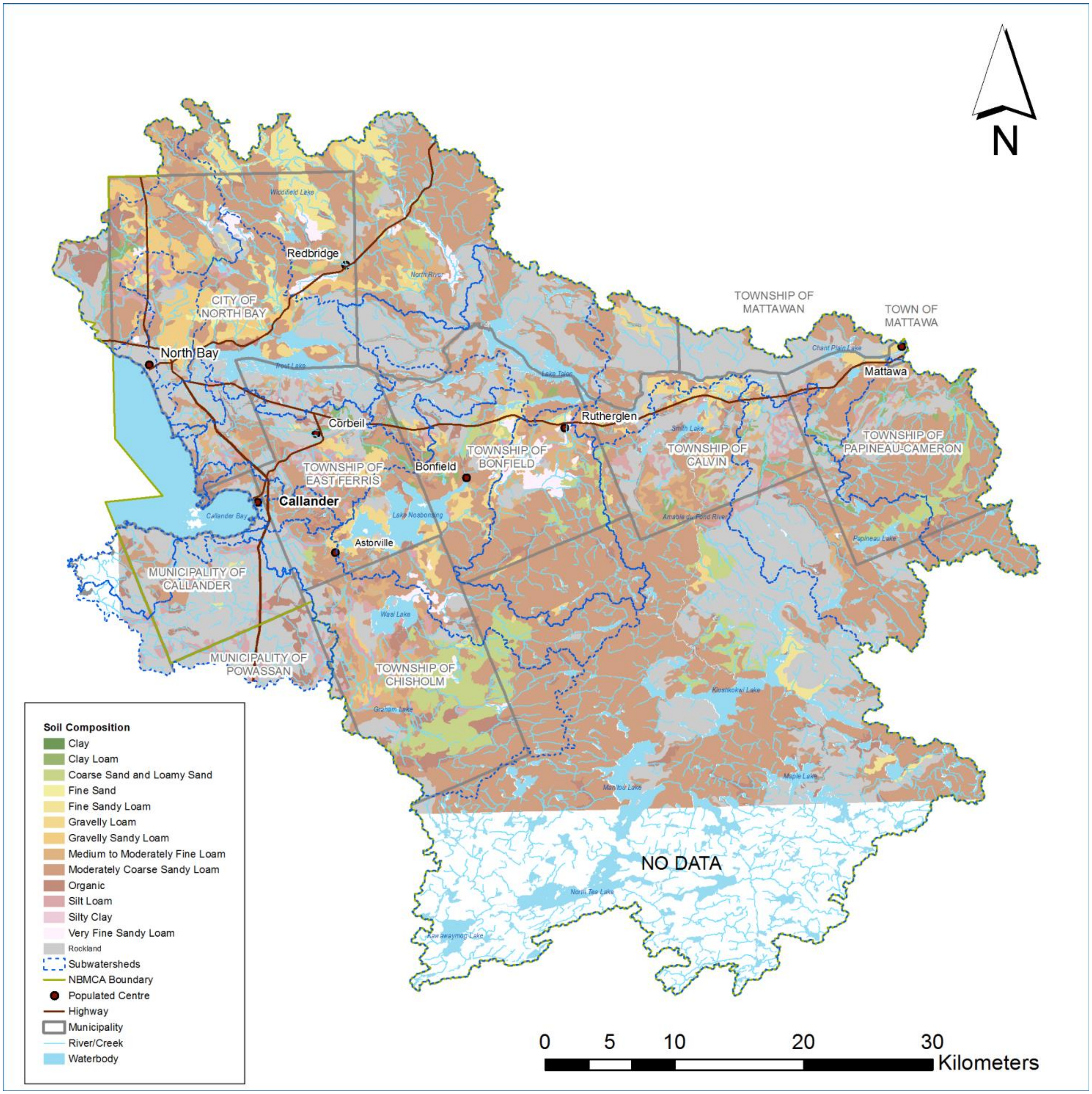
4.1.2 Gleysols

In imperfectly drained areas gleysolic soils have developed, often under mixed (neutral pH) and coniferous (slightly acidic pH) forest cover. While gleysolic soils can have a wide variety of soil textures, they tend to have a higher silt and clay content compared to upland soils. Saturation results from imperfect surface drainage or a seasonally high water table which interferes with soil development (Soils of Canada, 2012). Organic material can build up to create a thicker A layer. Soil oxygen levels are depleted by soil saturation to create temporary anaerobic or anoxic conditions. Anaerobic conditions can transform metals such as iron and (to a lesser degree) manganese. Iron is reduced and takes on a greyish blue hue. Reduced iron is also mobile and can concentrate within the profile and re-oxidize to produce reddish or brown mottling. Gleysols are often found and can be interpreted as a transitional soil between upland podsolic and lowland organic soil orders.

4.1.3 Luvisols

Luvisolic soils have developed in relatively flat lacustrine basin deposits mainly in the Mattawa lowlands under a deciduous forest. Luvisols have higher silt, clay and loam content and display excellent soil moisture retention properties that minimize the leaching of minerals and nutrients. These soils are generally mapped as silty loams (Soils of Canada, 2012). A diagnostic feature of luvisolic soils is a textural contrast between the A and the B horizon – with the Ae horizon having less clay than the Bt horizon. Luvisolic soils, primarily grey in colour, can have a high base cation content of calcium or magnesium. Because of high base cation content these soils typically have relatively neutral pH. Due to high moisture and nutrient retention properties Luvisols have the highest agricultural rankings in the region.

Figure 4.1 Soils within the NBMCA



Source: Ontario Institute of Pedology, Soils of North Bay Area (4 Maps), 1986.

4.1.4 Organics

Organic soils are common within the NBMCA and have formed in a continuously saturated environment. Organic soils are commonly made up of peat, bog or fen soils, or muck depending on the vegetative cover and availability of mineral material (Soils of Canada, 2012). Organic soils usually accumulate in stagnant ponded water environments, often starting as small water bodies which fill in over time. Stagnant water creates anaerobic or anoxic conditions. The decomposition of organic matter contributed annually from wetland plants slows or ceases altogether as microorganisms are unable to function in anoxic conditions, and unaltered or partially decomposed organic matter accumulates into a rich organic mat. Organic accumulations build over time and gradually fill the entire water surface area and begin to support woody vegetation growth. Organic deposits have had more time to develop and infill in upland areas.

4.2 Areas with Limited Soils

Portions of the NBMCA have limited soil cover and are mapped as Rockland. Predominantly bedrock areas either escaped glacial deposition or have had unconsolidated materials swept away by post glacial water action. Soil formation within bedrock areas is at rudimentary stages. Weathered minerals, sediment and organic matter gradually build up in cracks, depressions and gullies. Vegetation such as lichen and moss begin to take hold and eventually small ground shrubs such as blueberry can eke out an existence. Larger forms of vegetation that try to establish usually succumb to drought on exposed bedrock knobs due to a lack of groundwater.

4.3 Soil Erosion

Soil erosion is a naturally occurring process facilitated by wind and water (OMAFRA, 2003). Agricultural soil erosion can be a slow process that continues relatively unnoticed or it may occur at an alarming rate causing serious loss of topsoil and agricultural productivity. Soil erosion deters water quality and affect aquatic habitat caused by siltation. OMAFRA rates sand, sandy loam and loam textured soils as less erodible than silt, very fine sand and certain clay textured soils. Erosion susceptibility is also affected by slope gradient and length as well as rainfall intensity duration and frequency.

Soil erosion caused by wind and water is not a significant issue within the NBMCA as most of the NBMCA watershed remains forested and annual soil exposure is minimal. Most agriculturally productive areas in the region practice no tillage crop production or run livestock operations. Stream bank erosion has been identified as an issue within in the Graham Creek subwatershed in Chisholm Township. Stream bank erosion was caused by inadequate stabilization of stream banks after agricultural drainage improvements. Flow velocities and duration in Graham Creek occasionally exceed critical levels for the predominantly sand and silt soil groups that line its banks (Wistiwasing River Management Study, 1986). The current status of Graham Creek erosion and siltation is unknown.

Generally the largest exposure to soil erosion within the NBMCA is from construction activity. The NBMCA strictly regulates this activity through their Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulations.

4.4 Significance of Soil Formations and Gaps

Soils have been ranked based on their agriculture capabilities. Luvisols generally have the highest agricultural rankings followed by gleysols and then podsols which are often limited by sandiness or stoniness and which tend to leach nutrients more rapidly due to acidity. Organic and bedrock areas have limited capabilities for agriculture. A large portion of the settlement area was originally deforested and farmed but many areas (usually with podsolic soils) were abandoned due to poor soil nutrient retention which affected productivity after only a short period of use (Singer, 2002). Peat is extracted on a limited basis and used by contractors to make top soil.

Soil texture mapping can be used to interpret water balance information for watersheds. Soils have varying capacities to retain and supply moisture to plants and forest cover. Soils with good moisture holding capacities are less likely to develop soil moisture deficits at the warmest times of the year. Soil depth is also important as vegetation can seek deeper soil moisture when deficits are stressing vegetation. Water balance characteristics for the NBMCA are further examined in sections on Water Quantity and Climate Change.

It is noted that a correlation is observed between subwatersheds with the significant presence of podsolic soils under mature forest cover and the trophic status of water bodies. Cold water streams and oligotrophic water bodies are most often associated with watersheds that have such features. Areas with extensive podsolic soils may have an inherent ability to attenuate phosphorous, which is limited in the environment in general. Higher iron/aluminum content in podsols may facilitate phosphorous retention in the upper soils mantle which becomes available and is readily used by vegetation. It is noted that phosphorous retention would be effective to trap nutrients at the surface of the soil from decomposing organic material and atmospheric outfall but would not be very effective to attenuate septic nutrients which are deep within the soil mantle.

Soil mapping (1986) for the southern watershed areas, mainly in Algonquin Park, is not available.

5.0 Groundwater and Hydrogeology

NBMCA groundwater characterization has been completed within the NBMCA Groundwater Study (Waterloo Hydrologic Inc., 2006) and important supplementary information has been provided through Source Water Protection analysis of drinking water sources (Waters

Environmental Geoscience, various reports, 2008 – 2012). Of the three municipal drinking water supplies within the NBMCA only Mattawa depends on a groundwater source. Approximately 78.5% of the NBMCA's population is dependent on municipal water supplies for their domestic requirements and 21.5% rely on private sources. Approximately 87.1% of the NBMCA's total population derives their supply from surface water sources and 12.9% rely on groundwater supplies. Groundwater remains the dominant and primary source of drinking water within rural areas of the NBMCA. As well as its importance to humans, groundwater is also essential to the environment as it act to balance water demands within the hydrosphere and the biosphere when rain and snow melt are unavailable.

Waterloo Hydrogeologic assessed groundwater within the NBMCA by examining selected provincial Water Well Information System (WWIS) records to develop regional cross-section profiles. The WWIS primarily contains records for wells that source water from bedrock and sufficient information for dug wells needed for regional overburden aquifer characterization was unavailable. There are more than 4,800 WWIS well records for the NBMCA's area of jurisdiction. Overburden aquifer characteristics in Mattawa and Powassan are revealed in reports that examine municipal drinking water systems.

Aquifer characterization has also been provided in Source Water Protection Tech Memos and Assessment Documents. Private well clusters in Corbeil, Astorville, Bonfield and Callander/Derland have been assessed in a recently released draft Pilot Study Report (Waters, 2012). It is noted that assessed communities mainly use bedrock aquifers as a source of water. Stantec has also obtained overburden aquifer characterization information from Marsh Drive Landfill Leachate Monitoring Reports. General groundwater characteristics for Northern Ontario have been reported by Singer, S. N. and Cheng, C. K.*, An Assessment of the Groundwater Resources of Northern Ontario: Areas Draining into Hudson Bay, James Bay and Upper Ottawa Rivers*, Environmental Monitoring and Reporting Branch, Ministry of the Environment, 2002.

Ground water quality and long term groundwater level information are monitored by the NBMCA through the Provincial Groundwater Monitoring Network. The NBMCA began participating in this program in 2003. Groundwater levels are monitored at 6 well locations and groundwater quality is currently monitored at 4 well locations within the NBMCA. All of the above information is further discussed in following subsections.

5.1 Regional Groundwater Flow Regimes

Groundwater and regional flow regimes occur in two geologically distinct environments within the NBMCA. Groundwater exists within and moves through unconsolidated surficial overburden deposits which are high variability depending on the thickness and composition of surficial deposits present. General characterization of surficial aquifers is not available. Site specific characteristics can be interpreted for individual sites. Groundwater also exists and moves through interconnected bedrock fracture zones within the upper bedrock mantle. Bedrock within the NBMCA generally has low permeability and water movement is restricted to narrow ranges of variability. General bedrock aquifer characterization, as determined from regional well records, is mainly limited to settled areas.

Records within the MOE Water Well Information System for wells drilled in the NBMCA suggest that groundwater level elevations range from 404 meters above sea level (masl) in the highlands, to 120 masl near Lake Nipissing and Mattawa. Generally, the water table surface mirrors surface topography and groundwater is interpreted to flow from the highlands in the north and south, to the Mattawa River and eventually to the Ottawa River, or to Lake Nipissing (WHI, 2008).

5.2 Regional Aquifers

5.2.1 Surficial and Overburden Aquifers

As illustrated previously in Figure 3.2, overburden thickness varies considerably across the regional landscape. The NBMCA has large areas where less than a meter of overburden overlies bedrock. The NBMCA has limited areas with more than 100 m of overburden overlies bedrock (WHI, 2008). Overburden thickness and material composition can have a large influence over the occurrence of and capacity of NBMCA surface aquifers. However quantification and risk assessment for shallow groundwater aquifers within the NBMCA, which directly influence annual hydrologic cycles and regional flow regimes, have not been completed.

Regional surficial groundwater flow regimes within the NBMCA can be conceptualized as shallow groundwater flow systems marked by many small, localized aquifers. Surficial aquifers in unconsolidated overburden deposits are highly variable and discontinuous or absent where only a veneer of overburden exists. Thick glacial deposits (sandy gravel. gravelly sand, sand, silty sand) are relatively infrequent and form isolated aquifers within the NBMCA. Harrison (1972) identifies highly permeable sand and gravel deposits in the vicinity of Town of Mattawa as the largest source of untapped groundwater in the North Bay-Mattawa region. Municipal water supplies in Powassan (outside of the study area) and the Town of Mattawa rely on overburden aquifers suggesting that overburden aquifers have local significance.

The NBMCA Groundwater Study observed that NBMCA overburden wells are primarily located within kames, eskers or glacial outwash sand and gravel deposits. Larger regional shallow aquifers have the capacity to supply high water yields. Singer, 2002 observed that the geometric mean of the specific capacity of overburden wells in the upper Ottawa and Moose basins was 5.1 L/min/m.

Overburden aquifer information can be derived from municipal reports. Overburden aquifers beneath the Town of Mattawa (in an alluvial formation) and near the Town of Powassan (in a Glaciolacustrine formation) supply municipal water and are profiled in detail in Drinking Water Source Protection background studies. An overburden aquifer at the closed Marsh Drive Landfill near the North Bay Airport has been examined in detail in Annual Reports for this landfill site. These overburden aquifers are profiled in the following sections as case examples to reveal local characteristics.

5.2.1.1 Town of Mattawa Overburden Aquifer

The Town of Mattawa sources its water from a deep unconfined alluvial overburden formation beneath the town (Waters Environmental, 2009). It is noted that similar alluvial formations within the NBMCA are rare. River sediments are reported to have filled in the Mattawa fault beneath the Town of Mattawa over time. The fault extends at least 30 to 35 m below ground surface and is filled with highly permeable coarse sands and gravels (Harrison, 1971).

The Town of Mattawa municipal water system draws water from two wells housed in a single structure located at the corner of Bissett Street and Fourth Street as shown on Figure 5.1 (Waters Environmental, 2006). The well field is on the north bank of the Mattawa River approximately 60 m from the river's edge. The water table at the well field is about 5 m below ground level which is similar level to the adjacent Mattawa River. Wells supply the entire Town of Mattawa (population of 2,023 in 2011 Census). A cross-section of the Mattawa aquifer is presented in Figure 5.2 (this profile illustrates the gravel and gravelly sand that has accumulated within the fault near Lake Chant Plein).

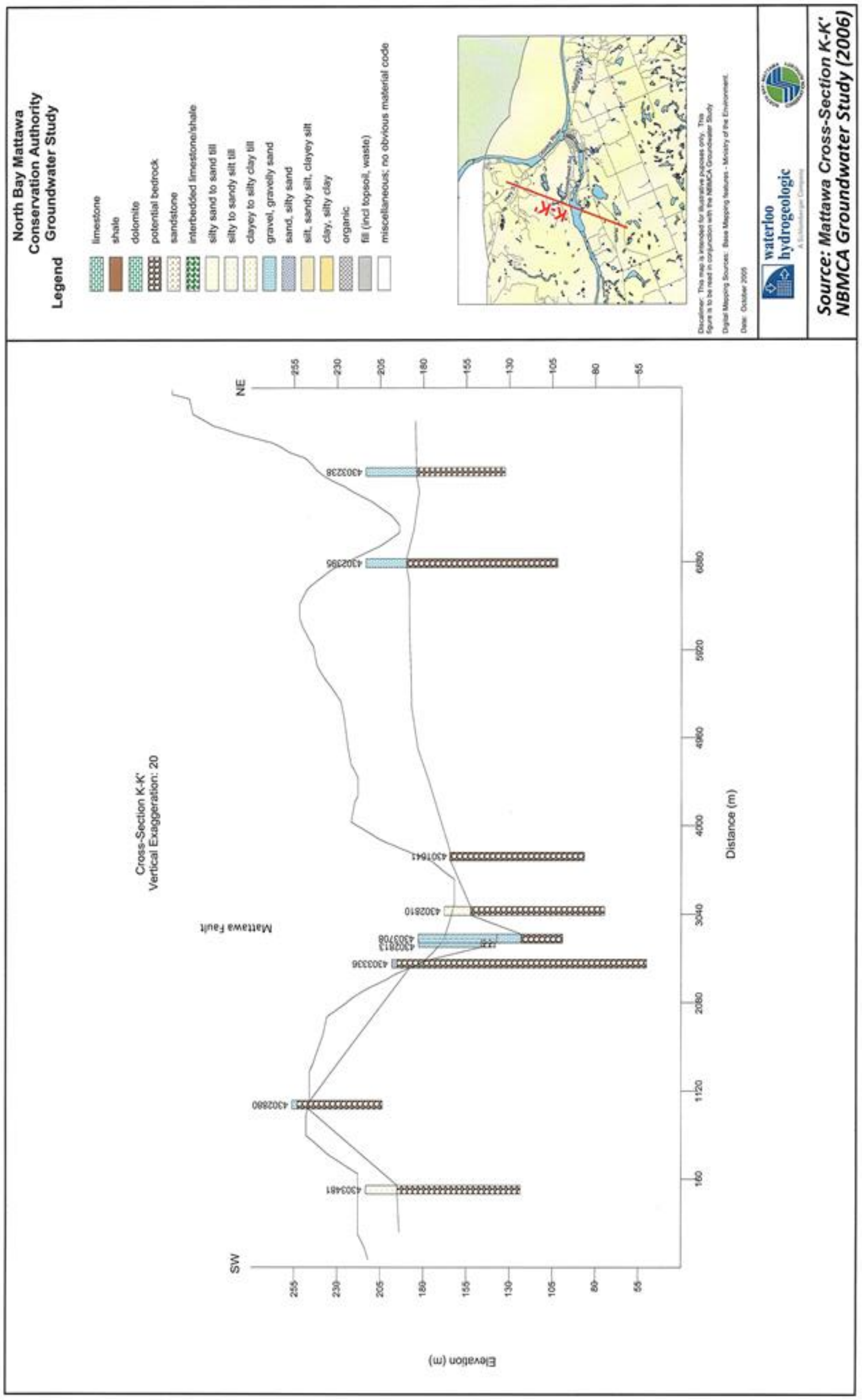
The maximum permitted pumping rate for combined wells is 6,546 m^3/day (Permit to Take Water No. 02-P-5059; MOE, 2011). Mattawa's "average day" pumping rate was reported as 1,940 m^3/day which is well within permitted limits (Waters Environmental, 2009). In May 1998 Mattawa experienced a maximum day pumping rate of 2,907 m^3/day which is also well within permitted limits. Mattawa's population and water consumption rates are stable or gradually trending lower over time (Waters Environmental, 2009).

The horizontal and vertical dimensions of the Mattawa overburden aquifer are not well understood. Production wells have not intersected bedrock and nearby wells are not advanced to sufficient depths due to the presence of large boulders. Well pump tests have been used to estimate the Mattawa aquifers porosity (specific yield), transmissivity and hydraulic conductivity. Aquifer porosity (specific yield) is assumed to range between 0.18 and 0.30 and an apparent transmissivity value of 1,009 m^2/day is reported for the combined well field. Based on an assumed saturated thickness of 20.6 m the associated aquifer hydraulic conductivity is 49 m/day (or 5.7 x 10^{-2} cm/sec). These values were accepted as reasonable and fell within the range of hydraulic conductivity values commonly reported for sand and gravel aquifers (Waters Environmental, 2009).

Figure 5.1 Location of Mattawa Municipal Wells

Source: Updated Assessment Report, Drinking Water Source Protection, NBMCA, 2011

Figure 5.2 Cross-Section of the Mattawa Overburden Aquifer



Groundwater vulnerability for capture zones around the Mattawa well heads is a two dimensional representation (or map views) of the lateral extent of the subsurface volume of aquifer that supplies water to the well field. Waters Environmental reports that capture zones are actually 3 dimensional and the depth of the groundwater flowing to the well field cannot be determined. Estimated Mattawa wellhead vulnerability zones are identified in Figure 5.3.

Figure 5.3 indicates that the Mattawa well field can draw water from the edge of the Mattawa River. Consequently the Mattawa system was evaluated to determine if it was directly influenced by surface water. This assessment determined that the Mattawa system did not meet GUDI (Ground Water under the Influence of Surface Water) criteria (Waters Environmental, 2009). The following definitions were used to define vulnerability zones. These definitions characterize the movement of groundwater through the Mattawa overburden aquifer.

Well Head Protection Area – A = 100 m radius around the well field

Well Head Protection Area – B = Travel time to the wells are less than or equal to 2 years

Well Head Protection Area – C = Travel times are greater than 2 years but less than 5 years

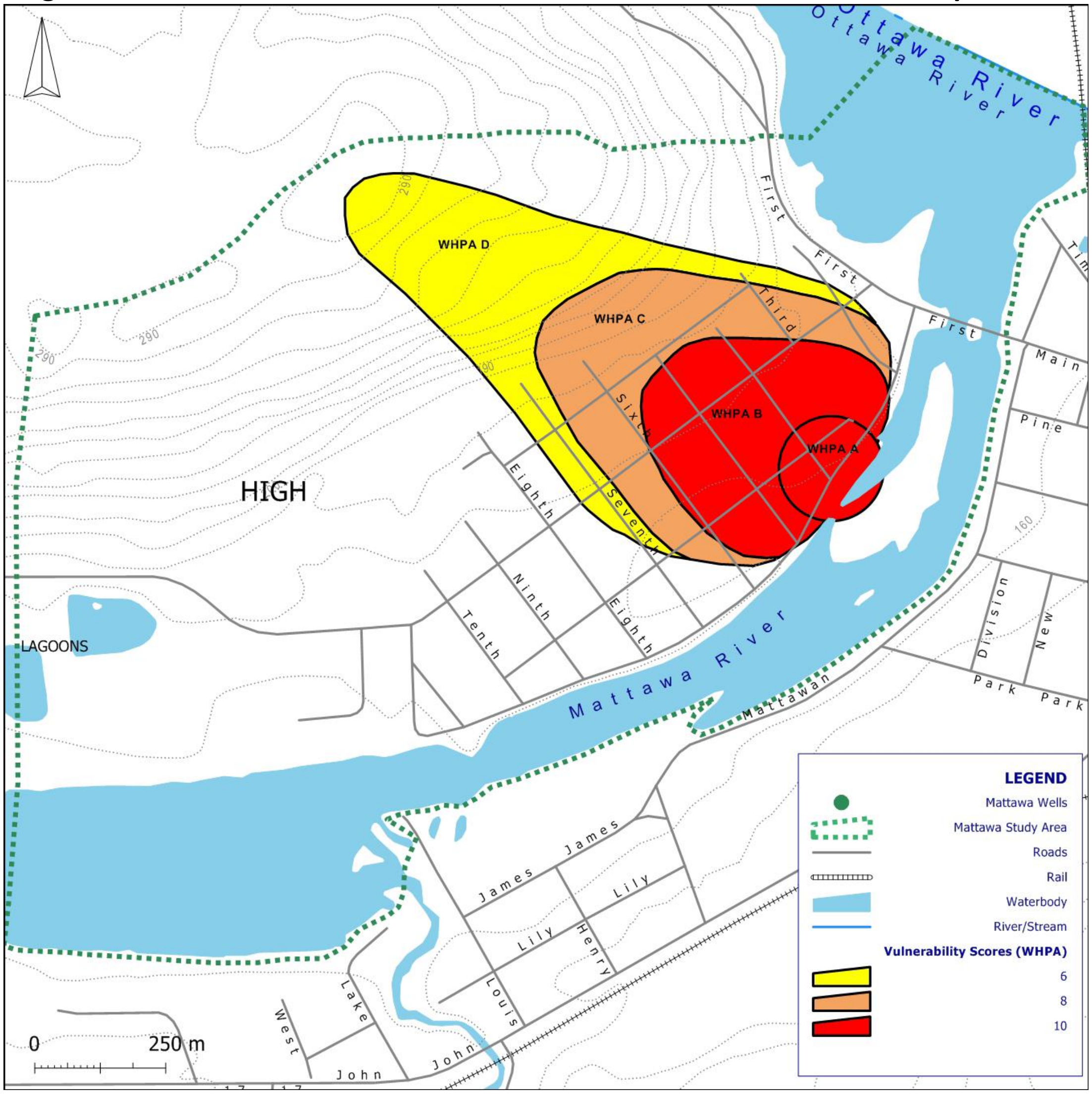
Well Head Protection Area – D = Travel times are greater than 5 years but less than 25 years

The alluvial overburden aquifer contained within the Mattawa fault has the potential to yield significant quantities of water. This deposit is rare within the NBMCA. This aquifer has limited protection from surface influences other than the protection afforded to the Town of Mattawa drinking water system through Drinking Water Source Protection Planning.

5.2.1.2 Town of Powassan Overburden Aquifer

The Powassan municipal water supply is sourced from a confined overburden aquifer which may typify other confined overburden aquifers identified in Figure 5.7 as having moderate intrinsic susceptibility within the NBMCA. Areas identified with moderate susceptibility all share a common Glaciolacustrine history and harbour a protective layer of finer material that protects deeper overburden groundwater. This water supply has been examined within the NBMCA Groundwater Study as well as within the NBMCA Source Water Protection Plan. While this drinking water system is outside of study area boundaries, no information exists for confined aquifers within the NBMCA and consequently the Powassan overburden aquifer has been examined to reveal characteristics of this geologic environment.

Figure 5.3 Well Head Protection Zones around the Mattawa Municipal Wells



Source: Updated Assessment Report, Drinking Water Source Protection, NBMCA, 2011

The Powassan well field is located near the Town of Powassan, north of Highway 534 and west of Highway 11, as identified in Figure 5.4. The well field is positioned in gently sloping topography near Genesee Creek. This system services approximately 1,025 people based on 2006 census figures.

Powassan's maximum permitted pumping rate for combined wells is 1,313 m^3/day (Permit to Take Water No. 82-P5292). Between 2003 and 2008 Powassan pumped an average of 508 m^3/day but pumping rates were highly variable. In December 2008 Powassan reported a maximum day pumping rate of 613 m^3/day. These pumping rates are all within permitted limits. Growth information for the Powassan service area was not available. Water consumption trends reported between 2003 and 2008 can be interpreted as being stable or declining over time (note: growth observations for Powassan are included in Growth and Land Use Change Assessment in Section 12).

Powassan wells are characterized as 6.25 (Well #1) and 12 inch (Well #2) diameter encased with screening at depths between 11.0 and 23.2 meters below the land surface. Well records show that overburden has three distinct layers with an upper fine sand/sand layer, a middle 5 to 8 meter thick clay/silty clay to fine sand layer and a deeper coarse sand/gravel layer that has inclusions of clay, fine sand and cobble intermixed. The upper two layers represent post glacial lacustrine deposition (with possible more recent alluvial deposition in the upper layer from the creek) and the lower layer represent glacial fluvial deposition laid down in advance of lake environments following glaciation. The middle layer of finer material significantly restricts water movement between the upper and lower deposits. A conceptualized cross-section of Powassan well field stratigraphy is presented in Figure 5.5.

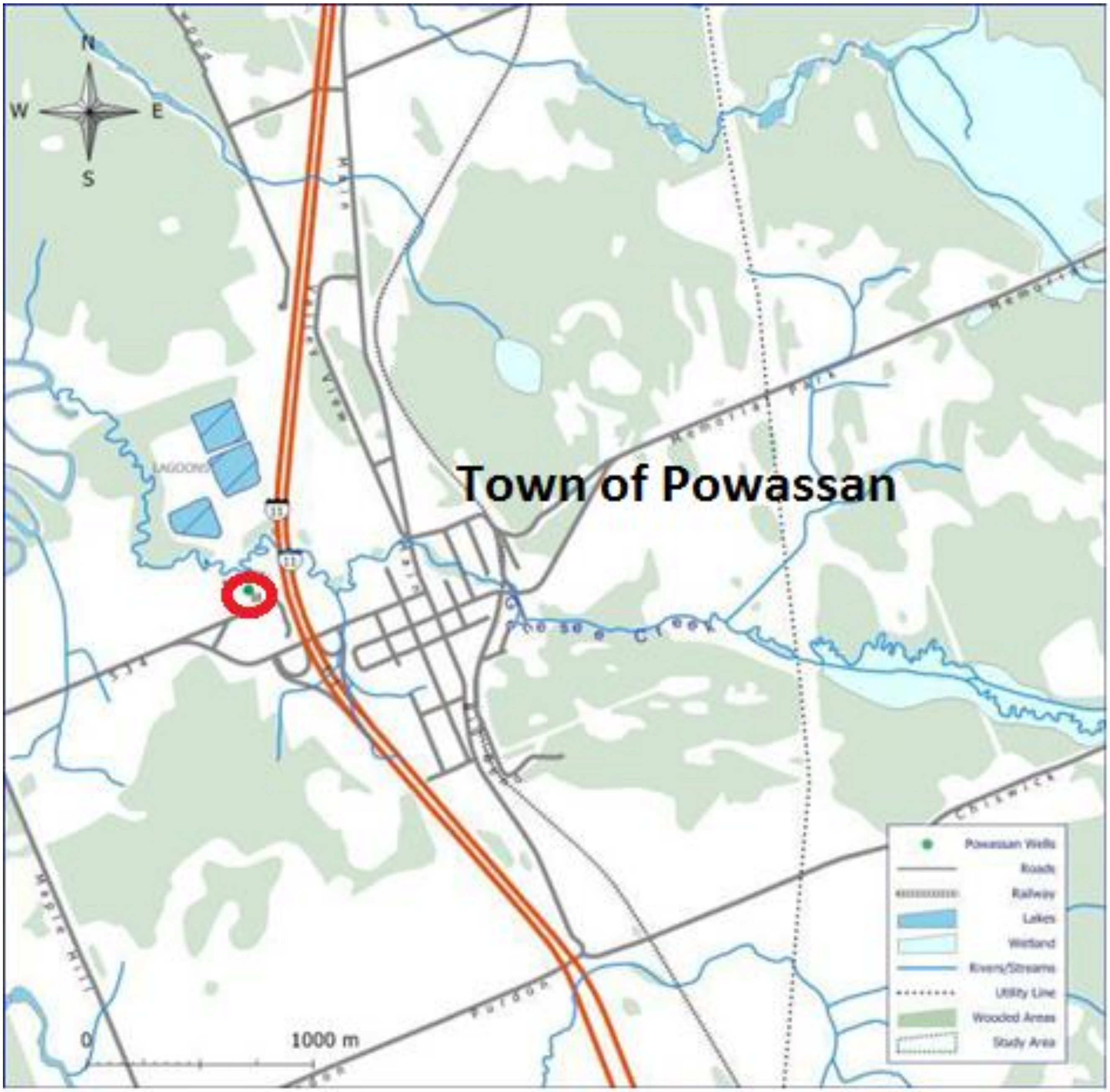
Waters Environmental reviewed initial pump test records from when wells were installed. The geometric mean of all transmissivity values was 220 m2/day for the combined wells indicating that the Powassan well field is highly capable of sustaining municipal demand. Transmissivity values were calculated using the draw down period in adjacent test wells. During draw down water dropped at a decreasing rate and then stabilized during the test. It was interpreted that the drawdown cone was being influenced by recharge from Genesee Creek. Because flattening of the draw down was not immediate, it has been interpreted that the Creek will only recharge to the wells below the confining layer if pumping rates are very high. The middle stratum was interpreted to be semi impervious (it has been intersected by improperly decommissioned wells and has low placisity) and that the lower aquifer zone is not truly confined. Analysis was completed to see if the Powassan wells are under the direct influence of surface water (GUDI). These wells do not meet GUDI criteria.

Capture zones around the Powassan wells have been evaluated and interpreted into vulnerability zones. Powassan well head vulnerability zones are identified in Figure 5.6. The definitions used to define these vulnerability zones are the same as those used in Mattawa (see Mattawa vulnerability definitions above). It is noted that considerable evaluation of threats within these well head protection zones has subsequently been completed as part of the Source Water Protection Assessment.

5.2.1.3 Characterization of the Marsh Drive Landfill Site Overburden Aquifer

The Marsh Drive Landfill Site was used as a domestic waste disposal site by the City of North Bay between 1962 and 1994 (Stantec, 2011). It is located above the North Bay escarpment immediately northwest of the North Bay Airport. The landfill is situated in a former sand and gravel deposit of noncalcareous glaciofluvial sand. A 700 m long leachate plume is present migrating from former waste areas through overburden infilled in a bedrock trough. This leachate plume is intersected by a monitoring well network and has been subject to considerable hydrogeological study. This aquifer exists in glaciofluvial deltaic deposit which has

Figure 5.4 Location of Powassan Municipal Well Field



Source: Updated Assessment Report, Drinking Water Source Protection, NBMCA, 2011

Figure 5.5 Conceptualized Cross-Section of the Powassan Well Field

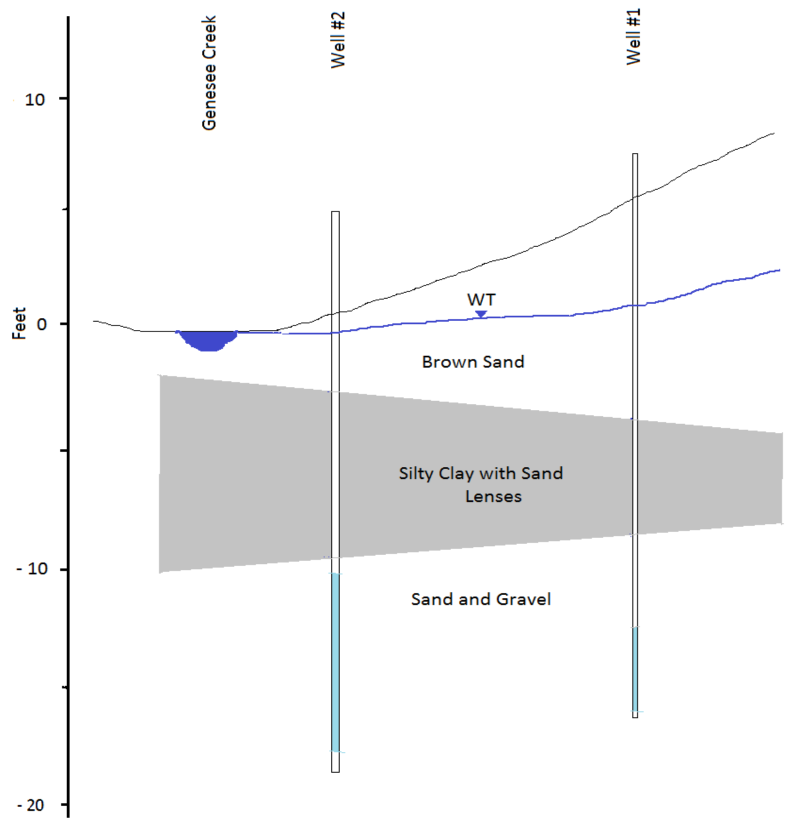
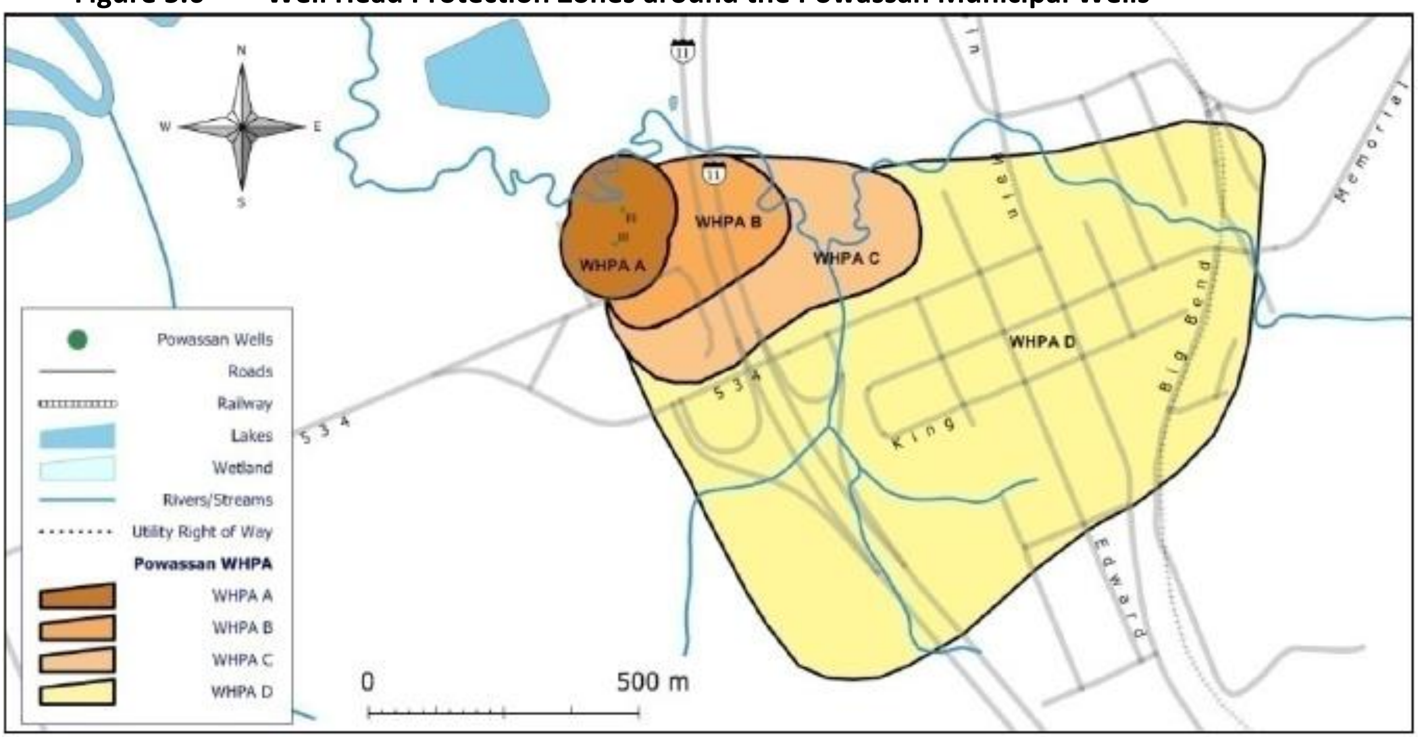


Figure 5.6 Well Head Protection Zones around the Powassan Municipal Wells



Source: Waters Environmental Geoscience Ltd, 2009.

been substantially altered from aggregate mining activity. The Landfill was closed in 1994 but the site continued to receive sewage sludge which was spread on the surface of the site as part of closure until 2011 (Stantec, 2011).

In 1989 the City of North Bay began to extract leachate from the foot of the landfill which was pumped to a nearby sanitary sewer. Before leachate management efforts were in place partially attenuated leachate exceeding Provincial Water Quality Objectives (PWQO) discharged to Chippewa Creek southwest of the site. Landfill contaminants degraded stream chemistry for a considerable distance downstream of the discharge zone. After leachate extraction began the leachate impacts to the stream declined over time. It took about a decade for the full impact to reach the discharge zone at the edge of Chippewa Creek although some parameters responded more quickly than others. By 2000 discharges to the creek from the leachate discharge zone complied with PWQO (Stantec, 2011).

The Marsh Drive Annual Report describes the geologic setting of the landfill as a former deltaic outwash plain at the end of esker/kame complex that extends north of the landfill site. Lands surrounding the site are covered by 5 to 25 meters of well sorted sand and gravel over bedrock. Bedrock is exposed at surface on the upper gradient (north) side of the landfill. Leachate moves through the water table from the landfill to a discharge zone at the edge of Chippewa creek as illustrated in Figure 5.7. A series of monitoring wells track groundwater levels and groundwater chemistry within the plume. Wells have been monitored 4 times a year since 1995. A profile of the leachate plume is presented in Figure 5.8. The extent of the volume of overburden reported to be removed (used in landfill operations) from above the leachate impacted zone is evident by a hump of land between monitoring wells G110 and G130 which is the only area that remains at natural surface elevations. Bedrock knobs are exposed at the surface in close proximity to the leachate plume within the excavated zone.

Groundwater in the leachate plume has been reported to be moving through three distinct geologic layer (in the excavated zone) described as follows:

- The surface layer of overburden is described as a well sorted medium to coarse sand with a thickness ranging between 4.3 and 5.7 m.
- The middle overburden layer ranges from well sorted fine to medium grained sand to silty-fine sand with a thickness between 3.2 and 5.0 m.
- The deepest overburden layer directly above bedrock is comprised of a silty-sand till. The till is reported to be between 1.0 and 1.9 m thick and may be absent in some areas.

Bedrock underlies the plume and is assumed to be non-porous. None of the overburden layers act as a confining layer (Stantec, 2011).

The average groundwater flow velocities along the primary axis of leachate plume are calculated to range between 6.6 X 10^{-6} m/sec to 2.8 X 10^{-5} m/sec (208 to 881 m/year). Hydraulic conductivity was estimated to range between 1 X 10^{-5} to 5 X 10^{-5} m/sec and an average porosity of 40%. The pumping system is described as removing a significant portion of the leachate plume. In 2010 184,683 m^3 of contaminated groundwater were removed from the aquifer which is an average rate of 507.4 m^3/day (which is within permitted withdrawal rates (Stantec, 2011)). The water taking permit for this system is listed in the Permits to Take Water – Groundwater section below. This pumping system has the third highest approved pumping rate of all groundwater systems within the NBMCA's area of jurisdiction (only exceeded by the Town of Mattawa municipal wells). This example illustrates the dynamics of water flow through a glaciofluvial deposit which is rapid and profiles how significant recharge areas are to discharge zones. Contaminants move rapidly through unconsolidated overburden deposits and significant management efforts are required for remediation.

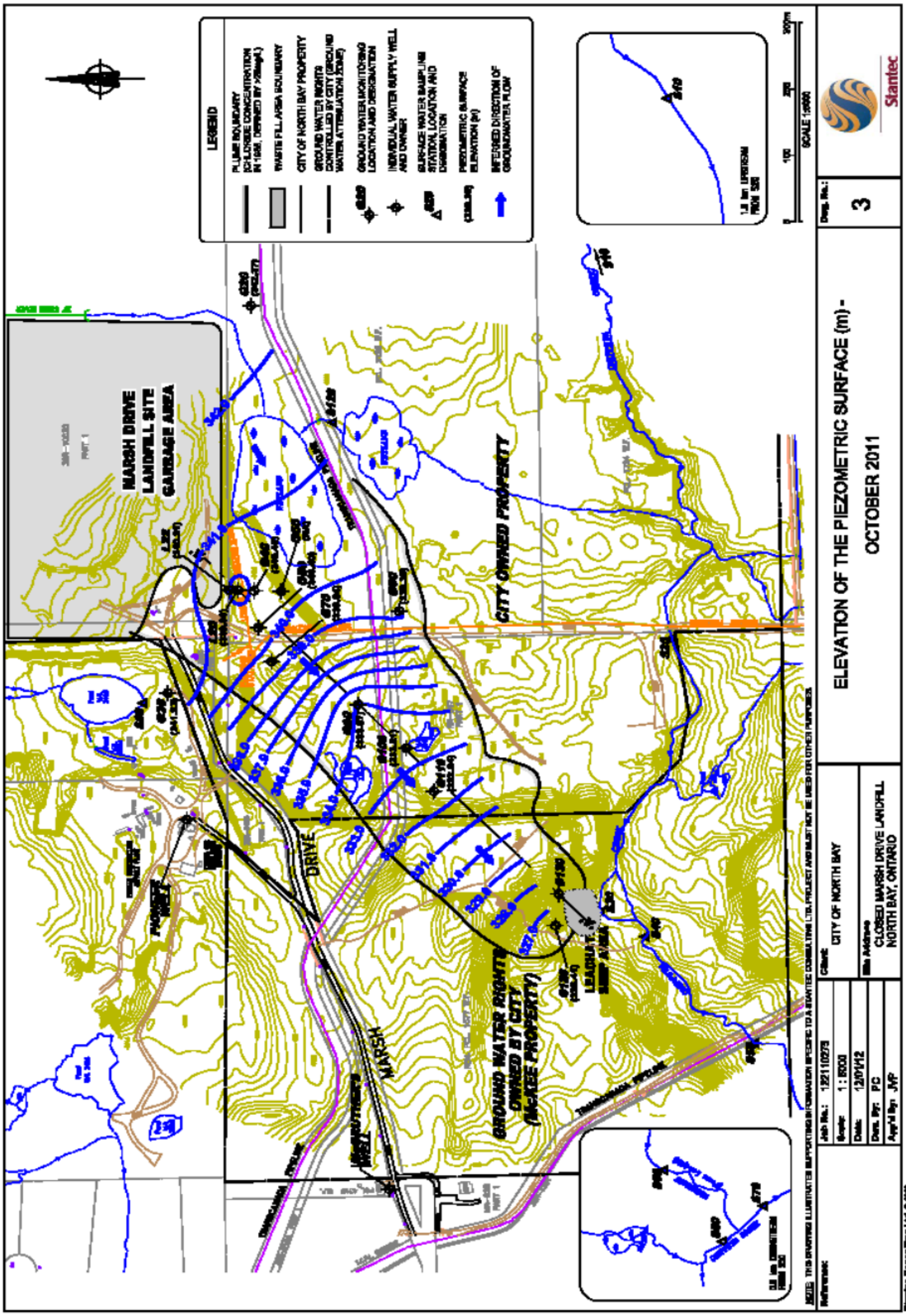
5.2.2 Bedrock Aquifer Characterization

Deep groundwater aquifers are held within bedrock fracture zones up to 400 meters beneath the land surface (Gascoyne, 2003). Deeper water within this aquifer is disconnected from annual hydrologic cycles and water near the bedrock surface is only marginally influenced by annual hydrologic trends. Bedrock aquifers are the primary source of drinking water for watershed residents not on municipal systems or deriving water from surface sources and the majority of productive wells obtain water from a depth of less than 100 m (the average mean depth of wells in Corbeil, Astorville, Bonfield and Callander/Derland is 50.8 m and range from 40 m to 60 m). Singer, 2002, reports that a study of more than 10,000 wells on the Canadian Shield found that 90% of wells obtained water at depths of 67.1 m or less and that 50% of wells obtain water at depths of 28.4 m or less. Generally bedrock aquifers have limited ability to supply higher specific yields. Singer 2002 reports that the specific mean capacity distribution of wells in Precambrian rock in the northern Ontario is 1.9 L/Min/m.

Regional bedrock water table elevations developed by Waterloo Hydrogeologic are presented in Figure 5.9. Water Well Information System (WWIS) records used to map regional water table elevations are limited in upland areas. Consequently surface water elevations were used in rural areas to develop the water table surface interpretation.

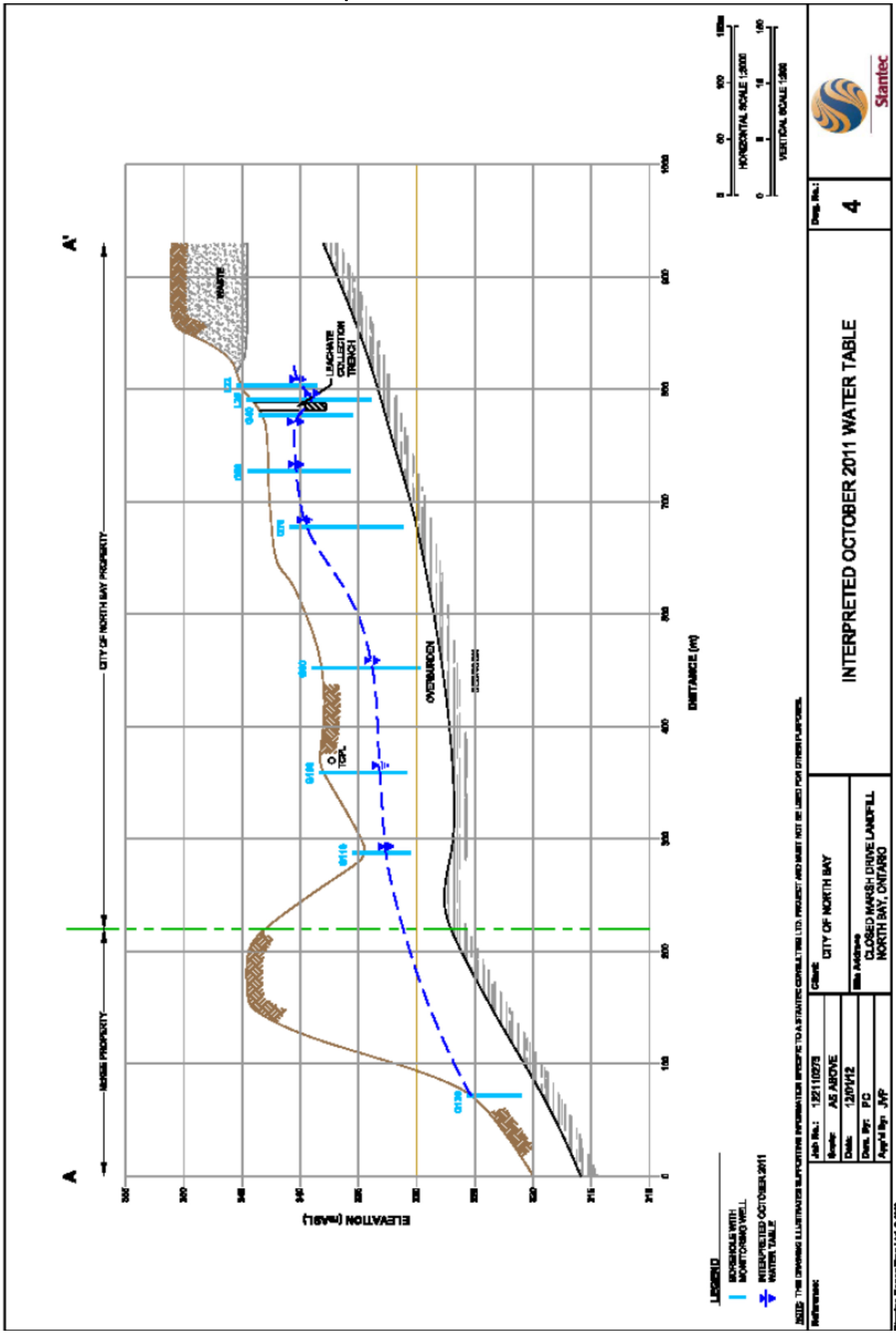
Interpreted bedrock equipotential for the study area reflects true water elevations from well head data. At the regional scale bedrock equipotential elevations can't be distinguished from water table elevations (it looks the same as Figure 5.9). Groundwater flow in bedrock is interpreted to trend towards the major surface water bodies.

Figure 5.7 Piezometric Surface Elevation of Groundwater in the Marsh Drive Landfill Leachate Plume



Source: Stantec Consulting Inc., 2011

Figure 5.8 Cross Section of the Interpreted Water Table in the Marsh Drive Landfill Leachate Plume



Source: Stantec Consulting Inc., 2011

5.2.2.1 Recharge and Discharge Areas

Recharge is a term used to describe the process of adding water to the groundwater system. Although difficult to measure directly, it is possible to define areas with recharge potential based on interpretations of ground surface elevations and groundwater elevations. Upland areas in the northern and southern portion of the NBMCA are defined groundwater recharge areas (WHI, 2008). The lowland areas surrounding the Mattawa River and near Lake Nipissing are interpreted to be groundwater discharge areas.

Bedrock recharge and discharge zones have been identified in settled areas by comparing bedrock potentiometric groundwater levels to ground surface elevations. Areas where bedrock potentiometric groundwater levels are higher than the ground elevation, water is assumed to be discharging to surface/surface aquifers. Conversely, areas were the bedrock potentiometric groundwater levels are below the ground surface, recharging conditions are interpreted to exist. Bedrock recharge/discharge zones are displayed in Figure 5.10.

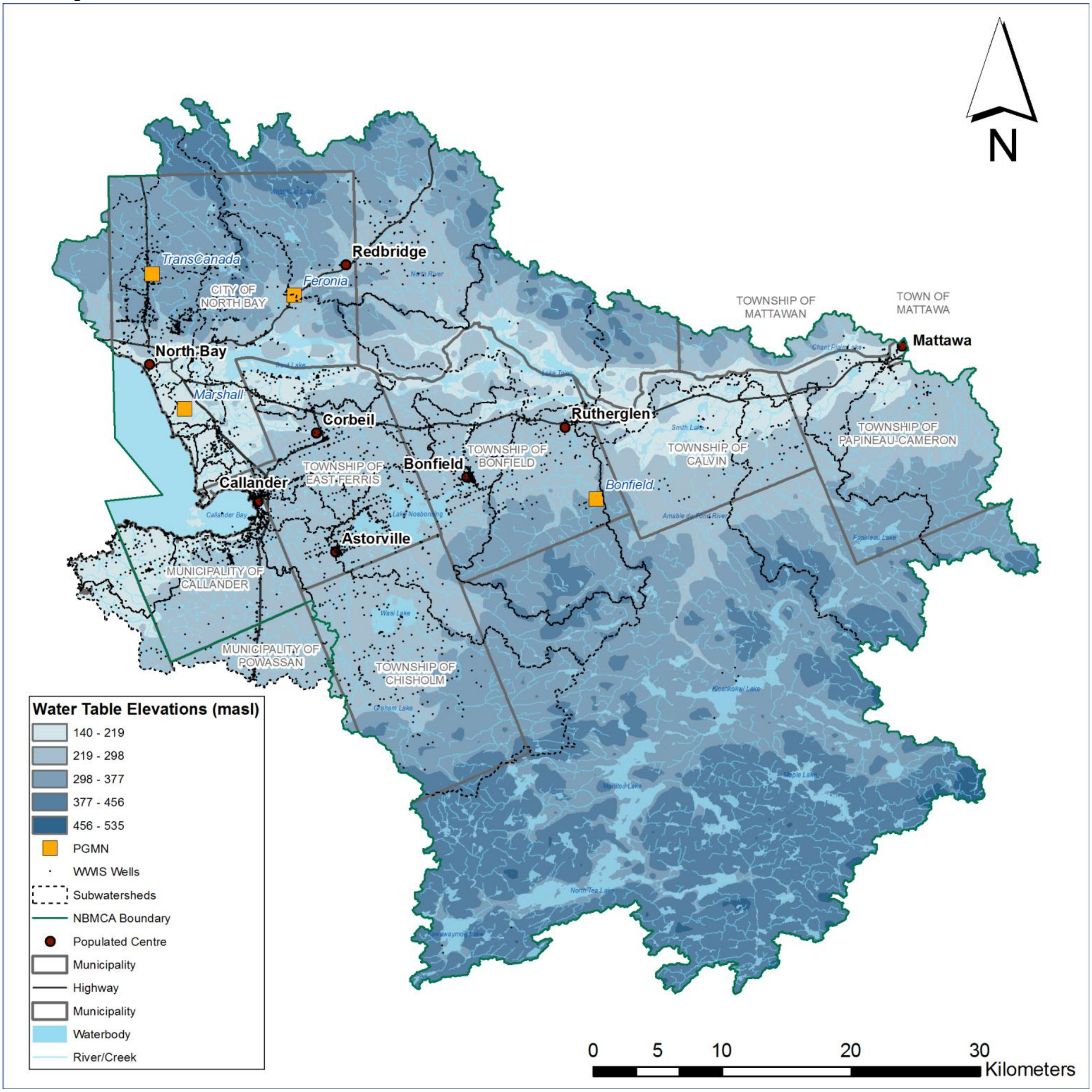
Vast upland areas in the northern and southern limits of the study area are interpreted to be recharge areas where groundwater flow is in a downward direction. The lowland areas surrounding the Mattawa River and Lake Nipissing are interpreted to be discharge areas where groundwater flows upwards from the bedrock into surrounding overburden or directly to water bodies.

5.2.2.2 Bedrock Specific Capacity and Deep Groundwater Flow Regimes

Bedrock specific capacity within the NBMCA was examined in the 2008 NBMCA Groundwater Study. Specific capacity is calculated from pump test conducted at the time a well was installed. Specific capacity is calculated by dividing the measured pumping rate during the pump test by the observed drawdown. Specific capacity is reported to be highly variable. Most bedrock wells are interpreted to have low specific capacity. Yields are often suitable for domestic uses but with limited ability to supply higher yields. Generally higher yielding wells within the study area are found within overburden aquifers.

Groundwater mobility within Precambrian granitic batholiths (study area batholiths are identified in Figure 2.1) through research conducted to evaluate these geologic environments as repositories for nuclear waste storage has been completed by Gascoyne 2003. Gascoyne examined a batholith on the Precambrian Shield in Manitoba (similar geologic formations are encountered within the study area). Gascoyne's investigations are not in close proximity to the study area but no comparable local information exists and the body of work offers important interpretive value. Gascoyne identified that groundwater is partially interconnected through sub vertical fracturing to a depth of 200 m below ground surface. Hydraulic conductivity as

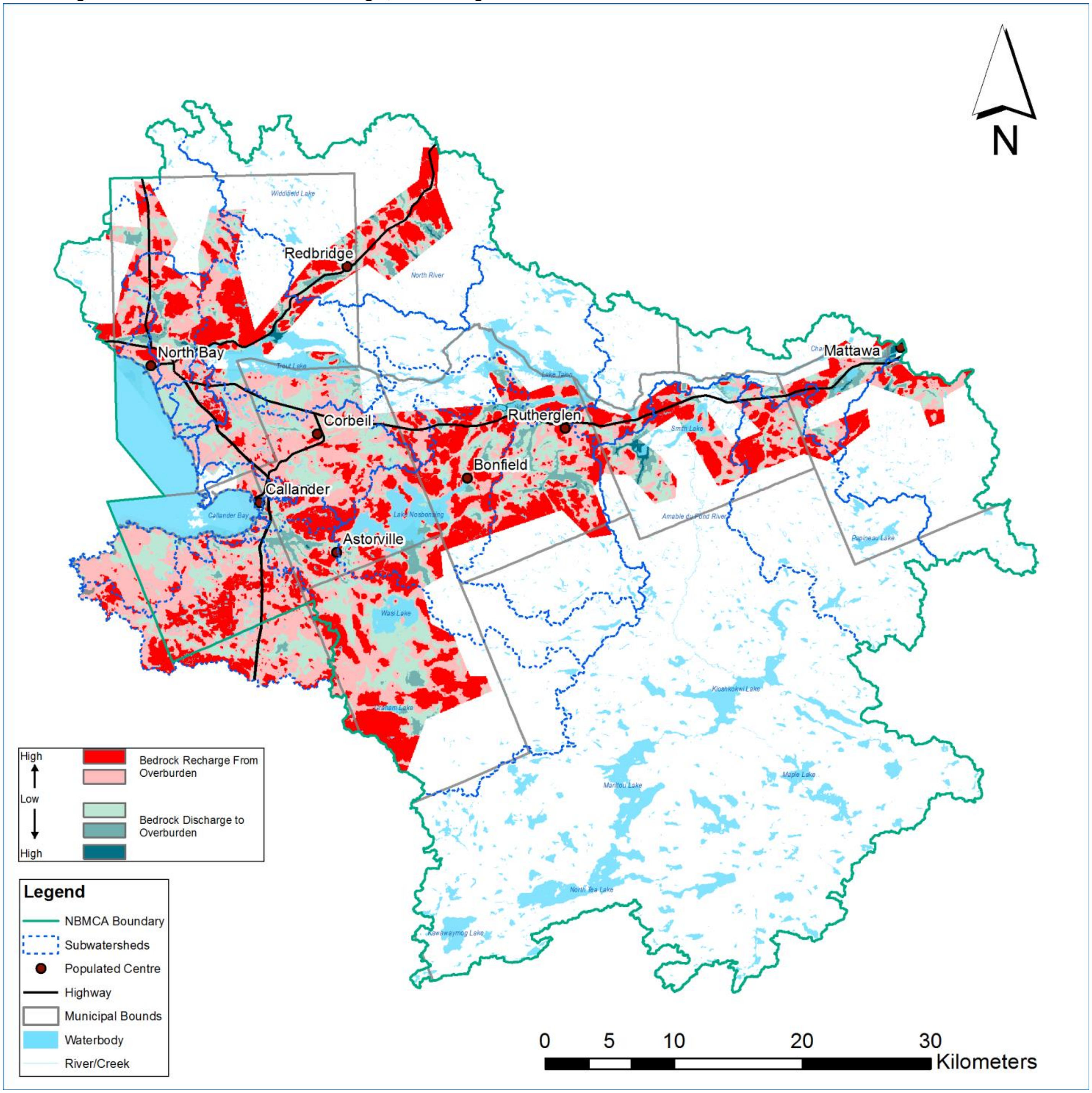
Figure 5.9 Groundwater Table within the NBMCA



Source: NBMCA Groundwater Study, Waterloo Hydrogeologic Inc., 2006.

high as 10 $^{-4}$ m/s was reported within fracture zones whereas hydraulic conductivity in non-fractured bedrock ranged between 10 $^{-7}$ and 10 $^{-13}$ m/s (Gascoyne, 2003).

Figure 5.10 Bedrock Recharge/Discharge Areas



Source: NBMCA Groundwater Study, Waterloo Hydrogeologic Inc., 2006.

Gascoyne observed that near the bedrock surface bedrock flow regimes are influenced by local scale flow systems, which are usually recharging at upland locations and discharging to lowland areas near water systems. He observed that surface water mainly enters bedrock through bedrock surface fractures. Water chemistry analysis carried out by Gascoyne indicates that thick overburden aquifers overlying bedrock aquifers do not necessarily imply that bedrock recharge is prevalent.

It is noted that within the study area lamprophyre sills and dykes may also facilitate groundwater movement within the bedrock mantle. Also noted is that major faults and terrane boundaries may also influence groundwater movement. No groundwater assessment related to these geologic features is available.

Gascoyne (2003) has examined groundwater isotopes to assess the age of groundwater in the Manitoba batholith. In bedrock groundwater recharge areas (comparable to the Mattawa and Algonquin highlands) water was found to have warm climate isotopic signatures up to 300 m below the bedrock surface. Water up to 100 m in depth in bedrock recharge areas was thought to be up to 50 years old. Groundwater between 120 meter and 200 meter was identified as a mixing zone between water 50 years old and water that was up to several thousand years old. Between 220 and 300 meters groundwater was found to between 10,000 and 20,000 years old. Water below this depth (up to 400 meters) was slightly saline and determined to predate the latest period of glaciation. It is noted that saline groundwater aquifers have not been identified within the NBMCA watershed and wells are generally less than 200 m deep. Water ages suggest that water movement through bedrock is very slow and that bedrock aquifer recharge and discharge to overburden aquifers (or surface water) is isolated to shallow fracture zones in close proximity to the bedrock surface.

Significant movement of groundwater in upper bedrock aquifers is entirely dependent on the bedrock permeability created by the fractures in the rock (Singer, 2002). Singer notes that the intensity and distribution of the fracture systems play a major role in determining the total porosity of the rocks of the Canadian Shield, their hydraulic conductivity, water yield and groundwater recharge. The hydraulic conductivity of a fracture zone depends on the degree of crushing, the presence of fracture filling, and the characteristics of individual fractures. Because these openings can begin and end abruptly and because they possess strong directional orientation, well yields in Precambrian rock is highly variable and unpredictable.

Bedrock groundwater quality issues commonly experienced when used for domestic consumptive purposes are usually aesthetic in nature. Bedrock water quality can be affected by mineralization within the bedrock. Typically groundwater from bedrock sources within the study area can have elevated iron and manganese levels which detract from the aesthetic qualities of the water. Other aesthetic or operational parameters commonly observed are elevated Alkalinity, Chloride, Sodium, Sulphate, Sulphide and Total Dissolved Solids (Singer, 2002). These characteristics can be reduced using appropriate treatment. Overall the quality of water in bedrock aquifers within the NBMCA is considered excellent (Waterloo Hydrogeologic, 2006).

5.3 Groundwater Vulnerability

The North Bay-Mattawa Source Protection Area - Approved Updated Assessment Report (January 2012) includes a section dedicated to regional groundwater vulnerability. The susceptibility of regional aquifers to water-borne contaminants is assessed by the nature of overburden deposits. Soil layers are classified as to thickness and how readily they transmit water to determine total susceptibility at any point within the study area. The NBMSPA Approved Updated Assessment Report 2012 identified almost the entire NBMCA region as having high susceptibility to contamination. It was noted that the accuracy of the mapping in remoter areas was hampered by a lack of data. Intrinsic Groundwater Vulnerability for the NBMCA area of jurisdiction is presented in Figure 5.11.

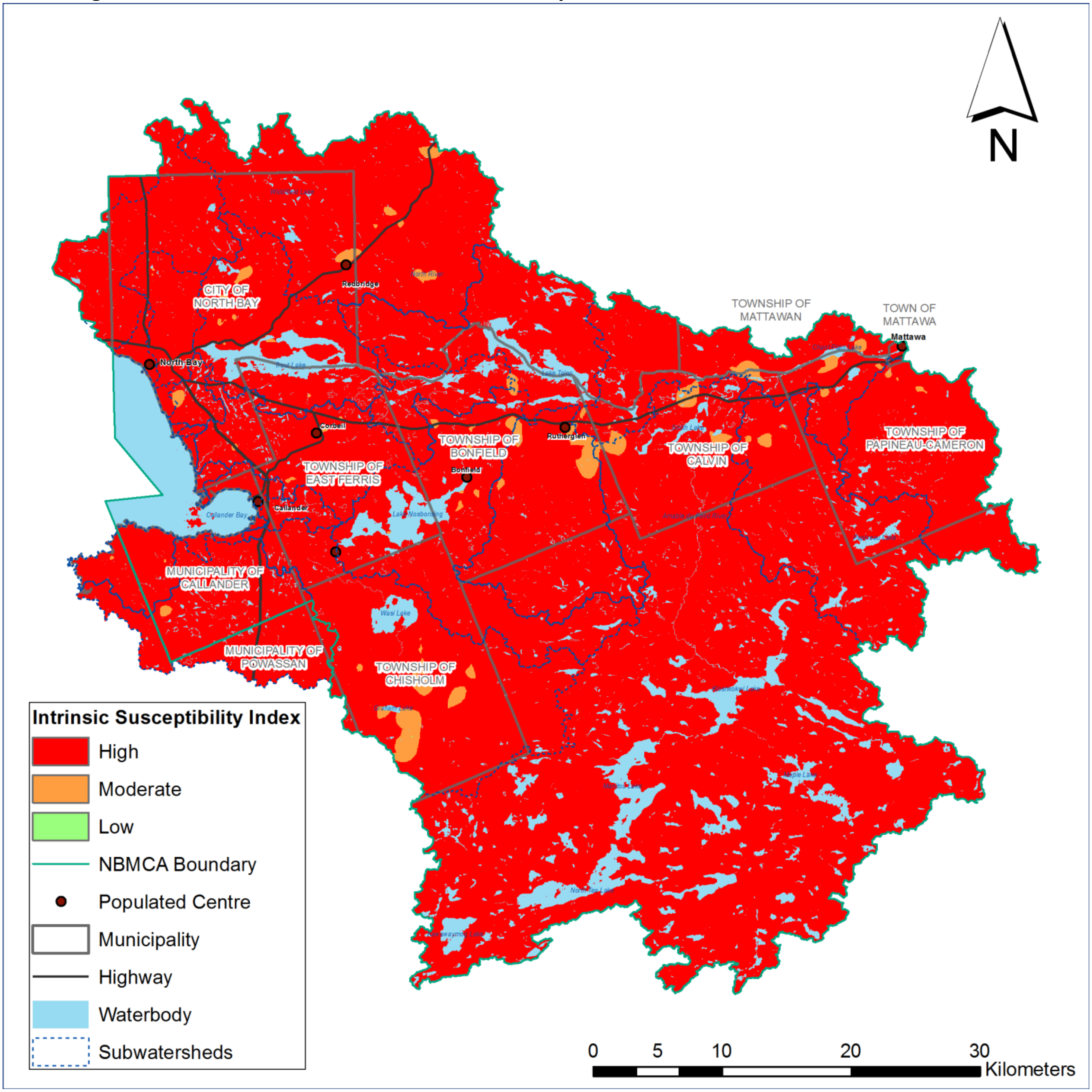
Significant groundwater recharge areas have been defined as areas with above average recharge rates (i.e. greater than 115% of average recharge for the entire region) which are connected to surface water bodies or aquifers used as a drinking water source (NBMSPA, 2012). Significant groundwater recharge areas are scored as areas of high (red), or moderate (orange) vulnerability in Figure 5.12. It is the intention of the Province of Ontario to protect Significant Groundwater Recharge Areas across the broader landscape pursuant to the Clean Water Act (2006) (NBMSPA, Approved Updated Assessment Report, 2012).

Highly vulnerable aquifers are defined in the Approved Updated Assessment Report as subsurface areas that lie beneath highly vulnerability recharge areas which have been identified within the NBMCA area of jurisdiction using the intrinsic susceptibility method. Figure 5.13 indicates that most aquifers have little overburden protection as virtually the entire area of study has highly vulnerability. Areas not identified as having highly vulnerability have confined protection layers in the stratigraphy similar to the Powassan well field. It is noted that due to a lack Water Well Information System data the vulnerability assessment has “high uncertainty in much of the area” (NBMSPA, Approved Updated Assessment Report, 2012).

5.4 Groundwater Quality

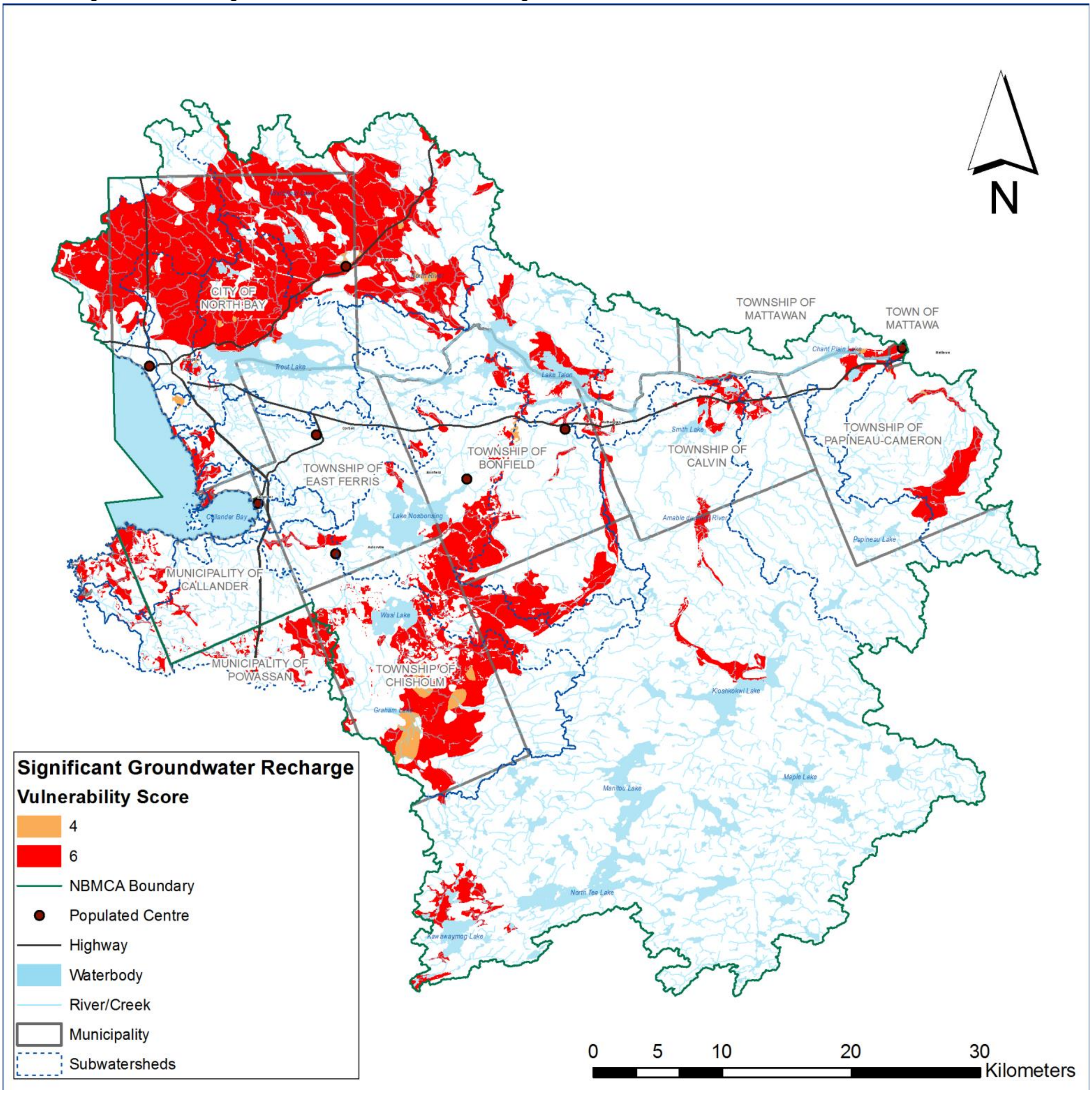
The understanding of ground water quality within the NBMCAs area of jurisdiction is limited by a lack of publicly accessible data. General groundwater quality in Northern Ontario has been reported by Singer, 2002. Municipal raw groundwater quality has been assessed through Engineers Reports prepared for Mattawa and Powassan well fields and additional assessment has been carried out for Source Water Protection evaluation purposes. Private bedrock wells located near the former Marsh Drive Landfill Site are monitored for deep leachate migration contamination and have publicly accessible data for comprehensive water chemistry since 1990 (sampled three times per year) (Stantec, 2011).

Figure 5.11 Intrinsic Groundwater Vulnerability in the NBMCA Area of Jurisdiction



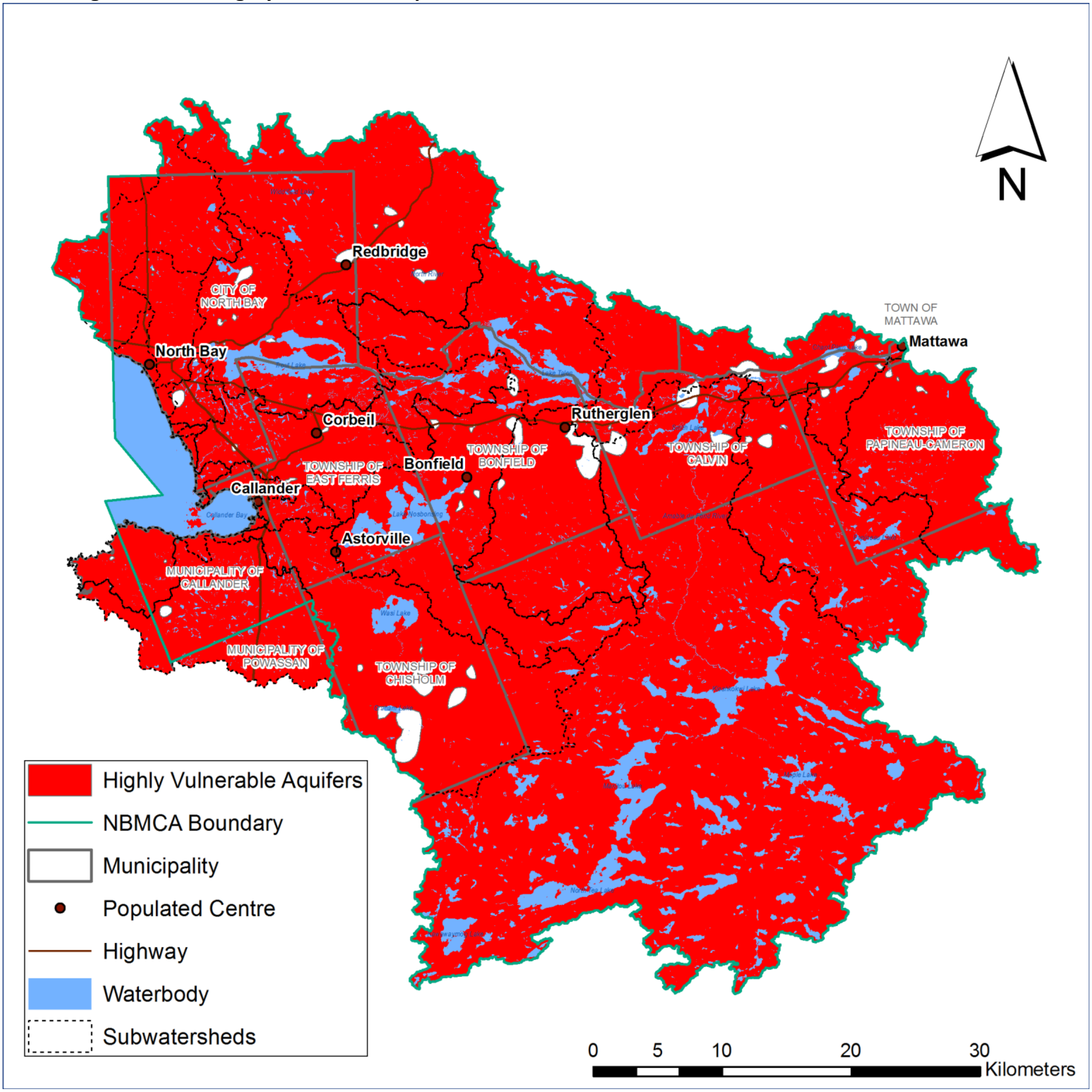
Source: NBMSPA, Approved Updated Assessment Report, 2012

Figure 5.12 Significant Groundwater Recharge Areas



Source: NBMSPA, Approved Updated Assessment Report, 2012

Figure 5.13 Highly Vulnerable Aquifers



Source: NBMSPA, Approved Updated Assessment Report, 2012

The NBMCA began monitoring groundwater quality in 2003 when it joined the Provincial Groundwater Monitoring Network (NBMSPA, 2012). Six monitoring sites have been established to continuously record ground water elevations (levels are recorded hourly). Groundwater quality is assessed on an annual basis (wells are sampled each fall). Wells are currently located on the west side of the study area. Additional well locations are being contemplated in areas where groundwater use is high such as the hamlets of Astorville, Corbeil and Callander/ Derland (communication from CA staff 2012). Provincial Groundwater Monitoring Network well locations are illustrated in Figure 5.14. Well characteristics are presented in Table 5.1. Water quality data (general chemistry and metals) for 5 wells can be found in Table 5.2.

Table 5.1 Provincial Groundwater Monitoring Network Wells monitored by the NBMCA

Well #	Well Name	Municipality	Subwatershed	Type of Well	Depth m	Static Head m bgs
W272	Fabrene	North Bay	La Vase River	Bedrock	24.7	5.5
W274	Marshall Park	North Bay	Parks Creek	Overburden	5.18	3.74
W277	Trans Canada	North Bay	Chippewa Creek	Overburden	10.8	7.74
W390	Chisholm	Chisholm	Wasi River	Bedrock	141	2.33
W391	Grand Desert	Bonfield	Sharpes Creek	Bedrock	79.3	10.54
W392	Feronia	North Bay	Trout Lake	Bedrock	91.9	10.07

Table 5.2 present data collected from PGMN wells between 2003 and 2009 as reported in the Approved Assessment Report (NBMSWP, 2012). The data has too short of a collection period to identify ground water quality trends. Several aesthetic parameters such as iron, manganese and hardness, detected at elevated levels, were attributed to natural sources. One elevated health related parameter was detected at three locations. Sodium levels above 20 mg/L were reported at the Marsh Park, Chisholm and Bonfield (Grand Desert) well monitoring sites and would be reportable drinking water exceedances if used as a source of drinking water. The Approved Assessment Report attributed higher sodium levels to natural sources.

General groundwater quality characterization within the NBMCA is difficult due to limited data availability. The NBMCA Groundwater Study Report concluded that regional groundwater is generally of good quality (Waterloo Hydrogeologic, 2006). This report inventoried point and non-point pollution sources that posed a groundwater risk. Waterloo Hydrogeologic identified that spills, hazardous waste generating sites and fuel storage sites made up over 90% of the chemical point sources in the region. Other chemical point sources included PCB storage sites, hazardous waste receiving sites, operating and closed landfill sites, solid and liquid waste handling sites, lumber yards and pipelines. Other sources determined to be threats to groundwater quality included septic systems, unreported spills, residential oil tanks, fertilizer, pesticide and herbicide storage and distribution centers, road salt and pickled sand storage facilities, sand and gravel pits and snow dumps. Source water protection planning has identified and evaluated comprehensive threats in the vicinity of municipal well systems (North

Figure 5.14 Location of NBMCA Provincial Groundwater Monitoring Network Wells

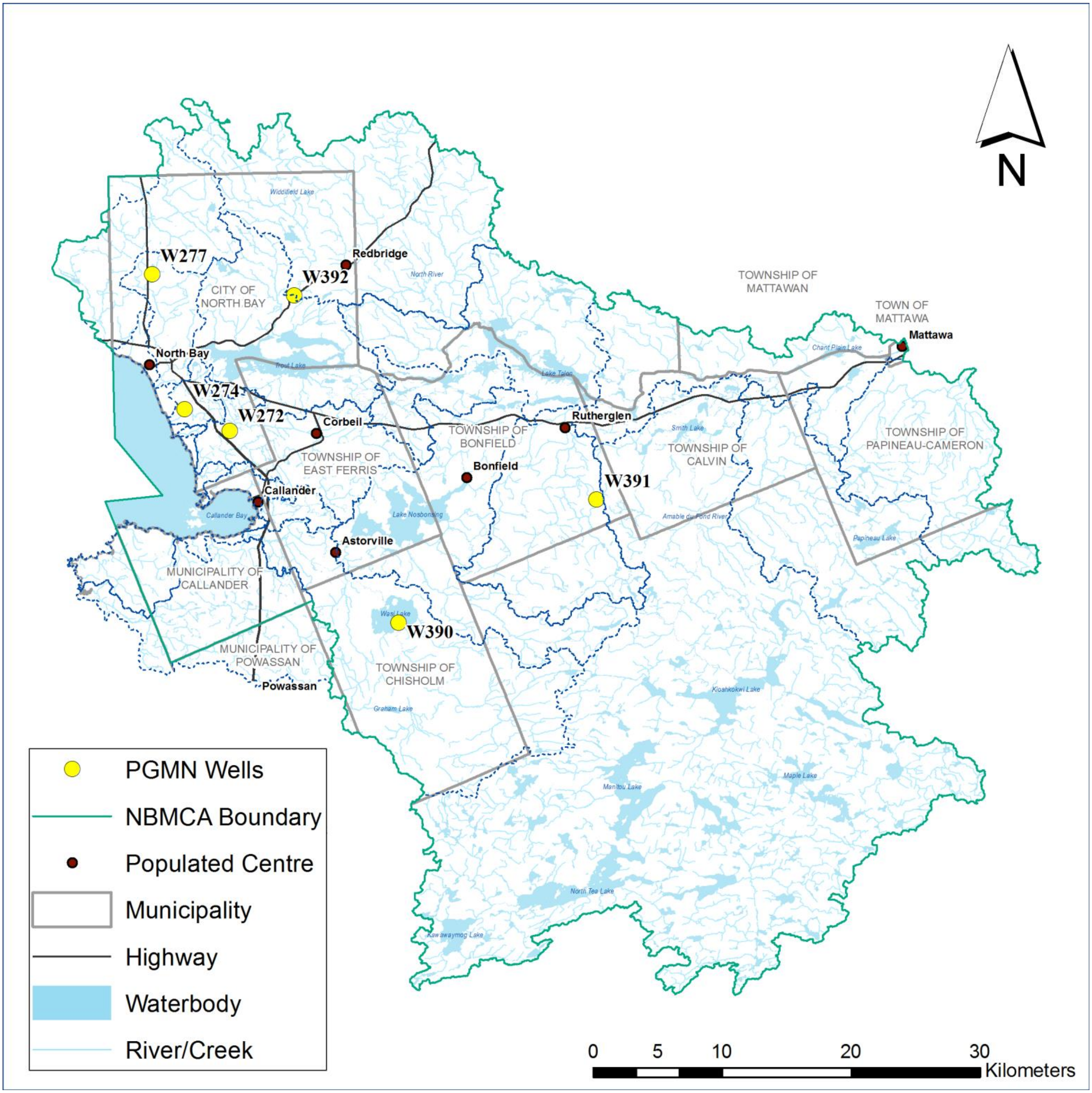


Table 5.2 Provincial Groundwater Monitoring Network – Ground Water Quality (2003 – 2009)

Variable	Statistic	PGMN Location and Well Number				
		Marshall Park	Trans Canada Pipeline	Chisholm	Bonfield	Feronia
		GA 274	GA 277	GA 390	GA 391	GA 392
Chloride (mg/L)	Minimum	5	7.7	10	0.5	9
	Maximum	45	14.6	46	1	29.5
Conductivity (uS/cm)	Minimum	867	73	-	144	237
	Maximum	878	98	348	155	501
DIC (mg/L)	Minimum	116	3	21	14.8	26
	Maximum	206	5.8	23.2	16.8	30
DOC (mg/L)	Minimum	15	0.7	0.8	0	0.6
	Maximum	20	1.15	4	0.6	1.2
Flouride (mg/L)	Minimum	0.1	0.01	0.95	0.11	0.67
	Maximum	0.2	0.027	1.7	0.15	1.11
Nitrate (mg/L)	Minimum	<0.005	1.05	<0.005	<0.005	<0.005
	Maximum	0.09	1.74	<0.005	0.2	3.98
Total Phosphorus (mg/L)	Minimum	0.16	0.02	<0.02	<0.02	<0.02
	Maximum	2.28	0.53	0.02	0.02	0.02
TDS (mg/L)	Minimum	570	28	128	94	144
	Maximum	828	64	226	144	326
Calcium (mg/L)	Minimum	123	2.8	19	17	39
	Maximum	173	6	23	150	72.6
Copper (mg/L)	Minimum	0.0004	0.0002	<0.001	<0.001	0.0002
	Maximum	0.004	0.002	0.002	0.003	0.003
Iron (mg/L)	Minimum	<0.05	0	<0.03	0.0006	0.008
	Maximum	28.9	<0.03	0.07	12	0.05
Magnesium (mg/L)	Minimum	25.2	0.64	4.5	5	3.65
	Maximum	43.2	1.05	6.1	38	8.8
Sodium (mg/L)	Minimum	37.7	7.8	31	2	9
	Maximum	72.6	9.86	44	56	13.1
Zinc (mg/L)	Minimum	0.0012	0.0003	<0.005	0.0005	0.0005
	Maximum	<0.01	<0.01	<0.01	<0.01	<0.01

Source: NBMSWP, 2012

Bay-Mattawa Source Protection Area, 2011). Groundwater surficial aquifers are at higher risk of contamination. Bedrock aquifers usually provide backup potable water sources if surficial aquifers or surface water sources experience degradation problems.

5.5 Groundwater Use - Permits to Take Groundwater

Current provincial permits to take groundwater are summarized in Table 5.3 (Provincial Permit to Take Water Data Base, to 2011, Ontario Ministry of the Environment as supplied by the

Table 5.3 Provincial Permits to Take Groundwater within the NBMCA's Area of Jurisdiction

Permit Number	Well # & Description	Location	Watershed	Category	Period of Taking (days)	Max/day m^3/day	Total Taking m^3/yr	Percent
02-P-5002	Well # 1	Nipissing Manor, Corbeil	La Vase	Water Supply - Communal	365	60	21,900	0.7
02-P-5002	Well # 2	Nipissing Manor, Corbeil	La Vase	Water Supply - Communal	365	60	21,900	0.7
02-P-5002	Well # 3	Nipissing Manor, Corbeil	La Vase	Water Supply - Communal	365	13	4,745	0.2
02-P-5002	Well # 4	Nipissing Manor, Corbeil	La Vase	Water Supply - Communal	24	60	1,440	0.1
5182-63SS2B	Well # 1	Fairview Park Camping & Marina	La Vase	Water Supply - Campground	365	91	33,215	1.0
5182-63SS2B	Well # 2	Fairview Park Camping & Marina	La Vase	Water Supply - Campground	365	91	33,215	1.0
1136-63CRCK	Leachate Collection & Pumping	Marsh Drive Landfill Site (closed)	Chippewa	Groundwater Remediation	365	1,200	438,000	14.0
2265-6KXLMZ	Well # 1	Trans Canada Pipeline	Chippewa	Industrial Power Production	365	80	29,200	0.9
2122-8ESJUA	Well TW1-09	North Bay Golf and Country	Chippewa	Water Supply - Other	214	328	70,192	2.2
3030-5Z4NMS	Well # 1	Samual de Champlain Prov Park	Pautois	Water Supply - Communal	365	220	80,300	2.5
02-P-5059	Well # 1	Mattawa Municipal Supply	Lower Mattawa	Water Supply - Municipal	365	4,582	1,672,430	53.5
02-P-5059	Well # 2	Mattawa Municipal Supply	Lower Mattawa	Water Supply - Municipal	365	1,964	716,860	23.0
				Total		**8,749**	**3,123,397**	

Source: 2011 PTTW Ministry of Environment

Table 5.4 Total Committed Groundwater Taking Percent/Use as of 2011

Drinking Water	82.7	%
Groundwater Remediation	14.0	%
Irrigation	2.2	%
Industrial Cooling	0.9	%

NBMCA). The total committed groundwater use on an annualized basis per use category is presented in Table 5.4.

The total annual potential taking from all permits is 3.12 million cubic meters per year based on permits that were valid in 2011. In excess of 95% and perhaps all of this taking is from overburden aquifers (well characteristics for the smaller users are not known). It is noted that users rarely take their maximum permitted quantities and this figure indicates a committed volume. It is estimated that natural recharge into overburden aquifers within the NBMCA is approximately 60 million cubic meters per year (in areas with greater > 10 m of overburden). The maximum permitted takings represents about 5 % of estimated water recharged to regional aquifers annually and consequently overburden aquifer reserves are not at risk of depletion. Most groundwater is extracted for domestic use and other water users not on municipal systems derive their supply from surface water sources. Groundwater taken at the closed Marsh Drive Landfill Site (Chippewa Creek watershed) is pumped to the North Bay Sewage Treatment Plant for treatment and then is released to Lake Nipissing.

A significant quantity of groundwater is extracted by the rural population for domestic use. This use does not require a permit to take water from the province. In the NBMCA area of jurisdiction the rural non serviced population is estimated to be approximately 9,000 (derived from NBMCA Groundwater Study calculations). Waterloo Hydrogeologic indicates that groundwater taking for rural domestic purposes averages approximately 0.175 m^3/capita per day which equals 1,575 m^3/day or 575,000 m^3/year. Most of this groundwater is derived from bedrock aquifers (Waterloo Hydrogeologic reported that 90% of private wells source their water from bedrock). Most of this water is returned to the ground as septic discharge. NBMCA total recharge to bedrock aquifers within the NBMCA is estimated to be approximately 240 million cubic meters per year (in areas with a bedrock surfaces or a thin mantle of overburden < 5 m thick) and consequently domestic rural groundwater takings from bedrock aquifers represents approximately 0.2% of water recharged to bedrock aquifers annually.

5.6 Significance of Groundwater and Information Gaps

Groundwater is stored and moves through the voids of unconsolidated formation within the NBMCA watershed as well as within the cracks and fissures of bedrock to form an integral part of the hydrologic cycle. Unlike the movement of water in the atmosphere or at the ground surface, groundwater moves slowly through subterranean environments and slow movement helps to counterbalance more rapid changes in the rest of the hydrologic cycle. Precipitation enters the ground at points above the water table and moves towards points of discharge near surface water boundaries. Over the millennia water has accumulated within thicker overburden deposits and in the upper bedrock mantle to create relatively accessible stores of fresh water that, within the NBMCA watershed, have largely remained unexploited. Water movement between aquifers is also occurring but this movement is less well understood on a regional basis. Groundwater discharge sustains flows to wetlands, lakes and streams between precipitation events and this base flow is crucial to sustaining aquatic and riparian environments. Groundwater acts as a reservoir to receive and redistribute water within the hydrologic cycle.

Groundwater is a major source of water supply to rural populations. There are 4,823 records of drilled wells within the NBMCA of which 90% are used for domestic water supply from bedrock aquifers. Water in surface aquifers supplies most of the base flow to wetlands, lakes, and streams to sustain flows moderate temperatures and dilute contaminants. The importance of groundwater in basin management cannot be understated and the NBMCA has made significant advancements in groundwater characterization within its area of jurisdiction.

Groundwater movement through bedrock aquifers is unpredictable and entrenchment can last from decades to centuries or longer. Bedrock aquifers are protected from surface influences by the low transmissivity of fracture zones and the impervious nature of the un-fractured bedrock that shelters it. Water movement within bedrock aquifers is obscure and flow directions may be disconnected from surface drainage patterns. Water yields are usually limited by low transmissivity through poorly connected fracture zones. Bedrock aquifers often contain elevated dissolved minerals contributed by the host rock which affects water aesthetics. These parameters can be removed using common treatment technologies. Bedrock aquifers provide a wide-spread secure source of water for human domestic consumption.

Groundwater is harboured by and moves through thicker overburden aquifers, which are regionally isolated within the NBMCA's area of jurisdiction, in more predictable ways and this movement is usually measured in years or decades. These aquifers harbour significant high quality reserves that can meet high volume demand (all high volume water taking permits source their water in overburden aquifers) but are at high risk of contamination from anthropogenic sources. Quantification and valuation of these overburden reserves is not well understood. Source Water Protection Analysis has concluded that most of these reserves are highly vulnerable to contamination. While the sources of contamination can be diverse, more significant threats that threaten the long term viability of these sources includes use of road salts for winter road maintenance and exploitation of unconsolidated materials to supply construction aggregates.

Specific groundwater characterization has been carried out for overburden aquifers by examining three different geologic setting where site details are available. Groundwater within rich alluvial deposits under the Town of Mattawa and within stratified glaciolacustrine deposits near Powassan (outside of the NBMCA area of jurisdiction) illustrates the regional importance of overburden aquifers. Groundwater in overburden aquifers near the closed Marsh Drive Landfill leachate plume moves rapidly through the environment and requires significant remediation efforts to protect discharge zones near Chippewa Creek. Information for other overburden aquifers is limited and Stantec is not in a position to determine if examples provided are reflective of the NBMCA watershed as a whole.

Ground water quality within the study area has limited data availability. General groundwater quality is reported as good and the quality of groundwater in surface aquifers used by municipalities is reported to be excellent. An inventory of potential contamination sources that pose a risk to regional groundwater has been completed and detail threats to municipal drinking water wells is also available. Regional overburden aquifers, interpreted to be significant recharge zones, are largely unevaluated, threats from point and non-point pollution sources have not been assessed and protection strategies, if required, remain undefined. It is noted that agricultural and industrial use of groundwater within the region is minimal.

6.0 Topography and Surface Drainage

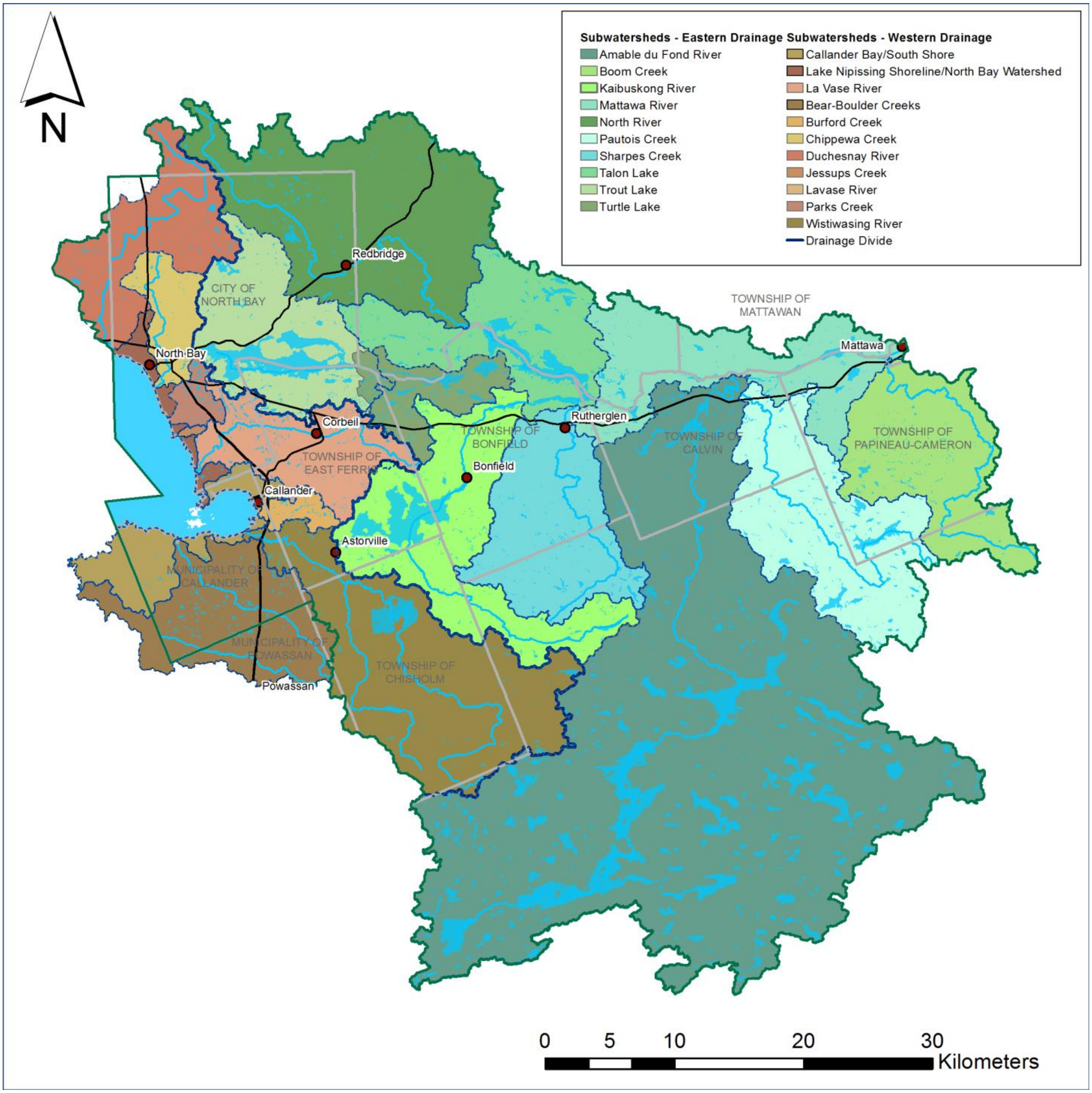
6.1 Drainage Basin Hierarchy

The NBMCA is located in the St. Lawrence River primary watershed, one of three primary watersheds in Ontario (the others being Hudson Bay and Nelson River). These three primary watersheds can be subdivided into 17 secondary watersheds (including Lake Huron and Ottawa River watersheds), which can in turn be divided into tertiary (including Lake Nipissing and Mattawa River watersheds) and then into quaternary watersheds. The NBMCA study area is divided into 20 subwatersheds based on quaternary watersheds and sub-quaternary watersheds in the NBMCA.

Figure 6.1 illustrates subwatersheds in the NBMCA of which 10 drain to Lake Nipissing and 10 drain to the Ottawa River through the Mattawa River system (interpreted as draining to the Ottawa River watershed in the following analysis).

Of the 20 study area subwatersheds, 17 are headwater systems with no upstream inputs. All of the Lake Nipissing basins are headwater basins. The three remaining basins are “flow-through”

Figure 6.1 NBMCA Subwatersheds



systems that are in part dependent on upstream management and are more complex in terms of, for example, defining headwater issues or approaching watershed management as a whole. The three flow-through basins, all located in the Ottawa River watershed, include Turtle Lake, Lake Talon and the Mattawa River basins. Headwater basins and subwatersheds affected by upstream inputs are identified in Table 6.1.

Table 6.1 Drainage Basin Hierarchy of NBMCA Subwatersheds

#	NBMCA Subwatersheds	Headwater or Upstream Inputs	Greater Watersheds
1	Duchesnay Creek Subwatershed	Headwater	Lake Nipissing/Great Lakes
2	Chippewa Creek Subwatershed	Headwater	
3	Parks Creek Subwatershed	Headwater	
4	Jessups Creek Subwatershed	Headwater	
5	La Vase River Subwatershed	Headwater	
6	Lake Nipissing Shoreline/North Bay	Headwater (shoreline)	
7	Windsor/Boulder/Bear Creek Subwtshd	Headwater	
8	Burford Creek Subwatershed	Headwater	
9	Callander Bay/South Shore	Headwater (shoreline)	
10	Wistiwasing River Subwatershed	Headwater	
11	North River Subwatershed	Headwater	Mattawa River/Ottawa River
12	Trout Lake Subwatershed	Headwater	
13	Turtle Lake Subwatershed	Trout Lake	
14	Kaibuskong River Subwatershed	Headwater	
15	Lake Talon Subwatershed	North River Turtle Lake Trout Lake Kaibuskong River Sharpes Creek	
16	Sharpes Creek Subwatershed	Headwater	
17	Amable du Fond River Subwatershed	Headwater	
18	Pautois Creek Subwatershed	Headwater	
19	Boom Creek Subwatershed	Headwater	
20	Lower Mattawa River Subwatershed	North River Trout Lake Turtle Lake Kaibuskong River Sharpes Creek Lake Talon Amable du Fond Patois Creek Boom Creek	

Two subwatershed planning areas are made up of left over catchment areas without a single identifiable drainage system. They are a compendium of small systems located in the Lake Nipissing basin. Because of this, Lake Nipissing/North Bay Shoreline and Callander Bay/South Shore subwatersheds are not able to be fully assessed as individual basins in Section 6.2.

Five basins have a large lake (or lakes) as central features within the watershed. Lake based systems are more complicated in terms of determining basin features. Lake basins (Trout Lake, Talon Lake, Turtle Lake, Kaibuskong River, and Amable du Fond River) are all located in the Ottawa River watershed and have the highest open water coverage of all subwatersheds in the NBMCA. These subwatersheds are usually dominated by lake management concerns.

6.2 Watershed and Subwatershed Basin Characteristics

6.2.1 Land and Water Areas

The study area has a total area of approximately 2,996 km^2 of which 232 km^2 or 7.7% is open water (excluding wetlands). Subwatersheds draining to the Ottawa River have a total area of 2,295 km^2 of which 210 km^2 or 9.2% is open water. The remainder of the study area draining to Lake Nipissing totals 701 km^2 of which 21 km^2 or 3.1% is open water (excludes Lake Nipissing). It is noted that the study area differs from the NBMCA jurisdictional area as a small portion of the Little Sturgeon River watershed is not included within the study area (6.61 km^2). Portions of the Burford Creek and Callander Bay/South Shore subwatersheds in East Ferris are outside of the NBMCA's regulatory boundaries (area outside the NBMCA in East Ferris totals 14.26 km^2) but are included within the study area. Also the Windsor/Boulder/Bear subwatershed extends beyond the NBMCA's jurisdictional boundaries into East Ferris, Chisholm, Powassan and Nipissing, which are also outside of the NBMCA's regulatory boundaries but are included within the study area (the total area of the Windsor/Boulder/Bear subwatershed outside of Callander is 58.73 km^2).

For this section it was necessary to separate the Windsor/Boulder/Bear subwatershed into its three watershed divisions. The land and water areas for the resultant 22 areas are given below in Table 6.3. Subwatershed areas range in size from 1.3 km^2 for Jessups Creek to 964 km^2 for Amable du Fond River. The broad range of basin sizes makes basin comparisons difficult.

Open water coverage (calculated as a percentage by dividing total water area by total subwatershed area) was ranked for each study subwatershed based on the range of values encountered in the study area. Rankings for open water coverage were assigned as follows: Low (1% – 7%), Moderate (7% - 12%), and High (12% - 17.5%). Of the 22 subwatersheds, Trout Lake watershed has the highest percentage of open water (17.5%) while Chippewa Creek has the least (1%). Open water coverage is generally lower in the watersheds draining to Lake Nipissing compared to the Ottawa River watersheds, mainly because of the number of lake dominated watersheds draining towards the Mattawa River.

6.2.2 Basin Topography

The basin topography can be characterized by elevation differences, length, slope of the basin itself and the stream network located within. The following parameter definitions are used to characterize NBMCA subwatersheds:

- **Highest Watershed Elevation (m)** is the highest point in the watershed, which is usually, but not necessarily, located in the headwaters.
- **Outlet Elevation (m)** is the elevation measured at the discharge point (the mouth). For areas draining to Lake Nipissing, the outlet elevation is taken as the average summer elevation of Lake Nipissing (195.83m) (Acres International Ltd., 1982).
- **Basin Relief (m)** is the elevation difference between the highest watershed elevation and the outlet elevation. For Trout Lake, Four Mile Creek is used as the major inflow to determine basin relief.
- **Basin Length (km)** is the distance from the outlet to the furthest point in the watershed.
- **Basin Relief Ratio (m/km)** is calculated as Basin Relief divided by Basin Length.
- **Maximum Main Channel Elevation (m)** is the elevation of the main channel at the highest point where the upper measurement ended for Main Channel Length (defined below).
- **Main Channel Length (m)** is measured from the upper most point of the drainage system to the outlet, based on provincial watercourse data and traced from orthophotography.
- **Main Channel Relief (m)** is the elevation difference between Maximum Main Channel Elevation and Outlet Elevation.
- **Main Channel Slope (m/km)** is calculated as Main Channel Relief divided by Main Channel Length.
- **Total Stream Length (km)** is the combined length of all streams in the basin (peripheral drainage and main channel) based on provincial water course data (modified where the main channel actually exists but didn't appear in the dataset) including linear length of any lake. Total Stream Length accounts for the channel irregular pattern and meandering.
- **Drainage Density (km/km^2)** is calculated as Total Stream Length divided by Total Area.

Basin parameters are reflective of drainage and runoff characteristics that are important to watershed management. To aid interpretation selected parameters have been distinguished as low, moderate or high depending on the resultant calculation. Parameters are ranked based on the range of values encountered in the study area. Rankings applied to each parameter are defined in Table 6.2.

Basin measurements and relative rankings are provided in Table 6.3. To aid with the analysis the highest values in each of the two tertiary watersheds are bolded in red and the lowest values are bolded in blue. The values between the highest and lowest for the calculated parameters have graduated shading to help illustrate the relative ranking within the range. The relative rankings are also shaded as follows: Low (blue), Moderate (purple), and High (orange). The highest and lowest values across the study area are shown in the bottom rows of the table. It is noted that each basin parameter can be further explored to distinguish how watershed drainage and flows are affected by basin and channel characteristics.

The highest elevation within the study area, 512 MASL (meters above sea level), is located in the Amable du Fond River watershed, which drains to the Mattawa and then the Ottawa River. The highest elevation in the Lake Nipissing watershed (467.5 MASL) in the study area is located in Wistiwasing River watershed. The lowest elevation in the study area is found at the mouth of the Mattawa River (152 MASL), which is taken as the mean historical elevation on the Ottawa River at Mattawa measured by Water Survey of Canada (based on an assumed datum of 100 MASL).

The Amable du Fond River watershed also has the highest basin relief of NBMCA watersheds. Basin relief ranges from 142 to 351 m in the Ottawa River watersheds and from 16 to 272 m in the Lake Nipissing watersheds. Watersheds flowing into the Ottawa River generally have greater basin relief than those draining to Lake Nipissing.

The Basin Relief Ratio (calculated as Basin Relief divided by Basin Length) is a reflection of the undulating nature of the basin. A higher ranking means that the watershed is more undulating (i.e. greater elevation differences over short distances). Basin Relief Ratios range between 5.9 and 17.9 m/km in the Lake Nipissing watershed and from 6.6 to 18.4 m/km in the Ottawa River watershed within the study area. These rankings are interpreted from Low to High based on the ranges encounter as presented in Table 6.2. The Ottawa River subwatersheds have greater basin relief ratios compared to the Lake Nipissing subwatersheds within the NBMCA.

Within the Lake Nipissing watershed the main channel slopes range between 1.3 and 8.8 m/km. The La Vase River has the flattest channel gradient and Burford Creek has the steepest channel gradient. Within the Ottawa River watersheds main channel slopes range between 0.6 and 9.0 m/km with the Kaibuskong River having the flattest and Four Mile Creek (in Trout Lake watershed) having the steepest channel slopes. Main channel slopes in Table 6.2 are progressively shaded from Low to High. Overall main channel slopes are somewhat steeper in Lake Nipissing watersheds.

Drainage density, a ratio of the total stream length in the watershed to the total area of the watershed, is greatest in the Parks Creek and Turtle Lake subwatersheds (both have a drainage density of 3.7 km/km^2). Drainage densities in Lake Nipissing watersheds range between 0.2 and

3.7 km/km^2, and between 1.8 and 3.7 km/km^2 in the Ottawa River watershed. Drainage density is somewhat lower in Lake Nipissing watersheds. This may be due to the higher open water coverage in the Ottawa River watersheds where the five lake based watersheds are located.

Drainage density ranked High in Burford Creek, Parks Creek and Turtle Lake relative to the values encountered within the remaining subwatersheds in NBMCA. High values of drainage density are indicative of higher runoff potential which can affect erosion and water quality.

Drainage density reflects a balance between climate and the erosive power in the streams to the resistance of the ground surface. Generally speaking, drainage densities can range from less than 5 km/km^2 when slopes are gentle, rainfall low, and bedrock permeable (e.g. sandstones) to greater than 500 km/km^2 in upland areas where the ground is harder and steeper with higher precipitation (Huggett, 2011). The drainage densities in the NBMCA watersheds are consequently very low overall by comparison.

Table 6.2 Ranking System for Selected Basin Parameters

Parameter	Definition	Range of Values Observed for NBMCA	Assigned Ranking
Open Water Coverage (%)	Water Area / Total Area	1 to 7	Low
		7 to 12	Moderate
		12 to 17.5	High
Basin Relief Ratio (m/km)	Basin Relief / Basin Length	5.9 to 9.9	Low
		10 to 13.9	Moderate
		14 to 18.4	High
Main Channel Slope (m/km)	Main Channel Relief / Main Channel Length	0.6 to 3	Low
		3 to 6	Moderate
		6 to 9	High
Drainage Density (km/km^2)	Total Stream Length / Total Area	0.2 to 1.4	Low
		1.4 to 2.8	Moderate
		2.8 to 3.7	High

6.2.3 Drainage Efficiency

The drainage efficiency of a subwatershed can be evaluated and ranked based on basin shape. In theory, elongated basins are more efficiently drained than circular basins. The drainage efficiencies for subwatersheds in the NBMCA have been assessed based on the approach followed in the 1982 NBMCA Watershed Plan. Basin shape is only one of many factors that contribute to drainage efficiency and thus results should be interpreted with caution.

Table 6.3 Basin Characteristics

No	Subwatershed	Land Area (km²)	Water Area (km²)	Total Area (km²)	Open Water Coverage (%)	Open Water Coverage Ranking	Highest Watershed Elevation (m)	Outlet Elevation (m)	Basin Relief (m)	Basin Length (km)	Basin Relief Ratio (m/km)	Basin Relief Ratio Ranking	Maximum Main Channel Elevation (m)	Main Channel Length (km)	Main Channel Relief (m)	Main Channel Slope (m/km)	Main Channel Slope Ranking	Total Length of all Streams (km)	Drainage Density (km/km²)	Drainage Density Ranking
1	Bear Creek	59.19	1.48	60.67	2.4	Low	311.9	195.8	116.0	19.60	**5.9**	Low	340.2	36.37	144.4	4.0	Moderate	77.76	1.3	Low
2	Boulder	40.22	1.27	41.49	3.1	Low	305.7	195.8	109.9	16.48	6.7	Low	289.6	28.90	93.8	3.2	Moderate	49.96	1.2	Low
3	Windsor	23.69	0.88	24.57	3.6	Low	303.0	195.8	107.2	10.74	10.0	Low	256.8	7.41	60.9	8.2	High	23.25	0.9	Low
4	Burford Creek	12.25	0.64	12.89	5.0	Low	300.3	195.8	104.4	6.32	16.5	High	241.9	5.23	46.1	**8.8**	High	45.20	3.5	High
5	Callander Bay/South Shore	63.85	1.02	64.86	1.6	Low	271.9	195.8	76.0	-	-	-	-	-	-	-	-	14.12	**0.2**	Low
6	Chippewa Creek	37.40	0.37	37.77	**1.0**	Low	386.4	195.8	190.5	10.63	**17.9**	High	354.7	19.31	158.9	8.2	High	64.92	1.7	Moderate
7	Duchesnay Creek	99.76	1.89	101.65	1.9	Low	434.9	195.8	239.1	18.21	13.1	Moderate	**400.0**	46.43	**204.2**	4.4	Moderate	182.14	1.8	Moderate
8	Jessups Creek	**1.29**	**0.01**	**1.31**	1.1	Low	**212.1**	195.8	**16.2**	**2.14**	7.58	Low	**209.0**	**2.07**	**13.2**	6.4	High	**2.91**	2.2	Moderate
9	Lake Nipissing Shoreline/North Bay	16.43	0.18	16.61	1.1	Low	340.5	195.8	144.6	-	-	-	-	-	-	-	-	30.22	1.8	Moderate
10	La Vase River	87.81	2.95	90.76	3.2	Low	306.8	195.8	111.0	17.62	6.3	Low	240.0	34.98	44.2	**1.3**	Low	248.26	2.7	Moderate
11	Parks Creek	13.04	0.97	14.01	**6.9**	Low	235.9	195.8	40.1	5.84	6.9	Low	210.3	4.60	14.4	3.1	Moderate	52.08	**3.7**	High
12	Wistiwasing River	**224.53**	**9.84**	**234.38**	4.2	Low	**467.5**	195.8	**271.7**	**30.55**	8.9	Low	**400.0**	**75.67**	**204.2**	2.7	Low	**387.42**	1.7	Moderate
	Total to Lake Nipissing	**679.45**	**21.51**	**700.97**																
13	Amable du Fond River	**850.69**	**113.72**	**964.41**	11.8	Moderate	**512.0**	161.0	**351.0**	**53.12**	**6.6**	Low	401.3	**105.05**	240.3	2.3	Low	**2152.78**	2.2	Moderate
14	Boom Creek	135.44	**2.42**	137.86	1.8	Low	422.6	153.8	268.8	20.30	13.2	Moderate	**410.3**	55.44	**256.5**	4.6	Moderate	324.15	2.4	Moderate
15	Kaibuskong River	159.93	21.95	181.88	12.1	High	452.9	196.0	256.9	20.01	12.8	Moderate	230.5	56.88	34.5	**0.6**	Low	369.99	2.0	Moderate
16	Mattawa River	134.36	9.03	143.39	6.3	Low	436.9	**152.0**	284.9	26.09	10.9	Moderate	214.9	35.24	62.8	1.8	Low	288.97	2.0	Moderate
17	North River	243.81	3.96	247.77	**1.6**	Low	474.4	195.4	279.0	26.79	10.4	Moderate	409.3	69.82	213.9	3.1	Moderate	454.10	**1.8**	Moderate
18	Pautois Creek	167.20	8.58	175.78	4.9	Low	472.6	170.0	302.6	23.94	12.6	Moderate	401.3	53.07	231.3	4.4	Moderate	353.95	2.0	Moderate
19	Sharpes Creek	134.13	2.75	136.88	2.0	Low	453.7	196.5	257.2	17.10	15.0	High	396.6	44.96	200.1	4.5	Moderate	259.14	1.9	Moderate
20	Talon Lake	111.39	18.70	130.09	14.4	High	436.1	189.5	246.6	20.91	11.8	Moderate	**212.4**	24.33	**22.9**	0.9	Low	281.24	2.2	Moderate
21	Trout Lake	108.67	23.00	131.67	**17.5**	High	411.2	**202.0**	209.2	15.61	13.4	Moderate	371.8	18.82	169.8	**9.0**	High	326.18	2.5	Moderate
22	Turtle Lake	**38.99**	6.09	**45.08**	13.5	High	**344.0**	**202.0**	**142.0**	**7.70**	**18.4**	High	239.5	**9.78**	37.5	3.8	Moderate	**168.71**	**3.7**	High
	Total to Ottawa River	**2084.61**	**210.20**	**2294.81**																
	Total Study Area	**2764.06**	**231.71**	**2995.78**																
	Highest value			964.4	17.5		512.0	202.0	351.0	53.1	18.4		410.3	105.0	256.5	9.0		2152.8	3.7	
	Lowest value			1.3	1.0		212.1	152.0	16.2	2.1	5.9		209.0	2.1	13.2	0.6		2.9	0.2	

[A] Highest values in each tertiary watershed are shown in red bold (e.g. **224.53**)

[B] Lowest values in each tertiary watershed are shown in blue bold (e.g. **1.29**)

Three different drainage efficiency factors have been examined: form factor, basin elongation, and lemniscate. These factors are all calculated based on basin area and basin length. Drainage efficiency can also be affected by other factors such as basin and stream channel slopes, vegetative cover and land uses, as well as rates of infiltration associated with the land surface. For example, the drainage efficiency for the La Vase subwatershed, based on its shape factors has been rated as Moderate/High however actual drainage is influenced by flat relief and extensive exposed areas of undulating bedrock, which has created many small lakes and wetland areas in its middle reaches (which suggests it has poor drainage).

Drainage efficiencies have been ranked based on the range of values encountered within NBMCA watersheds and do not necessarily apply outside of the study area. The ranking system developed for the drainage efficiency properties is provided in Table 6.4.

Overall drainage efficiency ratings have been developed for each system based on all three efficiency measurements. The Callander Bay/South Shore subwatershed and the Lake Nipissing North Bay subwatershed have not been evaluated because they are a compendium of many basins and basin length cannot be properly measured. Overall drainage efficiency rankings are presented in Table 6.5.

Table 6.4 Ranking System for Various Drainage Efficiency Properties

Property	Formula	Range of Values Observed in NBMCA	Assigned Ranking
Form Factor[1] (Horton, 1932)	FF = Basin Area / Basin Length^2	0.15 to 0.4 (more elongated)	High
		0.4 to 0.6	Moderate
		0.6 to 0.76 (more circular)	Low
Basin Elongation[2] (Schumm, 1956)	BE = 2 x (Basin Area)$^{1/2}$ /(Basin Length x $(\pi)^{1/2}$)	0.44 to 0.6 (more elongated)	High
		0.6 to 0.8	Moderate
		0.8 to 0.98 (more circular)	Low
Lemniscate Ratio[3] (Chorley et al. 1957)	Lem = Basin Length^2 / (4 x Basin Area)	0.33 to 0.7 (more circular)	Low
		0.7 to 1.1	Moderate
		1.1 to 1.64 (more elongated)	High

1 Form factor of a circle is 0.785. More elongated basins have lower values.
2 Basin elongation of a circle is 1.0. More elongated basins have lower values.
3 Lemniscate ratio of a circle 0.318. More elongated basins have higher values.

Table 6.5 Drainage Efficiency Rankings of NBMCA Subwatersheds

No	Subwatershed	Form Factor	Efficiency Rating (FF)	Basin Elongation	Efficiency Rating (BE)	Lemniscate	Efficiency Rating (Lem)	Overall Efficiency Rating
				NBMCA Areas Draining to Lake Nipissing				
1	Bear Creek	0.16	High	0.45	High	1.58	High	**High**
2	Boulder	0.15	High	0.44	High	1.64	High	**High**
3	Windsor	0.21	High	0.52	High	1.17	High	**High**
4	Burford Creek	0.32	High	0.64	Moderate	0.77	Moderate	**Moderate/High**
5	Callander Bay/South Shore	-	-	-	-	-	-	**-**
6	Chippewa Creek	0.33	High	0.65	Moderate	0.75	Moderate	**Moderate/High**
7	Duchesnay Creek	0.31	High	0.62	Moderate	0.82	Moderate	**Moderate/High**
8	Jessups Creek	0.28	High	0.60	Moderate	0.88	Moderate	**Moderate/High**
9	Lake Nipissing Shoreline/North Bay	-	-	-	-	-	-	**-**
10	La Vase River	0.29	High	0.61	Moderate	0.86	Moderate	**Moderate/High**
11	Parks Creek	0.41	Moderate	0.72	Moderate	0.61	Low	**Moderate/Low**
12	Wistiwasing River	0.25	High	0.57	High	1.00	Moderate	**High/Moderate**
				NBMCA Areas Draining to Ottawa River				
13	Amable du Fond River	0.34	High	0.66	Moderate	0.73	Moderate	**Moderate/High**
14	Boom Creek	0.33	High	0.65	Moderate	0.75	Moderate	**Moderate/High**
15	Kaibuskong River	0.45	Moderate	0.76	Moderate	0.55	Low	**Moderate/Low**
16	Mattawa River	0.21	High	0.52	High	1.19	High	**High**
17	North River	0.35	High	0.66	Moderate	0.72	Moderate	**Moderate/High**
18	Pautois Creek	0.31	High	0.62	Moderate	0.82	Moderate	**Moderate/High**
19	Sharpes Creek	0.47	Moderate	0.77	Moderate	0.53	Low	**Moderate/Low**
20	Talon Lake	0.30	High	0.62	Moderate	0.84	Moderate	**Moderate/High**
21	Trout Lake	0.54	Moderate	0.83	Low	0.46	Low	**Low/Moderate**
22	Turtle Lake	0.76	Low	0.98	Low	0.33	Low	**Low**

The overall drainage efficiency rankings for the tertiary watersheds are summarized in Table 6.6. The drainage efficiency of 98% of all subwatersheds draining to Lake Nipissing ranks as "Moderate/High" or "High" and no subwatershed ranked less than "Moderate/Low". By comparison, the drainage efficiency for 78% of the NBMCA subwatersheds draining to the Ottawa River are ranked "Moderate/High" or "High"; and 22% are ranked as "Low" or "Moderate/Low". The basins within the study areas draining to Lake Nipissing appear to have a more efficient shape than subwatersheds draining to the Ottawa River. As noted above drainage efficiency is also affected by other basin characteristics.

Table 6.6 Summary of Overall Drainage Efficiency Rankings for NBMCA Subwatersheds Draining to Lake Nipissing and Ottawa River

Overall Drainage Efficiency Ranking	Subwatersheds draining to Lake Nipissing (excluding shoreline basins)		Subwatersheds draining to Ottawa River	
	(km^2)	(%)	(km^2)	(%)
High	127	20%	143	6%
High/Moderate	234	38%	0	0%
Moderate/High	244	39%	1656	72%
Moderate	0	0%	0	0%
Moderate/Low	14	2%	319	14%
Low/Moderate	0	0%	132	6%
Low	0	0%	45	2%

6.3 Summary and Data Gaps

The study area is approximately 2,996 km^2 in size, of which 701 km^2 drains to Lake Nipissing and 2,295 km^2 drains through the Mattawa River system to the Ottawa River. The study area has been divided into 22 quaternary or sub quaternary subwatersheds for analysis purposes that range in size from 1.3 to 964 km^2, which represents less than 1% to greater than 30% of the study area. This large size variance makes basin comparisons difficult.

Based on total subwatersheds 89% of the study area is comprised of headwater systems. Headwater systems mainly rely on internal controls and management efforts. Turtle Lake, Lake Talon and the Lower Mattawa River subwatersheds are flow-through systems with upstream inputs. Flow-through systems have more complex management considerations that depend on upstream management efforts. Lake-dominated systems tend to focus on lake management concerns. Shoreline subwatersheds only include localized drainage and have to contend with dynamic beach environments.

Basin and stream measurements can be evaluated to reveal characteristics that may influence runoff, rates of erosion, water and habitat quality or which may be a determinant in whether an area is suitable for settlement. For example, Dunn and Leopold states that high drainage density subwatersheds may experience higher flooding, sediment loading and erosion; and may be more difficult to access and be less suitable for agriculture (Dunn and Leopold, 1978). The high drainage densities in the study area were identified in the Parks Creek and Turtle Lake subwatersheds.

Drainage efficiency was evaluated for each subwatershed based on 3 basin shape parameters including form factor, elongation, and leminiscate. Bear, Boulder, Windsor, and Lower Mattawa River subwatersheds are rated as having “High” drainage efficiencies while the Wistiwasing River efficiency is rated as “High/Moderate”. These rankings may be suggestive of higher potential for erosion and water quality issues.

The steepest stream gradients exist in the Windsor Creek, Burford Creek, Chippewa Creek, Jessups Creek, and Four Mile Creek (Trout Lake) subwatersheds. These watersheds may be more prone to erosion due to higher rates of runoff. The flattest stream gradients exist in La Vase, Kaibuskong River and Talon Lake. These watersheds may experience sediment deposition issues if erosion contributes sediment to these systems.

This section updates the geomorphological basin assessment approach that was developed in the first watershed plan with more subwatersheds included and with improved interpretation of the data. The approach examines each basin characteristic individually and compares basin features between study area basins only. As identified above the interpretation of a single parameter may, in itself, be misleading. It may be possible to add interpretive value by developing a matrix that evaluates the various basin rankings in a more comprehensive manner. Value would be added if individual basin infiltration characteristics were assessed as well as total wetland areas and stream morphology factors were considered. It may be advantageous to group watersheds into quaternary and sub-quaternary basins for comparison purposes. It is also possible to do a more in-depth assessment for each basin feature and comparisons can be expanded to external basins when data is available.

Stream and basin morphologic assessment approaches have advanced significantly over the past 30 years however generally speaking these types of assessments remain a data gap for Ontario’s Conservation Authorities (Conservation Ontario, 2010). Stream morphological assessment can assist with the understanding of watershed responses to rainfall, snowmelt and runoff as well as to understand erosion potential, water quality tendencies and watershed suitability/sensitivity to settlement. A subwatershed-based assessment of soil and erosion processes in the North Bay-Mattawa Conservation Authority was completed more than 30 years ago (Shrubsole, Goodman, Sullivan, 1980). New approaches developed since then in this field can expand the interpretive value of this work.

7.0 Climate and Climate Change

7.1 Introduction

A range of weather and climate variables influence a region's climate with numerous non-linear interactions between the atmosphere, the cryosphere, ocean, land, and ecosystems (IPCC 2007). The relationships between these variables and their interactions can change the weather and climate at global, regional, and local scales. These changes in turn can impact watersheds, other natural resources, and human infrastructure. The following sections profile the climatic characteristics of the jurisdictional area of the NBMCA and reports on detailed aspects of climate change that are important to hydrologic and ecologic functions of the watersheds within this region.

7.2 Regional Climate

The climate for the NBMCA's area of jurisdiction is influenced by its inland positioning on the North American continent, the general forested landscape of central and northeastern Ontario, and its proximity to large water bodies including the Great Lakes. The Köppen Climate Classification System places the climate of the NBMCA's watershed within the climatic region defined as 'Dfb' (Atlas of Canada, 3rd Edition, 1957, map is available online from Natural Resource Canada) which means that the study area has a humid continental climate with severe winters and warm summers and it encounters no dry season. Generally weather patterns track across the region from west to east and prevailing winds are typically southwest in the warmer months and out of the north in the winter.

7.3 Local Climate

General climatic conditions for the North Bay-Mattawa Conservation Authority's area of jurisdiction have been assessed within the Watershed Plan Background Inventory Report (NBMCA, 1982), in the Groundwater Study (Waterloo Hydrogeologic Inc, 2006), and within Drinking Water Source Protection Watershed Characterization Assessment Report (NBMCA, 2008). The NBMCA's watershed hydrologic water balance has been examined in the Source Water Protection Planning North Bay-Mattawa Source Protection Area Conceptual Water Budget (Gartner Lee, 2008). Detailed examination of potential climate change impacts to the hydrologic balance of Trout/Turtle Lake basin has been completed through two Source Water Protection background reports (Aqua Resource Inc, 2010a and 2010b). Preliminary findings of a Tier One review resulted in detailed assessment of climatic stress and risk posed by summer and winter water withdrawal from Trout/Turtle Lake by the City of North Bay.

Considerable work has been carried out in Ontario concerning the types of climate change impacts anticipated and when changes will occur. Of note is the "Current and Projected Future Climatic Conditions for Ecoregions and Selected Natural Heritage Areas in Ontario" completed by the Ontario Ministry of Natural Resources in 2010. Changing severe weather patterns have been examined by the Insurance Bureau of Canada in a report entitled “Telling the Weather Story” June, 2012. Extensive climate change research has been undertaken at a global scale by various groups, such as the International Panel on Climate Change. This body of research was generally considered in the following sections.

7.3.1 Local Climate Data

Temperature and precipitation data are available on a regional basis for a variety of locations and periods. Historic data presented in the first NBMCA Watershed Plan Background Inventory (NBMCA, 1982) has been updated in Table 7.1.

Table 7.1 Weather Stations and Data available for the NBMCA Area of Jurisdiction

Station Name	Station I.D. Number	Lattitude	Longitude	Elevation m	NBMCA Location	Period Available	Data Online	Temp	Precip	Other	Meets WMO Standards	Current Status
La Cave	6084278	46o 22' N	78o 44' W	172.2	outside	1950 - 1976		✓	✓			Inactive
South River		45o 50' N	79o 23' W	395.9	outside	1977 - N/A		✓	✓			Inactive
Nipissing	6116555	45o 56' N	79o 12' W	185.6	outside	1915 - 1919			✓			Inactive
Chisholm Township	6116702	46o 07' N	79o 15' W	274.3	inside	1974 -	☑	✓	✓		✓	Active
Powassan	6116703	46o 05' N	79o 21' W	274.3	outside	1970 - 1974		✓	✓			Inactive
Bingham Chutes	6110745	46o 05' N	79o 24' W	242.3	outside	1933 - 1970		✓	✓			Inactive
Nipissing (McNab Chutes)	6115667	46o 06' N	79o 26' W	214.6	outside	1921 - 1933		☑	✓			Inactive
Lake Talon	6084304	46o 18' N	79o 05' W	N/A	inside	1905 - 1906			✓			Inactive
Rutherglen	6087255	46o 15' N	79o 04' W	240.5	inside	1891 - 1940		☑	✓			Inactive
Lake Kioshkokwi	6084201	46o 05' N	78o 53' W	301.1	inside	1905 - 1906			✓			Inactive
North Bay (King St)	6085682	46o 19' N	79o 23' W	201.2	inside	1886 - 1982	☑	✓	☑			Inactive
North Bay Airport	6085700	46o 22' N	79o 28' W	368.8	inside	1937 -	✓	✓	✓	✓	✓	Active
North Bay (OWRC)	6085704	46o 18' N	79o 25' W	198.1	inside	1969 - 1971		✓	✓			Inactive
Trout Creek	6118938	46o 02' N	79o 23' W	333.1	outside	1981 - N/A	☑		✓			Inactive
									☑	Some Years		

There are currently two active weather stations within the NBMCA’s area of jurisdiction, the North Bay Airport maintained by Environment Canada and a site maintained by Keith Topps (Retired Professor from Nipissing University, who taught meteorology) at his home in Chisholm Township (this station is listed as Powassan online). Both of these sites comply with United Nations World Meteorological Organization standards. Climatic normals are available online for four stations (Environment Canada 2012) that are within or near the NBMCA watershed boundaries. Climate normals show the average recordings for climatic variables (such as precipitation and temperature) over a period of 30 years. Stations and data available online are summarized in Table 7.2

The most long standing source of meteorological data for the NBMCA watershed is the North Bay Airport weather station which has been collecting daily climatic data since January 1939 and hourly data since January 1953. A selection of 1971 - 2000 climate normals for this station, available from Environment Canada, is summarized in Table 7.3 (Note: Stantec has generated climatic normal data for other normal periods including 1981 – 2010 from annual records to assist with climate change analysis – comprehensive normal data for the North Bay Airport is only available from Environment Canada for 1971 - 2000).

Table 7.2 Weather Stations with Climate Normals within the NBMCA Area of Jurisdiction

Station	Data Available
Powassan*	1971 – 2000 Climate Normals
Trout Creek	1971 – 2000 Climate Normals
North Bay (King St)	1961 – 1990 Climate Normals
North Bay Airport*	1961 – 1990 Climate Normals, 1971 – 2000 Climate Normals, All historic weather

* Complies with World Meteorological Organization standards

Table 7.3 Summary of Historic Climate Normals for the North Bay Airport (1971 – 2000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Precipitation (mm)	67.6	52.6	65.4	67.2	87.6	95.2	100.1	100.1	113.5	97.6	89.9	70.9	**1007**
Rainfall (mm)	16.9	9.6	31.9	51.4	85.5	95.2	100.1	100.1	113.3	92.2	58.6	19.9	**774.6**
Snowfall (cm)	63	52.2	38	16.2	2.1	0	0	0	0.2	5.5	35	61.2	**273.4**
Average Snow Depth (cm)	39	51	44	11	0	0	0	0	0	0	4	18	**14**
Extreme Daily Rainfall (mm)	52.7	21.3	45.7	62.2	50	63.8	93.2	96.3	71	75.2	53.2	38.4	
Year	1997	1968	1942	1939	1970	1957	1990	1952	1999	1983	1995	1961	
Temperature °C	-13	-10.9	-4.8	3.3	11.2	15.9	18.6	17.3	12.2	5.9	-1.4	-9.1	**3.8**
Daily Maximums °C	-8	-5.8	0.2	8.4	16.8	21.3	23.8	22.3	16.9	10.1	2.2	-4.7	**8.6**
Daily Minimums °C	-18	-15.9	-9.8	-1.8	5.5	10.5	13.3	12.3	7.4	1.7	-4.9	-13.5	**-1.1**
Wind Speed (km/hr)	13.6	13.6	14.8	14.8	13.5	12.2	11.5	10.7	11.8	13.1	13.9	13.2	**13.1**
Wind Direction (common)	SW	N	N	N	SW	SW	SW	SW	SW	SW	S	E	**SW**
Relative Humidity @ 6 am	77.2	75.6	74.4	74	74.9	80.9	84.6	88.8	90.1	85.8	85.4	81.9	**81.1**
Relative Humidity @ 4 pm	70.3	65	58.7	52.5	50.6	56	57.6	61.3	66	65.3	74.8	75.3	**62.8**
Heating Degree Days > 18° C	961.4	815.9	707.2	442	217.2	86.8	31.3	54.4	181.8	374.8	581.3	841.1	**5295.2**
Cooling Degree Days < 18° C	0	0	0	0.7	6.2	24.3	48.3	33.1	6.5	0.2	0	0	**119.3**
Rain and Snow Melt (mm)*	15.4	27.2	115.6	151.8	88.9	95.2	101.1	101.1	113.5	97.5	75.8	25.7	**1006.7**
Evapotranspiration (mm)*	0.2	0.08	5.1	26.1	75.5	107.3	125.7	108.1	66.7	30.8	6.9	0.8	**554**
Runoff (mm)*	15.1	26.5	110.5	125.7	13.4	-12.1	-25.6	-8	46.7	66.7	68.8	24.9	**452.7**
* Calculated by Stantec													

Source: Environment Canada with Hydrologic Water Balance information calculated by Stantec (see Appendix A)

Online normal data for Powassan and the North Bay Airport (Environment Canada) as well as data summarized for a number of now inactive weather stations in the Watershed Plan Background Inventory Report (1982) show subtle differences in regional temperatures and precipitation across the watershed. Gartner Lee (2008) has described the dominant weather modifiers within the NBMCA watershed as follows (note these modifiers affect both temperature and precipitation):

- the modifying effect (on temperature) of Lake Nipissing and Georgian Bay;
- the orographic effect of the Northern uplands resulting in a higher precipitation average from cyclonic disturbances in the north through to the northwest;
- the orographic effect of the Nipissing-Algonquin Highlands resulting in a higher precipitation average in the south;
- the rain shadow and temperature inversions which result in low precipitation occurring in the Mattawa lowlands; and
- the urban heat island effect that occurs over North Bay.

When assessing trends in historic climatic data, regional and local influencing factors should be considered (for example, meteorological stations are often influenced by urban environments).

7.3.2 Temperature

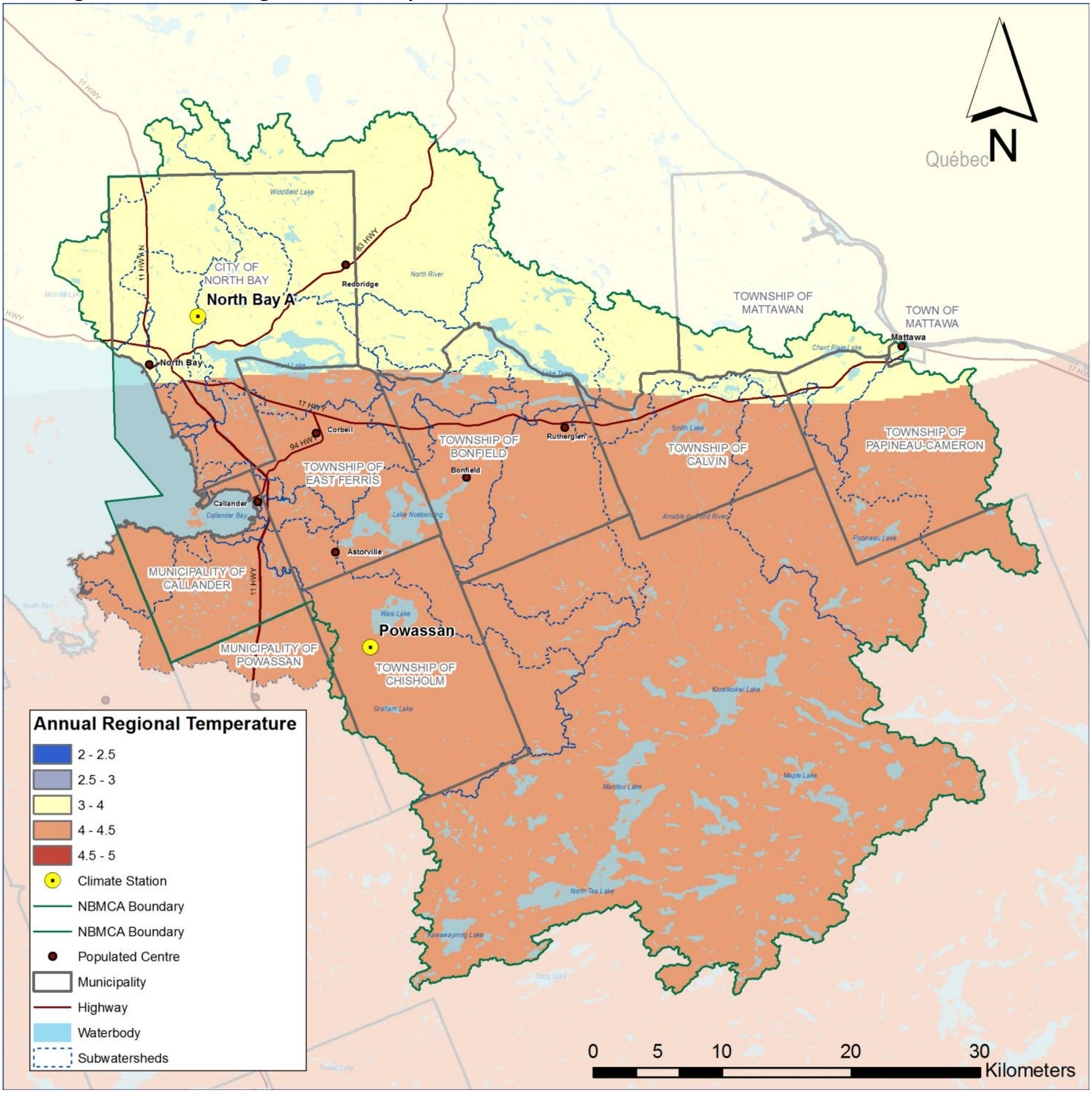
Annual average temperatures display a north-south trend, as they range between 3.5 and 4.0^{o} C north of the North Bay-Mattawa escarpment and between 4.0 and 4.5^{o} C below this escarpment and in the Algonquin highlands (see Figure 7.1) (NBMCA, 2008). The NBMCA experiences a high temperature variation between seasons. Based on online data available from Environment Canada for the NBMCA, average summer temperatures (for the four warmest months) range between 16.0 and 17.5^{o} C, while average winter temperatures (for the four coldest months) range between – 8.5 and – 10.0^{o} C (Environment Canada, 2012).

7.3.3 Precipitation

Climatic data from all stations indicate that, on average, the NBMCA area of jurisdiction receives approximately 1000 mm of precipitation annually. Figure 7.2 illustrate the higher annual average precipitation received in upland areas compared to the Mattawa lowlands. Precipitation is received throughout the year, with greater monthly accumulations between May and November (when prevailing winds are from the southwest) and lower monthly totals are experienced between December and April. Generally precipitation falls as rain in the eight warmer months and as snow in winter.

Based on a comparison of climate normals between North Bay Airport and Powassan, approximately 25 % of precipitation falls as snow in lower elevations, while 30% of precipitation falls as snow in higher elevations. Moderately high humidity occurs in the region throughout the year. During the 1971 – 2000 climate normal period relative humidity averaged 72 % at the North Bay Airport, with humidity being higher in the summer and fall, and lower in winter and early spring (Environment Canada 2012).

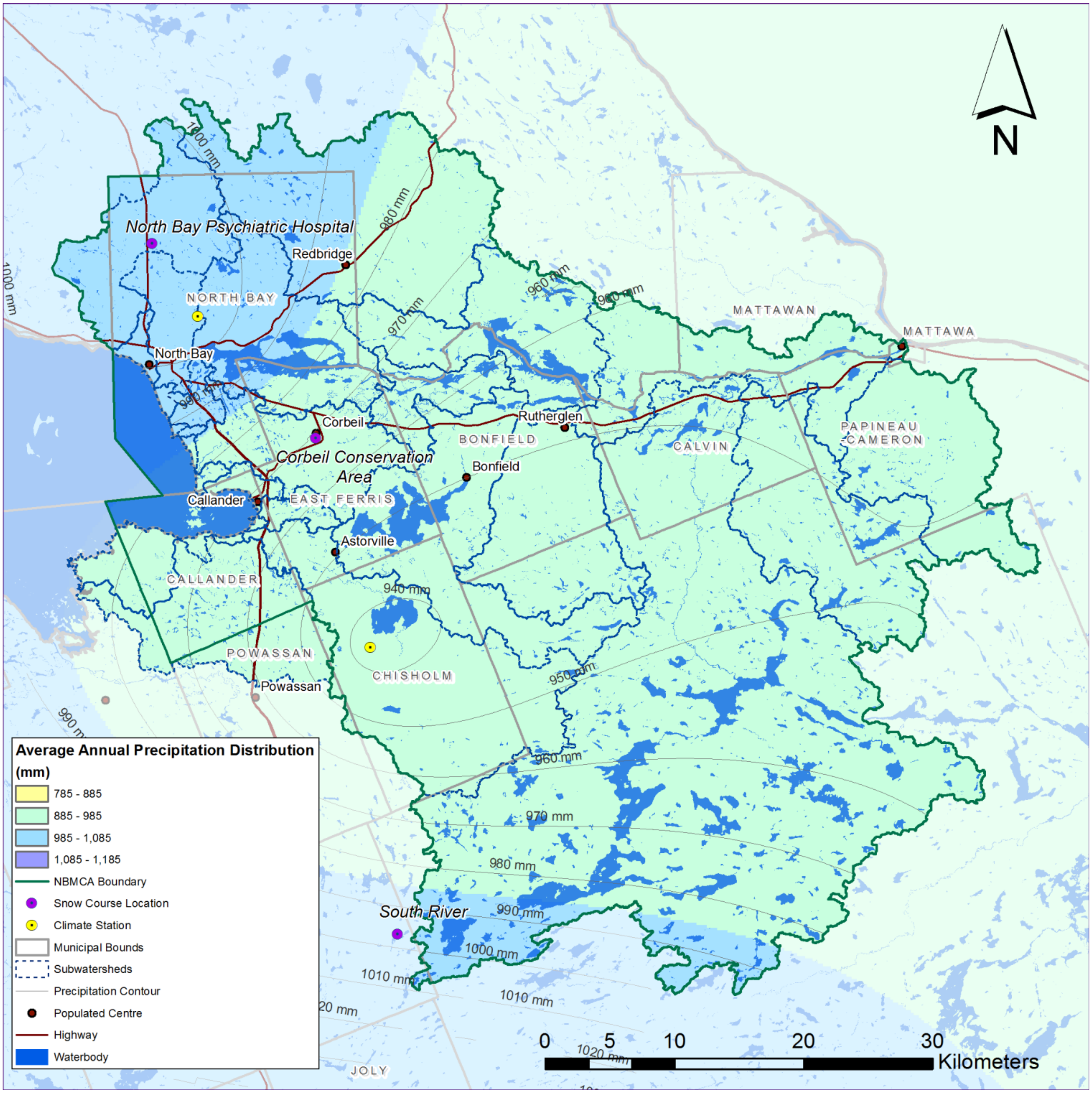
Figure 7.1 Average Annual Temperatures for 1971-2000 within the NBMCA Watershed



Source: Drinking Water Source Protection (NBMCA 2008)

Data in Table 7.3 demonstrates that winter temperatures support the accumulation of snow on the ground, which builds in mass in early winter, peaks in February and condenses in late winter. When snow conditions are "ripe" snow can rapidly melt to create a spring freshet. The annual freshet is closely monitored by water management agencies to ensure that critical water surface elevations stay within normal ranges for the period and that depleted storage from winter draw down is replenished. A formal management advisory committee oversees the management of water levels on Lake Nipissing. Other water management structures within NBMCA watersheds are typically managed by the Ministry of Natural Resources following internal operation and control guidelines.

Figure 7.2 Annual Average Precipitation for 1971-2000 within the NBMCA Watershed



Source: Drinking Water Source Protection (NBMCA 2008)

7.3.4 Snow Course Monitoring

The NBMCA monitors snow depths and water content at three snow survey locations within its area of jurisdiction; North Bay, East Ferris, and Chisholm. The data is collected as part of a provincial monitoring network. Snow is monitored biweekly between November and May. The Ministry of Natural Resources synthesizes snow course data for the entire province. This data is used for many purposes including water level management, flood forecasting, and flood warning. Snow courses and the period of data collection are summarized in Table 7.4.

Table 7.4 NBMCA Snow Course Location and Period of Data Collection Summary

Name of Snow Course	Location	Period of Data Available
North Bay Regional Mental Health Centre	Highway 11 North, North Bay	1988 – 2011*
Corbeil Conservation Area	Corbeil Conservation Area, East Ferris	1987 – present
Shirley Skinner Conservation Area	Memorial Park Drive, Chisholm	2006 – present

* Station relocated to North Bay Golf and Country Club

7.3.5 Hydrologic Water Balance

Gartner Lee developed a conceptual water budget for the North Bay Mattawa Source Protection Area in 2008. Climatic data from the North Bay Airport, Powassan plus eleven weather stations surrounding the study area where used for this assessment. The analysis used climate normals for the period 1971 – 2000. The water budget was calculated on a watershed basis and illustrates variations experienced across the region. The following section describes the hydrologic water balance results of this report.

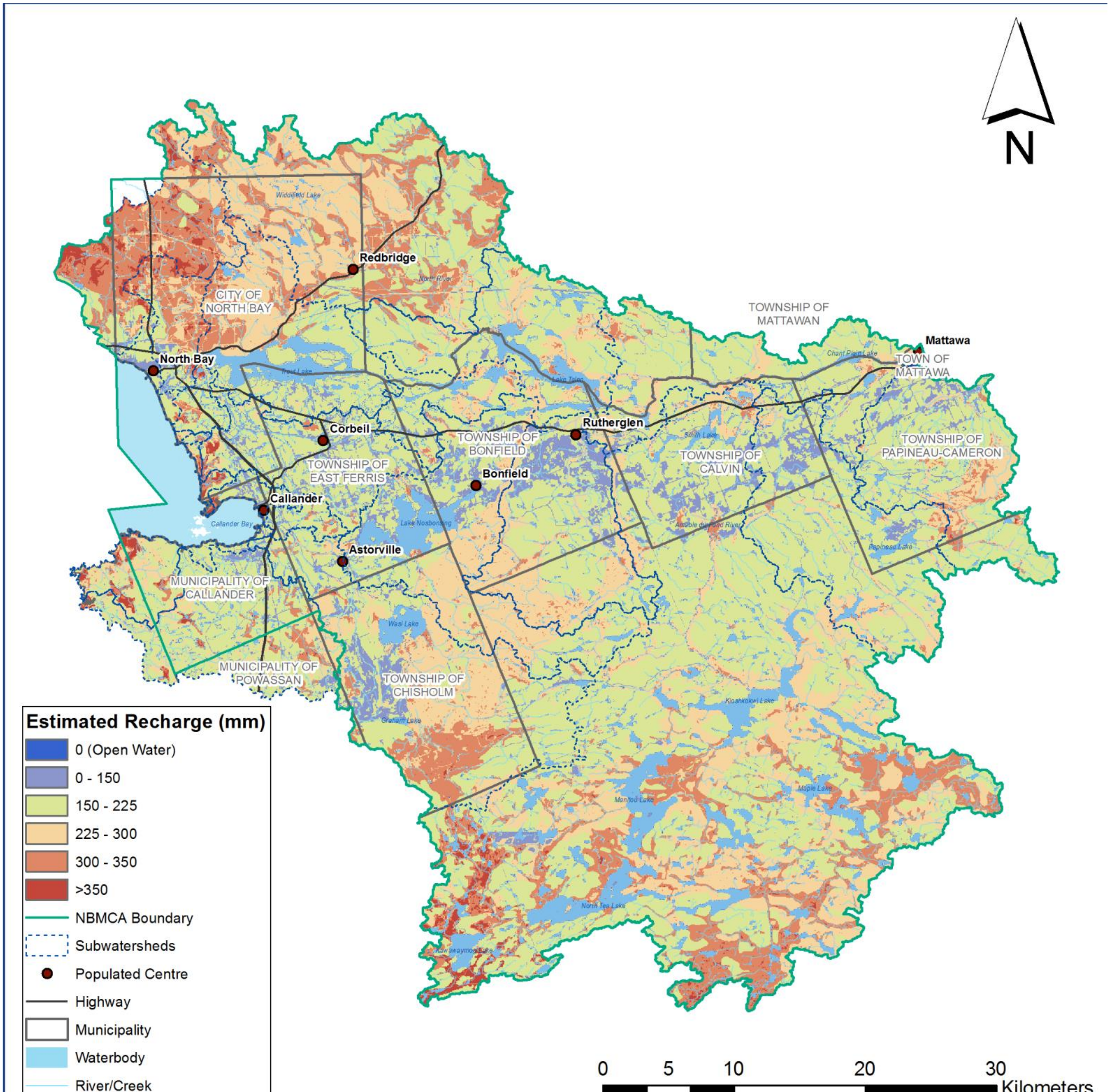
Gartner Lee (2008) calculated regional actual evapotranspiration rates for the 1971 – 2000 period for the 13 stations using the Thornthwaite and Mather (1957) method. Rates were produced using monthly precipitation (segregated into rainfall and snowfall), temperature, hours of daylight, and assumed a soils water holding capacity of 100 mm for a general sandy soil type. Total mean annual evapotranspiration for the North Bay Airport for the 1971 – 2000 period was 533.7 mm or 53.0 % of the total precipitation received (1007.7 mm). Total mean annual actual evapotranspiration for Powassan was 539.2 mm or 57.6 % of the total precipitation received (935.7 mm). These weather stations, and stations outside of the watershed, were used to develop regional evapotranspiration rates for the 1971 – 2000 period, as illustrated in Figure 7.3. Gartner Lee (2008) observed that a low variation in evapotranspiration rates occur across the region.

Gartner Lee (2008) calculated water surplus by subtracting evapotranspiration from total precipitation. The surplus has been partitioned into recharge and runoff by considering topography, soil texture, vegetation cover or type and available water for each subwatershed. Regional annual average recharge rates for the NBMCA watershed (1971 – 2000) are presented in Figure 7.4 and regional annual average runoff rates (1971 – 2000) are presented in Figure 7.5.

Figure 7.3 Regional Annual Evapotranspiration Rates within the NBMCA Watershed (1971 – 2000)

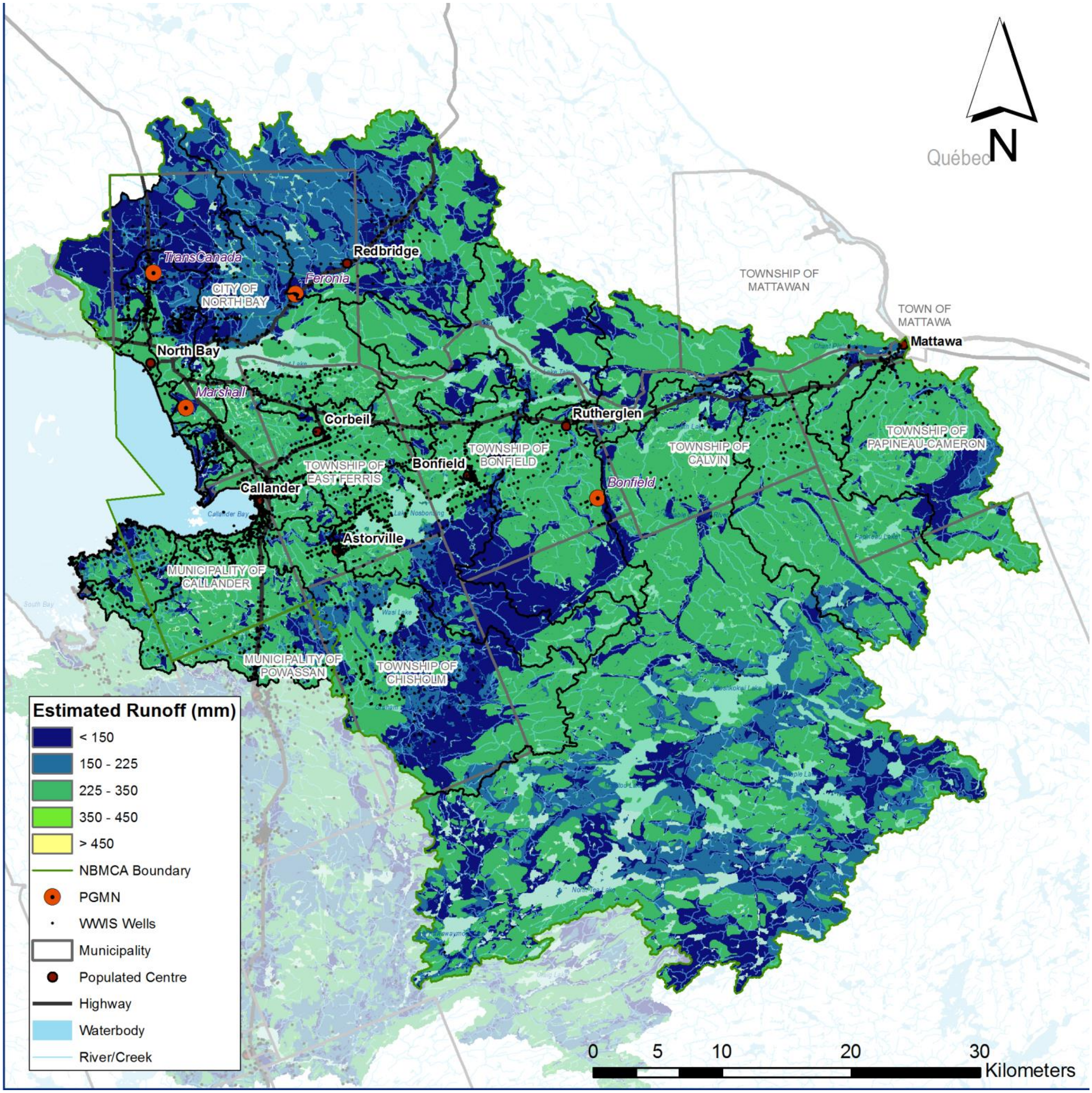
Source: North Bay-Mattawa Source Protection Area Conceptual Water Budget (Gartner Lee 2008)

Figure 7.4: Regional Annual Recharge Rates within the NBMCA Watershed (1971 – 2000)



Source: North Bay-Mattawa Source Protection Area Conceptual Water Budget (Gartner Lee 2008)

Figure 7.5 Regional Annual Runoff Rates within the NBMCA Watershed (1971 – 2000)



Source: North Bay-Mattawa Source Protection Area Conceptual Water Budget (Gartner Lee 2008)

7.4 Recent Local Climate Change

The NBMCA has examined climate change impacts to Trout Lake/Turtle Lake in a memorandum entitled "Climate Change Hydrologic Impact Assessment for the Trout Lake/Turtle Subwatershed" (Aqua Resources, 2010). This study applied 10 global climate change scenarios out of a possible 76 modeled scenarios to the Trout Lake/Turtle Lake basin. The 10 scenarios selected ensured that a full range of possible outcomes were explored. The 10 climate change scenarios used the climate normals for 1961 – 1990 for the grid point closest to the North Bay Airport climate station (AES 6085700) and projected an increase in mean annual temperature ranging from 1.76 to 4.23° C with a median warming of 2.76° C by 2041 – 2070. Precipitation changes were predicted to increase between 0.92 and 12.97 percent over this period (Aqua Resources, 2010). This approach applied methodologies stipulated by the Source Water Protection guidelines; principally the draft "Guide for Assessment of Hydrologic Effects of Climate in Ontario (Guide)" prepared by MNR and the Credit Valley Conservation Authority, 2009.

Supplemental climatic analyses have been conducted by Stantec to complete a climate change stress assessment to support the Integrated Watershed Management Plan. Climate change trends in the NBMCA watersheds were observed through examination of 60+ years of data available from the North Bay Airport. This weather station is the only station within the NBMCA's area of jurisdiction with an extensive record period (comprehensive data is available for a 70+ year period) and meets quality standards set by the World Meteorological Organization. Trends at the North Bay Airport were examined to assess annual, decadal, and multi-decadal (30 year climate normals) changes in climate. Data from the 30 year climate normals are compared on a month-by-month basis to determine how changes evolved throughout the year, and from season to season.

To determine if the data from the North Bay Airport is representative of climate change occurring within other watersheds within the NBMCA's area of jurisdiction, data from Powassan has been examined. Climate normals from other selected stations outside the NBMCA's area of jurisdiction were also examined to assess whether climate change trends observed within the NBMCA watersheds are typical of the region, or whether they are unique to the NBMCA watersheds.

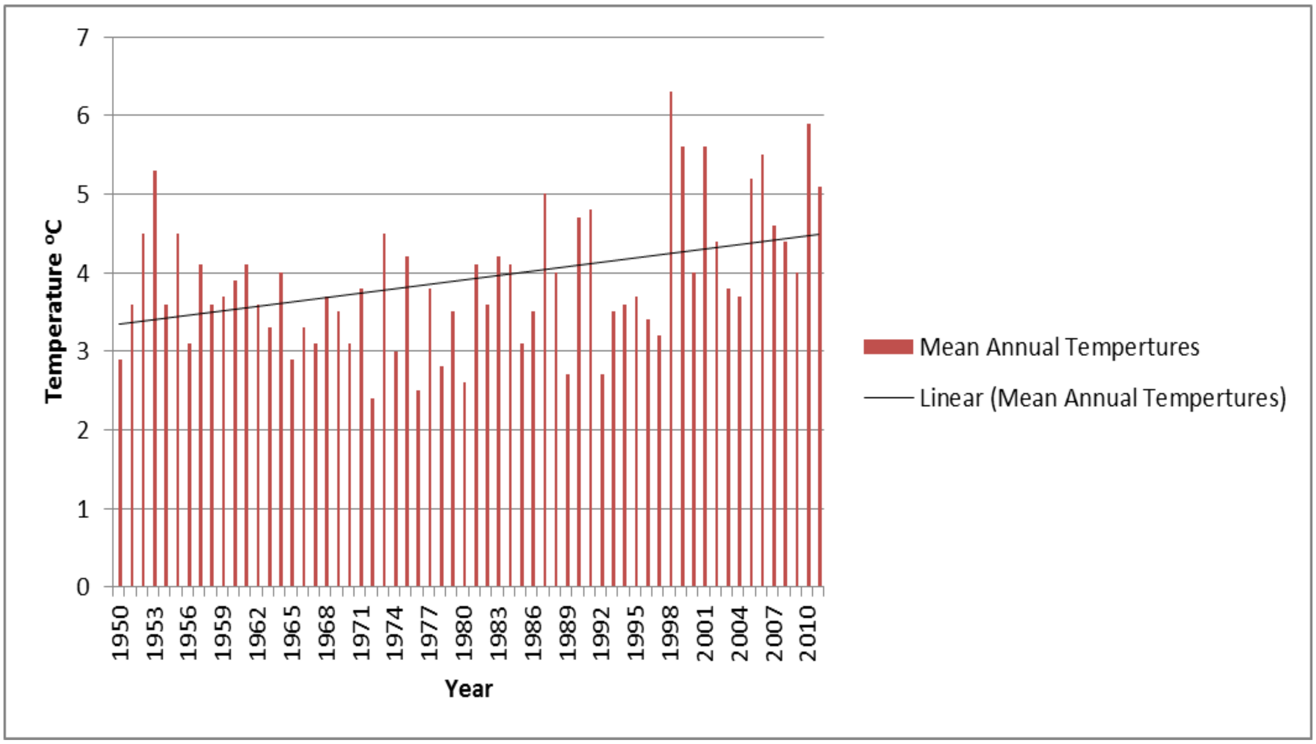
7.4.1 Observed Trends in Temperature

Mean annual temperatures at the North Bay Airport have been trending higher since the 1950's, as illustrated in Figure 7.6. Annual temperatures are increasing at an average rate of approximately 0.126^{o} C per decade since 1950 but this trend is not evenly distributed. Average annual temperatures were relatively stable until 1997, after which a distinct warming trend has been observed. Of the eight years where annual average temperatures exceeded 5.0^{o} C since

1950, seven occurred in the last 15 years, with 1998 being the warmest year recorded at the North Bay Airport.

Decadal trends in mean average temperatures, as well as mean maximum and mean minimum temperatures, are illustrated in Figure 7.7. Calculations for each decade were completed by averaging the annual temperatures (maximum, mean and minimum) for each decadal period, e.g. from 1950 – 1959. Figure 7.7 shows a slight decline in mean temperatures until the 1970's, after which a fairly consistent increase was observed. Mean maximum temperatures did not increase as much between the 1990's and 2000's as the mean average temperature, suggesting that average temperature increases were more affected by rising daily minimums.

Figure 7.6 Mean Annual Temperatures, North Bay Airport (1950 – 2011)



Mean minimum, mean maximum, and mean average annual temperature statistics for four consecutive climate normals for the North Bay Airport are summarized in Table 7.5 and illustrated in Figure 7.8 (Note: Stantec generated data for the climate normals from annual records for 1951 – 1980 and 1981 – 2010 for the purpose of this analysis).

The lumping of data into 30-year moving averages filters out decadal variances and the results suggest that minimum, maximum, and mean temperatures are gradually rising. Records show that the mean average temperature has increased by 0.63^{o} C from the 1951 – 1980 climate normals to the 1981-2010 climate normals.

Figure 7.7 Mean Minimum, Mean Maximum, and Mean Average Temperatures at North Bay Airport for Decadal Periods from 1950 to 2000

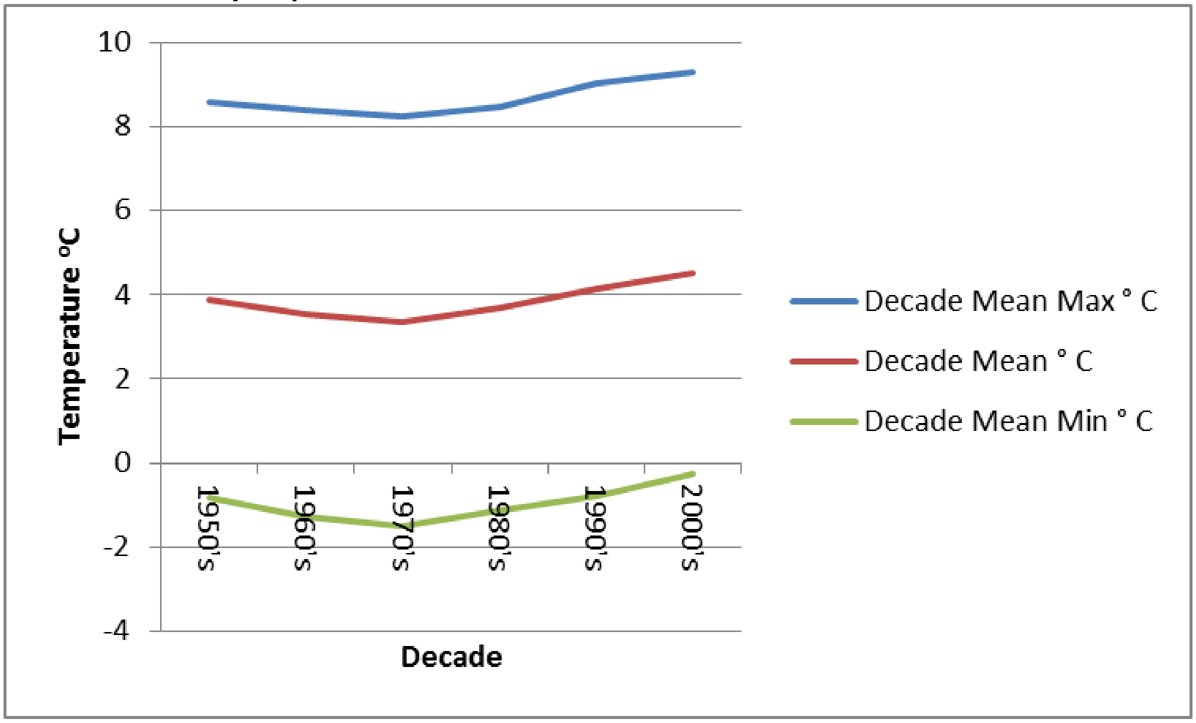


Table 7.5 Mean Average, Mean Maximum, and Mean Minimum Temperatures for Climate Normals - North Bay Airport

Period	Mean Average Temps ° C	Mean Ave Max ° C	Mean Ave Min ° C
1951 – 1980	3.59	8.37	- 1.21
1961 – 1990	3.57	8.40	- 1.28
1971 – 2000	3.76	8.62	- 1.12
1981 – 2010	4.22	9.04	- 0.61

Monthly data was assessed to determine seasonal variation within the warming trend. This was conducted by comparing North Bay Airport mean monthly climate normal temperatures for 1951 - 1980 and 1981 - 2010. Results are presented in Figure 7.9. Mean monthly temperatures were higher in the 1981 – 2010 climate normal in every month except October. Mean temperature increases were greatest in December (+ 1.45° C) and February (+ 0.93° C) and smallest in October (- 0.24° C) and November (+ 0.11° C). The data from the North Bay Airport shows the largest impact is experienced in the winter months and the least impact occurs in the fall. Increasing mean winter temperatures may be associated with a reduced albedo from a declining period of snow cover. It is unknown why there has been a smaller rise in mean temperatures during the fall months, or why there was a decline in mean temperature

Figure 7.8 Mean Average, Mean Maximum and Mean Minimum Temperatures for Climate Normals – North Bay Airport

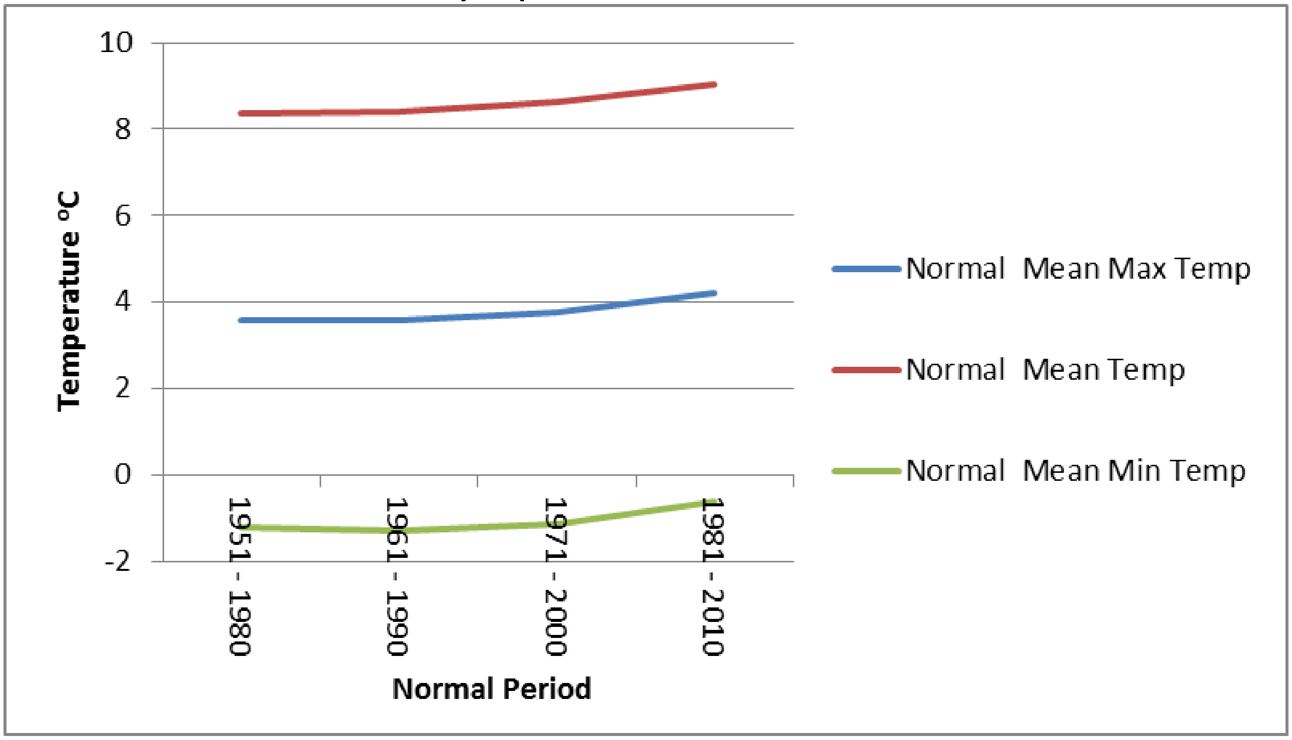
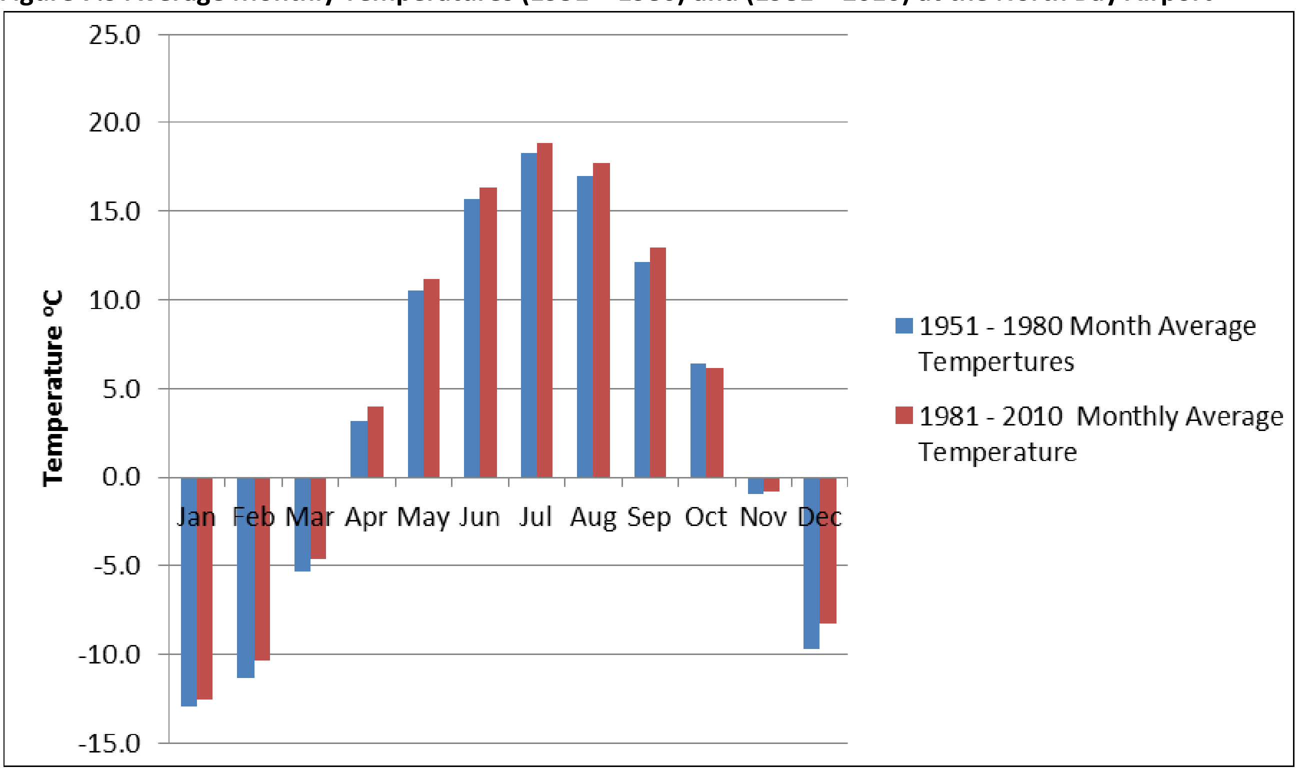


Figure 7.9 Average Monthly Temperatures (1951 – 1980) and (1981 – 2010) at the North Bay Airport



in October. Overall, mean monthly temperatures have increased by an average of 0.63° C between 1951-1980 and 1981-2010 climate normal periods.

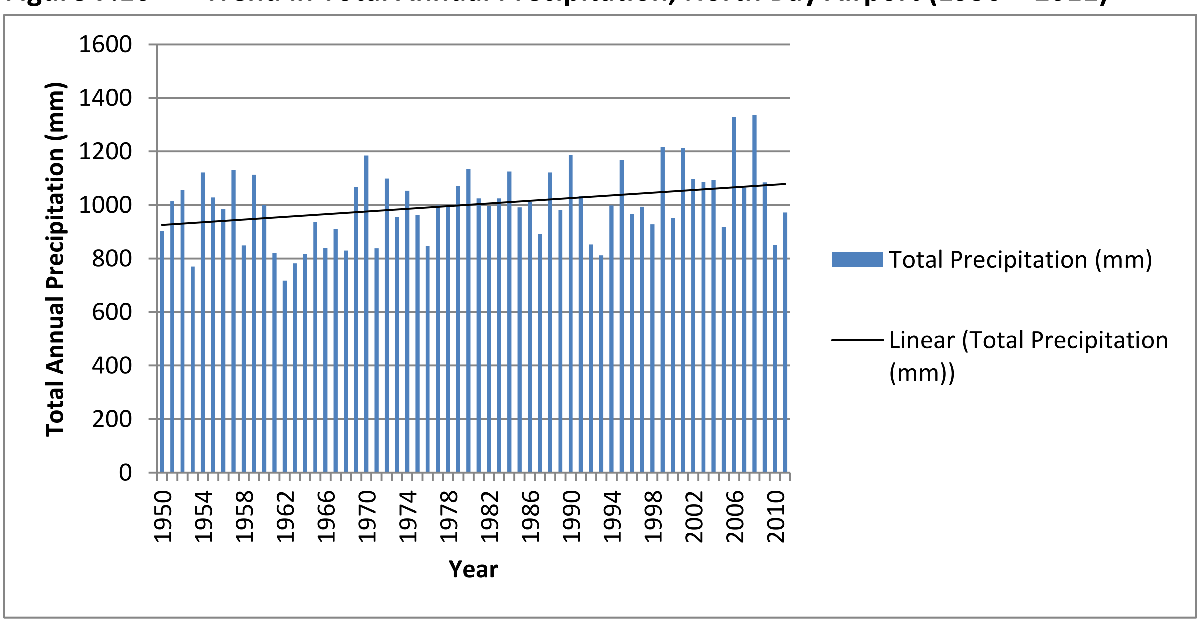
7.4.2 Observed Trends in Precipitation

Annual data from the North Bay Airport shows that average precipitation has trended higher since the 1950's (as illustrated in Figure 7.10). On average precipitation is increasing at a rate of 2.4% per decade. Annual, decadal and normal period averages illustrate that precipitation changes can be variable over these different periods of analysis.

Figure 7.11 illustrates the decadal changes in total precipitation at the North Bay Airport, as well as the rain and snow composition within these total averages. Precipitation declined slightly from the 1950's to the 1960's after which there has been increase for each decade. The largest increase occurred in the decade of the 2000's, which recorded 245.1 mm more total precipitation than in the 1960's, which had the lowest decadal precipitation in the period of analysis. In the 62 years of records analyzed only four years have experienced more than 1200 mm of precipitation and all have occurred since 1997.

Figure 7.11 also indicates that prior to the 2000's precipitation was primarily influenced by changes in rainfall as snowfall remained relative stable. However precipitation increases in the 2000's resulted from increased rainfall and snowfall, with snowfall contributing more to the precipitation increase at the North Bay Airport. Increased snowfall at the North Bay Airport may be caused by warming conditions in the winter stimulating heavier "lake effect" snow squalls from Georgian Bay/Lake Huron and to a lesser extent Lake Nipissing. The lake effect occurs when cold winds move over large open expanses of warmer lake water, increasing the amount of moisture within the cold air masses, which freezes and is then deposited on the leeward shores. Reasons for increasing snowfalls caused by the lake effect are further discussed in Section 7.4.3.

Figure 7.10 Trend in Total Annual Precipitation, North Bay Airport (1950 – 2011)



Mean annual precipitation data for consecutive climate normals for the North Bay Airport weather station are summarized in Table 7.6 and illustrated in Figure 7.12 (Note that Stantec has generated normal data from annual records for 1951 – 1980 and 1981 – 2010 for this analysis).

Figure 7.11 Decadal Comparisons of Total Rainfall, Total Snowfall and Total Precipitation – North Bay Airport

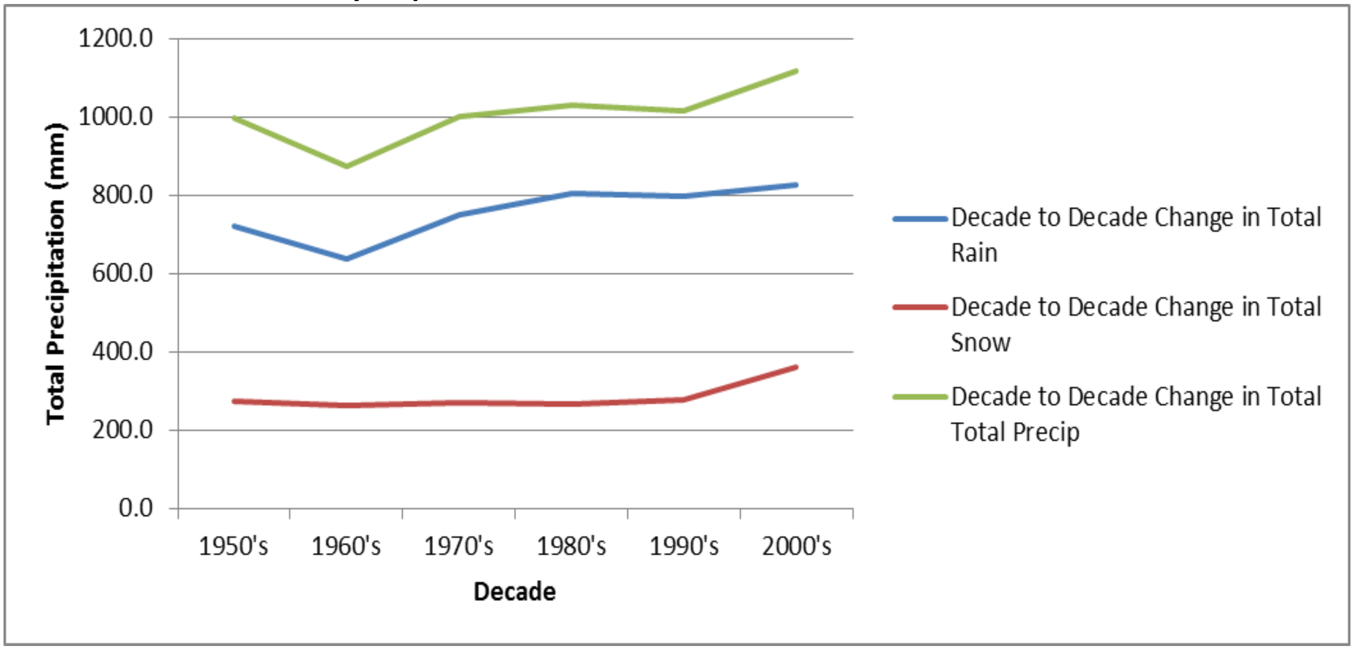


Table 7.6 Mean Annual Rainfall, Snowfall and Precipitation for Climate Normals - North Bay Airport

Period	Mean Annual Rain (mm)	Mean Annual Snow (cm)	Mean Annual Precipitation (mm)
1951 – 1980	709.9	269.9	964.1
1961 – 1990	735.8	268.4	974.2
1971 – 2000	774.6	273.4	1007.7
1981 – 2010	802.9	299.6	1044.6

Lumping data into a 30-year moving average filters out annual and decadal fluctuations, to more accurately reflect climate change. Results in Table 7.6 and Figure 7.12 suggest that overall precipitation has subtly been trending higher since the 1950's. From the 1951 – 1980 to the 1981-2010 climate normal, precipitation has increased by 80.5 mm or 8.3%, with a steady rate of increase over this time period. The results also illustrate that snowfall is starting to contribute more to these precipitation increases.

Long term monthly and seasonal differences in precipitation were examined for climate normals for the periods 1961 – 1990, 1971 – 2000 and 1981 – 2010, as illustrated in Figure 7.13 (note that monthly data for 1951 – 1980 was not available when analysis was completed).

Figure 7.12 Change in Climate Normals for Mean Annual Rainfall, Snowfall, and Total Precipitation - North Bay Airport

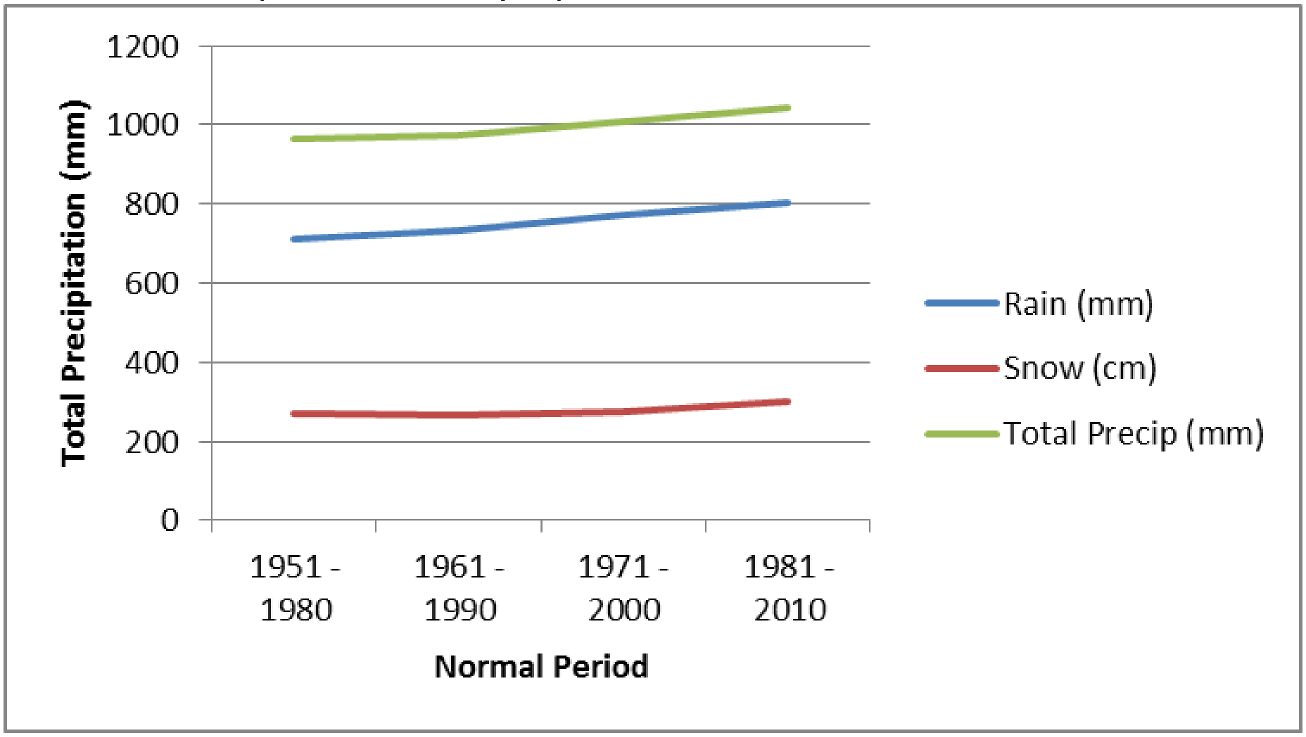


Figure 7.13 Monthly Precipitation Variations in the Climate Normals – North Bay Airport

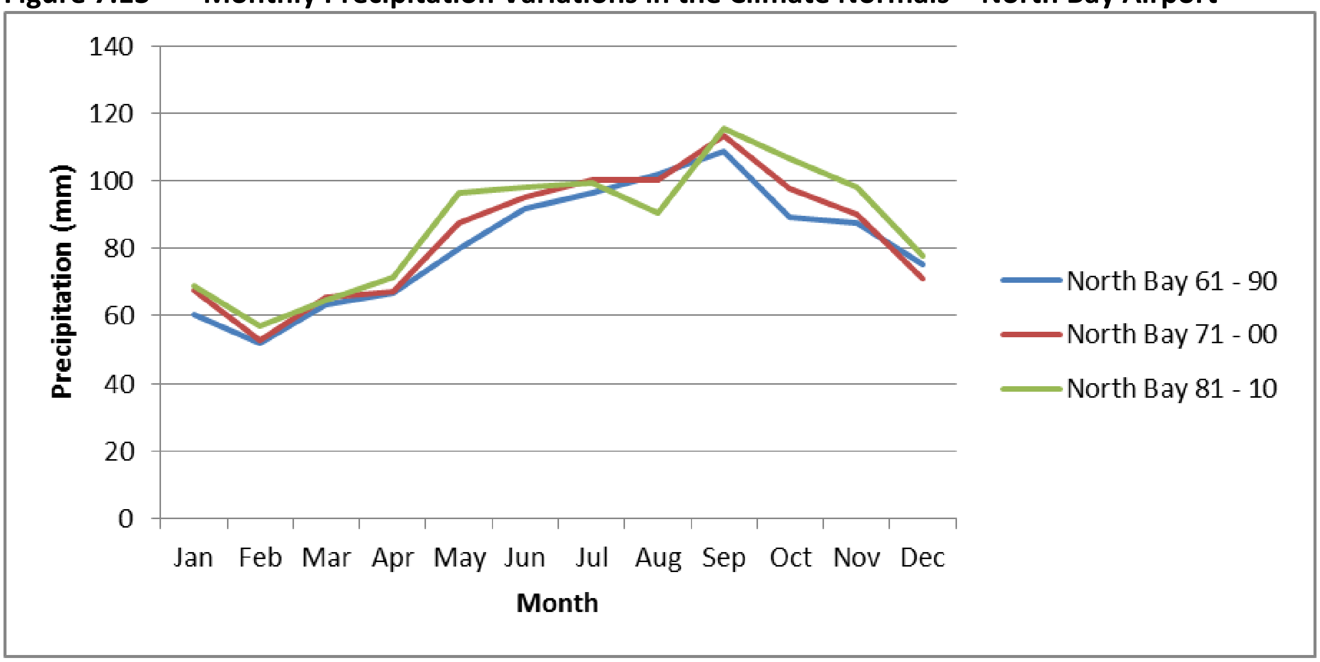


Figure 7.13 indicates that monthly precipitation is typically stable or slightly increasing, though a decreasing trend is noted for August. The lowest monthly precipitation is encountered in February (note that this dip is accentuated by the shorter period of data collection). March remains relatively stable over time and the rate of increase in July and September seems to be

leveling off. On a seasonal basis, precipitation is increasing in the spring and fall, with May having the largest spring increase (precipitation has increased by 16.6 mm between 1961 – 1990 and 1981 – 2010) and October having the largest fall increase (precipitation has increased by 17.3 mm between 1961 – 1990 and 1981 – 2010). Spring and fall increases contribute to the majority of the overall annual precipitation increase at the North Bay Airport, despite a decline experienced in August. These trends are further explored in Section 7.4.4.

7.4.3 Observed Trends in the Hydrologic Water Balance

With evolving precipitation and temperature trends it is important to assess the hydrologic responses to these climatic variables within the study area. Increased precipitation implies that more water is generally available, but as temperature also increase, more water can be absorbed and transpired by plants or directly evaporated back into the atmosphere. If increasing water availability is not utilized by plants or lost to evaporation, this water can end up being added to storage or lost to increased runoff. Examining hydrologic water balance characteristics over time can help identify how climate change is altering the hydrology of watersheds within the NBMCA.

Stantec has generated annual hydrologic water balance statistics for the North Bay Airport for the period 1950 to 2010 (details are presented in Appendix A). Mean monthly water balance characteristics for four consecutive normal periods (1951- 1980, 1961 – 1990, 1971 – 2000 and 1981 – 2010) have been assessed to examine how water is responding to evolving climatic conditions throughout the year and from season to season. Water balance data for rain and snowmelt, potential evapotranspiration (PE) and actual evapotranspiration (AE) have been obtained from Environment Canada. AE was determined assuming a soils water holding capacity of 300 mm for a mature forest cover and a fine, sandy loam soil (MOE 2003). The 2008 Conceptual Water Budget for the NBMCA watersheds used a variety of vegetation cover and soils assumptions to develop regional mapping.

The purpose of this analysis is to examine trends over time, for which the soil and vegetation cover assumptions are not considered critical factors. For analysis purposes Stantec has assumed that water not evaporated or transpired back to the atmosphere is lost to runoff. Some of this water enters the soil and water table as recharge or enters lakes and rivers directly (monthly or seasonally). Despite monthly or seasonal water surpluses or deficits, water tables and lake levels are assumed to remain within long term normal ranges over the long term. In the following sections water available after evapotranspiration is reported to be lost to runoff although subtle changes may be occurring in regional overburden or bedrock aquifers and groundwater recharge rates may also be evolving from increased water availability.

In assessing the impacts of climate change to the hydrologic water balance, precipitation is expressed as rain and melt water inputs which factors in seasonal temperature influences.

Precipitation is presumed to be stored as snow mass when daily temperatures remain below freezing. Details of how rain and snow melt are calculated are included in Appendix A. Figure 7.14 shows changes in annual rain and snow melt measured at the North Bay Airport between 1950 and 2010. Rain and snow melt inputs to the hydrologic cycle were modeled to be increasing at an average rate of 2.7 mm/year at the North Bay Airport. Total annual evapotranspiration rates are also increasing at an average rate of 0.7 mm/year (as illustrated in Figure 7.15). Evapotranspiration, affected by trends in annual mean temperatures, remained relatively steady until 1997, after which an increase has been observed as mean temperatures also increased. Water available for runoff is increasing at an average rate of 2.0 mm/year (as illustrated in Figure 7.16) although significant year-to-year variations are evident.

These figures indicate that climate change is causing runoff to increase at a faster rate than evapotranspiration and it is also causing runoff to become more erratic. Evapotranspiration is insensitive to years that experience abnormally high or low rain and melt water inputs and consequently the impact on runoff is amplified in these years. This has caused runoff variation of more than 100% from year-to-year. Based on the average rate of change, a total of 162 mm of rain and snow melt has been added to the hydrologic cycle from 1950 to 2010, of which 42 mm is lost to evapotranspiration (on average) and 120 mm is lost to runoff (on average).

Figure 7.14 Trend in Total Annual Rain and Melt Water Inputs (1950 – 2010) – North Bay Airport

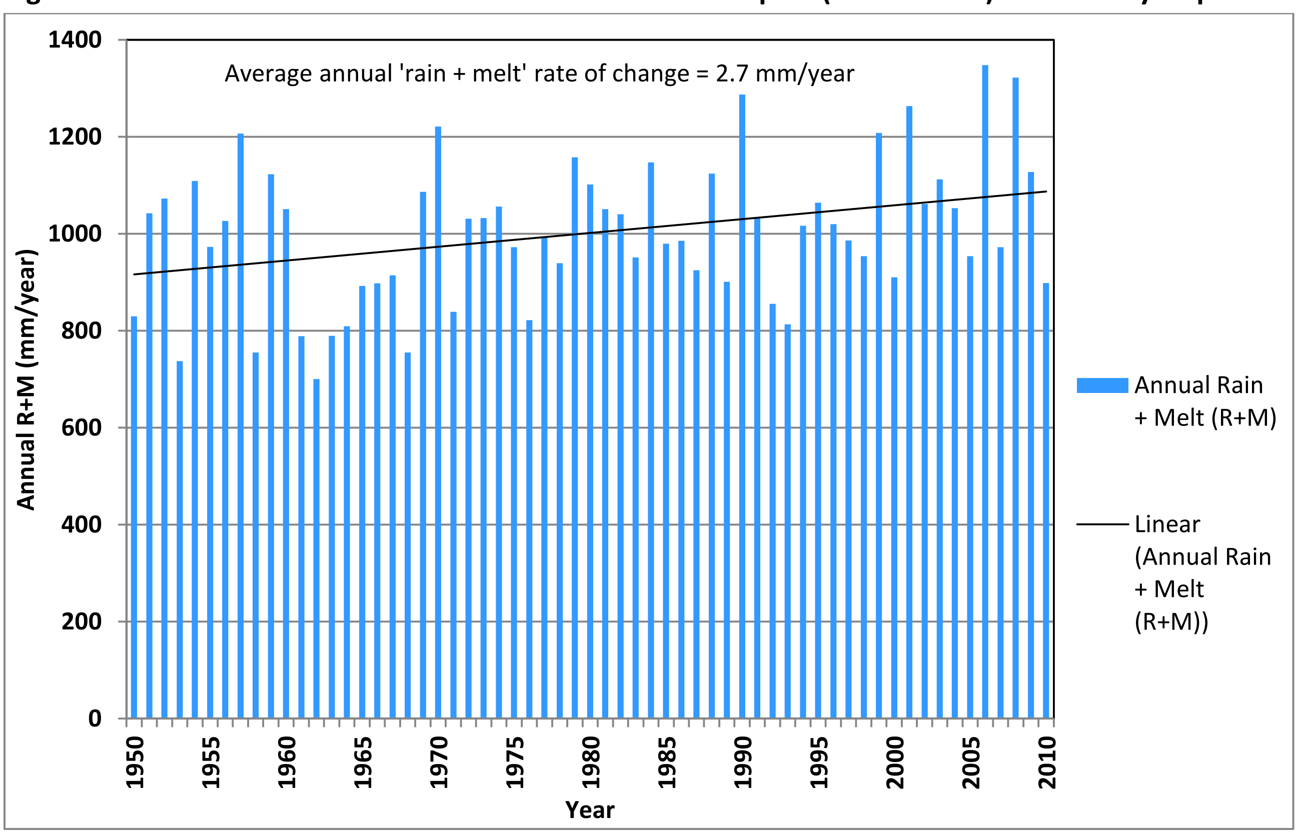


Figure 7.15 Trend in Total Annual Evapotranspiration Rates (1950 – 2010) – North Bay Airport

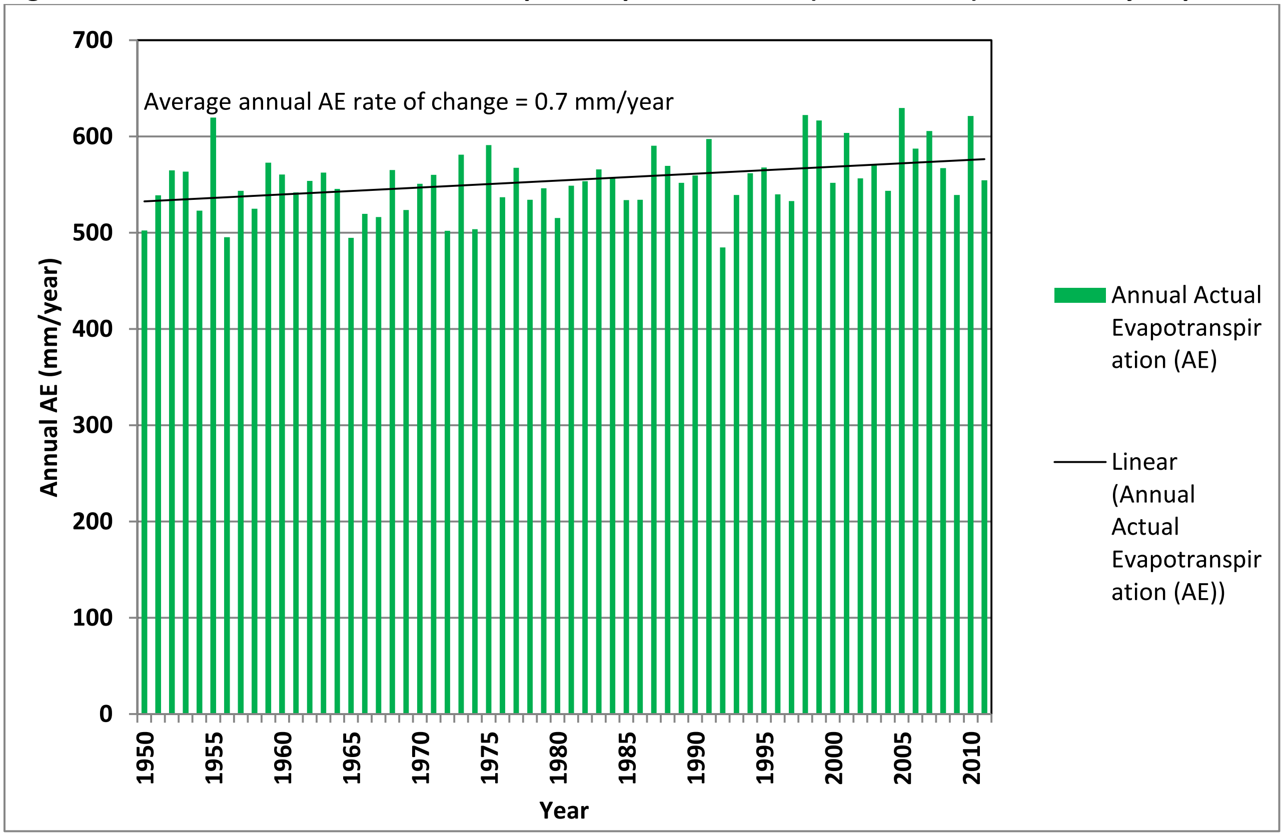
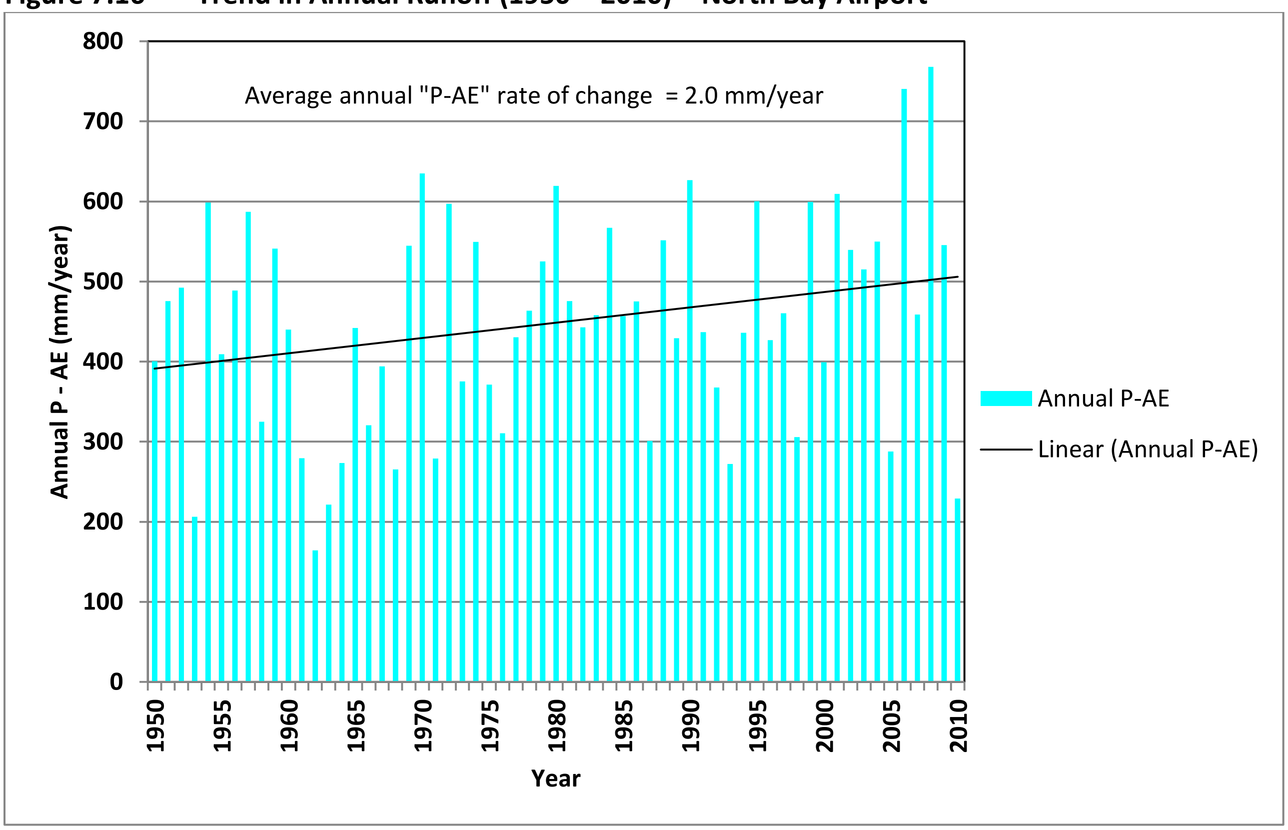


Figure 7.16 Trend in Annual Runoff (1950 – 2010) – North Bay Airport



Hydrologic water balance averages for four consecutive normal periods at the North Bay Airport are presented in Table 7.7. North Bay Airport water balance values for the most recent normal period (1981 – 2010) indicate that of the 1045.6 mm of water normally available each year (from rain and snow melt), 566.9 mm (54.2%) are lost to evapotranspiration and 478.7 mm (45.8 %) are lost to runoff. This table indicates that all water balance parameters are increasing, though runoff is increasing relatively more quickly than evapotranspiration.

Table 7.7 Hydrologic Water Balance Calculations for Normal Periods – North Bay Airport*

Normal Period	Rain and Snow Melt	Evapo-transpiration		Runoff	
	(mm)	(mm)	%	(mm)	%
1951 - 1980	963.3	544.0	56.5	419.3	43.5
1961 - 1990	973.2	546.1	56.1	427.1	43.9
1971 - 2000	1006.7	554.0	55.0	452.7	45.0
1981 - 2010	1045.6	566.9	54.2	478.7	45.8

* Note that rainfall and snow melt totals vary slightly from annual precipitation totals for the same period which is caused by error introduced by the modeling of snow available for runoff as well as from possible data rounding impacts.

Monthly water balance values for the most recent normal period are presented in Figure 7.17.

Figure 7.17 (1981 – 2010) Monthly Normal Water Balance Characteristics – North Bay Airport

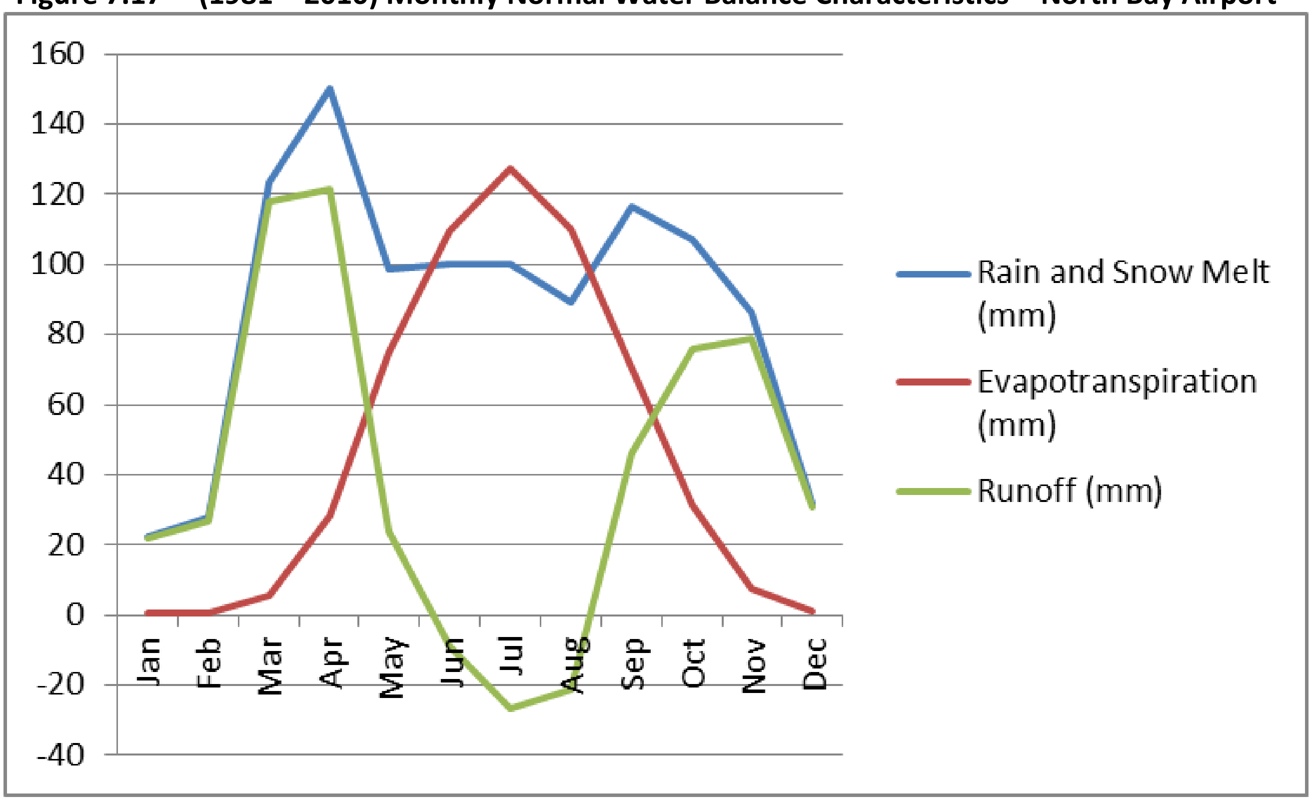


Figure 7.17 indicates that rain and snow melt, evapotranspiration and runoff are highly variable from month-to-month. Water in the form of snow has a water balance "hiatus" in the three

coldest months of the year and is mostly delayed from entering the hydrologic cycle until March/April. When this water is released it combines with precipitation to create the wettest period of the year. A second wet period occurs in September/October and water begins to accumulate as snow mass in December where it is stored until it melts. Evapotranspiration, directly responding to temperature and the growing season, is barely measurable in winter and reaches peak values in summer. Evapotranspiration exceeds rainfall inputs in the three warmest months of the year (resulting in water being drawn from the soil by plants). Runoff is sustained during this period from the water table and lake storage drawdown. Water available for runoff is also minimal in the winter as it is typically frozen. Water is most available for runoff in both the early spring and fall periods. During these periods, water replenishes soil moisture and recharges groundwater and lake storage. Storage levels were assumed to remain within normal ranges over the long term.

Figure 7.18 demonstrates how normal monthly evapotranspiration rates are changing over time. Monthly evapotranspiration rates are compared between climate normal periods 1951 – 1980 and 1981 – 2010. Evapotranspiration is increasing in every month on average, except October and November, which is likely caused by the decline in average mean temperatures (see Figure 7.9) during this period. Reasons for the average mean temperature declines are unclear.

Figure 7.18 Trends in Monthly Evapotranspiration (comparing 1951 – 1980 to 1981 – 2010) – North Bay Airport

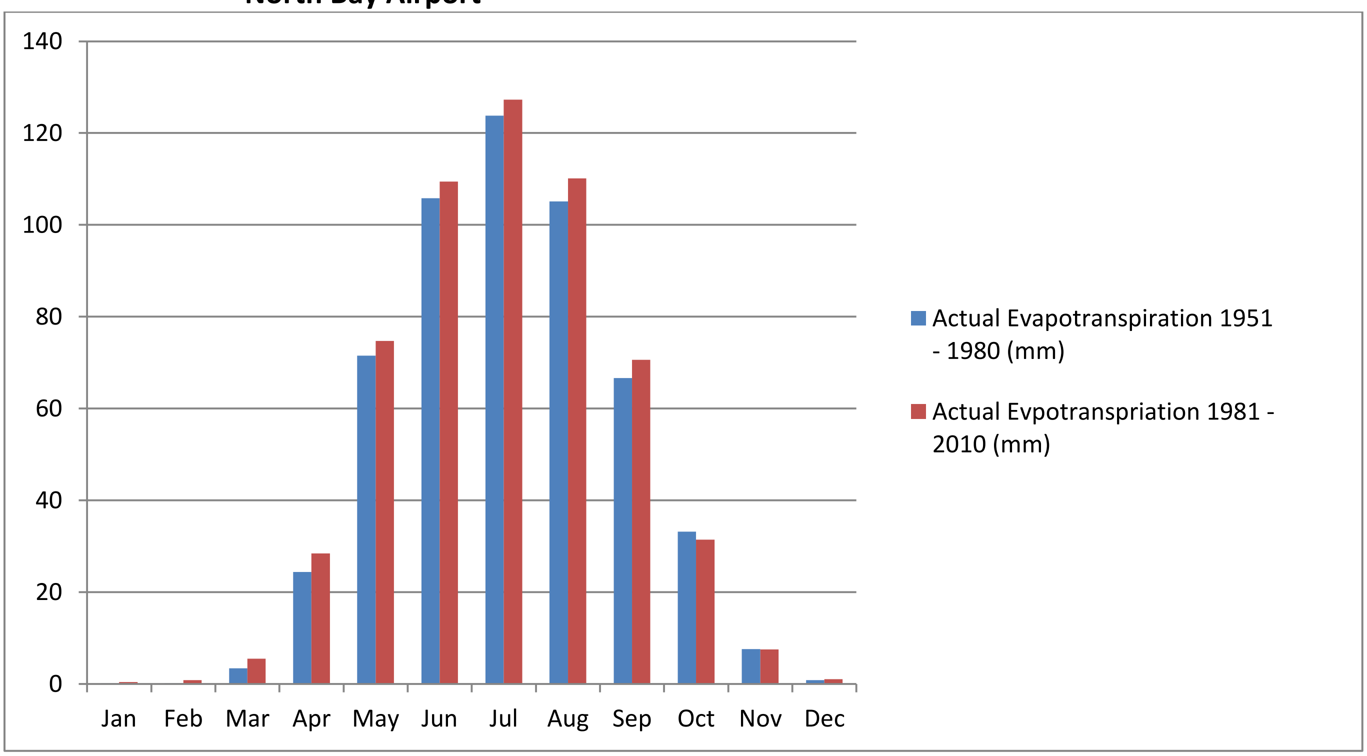


Figure 7.19 illustrates how normal monthly runoff rates are evolving at the North Bay Airport. Monthly runoff was assessed between climate normal periods 1951 – 1980 and 1981 – 2010.

Figure 7.19 Trends in Monthly Runoff (comparing 1951 – 1980 to 1981 – 2010) – North Bay Airport

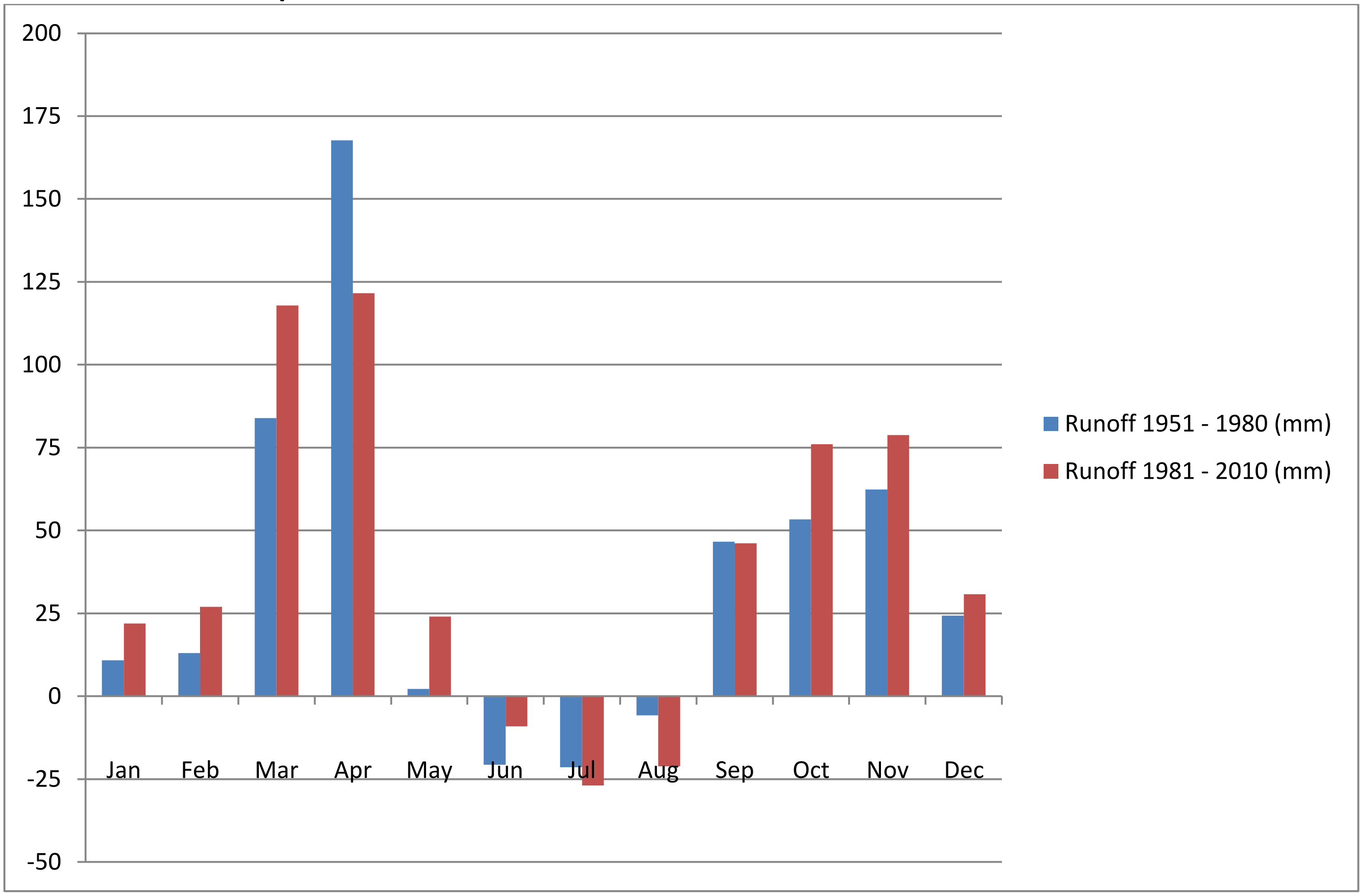


Figure 7.19 illustrates that runoff during the winter period is increasing and has more than doubled in January and February. Consequently, the amount of water available for the March/April freshet has declined slightly, as these two months have experienced a 12.1 mm decline in runoff between the two climate normal periods. This decline is counterbalanced by increased runoff in May, resulting from increasing precipitation in May (see Figure 7.13). The period between spring freshet and the drier summer months is expanding. The spring freshet is occurring earlier in the year (transitioning from April to March) and the drier summer months are shifting to later in the year (the dominant low runoff months have shifted from June/July to July/August). Also, the June/July/August summer water deficit has deepened from - 49.2 mm to - 58.6 mm between the two periods of analysis. There is growing water surplus evident in the fall, caused by an increase in precipitation, which is increasing runoff. Quantitatively, runoff has increased by 41.6 mm in the months of October/November/December (1981 – 2010) compared to the same period in 1951 – 1980; which is 8.7 % of total annual runoff. Overall, higher water volumes and increased runoff were observed in 8 of the 12 months in the assessment period.

7.4.4 Regional Factors affecting Observed Trends in Climate

Impact of the Large Water Bodies and Forest Cover

Lake Nipissing has a moderating effect on local temperatures with the greatest impact being experienced within a few kilometers of its shoreline. Georgian Bay/Lake Huron, and to a lesser extent Lake Nipissing, influence precipitation within the NBMCA watersheds, as "lake effect", further discussed below, can cause large amounts of snowfall. The North Bay Airport appears to have an increasing trend in the amount of snowfall it receives (Section 7.4.2). This may also be occurring in other NBMCA watersheds, though this would require further research. Broader precipitation characteristics for Ontario can be observed by examining provincial monthly precipitation map summaries available at:

http://www.utoronto.ca/imap/collections/climate_and_biota/ontario_bioclimate3.htm#Water

These maps show summarized data for the entire province based on 1961-1990 climate data (Watson and MacIver 1995), including what is experienced near Lake Nipissing and Georgian Bay on a month-by-month basis which have been examined in detail. Monthly precipitation maps for Ontario show that lands in the lee of Lake Huron/Georgian Bay experience lake effect in the winter period. Winter precipitation is typically the greatest where there is a large open water fetch located northwest of an area, due to the prevailing northwest winter winds. Precipitation accumulation is highest near the edge of the lake and diminishes with distance from the lake. This lake effect is most pronounced in December/January.

Lakes also influence the amount of precipitation received in the summer, where precipitation is greatest where there is a large open water fetch relative to the prevailing winds. Rainfall is highest where there is increasing land elevations after air masses leave the lake (in the direction of the prevailing winds), and where topographic changes are sufficient to cause air masses to rise, condense, and form precipitation. This is known as the "orographic effect". The influence of the prevailing winds over lakes causing localized orographic rainfall seems most evident in July/August based on Bio Climate Mapping (Watson and MacIver 1995).

Overall, the amount of snowfall appears to be increasing at the North Bay Airport, which in part may be due to global or regional temperature changes causing an increase in the magnitude of the lake effect (during the winter). This change has been outlined in Table 7.5, Figure 7.8 and Figure 7.13. This trend of increasing snowfall may apply to other NBMCA watersheds as well.

The lake effect from Lake Huron/Georgian Bay seems to be intensifying and this is thought to be caused by declining ice coverage. Wang (2012) noted that ice cover on Lake Huron is declining at an average rate of 1.64 % per year and that Lake Huron winter ice has declined by 62 percent between the winters of 1972/73 and 2009/2010. Ice on all Great Lakes is forming later in the winter and dissipating earlier in the spring. The trend towards an increasingly higher percentage of open water during the winter period may be increasing the amount of area covered by the lake effect within the NBMCA watersheds during the winter period. It is noted that a trend of declining ice cover has not been detected on Lake Nipissing, possibly due to its shallowness and smaller size.

Changes in mid-summer precipitation within the NBMCA watersheds are likely influenced by a number of climatic variables, including evaporative rates over the Great Lakes. Changes in precipitation patterns within the study area may be attributed to environmental influences such as shifts in transpiration rates or shifts in prevailing winds. Prevailing winds that blow across the NBMCA watersheds during mid-summer have historically correlated with large fetch areas on Lake Huron/Georgian Bay, (interpreted from monthly rainfall patterns developed by Watson and MacIver, 1995). However, this may not always occur, as a decline in precipitation received in August at the North Bay Airport observed in the 1981-2010 climate normals, compared to the preceding climate normals (Figure 7.12). This might be considered unusual, as it occurred when evaporation from Lake Huron/Georgian Bay would typically be at its highest.

A decrease in precipitation observed in August may correlate with changing regional transpiration rates between the NBMCA watersheds and Georgian Bay (which is mainly forested). It has been widely documented that global warming has been causing a lengthening in the growing season in Ontario and this has most recently been reported for Ontario Ecoregions by the Ontario Ministry of Natural Resources (2010). Table 6 in Current and Projected Future Climatic Conditions for Ecoregions and Selected Natural Heritage Areas in Ontario (Ontario Ministry of Natural Resources 2010) projects that the growing season for Algonquin Park will increase from 183.5 days per year from the 1971 – 2000 climate normals to 199.8 days in the 2041 – 2070 climate normals and would start 7.4 days earlier in the year.

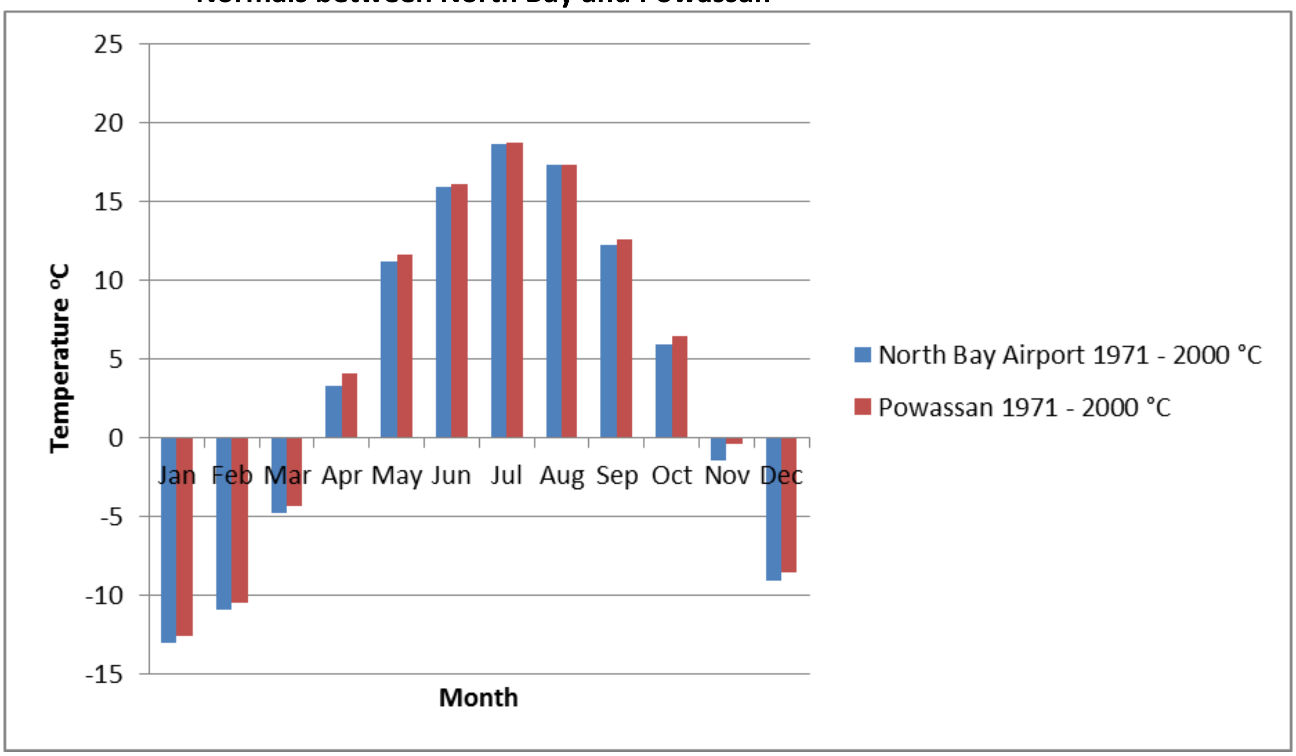
Precipitation increases in the spring and decreases in August suggest that the mainly forested foreland between Georgian Bay and the NBMCA watersheds may exert a localized influence on precipitation. An earlier start to the growing season and warmer temperatures overall may lead to a more rapid depletion of soil moisture within the region by peak summer. As soil moisture declines, biological activity slows and transpiration rates decline. Therefore, while global warming may be increasing lake evaporation at peak summer, it may also be depleting soil moisture, which in turn may be decreasing moisture contributed to the atmosphere by forest transpiration. Reduced transpiration may counteract increased lake evaporation during this period. If this observation is correct, it may also be causing regional vegetation to experience stress as the summer progresses due to an intensifying moisture deficit over time. Regional transpiration may be one of many variables affecting peak summer precipitation rates.

Impact of Topography on Regional Climate

To explore how temperature and precipitation patterns may be influenced by topography, North Bay Airport climate normals have been compared to Powassan climate normals for the same period. Monthly comparisons of mean temperatures for the 1971 – 2000 climate normals between these two stations are presented in Figure 7.20. Results show that Powassan experiences warmer mean temperatures in every month except August (where results were the same). The mean annual temperature for the climate normal for 1971 - 2000 was recorded to be 0.4^{o} C warmer at Powassan, compared to the North Bay Airport. This results suggests that the Mattawa lowlands (where Powassan is located) is warmer compared to the northern escarpment region (where North Bay Airport is located). The difference can be attributed to elevation and latitude differences.

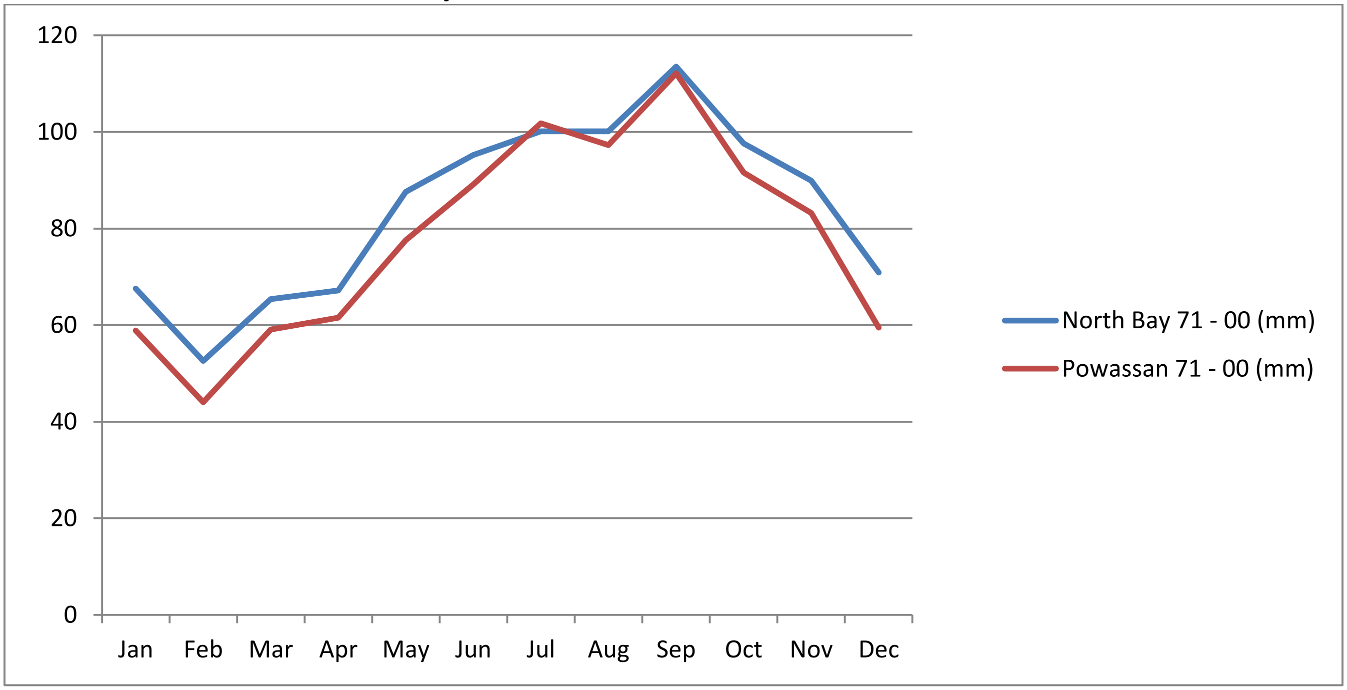
Figure 7.21 demonstrates that both North Bay and Powassan have similar monthly precipitation patterns throughout the year. Powassan receives slightly less precipitation in all months (except July) and this is likely due to a less pronounced orographic effect at lower elevations compared to the North Bay Airport. Summer climate normals between these stations are very similar. The relative increase in precipitation during the summer period in Powassan may be sourced, in part, from saturated air masses over Lake Nipissing that pass over Powassan. Further research would be required to investigate this, but currently this assessment is limited by the lack of regional climatic data.

Figure 7.20 Monthly Comparisons of the Mean Temperatures for the (1971 – 2000) Climate Normals between North Bay and Powassan



Monthly comparisons of precipitation for the 1971 – 2000 climate normals between North Bay Airport and Powassan are presented in Figure 7.21.

Figure 7.21 Monthly Comparison of Precipitation for the (1971 – 2000) Climate Normals between North Bay and Powassan



Comparisons of Study Area Precipitation to Stations outside of the Study Area

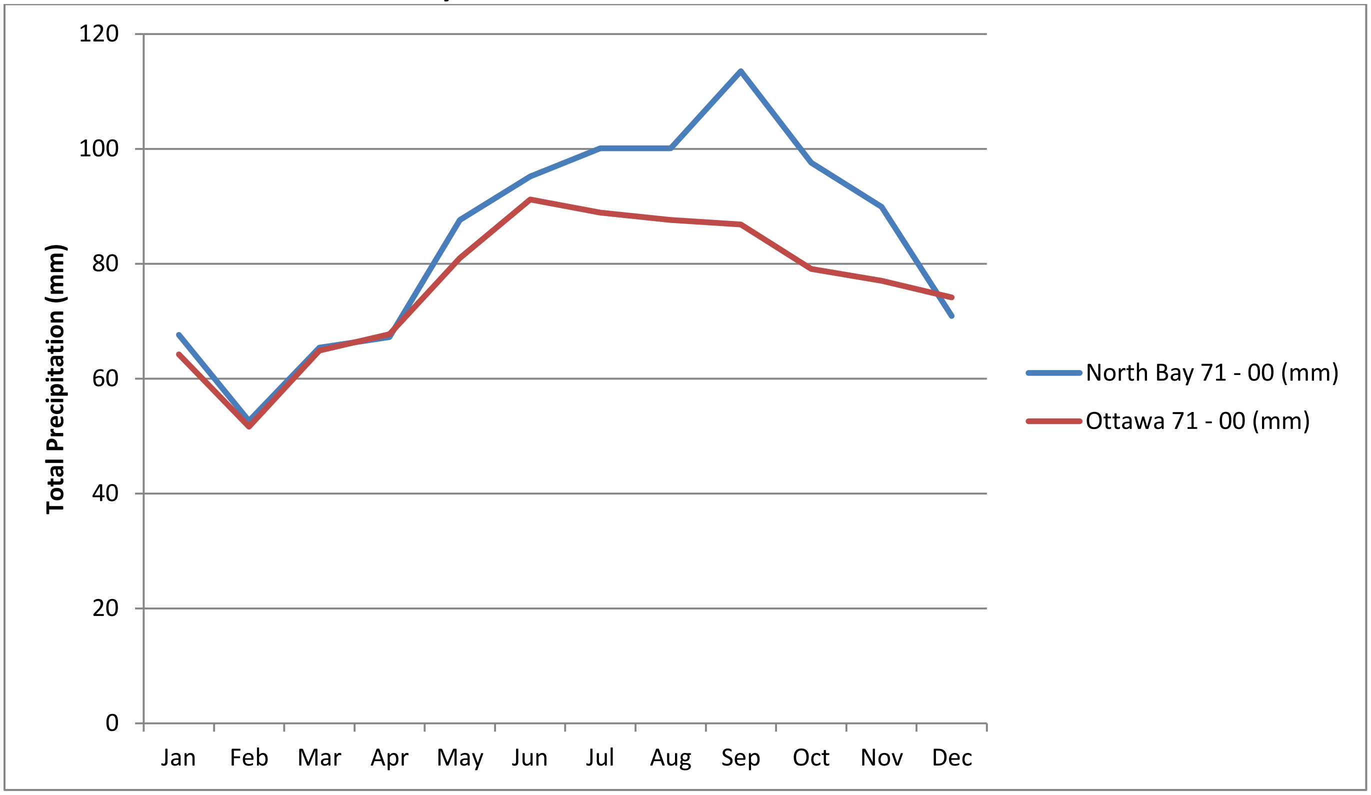
To differentiate how the NBMCA watershed's precipitation trends are unique from other areas, the North Bay Airport weather station was compared to weather stations in Ottawa, Sudbury and Huntsville.

Ottawa (station Ottawa CDA) was selected because it has similar latitude, data for the same period is readily available online, and it is not directly influenced by a significant water body. Monthly comparisons of 1971 – 2000 climate normals between North Bay and Ottawa are presented in Figure 7.22. Figure 7.22 shows that monthly precipitation patterns between these two stations are remarkably similar in the winter period, but North Bay experiences higher precipitation in the summer and fall with the highest difference occurring in September.

The North Bay Airport receives approximately 10% more precipitation annually than Ottawa. The higher summer precipitation received at North Bay may be caused by the saturation of air masses that pass over Georgian Bay/Lake Huron and Lake Nipissing, and the orographic release of this moisture as it rises over downwind land areas.

Sudbury (Sudbury Airport) was selected because it has similar latitude, data for the same period is readily available online, and it is within the influence zone of Georgian Bay/Lake Huron. The monthly precipitation comparison of 1971 – 2000 climate normals between the North Bay

Figure 7.22 Monthly Comparison of Precipitation for the (1971 – 2000) Climate Normals between North Bay and Ottawa



Airport and a weather station in Sudbury are presented in Figure 7.23. Like North Bay and Ottawa, Sudbury has remarkably similar precipitation patterns during the winter. The Sudbury weather station has considerably less precipitation in the summer period. Sudbury, while it shows some orographic effect, has less exposure to lake fetch from Lake Huron/Georgian Bay, as it is in the lee of Manitoulin Island. Sudbury also has a foreland that has been largely deforested, or was in the early stages of regrowth (driven by Greening Sudbury initiatives). Thus a lack of vegetation to retain soil moisture, and the absence of significant evapotranspiration in the growing season may contribute to reduced precipitation over the summer period in Sudbury.

Huntsville was selected to illustrate how the winter lake effect from Lake Huron/Georgian Bay is influencing snowfall, as well as how a shorter fetch exposure can influence total precipitation in the summer. The monthly comparison of precipitation for the 1971 – 2000 climate normals between North Bay and Huntsville are presented in Figure 7.24. The winter lake effect of Georgian Bay is evident in Huntsville, with the largest impact occurring in December/January. Huntsville receives almost as much precipitation in January as it does in September. The lower precipitation received through the summer can be explained from prevailing winds having a smaller fetch over the Great Lakes, compared to North Bay at peak summer.

Figure 7.23 Monthly Comparison of Precipitation for the (1971 – 2000) Climate Normals between North Bay and Sudbury

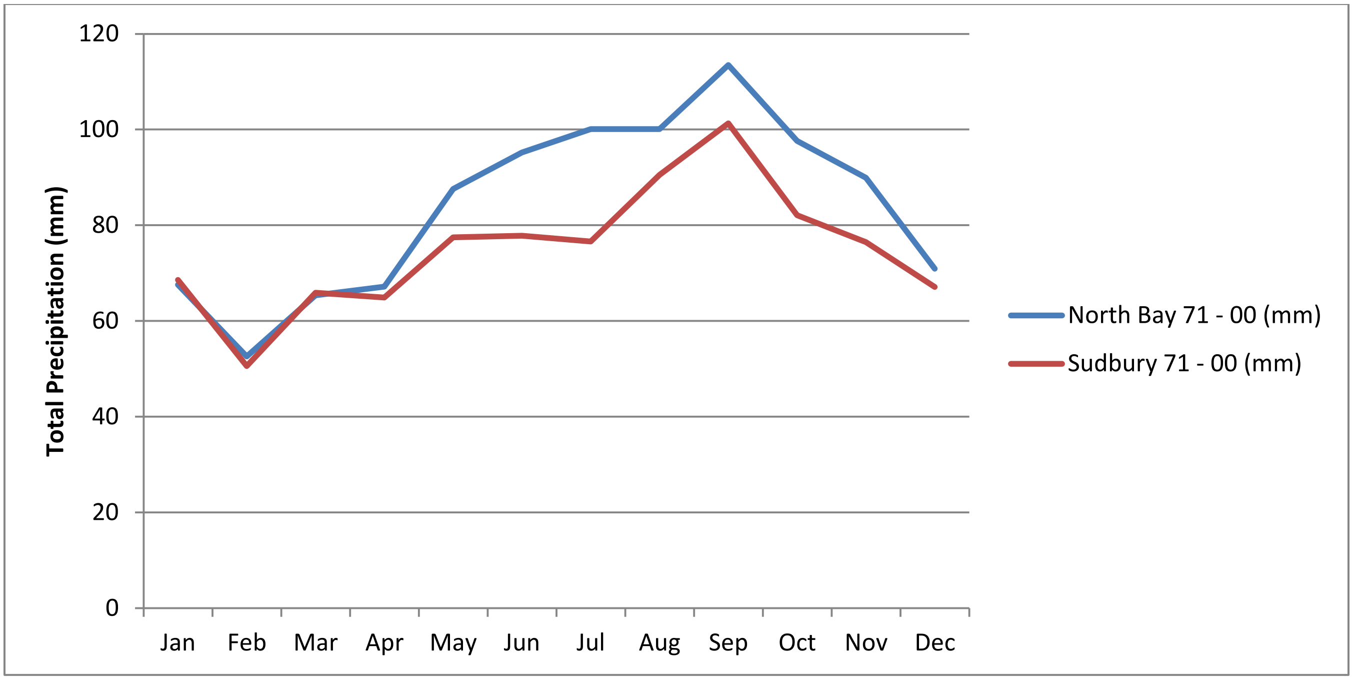
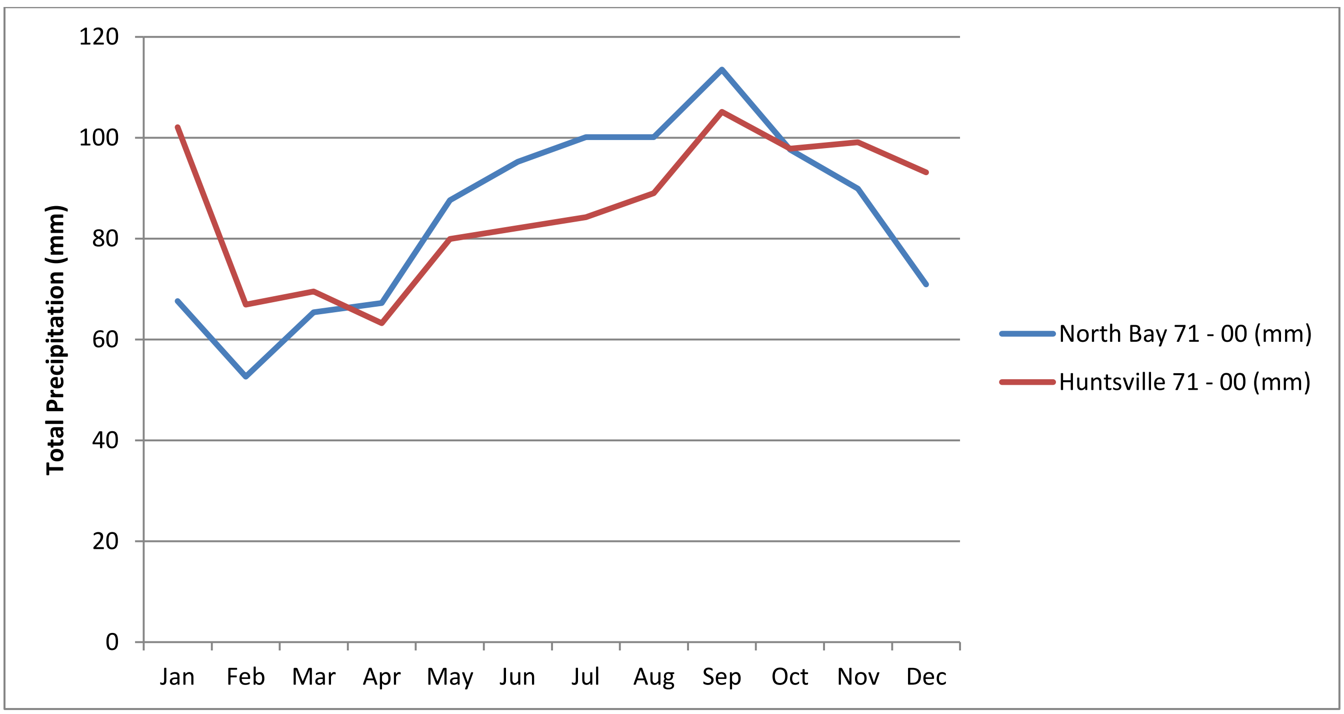


Figure 7.24 Monthly Comparison of Precipitation for the (1971 – 2000) Climate Normals between North Bay and Huntsville



7.4.5 Severe Weather Events

Severe weather events include intense thunderstorms, tornados, heavy rainfall or snowfall, extreme temperatures, hail storms, extreme wind events, freezing rain, or severe cold fronts causing derechos (a long lasting wide spread storm band at the leading edge of a cold front which causes severe instantaneous winds and heavy rain). Additionally, normal levels of rain at vulnerable times (when air temperatures are below freezing or when the snow mass is ripe) can also have severe consequences, such as ice damage or increased runoff. Severe weather also results when tropical storms, often dissipating hurricanes, pass over the area. These storms are often associated with heavy winds, intense rain, hail, and can lead to flooding, erosion, and wind damage if conditions are severe enough. The annual risk posed by severe weather events is increasing in all categories, driven by more energy being trapped within the troposphere.

According to the Insurance Bureau of Canada (2012), global warming is increasing the risk of severe weather in Canada. Global warming is increasing the occurrence of heat waves, which in turn increases the probability intense rainfall events. Conservation Authorities in Ontario rely on storm intensity, duration and frequency probabilities to manage flood and erosion risks within their area of jurisdiction. The design of water conveyance infrastructure such as storm sewers, bridge openings, and constructed channels use probability information to determine appropriate sizing. The extent of flooding around lakes and streams can also be determined by analyzing statistics and historic events to determine areas of vulnerability and strategies for protection. If the intensity, duration or frequency of severe weather is increasing, then Conservation Authorities need to be aware of this increased risk and be prepared to adapt their management strategies based on calculated impacts to watershed areas. The Insurance Bureau of Canada (2012) reports that in some parts of Canada, severe weather events that once occurred every 40 years are now being experienced every 6 years on average.

The changing risk of severe weather within the NBMCA's area of jurisdiction can be assessed by looking at climate extreme data. Changes to temperature extremes can be analyzed to determine if severe weather has a higher probability of occurring over time. The NBMCA watersheds may have unique trends that differ from other areas in Ontario, as the Insurance Bureau of Canada (2012) research noted "For North Bay, an interesting trend is observed. While the days with greater than 10 mm precipitation remained unchanged, the number of days with higher precipitation, above 30 mm, has moderately increased…". To investigate the probability of severe weather events occurring with more frequency in the NBMCA watersheds, and to investigate causes, extreme weather data from the North Bay Airport has been examined between 1950 and 2011.

Warmer temperatures typically increase the potential for storms to occur and for storms to be more violent (Insurance Bureau of Canada, 2012). Increasing temperatures (as discussed in

Section 7.2.4.2) can affect storm frequency, intensity, spatial extent, duration and the time-of-year that storms occur. These changes are investigated in the following sections.

Trend in the Frequency of Severe Weather Events

Stantec has assessed the changing probability of storm frequency by looking at trends in days with extreme temperatures that exceed 30^{o}C (approach is adapted from the Insurance Bureau of Canada, 2012). Stantec completed a preliminary examination of Storm Intensity/Duration and Frequency (IDF) data for the North Bay Airport but there is insufficient data available to complete a detailed assessment. Instead assessment of temperature data between 1950 and 2011 shows that the average number of days per year that extreme heat is experienced has doubled, from approximately 1.5 days per year in 1950, to slightly greater than 3 days per year by 2010 (see Figure 7.25). In 2005 14 extreme heat days were experienced, which is the highest on record. Days with extreme heat can lead to the development of severe thunderstorms that can cause hail, intense rainfall and heavy winds and on rare occasions, tornados.

An analysis of extreme temperature days per decade was conducted from the 1950's to 2000's, and the results are presented in Figure 7.26. This figure shows a marked increase in days over 30.0^{o}C in decade of the 2000's. The number of extreme heat days increased by approximately 50% making it twice as likely that extreme weather events could occur within the 2000's relative to the previous decades assessed.

Comparing changes over consecutive climate normals helps to reduce short term variations to reveal general trends within 30 year periods. Figure 7.27 indicates that before the decade of the 2000's, the number of days with extreme heat was relatively stable, averaging around 50 days/normal period. The most recent climate normal (1981-2010) saw a substantial change, as the total increased to 80 days. These analyses of extreme heat days suggest that a significant shift occurred in the decade of the 2000's, which has increased the risk of severe weather.

Trends in the Time of Year Severe Weather Events Occur

Changes in the time of year that severe weather events occur can be assessed by looking at the monthly distribution of extreme temperatures over the summer. Total days per month that exceed 30^{o}C between April and October for each decade from the 1950's through the 2000's are presented in Figure 7.28. This figure shows that historically July experienced the highest number of days exceeding 30^{o}C (since the 1950s), and therefore, this would suggest extreme weather events in the summer would be most likely to occur in July. Figure 7.28 indicates that in the 2000's extreme temperatures expanded to also affect June and August, with August experiencing the highest number of days exceeding 30^{o}C during the 2000's. Severe weather is now possible in the three warmest months of the summer, if the 2000's are representative of what is to be expected in the future.

Figure 7.25 Total Number of Days per Year that Temperatures Exceed 30.0°C at North Bay Airport

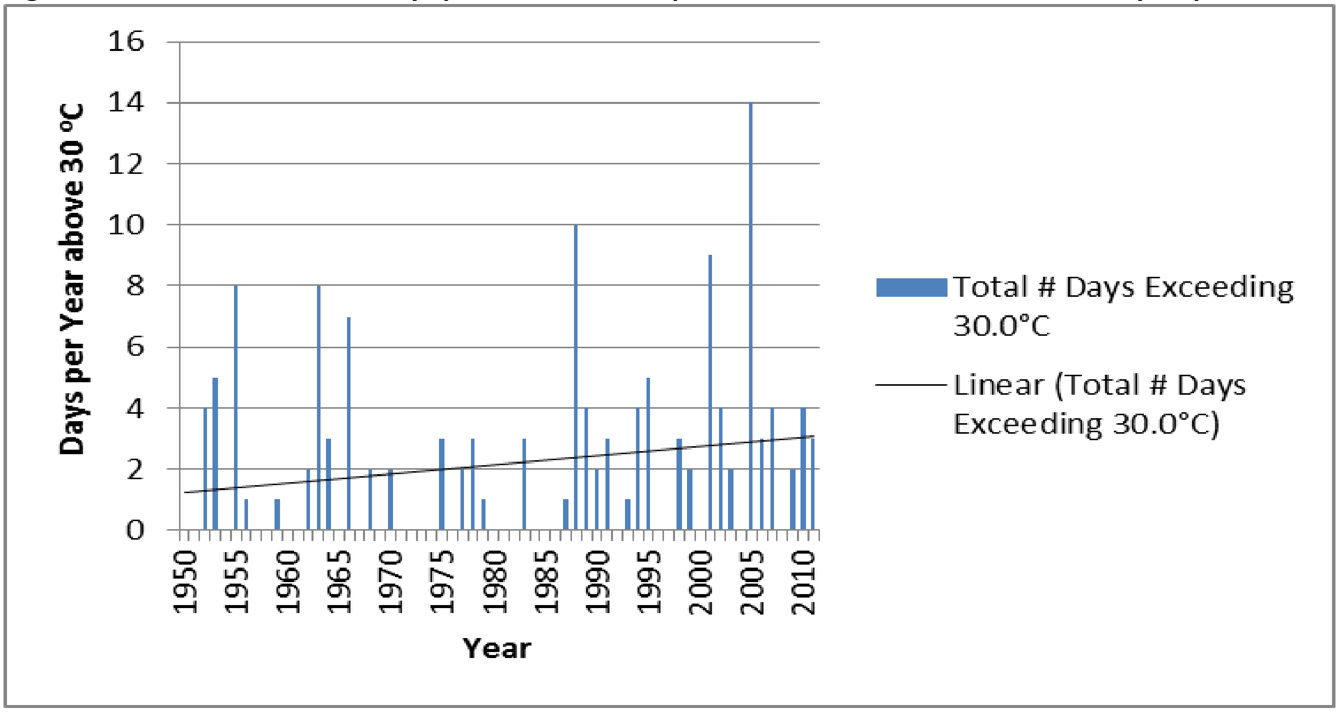


Figure 7.26 Total Number of Days per Decade that Temperatures Exceed 30.0°C at North Bay

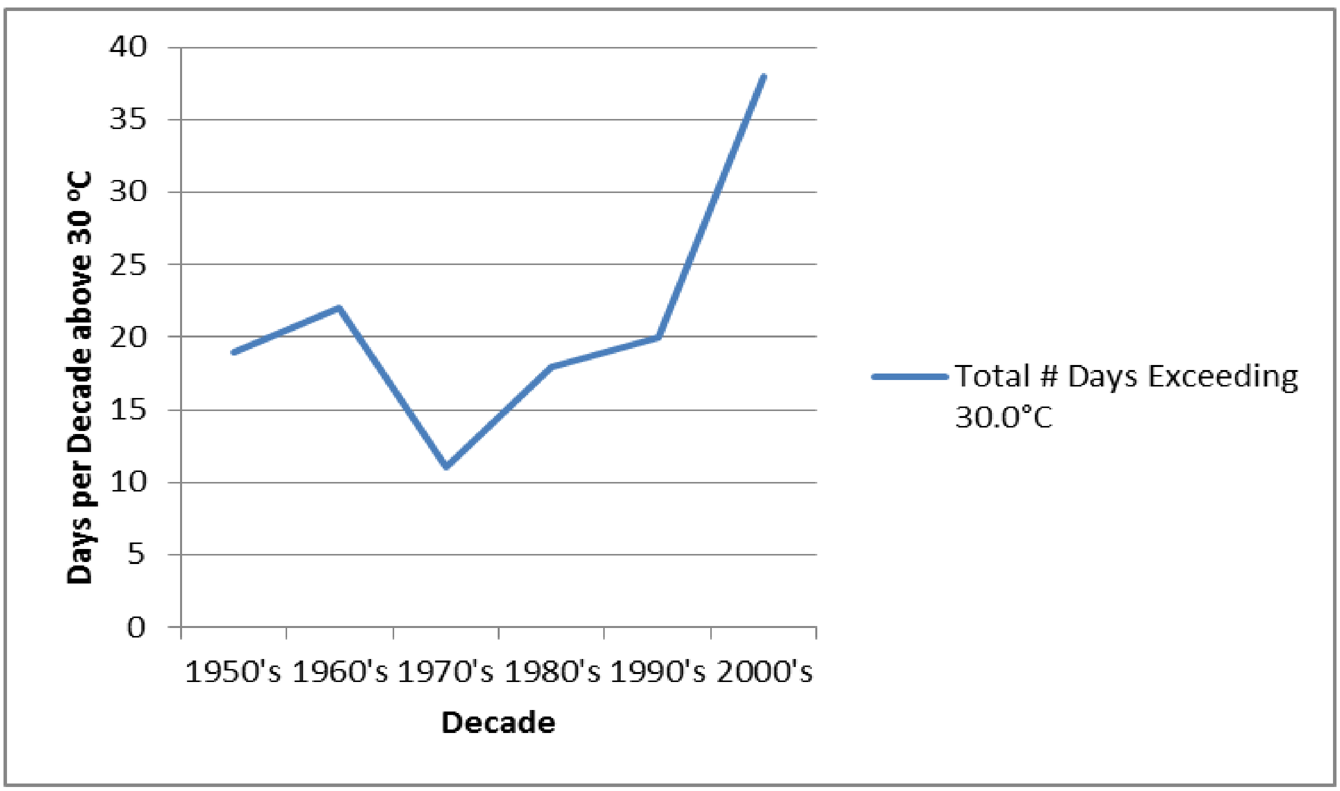


Figure 7.27 Total Number of Days exceeding 30.0°C for Climate Normals at North Bay Airport

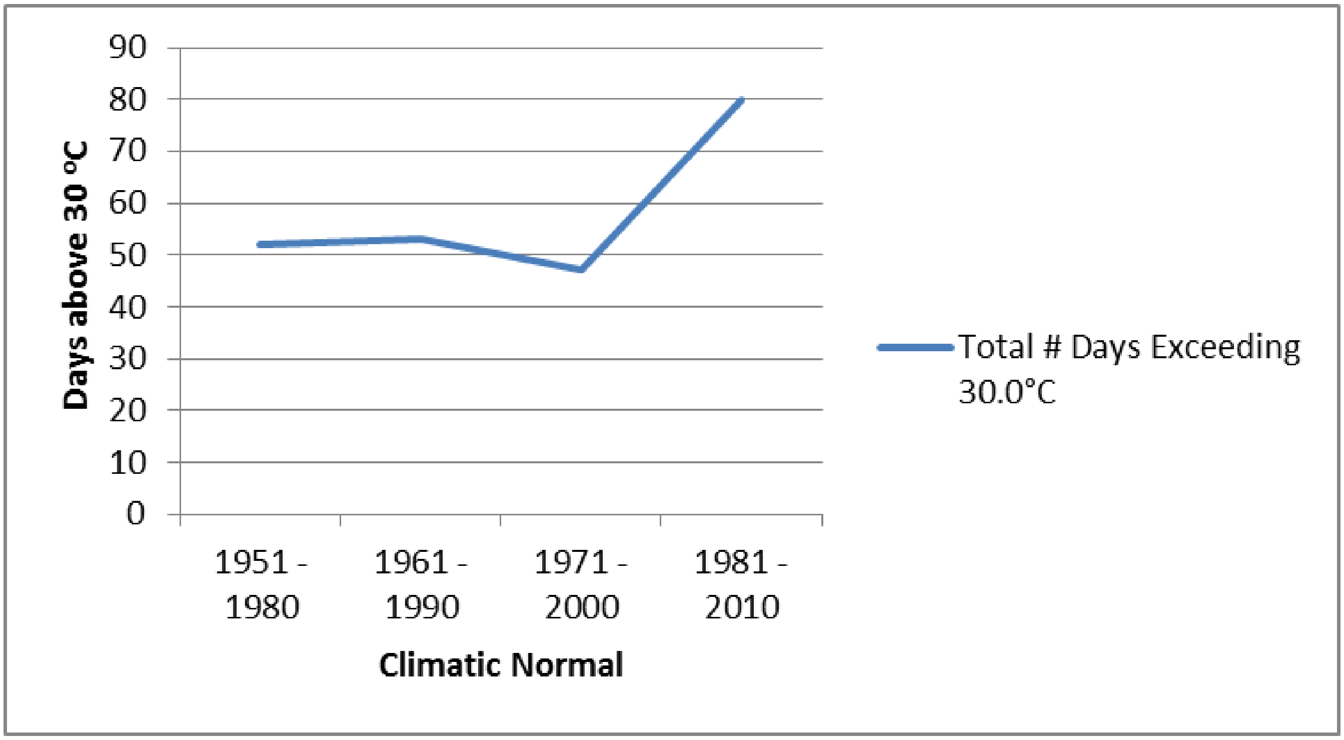
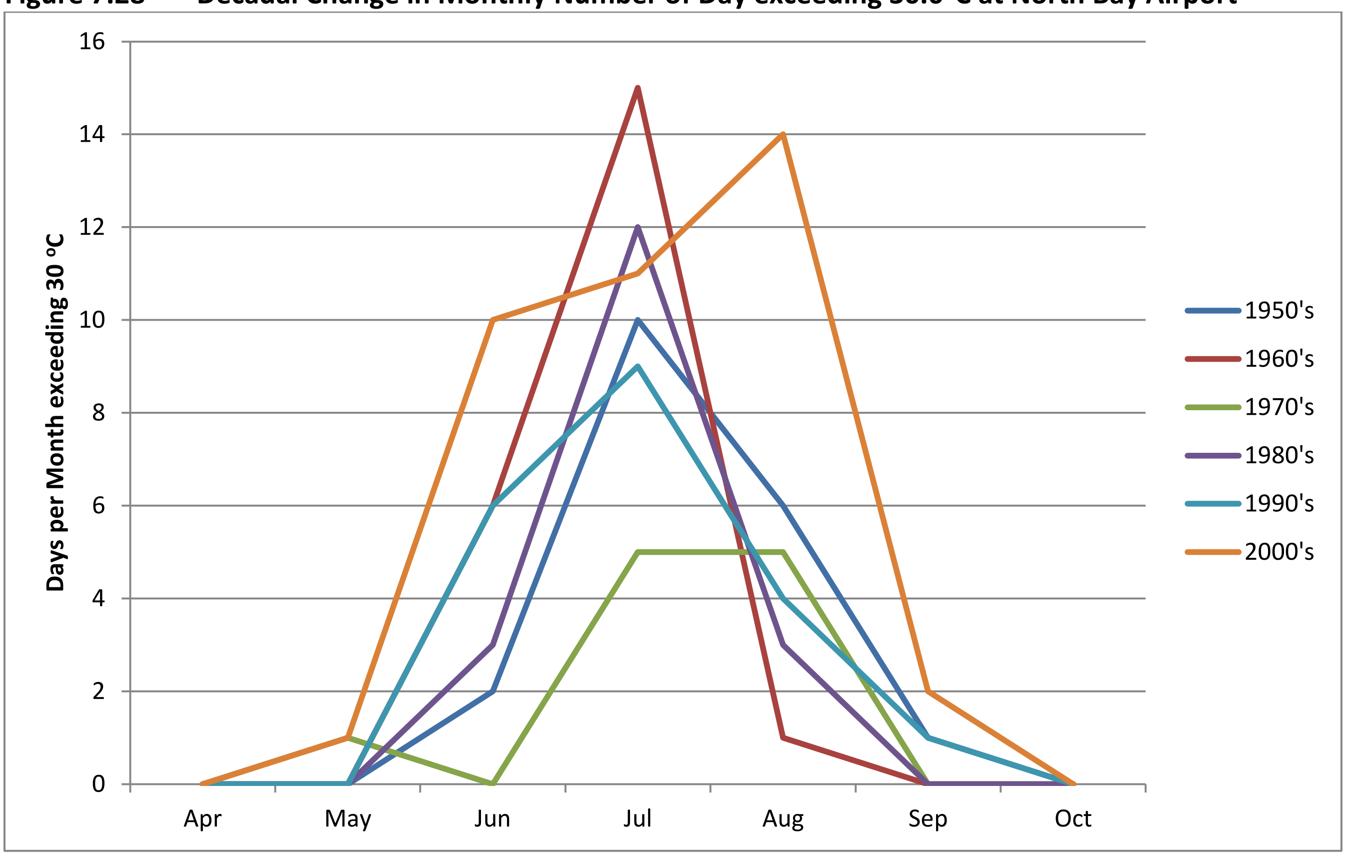


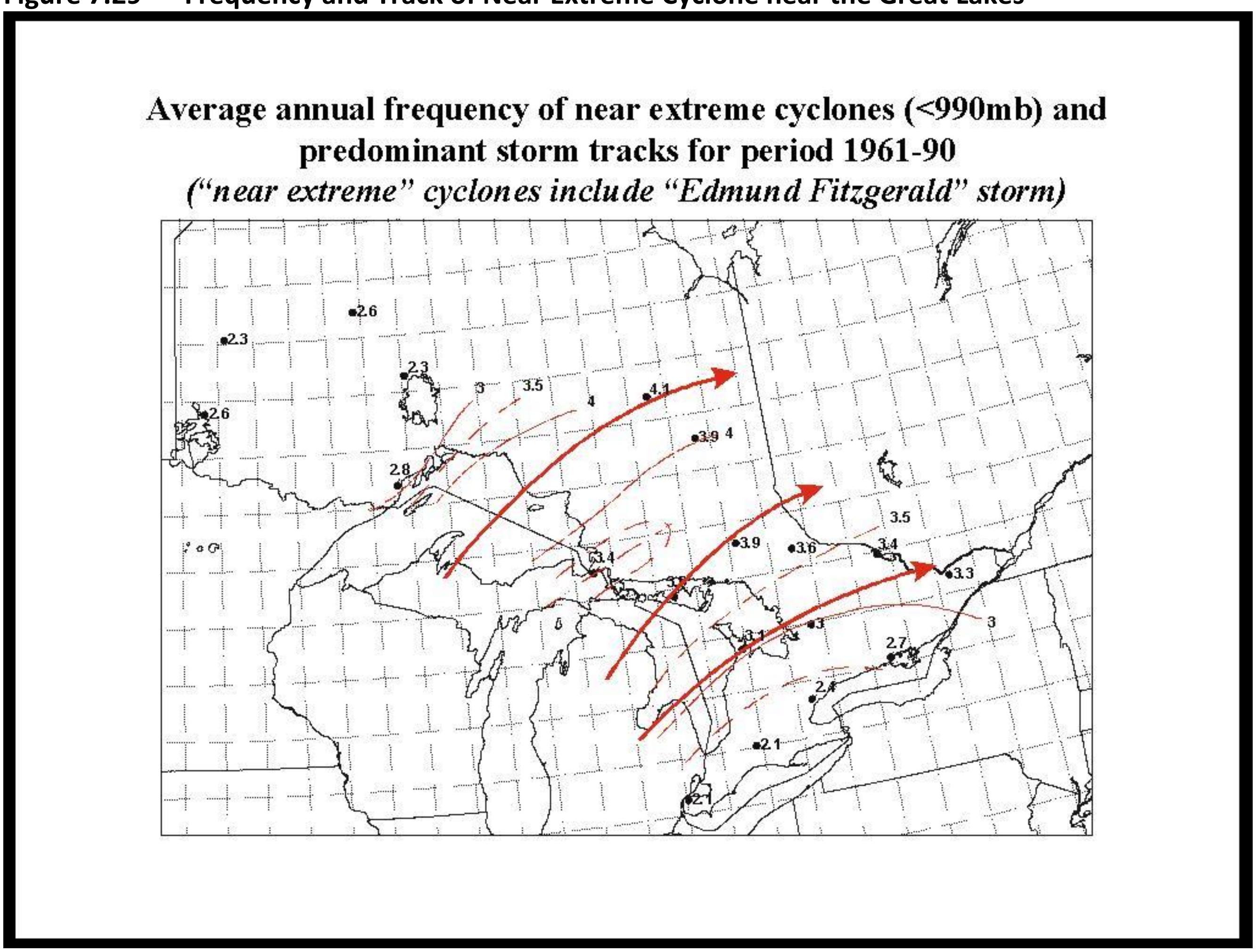
Figure 7.28 Decadal Change in Monthly Number of Day exceeding 30.0°C at North Bay Airport



Other Trends in Severe Weather

The Ontario Climate Change Guide (Ontario Ministry of Natural Resources, 2010) documents trends in intense daily rain events for the province, and concludes that they are increasing. An increase of 0.9% (1910 to 1970) to 7.2% (1970 to 1999) for extreme rainfall events has been observed in Ontario and an increase of 1.5% (1910 to 1970) to 14.1 % (1970 to 1999) for extreme weather events (cyclones) has been observed. The guide suggests that the trend of increasing extreme rainfall and weather events in Ontario will continue. A range of possible future scenarios for extreme weather event occurrences in Ontario was developed based on data available from global climate change models (Ontario Ministry of Natural Resources, 2010). Most of the global climate models predict that the biggest change will occur in extreme rainfall events, which will become more frequent and more intense in Ontario. This result concurs with the Insurance Bureau of Canada's' (2012) observation that North Bay is experiencing an increase in precipitation events over 30 mm. The average annual frequency and storm tracks for near extreme cyclones between 1961 and 1990 are presented in Figure 7.29.

Figure 7.29 Frequency and Track of Near Extreme Cyclone near the Great Lakes



Source: Watson and MacIver, 1995

The spatial zone of impact from extreme weather events is often limited to relatively small areas. This makes detection and assessment of these events more difficult when they occur in areas with few weather stations. A case example of spatial differences in extreme precipitation events for the NBMCA watersheds is described below.

Within the NBMCA watersheds, intense thunderstorms caused extensive basement flooding and major damage to roads and municipal infrastructure in the East Ferris and Bonfield Townships on August 5th 2008. Rainfall data collected by the NBMCA for the event indicates 124 mm of rain fell within a 7 hour period at a private rain gauge near Bonfield and that the storm affected a discrete area. Flooding caused both communities to declare emergencies and both received disaster relief from the provincial government. The severity of the event was not recorded at either the North Bay Airport or Powassan meteorological stations, as the main impact zone of the storm was restricted to a narrow swath (North Bay Airport recorded 36.2 mm and Powassan recorded 66.2 mm of rainfall on that day). This event suggests that increased weather data collection coverage of the NBMCA watersheds would be required to assess spatial and temporal changes in extreme weather events within the watersheds.

7.5 Predicted Climate Change in the NBMCA Watersheds

Weather stations reporting climate normals for 1971 – 2000 within the NBMCA watersheds are identified in Table 7.2. Projected changes for temperature and precipitation are provided for the North Bay Airport and Powassan in Tables 7.8 to 7.11. The projections were populated using a tool created by the Canadian Climate Change Scenarios Network (CCCSN) called the Localizer (CCCSN, 2012). The Localizer uses baseline temperature and precipitation data collected between 1971 -2000 from local Environment Canada weather stations, and uses a range of global and regional climate models to make future projections (2020s, 2050s, and 2080s) for the local area of interest. The CCCSN provides projections under three different emission scenarios: A2-High Emission Scenario (average of 20 models); A1B-Medium Emission Scenario (average of 24 models); and B1-Low Emission Scenario (average of 21 models), and these emission scenarios were created by the IPCC (2000). The results presented in Tables 7.8 to 7.11 are based on the A2 - High Emission Scenario, as the global trend appears to be for continued high emissions of greenhouse gases. The lack of international agreement at the Copenhagen climate change summit held in 2009 on reducing greenhouse gas emissions has meant a common acceptance of the application of the A2 emission scenario, and this was reinforced when no global emission reduction agreements were ratified in 2012. A report by the International Energy Agency (2007) stated that greenhouse gas emissions to 2030 will increase more rapidly than the highest IPCC scenario predicted.

The Localizer does not provide climate projections beyond the surface air temperatures and precipitation. Future projections for other climate variables, such as degree days, fog and cloud cover, and extreme climate events are not available through the Localizer. Downscaling to specific locations has inherent accuracy risk, and further details about the process can be found online (CCCSN 2012).

The two weather stations show a predicted increase for both temperatures and precipitation. Changes to the temperatures for both stations are similar. North Bay airport is anticipated to have an annual increase in temperature of 2.8°C by the 2050s, compared to the 1971-2000 climate normals, with winter temperatures increasing an estimated 3.5°C and summer temperatures by 2.6°C. At Powassan, the anticipated annual increase in temperature by the 2050s is 2.7°C, with winter temperatures increasing an estimated 3.1°C and summer temperatures by 2.7°C. Precipitation at the North Bay airport is projected to have an annual increase of 78 mm from the 1971-2000 climate normals to the 2050s, with the largest increase occurring in winter. At Powassan, the annual increase is estimated to increase by 58 mm for the same period, with the largest increase also occurring in winter. Both stations are anticipated to see a decline in summer precipitation beyond the 2020s.

7.6 Climate Change Stress Assessment

Climate change has been assessed for the NBMCA watersheds, through analyses of recorded trends at the North Bay Airport, through an assessment of regional factors affecting weather and climate experienced within the NBMCA watersheds, and by predicting changes to temperature and precipitation using the Canadian Climate Change Scenarios Network (CCCSN) modeling tools. The potential stresses that climate change poses to water management activities and the environment projected for the climate normal period of 2041 – 2070 (30-50 years into the future) is presented in Table 7.12. This chart also explores management implications associated with each stress factor identified.

7.7 Significance of Climate Change

Climate change has emerged as a significant variable in watershed management. Once thought of as a relatively stable factor only requiring acknowledgement of existing climatic conditions and consideration for regional variations or changes driven by evolving land uses; climate has emerged as a dynamic variable that is driving the development of new watershed management approaches that include adaption strategies. A major challenge has been to identify how global climate change is evolving at a local or regional scale and to project future conditions for local and regional areas. The NBMCA has already started to examine the climate impact changes on municipal water supplies as part of Source Water Protection Work (Aqua Resources 2010a and 2010b). This report has examined existing climatic trends within the NBMCA's area of jurisdiction, projected future scenarios that may be experienced within the NBMCA watersheds, and considered how management practices might have to accommodate changing conditions. Stantec has incorporated new trend analysis that is primarily based on data from the North Bay

Table 7.8 Projected annual and seasonal mean daily temperatures ranges for North Bay Airport compared to the (1971 -2000) Climate Normals

°C	annual	winter	spring	summer	autumn
1971-2000	3.8	-11.0	3.2	17.2	5.6
2020s	5.1 ± 0.4	-9.4 ± 0.6	4.4 ± 0.6	18.4 ± 0.4	6.8 ± 0.4
2050s	6.6 ± 0.6	-7.5 ± 0.8	5.8 ± 0.8	19.8 ± 0.7	8.1 ± 0.6
2080s	8.5 ± 1.0	-5.2 ± 1.2	7.5 ± 1.2	21.7 ± 1.2	9.9 ± 1.0

Table 7.9 Projected annual and seasonal precipitation ranges for North Bay Airport compared to the (1971 -2000) Climate Normals

mm	annual	winter	spring	summer	autumn
1971-2000	1006.9	190.2	220.4	295.3	301.0
2020s	1045.5 ± 28.6	200.4 ± 6.5	236.8 ± 14.4	300.9 ± 11.1	307.1 ± 19.2
2050s	1084.6 ± 38.9	219.7 ± 11.6	248.1 ± 15.2	295.5 ± 21.3	320.5 ± 20.8
2080s	1126.7 ± 68.8	236.7 ± 17.5	272.1 ± 29.6	287.1 ± 38.4	331.2 ± 28.4

Table 7.10 Projected annual and seasonal mean daily temperatures ranges for Powassan compared to the (1971 -2000) Climate Normals

°C	annual	winter	spring	summer	autumn
1971-2000	4.2	-10.5	3.8	17.3	6.1
2020s	5.5 ± 0.3	-9.1 ± 0.5	5.0 ± 0.5	18.5 ± 0.4	7.4 ± 0.3
2050s	6.9 ± 0.6	-7.4 ± 0.8	6.3 ± 0.8	20.0 ± 0.7	8.6 ± 0.5
2080s	8.7 ± 1.0	-5.5 ± 1.2	8.0 ± 1.1	21.9 ± 1.3	10.5 ± 0.9

Table 7.11 Projected annual and seasonal precipitation ranges for Powassan compared to the (1971 -2000) Climate Normals

mm	annual	winter	spring	summer	autumn
1971-2000	935.3	162.1	198.2	288.2	286.9
2020s	961.3 ± 30.1	169.7 ± 6.7	205.5 ± 11.2	292.1 ± 15.8	291.8 ± 19.1
2050s	993.5 ± 46.5	182.3 ± 8.3	216.4 ± 16.3	285.1 ± 27.4	302.7 ± 22.3
2080s	1024.8 ± 82.5	193.7 ± 13.8	234.2 ± 27.4	277.6 ± 47.5	307.2 ± 33.3

Airport, and these trends require further verification through the collection of additional long term regional climatic data from stations other than the North Bay Airport.

Understanding climate change is crucial to the successful management of water and watersheds. Climate influences the behavior of water in the environment and even subtle changes over time can have serious long term impacts and consequences. Understanding the dynamics of climate change and its influence on watersheds and their sub components are needed to development of adaptive strategies for the management of surficial and ground water resources. Climate change has emerged as an important and challenging variable that requires adaptive management practices and a redefining of risk at a watershed level to ensure that levels of protection sought are maintained in the climate of the future.

Table 7.12 The Anticipated Impacts of Climate Change within the NBMCA Area of Jurisdiction

Current Observed Trend and Regional Climate Influences	Projected Climate for 2041 – 2070	Possible Impacts to NBMCA Watersheds	Management Implications
1. Average Annual Temperatures have risen by 0.126° C per decade since the 1950's however most of this increase has been observed in the last 20 years of analysis. The annual average daily temperature for the North Bay Airport reached 4.22° C for the 1981-2010 climate normals. Similar Climate Normals for Powassan for this period will shortly be reported by Environment Canada	At the recent rate of temperature increase experienced in the last 20 years at the North Bay Airport (change between 1980s and 2000s averaged 0.415° C/decade) temper-atures will rise to the range predicted for 2050 in Table 7.8 to 7.11 for North Bay Airport and Powassan (a range of between 6.6°C to 6.9°C across the NBMCA watersheds ± 0.6° C) This would mean that the region will have a temperature regime similar to Orillia/Barrie in the 1971 – 2000 period. Average temperatures will increases in every month with the greatest increase expected in late summer and early winter. For the Trout Lake region, a mean increase of 2.76°C is projected by the 2041-2070 period (Aqua Resources 2010) which is in line with the above predictions.	Increasing temper-atures could lead to: • Positive benefits to tourism, recreation and agriculture • Increasing stress to plants and wildlife • Prolonged dry periods • Improved opportunity for pests such as mosquitos (West Nile Virus) and ticks (Lime Disease) causing increased health risk • Declining quality of timber • Decline in moose populations (which are heat intolerant) • Stress to fisheries due to declining dissolved oxygen levels especially to cold water habitat • Increase risk of forest fires	Incorporate precautionary management of forests and agriculture that adapt to changes (e.g. droughts, pest insect outbreaks, reduced yields). Increase preparedness for forest fires. Make residents and tourist aware of increasing health risk (such as West Nile and lime disease) over time. Start incorporating climate change impacts into planning documents and insure that future water supply is available for all users. Monitor climate change trends and adapt management practices as necessary.

Current Observed Trend and Regional Climate Influences	Projected Climate for 2041 – 2070	Possible Impacts to NBMCA Watersheds	Management Implications
2. Based on data at the North Bay Airport total precipitation is increasing at a rate of 2.4% per decade which is more than double the provincial average. Since the 1950s precipitation has increased at an average rate of 24.06 mm/decade at the North Bay Airport. The annual average precipitation experienced at North Bay for the 1981-2010 climate normal was 1044 mm. This is the amount of precipitation predicted for the North Bay Airport in 2020 in Table 7.9. Modeling seems to underestimate regional precipitation trends.	At the 2.4 % rate of increase/decade experienced since 1950s total precipitation within the NBMCA watersheds would increase to an average of 1190 mm/year at the North Bay Airport (with ranges between 1130 mm to 1230 mm/year across the watershed) which significantly exceeds precipitation predictions in Tables 7.9 and 7.11. This would match or exceed the current most extreme precipitation regions in Ontario which are on the shores of a Great Lake (such as Parry Sound or Owen Sound). This increase does not factor in declining precipitation in the summer period that is evident in recent trends and which models are predicting.	Higher water volumes in watersheds may: • Offset water losses caused by higher temperatures. • Increase the snow mass/pack in winter (short term) and runoff encountered in winter (long term). • Increase base flows/ stage levels which could increase the potential for flooding and exacerbate erosion. More severe flooding and erosion threatens public safety and risk of damage to property/ infrastructure. • Dilution may improve water quality but aquatic habitat may be deterred by sedimentation. • Impact stormwater infrastructure design.	Modeling of flood scenarios could help to identify areas of vulnerability within the watershed. Shorelines that are vulnerable to erosion should be subject to risk assessment and will require additional protection including protection of vegetation/ wider vegetative buffers and allowance for a widening meander zone of flowing systems. Low lying areas within the watershed should prepare flooding emergency procedures. Incorporate knowledge of flash flooding into future project and infrastructure design.
Current Observed Trend and Regional Climate Influences	**Projected Climate for 2041 – 2070**	**Possible Impacts to NBMCA Watersheds**	**Management Implications**
3. Winter snowfall has increased in the decade of the 2000s. This is thought to be caused by increasing lake effect from Lake Huron/Georgian Bay on the region. Factors causing increased snowfall are expected to continue to develop at recent rates.	Increased snowfall is expected within the NBMCA watersheds as ice cover continues to diminish on Lake Huron/ Georgian Bay. This is expected to increase the amount of precipitation received in the NBMCA watersheds in the early winter period.	Increased early winter precipitation can cause: • Snow squalls/freezing rain creating hazardous conditions, property damage and vegetation impacts • Deeper snow affects wildlife dynamics including predator-prey relationships (undulates are at risk) • Increasing snow depths affect moose body mass. • Improved maple syrup harvests	Local authorities will need to plan for an increased frequency in these emergency events. Land users should also prepare for these hazardous conditions.

Current Observed Trend and Regional Climate Influences	Projected Climate for 2041 – 2070	Possible Impacts to NBMCA Watersheds	Management Implications
4. Increasing precipitation and temperatures in the summer shoulder seasons.	Precipitation increases will occur earlier in the spring and later in the fall as shoulder seasons warm. Higher evapotranspiration will shift earlier into the spring within the NBMCA watersheds and its forested foreland as the growing season broadens. The fall growing season will be extended.	The spring freshet may shift earlier, and become more intense and a wetter fall with an extended growing season may cause: • Northward shift of non-native plants and wildlife that can increase competition with native species • Increased invasion of undesirable weeds and pests • Increased stress/ invasion of pests could affect native tree species which could impact forestry and increasing the risk of forest fires. • Greater stress to Species at Risk due to greater comp-etition/changing habitat conditions • Changing water levels and temperatures could affect fish spawning behavior and success rates • Changing seasons could affect the reproductive success of wildlife species • Higher precipitation increases the risk of flooding and erosion • Evolving water balance with evolving recharge, discharge and runoff • New opportunities for agricultural which could result in new crops and farming practices	Increase ecosystem monitoring, specifically the condition of vulnerable vegetation, and for the presence of potential weed/pest species currently confined to more southern latitudes. Adapt by Investigating new tree species with higher genetic tolerances to evolving climatic conditions. Match agricultural crops to changing climatic conditions.

Current Observed Trend and Regional Climate Influences	Projected Climate for 2041 – 2070	Possible Impacts to NBMCA Watersheds	Management Implications
5. Reduced peak summer precipitation and an increasing water deficit, possibly caused by shifting transpiration rates in the forested foreland of the NBMCA watersheds.	Reduced precipitation in July and August as transpiration exhausts soil moisture earlier in the summer and reduces moisture exhausted by plants to the atmosphere by peak summer. Rainfall that does occur will increasingly be associated with heavy downpours from thunderstorms.	Declining precipitation in July/August with precipitation increasingly falling during heavy storm events can result in: • Increased stress to ecosystems at an already stressed time. • Increased fire risk • Increased risk of flash flooding • water temperature increases and dissolve oxygen level decreases causing stress to fish (including Lake Trout) and reducing benthic organism biodiversity • Stress to wetlands which may reduce their natural functions and displace water dependent species • Increased stress to aquatic Species already at Risk • Increased opportunity for invasive species and vectors carrying disease to invade • Lower water quality (lack of dilution and impact of intensive flushing) • Higher water demand • Lower water levels restricting navigation/ recreational use of waterways and surface water takings with increased need for Low Water Response measures	Sensitive watersheds should be identified where fisheries, wetlands, Species at Risk, water levels or water quality, risk of flash flooding are sensitive to mid-summer impacts and methods to protect critical watershed functions should be identified that increase basin or stormwater storage capacity, protect fish and aquatic habitat, and preserve critical basin functions. Where mitigation is not possible develop adaptive management strategies which may include adjusting harvest limits

Current Observed Trend and Regional Climate Influences	Projected Climate for 2041 – 2070	Possible Impacts to NBMCA Watersheds	Management Implications
6. The number of days that exceed 30°C are increasing, and subsequently the probability of encountering severe weather is also increasing (a 60 to 100% probability increase was observed in the decade of the 2000's over previous decades). Risk has broadened to be earlier and later in the summer to include the 3 warmest months of the year.	The frequency and duration of thunderstorms in the warmest months of the year are anticipated to increase, thus increasing the probability of hail, severe winds, flooding and possibly forest fires caused by lightening. Tornados are rare within the NBMCA watersheds and although the likelihood of their occurrence is increasing, tornadoes will continue to be rare meteorological events in the region relative to other parts of Ontario.	As days with extreme temperatures and risk of more frequent/severe weather increases possible impacts include: • Higher probability of localized or regional damage such as the damage caused by severe flooding in Bonfield/East Ferris in August 2008 or the severe wind (derecho) storms of 2006. • Severe weather has devastating short termed impacts and more subtle longer term impacts such as impacts to forestry from wind damage to forest stands • Associated higher probability of having poor air quality and increased health risks from heat stress and breathing difficulties • Increasing probability of power outages	Local authorities should incorporate storm event impacts in their emergency planning and anticipate an increased frequency in storm event occurrence. Management of watersheds will require adaptive management to allow for the variety of impacts that could occur with extreme storm events. The forest industry may want to alter its harvest and regeneration strategies and consider planting species with more tolerance to heavy winds
Current Observed Trend and Regional Climate Influences	**Projected Climate for 2041 – 2070**	**Possible Impacts to NBMCA Watersheds**	**Management Implications**
7. Ice conditions on Lake Nipissing have not shown any significant signs of change based on records available contrary to trend observed on the Great Lakes.	As temperatures move to be more akin to recent climate normals for Orillia/Barrie, ice conditions of Lake Nipissing may mirror changes recently experienced at Lake Simcoe. This includes later freezing, earlier ice off and thinner ice conditions over the winter period	Reduced ice cover on Lake Nipissing may: • Increase precipitation in the early winter and early spring due to the lake effect, which would likely have a localized effect • Increasing pressure on warm weather tourism /recreation as cold weather tourism/ recreation declines (less ice fishing and snowmobiling)	Monitor Lake Nipissing ice cover conditions, and prevailing winds to determine where localized impacts may occur in the watersheds.

Current Observed Trend and Regional Climate Influences	Projected Climate for 2041 – 2070	Possible Impacts to NBMCA Watersheds	Management Implications
8. Water balance analysis suggests that more water is being lost to runoff in the winter period, a dwindling freshet is moving earlier in the year; a water deficit is intensifying at the warmest time of the year and shifting later in the summer with an 8.7% increase in runoff experienced in the fall period. Overall runoff is becoming more erratic on an annualized basis from extreme conditions.	A continued weakening of the spring freshet is expected as snow melt during the winter increases. As precipitation increases more rapidly than the effects of evapotranspiration more runoff will generally be available. Summer water deficits will gradually deepen and shifting deeper into August and, in the longer term, possibly into early September. Runoff will continue to be erratic in extreme years (greater number of drought and very wet years).	The current high risk period of flooding from rain in combination with rapid snow melt during spring freshet will diminish as risk of flooding from summer storms (particularly in early summer when storage and soil moisture levels are still high) increase. Higher probability of extremes in runoff with more years of no freshet and increasing potential for fall flooding.	Changes to flood monitoring and warning to better predict summer events (less importance of snow courses and more reliance on ability to predict severe thunderstorms). Operating procedures for recreational dams must adapt to a declining freshet and increasing fall and winter runoff. More extreme years could create pressure to balance out large variations with more or better water control structures

8.0 Surface Water Quantity

The NBMCA relies on a detailed understanding of water quantity characteristics for individual drainage basins to carry out many of its core responsibilities. This understanding is obtained from long-term stream flow and lake level data collected at key locations. Streamflow and lake level data are used to generate regulatory floodplain mapping as well as to forecast floods and low water events, to manage recreation/navigation water levels and to facilitate an understanding of geomorphological and biological aspects of the environment. Hydrologic data supports regulatory instruments used by the NBMCA to meet water management responsibilities. This section examines annual and monthly stream flow and water level trends from gauges operated by Environment Canada (Water Survey of Canada). Technical reports supporting calculated flood elevations and floodplain mapping have been summarized. Surface water use is examined. Water takings relative to water availability in the study area have also been examined. The following section summarizes water quantity characteristics of the NBMCA.

8.1 Stream Flow and Water Level Gauges

Historic stream flow and water level data is available for active and formerly active gauges (hydrometric stations) located across the NBMCA. Hydrologic data is available on-line from HYDAT, a data base maintained by the Water Survey of Canada. Water Survey of Canada currently maintains four active stream flow gauges and one active water level gauge within NBMCA's jurisdiction. Active gauges are located on the La Vase River, Chippewa Creek, Amable du Fond River at Kiosk (Upper), Wistiwasing (Wasi) River and at Lake Nipissing–North Bay. Water Survey of Canada also provides historical HYDAT data for formerly active gauges for four locations (Duchesnay, Mattawa River at Bouillon Lake, Amable du Fond at Samuel de Champlain Provincial Park and Mattawa River below the confluence with the Amable du Fond River). The Ottawa River at Mattawa gauge primarily monitors Ottawa River water levels and has not been assessed in detail.

The longest operating active stream flow gauges are located on the La Vase River and on Chippewa Creek in North Bay, which have both been in operation since 1974. A gauge on the lower Amable du Fond River in Samuel de Champlain Provincial Park also has a lengthy period of record but it ceased operating in 1995. The NBMCA re-established monitoring of the Amable du Fond River at Kiosk (Upper Amable) in 1995 however the gauge was not operated by Water Survey of Canada until 2006. The newest gauge within the NBMCA's jurisdiction was established on the Wasi River near Astorville in 2007 (data is available from 2008). The gauge on the Mattawa River below Bouillon Lake was established in 1971 and discontinued in 1998. An older Mattawa River gauge (Rutherglen), located below the Amable du Fond River mouth, operated between 1962 and 1971. No active gauges exist anymore in the lower Mattawa River basin. The Duchesnay Creek stream flow gauge ceased operating more than 30 years ago (1956-1982). In some cases short term stream flow data has been collected for subwatersheds management studies, however data is not suitable or long enough for long term trend analysis. The Lake Nipissing – North Bay water level gauge is active and has a lengthy record period (1933-2011). Figure 8.1 illustrates the location of active and selected formerly active hydrometric stations that provide data and are maintained by the Water Survey of Canada (Environment Canada).

8.1.1 Stream Flow Record Period

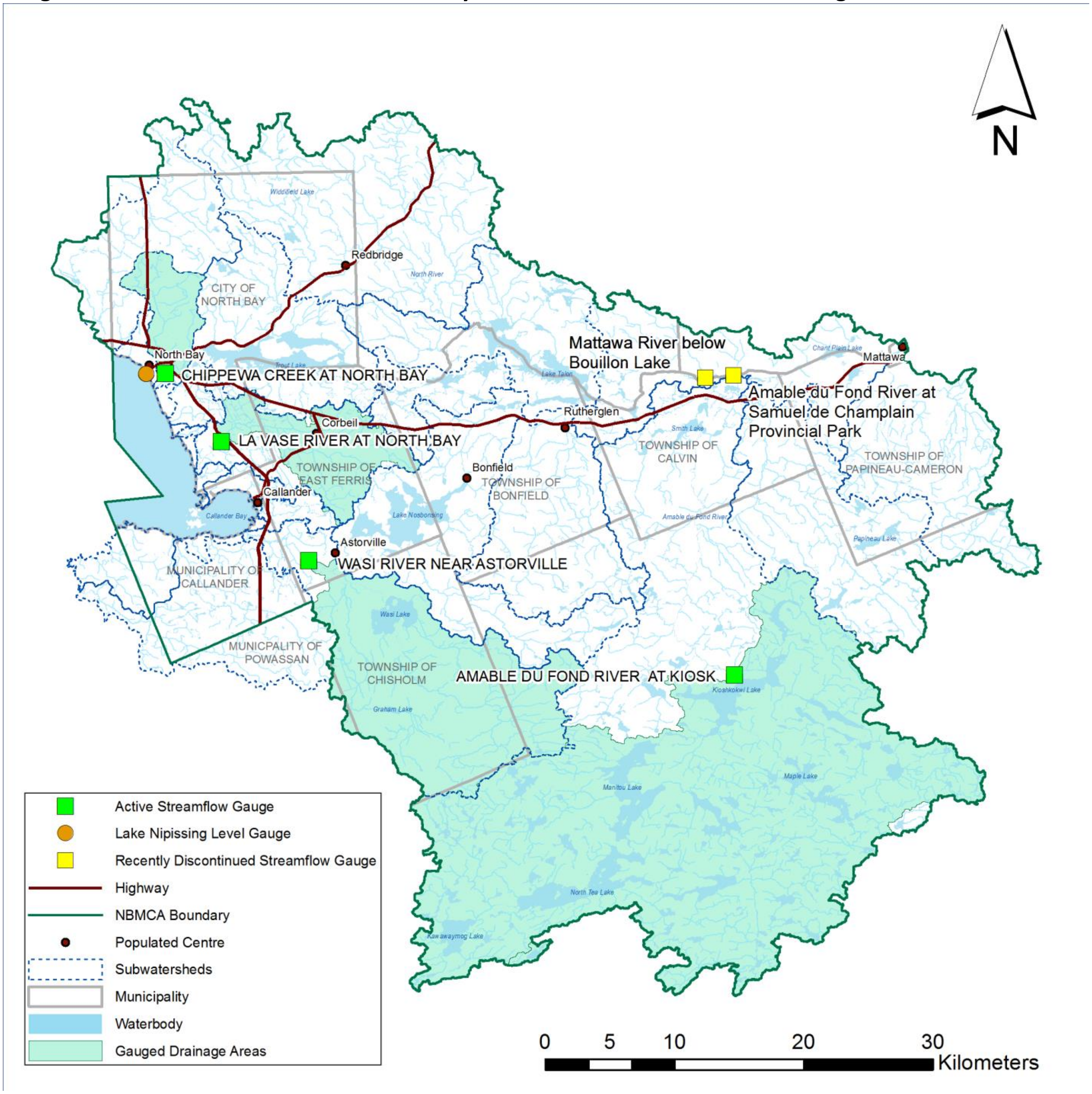
The Chippewa Creek and La Vase River stream flow gauges have the longest record periods (1974-2011), while Wasi River has the shortest record period (2008-2011). The record period provided in HYDAT is sometimes slightly different than what is found in the data base. For example HYDAT shows that the data period for the Wasi system is between 2007 and 2011 however no 2007 data is available. HYDAT lists the Amable du Fond River at Kiosk as "active" however 2011 data was not posted at the time of analysis. Characteristics for active and recently active stream flow gauges within NBMCA are provided in Table 8..

Drainage areas contributing to each stream flow gauge are usually provided in HYDAT. Drainage areas were reviewed and three issues were identified. The Amable du Fond gauge at Kiosk did not report a drainage area. Also the drainage areas listed for the Wasi River gauge and the Mattawa River at Bouillon Lake gauge were incorrect. Drainage areas for two of these gauges have been checked by the NBMCA using GIS analysis tools. The Amable du Fond River gauge at Kiosk has a contributing drainage area of 706 m^2. The Wasi River gauge, which lists a drainage area of 301 km^2, is actually 211.5 km^2. The drainage area for the Mattawa River gauge reported as 909 km^2 was calculated by Gartner Lee (2008) to be 951.5 km^2. Based on the watershed area above the Lake Talon Dam (876.4 km^2), and the fact that this gauge captures about half of the lower Mattawa River subwatershed, the Gartner Lee area for this gauge is considered accurate. These corrected areas have been used for the analysis below.

Drainage areas with long term data within the NBMCA thus range between 211.5 km^2 (Wasi River) and 1130 km^2 (Lower Amable du Fond at Samuel de Champlain – formerly active). The largest drainage area currently monitored is 706 km^2 (Upper Amable du Fond at Kiosk). In total 1,025 km^2 of area of the NBMCA is currently gauged, which represents 34% of its total area (2,995 km^2). Three of four active gauges are located within the Great Lakes watershed and collectively gauge 319.24 km^2, which is 53% of the NBMCA's area of jurisdiction within this basin. Formerly active gauges on the Mattawa River and the lower Amable du Fond represented a large percentage of the Mattawa River watershed that is no longer monitored.

As these gauges only became no longer active recently and because they cover a large portion of the Mattawa River watershed, they have been included in the hydrological assessment below. The drainage areas of active and formerly active stream flow gauges within NBMCA are indicated in Table 8.1.

Figure 8.1 Active and Selected Formerly Active Stream Flow and Level Gauges within NBMCA



8.1.2 Annual Stream Flow and Runoff Characteristics

Annual flow rates (median and mean values) and calculated runoff depths (median value) using data from HYDAT for each of the NBMCA gauges and are listed in Table 8.6. Mean annual runoff is calculated from mean monthly flows reported in HYDAT, which are accumulated for the year and divided by the gauged drainage area. Links to HYDAT databases used for assessment are provided at the bottom of Table 8.2. La Vase River and Chippewa Creek annual runoff values can be directly compared as they share a common record period (1974-2011). The mean annual runoff for the La Vase River (412 mm) was 20% lower than Chippewa Creek (516 mm) during the reported period for a number of reasons including lower rainfall, flatter basin and stream gradients and lower degree of urbanization. Drainage basin characteristics are reported in Sections 6 and 14.

Mean annual runoff values for Chippewa Creek (516 mm) in Table 8.2 can be contrasted with mean annual water surplus values (expressed as runoff) for the North Bay Airport in Section 7. The North Bay Airport is located within the Chippewa Creek subwatershed. Stantec has adjusted runoff calculations for the North Bay Airport to match the Chippewa Creek gauged period of record (1974–2011). The calculated North Bay Airport mean annual water surplus for the 1974 to 2011 period is 476 mm. The water surplus has been interpreted to represent runoff because recharge and discharge were assumed to be equal over the long term. For the same period the annual average evapotranspiration rate was 562 mm, which was subtracted from average annual precipitation (1,038 mm). It is noted that water balance calculations generated by Stantec were not originally intended for comparison to the entire Chippewa Creek watershed (for example the contributing area is assumed to be entirely forested), however the calculated value is within a 90% confidence interval of actual flows measured for the period.

Mean annual runoff for Chippewa Creek can also be contrasted with water budget values calculated by Gartner Lee in “Source Water Protection Planning North Bay-Mattawa Source Protection Area Conceptual Water Budget” (2008). Gartner Lee developed a water balance for Chippewa Creek for the 1971 to 2000 period as shown in Table 8.3. The Chippewa Creek water surplus was identified as 472 mm for the period (note the period is not directly comparable to the above 2 examples). Gartner Lee further apportions the water surplus into runoff (193 mm) and groundwater recharge (279 mm). The gauged watershed area reported by Gartner Lee differs from the area reported by Water Survey of Canada. If the watershed area is adjusted to the corrected gauged area the stream flow would be 539 mm for the period. The Gartner Lee water budget was developed for watershed characterization while the Stantec water budget assessment in Section 7 is mainly intended for climate change stress assessment. Although based on an earlier time period (1971-2000), the Gartner Lee data is likely more representative

Table 8.1 Periods of Record/Gauged Areas for Streamflow Gauges within the NBMCA

Station ID	Station Name	Period of Record Studied	Years of Record	Gauged Basin Area (km²)	Status	Control
02DD013	La Vase River at North Bay	1974-2011	38	70.4	Active	Natural
02DD014	Chippewa Creek at North Bay	1974-2011	38	37.3	Active	Natural
02DD024	Wasi River Near Astorville	2008-2011[1]	4	211.5[3]	Active	Natural
02JE019	Amable du Fond River at Samuel de Champlain Provincial Park (Lower)	1972-1995	24	1130	Formerly active	Regulated
02JE020	Mattawa River Bouillon Lake	1971-1998	27	951.5[5]	Formerly active	Regulated
02JE027	Amable du Fond River at Kiosk (Upper)	2006-2010[2]	5	706[4]	Active	Natural

1. HYDAT reports the period of record for Wasi as 2007-2011 however no data is available for 2007.
2. HYDAT reports the period of record for Amable du Fond gauge (02JE027) as 2005-2010 but no data is available for 2005. The period of record is actually 2006-2010. Data from 2011 was not posted at the time of analysis.
3. The drainage area to the Wasi River gauge is incorrectly listed as 301 km² in HYDAT.
4. HYDAT does not list a drainage area to the Amable du Fond River at Kiosk gauge.
5. The drainage area to the Mattawa River Bouillon Lake gauge is incorrectly listed as 909 km² in HYDAT.

Table 8.2 Annual Flow Rates and Runoff Depths for Reported Record Periods within the NBMCA

Station Name	Period of Record	Annual Flow Rate (m^3/s)			Annual Runoff Depth[1] (mm)	
		Mean[4] (m³/day/km²)	Mean[1]	Median[2]	Mean[3]	Median[2]
La Vase River at North Bay	1974-2011	1128	0.919	0.900	412	403
Chippewa Creek at North Bay	1974-2011	1413	0.610	0.622	516	513
Mattawa River Bouillon Lake	1971-1998	1398	15.4	15.5	510	n/a[5]
Wasi River Near Astorville	2008-2011	1115	2.73	-	407	n/a[5]
Amable du Fond River at Samuel de Champlain Provincial Park (Lower)	1972-1995	1231	16.1	15.4	449	432
Amable du Fond River at Kiosk (Upper)	2006-2010	1469	12	12.0	536	572

1. From Hydrometric Data, Environment Canada http://www.wsc.ec.gc.ca/applications/H2O/index-eng.cfm.
2. From Water & Streamflow Statistics, Environment Canada http://www.wsc.ec.gc.ca/staflo/index_e.cfm?cname=HydromatD.cfm
3. Mean annual surplus depth was calculated based on mean monthly flow and drainage area.
4. Mean annual flow rate ($m^3/d/km^2$) was calculated based on mean annual flow rate (m^3/s) and drainage area.
5. Median runoff values for Wasi and Mattawa (Bouillon) in HYDAT not shown due to inaccurate drainage areas.

Table 8.3 Gartner Lee Water Budget for Chippewa Creek (1971 – 2000)

Subwatershed	Gauged Area	Data Period	Annual Average Precipitation mm	Annual Average ET mm	Water Surplus mm	Runoff mm	Recharge mm	Streamflow mm	Base Flow mm
Chippewa Creek	32.4	1971 - 2000	1005	533	**472**	193	279	621	256

Source: Gartner Lee, SWPP NBMSPA Conceptual Water Budget (2008)

of actual watershed conditions. Water balance information for each gauge is to be further evaluated on a subwatershed basis in Section 14.

Mean annual runoff values for active stations were generated for the period they share in common (2008-2010) (see Table 8.4). For this common period the Wasi River basin experienced the lowest mean annual water surplus (413 mm) followed by the La Vase River (430 mm), the Upper Amable du Fond River(521 mm), and Chippewa Creek (532 mm). The Wasi system is mainly situated within the Mattawa - Nipissing lowlands and the Powassan climatic station, located in the Wasi system has lower precipitation than experienced in upland areas. The Wasi system may also encounter high rates of infiltration/recharge due to the presence of thick sand and gravel glacial deposits. The Amable du Fond River at Kiosk is also above the Algonquin ridge and receives higher precipitation; the watershed is extensively covered by wilderness and abundant lakes, which is uncommon in other compared drainage basins. This watershed is also reported to have thin overburden. Chippewa Creek encounters the highest water surplus because of higher rates of precipitation, a steep basin gradient and the highest degree of urbanization.

Table 8.4 Annual Flow Rates and Runoff Depths for 2008-2010

Station Name	Gauged Basin Area (km²)	Mean Annual Flow Rate[1] (m^3/s)	Mean Annual Runoff Depth (mm)
Wasi River Near Astorville	211.5	2.77	413
La Vase River at North Bay	70.4	0.960	430
Amable du Fond River at Kiosk	706	11.7	521
Chippewa Creek at North Bay	37.3	0.629	532
1. Flows obtained from Hydrometric Data, Environment Canada http://www.wsc.ec.gc.ca/applications/H2O/index-eng.cfm.			

The La Vase River was selected to test if any statistically significant changes in mean annual runoff are occurring overtime (period of record is 1974-2011) and no trend was identified.

8.1.3 Monthly Runoff Characteristics

Mean monthly runoff depths have been calculated for active and selected formerly active gauging sites using mean monthly flow data and applying updated drainage areas identified in the previous section. Monthly runoff values for each gauged site are shown in Figures 8.2 to 8.7. These plots show the mean and standard deviation of the monthly runoff values. The red bars extend to plus and minus one standard deviation beyond the mean. At all gauges the highest monthly runoff occurs in April which is affected by the spring freshet. Spring runoff recedes quickly in smaller watersheds but lingers into May in larger systems due to delayed response times. A second runoff peak occurs in November in northern watersheds but is delayed until December/January in the southern watersheds.

The lowest mean monthly runoff occurs in August in northern watersheds and in September in southern watersheds. In most watersheds a second low runoff period is experienced in February, in part due to fewer days in the month. This winter runoff minimum almost equals the summer runoff minimum except for in the upper Amable du Fond River and the Wasi River. Both of these gauges have only operated for a short period of time and observations may reflect changes in runoff patterns caused by climate change.

Figure 8.2 Mean Monthly Runoff for La Vase River, North Bay (1974 – 2011)

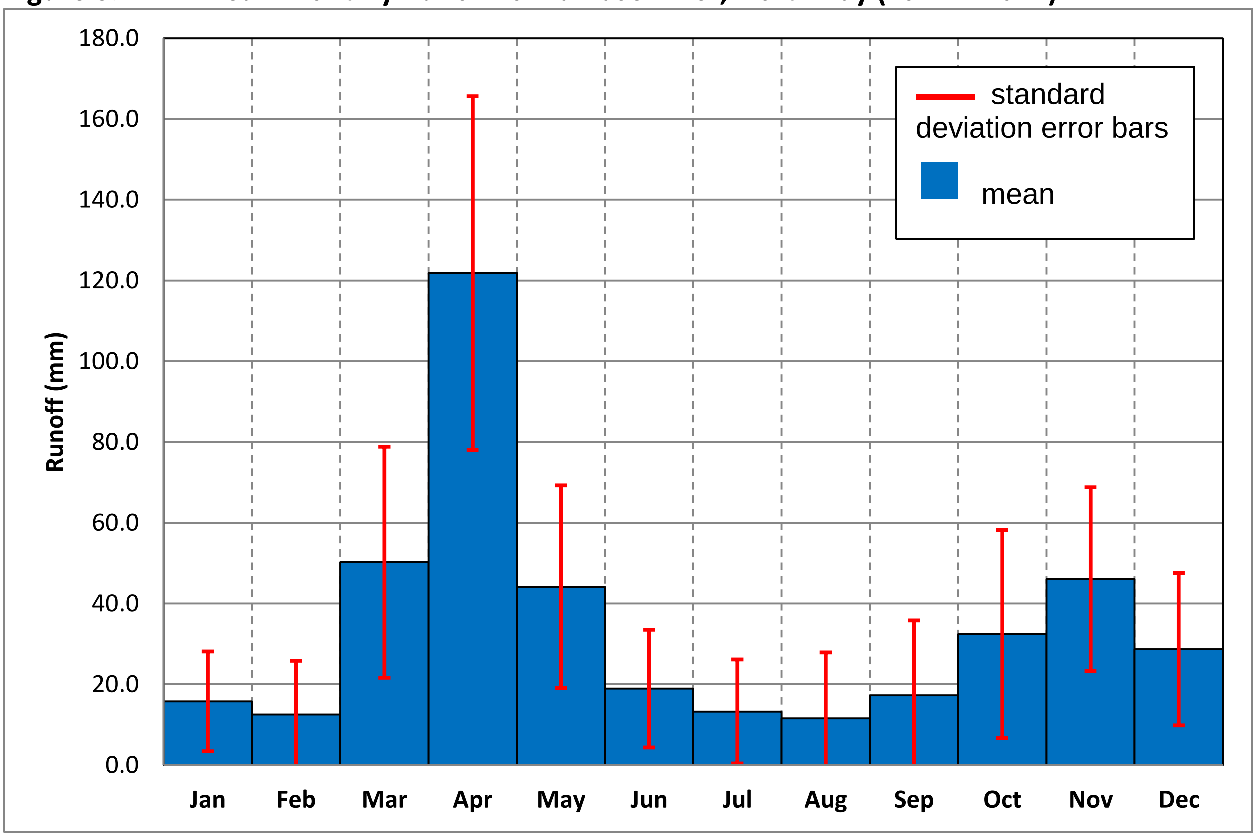


Figure 8.3 Mean Monthly Runoff for Chippewa Creek, North Bay (1974 – 2011)

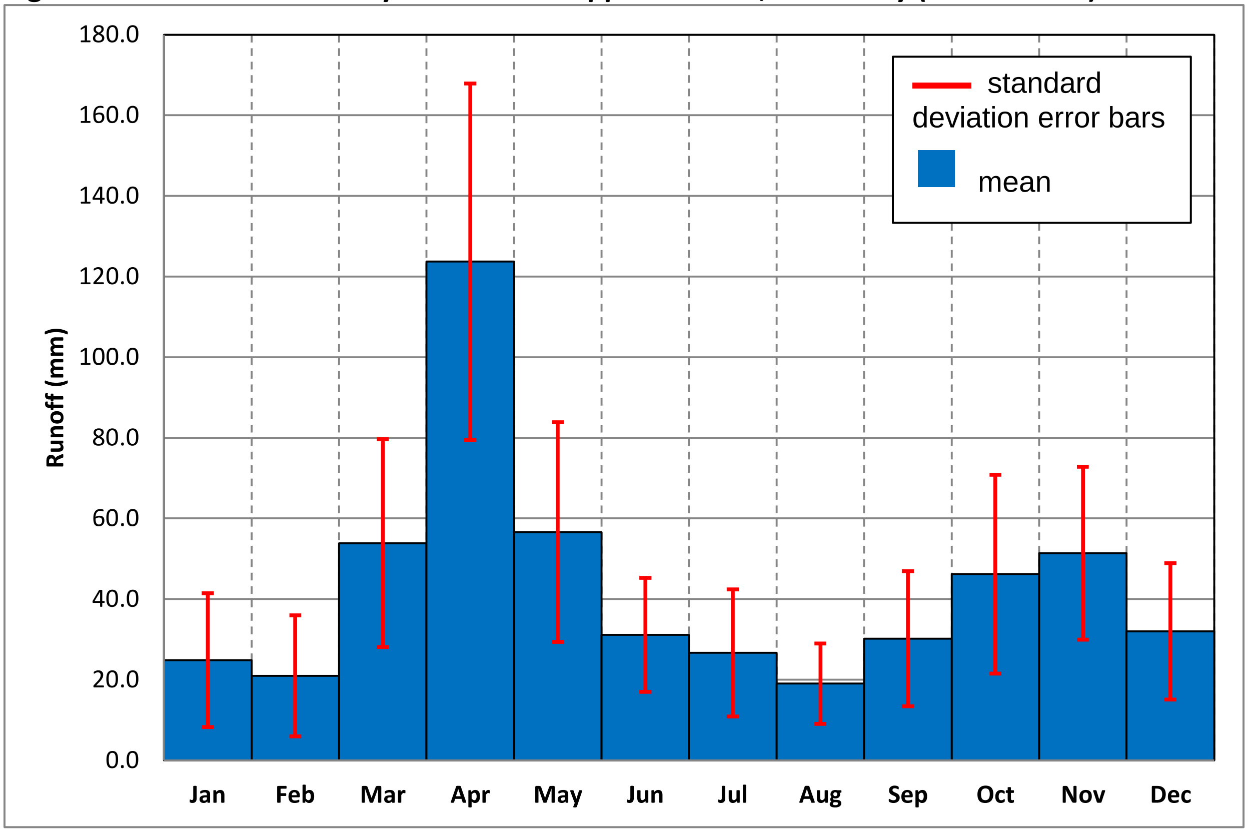


Figure 8.4 Mean Monthly Runoff for Mattawa River, Bouillon Lake (1971 – 1998)

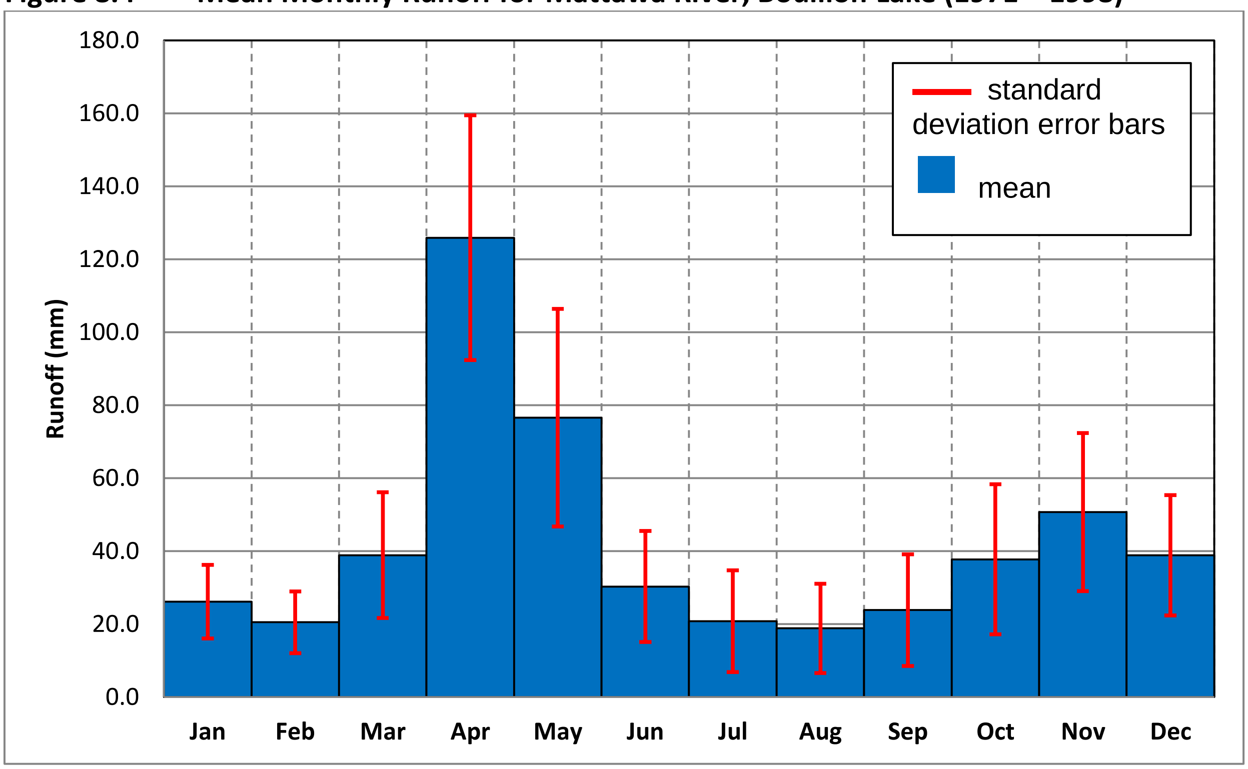


Figure 8.5 Mean Monthly Runoff for Wasi River, Astorville (2008 - 2011)

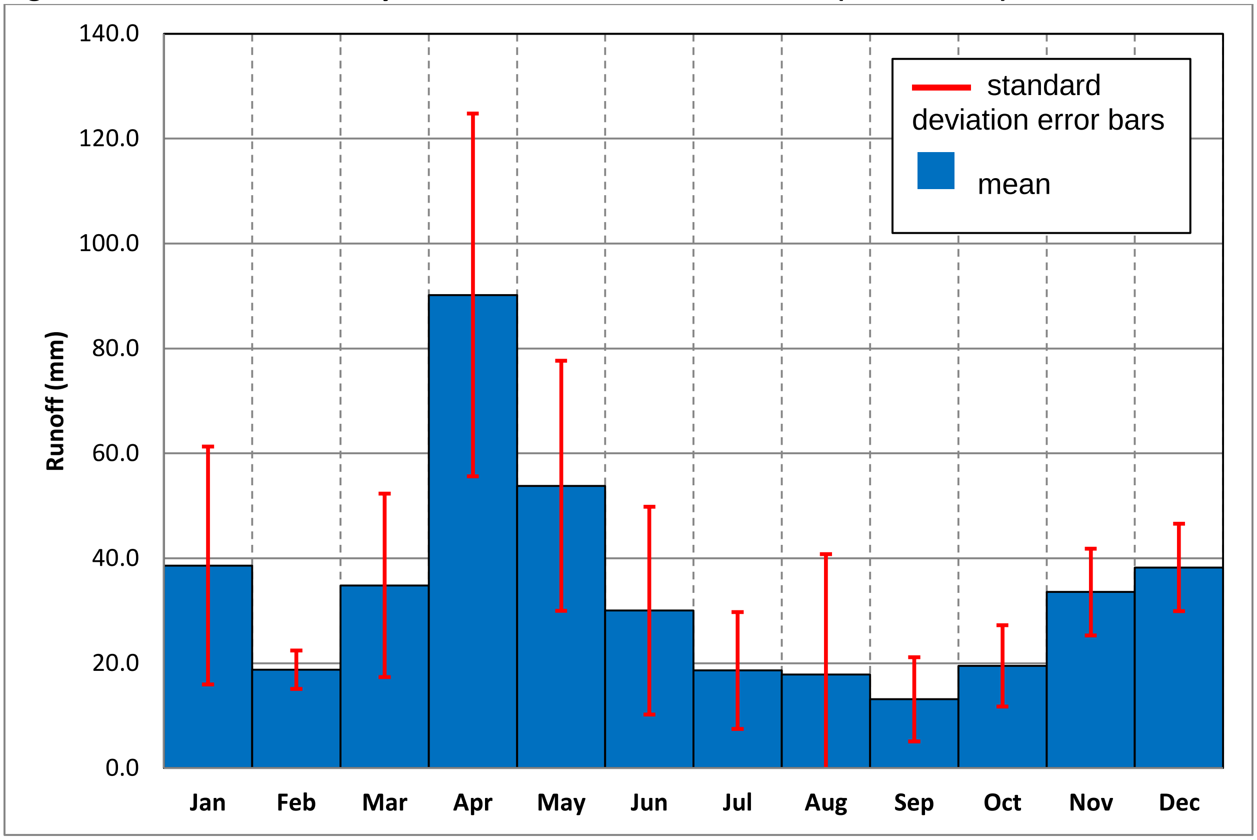


Figure 8.6 Mean Monthly Runoff for Amable du Fond River, Samuel de Champlain Provincial Park (1972 – 1995)

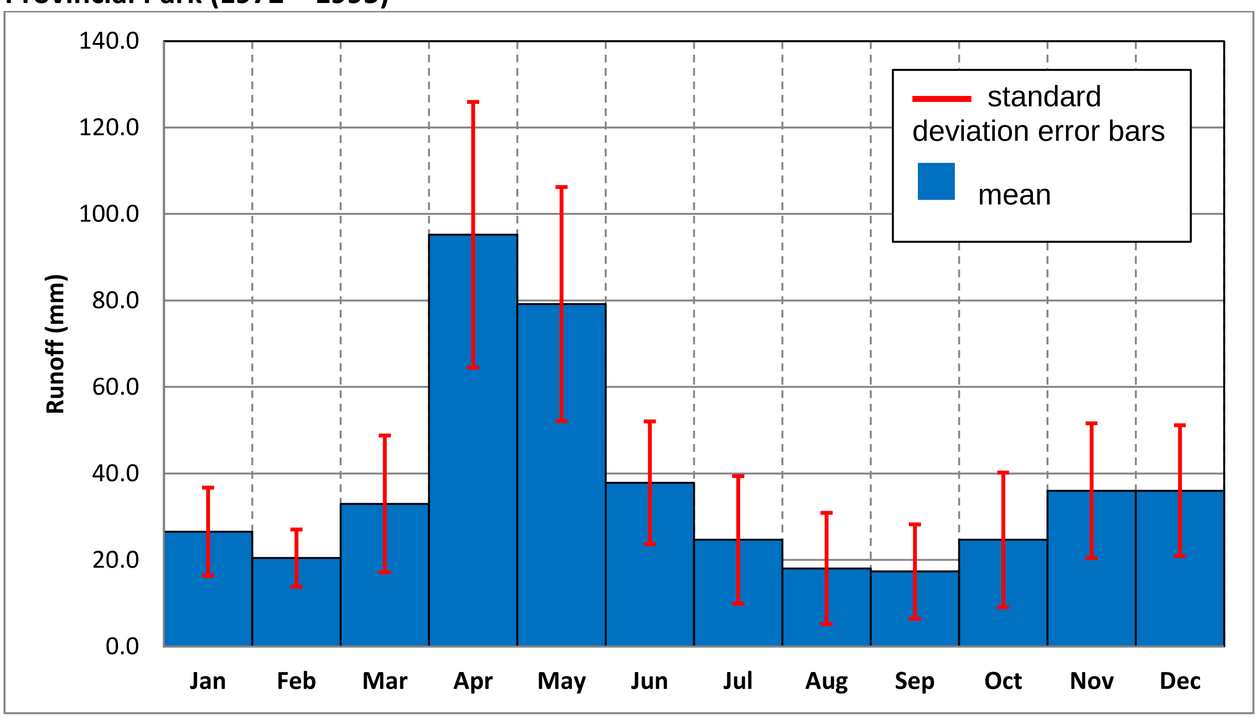
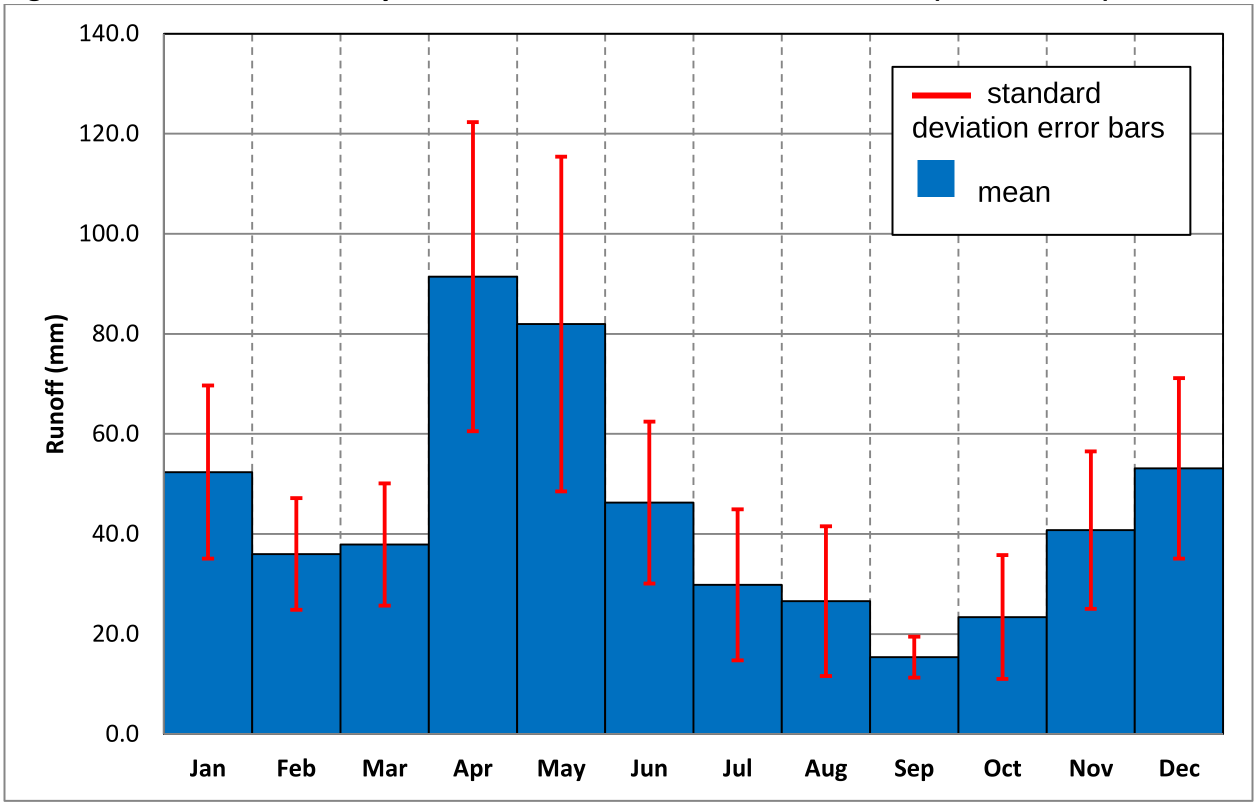


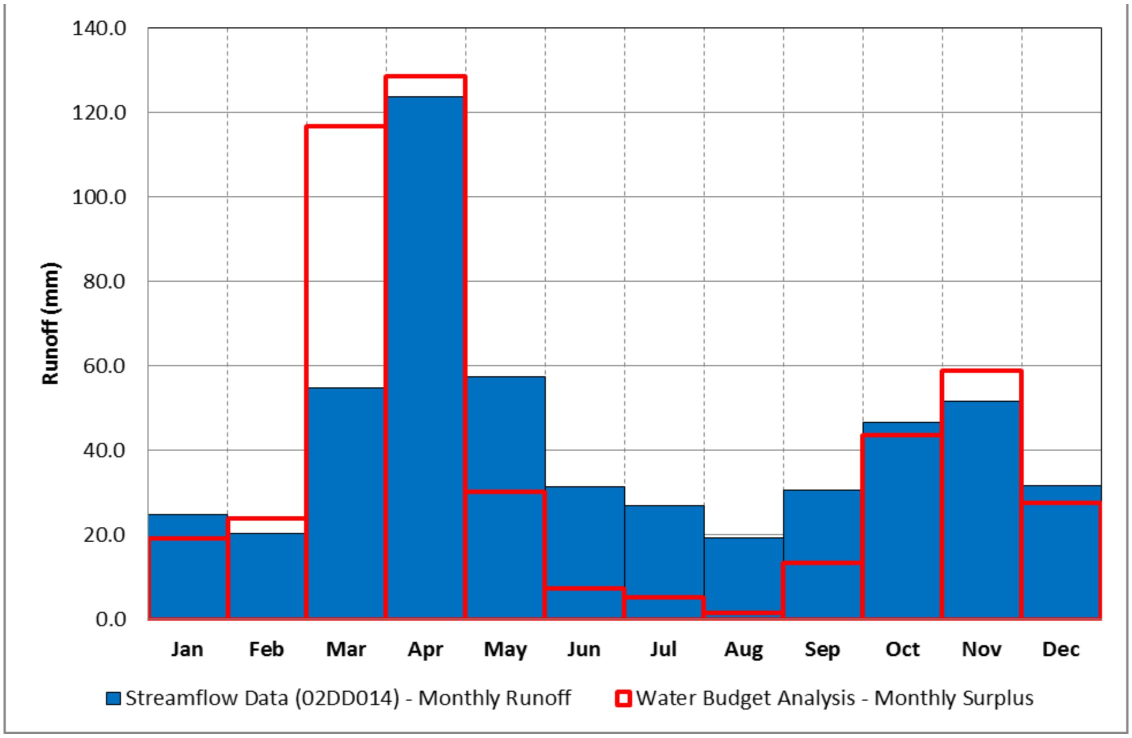
Figure 8.7 Mean Monthly Runoff for Amable du Fond River, Kiosk (2006 – 2010)



Mean monthly runoff values for Chippewa Creek are compared to the mean monthly water surplus values generated for the North Bay Airport (as part of the water budget analysis completed in Section 7 Climate and Climate Change) in Figure 8.8 (North Bay Airport data has been adjusted for the same period). Calculated and gauged values both indicate peak runoff in April and runoff minimums in August. The water budget calculations over-predict runoff in March and under-predict runoff during the summer period. Snow melt and runoff values for March, calculated for the Climate Change Assessment, are computed based on temperature data, but actual runoff has not shifted into March as modeling suggests. Modeling may not be allowing for the lag time required for the snow mass to ripen. The Chippewa Creek basin also experiences higher runoff during dry periods than what the water balance modeling suggests (note that the model was not calibrated for comparison purposes – as a forested watershed with 300 mm soil depths were assumed).

The La Vase River was selected to test for any statistically significant changes in mean monthly runoff overtime (period of record is 1974-2011) and two data points fell out of the 90% confidence range. The mean monthly flows in January have increased by 0.009 m^3/s/year over the period of record while September has experienced a decrease of 0.007 m^3/s/year. La Vase was selected for the trend test because of the length of record (38 years) and lack of regulation. Statistical T and F tests followed the same approach as reported in Section 7.

Figure 8.8 Monthly Gauged Runoff (1974–2010) and Monthly Calculated Runoff (1974–2010)



8.1.4 Maximum and Minimum Daily Flow Characteristics

Extreme maximum and minimum daily flows obtained from HYDAT for active and formerly active gauges are summarized in Table 8.5. The highest extreme daily flows occurred in April at all stations except the Wasi River, which occurred in January (this gauge has a short record period). Extreme daily flow data suggests that the freshet peaks in early April in small watersheds and in late April in larger watersheds. Extreme maximum daily flows range between 5 and 26 times the annual mean flows rates. The highest maximum daily flow reported at the La Vase River gauge is 26 times higher than the reported mean annual flow. It is noted that the August 5, 2008 storm, discussed in the Climate section, did not result in the highest maximum daily flow at the La Vase gauges for that year.

Extreme minimum daily flows were equally observed for August and September between the six gauging sites. Flows in the La Vase River and Chippewa Creek can be negligible in extreme conditions reflecting a lack of recharge near gauging sites. Chippewa Creek is the only gauged system to report no flow (0 m^3/s on August 18, 1975 and also has occurred at other times) while La Vase River has recorded a negligible flow (6 L/s) on September 22, 2011. Extreme daily minimum flows on record comprise 5% of the mean annual flow in the Mattawa River and Wasi River and increase to 15% of the mean annual flow in the Amable du Fond at Kiosk (Upper). It is difficult to directly compare daily maximum and minimum flow data because of the difference in the period of records.

Table 8.5 Extreme Maximum and Minimum Daily Flows at Streamflow Gauges within NBMCA

Station Name	Period	Maximum Daily Flow		Minimum Daily Flow	
		Flow (m^3/s)	Date	Flow (m^3/s)	Date
La Vase River at North Bay	1974-2011	24.5 (26X) [1]	Apr 1, 1998	0.006	Sep 22, 2011
Chippewa Creek at North Bay	1974-2011	11.6 (18X) [1]	Apr 9, 1980	0.000	Aug 18, 1975[3]
Mattawa River Near Bouillon Lake	1971-1998	176 (11X) [1]	Arp 25, 1985	0.714 (5%)[2]	Aug 15, 1978
Wasi River Near Astorville	2007-2011	25.5 (9X) [1]	Jan 9, 2008	0.154 (6%)[2]	Aug 31, 2010
Amable du Fond River at Samuel de Champlain Park	1972-1995	138 (8X) [1]	Apr 24, 1985	1.48 (9%)[2]	Sep 5, 1975
Amable du Fond River at Kiosk (Upper)	1995 - 2010	54.3 (4.5x) [1]	Apr 26, 2008	1.81 (15%)[2]	Sep 01, 2010

1. (X) denotes the magnitude of how the maximum flow is greater than the mean annual flow.
2. (%) denotes the equivalent percentage of the mean annual flow.
3. Chippewa Creek has also experienced 0 flows at other times

8.2 Lake Nipissing Water Levels

A Water Survey of Canada water level gauge, located at the Kings Landing Dock in North Bay (02DD006), is an active gauge that has operated since 1933. The NBMCA uses information from this gauge to monitor Lake Nipissing shoreline impacts in North Bay and Callander.

Figure 8.9 shows Lake Nipissing annual daily maximum and minimum water levels for the North Bay gauge between 1933 and 2010. HYDAT data is converted to geodetic datum by adding 190 m. Both maximum annual daily and minimum annual daily water levels are trending lower over time. Maximum annual daily levels are declining at a rate of 3 mm per year over the period of record. Minimum levels are declining at a similar rate. Possible causes include differential isostatic rebound rates between North Bay and the outlet of the lake, changes in management operating procedures and controls and the impact of climate change. Figure 8.10 illustrated the change that has occurred in lake management practices between 1933 – 1951, 1952 – 1979 and 1980 – 2011. These time intervals where chosen to correspond when the Portage Dam dam became operational (1951) and the 1979 Flood. This table indicates that the lake is now operated at a lower level (since 1952) with an average water level decrease of 0.181 meters/year after 1951. Changes in water levels management since 1952 can be explained by Climate Change impacts (more winter precipitation, earlier freshet, higher evaporation rates in the summer period).

Lake Nipissing mean monthly water levels, between 1933 and 2010, are presented in Figure 8.11. Mean monthly data illustrates changes in water levels caused by winter drawn down and spring fill up as well as the gradual decline experienced over the summer period (Lake Nipissing operating ranges are further discussed in Section 14). Monthly maximum and minimum water levels are also shown in Figure 8.9. Data indicates that between April and July the lake experiences greatest water level variability compared to other months. Mean monthly water

Figure 8.9 Maximum and Minimum Annual Daily Water Levels for Lake Nipissing (1933-2010)

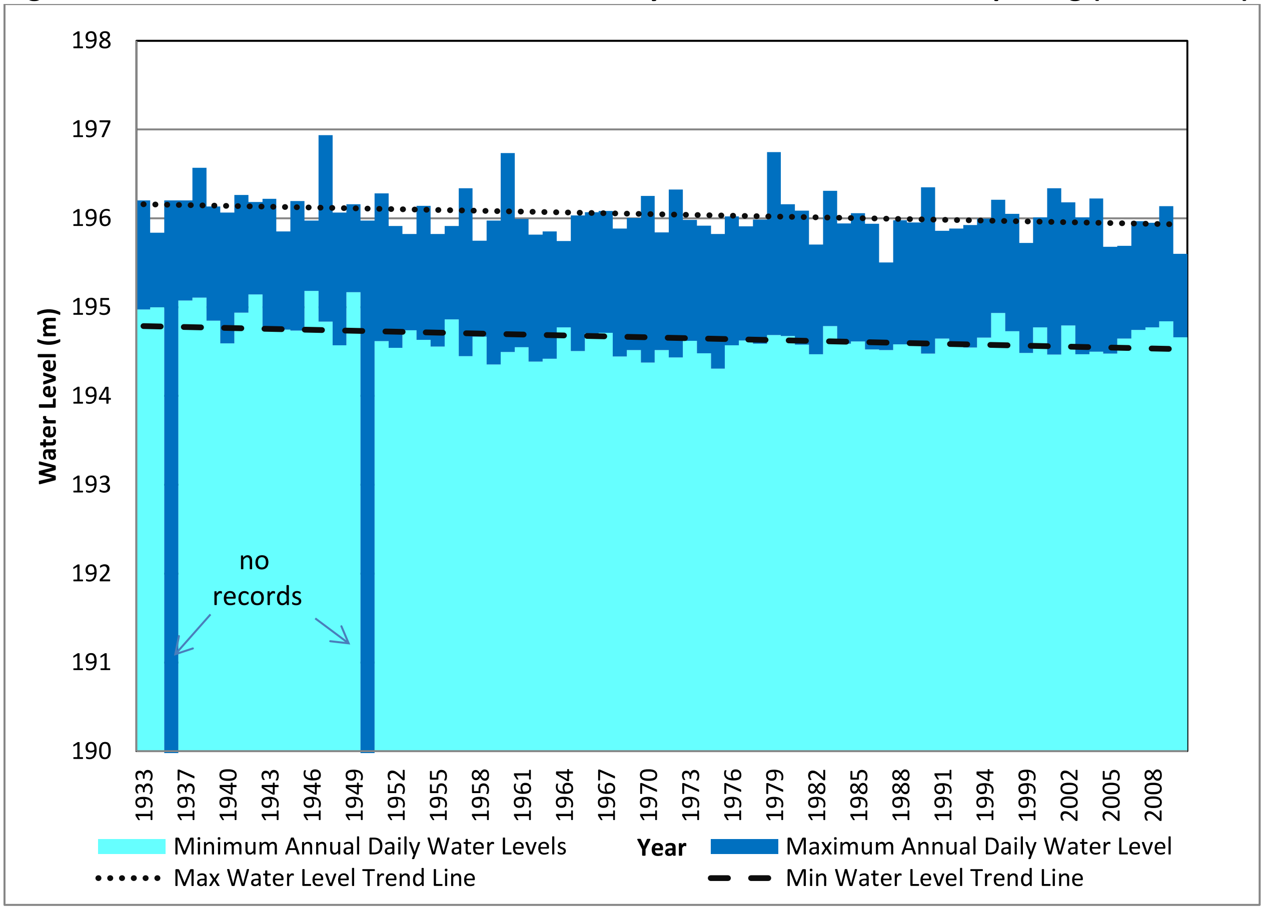
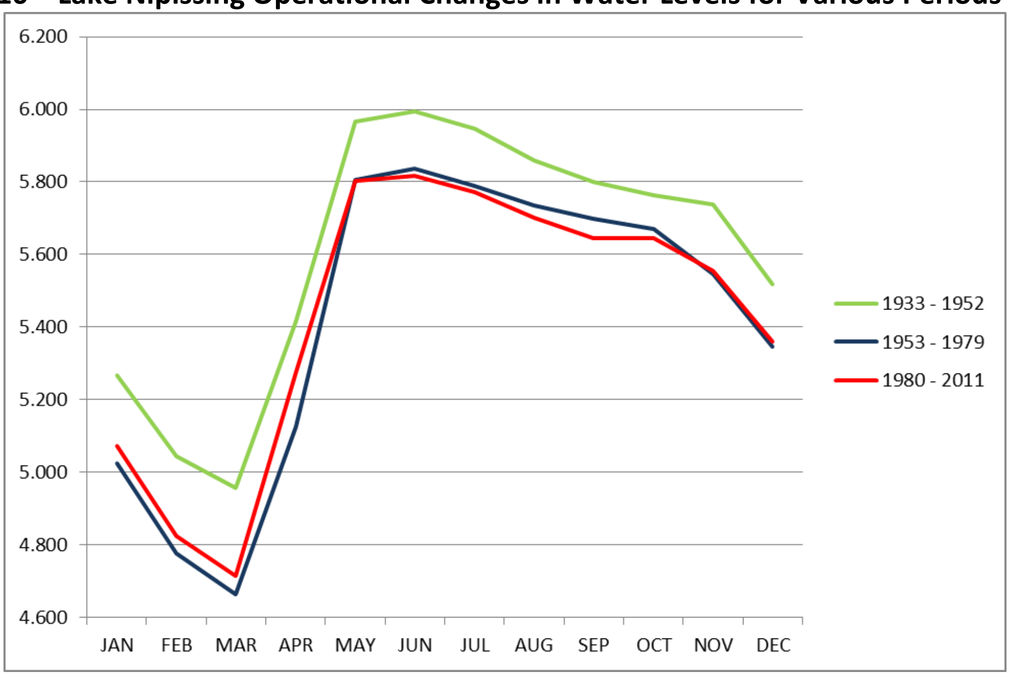
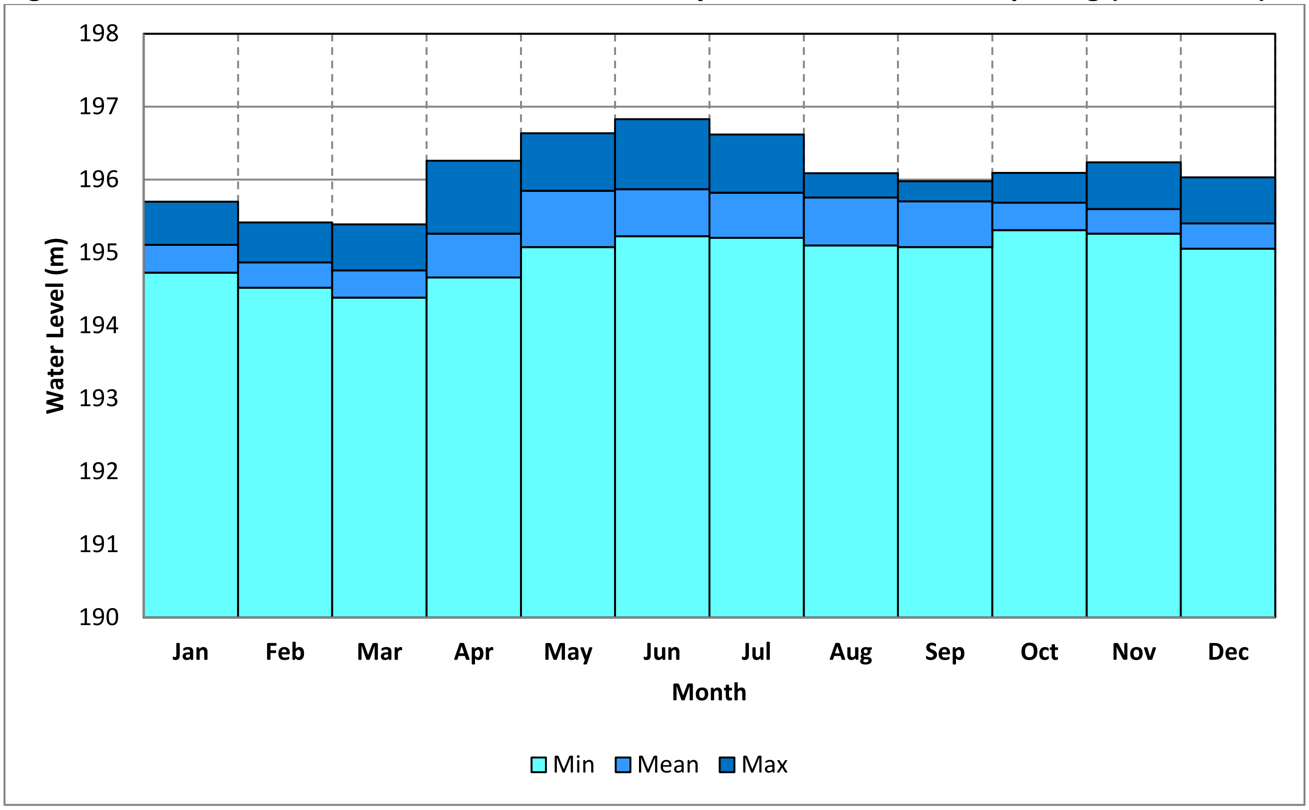


Figure 8.10 Lake Nipissing Operational Changes in Water Levels for Various Periods



Source: Lake Nipissing-North Bay Hydat Database (note that to convert to geodetic datum add 190 m)

Figure 8.11 Maximum, Minimum and Mean Monthly Water Levels - Lake Nipissing (1933-2010)



levels can vary by up to 1.6 meters in the months of April, May and June, which is 0.6 meter greater than the variation experienced between August and March.

8.3 Flood Plain Studies and Flood Plain Mapping

Design flood magnitudes on rivers and lakes follow one of two basic approaches:

1) Statistical frequency analysis using stream flow gauge data inputs
2) Stream flow simulation using rainfall and snowmelt data inputs

The selected method depends on the quantity and quality of data available as well as the project application needs.

Flood frequency analysis examines past hydrologic records to calculate the statistical probability that a flow rate of a certain magnitude will occur in a river in a certain period of time (e.g. once in 25 years). Frequency analysis is based on long-term maximum daily discharge rates that satisfy certain statistical criteria. A single station analysis or regional regression analyses (or combination) can be undertaken depending on the quantity of data and whether it is a natural or regulated system. A goodness of fit test is used to determine its distribution (e.g. lognormal, Gumbel etc). Floodplain and/or fill line mapping is available for most NBMCA subwatersheds.

Table 8.6 summarizes regulatory floodplain information available on a subwatershed basis. A summary of hydrologic and hydraulic analyses that support NBMCA flood plain calculations is provided in Table 8.7. Individual studies should be referenced for further details (some studies may contain information for return periods not fully reflected in Table 8.7). Floodplain policies applied in each subwatershed are complex and have not been summarized.

Peak flows from the North Bay Mattawa Floodplain and Fill Line Mapping report (M. M. Dillon, 1975) are given in Table 8.8. These flows, calculated by the Ministry of Natural Resources, were used to delineate the Regional Storm flood lines on various watercourses. The Timmins Storm was used as the Regional Storm, except in Mattawa, where the 100 year flood of the Mattawa River governs. As requested by NBMCA Stantec has converted the results from imperial to metric. Although old it represents the only hydrologic information available for some of the more remote, smaller or non-gauged systems in the study area. For detailed application of this information the original report should be consulted.

Table 8.6 Flood Plain/Fill Line Mapping Studies

Subwatershed	Lake or Tributary	Flood Plain/Fill Line Mapping	Regulatory Event	Regulatory Level Available	Information Source/Date	Channelization
Duchesnay Creek[1]	Lower	Flood Plain Mapping	Timmins Storm	Variable	M. M. Dillon, 1975	
	Upper	Fill Line Mapping[1]	TBD	TBD	M. M. Dillon, 1975	
Chippewa Creek[1]	Lower Main	Flood Plain Mapping	1:100 yr	Yes	Northland Engineering, 1984	Yes
	East View	Flood Plain Mapping	1:100 yr	Yes	Northland Engineering, 1984	Yes
	Johnston	Flood Plain Mapping	1:100 yr	Yes	Northland Engineering, 1984	Yes
	Delaney L	Flood Plain Mapping	1:100 yr	205.98 m	Northland Engineering, 1984	
	Golf Club	TBD	TBD	TBD		
	Upper Main	Flood/Fill Line Mapping[1]	Timmins Storm	TBD	M. M. Dillon, 1975	
Parks Creek[1]	Lower Main Channel	Flood Plain Mapping	1:100 yr	Yes	Totten Sims Hubicki, 1992	
	Passmore L	Flood Plain Mapping	1:100 yr	202.14	Northland Engineering, 1982	
	Twin Line L	Flood Plain Mapping	1:100 yr	203.11 m	Totten Sims Hubicki, 1992	
	Depensier L	Flood Plain Mapping	1:100 yr	203.11 m	Totten Sims Hubicki, 1992	
	Circle L	Flood Plain Mapping	1:100 yr	203.12 m	Totten Sims Hubicki, 1992	
	McLean L	Flood Plain Mapping	1:100 yr	203.10 m	Totten Sims Hubicki, 1992	
La Vase River[1]	Main - North Bay	Flood Plain Mapping	1:100 yr	Yes	Northland Engineering, 1982	
	Cooks Creek	Flood Plain Mapping	Timmins Storm	Yes	Northland Engineering, 1982	
	Main - East Ferris	Flood Plain Mapping	1:100 yr	Yes	Totten Sims Hubicki, 1998	
Lake Nipissing Shoreline/North Bay[1]	Lake Nipissing	Flood Plain Mapping	1:100 yr	197.25 m[(6)]	MacLaren Plansearch Inc, 1982	
	Pinewood Parkway Cr	Elevations Only	1:100 yr	Yes	Northland Engineering, 1997	
Jessups Creek[1]		Flood Plain Mapping	1:100 yr	Yes	Northland Engineering, 1982	Yes
Windsor/Boulder/ Bear Creek		TBD	TBD	TBD	TBD	
Burford Creek		TBD	TBD	TBD	TBD	
Callander Bay/South Shore		Flood Plain Mapping	1:100 yr	197.25 m[(6)]	MacLaren Plansearch Inc, 1982	
Wistiwasing River[1]	Main River	Flood Plain Mapping[4]	1:100 yr	Yes	Northland Engineering, 1993	
	Wasi Lake	Elevation Only	1:100 yr	265.67 m	Marshall Macklin Monahan, 2007	
	Graham Creek	TBD	TBD	TBD	TBD	Yes
	Graham Lake	Elevation Only		278.38 m	A. J Robinson, 1986 pg 49	
North River[1]		Fill Line Mapping[1]	TBD	TBD	M. M. Dillon, 1975	
Trout Lake[1]	Main Lake	Flood Plain Mapping	Timmins Storm	202.69 m	M. M. Dillon, 1975	
	Lees	Flood Plain Mapping	Timmins Storm	Yes	M. M. Dillon, 1975, B. Dawdy 1988	
	Four Mile Cr	Flood Plain Mapping	Timmins Storm	Partial	M. M. Dillon, 1975, B. Dawdy 1988	
	Four Mile Lake	Elevation Only/Fill Line Mapping[1]	Timmins Storm	360.88 m	M. M. Dillon, 1975, B. Dawdy 1988	
	Hillside Lake	Flood Plain Mapping	Timmins Storm	357.04 m	M. M. Dillon, 1975	
	Doran Cr[2]	Fill Line Mapping[1]	TBD	TBD	M. M. Dillon, 1975	
Kaibuskong River[1]	Lake Nosbonsing	Flood Plain Mapping	Timmins Storm	237.6 m	Northland, 1982	
	Upper Kaibuskong	Flood Plain Mapping	Timmins Storm	Yes	M. M. Dillon, 1975	
	Kaibuskong River at Outlet of Sheedy Lake	Floodplain elevation	TBD	101.0 m[(3)]	B. Dawdy, 1993	
Lake Talon[1]		Elevation Only	1:100 yr	195.52 m	B. Dawdy, 1988	
Sharpes Creek[1]		TBD	TBD	TBD	TBD	
Amable du Fond River[1]	Main River	TBD	TBD	TBD	TBD	
	Smith Lake	Elevation Only	1:100 yr	176.96 m	B. Dawdy, 1988	
Pautois Creek[1]	Main	TBD	TBD	TBD	TBD	
	Papineau Lake	TBD	TBD	TBD	TBD	
Boom Creek[1]		TBD	TBD	TBD	TBD	
Lower Mattawa River[1]	Lake Chant Plein	Elevation Only/Fill Line Mapping[1]	1:100 yr	160.78 m	Hurdman Dam Feasibility Study, No Date	
	Mattawa River[5]	Flood Plain Mapping	Timmins Storm	156.48 m	M. M. Dillon, 1975	
	Mattawa River[5]	Flood Plain Mapping	1:100 yr	156.40 m	Proctor and Redfern, 1982	
	Earl's Lake	Elevation Only	1:100 yr	178.0 m	Northland, 1988	
	Taggart Lake	TBD	TBD	TBD	TBD	
Turtle Lake		TBD	TBD	TBD	TBD	

1. NBMCA has extended the fill line mapping in-house to cover most of its jurisdiction with patented land. Fill line mapping completed in-house on the south side of the study area does not extend much beyond organized municipalities or into Algonquin Park. Fill lines have not been developed for new subwatersheds (Callander Bay, Windsor/Boulder/Bear, and Burford Creek).
2. Mapping available for Hazelton Subdivision
3. Sheedy Lake regulatory flood elevation (101.0 m) is relative to an assumed reference datum. It is not a geodetic elevation.
4. Available in the Municipality of Callander only
5. Elevation present are for In the Town of Mattawa.
6. The MacLaren Plansearch 1:100 yr flood level for Lake Nipissing includes wind tilt and wave uprush. The 1:100 yr static elevation calculated by MacLaren in 1982 was 196.94 m. Recent work completed by Public Works and Government Services Canada for the reconstruction of the Big Chaudière Dam on Lake Nipissing identified 196.8 m as the 1:1000 yr static flood elevation. This elevation is lower than the MacLaren 1:100 yr static elevation (which correlates with the 1947 flood level reported at the Lake Nipissing North Bay HYDAT gauge and is the highest elevation on record).

Table 8.7 Overview of Approaches to Hydrologic and Hydraulic Analyses

Subwatershed	Hydrologic Analysis		Hydraulic Analysis		Report Year	Reports Principle Author
	Single Station/ Regional Analysis	Hydrologic Model	Hydraulic Model	Other		
Chippewa Creek	-	HYMO	HEC-2	-	1984	Northland Engineering
	-	INTERHYMO.89 existing and future land use conditions (2 to 100yr return)	-	-	1996	Proctor & Redfern
Amable du Fond (Smith Lake)	Regional flood frequency analyses	-	HEC-2	-	1988	B. Dawdy
La Vase River & Cooks Creek (West Ferris)	-	HYMO (Timmins, 100yr)	HEC-2	-	1982	Northland
La Vase River near Corbeil & Tributary at Corbeil	Single station frequency analysis	-	HEC-2 (100yr, 500yr)	-	1998	Totten Sims Hubicki
La Vase River downstream of Highway 11B	-	HYMO (25yr)	HEC-2 (25yr, 100 yr)	-	1988	B. Dawdy
Jessups Creek (West Ferris)	-	HYMO, SWMM (Timmins, 100yr)	HEC-2	-	1982	Northland
Parks Creek (West Ferris)	-	OTTHYMO-89 (2 yr to 100yr)	HEC-2	-	1992	Totten Sims
Parks Creek (West Ferris)	-	HYMO, SWMM (Timmins, 100yr)	HEC-2	-	1982	Northland
Lake Nosbonsing	-	SLURP	-	Storage-Indication Routing	1992	Northland/Beak
Lower Mattawa River (Town of Mattawa)	Regional flood frequency 2 to 100 yr)	-	HEC-2	-	1982	Proctor & Redfern
Pinewood Creek	-	OTTHYMO 89	HEC-RAS (2 to 100 year)	-	1997	Northland
Talon Lake	Single station analysis	-	-	Stage-discharge at dam	1988	B. Dawdy
Trout Lake – Four Mile Lake	-	HYMO	HEC-2	-	1988	B. Dawdy
Trout Lake – Lees Creek	-	HYMO (100 year, Timmins)	HEC-2	-	1988	B. Dawdy
Trout Lake – Main and Four Mile Bay	Water balance/empirical	-	-	-	1988	Conestoga Rovers
Wistiwasing River (Wasi)	-	QUALHYMO (5, 20, & 100 yr)	QUALHYMO (rating curves)		1986	A.J. Robinson

Table 8.8 Metric Conversion of Regulatory Flows from North Bay Mattawa Floodplain and Fill Line Mapping (MM Dillon, 1975)

Watershed Description	Drainage Area (ha)	Storm Rainfall (mm)	Runoff Curve Number	Runoff Volume (m^3 x1000)	Runoff Volume (ha-m)	Peak Flow (m^3/s)
Talon Chutes Dam (inflow)	84,304	129.8	64.2	39,216	3,922	711.9
Talon Chutes Dam (outflow)	84,304	129.8	64.2	39,216	3,922	72.8
Walder Creek	2,357	175.3	60.0	1,521	152	78.7
North River	22,792	121.7	58.2	6,858	686	208.6
Balsam Creek	7,511	159.3	60.0	4,036	404	155.9
Doule Creek	1,347	181.1	60.0	916	92	46.2
Redbridge Creek	1,243	184.9	60.0	873	87	45.4
Little North River	855	193.0	62.4	770	77	4.8
Glassy Creek	1,917	189.5	60.0	1,410	141	85.4
Cahill Creek	1,321	190.0	60.0	1,003	100	58.2
Bushtrail Creek	1,399	176.5	60.0	924	92	47.0
Kaibuskong River	17,198	152.4	72.8	14,709	1,471	67.4
Nosbonsing Lake Dam (inflow)	13,960	157.5	75.0	13,160	1,316	270.0
Nosbonsing Lake Dam (outflow)	13,960	157.5	75.0	13,160	1,316	21.2
Sharpes Creek	13,831	156.5	63.3	8,871	887	331.5
Blueseal Creek	4,222	162.6	65.0	2,860	286	122.6
Sparks Creek	4,532	177.8	65.0	3,398	340	138.2
Turtle Lake Dam (inflow)	17,068	151.9		11,626	1,163	476.7
Turtle Lake Dam (outflow)	17,068	151.9		11,626	1,163	10.8
Four Mile Creek	3,574	178.8		2,873	287	125.1
Four Mile Bay West Creek	544	193.0		408	41	25.9
Four Mile Bay East Creek	699	193.0		534	53	26.9
Trout Mills Creek	570	193.0		463	46	29.7
Doran Creek	1,088	188.2		883	88	45.3
Loren Lake Creek	1,839	171.7		1,231	123	26.8
Hurdman Dam (inflow)	223,904	119.1		84,740	8,474	320.7
Hurdman Dam (outflow)	223,904	119.1		84,740	8,474	213.8
Chant Plein Damsite (inflow)	206,344	119.1		84,741	8,474	321.0
Chant Plein Damsite (outflow)	206,344	119.1		84,741	8,474	274.1
Earl Lake Creek	2,150	163.1		1,206	121	38.5
Boon Creek	14,556	131.6		5,429	543	169.3
Landis Creek	3,600	156.5		2,014	201	101.9
Amable Du Fond River	111,499	120.7		52,181	5,218	275.8
Kiosk Dam (inflow)	70,810	136.7		42,227	4,223	121.8
Kiosk Dam (outflow)	70,810	136.7		42,227	4,223	33.6
Duchesney River	10,179	155.7	60	5,232	523	172.4
La Vase River	5,833		82			224.3
Parks Creek	754	193.0	85	995	100	30.6
Chippewa Creek[1]						82.7
Centennial Cres. Creek						19.3
Payne Island Creek						16.1

[1] Chippewa Creek flows were revised at the request of the Ministry of Natural Resources. These revisions are presented in more detail in the Chippewa Creek Preliminary Engineering Report.

8.4 Low Water and Low Water Response

The NBMCA Low Water Response program is summarized below based on a draft report prepared by NBMCA and information available at the MNR website: www.ontario.ca/lowwater. The Ontario Low Water Response Program (OLWR) has been developed by the Province to ensure that appropriate authorities are aware of and prepared in the case of low water conditions. The province operates in partnership with local authorities, provides overall direction and coordinates policies, science and information systems. Local authorities collect local information, interpret policy and coordinate necessary local actions to minimize low water impacts.

The Low Water Response Program relies on a regional Water Response Team coordinated by the Conservation Authority. The Water Response Team can have representation from the province, municipalities, the Conservation Authority and from local water users and interest groups. At a minimum, the local Water Response Team will include representatives from:

- North Bay-Mattawa Conservation Authority;
- Ontario Ministry of Natural Resources;
- Ontario Ministry of Environment;
- Ontario Ministry of Agriculture, Food and Rural Affairs; and
- Potentially affected municipalities.

Key responsibilities of the Water Response Team is to initiate and monitor the effectiveness of water use restrictions and to ensure that communications are occurring between the Province, CA, municipalities, local media and citizens living and working within effected watersheds. The Water Response Team is also responsible to assess local water supply and demand, to monitor local conditions as they evolve, and to work with local water users to curb demand and minimize shortages.

The Ontario Low Water Response Program applies three advisory levels. A Level I advisory is used at the first indication of a potential water supply problem. A Level II advisory is used when a potentially serious problem is identified. A Level III advisory is used when the water supply has failed to meet demand and is resulting in creating socioeconomic hardship as it progressively worsens.

Each advisory level necessitates an increasing level of response. At a Level I advisory water users are asked to voluntarily reduce water consumption by 10 per cent. At Level II advisories water users are asked to voluntarily reduce water use by 20 per cent or greater. Under a Level III advisory, very restrictive actions proposed by the Water Response Team and approved by the Province could be legislated.

The Ontario Low Water Response Program uses a risk-based hierarchical approach that relies on voluntary reductions and conservation at Level I and II advisory levels through local media and sector-specific forums. The NBMCA would need to identify communications and action strategies for severe drought conditions which are identified as having minimal impacts in the region. Once Level III conditions are met regulatory restrictions can automatically be imposed if set out in a Low Water Response Plan.

8.4.1 Local Low Water Response

The Ontario Low Water Response Program uses precipitation and stream flow data as the primary indicators for defining low water levels and drought. Threshold levels for the three advisory levels are indicated in Table 8.8. Stream flow data for the La Vase River and Chippewa Creek are used to monitor condition levels. Precipitation data is obtained from the North Bay Airport climate station which is in the Chippewa Creek subwatershed.

Table 8.9 Low Water Response Thresholds

Condition Level	Definition	Ontario Low Water Response (OLWR)		Local OLWR	
		Condition Indicator		Monthly Streamflow (m^3/s)	
		Precipitation	Streamflow	Chippewa Creek	La Vase River
Level I	First indication of a potential water supply problem	< 80 % of average in previous 18 months and 3 months	Spring: monthly flow < 100% of lowest average summer monthly flow. Other months: monthly flows < 70% of lowest summer month average	0.190	0.203
Level II	Potentially a serious water supply problem	< 60 % of average, weeks with less than 7.6 mm of rain	Spring: monthly flow < 70% of lowest average summer monthly flow. Other months: monthly flows < 50% of lowest summer month average	0.136	0.145
Level III	Water supply fails to meet water demand resulting in more severe and widespread effects	< 40 % of average	Spring: monthly flow < 50% of lowest average summer monthly flow. Other months: monthly flows < 30% of lowest summer month average	0.082	0.087

8.4.2 Low Water Condition Updates (MNR)

The Ministry of Natural Resources monitors the Province and posts low water conditions on their website (www.mnr.gov.on.ca) which indicates when watersheds are confirmed to be experiencing Level I, II or III conditions. Indicator maps are also provided that show areas of the Province where a Low Water Condition are identified. Reported conditions are followed up by the local Water Response Team. Changes to Confirmed Conditions are made daily, as advised by the local Water Response Team based on local conditions. Historic "Confirmed Conditions Maps", available from 2003 to 2013 (inclusive), were reviewed. Only one confirmed low level conditions (Level 1) was posted for the NBMCA during this period (from August 14 to October 11, 2012) and the local Water Response Team reacted by issued a media release advising the public that a Level I drought was occurring during this period.

8.5 Surface Water Use

8.5.1 Permits to Take Water Program

The Province manages water takings through the Permit to Take Water (PTTW) program. Water takings in Ontario are governed by the *Ontario Water Resources Act (OWRA)* and the Ontario Water Taking and Transfer Regulation (O. Reg. 387/04). The Ministry of the Environment (MOE) regulates all Permits to Take Water in Ontario. The MOE sets limits on the total quantity of water each permit holder can take for the duration of the permit. Water taking permits are issued for up to 10 years. Section 34 of the *OWRA* requires anyone taking more than 50,000 liters of water in a day from a surface water source (lake, river, stream, etc) or groundwater source, with some exceptions, to obtain a Permit. Permits help to ensure the conservation, protection, management and sustainable use of Ontario's water. Permits are not required for water taken for emergency firefighting, watering of livestock, or private domestic use. Permits for new or increased takings that remove water from a watershed, where that watershed already has a high level of use, will be refused. Provincial maps of high and medium use watersheds are available on-line at www.ene.gov.on.ca. The NBMCA is located in a low water use area of the province.

8.5.2 Permits to Take Surface Water

Permits to Take Water (PTTW) from surface water sources within NBMCA's jurisdiction are summarized in Table 8.9 and 8.10. In 2011 there were 10 active surface water taking permits within NBMCA. Table 8.9 indicates the percentage of the total permitted surface water takings that each permit represents. The City of North Bay has the largest surface water taking permit within the NBMCA area of jurisdiction. Water is taken to supply the municipal drinking water system. The City of North Bay's takings are consumptive in that water is withdrawn from the Mattawa River watershed and ends up being treated as wastewater that is discharged to Lake Nipissing; a different quaternary watershed. All other water takings are not considered consumptive as the water is used within the watershed it is taken from.

Callander Bay municipal water supply (Permit 6378-7T3MA8) is listed in Table 8.9 separately. Because Callander Bay withdraws water from Lake Nipissing, which is outside the NBMCA's drainage system, its allowable withdrawal rate has been excluded from the total permitted takings for NBMCA for detailed analysis purposes. The location of surface water taking permit within the NBMCA are shown on Figure 8.12

Allowable takings in Table 8.9 list maximum allowable takings and are not reflective of actual volumes taken. NBMCA (March 2011) reported that actual water consumption by the City of North Bay between June 2002 and December 2008 averaged 35,000 m^3/day, which is less than half of daily permitted taking (North Bay Permit to Take Water has a maximum taking of 79,500 m^3/day). Maximum permitted takings reflect a committed volume. MOE requires permit holders to report actual water takings each year.

Figure 8.12 Permits to Take Water Locations within the NBMCA

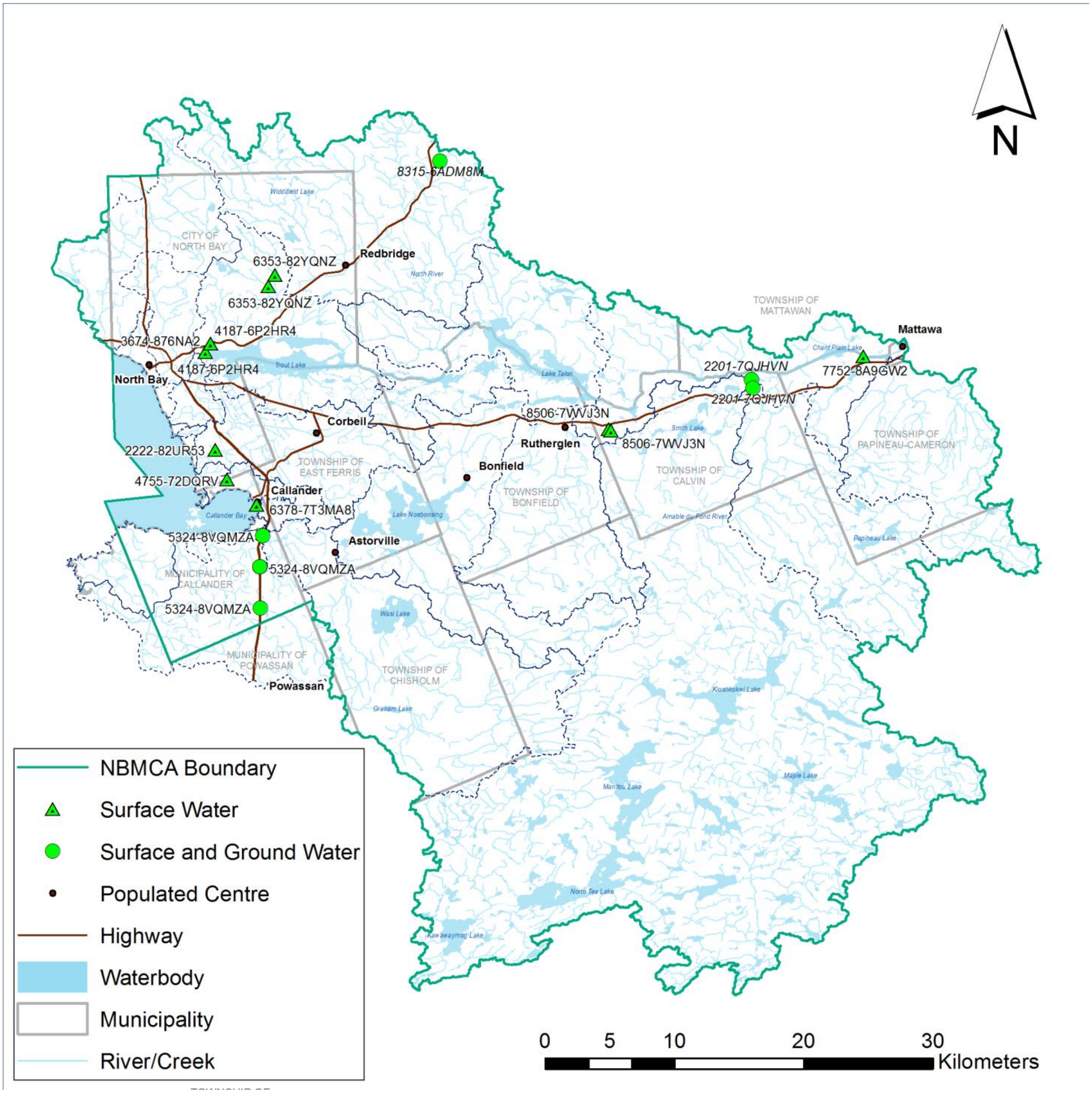


Table 8.10 Maximum Permitted Surface Water Takings within the NBMCA

Permit	Watershed	Purpose	Source	Days per Year for Allowable Taking	Allowable Daily Taking (m^3/day)	Allowable Annual Taking (m^3/year)	Percentage of Total Takings	Municipality
3674-876NA2	Trout Lake	Municipal water supply	Trout Lake	365	79,500	29,017,500	81.93%	North Bay
4187-6P2HR4	Trout Lake	Industrial cooling water	Trout Lake	365	10,683	3,899,216	11.01%	North Bay
				365	54.50	19,894	0.06%	North Bay
6353-82YQNZ	Trout Lake	Agriculture field and pasture crop	Four Mile Creek Tributary	30	170.0	5,100	0.01%	North Bay
8506-7WVJ3N	Lower Mattawa	Other water supply	Pimisi Creek	244	28.5	6,954	0.02%	Calvin
			Log Spray Pond	244	374.4	91,354	0.26%	Calvin
2201-7QJHVN[1]	Lower Mattawa	Campground water supply	Long Lake	184	220.0	40,480	0.11%	Calvin
2222-82UR53	La Vase	Golf course irrigation	La Vase River	183	317.9	58,179	0.16%	North Bay
4755-72DQRV	Callander Bay South Shore	Golf course irrigation	10 ponds (stormwater)	184	981.9	180,676	0.51%	Callander
2122-8ESJUA[1]	Chippewa Creek	Golf course irrigation[2]	Irrigation Pond	214	1,136	243,182	0.69%	North Bay
			Golf Club Tributary	214	1,788	382,735	1.08%	
8315-6ADM8M[1]	North River	Aquaculture	Headwater Spring of Balsam Creek	365	4,032	1,471,680	4.16%	French
Total within the NBMCA not including Lake Nipissing (m^3)					**100,000**	**35,500,000**		
6378-7T3MA8	Callander Bay South Shore	Municipal water supply	Lake Nipissing	365	3,000	1,095,000[3]		Callander

1. Permit is listed as a "Surface and Ground Water" Taking but has been filtered out as a Surface Water taking based on the source description.
2. Permit 2122-8ESJUA is listed as "Other Water Supply" under "Purpose of Taking" in provincial database but has been changed here to "Golf course irrigation" based on its "Specific Source of Taking".
3. Permit 6378-7T3MA8 is excluded from total NBMCA withdrawal because it withdraws water from Lake Nipissing.

Table 8.11 Summary of Permitted Surface Water Takings by Type and Location

Percentage of Permitted Surface Water Takings		Location	Subwatershed
Municipal Drinking Water	82%	Trout Lake	Trout Lake
Industrial cooling water	11%	Trout Lake	Trout Lake
Aquaculture	4.2%	Balsam Creek	North River
Golf course irrigation	2.4%	various sources	La Vase, Callander Bay South Shore, Chippewa Creek
Other Water Supply	0.3%	Pimisi Creek	Lower Mattawa
Campground water supply	0.1%	Long Lake	Lower Mattawa
Agricultural	0.01%	Four Mile Creek	Trout Lake

The total committed volume of surface water takings within NBMCA is 35,500,000 m^3/year, which is about 1.2 % of the annual precipitation received or 2.8 % of the estimated water surplus available. Water takings are not evenly distributed as they vary by subwatershed and by time of year. Actual surface water takings are small relative to volumes of water available within the NBMCA. However, the Trout/Turtle Lake subwatershed is subject to 93 % (33,000,000 m^3/year) of the committed volumes and the concentration of takings from this watershed prompted the Tier 2 and Tier 3 assessments as further discussed below.

Water takings from Lake Nipissing are outside of the NBMCA's catchment area and consequently have not been considered in the supply analysis below. Water consumption information for the Callander Municipal Water System is provided in Section 13.

8.5.3 Estimated Agricultural Water Use

Annual agricultural water use estimates are provided for each quaternary watershed in NBMCA in Table 8.11. This table has been extracted from NBMCA's *draft* Low Water Response report (March 2011). The estimates are based on the 2006 Census agriculture data and water use coefficients.

Total annual agricultural water use in NBMCA is estimated to be approximately 60,000 m^3/year (NBMCA, draft 2011) and takings are fairly widely distributed across the NBMCA. Agricultural water use includes the one Water Taking Permit that accounts for roughly 8% of total agricultural water use. Agricultural water takings do not distinguish between surface and groundwater sources. Most agricultural takings are assumed to be taken from surface water sources. Agricultural water use is low compared to seasonal and annual water availability and water takings are not considered consumptive.

Table 8.12 Annual Agricultural Water Use Estimates for NBMCA (m^3/year)

Quaternary Watershed	No. of Farms	Livestock	Field	Vegetable	Specialty	Total
North River (2JE-09)	0	0	0	0	0	0
Duchesnay Creek (2DD-19)	0	0	0	0	0	0
La Vase River (2DD-20)	13	3,497	13	4,501	4,209	12,220
Mattawa River (2JE-02)	18	4,612	32	2,000	1,866	8,511
Bear-Boileau Creeks (2DD-21)	13	5,580	27	197	1,996	7,799
Wistiwasing River (2DD-22)	36	11,301	86	1,113	1,002	13,500
Upper Amable Upper South Rivers (2JE-04)	0	81	1	0	0	82
Amable du Fond River (2JE-03)	19	4,612	34	18	0	4,663
Pautois Creek (2JE-05)	7	1,591	11	7	0	1,609
Sharpes Creek (2JE-06)	11	2,975	28	0	0	3,003
Kaibuskong River and Depot Creek (2JE-07)	19	5,255	40	1,556	1,449	8,300
Boom Creek (2JE-17)	0	0	0	0	0	0
Total	**136**	**39,504**	**272**	**9,392**	**10,522**	**59,687**

Source: North Bay – Mattawa Conservation Authority, 2011 – Table 12

8.5.4 Estimated Rural Domestic Surface Water Use

The unserviced rural population within the NBMCA has been estimated to be approximately 15,000. This population obtains domestic water from private sources. Urban and rural water consumption practices are discussed in Section 13.4.2 Water and Waste Water Treatment and Disposal. As outlined in Section 5, it is estimated that 9,000 rural residents source water from wells, which mean approximately 6,000 rural residents rely on surface water sources to supply domestic needs. Applying an average per capita water use rate of 175 L/cap/day (MOE, 2001) suggests that rural takings for domestic purposes total 1,050 m^3/day or 383,000 m^3/year. Domestic rural water use represents about 1 % of total water use. Private domestic water use therefore is not significant compared to general surface water availability. Rural domestic surface water use is not considered consumptive.

8.5.6 Summary of Total Permitted and Non-Permitted Surface Water Use

Total maximum and estimated NBMCA surface water takings, as summarized in Table 8.12, are calculated to be 35,938,000 m^3/year. Surface water takings through Permits to Take Water account for 98.8 % of total surface water use. As noted above using maximum water taking volumes from Permits overestimates actual consumption. Surface water is also used to meet agricultural and rural domestic demands that are, with the exception of one user, not regulated through a Permit to Take Water. These combined takings represent 1.2 % of total surface water use within the NBMCA on an annual basis.

Table 8.13 Total Surface Water Takings

Category	Maximum or Estimated takings (m^3/year)	Percent of Total Takings	Equivalent Depth over Watershed (mm/year)[3]
Permitted water takings (PTTW - surface water)	35,500,000	98.8%	11.9
Agricultural water takings[1, 2]	60,000	0.2%	<0.1
Rural (unserviced) water takings	383,000	1%	0.1
Total Surface Water Takings (m^3/year)	**35,938,000[4]**	**100%**	**12.0**

1. May include some groundwater takings.
2. Includes permitted and non-permitted takings under the PTTW program.
3. Equivalent depth calculated based on total watershed area of 2,995 km^2.
4. Total is adjusted (and rounded) as there is double counting of 5,100 m^3/year that appears in PTTW and Agricultural Takings totals.

8.6 Assessment of Regional Water Demand Relative to Annual Water Supply

The annual water surplus available for runoff based on water balance calculations completed by Stantec for the North Bay Airport climate station is 453 mm/year for the 1971 – 2000 normal period and 478 mm/year for the 1981 – 2010 normal period (assuming 300 mm as the maximum amount of water that can be stored in a fine sandy soil with forested cover). These surplus values are lower than the values generated within the Conceptual Water Budget prepared by Gartner Lee, 2008. Gartner Lee reported a surplus of 474 mm/year for the North Bay Airport for the 1971 – 2000 normal period (assuming 100 mm as the maximum amount of water that can be stored in a sandy soil). Gartner Lee also reported the regional water surplus rate for the SWP study area as 437 mm/year, which appears to be the average between the North Bay Airport and Powassan, is within 10% of the value Stantec calculated for the 1981 – 2010 normal period for the North Bay Airport. If the Gartner Lee regional water surplus value of 437 mm/year is applied (most conservative value), the total surface water takings (12 mm/year), calculated based on the NBMCA's total area of jurisdiction of 2,995 km^2, represents about 2.7% of the potential water available on an average, annual basis.

8.6.1 Monthly Analysis of Surface Water Demand for Trout Lake

AquaResource Inc (2010) completed a detailed analysis of Trout/Turtle Lake subwatershed for the NBMCA Source Water Protection Plan, which was prompted by the takings of the City of

North Bay from this system. A Tier 1 assessment found potential for moderate stress that necessitated completing of Tier 2 stress assessment and Tier 3 risk assessment.

A Tier One Water Budget and Water Quantity Stress Assessment (Gartner Lee, 2008) was completed for Trout/Turtle Lake Subwatershed based on stream flow data from the Mattawa River gauge below Bouillon Lake, and runoff calculated from precipitation data from the North Bay Airport. Water consumption was based on the highest historic water takings at the North Bay WTP and other permitted water uses. All water takings at the WTP were treated as consumptive. The Tier One Stress Assessment identified that the Trout Lake/Turtle Lake subwatershed was subject to potential moderate stress at times. This prompted the need to complete a more in-depth assessment.

The Trout/Turtle Lake Subwatershed Tier Two Stress Assessment (AquaResource Inc, 2010) was completed using a numerical surface water flow model and a reservoir routing model. The surface water flow model estimated inflows to Trout/Turtle Lake. The reservoir routing model used inflows to estimate water levels. Percent water demand was calculated under current conditions, planned system conditions, and future conditions. Drought conditions were not considered as the lake had significant potential stress under normal conditions. Trout/Turtle Lake subwatershed was found to experience significant potential stress under existing conditions for the months of December, January, and February, and a Moderate potential stress under existing conditions for May through September. The uncertainty was classified as Low. These results triggered the need for a Tier Three Risk Assessment.

The Trout/Turtle Lake Subwatershed Tier Three Local Area Risk Assessment (AquaResource Inc, 2010) evaluated the risk of a municipal system not meeting existing or planned pumping rates under average climatic conditions, drought conditions and for existing and planned land uses. For the Tier Three Assessment, lake levels were simulated under four scenarios for land use, pumping, and climate using the hydrological and reservoir routing model from Tier Two, which were then compared against minimum operational lake levels and the municipal intake elevation. Resultant simulated lake levels were above critical levels for all four scenarios. As a result, the Risk level associated with the area that supplies raw water to North Bay was considered low.

The Trout Lake Assessments only considered permitted surface water takings. Reported (instead of permitted) water takings from the North Bay Water Treatment Plant for 2008 were used. The water consumption in 2008 would be below the long-term average because 2008 had the highest precipitation of all years on record. Consumptive water use factors prescribed by MOE were applied to the withdrawals (2% was assigned to the cooling taking and 100% to the municipal supply), which resulted in a total consumptive withdrawal of 398 L/s from the subwatershed (34,387 m^3/day). This water taking estimate is very conservative for average conditions and would not represent consumption rates in drought years.

The Stress Assessment did not consider the agricultural permit to take water of 0.2 L/s from Four Mile Creek as the permit did not exist at the time. This permit is restricted to 30 days but no information is provided on when this taking occurs. This taking is also not likely consumptive. The Tiered assessments did not consider impacts to the environment including impacts downstream of the Turtle Lake Dam.

8.7 Water Diversion

The only water diversion from one major watershed to another watershed is through the North Bay municipal drinking water systems, which takes water from the Ottawa River Watershed and discharges treated sewage to the Great Lakes Watershed. Raw water, withdrawn from Trout Lake and treated at the North Bay water treatment plant, is distributed within the municipal service area by the City's piped water system for consumption. Untreated wastewater is then discharged to the City's municipal wastewater collection system and treated at the North Bay Waste Water Treatment Plant on Memorial Drive. Treated effluent is discharges to Lake Nipissing.

In 2011, an average of 34,925 m^3/day was taken from Trout Lake for consumption. In that same year, an average of 42,094 m^3/day of treated wastewater was discharged into Lake Nipissing. Factors contributing to higher sewage treatment volumes include groundwater infiltration and stormwater inflows into the wastewater collection system and discharge of process backwash water from the water treatment plant.

8.8 Surface Water Quantity Data Gaps

Long term stream flow gauging in the lower Mattawa River basin has ceased and no replacement gauges are contemplated. The impact of climate change on the Mattawa River system cannot be monitored. The lack of general hydrologic data in many subwatersheds results in floodplain calculations that are not verifiable and consequently assumptions have considerable safety built in. New rainfall and stream flow gauging sites have been recommended in various studies including the West Ferris Flood Plain Management Study, 1982.

No stream flow data is available for the following areas:

- Parks Creek, Jessups Creek, Burford Creek, Windsor Creek, Boulder Creek, Bear Creek, Trout/Turtle Lake (data has been calculated for Water Balance assessment), North River, Kaibuskong River, Lake Talon, Pautois Creek, Sharpes Creek, Boom Creek, Lower Mattawa River

Stream flow data is no longer being collected for the following areas:

- Duchesnay Creek, Lower Amable du Fond, Upper Mattawa River (above the mouth of the Amable du Fond River)

No flood plain information has been developed for the following areas:

- Windsor/Boulder/Bear, Burford (only partially within the NBMCA area of jurisdiction), upper Duchesnay, lower Kaibuskong River, Sharpes Creek, lower Amable du Fond River (except Smith Lake), Pautois Creek, Papineau Lake, Taggart Lake and Boom Creek.

Reported HYDAT drainage areas established for gauging sites are unreliable. All gauged watershed areas should be carefully checked and if water balance results cannot be substantiated against runoff, additional flow measurement and calibration work for gauge locations may be warranted.

The lack of flow data for the Turtle Lake Dam was considered a limitation in the water balance investigations completed for the Trout/Turtle Lake Reservoir.

The Tier 3 water quantity risk assessment for the Trout/Turtle Lake basin completed by AquaResource Inc, 2010, was not permitted to carry out comprehensive analysis of water taking impacts. Tier 3 technical rules stipulated that only the impact to the municipal supply could be evaluated. Impacts to lake features such as water quality, fisheries and depletion of the hypolimnion have not been examined. The impact to other Trout Lake uses including navigation and recreational water use was not analyzed nor was impacts to docks, private water intakes, etc. Impacts to Turtle Lake and downstream of the Turtle Lake Dam, which may encounter extended periods with zero discharge, are also outstanding. Average pumping rates were applied to assess risk in a drought year. Pumping rates are typically very high in a drought year particularly during the summer. The above issues could also be evaluated in the context of potential effects of climate change as outlined in Section 7.

Long term declining Lake Nipissing water levels have not been checked against data from the French River at Lake Nipissing gauge to determine the extent to which isostatic rebound is affecting the North Bay/Callander Bay shoreline. A more in-depth study of long term changes in operational policies, dam capacities, interpretation of flood limits and impact of climate change may assist in verifying that the regulatory flood elevation remains valid. Declining water levels and/or rising land elevations could also have long term implications to beach dynamics as well as Lake Nipissing and inflowing stream flood elevations (near their mouths). Impacts of declining annual maximum and minimum water levels during the navigation season on Lake Nipissing have not been examined.

The NBMCA Low Water Response Program does not have Level III Response Actions identified – the potential impacts are considered minimal within the region. Without any pre-identified response program, implementation of mandatory restrictions, if Level III conditions are reached, would be delayed while approval was sought.

Most floodplain mapping within NBMCA is now 25 years old or older. For the most part, the 100 year storm has been used to define the regulatory floodplain. The Timmins storm was widely applied by M.M. Dillon in the North-Bay Mattawa Floodplain and Fill Line Mapping study in 1975. Consequently the Timmins Storm continues to define floodplain limits unless it has been updated by subsequent studies. Subsequently most hydrologic studies after 1975 have applied a 1:100 year probability approach to calculate the regulatory floodplain. The criteria for the NBMCA are to apply the greater of the Timmins Storm and the 100 year flood. However if the regulatory flood is too restrictive in developed areas a lower standard can be applied with approval. Two Zone and Special Policy Areas approaches have been adopted in Mattawa and North Bay. Both local and provincial approvals are required for application of more flexible development policies.

9.0 Surface Water Quality

Surface water quality was characterized within the first Watershed Plan Background Inventory (NBMCA, 1982), within the Drinking Water Source Protection North Bay-Mattawa Watershed Characterization Assessment Report (NBMCA, 2008 Draft) and within the North Bay-Mattawa Source Protection Area Approved Updated Assessment Report (NBMCA, 2012). Some of the NBMCA subwatersheds have Comprehensive Basin Management Studies, which include water quality assessment. Raw surface water quality data is available for numerous locations from years of monitoring; however detailed characterization is made difficult by the diversity of data available, the complexities of the environments monitored, seasonal and annual variations, in some cases the lack of data quality information and from gaps in available data.

This section consolidates surface water quality information in general terms for the NBMCA area of jurisdiction from above-referenced sources, supplemented with water quality data that has been collected between 2007 and 2012. Specific water quality basin management issues are identified within the subwatershed characterization section of this report.

9.1 Water Quality Monitoring

Surface water quality monitoring is currently undertaken by the NBMCA pursuant to the Provincial Water Quality Monitoring Network at six sites within the watershed (Figure 9.1). Monitoring is carried out for the following water bodies: Amable du Fond River, Chippewa Creek, Duchesnay Creek, Kaibuskong River, Mattawa River, and Wasi River.

Historically, routine surface water quality monitoring was carried out by the Ontario Ministry of Environment. The number of monitoring sites was gradually reduced overtime until all provincial monitoring ceased within the NBMCA area of jurisdiction by 1994. In the decade following the year 2000, the NBMCA reactivated several monitoring stations and has established one new station. For most locations sufficient data is generally available for characterization purposes, although in some cases large data gaps exist or the data available is outdated. As many as 28 stations have existed within the watershed at one time or another. Information on the geographic location and years of monitoring at water quality monitoring stations in the NBMCA area of jurisdiction is presented in Table 9.1.

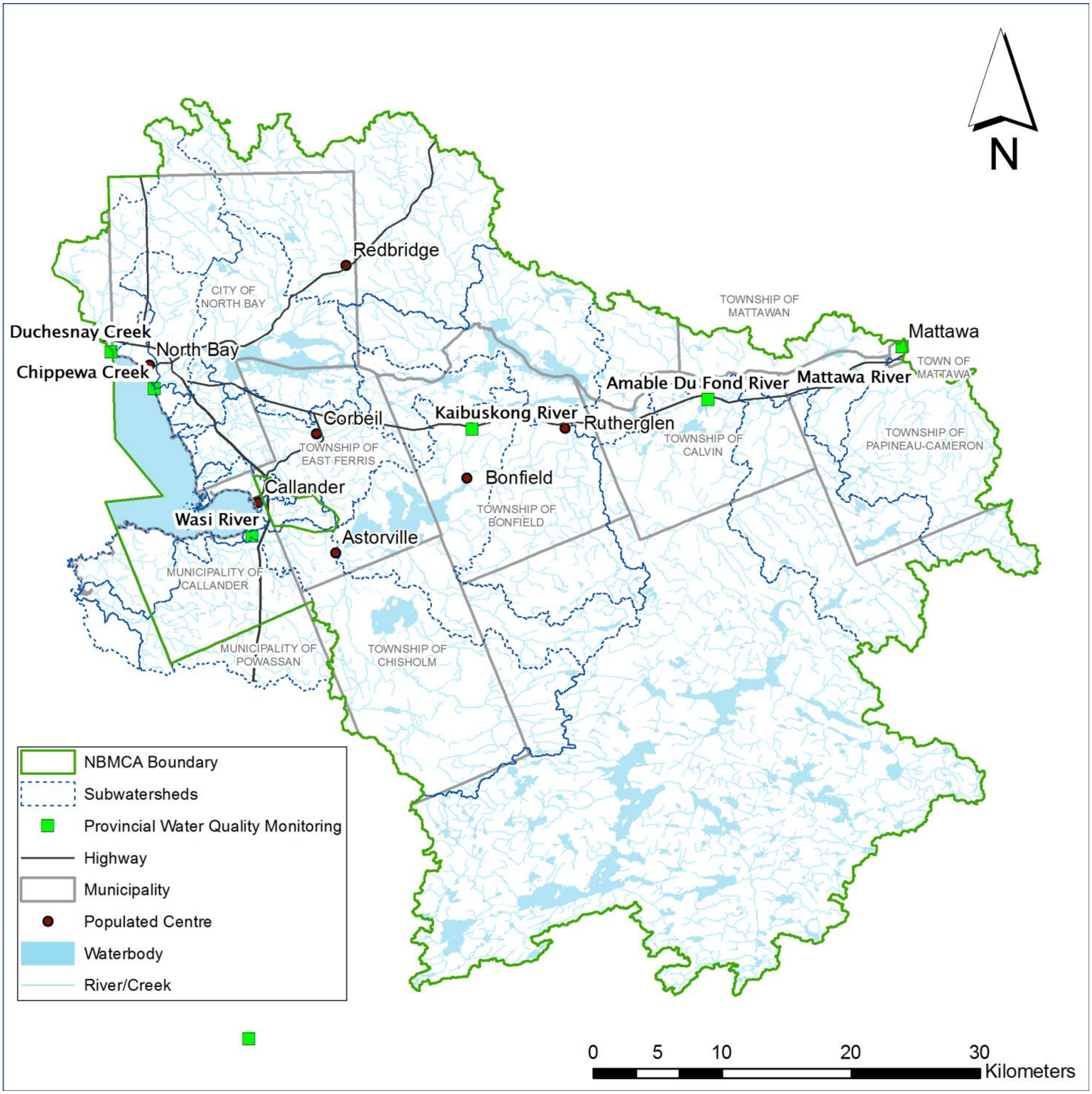
Area lakes have also been subject to annual water quality monitoring. Spring phosphorus concentrations have historically been monitored by the Ontario Ministry of Environment on an ad hoc basis and data is available for sporadic years back to the mid-1970s. Currently, monitoring of spring phosphorous concentrations in several lakes within the watershed is conducted on a volunteer basis through the Ministry of Environment's Lake Partner Program. Summer surface water quality monitoring of lakes and streams is carried out by the NBMCA based on stakeholder and municipal interests. Bacteriological quality is monitored at selected beaches by the North Bay Parry Sound District Health Unit during the swimming season. Long-term raw water quality data is available for surface water sources used for municipal drinking water. Periodic focused data collection, which provides a snap shot in time, is often undertaken in support of comprehensive watershed management studies.

9.2 Water Quality – Provincial Water Quality Monitoring Network

The NBMCA re-established surface water quality monitoring at the Chippewa Creek and Wasi River stations in 2003 as part of the Provincial Water Quality Monitoring Network. Subsequently, the NBMCA reactivated the Duchesnay, Kaibuskong, Amable du Fond and Mattawa monitoring stations in 2007. Because most stations were re-established after many years of inactivity, the datasets have large gaps, typically between 1968 and 2003 or 2007.

Generally, Provincial water quality monitoring consists of eight sampling events each year during the ice free season (NBMCA unpublished). Analysis is completed by Laboratory Services Branch of the Ministry of the Environment and consequently data accuracy is considered high.

Figure 9.1 Active Provincial Water Quality Monitoring Stations with the NBMCA Watershed



Each sample is analyzed for water quality parameters including nutrients, pH, suspended solids, chloride, metals and various others (NBMCA, unpublished).

Table 9.1 Water Quality Monitoring Stations within the NBMCA

Station No.	Name	Location	Status	First Year	Last Year	Total Years	Missing Years	Longitude	Latitude
18607008002	Amable Du Fond River	Hwy 17, W of Mattawa	Active	1972	2010	9	30	-78.90428510610	46.28670851620
03013300901	Callander Bay	Near docks, Callander Bay	Inactive	1968	1991	19	5	-79.37122785650	46.22042351620
03013301902	Chippewa Creek	At mouth, Memorial Dr, Amelia Park, North Bay	Active	1968	2010	33	10	-79.46142335660	46.30044376630
03013302502	Chippewa Creek	Golf Club Rd, North Bay	Inactive	1973	1994	20	2	-79.45044148160	46.34466026630
18607013002	Doran Creek	Hwy 63 (Trout Lake Rd)	Inactive	1988	1990	3	0	-79.37750398150	46.32988426630
03013301202	Duchesnay Creek	Hwy 17, North Bay	Inactive	1968	1990	23	0	-79.51103998160	46.33411376630
03013301302	Duchesnay Creek	Hwy 17B, Main St W, North Bay	Active	1968	2010	30	13	-79.50328060660	46.32851626630
03013302102	Duchesnay Creek	Hwy 11, W of North Bay	Inactive	1973	1975	3	0	-79.46621060660	46.41100514140
18607010002	Four Mile Creek	Northshore Rd, upstrm mouth at Four Mile Bay	Inactive	1982	2005	15	9	-79.33667423150	46.33530414130
18607011002	Hogan Creek	Hwy 63, (Trout Lake Road)	Inactive	1988	1994	6	1	-79.34571835650	46.33764539130
18607006002	Kaibuskong River	Hwy 17, N of Bonfield	Active	1972	2010	9	30	-79.14253073130	46.26982664120
18607009002	Kaibuskong River	Dam in Bonfield	Inactive	1972	1992	5	16	-79.14930898130	46.23232964120
03013301402	La Vase River	approx 1 km E of Hwy 11	Inactive	1973	1992	15	5	-79.38272798150	46.27194476620
03013301502	La Vase River	Riverbend Rd	Inactive	1968	1992	19	6	-79.40318148150	46.25808139120
03013302402	La Vase River	At mouth, North Bay	Inactive	1973	1994	22	0	-79.42178548160	46.24331664120
03013303602	La Vase River	Lakeshore Dr, (Hwy 11B), Nipissing Junction	Inactive	1992	1992	1	0	-79.39519860650	46.26322239120
03013303702	La Vase River	Voyer Rd, W of Hwy 94	Inactive	1992	1992	1	0	-79.32237435650	46.27031326620
03013303802	La Vase River	W of Dube Rd, S of Hwy 17	Inactive	1992	1992	1	0	-79.25224823140	46.27099551620
03013301001	Lake Nipissing	Amelia Beach, North Bay	Inactive	1968	1989	16	6	-79.46609673160	46.29895914130
03013301101	Lake Nipissing	Dwnstrm Govt Docks, North Bay	Inactive	1968	1990	23	0	-79.47142998160	46.31037001630
03013303302	Lake Nipissing	Outside Govt Dock, North Bay	Inactive	1987	1994	8	0	-79.47399998160	46.31131001630
03013303202	Lake Nipissing	Graham Creek at River Rd	Inactive	1984	1992	6	3	-79.2733751064	46.1490230161
03013303102	Lake Nipissing	Wistiwasing River at 10th Sideroad, Chisholm Twp	Inactive	1984	1992	6	3	-79.2814097314	46.1668366411
18607012002	Lees Creek	Hwy 63 (Trout Lake Rd),Trout Mills	Inactive	1988	1990	3	0	-79.39924335650	46.33136101630
18607002002	Mattawa River	Hwy 533 bridge, Mattawa	Active	1968	2010	30	13	-78.70700473090	46.31859501630
18607004002	Mattawa River	Upstrm of dam from Mattawa	Inactive	1968	1971	4	0	-78.74996248090	46.31144914130
03013302602	Parks Creek	Lakeshore Dr, North Bay	Inactive	1973	1988	11	5	-79.44556110660	46.27650901620
03013303002	Wasi River	Lake Nosbonsing Rd, Hwy 564, S of Callander	Active	1984	2010	18	9	-79.36637385650	46.19659489120

Source: Data from Ministry of Environment (2012) Provincial (Stream) Water Quality Monitoring Network (PWQMN) data, 2002-2011

Table 9.2 provides a summary of water quality data including minimum, maximum, and average or median values for selected water quality parameters from stations currently monitored by the NBMCA. For comparison purposes, Provincial Water Quality Objectives (MOE, 1994) are provided. Where no Provincial objectives are available, the Canadian Council of Ministers of the Environment Water Quality Guideline criteria (CCME, 1999) is provided. The water quality parameters presented in Table 9.2 are basic water quality parameters that influence the aquatic communities (aquatic vegetation, fish and invertebrates) and indicators of pollution, such as nutrients (phosphorus and nitrogen).

Increases in nutrients (phosphorus and nitrogen) in surface waters can lead to increases in aquatic plant and algae growth, which in turn can affect the aesthetic appearance of a water system. Phosphorous and nitrogen exist in a variety of forms in water. These nutrients can enter surface water bodies through various routes, including atmospheric deposition, decaying plant or animal material, erosion and runoff, agricultural fertilizers, manure, domestic sewage or weathering of geological formations (MOE, 2011).

Phosphorous is a nutrient that influences primary productivity in a water body and in most freshwater bodies, particularly on the Canadian Shield; phosphorous is often limited in supply (Environment Canada 2006). Total phosphorous, which is a measure of all phosphorous in a sample, has been monitored at each of the six active NBMCA monitoring stations, recently and historically. The Interim Provincial Water Quality Objective for total phosphorous varies according to the type of water body being considered (MOE, 1994):

- To avoid nuisance concentrations of algae in lakes during the ice free period, the objective is 20 µg/L.
- For a high level of protection against aesthetic deterioration (which should be applied to all lakes naturally occurring below this value) the objective is 10 µg/L
- For elimination of excessive plant growth in rivers and streams, the total phosphorous should not exceed 30 µg/L.

Provincial Water Quality Monitoring Network stations within the NBMCA are all river stations, and therefore the applicable objective used for phosphorous is 30 µg/L. The maximum total phosphorous concentrations exceeded the Provincial Water Quality Objective at each of the six river stations. The average total phosphorous concentrations exceeded the Provincial Water Quality Objective at Chippewa Creek, Duchesnay Creek and Wasi River stations. However, using only the results of the water quality monitoring conducted since 2003 (56 samples), only the Wasi River continues to have an average concentration of total phosphorous (43 µg/L) that exceeds the Provincial Water Quality Objective. The average total phosphorous concentration at Chippewa Creek since 2003 (56 samples) was 21 µg/L and the average total phosphorous concentration at Duchesnay Creek since 2007 (37 samples) was 25 µg/L.

Table 9.2: Summary Statistics for Selected Water Quality Parameters for Active Provincial Water Quality Monitoring Stations in the NBMCA Watershed (1968 to 2011)

Variable	Statistic	PWQMN Location and Site Number						Relevant Guideline
		Amable Du Fond River	Chippewa Creek	Duchesnay Creek	Kaibuskong River	Mattawa River	Wasi River	
		18607008002	3013301902	3013301302	18607006002	18607002002	3013303002	
Total Phosphorous (µg/L)	# Samples	67	285	232	257	253	112	30 µg/L [1]
	Minimum	<2	7.0	3.0	3.0	2.0	11	
	Maximum	140	1,100	2,290	210	304	112	
	Average	13	90	68.4	19	20	40	
Nitrate (mg/L)	# Samples	64	180	215	244	198	48	13 mg/L [2] 550 mg/L [3]
	Minimum	<0.001	0.0120	<0.010	0.001	0.003	0.005	
	Maximum	0.25	1.89	0.530	0.535	1.12	0.455	
	Average	0.047	0.554	0.105	0.149	0.136	0.095	
pH [4]	# Samples	32	51	32	32	12	51	6.5 to 8.5 [5]
	Minimum	6.31	6.41	4.25	6.47	6.64	6.06	
	Maximum	7.83	8.23	7.44	7.75	7.64	9.50	
	Median	7.00	7.20	6.93	7.12	7.08	7.28	
Total Suspended Solids (mg/L)	# Samples	43	262	205	134	198	110	see notes [6]
	Minimum	0.50	0.80	1.10	0.60	0.10	2.0	
	Maximum	4.0 (or <15)	500	634	25	148	45	
	Average	1.8	21	13.1	4.2	4.9	9.1	
Chloride (mg/L)	# Samples	67	276	221	212	228	111	120 mg/L [2] 640 mg/L [3]
	Minimum	0.40	2.00	1.30	1.00	1.00	1.58	
	Maximum	5.0	775	228	37.0	37.0	67.0	
	Average	1.3	73.5	11.2	2.85	2.65	4.80	

Data Source: NBMCA – PWQM station data (1968 to 2011)
Notes:
[1] Provincial Water Quality Objectives – Interim Objective to eliminate excessive plant growth in rivers and streams (MOE 1994)
[2] Canadian Council of Ministers of the Environment Water Quality Guidelines for the Protection of Aquatic Life – long-term exposure (CCME 2011, 2012)
[3] Canadian Council of Ministers of the Environment Water Quality Guidelines for the Protection of Aquatic Life – short-term exposure (CCME 2011, 2012)
[4] pH measured in the field
[5] Provincial Water Quality Objective
[6] Canadian Council of Ministers of the Environment Water Quality Guidelines for the Protection of Aquatic Life – maximum increase dependent upon flow and background levels (CCME 2002)

Nitrogen is a nutrient that can affect aquatic plant growth as well as human health. Ammonia, nitrates and nitrites are common forms of nitrogen that are measured in water samples. Nitrate generally represents the greatest portion of total available nitrogen in surface water bodies (CCME 2012) and has been monitored at each of the six current NBMCA monitoring stations, recently and historically. There is no standard under the Provincial Water Quality Objectives for nitrate; however, the maximum allowable concentration for nitrate under the Ontario Drinking Water Standards is 10 mg/L. The Canadian Council of Ministers of the Environment (2012) has derived Canadian Water Quality Guidelines for nitrate ion for the protection of aquatic life: 13 mg/L for long-term exposure (7 or more days for fish and invertebrates, 24 hours or more for plants and algae) and 550 mg/L for short-term exposure (24 to 96 hours). The average and maximum nitrate concentrations were well below the relevant standards and guidelines at each of the six river stations.

A measurement of hydrogen ions, pH is measured in-situ at NBMCA monitoring stations and indicates acidity or alkalinity of water. The acidity of surface waters is primarily dictated by the soils and geology, but is also influenced by nutrients, industrial discharges and atmospheric deposition. The Provincial Water Quality Objective for pH states that pH should be maintained between 6.5 and 8.5 to protect aquatic life and for recreational purposes (MOE 1994). The median pH levels were within the range of 6.5 to 8.5 at each of the six river stations; however, pH levels were recorded below 6.5 at Amable du Fond River, Chippewa Creek, Duchesnay Creek and Kaibuskong River water quality monitoring stations and above 8.5 at Wasi River.

Total suspended solids are a general indicator of sedimentation and erosion, which can negatively affect aquatic habitat. Sediment particles suspended in the water column can directly affect fish and aquatic invertebrates, and deposited sediments can alter the streambed and cover aquatic vegetation. There is no standard under the Provincial Water Quality Objectives or Ontario Drinking Water Standards for TSS. The Canadian Council of Ministers of the Environment (2002) has derived Canadian Water Quality Guidelines for suspended sediments for the protection of aquatic life, which vary depending on the stream flow and background levels:

- Clear flow
  - maximum increase of 25 mg/L from background levels for short-term exposure
  - maximum average increase of 5 mg/L from background levels for longer term exposures
- High flow
  - maximum increase of 25 mg/L from background levels when background levels are between 25 and 250 mg/L
  - maximum increase of 10% above background levels when background levels are greater than 250 mg/L

Flow data is not available that coincides with the water quality monitoring stations and sample dates; however, total suspended solids concentrations were more than 250 mg/L above average in four samples (collected in 1971, 1981, 1994, and 2009) from Chippewa Creek and one sample (collected in 1968) from Duchesnay Creek.

Chloride concentrations in surface water are often used as an indicator of urban impacts in a watershed. Although chloride is naturally occurring, it can also enter water bodies through runoff from road salt applications, wastewater effluent, and leaching from contaminated soils (CCME 2011). Chloride does not have a Provincial Water Quality Objective; however the Ontario Drinking Water Standards has an Aesthetic Objective (under Table 4 objectives) of 250 mg/L. The Canadian Council of Ministers of the Environment (2012) has derived Canadian Water Quality Guidelines for chloride ion for the protection of aquatic life: 120 mg/L for long-term exposure (7 or more days for fish and invertebrates, 24 hours or more for plants and algae) and 640 mg/L for short-term exposure (24 to 96 hours). Chloride concentrations were greater than the 640 mg/L guideline for short-term exposure in one sample (collected in 1977) from Chippewa Creek. Chloride concentrations were greater than the 120 mg/L guideline for long-term exposure in 29 samples from Chippewa Creek and one sample (collected in 1977) collected from Duchesnay Creek.

9.3 Trends in Water Quality

The long-term data from the Provincial Water Quality Monitoring Network was analyzed using the Mann-Kendall test to assess changes in water quality over time. Table 9.3 summarizes the results of the trend analysis, indicating statistically significant changes for each selected parameter at each station. However, differences in analytical methods and detection limits before and after the 1990s will affect the water quality data and influence the ability to accurately detect trends. Current water quality conditions at the active Provincial Water Quality Monitoring stations, based on monitoring from 2003 to 2011, are shown in Table 9.4.

Trend analysis suggests that total phosphorus concentrations and total suspended solids concentrations are generally decreasing, while nitrate, dissolved oxygen, pH and chloride measurements are increasing. Overall trends at active river monitoring stations within the NBMCA's area of jurisdiction indicate general water quality improvement over time; the exception is the Wasi River in which water quality is declining over time. Increasing chloride levels at most stations may be the result of increased salt use for winter road maintenance.

A paleolimnological study of historic phosphorus concentrations in Callander Bay was conducted for the NBMCA (AECOM, 2009). AECOM found that Callander Bay total phosphorus concentrations have not changed significantly over the long-term (approximately 400 years)

Table 9.3 Water Quality Trends from Active Provincial Water Quality Monitoring Stations in the NBMCA Area of Jurisdiction (1968 to 2011)

Variable	PWQMN Location and Site Number					
	Amable Du Fond River	Chippewa Creek	Duchesnay Creek	Kaibuskong River	Mattawa River	Wasi River
	18607008002	3013301902	3013301302	18607006002	18607002002	3013303002
Total Phosphorus	Decreasing	Decreasing	Decreasing	Decreasing	Decreasing	Increasing
Nitrate	Decreasing	Increasing	Increasing	Increasing	Increasing	Decreasing
Dissolved Oxygen	No trend	Increasing	Increasing	Increasing	No trend	Decreasing
pH [1]	Increasing [2]	Increasing	No trend	Increasing	Increasing	Increasing
Total Suspended Solids	No trend	Decreasing	Decreasing	Decreasing	Decreasing	No trend
Chloride	Decreasing	Increasing	Increasing	Increasing	Increasing	Increasing

Notes: [1] pH trend is based on laboratory measurement of pH for which there was a greater amount of long-term data
[2] pH trend is based on measurements from 2007 to 2011

with the exception of an increase between 1948 and 1952. The average concentration of total phosphorus in Callander Bay from 1952 to 2007 was 32.5 µg/L (AECOM, 2009).

9.4 General Lake and River Water Quality Assessment

The NBMCA has abundant lakes and streams within its area of jurisdiction for which water quality is important for ecological characterization as well as to determine vulnerability to human impacts. Lakes and streams can be characterized based on their thermal regimes and based on their trophic status.

Aquatic thermal regimes of lakes and streams are affected by air temperature, vegetative cover, depth, volume, water flow and groundwater discharge and can reflect other influences such as human activity, development and susceptibility to climate change. A lake, stream or river is identified according to its thermal regime under the categories: 'Cold Water', 'Cool Water' or 'Warm Water' in Figure 9.2. Cold water bodies are usually deep, often relatively pristine, have ample water inflow and outflow or groundwater input, and have characteristics that generally offer protection from solar heating. Warm water bodies are generally shallow, often more enriched, may have restricted water flow and fewer groundwater inputs and, are more susceptible to solar heating often due to a lack of cover.

In addition to thermal regimes, lakes and streams can also be classified based on their trophic status. The trophic status of lakes and streams is an indicator of biological productivity. The Canadian framework for phosphorus management recognizes six classifications based on the total phosphorus concentrations in lake and river water (Environment Canada, 2004):

Ultra-oligotrophic	< 4 µg/L	**Meso-eutrophic**	20 - 35 µg/L
Oligotrophic	4 - 10 µg/L	**Eutrophic**	35 - 100 µg/L
Mesotrophic	10 - 20 µg/L	**Hyper-eutrophic**	> 100 µg/L

Table 9.4 Current Conditions for Selected Water Quality Parameters for Active Provincial Water Quality Monitoring Stations in the NBMCA Watershed (2003 to 2011)

Variable	Statistic	PWQMN Location and Site Number						Relevant Guideline
		Amable Du Fond River	Chippewa Creek	Duchesnay Creek	Kaibuskong River	Mattawa River	Wasi River	
		18607008002	3013301902	3013301302	18607006002	18607002002	3013303002	
Total Phosphorous (µg/L)	# Samples	37	58	37	37	37	56	30 µg/L [1]
	Minimum	<2	7.0	3.0	3.0	2.0	15	
	Maximum	20	525	52	81	20	112	
	Average	9.4	31	25	20	11	43	
Nitrate (mg/L)	# Samples	37	58	36	244	18	19	10 mg/L [2] 13 mg/L [3] 550 mg/L [4]
	Minimum	0.001	0.242	0.001	0.001	0.003	0.005	
	Maximum	0.188	0.812	0.228	0.185	0.122	0.173	
	Average	0.037	0.527	0.072	0.025	0.056	0.064	
Dissolved Oxygen (mg/L) [5]	# Samples	35	55	35	35	16	54	see notes [6]
	Minimum	7.49	7.80	7.27	6.13	7.89	5.6	
	Maximum	14.0	17.4	14.7	15.2	20.3	17	
	Average	9.93	10.8	10.4	10.4	10.9	9.6	
Total Suspended Solids (mg/L)	# Samples	36	57	37	37	37	55	see notes [7]
	Minimum	0.50	0.80	1.10	0.60	0.50	3.0	
	Maximum	3.6	337	15.6	6.3	8.3	25	
	Average	1.7	13.7	4.61	3.3	2.0	8.3	
Chloride (mg/L)	# Samples	37	58	37	37	37	56	250 mg/L [8] 120 mg/L [3] 640 mg/L [4]
	Minimum	0.40	21.1	1.90	3.8	2.2	2.0	
	Maximum	2.8	176	61	20.2	3.9	16.0	
	Average	1.2	95.3	19.5	6.48	3.1	4.73	

Data Source: NBMCA – PWQM station data (1968 to 2011)

Notes:

[1] Provincial Water Quality Objectives – Interim Objective to eliminate excessive plant growth in rivers and streams (MOE 1994)

[2] Ontario Drinking Water Quality Standards (O. Reg 169/03) Maximum Allowable Concentration

[3] Canadian Council of Ministers of the Environment Water Quality Guidelines for the Protection of Aquatic Life – long-term exposure (CCME 2011, 2012)

[4] Canadian Council of Ministers of the Environment Water Quality Guidelines for the Protection of Aquatic Life – short-term exposure (CCME 2011, 2012)

[5] Dissolved Oxygen measured in the field

[6] Provincial Water Quality Objectives minimum concentrations for cold and warm water fish communities dependent on water temperature: warm water – 7 mg/L at 0°C to 4 mg/L at 25°C; cold water – 8 mg/L at 0°C to 5 mg/L at 25°C.

[7] Canadian Council of Ministers of the Environment Water Quality Guidelines for the Protection of Aquatic Life – maximum increase dependent upon flow and background levels (CCME 2002)

[8] Ontario Drinking Water Quality Standards (O. Reg 169/03) Aesthetic Objective

In addition to the water quality data collected through the Provincial Water Quality Monitoring Network, phosphorous concentrations have been monitored by the NBMCA at several other locations (NBMCA unpublished). A summary of the phosphorous concentration data collected by the NBMCA at stations other than the Provincial Water Quality Monitoring Network stations is provided in Table 9.5. The trophic statuses of water bodies within the NBMCA are presented in Tables 9.5 and 9.6, and shown in Figure 9.3.

A water quality monitoring program conducted in the summer of 1999 (Aquafor Beech Limited, 2000) indicated that Jessups Creek would be classified as eutrophic based on total phosphorous concentrations.

A review of historical water quality data for the La Vase River watershed stated that total phosphorous concentrations were generally in the range of 40 to 80 µg/L prior to the 1990s (TSH 1997), which would classify this water body as eutrophic. A decrease in the total phosphorous concentrations was observed after 1990 (Totten Sims Hubicki, 1997), with concentrations in the meso-eutrophic to eutrophic range.

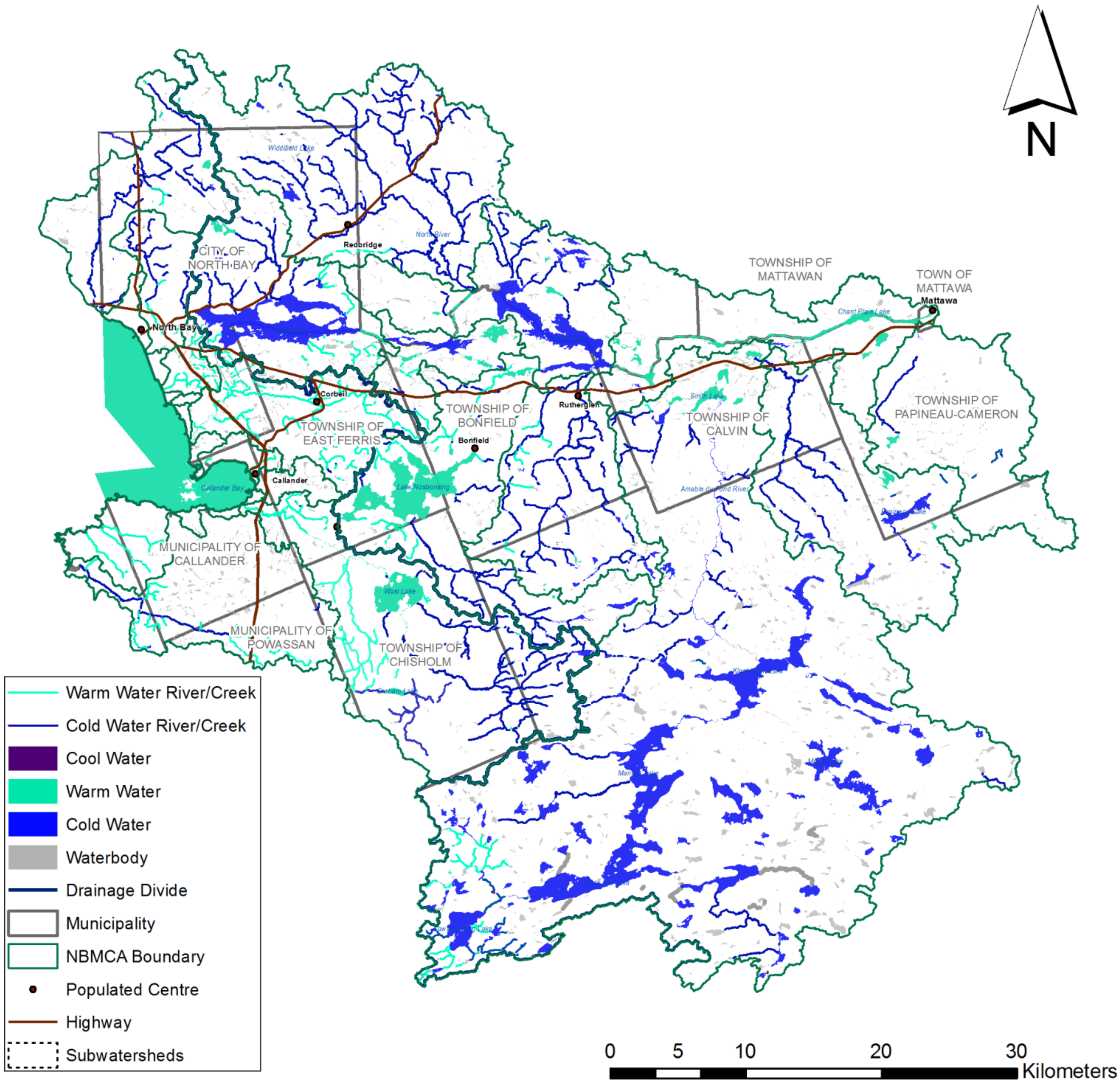
9.5 Biological Indicators of Water Quality

9.5.1 Benthic Macroinvertebrates

Benthic macroinvertebrates are organisms that live part of or all of their lives in or on the bottom sediments of a water body and their communities can be sampled to provide an indication of aquatic health. Changes in the macroinvertebrate community structure can indicate changes in water quality over time. The presence and abundance of benthic macroinvertebrates (e.g., mollusks, crustaceans, larval stages of insects like dragonflies, mayflies and caddisflies) is partly dictated by the aquatic conditions to which they are exposed. Aquatic conditions such as water flow and temperature, dissolved oxygen levels, sediment type and aquatic vegetation support different kinds of macroinvertebrates, while stressors on a water body, like pollution, change the conditions necessary for different species. As pollution, nutrient loading and temperature regime change, the presence and abundance of species change and monitoring the benthic community over time can be used to assess if water quality is changing.

The Drinking Water Source Protection – Watershed Characterization Report (Draft) (NBMCA, 2008) indicates that no routine benthic monitoring has been carried out in the NBMCA watershed, but does cite background studies that have included benthic sampling. Benthic data collected in the 1960s and 1970s exists for Trout, Wasi and Graham Lakes; Four Mile, Chiswick, Chippewa, Sharpes, Blueseal, Cahill and Landis Creeks; as well as Kaibuskong and North Rivers (NBMCA, 2008). The NBMCA (unpublished) has initiated routine sampling for benthic macroinvertebrates at six stations located on Chippewa Creek, Four Mile Creek and Lees Creek.

Figure 9.2 Thermal Aquatic Habitat Regimes within the NBMCA Area of Jurisdiction



Source: Gartner Lee Ltd., 2008

Table 9.5 Summary Statistics on Total Phosphorous Data from Sites outside Provincial Water Quality Monitoring Network in the NBMCA Area of Jurisdiction

Location	# of Sites	Years	# of Samples	Total Phosphorous (µg/L)			Trophic Status
				Min	Max	Average	
Callander Bay (summer)	2	2007-2011	85	14	153.6	24	Meso-eutrophic
Wasi Lake (summer)	6*	2007-2011	105	14.1	56.2	32.3	Meso-eutrophic
Wasi River Upstream (summer)	5*	2009-2012	114	6.25	100	37.5	Eutrophic
Wasi River Downstream (summer)	3	2009-2012	94	20	97	44	Eutrophic
Graham Creek (summer)	4	2009-2012	132	10	119	43	Eutrophic
Chiswick Creek (summer)	2	2009-2012	66	11	112	42	Eutrophic
Windsor Creek (summer)	1	2010-2012	23	39.6	154.4	72.6	Eutrophic
Burford Creek (summer)	1	2010-2012	23	12.7	74.9	32.8	Meso-eutrophic
Callander (Cranberry) Creek (summer)	1	2011-2012	15	25.7	150.2	46.2	Eutrophic
Trout Lake (spring)	8	1975-2011	188	1.0	20.0	5.6	Oligotrophic
Trout Lake (summer)	8	2000-2011	88	2.0	36	7.8	Oligotrophic
Four Mile Creek (spring)	4*	2002-2011	22	6.8	12.6	8.9	Oligotrophic
Four Mile Creek (summer)	4	2005-2011	20	8.0	32	20.5	Meso-eutrophic
Lake Nosbonsing (spring)	6	2003-2011	42	9.6	36.3	16.0	Mesotrophic

Notes: * Not all sites have been monitored over the stated period

Table 9.6 Summary Statistics on Total Phosphorous Data from Additional Lakes in the NBMCA Area of Jurisdiction Monitored through the Lake Partner Program

Location	Stn #	# of Sites	Years	# of Samples	Total Phosphorous (µg/L)			Trophic Status
					Min	Max	Average	
Boon Lake, Ballantyne	6906	1	2003	1	8.9	8.9	8.9	Oligotrophic
Depensier Lake, Widdifield	7255	1	2002	1	15.8	15.8	15.8	Mesotrophic
Four Mile Lake, Widdifield	1544	6*	2002-2012	26	5.3	12.6	9.4	Oligotrophic
Papineau Lake, Papineau-Cameron	4240	5	2002-2012	11	6.7	14.3	10.1	Mesotrophic
Nosbonsing Lake (Astorville Bay), East Ferris	4098	2*	2002-2012	11	9.4	36.6	19.6	Mesotrophic
Talon Lake, Phelps	6454	2*	2002-2011	14	5.4	28.0	12.7	Mesotrophic
Unnamed Lake SSFC60, Boyd	7286	1	2003	1	7.1	7.1	7.1	Oligotrophic
Unnamed Lake SSFC61, Boyd	7287	1	2003	1	5.7	5.7	5.7	Oligotrophic
Unnamed Lake SSFC62, Boyd	7288	1	2003	1	16.0	16.0	16.0	Mesotrophic
Unnamed Lake SSFC63, Boyd	7289	1	2003	1	15.2	15.2	15.2	Mesotrophic
Unnamed Lake SSFC64, Lauder	7290	1	2003	1	7.9	7.9	7.9	Oligotrophic
Weeharry Lake, Lauder	6890	1	2003	1	3.3	3.3	3.3	Ultra-oligotrophic

Data Source: Ministry of Environment (2013) Lake Partner Total Phosphorous (TP) Concentration Data (2002 to 2012)

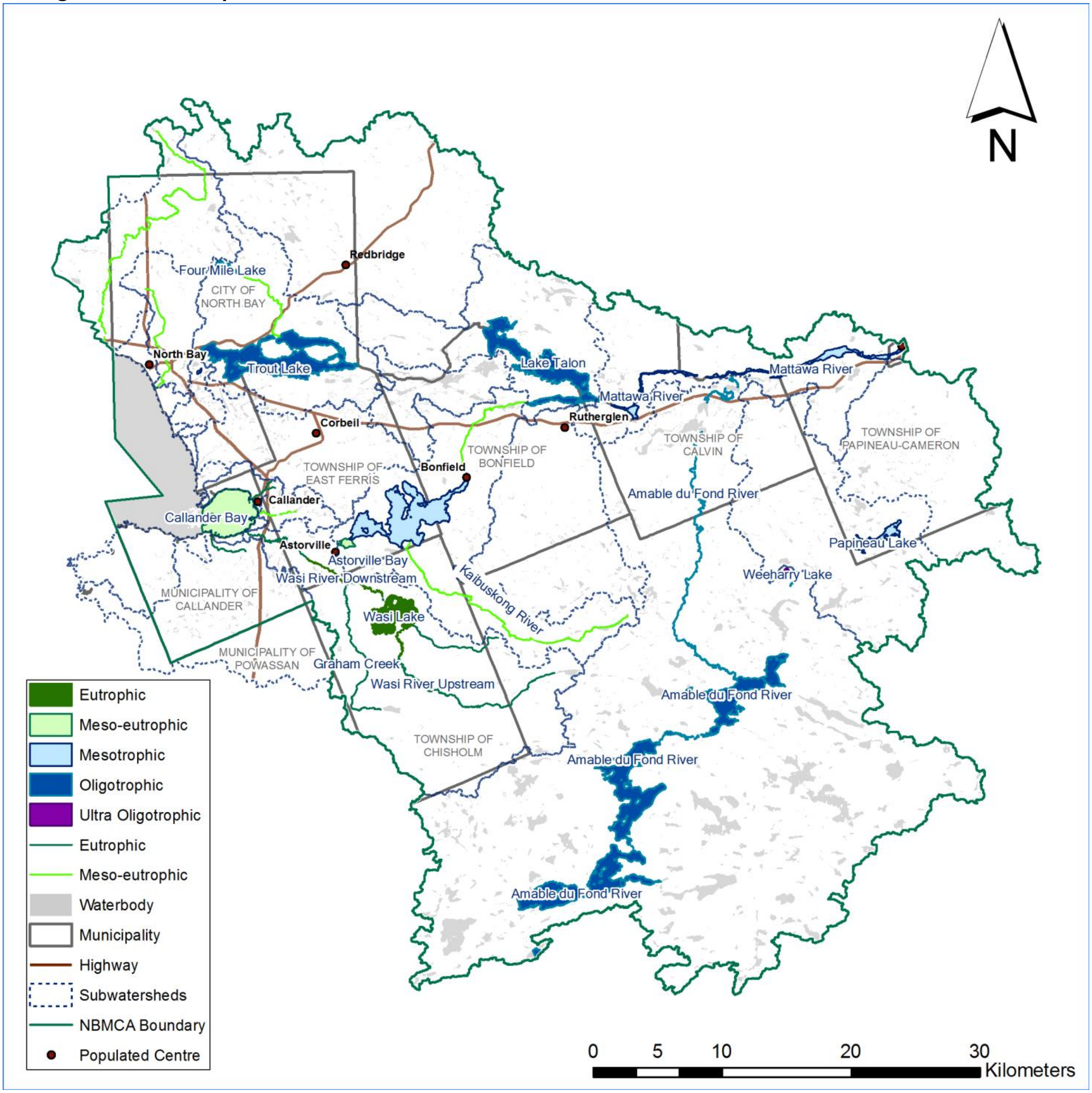
Notes:* Not all sites have been monitored over the stated period

From the previous studies in the 1960s and 1970s, macroinvertebrate diversity and abundance were found to be low in Graham Lake, Wasi Lake and Chiswick Creek (NBMCA 2012). In 1994, results of benthic macroinvertebrate sampling in Chippewa Creek indicated good water quality in the upper reaches and poor to very poor water quality in the lower reaches (Proctor & Redfern Limited 1996).

9.5.2 Coliform Bacteria

In the first Watershed Plan Background Inventory (NBMCA 1982), coliform bacteria were reported to be declining between 1970 and 1978 in Duchesnay Creek, Chippewa Creek, La Vase

Figure 9.3 Trophic Status of Water Bodies within the NBMCA Area of Jurisdiction



River and the Mattawa River, with lowest levels in the Mattawa River. Prior to 1986, fecal coliform levels in Chippewa Creek were measured at levels greater than 20,000 CFU/100 mL; however, from 1984 to 1989, levels dropped to below 8,000 CFU/100 mL (Proctor & Redfern

Limited 1996). Fecal coliform levels continued to exceed Provincial Water Quality Objectives[1] in Chippewa Creek in the 1980s (Hunter, 1992).

Data from the North Bay Department of Health in 1980 and 1981 indicated that fecal coliform levels in Lake Nosbonsing ranged from 0 to 1,200 CFU/100 mL (MNR, 1985). Fecal coliform levels in Wasi Lake reported from 1982 to 1984 were generally low (The Environmental Applications Group Limited and A.J. Robinson and Associates Inc., 1986). In 1987, fecal coliform levels in Trout Lake and Four Mile Bay were reported as ranging from 0 to 60 CFU/100 mL (CRA and Ecoplans, 1988). A water quality monitoring program conducted in the summer of 1999 (Aquafor Beech Limited, 2000) indicated that Jessups Creek had *E. coli* levels up to 800 CFU/100 mL.

In 2007, results of water quality monitoring by the NBMCA in Callander Bay showed that *E. coli* levels were generally below the Provincial Water Quality Objective (Hutchinson Environmental Sciences, 2010).

The North Bay Parry Sound District Health Unit carries out an annual Beach Sampling Program under the Ontario Public Health Standards. Available reports from 2005 to 2012 indicate that up to 11 beaches in the NBMCA area of jurisdiction were sampled as part of the Beach Sampling Program. Public beaches were posted with signs when there was evidence the water could be hazardous to bathers or when the daily geometric mean exceeds 100 E.coli/100 mL water (Land 2007). A summary of the Beach Sampling Program from 2005 to 2012 within the NBMCA area of jurisdiction is provided in Table 9.7. Amelia Beach was permanently posted after 2005 due to a history of adverse sampling results and proximity to an outfall. Marathon beach had samples exceeding 100 E.coli/100 mL water every season and was posted twice in 2005 and once in 2007. Several beaches were removed from the program when they no longer fit the criteria to qualify as a “public beach”. A cyanobacteria bloom was noted in Callander Bay in 2009.

9.5.3 Cyanobacteria

Cyanobacteria (also known as blue-green algae) are naturally occurring in surface waters, generally at low levels. Under certain conditions, cyanobacteria levels can increase (or bloom), resulting in aesthetic impacts on water quality, and potentially producing toxins. Algal blooms can result from elevated nutrient concentrations in combination with warm water temperatures.

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[1] The Provincial Water Quality Objective prior to 1994 was 100 counts per 100 mL for fecal coliforms and 1,000 counts per 100 mL for total coliforms; the current Provincial Water Quality Objective is 100 *E. coli* per 100 mL (MOE 1994).

Table 9.7 Summary of Beach Sampling Program in the NBMCA Area of Jurisdiction (2005 to 2012)

Beach Name	Location	Sampling Frequency	Results by Year							
			2005	2006	2007	2008	2009	2010	2011	2012
Amelia Beach	Lake Nipissing, North Bay	Weekly	Posted permanently							
Champlain	Lake Nipissing, North Bay	Weekly	-	*	No longer sampled					
Marathon	Lake Nipissing, North Bay	Weekly	Posted twice	*	Posted once	*	*	*	*	*
Olmstead	Trout Lake, North Bay	Weekly	-	*	-	*	-	*	*	*
Birchaven Cove	Trout Lake, North Bay	Weekly	-	*	-	-	-	-	-	-
Callander Bay	Callander	Monthly	Not sampled				Cyanobacteria bloom	-	-	-
Lake Nosbonsing	Astorville	Monthly	-	*	-	-	-	-	-	-
Mattawa	Mattawa	Monthly	-	*	-	*	-	-	-	-
Sturgeon Falls	Sturgeon Falls	Monthly	*	-	-	-	-	-	No longer sampled	
Bonfield Dam	Bonfield	Monthly	*	*	-	No longer sampled				
Wasi Lake	Chisholm Township	Monthly	-	-	-	No longer sampled				

Notes: - indicates no adverse sampling results during sampling season
* indicates one or more adverse sampling results during sampling season, but beach not posted

Source: North Bay Parry Sound District Health Unit Beach Sampling Reports, 2005 to 2012: Collins 2006, Land 2007, Palangio 2008 and 2011, Chalifoux 2009, Roscoe 2011, and Riley 2012.

In 2007, the NBMCA initiated a study to characterize the phytoplankton (algae) community in Callander Bay (AECOM, 2009a). Cyanobacteria were found to dominate the phytoplankton community on three of the four summer sampling dates (AECOM, 2009a). Cyanobacteria blooms were observed at Wasi Lake Beach and Callander Beach in 2009 during the Beach Sampling Program (Chalifoux 2009).

9.6 Water and Wastewater Treatment

Three municipalities within the study area have full water and sewer services. Treatment facilities are operated pursuant to Certificates of Approval issued by the Ontario Ministry of the Environment under the Ontario Water Resources Act. The City of North Bay, the Town of Mattawa and the Municipality of Callander have full water and waste water treatment and conveyance systems. All sewage conveyance systems are separated from stormwater systems. Both North Bay and Callander generate wastewater from water treatment plants which are treated at their sewage treatment facilities (Mattawa applies UV treatment which does not generate wastewater). Characteristics of water and wastewater treatment systems within North Bay, Mattawa and Callander are presented in Table 9.8

Table 9.8 Municipal Water and Waste Water Treatment Facilities within the NBMCA

Municiipality	Water Treatment System	Max Daily Capacity	Unit	Water Source	Average Daily Consumption	Unit/Year	Maximun Daily Consumption	Unit/Year
Callander	Conventional Filtration	3,000	m3/day	Lake Nipissing	452	m3/day/2011	839	m3/day /2011
Mattawa	UV	6,546	m3/day	Groundwater	1,545	m3/day/2011	2,959	m3/day /2011
North Bay	Membrane Filtration and UV	79,500	m3/day	Trout Lake	34,925	m3/day/2011	51,870	m3/day /2011
Municipality	**Waste Water Treatment System**	**Capacity**	**Unit**	**Discharge Waterbody**	**Average Daily Discharge**	**Unit/Year**	**Max Day**	**Unit/Year**
Callander	2 Cell Lagoon - Class 1	264,000	m3	Lake Nipissing	N/A	N/A	N/A	N/A
Mattawa	3 Cell aerated-facultative lagoon - Class 1	N/A	m3	Mattawa River	N/A	N/A	N/A	N/A
North Bay	Conventional Activate Sludge - Class 3	54,480	m3/day	Lake Nipissing	42,094	m3/day/2011	107,699*	m3/day 2011
* resulted in Chlorinated By-pass								
Source: Municipal Water System Reports 2011, + North Bay Waste Water Treatment Plan - Monthly Process Data, 2011								

The estimated total population connected to municipal services within the study area, based on 2011 Statistic Canada population statistics and percent connected stats reported in the Drinking Water Source Protection Report (NBMCA, 2008), is 54,934 (North Bay 95% = 50, 883, Mattawa 99% = 2,003, Callander 53% = 2,048). This represents 78.5 % of the total watershed population is on municipal services. The remainder of the population, roughly 15,000 or 21.5 % of the total population, relies on private water and waste water disposal systems in rural areas.

The Ontario Ministry of the Environment also regulates other private sewage and wastewater treatment facilities, which receive more than 10,000 liters per day, pursuant to the Ontario Water Resources Act. Large systems are constructed and operated under Sewage Works Certificate of Approval issued by MOE. The installation of small private wastewater treatment systems is regulated under the building Ontario Building Code and there are operational certificates required. Operational compliance is carried out through periodic re-inspections. Within the Districts of Nipissing and Parry Sound, the NBMCA is the designated authority to inspect and issue sewage system permits under the Ontario Building Code.

Most septic systems have septic tanks that rely on the occasional pump out. The frequency of pump out depends on the size of the tank and number of occupants using the system. Manufacturers and installers provide maintenance guidelines to owners. As a general rule septic tanks require pumping every 4 to 5 years. Municipalities are passing by laws to regulate septic pump out frequency as a watershed management tool (mainly along shorelines) to reduce phosphorous loading as well as to reduce the risk of bacteriological contamination from system malfunctions. Municipal bylaws require pumping frequency to be increased (typically permanently occupied buildings are required to file proof of pump out every 2 years). Licensed septic haulers dispose of septage (solids and liquid pumped from septic systems) at approved disposal sites which includes municipal waste water treatment facilities. Septic haulers often have private disposal sites that may be infrequently used. Liquid depots/dump sites are defined as “open, artificial ponds or basins that are used for storing liquids such as municipal sewage” (NBMCA, 2008). The locations of wastewater treatment facilities including municipal wastewater treatment facilities, private waste water disposal sites which include private lagoons and septic systems within the NBMCA are illustrated in Figure 9.4.

9.10 Data Gaps

Water quality data is currently collected primarily by the NBMCA. A large dataset has been collected between 1968 and 2012 for six stations within the NBMCA area of jurisdiction. However, large gaps in that dataset exist where monitoring ceased for a period, or physical and chemical parameters were not routinely sampled. Some lakes and rivers have been sampled sporadically; many of the lakes and rivers in the NBMCA area of jurisdiction are not routinely sampled for water quality. Based on Table 9.1, 9.5 and 9.6, the following subwatershed have no water quality data available:

- Boulder/Bear subwatershed
- North River subwatershed
- Sharpes Creek subwatershed
- Pautios Creek subwatershed
- Boom Creek subwatershed

Limited water quality data is available for:

- Windsor Creek
- Burford Creek
- Callander Bay/Southshore

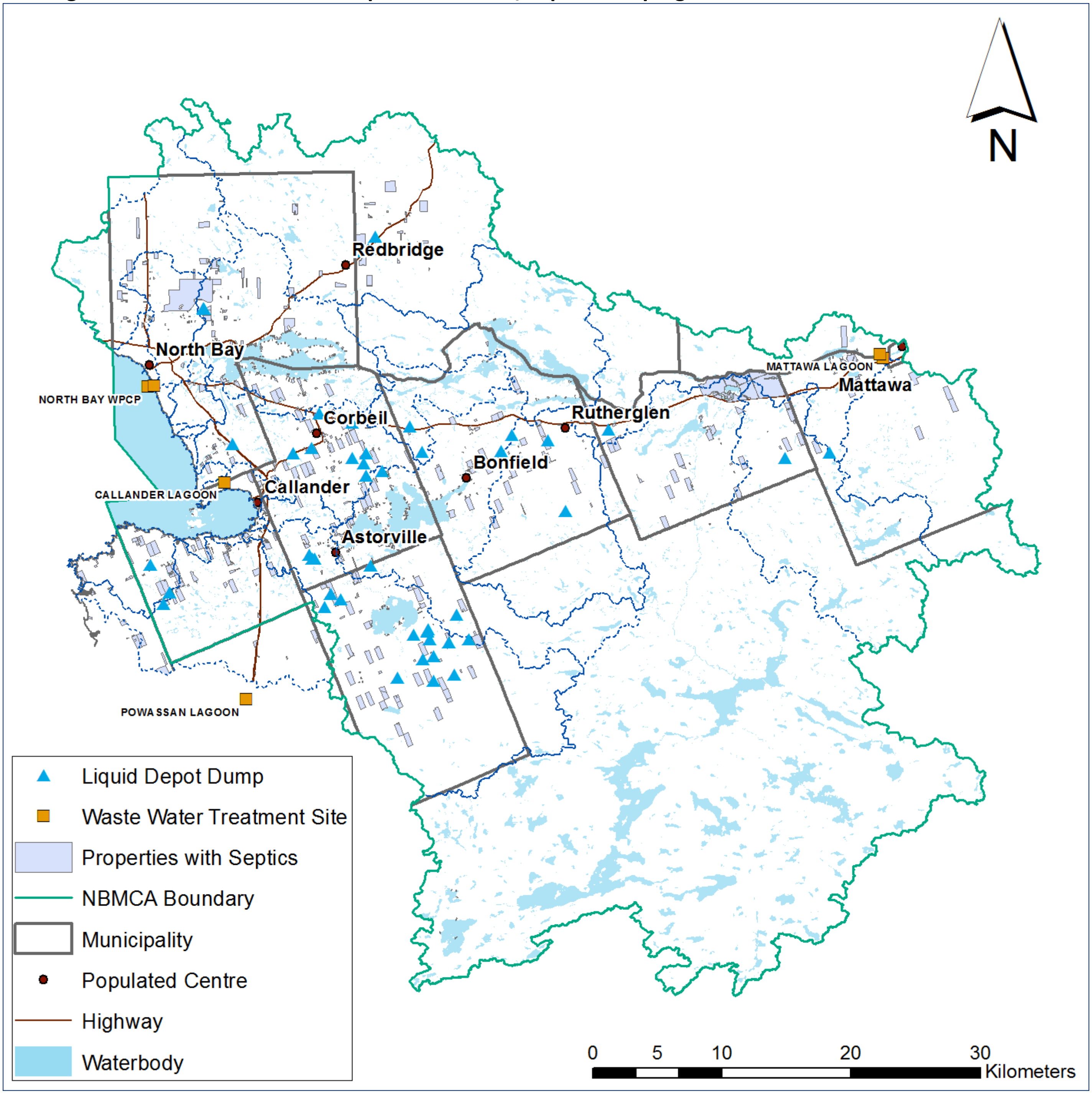
A baseline for benthic macroinvertebrate community composition has not yet been established. Sampling for benthic macroinvertebrate communities is currently restricted to six stations in three water bodies (note: Benthic data is available for Little Sturgeon River from City of North Bay at the Merrick Landfill Site).

The effectiveness of septic pump out by laws and septic re-inspection programs could be evaluated by comparing water quality trends in watershed that practice these controls to those that do not. Other areas where these types of controls could be beneficial to control nutrients and bacteriological loading should be evaluated.

10.0 Ecological Overview

An overview of the ecological features of the NBMCA area of jurisdiction was reported in the first Watershed Plan Background Inventory (NBMCA 1982). The Drinking Water Source Protection – Watershed Characterization Report (Draft) (NBMCA 2008) provided an updated overview and summary of ecological data within the NBMCA drinking water source protection area. This section updates and synthesizes the previously reported ecological information to

Figure 9.4 Waste Water Disposal Facilities/Liquid Dumping Sites within the NBMCA

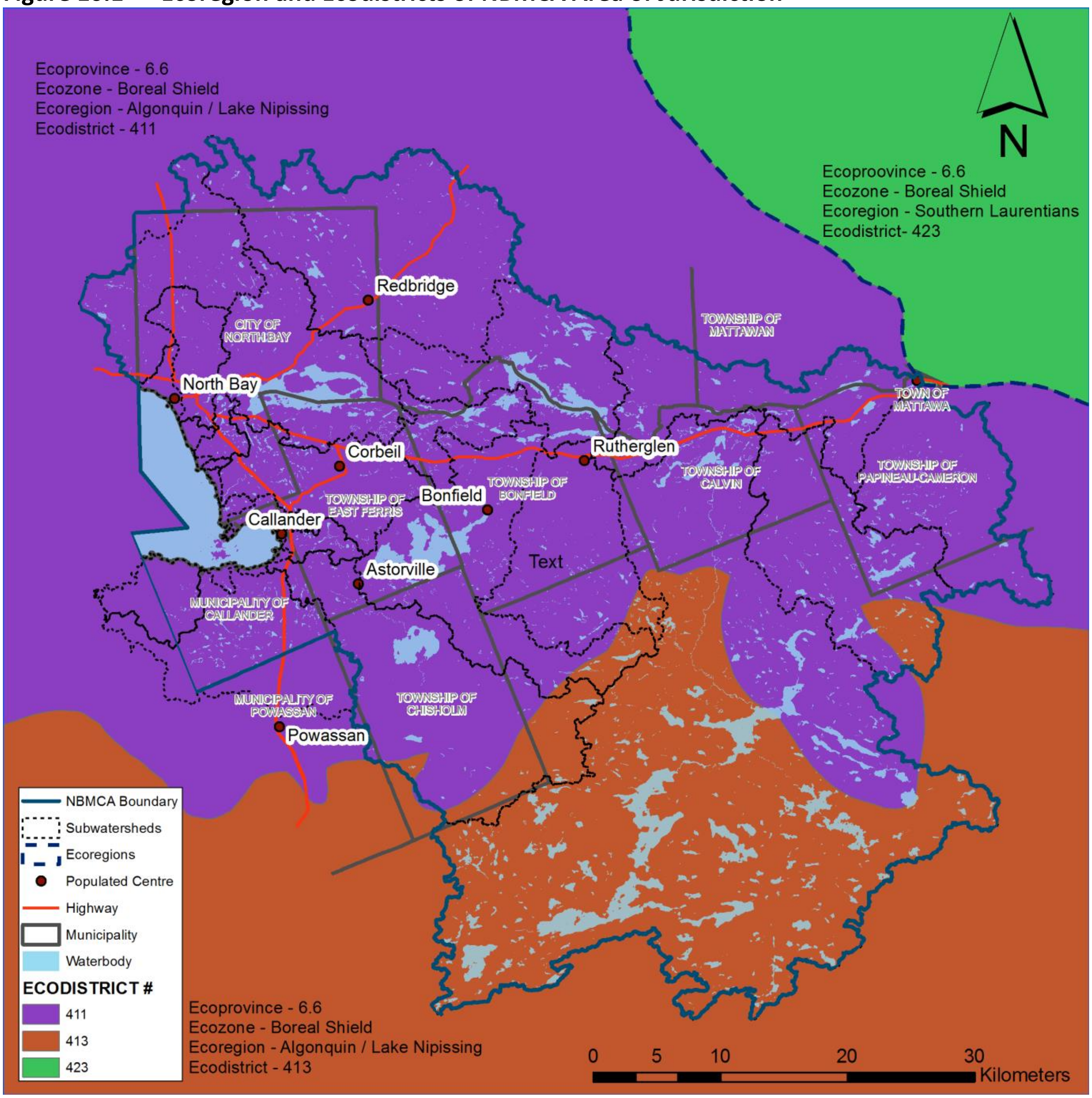


provide an overview of the present status and current knowledge of the existing natural environment features within the NBMCA area of jurisdiction.

Ontario has been subdivided into ecozones, ecoregions and ecodistricts that reflect regional differences in climate, geology and ecology. Based on the National Ecological Framework for

Canada (Ecological Stratification Working Group 1995), the NBMCA area of jurisdiction falls within the Boreal Shield Ecozone and the Algonquin - Lake Nipissing Ecoregion (Figure 10.1). Based on the Ontario Ecological Land Classification system (Crins et al. 2009), the NBMCA area of jurisdiction lies within the Ontario Shield Ecozone and is mainly within the Georgian Bay Ecoregion (Ecoregion 5E). The Georgian Bay Ecoregion is situated on the Precambrian Shield within the Great Lakes-St. Lawrence Forest Region and is characterized as having a cool-temperate, humid climate and land cover is dominated by forest (Crins et al. 2009).

Figure 10.1 Ecoregion and Ecodistricts of NBMCA Area of Jurisdiction



Source: National Ecological Framework for Canada (Ecological Stratification Working Group 1995)

10.1 Vegetation

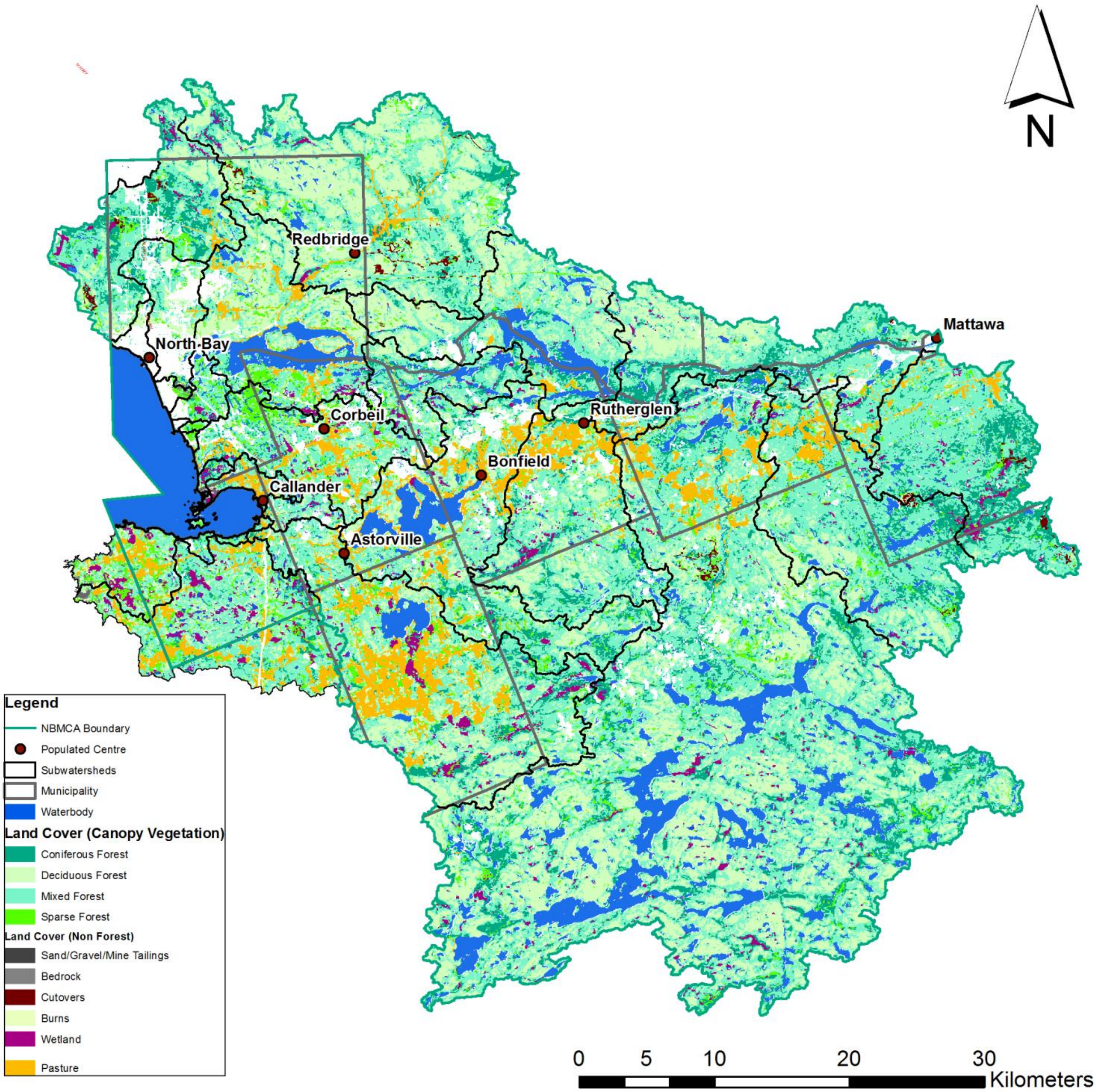
The NBMCA area of jurisdiction lies within the Great Lakes – St Lawrence Forest Region. Most of the forest cover throughout the watershed is mixed deciduous or deciduous forests. Coniferous forests are sparsely distributed throughout the watershed but land use analysis completed by Stantec suggests that deciduous forests are decreasing and coniferous stands are increasing. Wetlands are more plentiful at lower elevations (e.g., in the Mattawa lowlands). Figure 10.2 shows land cover within the watershed based on interpretation of 2011 imagery using Forest Resource Inventory land classifications completed by the NBMCA for this study.

The North Bay-Mattawa Conservation Authority Watershed Report Card 2013 (NBMCA 2013) states that approximately 80% of the NBMCA is covered by vegetative growth of which 80% is forest and 8.7% is wetland. The proportion of wetland within each subwatershed varies from 1% in Pinewood Parkway subwatershed and 27% in Jessup's Creek subwatershed (NBMCA 2013). Sparse vegetation cover occurs near urban areas, particularly in the vicinity of the City of North Bay and other urban centers, as well as in developed areas near transportation corridors. The Drinking Water Source Protection Report also identifies that naturally vegetated land is predominantly on Crown land or within parks or protected areas.

Provincial base mapping shows two forest stands that have been identified as Candidate Life Science Areas of Natural or Scientific Interest: the Widdifield Forest in the North River sub-watershed and the Doule Forest in the Trout Lake sub-watershed. These forests are protected by the Provincial Park designations. Provincial base mapping indicates that an old growth forest, known as the Boom Creek Old Growth Forest, exists in the Boom Creek sub-watershed at the eastern-most boundary of the NBMCA area of jurisdiction. This 590-hectare Conservation Reserve protects an old growth red and white pine stand (Nipissing Forest Resource Management Plan 2008).

The NBMCA area of jurisdiction is primarily within the Nipissing Forest Management Unit with the southern portion of the Amable du Fond River watershed being within the Algonquin Forest Management Unit. Eight provincial forest types are recognized by Forest Management Unit Plans: white birch, lowland conifer, upland conifer, jack pine, mixedwoods, poplar, red and white pine and tolerant hardwood forests. The dominant forest type within the NBMCA area of jurisdiction is tolerant hardwoods, consisting predominantly of hard maple (*Acer saccharum*) (NFRMP 2008). Further information of forestry activity within the NBMCA area of jurisdiction is presented is Section 13.3.4 Forestry.

Figure 10.2 Vegetative Cover within the NBMCA Area of Jurisdiction



10.2 Fish

Fish habitat is managed federally under the *Fisheries Act* by the Department of Fisheries and Oceans, and the NBMCA through agreement with DFO provides Level II technical and planning guidance for fish habitat protection. Some fisheries resources, such as Lake Trout lakes, are managed by the province. In the MNR Districts of North Bay and Algonquin Park, there are respectively 127 and 148 lakes managed as Lake Trout lakes (MNR 2006a) and many of these occur within the NBMCA area of jurisdiction. These lakes and their drainage basins are considered a special fisheries resource and have more specific management directives in planning decisions. Fisheries such as Walleye are important ecologic and economic resources in the NBMCA area of jurisdiction as well. Figure 10.3 shows the warm, cool and cold water fisheries areas within the watershed. Most of the lakes and streams within the NBMCA area of jurisdiction have been classified as either cold water or warm water fisheries.

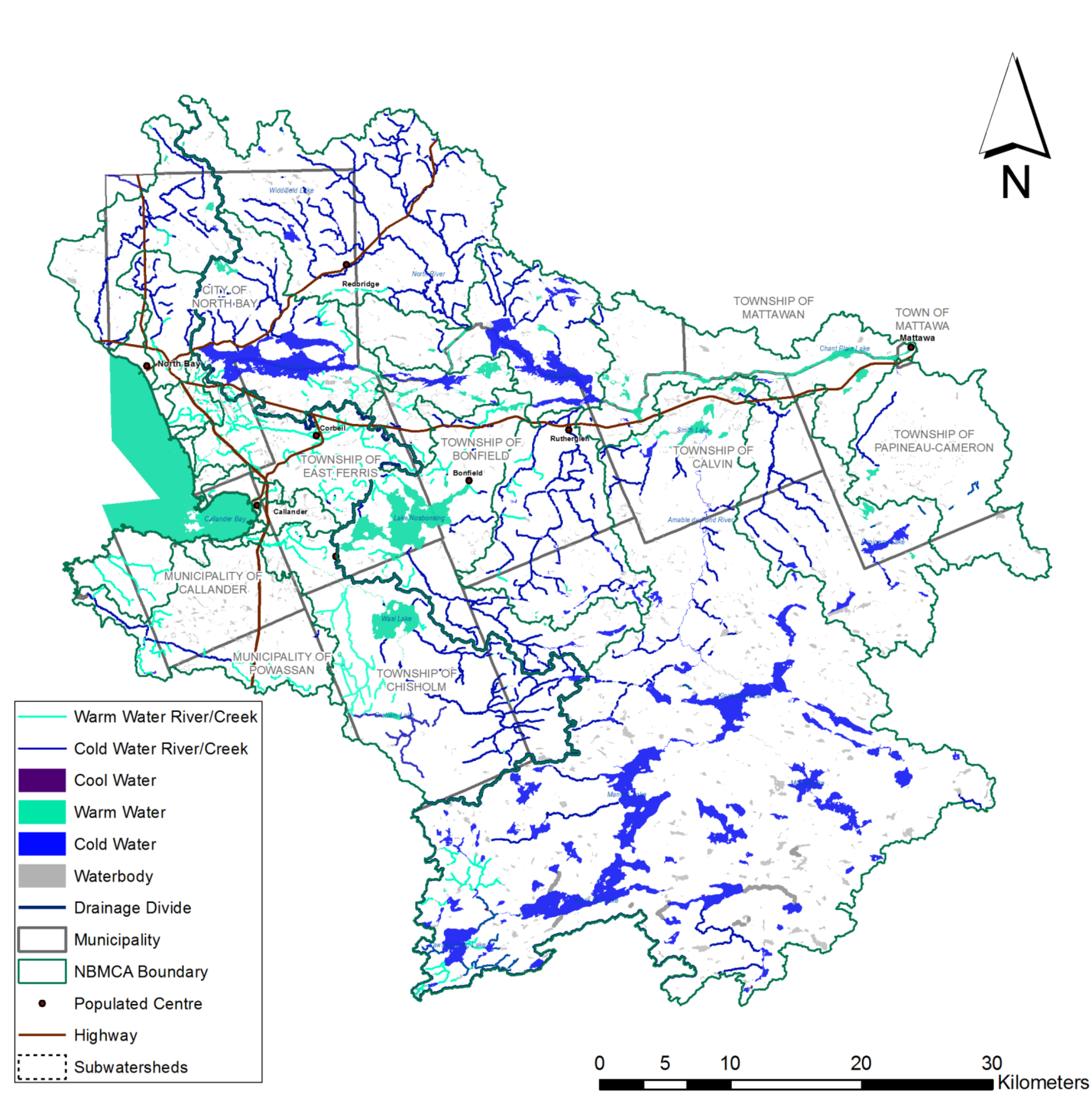
Warm water fisheries are primarily found in the Mattawa lowlands and cold water fisheries are typically located in headwater areas which are mainly at higher elevations. Cold water fisheries have survived in headwater areas where less human development has occurred and where streams are better sheltered by vegetative cover. The exceptions are Trout Lake, Talon Lake and parts of the Mattawa River which have considerable depth (within the Mattawa fault zone), and support cold or cool water fisheries. Callander Bay, Lake Nipissing, Lake Nosbonsing, Wasi Lake, Smith Lake, and Chant Plein Lake, among other smaller water bodies in the watershed lowlands, support warm water fisheries.

Typical cold water fish species that exist throughout the watershed are Lake Trout, Brook Trout, Whitefish, Lake Herring and Cisco. Warm water species that inhabit the warmer water bodies include Large and Smallmouth Bass and Pumpkinseed, and typical cool water species are Yellow Perch, Walleye (Pickerel), Northern Pike and Muskellunge (Muskie). There are some species of fish, including the Lake Sturgeon, Northern Brook Lamprey and Silver Lamprey that have been identified historically or currently as species at risk within the watershed. These species are discussed in more detail in Section 10.6.1.

A land-locked Atlantic Salmon species (*Salmo salar)* (known locally as Ouananiche) exists in Trout Lake. A stocking program in the mid-1900s was successful in Trout Lake and a self-propagating population was established. This population is the only known self-sustaining population of land-locked Salmon in Ontario (MNR 2006). The only documented spawning area of the species is Four Mile Creek, which flows into Trout Lake. Because of this, a sanctuary for the species was established in 1958 (Fitchco, 1996).

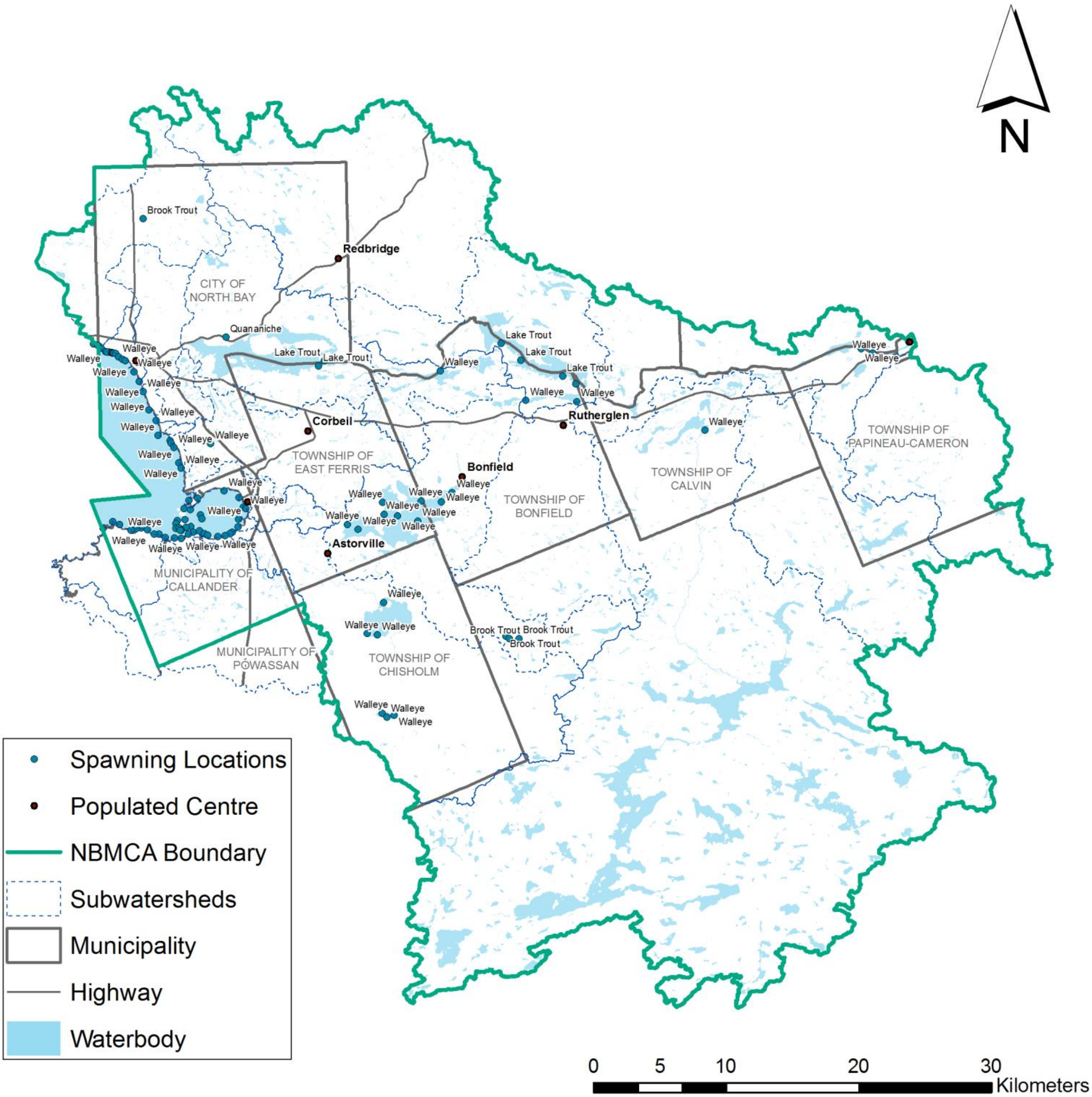
Fish habitat, as defined in the federal *Fisheries Act*, are those parts of the environment on which fish depend, directly or indirectly, in order to carry out their life processes. The range of habitats important to fish communities include those which provide overwintering, migration, feeding, spawning and nursery opportunities. The shores of Lake Nipissing in the municipalities of Callander and the City of North Bay support critical fish habitat, particularly for Walleye spawning (NBMCA 2008). Known spawning areas for Walleye, Lake Trout, Brook Trout and

Figure 10.3 Thermal Aquatic Habitat Regimes within the NBMCA Area of Jurisdiction



Lake Nipissing, which has a surface area of 87,000 hectares, has an average depth of 4.5 metres and is the largest lake in the Ministry of Natural Resources Fisheries Management Zone 11 (MNR 2012). The Ministry of Natural Resources prepared an Interim Fisheries Management Plan for Lake Nipissing for 2007 to 2010 (MNR 2006 Final Draft) that identified a number of

Figure 10.4 Identified Fish Spawning areas within the NBMCA Area of Jurisdiction



issues with respect to fisheries in the lake, and proposed management actions to address those issues. Lake Nipissing is a 'Specially Designated' Lake by the Ministry of Natural Resources. It is a popular fishing destination and important for tourism. It is also an important fishery for First Nations communities who live on the lake and depend on the fishery (MNR, 2012). The sport fishery in Lake Nipissing includes Walleye, Yellow Perch and Northern Pike. The Walleye population of Lake Nipissing is currently under stress and harvest limits have been reduced for the 2013 season. In addition to fishing pressure, the fishery may be affected by the invasion of the lake by the spiny water flea. In addition to Walleye, Yellow Perch and Northern Pike, among the 44 species of fish that live in the lake are also White Sucker, Lake Herring, Lake Whitefish, and one species at risk: Lake Sturgeon (MNR 2012). Northern Brook Lamprey is a species at risk that is found in streams flowing into Lake Nipissing (Dave Fluri, MNR, pers. Comm. 2013) The NBMCA's jurisdiction extends along shores at the eastern end of Lake Nipissing in both the City of North Bay and the Municipality of Callander, which has important fish nursery and spawning areas (particularly for Walleye). Upland management considerations within the contributing watersheds are important to protect the downstream fishery interests in Lake Nipissing.

10.3 Wildlife

Wildlife, and the habitat they require, vary somewhat across the watershed, and are influenced by the ecological conditions discussed previously. Wildlife within the watershed includes mammals, birds, reptiles and amphibians. Moose, deer, aquatic and terrestrial fur bearing animals such as otter, mink, fisher, beaver, bear and wolves and many others reside within the watershed.

The 1982 Watershed Plan (NBMCA 1982) identified 28 species of amphibians and reptiles, 209 species of birds, and 41 species of mammals living or migrating through the NBMCA area of jurisdiction. A recent search of the Ontario Reptile and Amphibian Atlas (Ontario Nature 2011) indicates that there are three species of turtles, eight species of snakes (five of which have not been recorded since 1992), and 16 species of amphibians (two of which have not been recorded since 1992) recorded in the NBMCA area of jurisdiction. The Ontario Breeding Bird Atlas (OBBA) lists 179 species of birds as breeding (or possibly breeding) in Regions 27 and 29, which includes the general area of the NBMCA area of jurisdiction.

A review of Provincial mapping shows a large area of the watershed is defined as a 'Bear Management Area'. Large areas of Black Bear management exist north of the Mattawa River to beyond the watershed boundary, and south to approximately the Algonquin Park boundary. One Black Bear denning site is recorded in Algonquin Park.

A major consideration for wildlife management is in the protection of suitable habitat. Some habitats are considered more important than others, and are identified as Significant under Ontario's Provincial Policy. Significant wildlife habitat areas within the NBMCA area of jurisdiction are discussed in more detail in Section 10.6.3.

10.4 Unique Landforms

Landforms in the NBMCA watershed can be identified based on their geological or ecological uniqueness. For example, the NBMCA Watershed Plan (NBMCA 1982) identifies eskers and glaciofluvial esker/kames and moraine complexes through Boulter, Bonfield and Chisholm townships, as well as in Papineau Township and North Bay as significant landforms. The report further identifies physiographic features in the watershed as gorges, cascades, and raised beaches. Table 6 of the First Watershed Plan Background Inventory lists significant physiographic features with the NBMCA area of jurisdiction which are categorized under geologic features, geological complexes, glacial formations, and post glacial formations.

Unique landforms often provide unique habitat opportunities for vegetation, wildlife and fish. Geological conditions influence groundwater interactions with the surface, for example, can provide spawning opportunities for cold water fisheries. Escarpments or old growth forests can provide unique nesting opportunities for birds, and the structure and quality of a forest ecosystem will dictate the quality of browse, denning, calving, or wintering opportunities for ungulates and many other mammals.

Unique landforms can also be recognized and conserved/protected through special status designations. For example, landforms may be protected as Significant Natural Heritage Features, under provincial or municipal planning initiatives or may be locally significant wetlands, Areas of Natural or Scientific Interest, or have other provincially significant designations as determined under the Province of Ontario's Natural Heritage Manual Guidelines.

Landforms are also protected through parks, conservation reserves and conservation areas designations. Park selection criteria often include consideration of unique landforms and these designated areas can be a useful way to profile the type of important landforms found within the NBMCA. The Drinking Water Source Protection Report (NBMCA 2008) identifies six provincial parks (encompassing approximately 25% of the area), nine conservation reserves (covering approximately 1% of the area), and 15 conservation areas (covering less than 1% of the area). Not all of these features lie entirely within the NBMCA area of jurisdiction. Parks, Conservation Reserves and Conservation Areas as well as features they protect are listed in Table 10.1.

10.5 Species at Risk

Species at risk are those given status rankings of extirpated, endangered, threatened or special concern by the provincial Committee on the Status of Species at Risk in Ontario or the federal Committee on the Status of Endangered Wildlife in Canada.

The tracking of species at risk occurs through federal mapping and the provincial Natural Heritage Information Centre database. It should be noted that the Natural Heritage Information Centre database contains records which may be 'historic' (i.e., older than 20 years) and may not reflect current conditions. Also, the database uses Element Occurrences to show locations of species. An Element Occurrence is defined as an area of land and/or water on/in which an element (e.g., species or ecological community) is or was present. For protection purposes, exact locations of species are not identified.

Table 10.1 Protected Areas in the NBMCA Watershed

Provincial Parks	**Important Landform Features/Attributes**
Algonquin Provincial Park	Large tracts of interior forest, uninterrupted habitats for flora and fauna, headwaters, forestry
Amable du Fond Provincial Park	Waterway Park, canoe routes, linkage, tourism, riparian protection
Mattawa River Provincial Park	Waterway Park, linkage, tourism, Canadian Heritage River, Mattawa River Fault Line is significant Earth Science feature, canyons, Life Science Area of Natural or Scientific Interest (*Delta-Blue Mountain Complex*)
Samuel de Champlain Provincial Park	Natural Environment Class Park, tourism, Mattawa River Fault Line,
Widdifield Provincial Park	Cold water source for large tributaries, headwaters, Life Science Area of Natural or Scientific Interest
Conservation Reserves	
Boom Creek Old Growth Forest	Old growth forest, rock outcrop habitats, brook trout habitat
Boutler-Depot Creek Conservation Reserve	Significant earth Science features; moraines, eskers. Significant life science features, variety of habitats including Brook trout. Two Areas of Natural or Scientific Interest (Boutler Creek Hill and Boutler Township Esker Complex). Protected area.
Callander Bay Wetland Conservation Reserve	Provincially Significant Wetland, including important life science values and important fish spawning habitat, and waterfowl habitat.
Conservation Areas	
Corbeil	Historic La Vase River, Interpretive trail
Eau Claire Gorge	Historic Amable du Fond River, waterfall, rapids, interpretive trail
Elks Lodge Family Park	Historic Portage Route between Trout Lake and Lake Nipissing
Eva Wardlaw Park	Shoreline of Lake Nipissing. Beaches
John P. Webster Nature Preserve	Outdoor recreation
Kate Pace Way	12 km trail linking North Bay and Callander
Kinsmen Trail	7 km trail linking North Bay waterfront to Airport Road, Ecopath
La Vase Portage	Provincially Significant Wetland, historical portage, linkage to Trout Lake from Lake Nipissing
Laurentian Escarpment	Hiking trails, unique habitat, tourism
Laurier Woods	Provincially Significant Wetland, other important wetland complex recognized as locally significant, manages flood waters, flow regimes, wildlife habitat
Mattawa Island	Urban Park and beach. Island habitat
Papineau Lake	Public Access to lake
Shields McLaren	Natural and historic features
Shirley Skinner Memorial Nature Reserve	Outdoor education

Source: NBMCA 2008 *Drinking Water Source Protection Watershed Characterization Assessment Report, Draft Report*

Species at risk within the NBMCA area of jurisdiction have been identified through various reports over the years, and because the status of these species change with time, a current search of existing information has been conducted to identify species at risk known to be in the watershed.

A review was conducted to compile a list of species at risk within the NBMCA area of jurisdiction for this report. Thirty-seven species (19 bird species, 2 mammal species, 5 fish species, 10 reptile species, 1 insect species, 1 plant species and 1 lichen species) were identified and are listed in Table 10.2.

Additional rare insect species listed within the Drinking Water Source Protection Report (NBMCA 2008) were all re-examined for their current status, and those identified in previous reports are not listed federally or provincially.

Table 10.2 Species at Risk Potentially Found in the NBMCA Watershed

Common Name	Scientific Name	ESA, 2007	COSEWIC	SARA	Data Source
Birds					
American White Pelican	*Pelecanus erythrorhynchos*	Threatened	Not at risk	Not listed	MNR 2013/ SARA Registry (2012)
Bald Eagle	*Haliaeetus leucocephalus*	Special Concern	Not at risk	Not listed	SARA Registry (2012)/ SARO (2012)
Barn Swallow	*Hirundo rustica*	Threatened	Threatened	No Status	MNR 2013/ SARA Registry (2012)
Black Tern	*Chlidonias niger*	Special Concern	Not at risk	Not listed	SARA Registry (2012)/ SARO (2012)
Bobolink	*Dolichonyx oryzivorus*	Threatened	Threatened	No Status	MNR 2013/ SARA Registry (2012)
Canada Warbler	*Wilsonia canadensis*	Special Concern	Threatened	Threatened	MNR 2013/ SARA Registry (2012)
Chimney Swift	*Chaetura pelagica*	Threatened	Threatened	Threatened	MNR 2013/ SARA Registry (2012)
Common Nighthawk	*Chordeiles minor*	Special Concern	Threatened	Threatened	MNR 2013/ SARA Registry (2012)
Eastern Meadowlark	*Sturnella magna*	Threatened	Threatened	No Status	MNR 2013/ SARA Registry (2012)
Eastern Whip-poor-will	*Caprimulgus vociferus*	Threatened	Threatened	No Status	MNR 2013/ SARA Registry (2012)
Kirtland’s Warbler	*Dendroica kirtlandii*	Endangered	Endangered	Endangered	MNR 2013/ SARA Registry (2012)
Golden-winged Warbler	*Vermivora chrusoptera*	Special Concern	Threatened	Threatened	MNR 2013/ SARA Registry (2012)
Least Bittern	*Ixobrychus exilis*	Threatened	Threatened	Threatened	SARA Registry (2012)/ SARO (2012)
Loggerhead Shrike	*Lanius ludovicianus*	Endangered	Endangered	Endangered	NHIC (2012)/SARA Registry (2012)
Olive-sided flycatcher	*Contopus cooperi*	Special Concern	Threatened	Threatened	MNR 2013/ SARA Registry (2012)
Peregrine Falcon	*Falco peregrinus*	Threatened	Non-Active	Threatened	NHIC (2012)/SARA registry (2012)
Red-headed Woodpecker	*Melanerpes erythrocephalus*	Special Concern	Threatened	Threatened	MNR 2013/ SARA Registry (2012)
Red-shouldered Hawk	*Buteo lineatus*	Not listed	Not at risk	Special Concern	SARA Registry (2012)/ SARO (2012)
Short-eared Owl	*Asio flammeus*	Special Concern	Special Concern	Special Concern	MNR 2013/ SARA Registry (2012)
Yellow Rail	*Coturnicops noveboracensis*	Special Concern	Special Concern	Special Concern	MNR 2013/ SARA Registry (2012)

Table 10.2 Species at Risk Potentially Found in the NBMCA Watershed

Common Name	Scientific Name	ESA, 2007	COSEWIC	SARA	Data Source
Mammals					
Eastern Cougar	*Puma concolor*	Endangered	No Status	No Status	MNR 2013/ SARA Registry (2012)
Eastern Wolf	*Canis lupus lycaon*	Special Concern	Special Concern	Special Concern	MNR 2013/ SARA Registry (2012)
Little Brown Bat	*Myotis lucifugus*	Endangered	Endangered	No Status	MNR 2013/ SARA Registry (2012)
Northern Myotis	*Myotis septentrionalis*	Endangered	Endangered	No Status	MNR 2013/ SARA Registry (2012)
Fish					
American Eel	*Anguilla rostrata*	Endangered	Threatened	No Status	MNR 2013/ SARA Registry (2012)
Lake Sturgeon (Great Lakes/Upper St. Lawrence Populations)	*Acipenser fulvescens*	Threatened	Threatened	No Status	SARA Registry (2012)/ SARO (2012)
Northern Brook Lamprey	*Ichthyomyzon fossor*	Special Concern	Special Concern	Special Concern	NHIC (2012)/SARA registry (2012)
Shortjaw Cisco	*Coregonus zenithicus*	Threatened	Threatened	Threatened	MNR 2013/ SARA Registry (2012)
Silver Lamprey	*Ichthyomyzon unicuspis*	Not listed	Special Concern	No status	SARA Registry (2012)/ SARO (2012)
Reptiles					
Blanding's Turtle	*Emydoidea blandingii*	Threatened	Threatened	Threatened	NHIC (2012)/SARA registry (2012)
Common Five-lined Skink (Southern Shield population)	*Plestiodon fasciatus*	Special Concern	Special Concern	Special Concern	MNR 2013/ SARA Registry (2012)
Eastern Hog-nosed Snake	*Heterodon platirhinos*	Threatened	Threatened	Threatened	SARA Registry (2012)/ SARO (2012)
Eastern Musk Turtle	*Sternotherus odoratus*	Threatened	Special Concern	Threatened	MNR 2013/ SARA Registry (2012)
Eastern Ribbonsnake	*Thamnophis sauritus sauritus*	Special Concern	Special Concern	Special Concern	SARA Registry (2012)/ SARO (2012)
Massasauga	*Sistrurus catenatus*	Threatened	Threatened	No status	MNR 2013/ SARA Registry (2012)
Milksnake	*Lampropeltis triangulum*	Special Concern	Special Concern	Special Concern	NHIC (2012)/SARA registry (2012)
Snapping turtle	*Chelydra serpentina*	Special Concern	Special Concern	Special Concern	MNR 2013/ SARA Registry (2012)
Spotted Turtle	*Clemmys guttata*	Endangered	Endangered	Endangered	MNR 2013/ SARA Registry (2012)
Wood Turtle	*Glyptemys insculpta*	Endangered	Threatened	Threatened	MNR 2013/ SARA Registry (2012)
Insects					
Monarch	*Danaus plexipus*	Special Concern	Special Concern	Special Concern	SARA Registry (2012)/ SARO (2012)
West Virginia White	*Pieris virginiensis*	Special Concern	Not designated	Not listed	MNR 2013
Plants					
Butternut	*Juglans cinerea*	Endangered	Endangered	Endangered	NHIC (2012)/SARA registry (2012)
Lichens					
Flooded Jellyskin	*Leptogium rivulare*	Threatened	Threatened	Threatened	MNR 2013/ SARA Registry (2012)

COSEWIC = Committee on the Status of Endangered Wildlife in Canada.
ESA, 2007 = *Endangered Species Act, 2007*
NHIC – Natural Heritage Information Centre
SARA = *Species at Risk Act*

10.6 Significant Natural Heritage Components

Significant Natural Heritage Components under section 2.1 of the Ontario Provincial Policy Statement (2005) are those features that are identified as natural areas that shall be protected for the long term. The following features are identified:

- Significant Habitat for Endangered and Threatened Species
- Significant Wetlands
- Significant Woodlands
- Significant Valleylands
- Significant Wildlife Habitat
- Significant Areas of Natural and Scientific Interest

No Significant Woodlands or Valleylands are found within the study area. Significant forests within the study area are recognized and protected under Area of Natural or Scientific Interest designations and including the Widdifield Forest and the Doule Forest. These forests are protected from cutting as previously identified.

10.6.1 Significant Habitat of Endangered and Threatened Species

Ontario's Provincial Policy Statement 2005 defines Significant Habitat for Endangered and Threatened Species as "…*the habitat, as approved by the Ontario Ministry of Natural Resources, that is necessary for the maintenance, survival and/or recovery of naturally occurring or reintroduced populations of endangered species or threatened species, and where those areas of occurrence are occupied by the species during all or any part(s) of its life cycle*". Section 10.5 provides a discussion of endangered and threatened species within the NBMCA area of jurisdiction.

Of the 15 species listed in Table 10.2, seven are listed as endangered or threatened under the *Endangered Species Act, 2007*. Recovery strategies have been prepared by the Province for three of the seven endangered or threatened species: Peregrine Falcon, Eastern Hog-nosed Snake and Lake Sturgeon. The recovery strategies include areas for consideration in developing habitat regulations for these species.

Significant habitat of endangered and threatened species is considered sensitive information and has not been mapped in this document.

10.6.2 Significant Wetlands

Ontario's Provincial Policy Statement 2005 defines Significant Wetland as "…*an area identified as provincially significant by the Ontario Ministry of Natural Resources using evaluation procedures established by the Province, as amended from time to time*…". Currently, Provincially Significant Wetlands are those wetlands identified as provincially significant by the Province in accordance with the *Ontario Wetland Evaluation System*. Wetlands are ranked by considering biological components, social (e.g., economical, recreational, cultural) components, hydrological components and other special features components such as provincially significant plant and animal species.

There are currently eight Provincially Significant Wetlands within the NBMCA area of jurisdiction as illustrated in Figure 10.5 including Callander Bay Wetland, Upper Chippewa Creek Wetland Complex, Duchesnay Creek Wetland, Gauthier Creek Marsh, La Vase River – Dreany Lake Wetland Complex, Parks Creek Wetland, Rice Bay Wetland, and Upper Wasi River Swamp.

Other wetlands within the NBMCA have been recognized as being locally significant by municipalities. These include Depot Creek, Astorville Wetland Complex and Quae Quae Wetland Complex in East Ferris, and others in, Callander and the Township of Chisholm (NBMCA, 2008 Draft). These wetlands are recognized and managed at a municipal level.

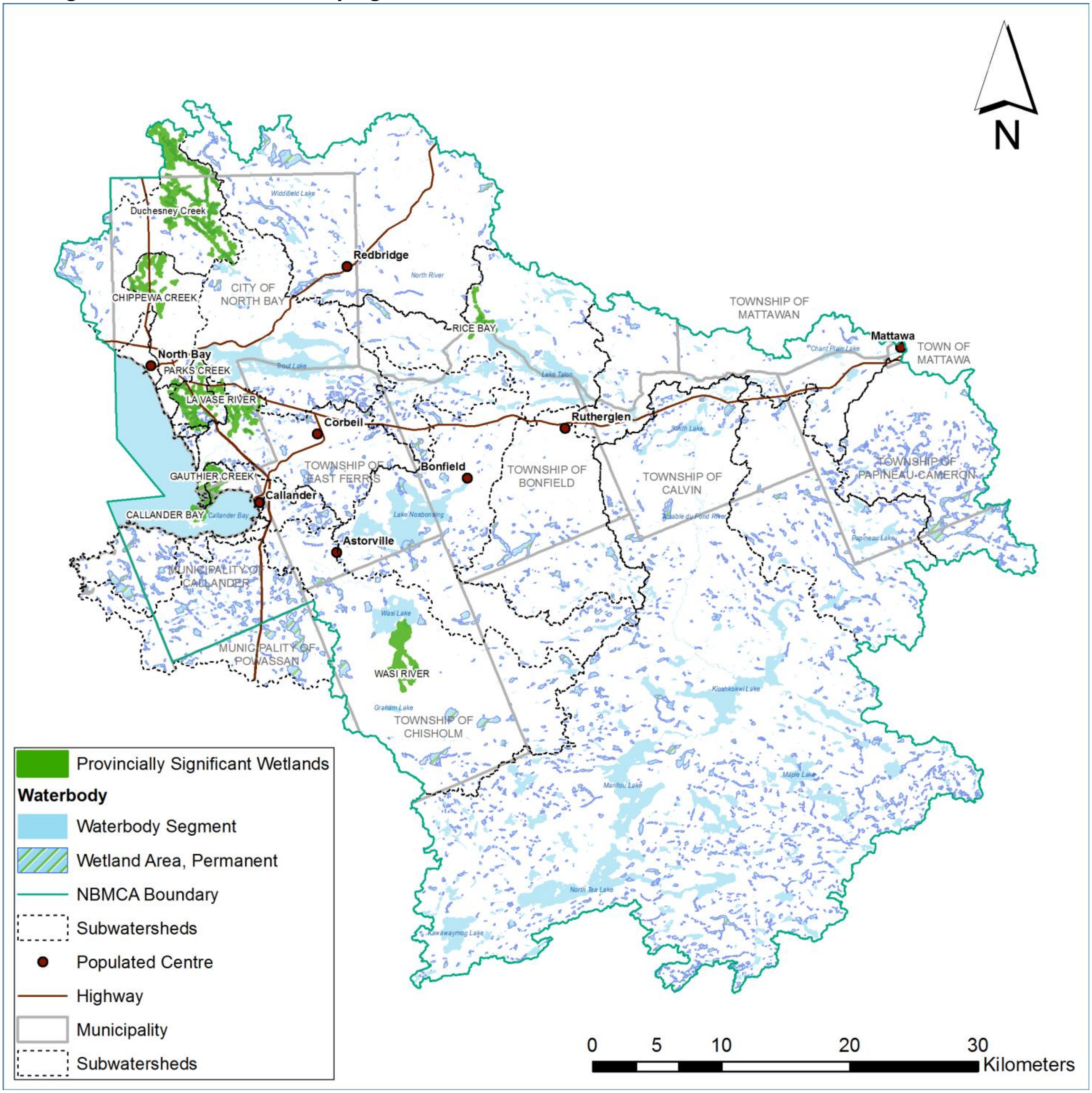
10.6.3 Significant Wildlife Habitat

Wildlife habitat as defined under Ontario's Provincial Policy Statement, 2005 is "…*areas where plants, animals and other organisms live, and find adequate amounts of food, water, shelter and space needed to sustain their populations. Specific wildlife habitats of concern may include areas where species concentrate at a vulnerable point in their annual life cycle; and areas which are important to migratory or non-migratory species*". Wildlife habitat is considered significant under the following definition within the same policy as "*…ecologically important in terms of features, functions, representation of amount, and contributing to the quality and diversity of an identifiable geographic area or natural Heritage System…*"

Significant wildlife habitat is one of the more complicated natural heritage features to identify and evaluate. Providing analysis of significant wildlife habitat within a large study area is a detailed endeavor. However, it can be identified and described in a broader sense. Data determining significant habitat exists under the identification of other natural heritage features mapping. There are four broad categories, identified by the Ministry of Natural Resources' *Significant Wildlife Technical Guide,* (MNR, 2000*)*, that can be used to identify significant habitat: 1) seasonal concentration areas, 2) rare vegetation communities or specialized communities for wildlife, 3) habitats of species of conservation concern, not including habitats for endangered and threatened species, and 4) animal movement corridors.

Seasonal concentration areas are those sites where large numbers of a species gather together at one time of the year, or where several species congregate. The following is a partial list of numerous potential examples: deer yards, amphibian breeding ponds, snake and bat hibernacula, waterfowl staging and molting areas, raptor roosts, bird nesting colonies,

Figure 10.5 Provincially Significant Wetlands within the NBMCA Area of Jurisdiction



shorebird staging areas, and passerine migration concentrations. Only the best examples of these concentration areas are usually designated as significant wildlife habitat. Areas that support a species at risk, or if a large proportion of the population may be lost if the habitat is destroyed, are examples of seasonal concentration areas which should be designated as significant (MNR, 2000).

Rare or specialized habitats are two separate components. Rare habitats are those with vegetation communities that are considered rare in the province. It is assumed that these habitats are at risk and that they are also likely to support additional wildlife species that are considered significant. Specialized habitats are microhabitats that are critical to some wildlife species. The *Significant Wildlife Habitat Technical Guide* (MNR, 2000) identifies a number of habitats that could be considered specialized habitats, such as habitat for area-sensitive species, forests providing a high diversity of habitats, amphibian woodland breeding ponds, turtle nesting habitat, highly diverse sites, seeps and springs. Rare vegetation communities or specialized habitats for wildlife include features such as old growth forest, moose calving areas, specialized raptor nesting habitat and amphibian woodland breeding ponds.

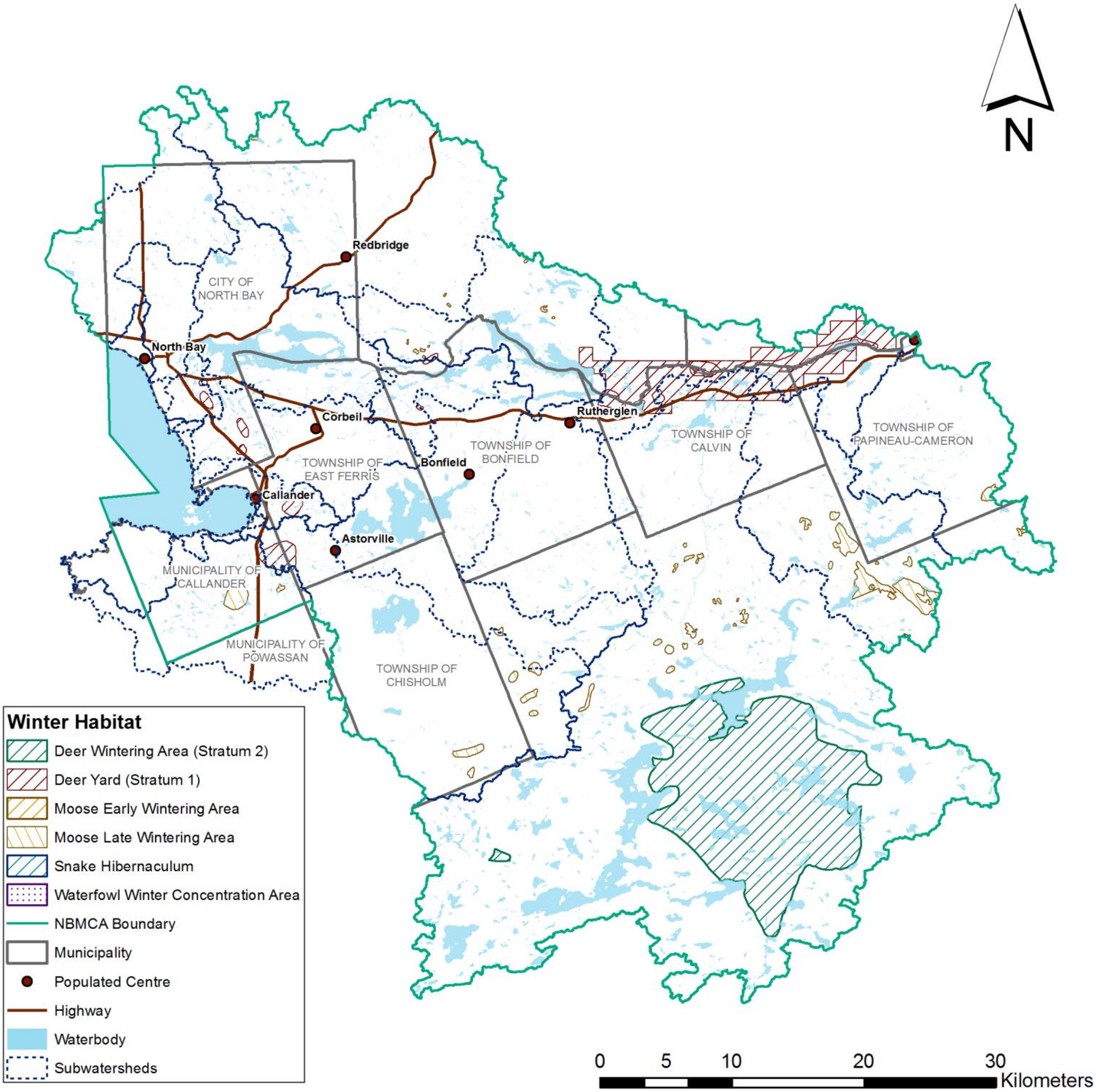
Habitats of species of conservation concern include species that are identified as globally, nationally, provincially, regionally or locally rare and animal movement corridors include linear features such as riparian areas, shorelines, valleys, and anthropogenic corridors. The largest habitat group to be assessed is habitat for species of conservation concern. This includes four types of species: (a) those that are rare; (b) those whose populations are significantly declining; (c) those that have been identified as being at risk to certain common activities; and (d) those with relatively large populations in Ontario compared to the remainder of the globe.

Migration corridors are areas that are traditionally used by wildlife to move to one habitat from another. This is usually in response to different seasonal habitat requirements. Some examples are trails used by deer to move to wintering areas, and areas used by amphibians between breeding and summering habitat.

A review of provincial base mapping provides habitat information based on landform characterizations such as Areas of Natural or Scientific Interest and Provincially Significant Wetlands. Provincial data also shows seasonal concentration areas and specialized wildlife habitat such as deer and moose yards and wintering areas, nesting sites for raptors, herons and others.

Deer yarding and wintering areas are those areas in a landscape that provide the conditions necessary for increased survival rates during the harsher winter season. These areas vary in size, but contain opportunities for access to winter browse on deciduous saplings, protection from the elements within dense stands of coniferous forest, and access to water. A large Deer Wintering Area exists in the south east part of the watershed, predominantly within the Algonquin Provincial Park boundary, as well as yarding areas at the east end of Lake Talon, and on each side of the Mattawa River to its confluence with the Ottawa River to the east. Smaller areas of deer yarding habitat exists on the western side of the watershed near the Wasi and the La Vase Rivers. Deer Yards and Deer Wintering Areas within the NBMCA area of jurisdiction are shown in Figure 10.6. One Moose calving site is indicated within the watershed boundary near

Figure 10.6 Undulate Yards and Wintering Areas within the NBMCA Area of Jurisdiction



Three Mile Lake in Algonquin Park. Late wintering Moose habitat has been identified in several small areas including south of Callander Bay, and sporadically to the north of the northern Algonquin Park Boundary. Moose Late Wintering Habitat and Calving Sites within the NBMCA area of jurisdiction are also shown in Figure 10.6.

Avian nesting sites for raptors (e.g., Bald Eagle, Broadwing Hawk, Osprey) and Great Blue Herons are scattered throughout the NBMCA area of jurisdiction, predominantly within the less developed and more densely forested areas. Known avian nesting sites within the NBMCA area of jurisdiction are shown in Figure 10.7.

As outlined in Section 10.5, eight wildlife species listed as special concern either provincially or federally have been documented within the NBMCA area of jurisdiction (Table 10.2). With the exception of Bald Eagle, significant habitat for these species has not been specifically identified within the NBMCA area of jurisdiction.

10.6.4 Significant Areas of Natural or Scientific Interest

Ontario's Provincial Policy Statement 2005 defines Area of Natural or Scientific Interest as ..."*areas of land and water containing natural landscapes or features that have been identified as having life science or earth science values related to protection, scientific study or education.*" Under this definition, six Life Science Areas of Natural or Scientific Interest and six Earth Science Areas of Natural or Scientific Interest have been identified within the study area:

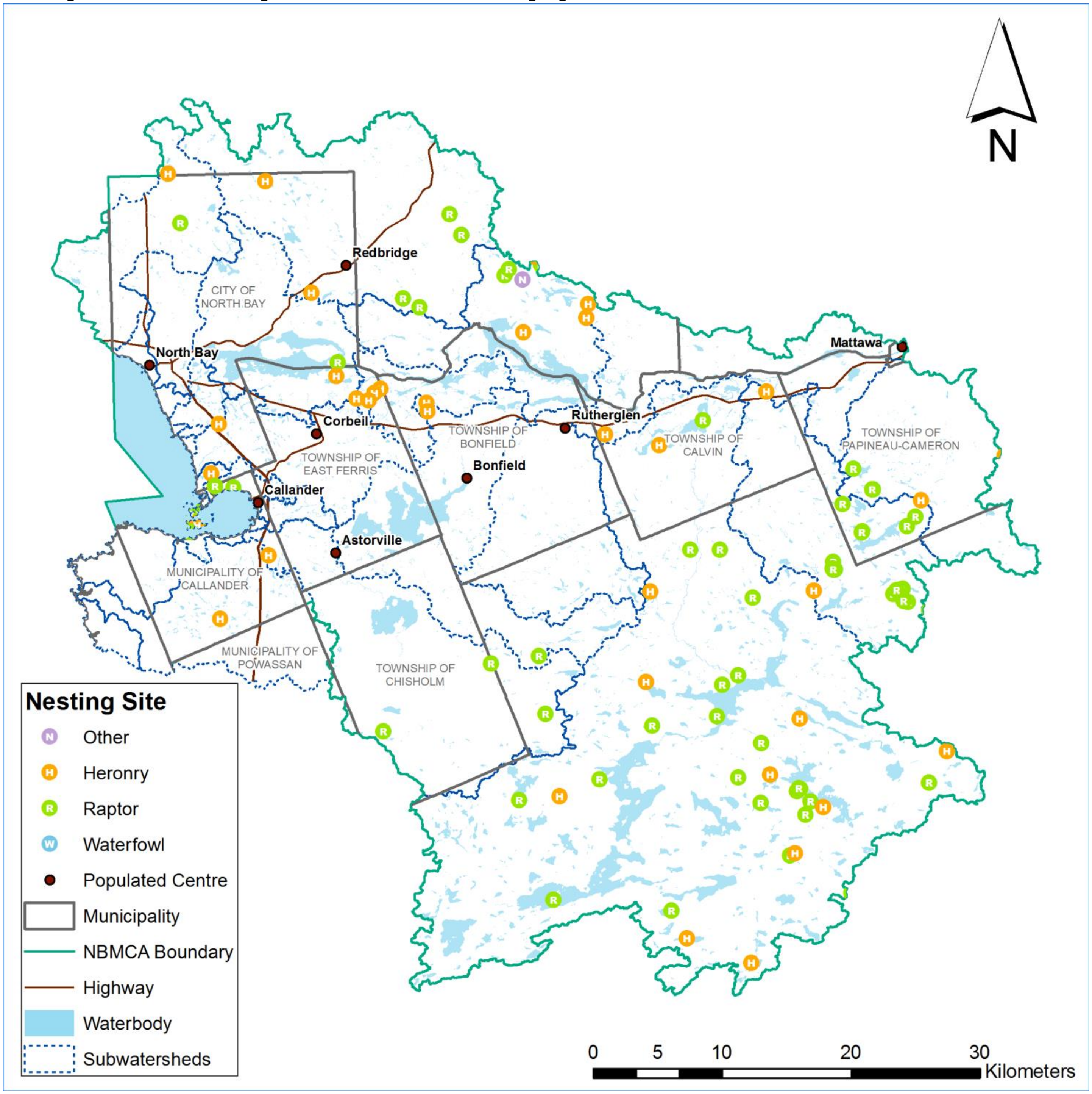
- Life Science Areas of Natural or Scientific Interest:
  - Widdifield Forest (Provincially Significant)
  - Boulter Township (Provincially Significant)
  - Rice Bay Delta-Blue Mountain Complex (Provincially Significant)
  - Sparks Lake Forest (Provincially Significant)
  - Doule Forest (Locally Significant)
  - Balsam Creek Esker (Locally Significant)
- Earth Science Areas of Natural or Scientific Interest:
  - Balsam Creek Ice-Contact Delta (Provincially Significant)
  - Blueseal Creek Hill (Provincially Significant)
  - Boulter Township Esker Complex (Provincially Significant)
  - Graham Hill (Provincially Significant)
  - Genesee Moraine and Fossmill Peatland (Provincially Significant)
  - Rutherglen Shoreline and Kame (Provincially Significant)

The locations of these Areas of Natural or Scientific Interest within the study area are shown in Figure 10.8.

10.7 Invasive Species

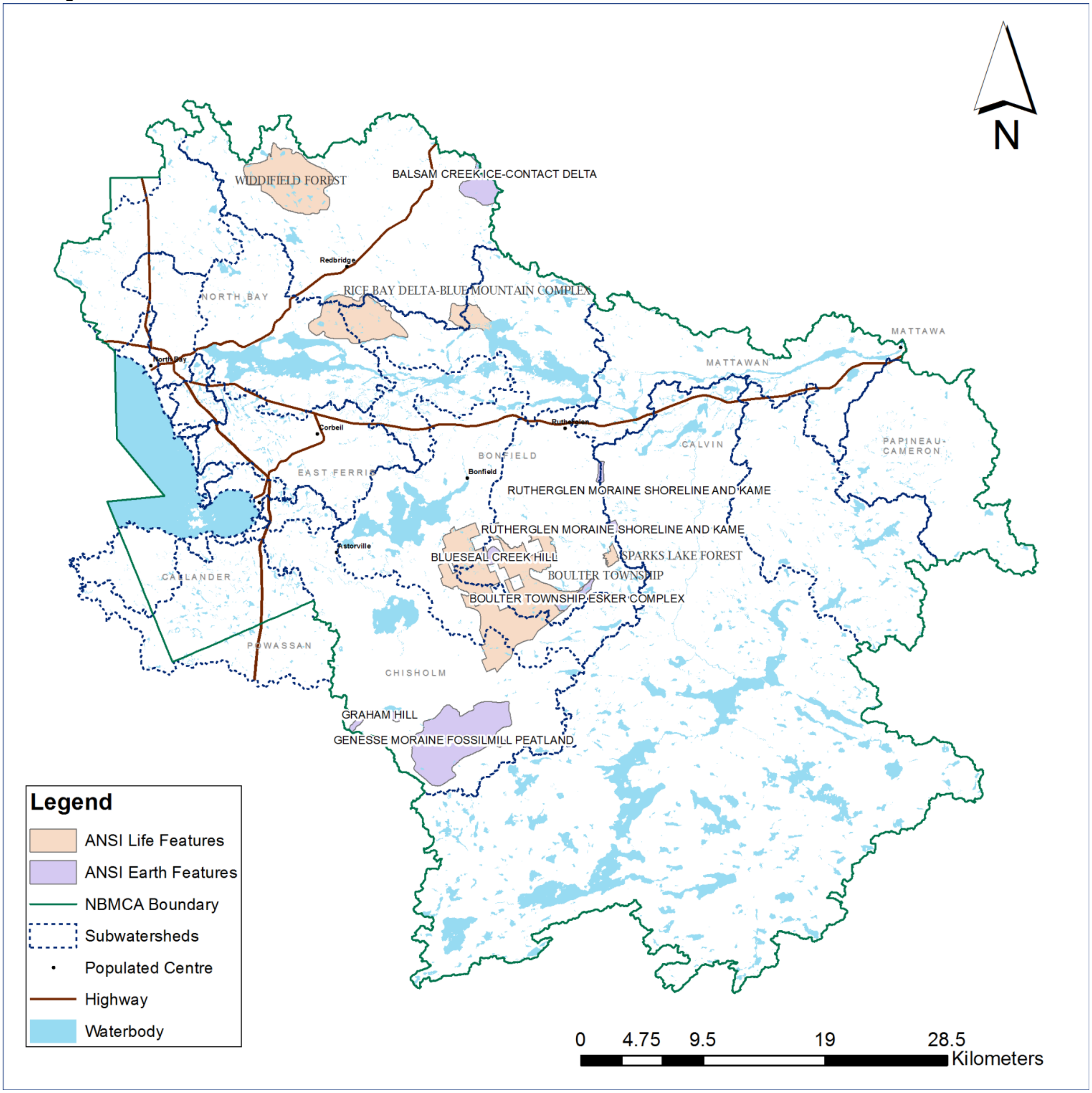
Many plants and animals that are non-native can be a threat to the ecological functions within the NBMCA area of jurisdiction. Invasive species can disrupt food chains, out complete native

Figure 10.7 Nesting Areas and Waterfowl Staging Areas within the NBMCA Area of Jurisdiction



species, introduce parasites and destroy habitat (MNR 2012). Invasive species are spread both intentionally and unintentionally by people and their actions and movements. Introduction of new species to local ecosystems can have costs in terms of biodiversity, as well as economically, as their invasion can have negative consequences to fishing, hunting, forestry, tourism and agriculture (MNR 2012).

Figure 10.8 Areas of Natural or Scientific Interest within the NBMCA Area of Jurisdiction



The North Bay-Mattawa Watershed Characterization report (Draft 2008) reports that there are over 160 non-native species within the Great Lakes watershed. The Ontario Federation of Anglers and Hunters, in partnership with the Ontario Ministry of Natural Resources, tracks invasive species and facilitates awareness and education programs to help stop the spread of these species. A review of the distribution maps indicates that the following species are known to occur in the NBMCA catchments: Purple Loosestrife (*Lythrum salicaria*), Rainbow Smelt (*Osmerus mordax*) and Spiny Water Flea (*Bythotrephes longimanus*). The NBMCA (2008) report indicates Zebra Mussel (*Dreissena polymorpha*) as an invasive species recorded in the larger source protection area. Whether these species have been recorded in the NBMCA area of jurisdiction or not, these and other species known to occur in Ontario, should be considered in monitoring and mitigation programs throughout the NBMCA. It is noted that the mapping on the Ontario Federation of Anglers and Hunters website indicates that no major lakes in the watershed have been monitored historically up until 2011 (OFAH 2012).

A more recent invasive species recorded in the NBMCA area of jurisdiction is Giant Hogweed (*Heracleum mantegazzianum*). This species was recorded just south of the watershed boundary in the Town of South River in 2010 (Hartill, 2010) and has been reported growing in the North Bay area. This invasive weed, originally from Asia, can be a serious health hazard as its sap can cause burning when it comes into contact with skin.

Japanese Knotweed (*Fallopia japonica*) has also been reported within the NBMCA area of jurisdiction. This species is a woody perennial plant that can be difficult to control once established.

10.8 Summary of Background Data/Historical Documentation

The Drinking Water Source Protection Report (NBMCA 2008) gives an overview of vegetation, wildlife, species at risk, and other ecological data and conditions across the watershed. In addition, many reports have been prepared over the years specific to smaller catchments or subwatersheds throughout the North Bay-Mattawa Conservation Authority area of jurisdiction. There are 20 subwatershed planning units and a summary of the ecological inventory information available for each subwatershed is provided in Table 10.3.

Table 10.4 summarizes ecological data according to subwatershed management units and indicates if natural heritage features are present. This list has been assembled from many of background reports that have been listed in the Bibliography. Fish, wildlife and vegetation information have been obtained from provincial sources including data from the Natural Heritage Information Centre and Department of Fisheries and Oceans.

Table 10.3 Summary of Background Data – Historical Reports - Review

Subwatershed	Location/Drainage	Wetland/Vegetation Studies	Fish/Wildlife Studies
Duchesnay Creek	North of North Bay, drained by the Duchesnay River into Lake Nipissing	-Duchesnay Creek Wetland (1996)	-no
Chippewa Creek	Drains through the City of North Bay into Lake Nipissing	-Chippewa Creek Watershed Management Study (1996) -Chippewa Creek Watershed Forest Description (1994) -Upper Chippewa Creek Watershed Complex Wetland Evaluation (1995) -Orsys Swamp Wetland Evaluation (1993)	-Chippewa Creek Watershed Management Study (1996)
Parks Creek	Within the City of North Bay and flows into Lake Nipissing	-The Parks Creek Environmental Assessment (NBMCA, 1990) -Parks Creek Watershed Environmental Study Report (1992) -Parks Creek Wetland Complex (1993)	-The Parks Creek Environmental Assessment (NBMCA, 1990) -Parks Creek Watershed Environmental Study Report Exhibit C – Biological Background Data (1992) Parks Creek Watershed Flood Damage Reduction Study (1992)
Jessups Creek	Within the City of North Bay and flows into Lake Nipissing	-Jessups Creek Subwatershed Management Plan - Jessups Creek Wetland (1993)	-Jessups Creek Subwatershed Management Plan
La Vase River	South of Trout Lake and flows into lake Nipissing	-La Vase River – Callander Bay Study(1989) -La Vase River Watershed Inventory Document – Final Report (1997) -La Vase River Watershed Management Study (1997) -La Vase River-Dreany Lake Wetland Complex Evaluation -Cooks Creek Wetland Evaluation (1998) -Bertha Road Wetland Evaluation (1997) -Centennial Crescent East Wetland Complex Evaluation (1998) -Nipissing Junction Wetland Complex Evaluation -Voyer Road Wetland Complex (1995) -Derland Road Wetland Complex (1995) -Taillefer Road Wetland Complex (1997) -La Vase Portage Wetland Complex (1995) -Voyer Road Wetland Complex (1995)	-La Vase River – Callander Bay Study(1989) -La Vase River Watershed Inventory Document – Final Report (1997) -La Vase River Watershed Management Study (1997)

Table 10.3 Summary of Background Data – Historical Reports - Review

Subwatershed	Location/Drainage	Wetland/Vegetation Studies	Fish/Wildlife Studies
Lake Nipissing Shoreline/North Bay	Within the City of North Bay and flows into Lake Nipissing	- Gauthier Creek Marsh Wetland Evaluation (1992)	- Interim Fisheries Management Plan for Lake Nipissing for 2007 to 2010
Burford Creek	East of Lake Nipissing and flows into Lake Nipissing via Callander Bay	-no	-no
Callander Bay/ South Shore	Perimeter of Callander Bay flowing into Lake Nipissing	-Callander Bay Wetland Complex Inventory (1988, 1993) -Astorville Road Wetland Complex Evaluation (1995)	-Callander Bay Wetland Complex Inventory (1988, 1993)
Windsor/Bear/ Boulder	South of Callander Bay flowing into Lake Nipissing	-Fish Bay Wetland Evaluation (1995)	
Wistiwasing River	Flows north easterly into Callander Bay and lake Nipissing	-The Wasi Watershed Wetland Inventory Report (1986) -Graham Creek Study (1986) -Wasi lake Dam Removal Project Evaluation Report -Chiswick Creek Wetland Complex Evaluation (1997) - Upper Wasi River Swamp Wetland Evaluation (1993)	-The Wasi Watershed Wetland Inventory Report (1986) -Graham Creek Study (1986) -Wasi lake Dam Removal Project Evaluation Report -Wasi River Management Study – Background Technical Report #3, Fisheries Resources (1986)
North River	Northern most subcatchment flowing into talon Lake and the Mattawa River	-Background Information for the Otter lake Master Plan (1979)	-Background Information for the Otter lake Master Plan (1979)
Trout Lake	East of North Bay and flows into Mattawa River	-Environmental Baseline Study of CFB North Bay (1986) -Trout Lake Watershed Management Study – Part A- Existing Watershed Conditions (1988) -Macpherson Park Plan (1986) -Johnston Road Wetland Evaluation (1992) -La Vase Portage Property Wetland Complex (1997) -Ski Club Marsh Wetland (1993) -Tower Drive Wetland Complex (1993)	-Environmental Baseline Study of CFB North Bay (1986) -Trout Lake Watershed Management Study – Part A- Existing Watershed Conditions (1988) -Macpherson Park Plan (1986) -Class Environmental Assessment to Service Anita Avenue, North Bay, Ont. (1993) -Inventory Information for the Trout Lake Watershed (1985)
Turtle Lake	Between Trout and Talon Lakes and flows into the Mattawa River	-Trout/Turtle Tier Two Subwatershed Stress Assessment and Tier Three Local Area Risk Assessment (2010)	-no

Table 10.3 Summary of Background Data – Historical Reports - Review

Subwatershed	Location/Drainage	Wetland/Vegetation Studies	Fish/Wildlife Studies
Kaibuskong River	Centrally located, dominated by lake Nosbonsing and flows into Mattawa River	-Nosbonsing Watershed Study (1985) -Lake Nosbonsing Watershed Management Plan (1989) -Depot Creek Wetland Evaluation (1993) - Astorville Road Wetland Complex (1995) -Astorville Wetland Complex Evaluation (1994) - Lake Nosbonsing South Bay Wetland Evaluation (1994) -Quae Quae Wetland Complex (1994) -Southshore Road Wetland (1995)	-Nosbonsing Watershed Study (1985) -Lake Nosbonsing Watershed Management Plan (1989) -Lake Nosbonsing Watershed Management Plan – Inventory and Analysis (1989)
Lake Talon	North east part of watershed and flows into Mattawa River	-Rice Bay Wetland Evaluation (no date) -Lake Talon Shields Point Wetland (1994)	-no
Sharpes Creek	Centrally located and flows into Mattawa River	-Blueseal Creek Wetland (1998)	-no
Amable du Fond	Largest subcatchment, flows into Mattawa River	-no	-Fish Habitat Reclamation Study Amable du Fond River (1982) -Smith and Crooked Chute Lake Shoreline Management Study (1987)
Pautois Creek	Eastern part of watershed and flows into Mattawa River	-Papineau Lake Master Plan (1979)	- Papineau Township 1988 Lake and Stream Studies to Support a Brook or Rainbow Trout Population (1988) -Fish Habitat Reclamation Study patois Creek (1982)
Boom Creek	Eastern most part of watershed flows into Mattawa River	-Crown Land Use Policy Atlas Policy Report: C124 Boom Creek Old Growth Forest, MNR, 2008	- Papineau Township 1988 Lake and Stream Studies to Support a Brook or Rainbow Trout Population (1988)
Lower Mattawa	Along shore of Mattawa River	-no	- Papineau Township 1988 Lake and Stream Studies to Support a Brook or Rainbow Trout Population (1988)

Table 10.4 Ecological Features and Protected Areas within the NBMCA Summarized on Subwatershed Basis

	Significant Natural Heritage Features						Protected Natural Areas	
Subwatershed	**Provincially Significant Wetland**	**Area of Natural or Scientific Interest**	**Nesting Sites**	**Deer Yarding or Wintering Areas**	**Moose Late Wintering Area or Calving Site**	**Important Waterfowl Staging**	**Provincial Parks Conservation Reserves**	**Conservation Areas / Natural Environment Areas**
Duschesnay Creek	Yes		Yes					
Chippewa Creek	Yes							Yes
Parks Creek	Yes			Deer Yard				Yes (2)
Jessups Creek				Deer Yard				
La Vase River	Yes		Yes	Deer Yard				Yes (2)
Lake Nipissing Shoreline/ Callander Bay	Yes		Yes					Yes (2)
Windsor/ Boulder/ Bear Creek			Yes		Yes	Yes		Yes
Burford Creek				Deer Yard				
Callander Bay/ South Shore	Yes		Yes				Yes	
Wistiwasing River	Yes	Yes	Yes	Deer Yard	Yes			
North River		Yes	Yes				Yes	
Trout Lake		Yes	Yes				Yes	
Turtle lake			Yes				Yes	
Kaibuskong River		Yes (2)		Deer Yard			Yes	Yes
Lake Talon	Yes	Yes	Yes	Deer Yard			Yes	Yes
Sharpes Creek		Yes (2)	Yes					Yes
Amable du Fond River		Yes (2)	Yes	Deer wintering	Yes/Calving		Yes (2)	Yes
Pautois Creek			Yes	Deer Yard	Yes			Yes
Boom Creek			Yes		Yes			Yes
Lower Mattawa River			Yes	Deer Yard			Yes (2)	Yes

10.9 Ecological Significance and Data Gaps

The NBMCA has been mandated pursuant to the Ontario *Conservation Authorities Act "…to establish and undertake, in the area over which it has jurisdiction, a program designed to further the conservation, restoration, development and management of natural resources other than gas, oil, coal and minerals*". Regional ecological resources and natural heritage features are important natural resource features that the NBMCA must have regard to and they share a responsibility with the Province and member municipalities to protect and conserve such features. Watershed management planning provides a tool to guide the management of natural resources. Identification and description of the ecological and natural heritage features of the NBMCA area of jurisdiction will assist in the following watershed management activities:

- identifying changes in ecological characteristics over time
- identifying priorities for protection, restoration or enhancement
- guiding planning initiatives

Ecological data is collected through a variety of mechanisms, including provincial resource management inventories, wetland evaluations, field inventories to support development applications, and reports from local field naturalists. Work completed to date has delineated many diverse environments and ecological characteristics which have allowed regulators to identify significant or unique features that are afforded some level of protection through a variety or land classifications/designations. Efforts have been made to compile and synthesize as up-to-date an assessment as is possible within the NBMCA.

Data is derived from reports available through the NBMCA or from provincial databases; however ecological systems are dynamic while the reports that describe them provide a snapshot in time. Some of the reports and data available for some areas are relatively old and have not been updated. There is generally more information available for areas that are under more development pressure, than for those that are less developed. For example, the NBMCA has thousands of wetlands within its jurisdiction, of which only 31 have been evaluated.

Priorities in research and data gathering often change following a change in policy or regulation. Species at risk or that pose a risk have also been identified but their occurrence frequency and location is often obscure. Many of the records available for species at risk are outdated (i.e., greater than 20 years old) and when new species are added to the list of Species at Risk in Ontario, there can be a time lag before a database of records is established for those species. Critical habitat areas for species at risk largely remain unconfirmed. Overall, important natural and ecologic features within the NBMCA have been subject to good stewardship; however, additional data may be required to accurately assess current trends and future impacts from stress factors.

11.0 Cultural Heritage and Archaeology

Archaeological and cultural heritage features within the NBMCA have been identified in the first Watershed Plan Background Report (1982) and further research has been carried out as part of the Parks Creek Flood Damage Reduction Study (1992) and La Vase River Watershed Management Study (1997). The central portion of Mattawa River was designated as a Canadian Heritage River System in 1988 and this designation was extended to the mouth of the Mattawa River as well as to include the La Vase Portages in 1999 (Canadian Heritage River System web site, accessed in November 2012).

Most cultural features and registered archaeological sites within the NBMCA are closely associated with waterways. Registered archaeological sites within the NBMCA are largely prehistoric and early historic sites associated with the use of the Mattawa River as a transportation corridor. Prehistoric travel and use of this river system is interpreted from prehistoric stone tools and debitage, pottery and pottery fragments, stone hearths and calcined bone fragments or from physical alteration of the landscape such as La Port de L'Enfer (CbGr-1) which is an red ochre mine site (Wright, 1974). While no prehistoric settlement sites have been confirmed within the NBMCA there is evidence, given the volume of artifacts found, to suggest that the Lake Talon area may have been used seasonally or annually for habitation possibly when the Great Lakes outlet was active. Large private artifact collections from this region are held by museums in North Bay and Mattawa. Heritage information for other river systems and watersheds including the upper Amable du Fond in Algonquin Park is sparse.

Portages along the Mattawa River are important cultural features within the NBMCA that are protected by the Mattawa River Provincial Park designation. The NBMCA is actively working to protect the La Vase Portages which are not within provincial park boundaries. There are also a number of forestry related heritage features from the lumbering era (including the abandoned Booth railway, saw mill sites, remnants of old wooden dams, sluiceways and log slides, cribs and anchor bolts) along waterway systems that are not protected as registered archaeological sites. Acidic soils have claimed most perishable artifacts within the region.

The precise location of registered archaeological sites within the NBMCA area of jurisdiction is considered sensitive and is not presented. Heritage sensitivity mapping does not exist.

As well as the banks and shores of exiting waterways, the NBMCA watershed has a number of natural heritage features that have a higher probability of harbouring archaeological evidence. Now abandoned outlet channels and shorelines of post glacial lakes have higher archaeological probabilities. Evidence suggests that prehistoric indigenous people were present in this part of

Ontario shortly after glaciation ended. Research has confirmed that old outlets and drainage corridors in the Parks Creek watershed were used prehistorically for water transportation (Parks Creek Environmental Assessment, 1990). Further research is needed to reconstruct and date other outlet features and post glacial lake margins to better develop an understanding of their significance and potential to have archaeological significance. Some features such as the Foss Mill Outlet and abandon beaches south of Graham Lake in Chisholm and Powassan have been recognized and protected by ANSI designations. Also Forest Management Plans for the Area have identified Native Heritage Values within Forest Management Units however information is considered confidential and has not been made public.

The North Bay Escarpment Resource Inventory and Digital Mapping Study (Totten Sims Hubicki, 1998) identified the following criteria for determining high potential areas along the escarpment:

- Glacial lake beaches from 7,000 to 9,000 years ago on the escarpment that may have been used by early man some 7 – 9 thousand years ago.
- Old fields (now overgrown) and farmsteads (foundations) from the pioneer settlement era circa 1880 – 1900, railway lines, wagon roads, etc.
- Viewpoints/lookouts that could be used by Native Peoples for fasting and vision quests.
- High potential areas (based on official Ministry of Tourism, Culture and Sports parameters) to contain presently unknown heritage sites
- New sites such as the prehistoric quartz crystal quarry site.

The above referred to Provincial screening criteria for determining in site has high probability of harbouring heritage features include:

- Within 300 m of water body including beach ridges and ancient shorelines
- Presence of prominent topographic features such as knolls, eskers
- Presence of sandy soils in an area dominated by bedrock or clay
- Presence of distinctive land formations including mounds, waterfalls, peninsulas
- Known burial sites
- Presence of food or scarce resource features such as traditional fishing areas, agricultural/berry extraction
- Closeness to Euro-Canadian settlement features
- Closeness to historic transportation routes including historic roads, trail and portages

In addition to archaeological resources, aspects of cultural heritage described in the most recent Provincial Policy Statement issued by the Province of Ontario (2005) may include built heritage resources, cultural heritage landscapes and protected heritage property. Examples of these can include cemeteries, churches, and distinguished buildings, sites of historical buildings or heritage land uses. Some watershed municipalities are actively identifying and preserving significant built cultural heritage features within their jurisdiction. Other than features associated with waterways, cultural heritage features and landscapes are rarely in conflict with watershed management activities.

11.1 Cultural Heritage Significance and Information Gaps

Archaeological and cultural heritage information for study area is restricted to existing waterways. The study area has a rich but largely unexplored quaternary history with many ancient shorelines, outlets and related drainage features created in the formation and evolution of the Northern Great Lakes. Occupation of the ancient Great Lake is well documented in other regions. Criteria suggested for the North Bay escarpment should be expanded to apply on a regional basis and for more recent time periods. These features require further research and should be mapped and assigned an appropriate cultural heritage probability ranking. Logging era features and other built heritage resource features should also be inventoried, assessed and protected, if warranted.

12.0 Settlement, Land Use and Land Cover

12.1 Introduction

The following sections characterize land use and settlement patterns within the NBMCA area of jurisdiction. The assessment includes a brief accounting of events that led to settlement within the NBMCA area of jurisdiction as well as the updating of demographic information, presentation of information on relevant first nations land claims and identification of MTO plans for improving watershed highways. Existing land uses within the NBMCA are examined through presentation of Official Plan schedules and policies of individual municipalities. Recent trends in land use have been determined using GIS tools to compare two recent time periods to detect changes in land use and vegetative cover. Future growth areas have been determined from interviews with municipal planning staff. Overall watershed growth and land use trends are summarized at the conclusion of this section.

For watershed management strategies to be more effective, an greater understanding of watershed landscapes in term of social and demographic characteristics as well as how land uses are evolving are important factors. The following sections attempt to characterize watershed social, demographic and land use characteristics with a focus on activities that are most influential or affected by the NBMCA mandate and areas of responsibly.

12.2 Watershed Settlement

A detailed account of prehistoric and early historic periods for the NBMCA area of jurisdiction have been documented in past plans and studies and have not been reproduced in this report. Readers are directed to Parks Creek Watershed Flood Damage Reduction Study Exhibit D:

Archaeological Background Report, Settlement Surveys Ltd in Association with Totten, Sims, Hubicki Associates, Sept, 1992 (available in the NBMCA library) which provides a detailed accounting of the regions prehistoric and early historic periods. Known archaeological sites and historic features are discussed in Cultural Heritage and Archaeology section above. Advancements in the understanding of first nation histories and occupational areas/land claims are actively being researched by First Nation communities and negotiated with senior levels government. Current land claims in the region are discussed below. Several active First Nation communities are located in the vicinity of NBMCA area of jurisdiction. They include the Nipissing and Dokis First Nation communities which are both situated on the shores of Lake Nipissing as well as the Antoine and Mattawa/North Bay Algonquin First Nations which are base in or near Mattawa. These communities existed at the time of settlement. Metis Nation of Ontario Council's exist in both North Bay and Mattawa. Prehistoric and early historic information can be updated when land claim documentation becomes available.

The continuous settlement of non-aboriginal populations in the area started with the arrival of railway in 1882 (Southcott, 2003). With the railway also came the telegraph and the means to more rapidly communicate with the outside world. In 1881 the Canadian Pacific Railway purchased and extended the Canadian Central Railway up the Ottawa valley (Kennedy, 1961). It reached Mattawa in 1882 and connected to its mainline being constructed west of the Town of Bonfield (Mattawa-Bonfield Economic Development Corporation Web Site accessed in November 2012). The arrival of the railway opened the region to government sponsored settlement (Kennedy 1961) and the development of railway towns (Southcott, 2003). Prior to the railway, settlement and communications were inhibited by a general lack of easy access which was primarily dependent water transportation.

In terms of interests that led to the settlement of the region; continental exploration, Christianization of First Nation peoples and the quest for furs first drew the first Europeans into the study area. Brule and Champlain discovered the principle trade route of the Huron in the early 17th century which followed the Nipissing Passageway (through Lake Nipissing and the Mattawa River) and linked to the Upper Great Lakes. Due to its directness and remoteness from Iroquois threats, this route became a principle fur trade supply route for the French and subsequently for the North West Company which operated out of Montreal. The significance of this route lasted almost two centuries.

The dominance of the fur trade in the study area as an economic force began to wane in 1821 when the Hudson's Bay Company absorbed the North West Company's trading areas and shifted supply routes to Posts on Hudson Bay. The importance of the supply route through the Nipissing Passageway was also affected by the opening of the Erie (1825) and Rideau (1832) Canals. These factors relegated the Mattawa River corridor to a secondary trade route after 1821 and resulted in an economic downturn in the area (Kennedy, 1961). The earliest reference to settlement in the NBMCA was the establishment of Mattawa House by the Nor'Westers at the junction of the Mattawa and Ottawa Rivers in 1784 (Canadian Heritage River System, 2005).

By the 1850's the timber industry was moving up the Ottawa River valley towards Mattawa in a quest for prime old growth species such as White Pine which were squared and exported to Europe. As highly sought old growth species were depleted, annual harvests advanced deeper into Ottawa River system and by the 1870's other species were being harvested to supply domestic (but still remote) lumber markets (Canadian Heritage River System, 2005). Mattawa was a vibrant lumbering depot and supply center when the railway reached it in 1882 (Ontario Heritage Trust Website accessed in November 2012) which already had steamboat service up the Ottawa River (Canadian Heritage River System, 2005). Mattawa was the principle supply center for settlement and economic development in northeastern Ontario and northwestern Quebec when the area was first settled. Study area waterways were also already significantly affected by the depletion of the old growth forest and by the construction of wooden dams and sluiceways used to float the timber harvest to market each year. J R Booth even constructed an independent railway between Wasi Falls on Lake Nipissing and Lake Nosbonsing to move timber over the major Great Lakes divide to reach his mills on the Ottawa River (Coons 1978).

Settlement was immediately preceded by the survey of most area townships in the late 1870's or early 1880's. Surveyors, in field notes, describe scattered settlers and the existence of random saw mills which were being set up to supply the coming railway (NBMCA 1982). Mattawa, the oldest community within the NBMCA, was endowed with a permanent Hudson Bay Post in 1838. Permanent settlement grew up around the post and at other nearby communities which sprang up along the Ottawa River. Halloran (1971) reports that by 1871 1,791 people were residing in Nipissing District. Most people at the time lived along the Ottawa River. Interior communities including North Bay did not exist until the early 1880's when railway preconstruction activity began ramping up. Some settlement had begun on the south shore of Lake Nipissing after the Nipissing Colonization Road was extended from the south to Nipissing in 1875.

The railways arrival started an era of rapid change which is responsible for most of the clearing and settlement now found across the central NBMCA area of jurisdiction. The railway was operating to Mattawa by early fall of 1882; by November it had reached North Bay and by the spring of 1883 regular rail service was being offered to Sturgeon Falls. With land patent availability being promoted and with improved access and communications; regional settlement was relatively swift. Between 1882 and 1895 most of the patented land within the NBMCA was claimed, cleared and put into agricultural production. Between 1881 and 1895 the population of Nipissing District soared from 1,959 to 13,020 (Halloran, 1971). This population was largely agricultural based but businesses where established at whistle stops to service the new comers and the railway. Existing land ownership classes within the NBMCA are illustrated in Figure 12.1.

Dates of the opening of major transportation routes and significant events that shaped settlement patterns and the economy of the NBMCA watershed in its formative years are presented in Table 12.1.

Table 12.1 Transportation Routes and Historic Events that have influenced NBMCA Settlement Patterns

1875 – Nipissing Colonization Road opened between Rosseau and Village of Nipissing
1882 – Completion of the Canadian Central/Canadian Pacific Railways through the watershed
1886 – Grand Trunk Railway opened to Nipissing Junction
1893 – Formation of Algonquin Provincial Park which limited further development
1894 – Construction of the Lake Temiscamingue Colonization Railway north of Mattawa
1903 – Temiskaming and Northern Ontario Railway construction began (now ONR)
1915 – Completion of Canadian National Railway through the watershed
1921/22 – Kings Highway (Highway 11) reaches North Bay from the south
1923 – 27 – Ferguson Highway (Highway 11) built between North Bay and Cochrane
1933 – Construction of Trans-Canada Highway through the Watershed (Highway 17)
1934 – Birth of the Dionne Quintuplets started Tourism in the Region

12.3 First Nation Land Claims

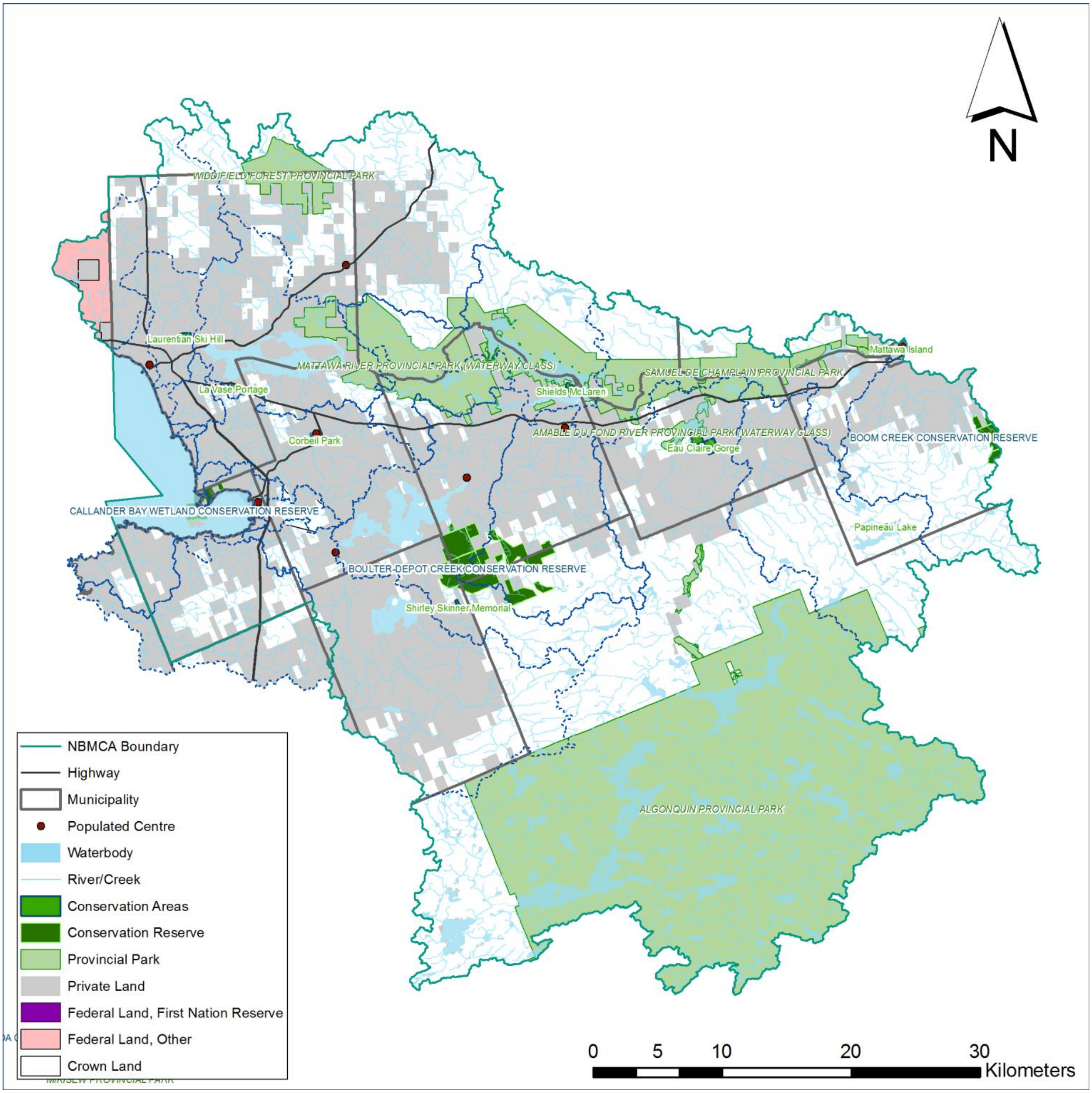
12.3.1 Algonquins of Ontario Land Claim

Algonquin petitions to the Crown seeking recognition and protection for Algonquin land and other rights date back to 1772. In 1983, the Algonquins of Pikwàkanagàn First Nation (known at the time as the Algonquins of Golden Lake) commenced the land claim by formally submitting the most recent petition with supporting research to the Governments of Canada in 1983 and the Government of Ontario in 1985. The Province of Ontario accepted the claim for negotiations in 1991 and the Government of Canada joined the negotiations in 1992.

Today, the Algonquins of Ontario (AOO) are comprised of ten Algonquin community located across the Settlement Area. These include the Algonquins of Pikwàkanagàn First Nation and the Algonquin communities of Antoine, Kijicho Manito Madaouskarini (Bancroft), Bonnechere, Greater Golden Lake, Mattawa/North Bay, Ottawa, Shabot Obaadjiwan (Sharbot Lake), Snimikobi (Ardoch) and Whitney and Area.

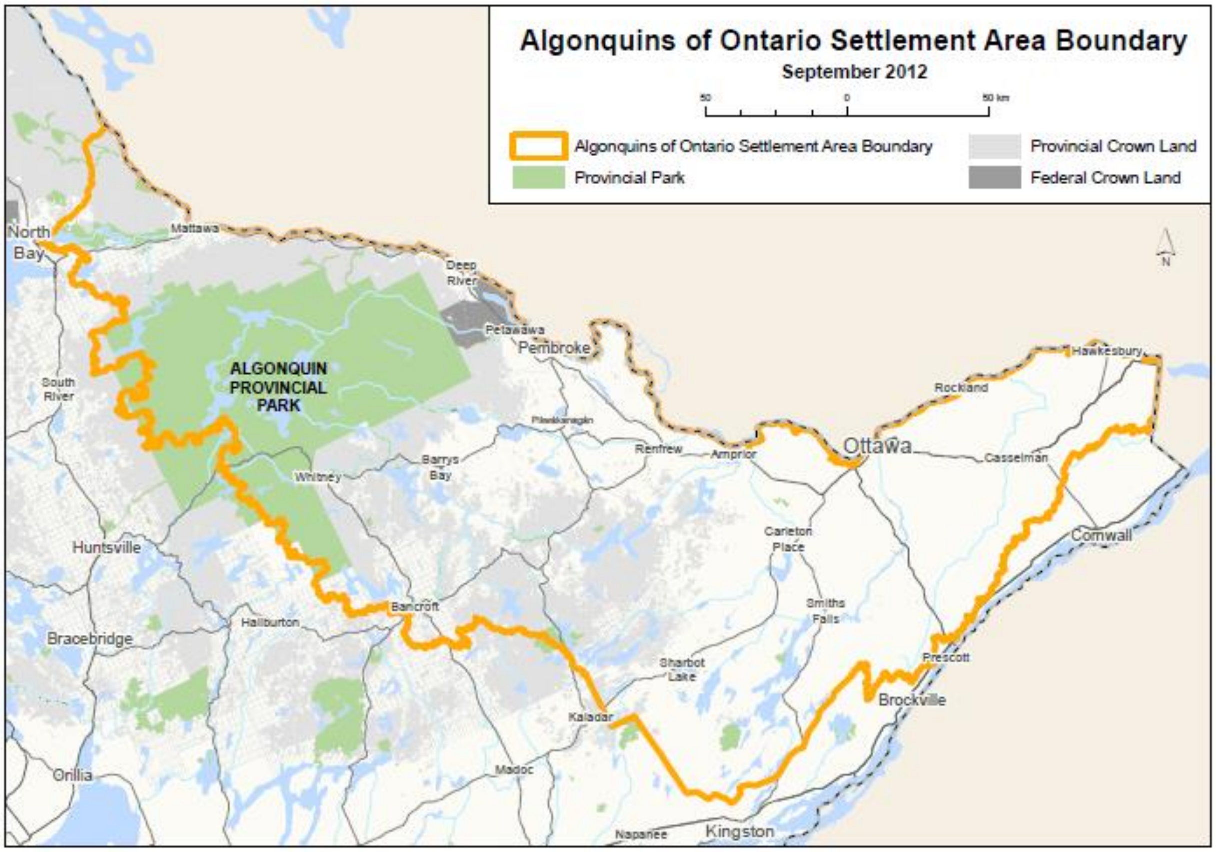
The Algonquins of Ontario claim is the largest and most complex land claim under active negotiation in Ontario covering an area of 9 million acres within the watersheds of the Kichisippi (Ottawa River) and the Mattawa River in Ontario. This unceded territory, referred to as the Settlement Area, covers most of eastern Ontario including CFB Petawawa, the National Capital Region and much of Algonquin Park. More than 1.2 million people live and work within the

Figure 12.1 Land Ownership Classes within the NBMCA Watershed



Settlement Area. There are 85 municipal jurisdictions fully or partially located within the Settlement Area, including 76 lower and single tier municipalities and 9 upper tier counties. The land claim area and settlement lands selected by the Algonquins of Ontario are presented in Figure 12.2. Settlement lands within the NBMCA watershed are illustrated in Figure 12.3.

Figure 12.2 Area Affected by the Algonquin of Ontario Land Claim



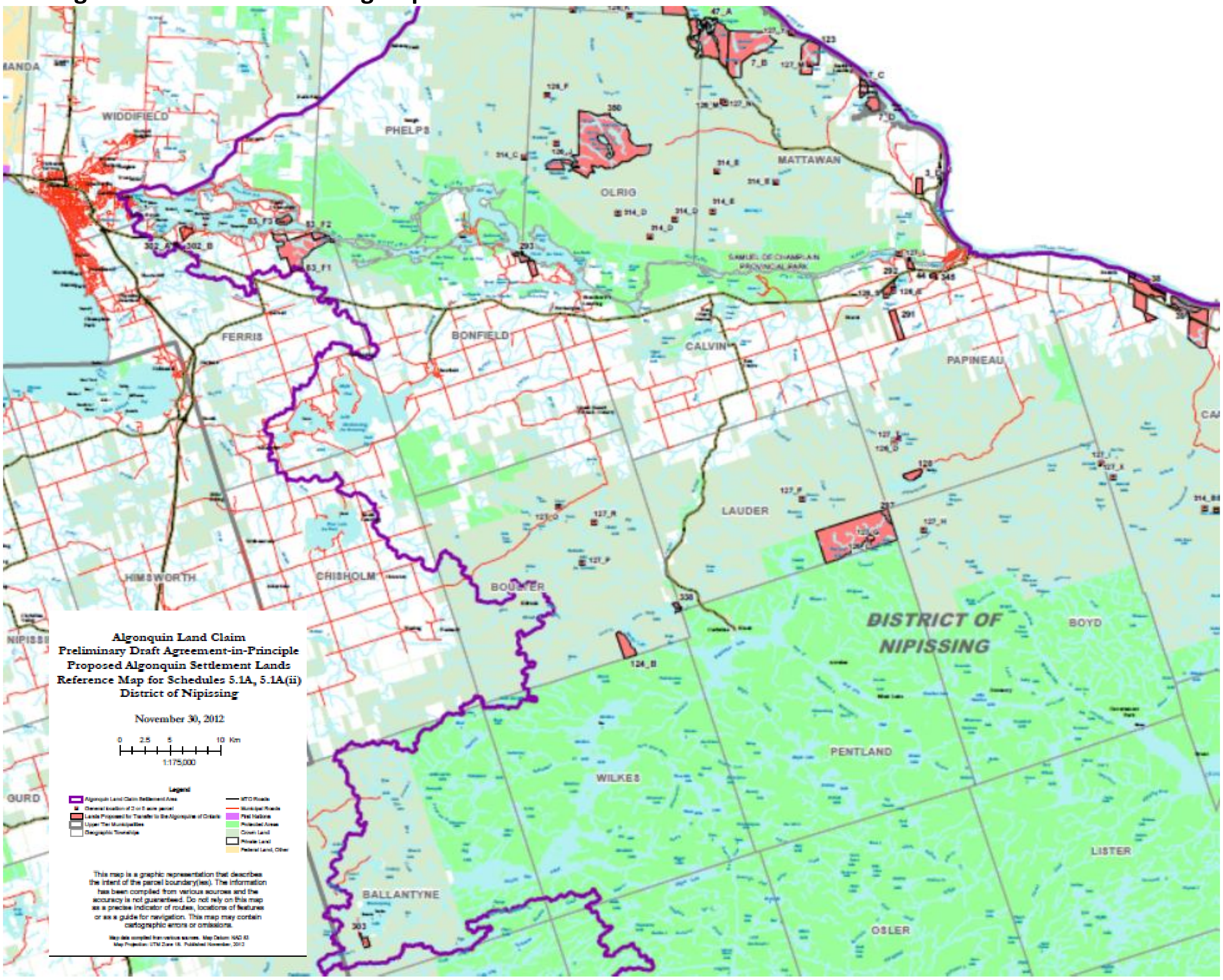
Source: Ontario Ministry of Aboriginal Affairs Web Site, 2013

Overview of the Preliminary Draft Agreement-in-Principle

On December 13, 2012, the Preliminary Draft Agreement-in-Principle (AIP) was released for public review. The Preliminary Draft AIP is a culmination of many years of negotiations between the Algonquins of Ontario, Canada and Ontario and proposes the following elements:

- $300 million capital transfer to the Algonquins of Ontario
- Transfer of not less than 117,500 acres of provincial Crown land to one or more Algonquin Institutions. This lands package consists of more than 200 parcels of land, referred to as Settlement Lands, ranging in size from a few acres to just over 30,000 acres. 35 Parcels are located within the NBMCA boundaries. Lands would be transferred in fee simple absolute, the highest form of land ownership in common law.
- Recommended approaches to address a number of related activities including:
    - Algonquin harvesting rights including wildlife, fish, migratory birds and plants
    - Forestry
    - Parks and Protected Areas
    - Algonquin heritage and culture
    - Algonquin eligibility and enrolment

Figure 12.3 Identified Algonquin Settlement Areas within the NBMCA Area of Jurisdiction



Source: Ontario Ministry of Aboriginal Affairs Web Site, 2013

Settlement Lands

The Preliminary Draft Agreement-in-Principle specifies that the Final Agreement will identify the Algonquin Institutions that would receive and manage the Settlement Lands and would be the recipient of capital transfers and other assets. Legal interests on Settlement Lands existing at the time of transfer – including hunt camps, public utilities, trap lines, mining leases and claims and aggregate licenses – would continue. Ontario would facilitate the negotiation of agreements between the Algonquins and the holders of existing rights or interests prior to the Final Agreement. Persons who hold legal interests will also have access across Settlement Lands through legal instruments, such as easements, for the exercise of that party's right, title or legal interest located off Settlement Lands. Settlement Lands subject to a Sustainable Forest License will be transferred to the Algonquins after the Forest Management Plan existing as of the date of the Agreement-in-Principle expire. If there are any proposed amendments to Forest Management Plans that could adversely affect Algonquin interests in those Settlement Lands prior to transfer, Ontario will consult the Algonquins of Ontario. The Preliminary Draft Agreement-in-Principle also provides the first right of refusal to the Algonquins of Ontario on a number of identified lands that are all located outside of the NBMCA's area of jurisdiction.

Forestry

Through several initiatives and collaborative partnerships, the Preliminary Draft Agreement-in-Principle carves out more meaningful participation for the Algonquins of Ontario within the forest industry. A number of proposed elements to be reflected in a Final Agreement include:

- Notifying the Algonquins of Ontario of government contracts and job opportunities related to forestry in Algonquin Park
- Encouraging potential Algonquin employment, training and contract opportunities with Sustainable Forest License holders
- The consideration of the potential for Algonquin benefits as a relevant factor when Ontario is evaluating tender bids or other government contracting procedures
- The provision of training opportunities by Ontario and the Algonquin Forestry Authority for the Algonquins of Ontario in the forestry industry in Algonquin Park, including silviculture
- The consultation of the Algonquins of Ontario by Ontario regarding any new forestry policy initiatives including the Ontario forestry tenure and pricing review

Harvesting

The Harvesting Chapter of the Preliminary Draft AIP identifies conservation as the fundamental principle in the management of fish, wildlife and migratory birds, including the protection of spawning grounds, breeding areas, migratory bird sanctuaries and fish sanctuaries. This Chapter highlights that the Algonquins of Ontario would have the right to harvest fish, wildlife, birds and plant for domestic purposes throughout the year on Crown lands and Settlement Lands within the Settlement Area, and on other lands where the private landowner consents. Algonquins would also have the right to trade and barter amongst themselves. These harvesting rights will be subject to Provincial and Federal measures or legislation necessary for conservation and public health and safety.

The Chapter also states that the Algonquins of Ontario, Canada and Ontario would work together with respect to the conservation and management of wildlife, fish and migratory birds within the Settlement Area. Moose and elk would continue to be 'Allocated Species' within the Settlement Area and the Algonquins of Ontario would continue to have access to Algonquin Park to harvest moose in the area currently harvested for that purpose. If in the future it is determined that there is a conservation risk to another species within or near the Settlement Area, the Minister of Natural Resources, in consultation with the Algonquins of Ontario, may designate it to be an Allocated Species as well. When an Allocated Species has been identified, the Minister of Natural Resources, in consultation with the Algonquins of Ontario, would establish a Total Allowable Harvest for that species or population and involve the Algonquins of Ontario in data sharing, gathering and analysis. Enforcement of Federal and Provincial Laws in relation to harvesting throughout the Settlement Area, including in Algonquin Provincial Park, would continue to be the responsibility of Canada or Ontario as appropriate.

Parks and Protected Areas

In the Parks and Protected Areas Chapter of the Preliminary Draft AIP, the Algonquins of Ontario, Canada and Ontario assert that ecological integrity would be the first priority in the management of Protected Areas, specifically Provincial Parks and Conservation Reserves in the Settlement Area. This Chapter also proposes that the Final Agreement would set out three levels of Algonquin engagement in Protected Area management planning, specifically:

- **Level 1:** The Algonquins of Ontario will review and comment on Protected Area Management Plans and Management Statements prepared by Ontario
- **Level 2:** The Algonquins of Ontario, as members on the Protected Area planning teams, will participate in the development and amendment of Management Plans and Management Statements
- **Level 3:** In Algonquin Provincial Park and 15 other identified Provincial Parks (including Mattawa River Provincial Park and Samuel de Champlain Provincial Park), the Algonquins of Ontario and the Protected Area Manager will work through an Algonquin Planning Committee to jointly develop, amend and examine Management Plans, Management Statements, Secondary Plans, Natural Heritage Education Programs and any other strategic plans for Protected Areas

Heritage and Culture

The Preliminary Draft AIP recognizes that Algonquin heritage resources represent the physical and spiritual manifestation of ancestral ways of life, traditional values and knowledge. As such, the Heritage and Culture Chapter acknowledges that the Algonquins of Ontario have an interest in the stewardship of these resources and specifies a number of key elements which would be negotiated prior to the Final Agreement. These elements include the development of an Algonquin burial site protocol, the establishment of an Algonquin repository to receive, protect and preserve Algonquin artifacts, data sharing agreements to foster the shared interest in conserving Algonquin heritage resources and Algonquin Native Values Mapping and cultural planning for the Settlement Area.

Next Steps

Since the release of the Preliminary Draft Agreement-in-Principle in December 2012, the Algonquins of Ontario, Canada and Ontario have engaged in an extensive consultation effort to obtain meaningful, constructive input on the proposed elements of the Preliminary Draft Agreement-in-Principle from Algonquin voters and the general public. Each comment received to date has been carefully considered and, where necessary and appropriate, revisions to the document are being negotiated by the three parties. These changes will be reflected in the Draft Agreement-in-Principle. Once a Draft Agreement-in-Principle is reached, it is critical that the document is then forwarded for ratification by the Algonquin voters.

Upon a successful Algonquin ratification vote, the Draft Agreement-in-Principle would be submitted to the Governments of Ontario and Canada for approval. Following such approval and signature by the Principal Negotiators, the Agreement-in-Principle, while non-binding, will form the framework for continued negotiations towards a Final Agreement. The negotiations generally take 4 to 5 years to complete. A Final Agreement would also need to be approved by the Algonquins of Ontario through a ratification vote and by legislation passed by the Legislature of Ontario and the Parliament of Canada. All of these steps are dependent upon a successful ratification vote on the Agreement-in-Principle (the preceeding section was edited by the Algonquins of Ontario Consultation Office which was provided by Janet Stavinga, Executive Director on August 20, 2013).

12.3.2 Nipissing First Nation Land Claim

The Nipissing First Nation signed the Robinson-Huron Treaty in 1850 but have disputed that the agreement was properly interpreted concerning western and northern reserve boundaries. The Nipissing First Nations have recently announced that they have voted in favour of acceptance of a cash settlement offer from the Federal Government in compensation for 106,800 acres of land at the western edge of their reserve (Reserve #10). The disputed lands are valued at $123,900,000.00 which is the amount of the settlement offered by the Federal Government. The settlement will allocate $20,000 to each Nipissing band member and the remaining $73 million will be held in a land trust. The land trust can be used to buy back lands within the disputed zone, which would be added to the Reserve, or to purchase other lands deemed to be of significance to the Nipissing Nation (North Bay Nugget, March 2013). Funds could also be used to purchase land that will generate capital income for the band. The announcement of the vote results was issued in March 2013 which indicated that future meetings would be held to discuss how the remaining funds will be used. Land Claims information is subject to regular updates at the Nipissing First Nation Web Site at: http://www.nfn.ca/index.php

The Nipissing First Nation land claim was first filed in 1999 and accepted by the Federal Government in 2008. Negotiations were carried out between 2008 and November 2011. The Federal Government also holds Nipissing First Nation lands in Commanda Township in trust which it intends to transfer once lands are exempt from certain Canadian Tax laws (lands shown in pink in Figure 12.1).

12.4 NBMCA Demographics/Demographic Trends

Demographic information for the NBMCA was originally assessed in the Watershed Plan Background Inventory completed (1982) and has been updated in the Drinking Water Source Protection NBMCA Watershed Characterization Report, NBMCA (2008). Stantec has updated information using 2011 Canadian Census data or 2006 data where 2011 data is unavailable. Extracting specific information for the NBMCA area of jurisdiction is made difficult by census area divisions which are principally based on municipal boundaries and do not overlap well with NBMCA watershed boundaries. Unorganized townships are lumped into broad census divisions. Characterizing the demographics of the NBMCA area of jurisdiction is also made difficult by the range of variation encountered across the watershed.

The total estimated population of the NBMCA watershed, based on 2011 census data with unorganized area information supplied by the Ministry of Municipal Affairs and member municipalities, is 70,000. It is noted that Census population data is often disputed by municipalities as being under representative of actual populations. Approximately 55,000 or 78.6 % of the NBMCA population lives in urbanized (on municipal services) portions of North Bay, Mattawa and Callander on less than 2% of the watersheds land base. The remaining 15,000 (17.4 %) live in rural or semi-rural settings (on private services) which include Hamlets of Bonfield, Rutherglen, Corbeil, Astorville, Derland and Redbridge (other place names within the watershed include Trout Mills, Feronia, Balsam Creek, Alderdale and Eau Claire). The rural population is situated on about 40% of the watershed land base which means that more than half of the NBMCA is unpopulated. North Bay is the dominant regional center with a population of 53,561 in 2011 and accounts for 77% of the NBMCA's total population. Population densities range from more than 500 people/km^2 in urbanized areas to approximately 12 people/km^2 in the settled rural area. Rural population densities vary and tend to be concentrated at the fringes of urban centers, near rural hamlets, surround accessible water bodies or are located near major highways. On average there are 2.51 people/household (based on area) with North Bay having a slightly higher average (2.7 people/household). With the exception of Phelps Improvement District, Lauder Township and Boulter Township, unorganized areas are unoccupied (no permanent residents). Population statistics for NBMCA watershed are presented in Table 12.2.

Table 12.2 Population Statistics for NBMCA Municipalities and Unorganized Townships from Census data which has been interpolated for Unorganized Areas

Municipality Organized	2,006 Population	2,011 Population	2,011 Total Male	2,011 Total Female	% Change Since 2006	Area km^2	Population Density/km^2	# Persons Household	Average Age	Population with NBMCA	2011 NBMCA Population
Bonfield	1,981	2,016	1,020	995	1.8	208	10	2.50	46	100%	2,016
Boulter (unorganized)*		40								100%	40
Callander	3,249	3,864	1,935	1,930	18.9	106	37	2.50	46	100%	3,864
Calvin	608	568	270	300	(6.6)	141	4	2.50	47	100%	568
Chisholm	1,318	1,263	645	615	(4.2)	207	6	2.60	44	98%	1,238
East Ferris	4,228	4,512	2,285	2,225	6.7	155	29	2.60	47	92%	4,151
Lauder (unorganized)*		40								100%	40
Mattawa	2,003	2,023	970	1,050	1.0	4	554	2.20	47	100%	2,023
Mattawan	147	162			10.2	201	1			33%	53
North Bay	53,966	53,651	25,785	27,865	(0.6)	319	168	2.70	44	100%	53,651
Papineau Cameron	1,058	978	505	475	(7.6)	567	2	2.50	46	65%	636
Phelps (unorganized)*		1,500								100%	1,500
Powassan	3,309	3,378			2.1	225	15			2%	68
All Areas above	**71,867**	**73,995**			**2.2**	**2,132**	**82**			**84%**	**69,848**
Dominant Municipalities		**68,910**	**33,415**	**35,455**				**2.51**	**46**		
Unorganized *		**1,580**									
	Source: Statistic Canada - 2011 Census										

* Data for Phelps and Lauder supplied through MMAH, data for Boulter supplied by Township of Bonfield

Table 12.2 demonstrates that the NBMCA region is maintaining modest population growth. The NBMCA population has grown by approximately 2.2% since 2006 which is lower than the Provincial growth rate of 5.7%. The NBMCA is at the fringe of a population growth area centered in the Greater Toronto Area (GTA). Generally areas of south of the NBMCA experience positive growth with the highest growth rates concentrated in the GTA and areas north of the NBMCA generally experience declining populations over time. The City of North Bay has maintained a stable population total over the past several decades while communities on the fringes of North Bay are experiencing population growth. The growth of communities surrounding the regional center is presumed to be because economic drivers such as a lower cost of living.

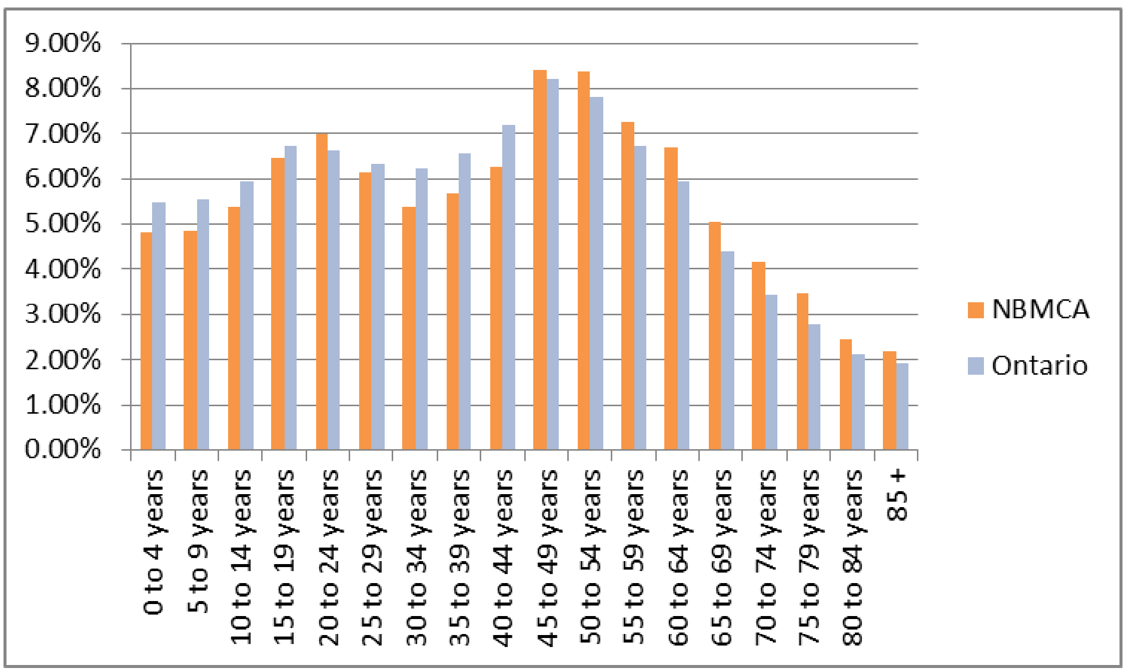
In terms of age distribution, the NBMCA population continues to be dominated by the "baby boomer" age class represented by the 45 to 64 age cohort in 2011. The dominance of this age bracket is illustrated in Table 12.3 and Figure 12.4 which compares the NBMCA age distribution to the Province of Ontario. In 2011 the median age of those living within the NBMCA was 45.9 years (equal number above and below this age) which is slightly older the provincial average. The median age within the NBMCA continue to increase over time.

Comparing NBMCA age distribution from the 2011 Census to the distribution present in the first Watershed Plan (from 1976), as illustrated in Figure 12.5, highlights the significance of age shifts that are occurring. Youth and young adults have declined as a percentage of total population (youth as a percentage of total population is down by about 1/3rd) and middle aged and seniors have significantly increased (people over the age of 65 has more than doubled and now make up 16.5% of the total population). The total watershed population in 1976 stood at 64,000 compared to the current 70,000. Looking ahead, as the baby boomer cohort moves into the seniors age bracket, the number of senior citizens will continue to grow as a percentage of the

Table 12.3 2011 Age Distribution by Percentage for the NBMCA and Ontario

Age Group	NBMCA	Ontario
0 to 4 years	4.82%	5.48%
5 to 9 years	4.87%	5.55%
10 to 14 years	5.38%	5.94%
15 to 19 years	6.48%	6.72%
20 to 24 years	7.00%	6.64%
25 to 29 years	6.13%	6.34%
30 to 34 years	5.37%	6.23%
35 to 39 years	5.66%	6.57%
40 to 44 years	6.27%	7.19%
45 to 49 years	8.40%	8.22%
50 to 54 years	8.38%	7.83%
55 to 59 years	7.25%	6.73%
60 to 64 years	6.68%	5.96%
65 to 69 years	5.05%	4.38%
70 to 74 years	4.15%	3.43%
75 to 79 years	3.47%	2.77%
80 to 84 years	2.45%	2.11%
85 +	2.17%	1.92%
Median age of Population	45.9	40.4
% of the population aged 15 and over	84.9	83.0

Figure 12.4 2011 Age Distribution by Percentage for the NBMCA and Ontario



total population which will put tremendous pressure on public and private services for health care and senior accommodation and may lead to a long term decline in the total population (stats for North Bay indicate total births are declining while total deaths are increasing – from

Watson and Associates, 2009). It is expected that seniors will congregate in built-up areas as they seek assisted living or move closer to needed services. As noted in the first Watershed Plan youth and young adults continue to experience a net out-migration presumably to seek higher education, employment or to expand their life experiences (Muskoka, Nipissing, Parry Sound Local Training and Adjustment Board, 2004).

Figure 12.5 Age Distribution of NBMCA Watershed Population 1976 - 2011

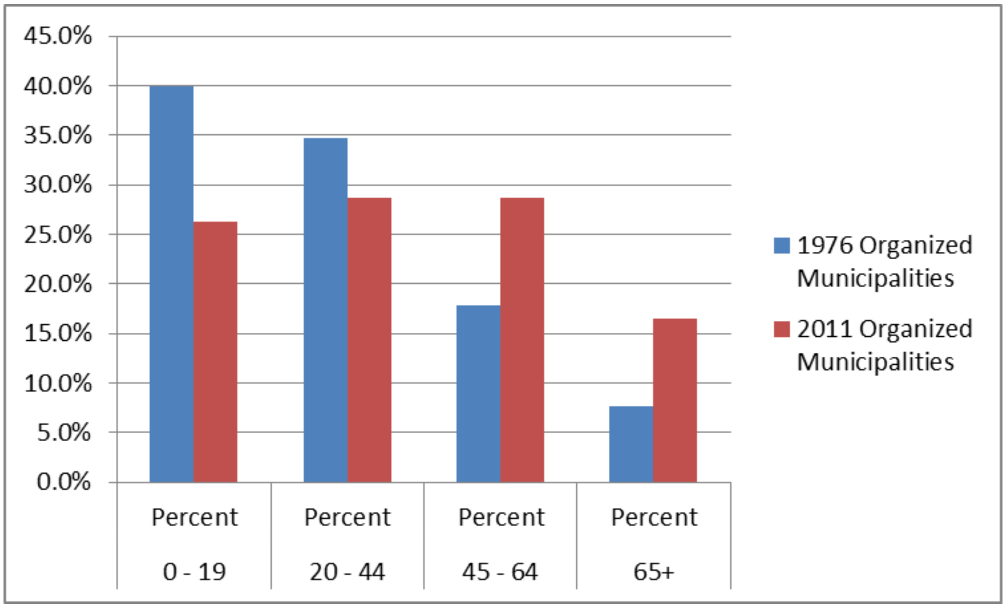


Table 12.4 examines the sex distribution of municipalities that are mainly within the NBMCA watershed. Overall females slightly outnumber males however males outnumbering females in the rural area. Females over 64 years significantly outnumber males in North Bay.

Stantec has profiled NBMCA watershed ethnicity by examining 2011 Census single responses reported for mother tongue as presented in Table 12.5. The data excludes people who reported speaking multiple languages which are mainly people who report speaking both English and French as a mother tongue (this data was too complex to be included). Population statistics have been included beside single responses to illustrate how many multiple responses are omitted. The dominant mother tongue of all people living within the NBMCA is English (80.8%) followed by French (15.4%). Italian and German are the next most common languages spoken within the study area (at 7.1% and 7.0% respectively).

Some interesting watershed observations include a relatively high percentage of people in Chisholm (and Powassan) reporting German as their mother tongue. People of Amish origin are being attracted to the high quality farming opportunities in Chisholm. Also Chinese is now the 6th most common language within the NBMCA followed by Dutch and Cree which now surpasses Ojibway. Ethnic statistics suggest that foreign immigration which is driving growth in the GTA is largely absent within the NBMCA watershed.

Table 12.4 2011 NBMCA Population Sex Distribution based on data for Dominant Municipalities (Municipalities most located within the NBMCA watershed)

Municipality Organized	2,011 Population	2,011 Total Male	2,011 Total Female	0-19 Male	0-19 Female	0-19 Total	20-44 Male	20-44 Female	20-44 Total	45 - 64 Male	45 - 64 Female	45 - 64 Total	65+ Male	65+ Female	65+ Total
Bonfield	2,016	1,020	995	285	305	580	275	240	525	385	390	785	385	390	785
Callander	3,864	1,935	1,930	505	515	1,025	530	510	1,040	660	705	1,365	320	275	605
Calvin	568	270	300	70	80	150	60	75	135	90	115	210	45	50	100
Chisholm	1,263	645	615	200	165	365	175	180	350	230	215	440	95	70	155
East Ferris	4,512	2,285	2,225	650	600	1,245	605	580	1,180	830	825	1,655	350	365	700
Lauder (unorganized)*	40														
Mattawa	2,023	970	1,050	285	285	580	245	270	515	315	315	630	185	250	430
Mattawan	162														
North Bay	53,651	25,785	27,865	7,605	7,550	15,155	8,495	8,640	17,140	7,555	8,110	15,660	3,905	5,370	9,280
Papineau Cameron	978	505	475	145	125	255	115	125	240	200	185	385	85	70	145
Phelps (unorganized)*	1,500														
Powassan	3,378														
All Areas above	**73,955**														
Dominant Municipalities	**68,870**	**33,415**	**35,455**	9,745	9,625	**19,355**	10,500	10,620	**21,125**	10,265	10,860	**21,130**	5,370	6,840	**12,200**
Unorganized *	**1,540**														
	Source: Statistic Canada - 2011 Census														

Table 12.5 2011 Census - NBMCA Watershed Residents Mother Tongue - Single Responses

Municipality Organized	2,011 Population	Total Single Reponses	Mother Tongue - Single Responses English	French	Italian	German	Polish	Chinese	Dutch	Cree	Spanish	Other
Bonfield	2,016	1,985	1,375	575	5	5	5	5	5	-	-	10
Callander	3,864	3,835	3,285	440	10	30	15	5	5	-	5	40
Calvin	568	550	460	80	-	5	-	-	5	-	-	-
Chisholm	1,263	1,240	915	190	-	110	-	-	10	-	-	15
East Ferris	4,512	4,285	3,170	1,020	5	20	10	-	10	-	-	50
Lauder (unorganized)*	40											
Mattawa	2,023	1,880	1,220	640	-	-	-	-	-	-	-	20
Mattawan	162	160	105	55	-	-	-	-	-	-	-	-
North Bay	53,651	52,085	42,440	7,435	480	290	120	130	85	115	90	900
Papineau Cameron	978	950	685	250	-	5	10	-	-	-	-	-
Phelps (unorganized)*	1,500											
Powassan	3,378	3,125	2,960	115	-	25	5	5	10	-	-	5
Total	73,955	70,095	56,615	10,800	500	490	165	145	130	115	95	1,040
Percent		100	0.808	0.154	0.0071	0.0070	0.002	0.002	0.002	0.002	0.001	0.015
	Source: Statistics Canada: 2011 Census				*data for unorganized areas has been obtained through Ministry of Municipal Affairs and Housing							

Statistics Canada has profiled 2011 Census data for mother tongue and language spoken at home for North Bay Region which includes North Bay, Callander, East Ferris and Bonfield in terms of official languages spoken within the region. Results are presented in Figure 12.6.

Figure 12.6 2011 Statistics Canada Profile of Official Languages spoken in North Bay Region

Population mobility characteristics for 2011 had not been released at the time of assessment. 2006 statistics, as presented in Table 12.6, indicates population mobility for 1 year and 5 year intervals. These statistics suggest that 15.3% of the NBMCA population moves annually and 41.6 % moves every 5 years; both figures are slightly above the provincial average. Most moves are within the same community. A very low percentage of the population moved to other provinces or to other countries in time periods reported.

Table 12.6 NBMCA Population Mobility Statics – 2006

	Bonfield	Callander	Calvin	Chisholm	East Ferris	Mattawa	Mattawan	North Bay	Papineau Cameron	Powassan	NBMCA		Ontario	
Total Mobility Status - 1 year ago	2,010	3,230	595	1,315	4,155	1,945	150	52,665	1,050	3,060	70,175	100.0%	11,893,180	100.0%
Non-movers	1,815	2,805	490	1,200	3,735	1,645	120	44,020	965	2,660	59,455	84.7%	10,299,250	86.6%
Movers	195	425	110	115	415	300	30	8,645	90	395	10,720	15.3%	1,593,925	13.4%
Non-migrants	90	175	10	10	130	160	-	5,625	10	170	6,380	9.1%	951,995	8.0%
Migrants	105	245	100	110	285	140	30	3,020	75	230	4,340	6.2%	641,930	5.4%
Internal migrants	95	230	100	110	260	135	30	2,895	70	225	4,150	5.9%	510,300	4.3%
Intraprovincial migrants	90	215	100	110	255	125	30	2,475	75	210	3,685	5.3%	453,460	3.8%
Interprovincial migrants	10	15	-	-	10	15	-	420	-	10	480	0.7%	56,840	0.5%
External migrants	10	10	-	-	20	-	-	125	-	10	175	0.2%	131,630	1.1%
Total Mobility Status - 5 year ago	1,960	3,100	580	1,270	3,975	1,850	150	50,645	995	2,950	67,475	100.0%	11,354,360	100.0%
Non-movers	1,370	1,690	355	895	2,605	1,015	95	28,620	670	2,095	39,410	58.4%	6,660,315	58.7%
Movers	590	1,410	225	385	1,365	830	60	22,020	330	855	28,070	41.6%	4,694,045	41.3%
Non-migrants	210	380	50	50	330	520	30	13,435	110	400	15,515	23.0%	2,542,885	22.4%
Migrants	380	1,025	175	330	1,040	310	25	8,585	220	455	12,545	18.6%	2,151,160	18.9%
Internal migrants	380	970	175	325	1,010	310	25	8,110	215	450	11,970	17.7%	1,584,450	14.0%
Intraprovincial migrants	335	910	175	320	930	215	25	6,910	125	430	10,375	15.4%	1,398,665	12.3%
Interprovincial migrants	40	65	-	-	80	90	-	1,195	85	20	1,575	2.3%	185,785	1.6%
External migrants	10	55	-	10	30	-	-	475	-	10	590	0.9%	566,785	5.0%
		Source: Statistics Canada 2006 Census												

Not reflected in Statistic Canada information because of the time of year that Census data is collected (mid-May) are seasonal shifts in population within the region which can be significant. Two trends are noted from general observations and information contributed by municipalities.

A significant number of seasonal properties exist in rural areas (many are located on lakes and streams) which have relatively high occupancy rates in warmer months and are unoccupied in colder months. The swelling of the area's population in the summer and summer shoulder seasons (swelling is more significant on weekends) is in part driven by tourism (which includes people seeking hunting and fishing opportunities) but is also the result of a significant migratory watershed population. There are a large number of seasonal residents (their main residence is usually outside of the watershed) that have ownership and consequently long term interests in the state of the natural environment within the region. The values and interests of this migratory population can sometimes vary from permanent residents. It is expected that there will continue to be growth in this seasonal population (that have a long term interests in watershed resource features) due to a number of factors including continued growth in the GTA, a reduction in travel time into the study area from improved highway access, declining opportunities for affordable seasonal properties south of the NBMCA and possibly because this area may be viewed as an escape from high temperatures brought on by climate change which may significantly impact areas to the south. Watershed management must consider and be sensitive to this seasonal population base that is not always present or aware of watershed trends or management activities.

A second seasonal population shift is from the "snow bird" impact. Many permanent residents leave the region to travel or to seek warmer climates during the winter. This trend is expected to increase as more baby boomers become "zoomers" in retirement. The NBMCA must be sensitive to the fact that permanent residents may be out of the country during the winter period and consequently making management decisions and/or seeking input must be conscious of the need to accommodate snow bird interests.

The above migratory populations likely also have significant economic consequences which are further discussed in the economic assessment section below. The impacts of seasonal population shifts to watershed management are not well understood and further assessment may be warranted.

12.4.1 Different Population Values

Often urban and rural communities can have different perspectives concerning environmental appreciation and awareness as well as the importance and value placed on natural resources within the region. Reasons for some of these differences have been explored in a federal publication developed to guide climate change adaption strategies. Differences between urban and rural areas from a report entitled “From Impact to Adaptation: Canada in a Changing Climate” (Government of Canada Publication, 2007) have been modified to apply to watershed management activities in Table 12.7. It should be noted that within the Canadian context even the City of North Bay is considered to be a rural community. This chart is stereotypical but may help to reveal different values and opinion between permanent and seasonal residents or between areas that are resource industry based vs. areas with limited resource sector ties.

Table 12.7 General Urban and Rural Strengths and Weakness to Cope with Resource Management Issues in Canada

Urban Centers	Rural Communities
Strengths	Strengths
• Greater access to financial resources	• Strong social capital
• Diversified economies	• Strong social networks
• Greater access to services	• Strong attachments to community
• Higher education levels	• Strong traditional and local knowledge
• Well-developed emergency response capacity	• High rates of volunteerism
• Highly developed institutions	
Limitations	Limitations
• Higher costs of living	• Limited economic resources
• More stress due to congestion	• Less diversified economies
• Less intune to the forces of the natural environment	• Higher reliance on natural resource sectors
• High dependence on critical, but aging infrastructure	• Isolation from services and limited access
• Issues of overlapping jurisdictions that complicate decision-making processes	• Lower proportion of population with technical background

Adapted from: "From Impact to Adaption: Canada in a Changing Climate 2007" Government of Canada Publication

12.5 Urban and Rural Watershed Communities and Land Use Change

Policies that influence current settlement, growth and land use trends within the NBMCA watershed can be found in Official Plans of member municipalities. Current settlement, growth and land use trends are closely tied to the area’s economy which is explored in further detail in Section 13. Growth and land use change is identified as a stress factor that will challenge watershed management strategies in the future. This section examines NBMCA growth and land use trends by assessing municipal Official Plan policies and development initiatives.

Municipal land use trends have been investigated by conducting interviews with staff of each member municipality. To facilitate land use and vegetative change discussions mapping of provincial Forest Resource Inventory (FRI) land classifications from a pre-1990 period and similar mapping based on 2011 orthoimagery interpreted by the North Bay-Mattawa Conservation Authority were used. Stantec explored a broad range of municipal growth and land use trends with each municipality. Interviews were conducted between November 2012 and January 2013. Findings are summarized in the following sections for each municipality. Urban municipalities which are focused on urban expansion are differentiated from rural municipalities that are more influenced by resource based economic activity.

Existing land uses within the NBMCA interpreted from Municipal Property Assessment Corporation (MPAC) land use classifications are presented in Figure 12.7. Most of the settled area within the NBMCA is used for residential or agricultural purposes. Areas with no data are mainly crown land areas that are under the oversight of the Province. Pre-1990 Forest Resource Inventory Mapping for the NBMCA used for municipal interviews is presented in Figure 12.8. 2011 Orthoimagery interpreted by the NBMCA to duplicate FRI land use categories within the NBMCA is presented in Figure 12.9.

12.5.1 Urban Centers

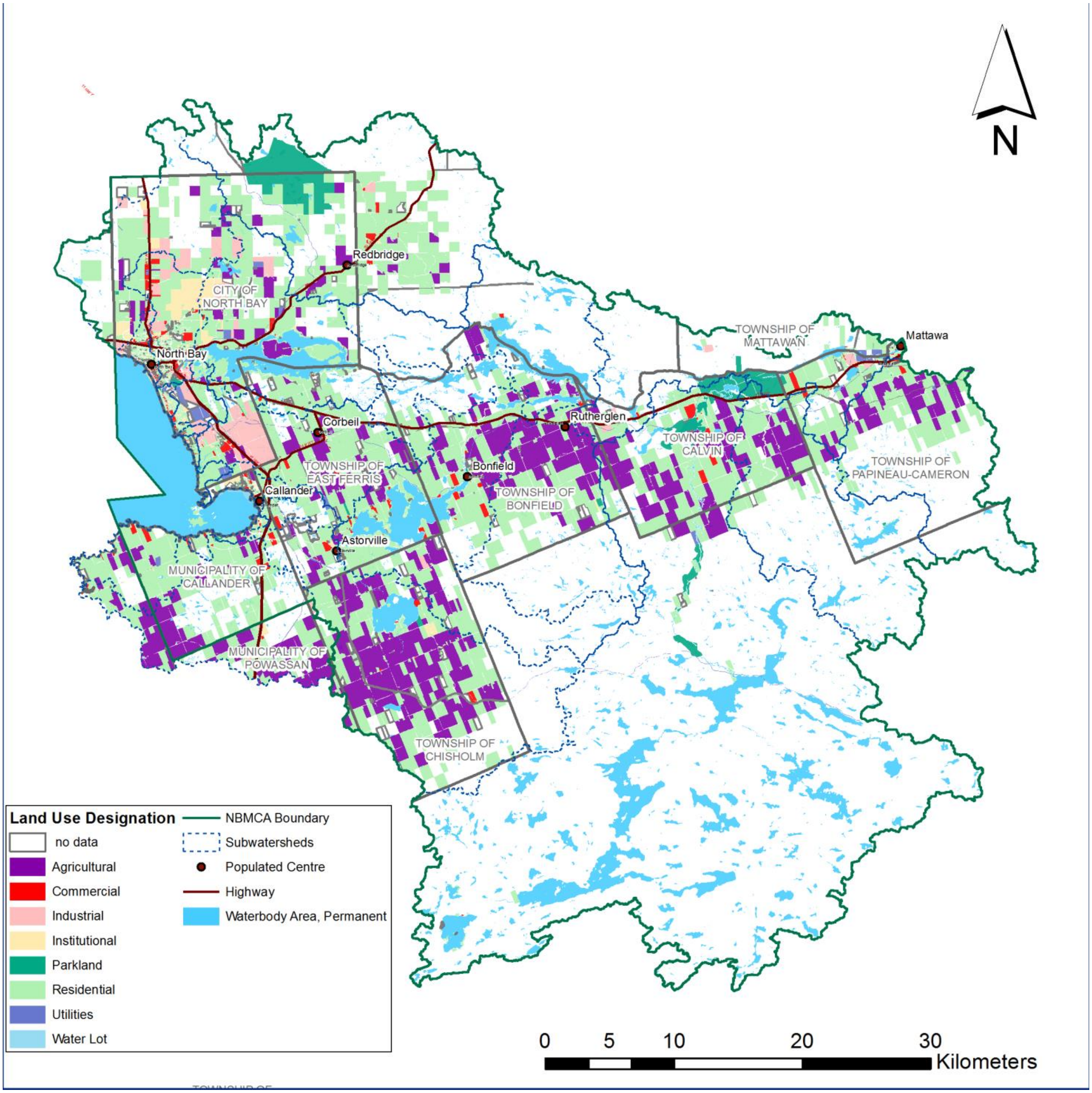
Three municipalities within the NBMCA have full urban services and a distinguishable central business districts. General planning policies and growth/land use changes for North Bay, Mattawa and Callander are described in the following sections.

12.5.1.1 North Bay

North Bay is both the largest municipality and the regional center of the NBMCA with a total population of 53,651 (2011 Census). This represents 76% of the total watersheds population. The City of North Bay revised its Official Plan in 2012 to guide community growth and development until 2031. The new Official Plan sets out objectives to balance social/cultural, economic and environmental interests in North Bay. North Bay has both urban and rural areas. Within the North Bay urban service boundary, existing and new development must be provided with full urban services. North Bay has a sizable rural area (80% of the municipality's area) were development relies on private water and septic servicing. Rural development primarily lines roadways or is situated on the shores of local lakes. Two major highway corridors (Highway 11 north and Highway 17 east) provide access to rural commercial and industrial uses. North Bay has several rural estate subdivisions and two mobile home parks within the rural area.

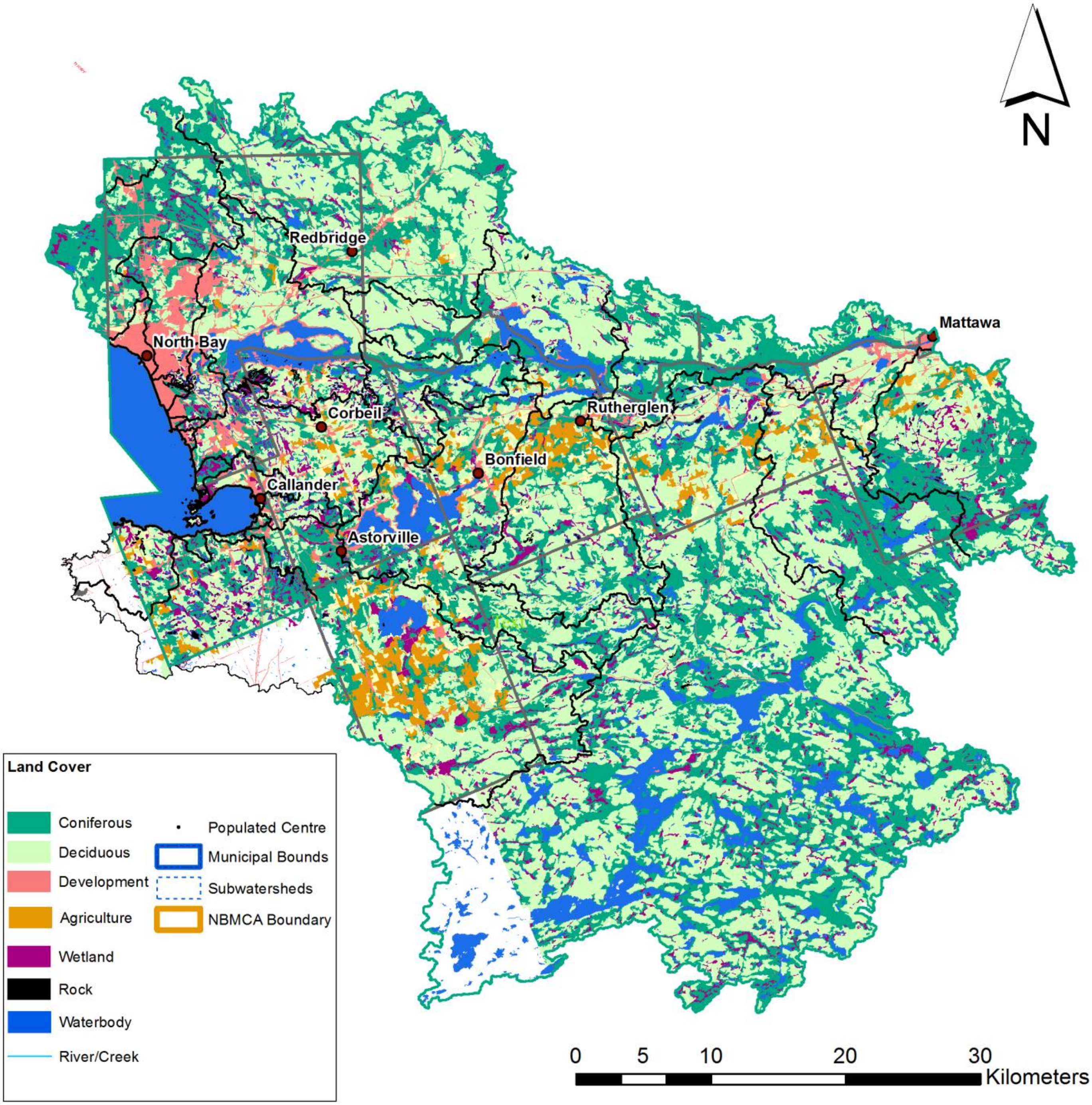
North Bay's Official Plan sets out policies to concentrate new growth and development within the City's urban service boundary and to limit rural residential growth. Urban growth is promoted through infilling, intensification and reclamation of brownfields within current

Figure 12.7 Municipal Property Assessment Corporation (MPAC) Land Use Classifications for the NBMCA Watershed



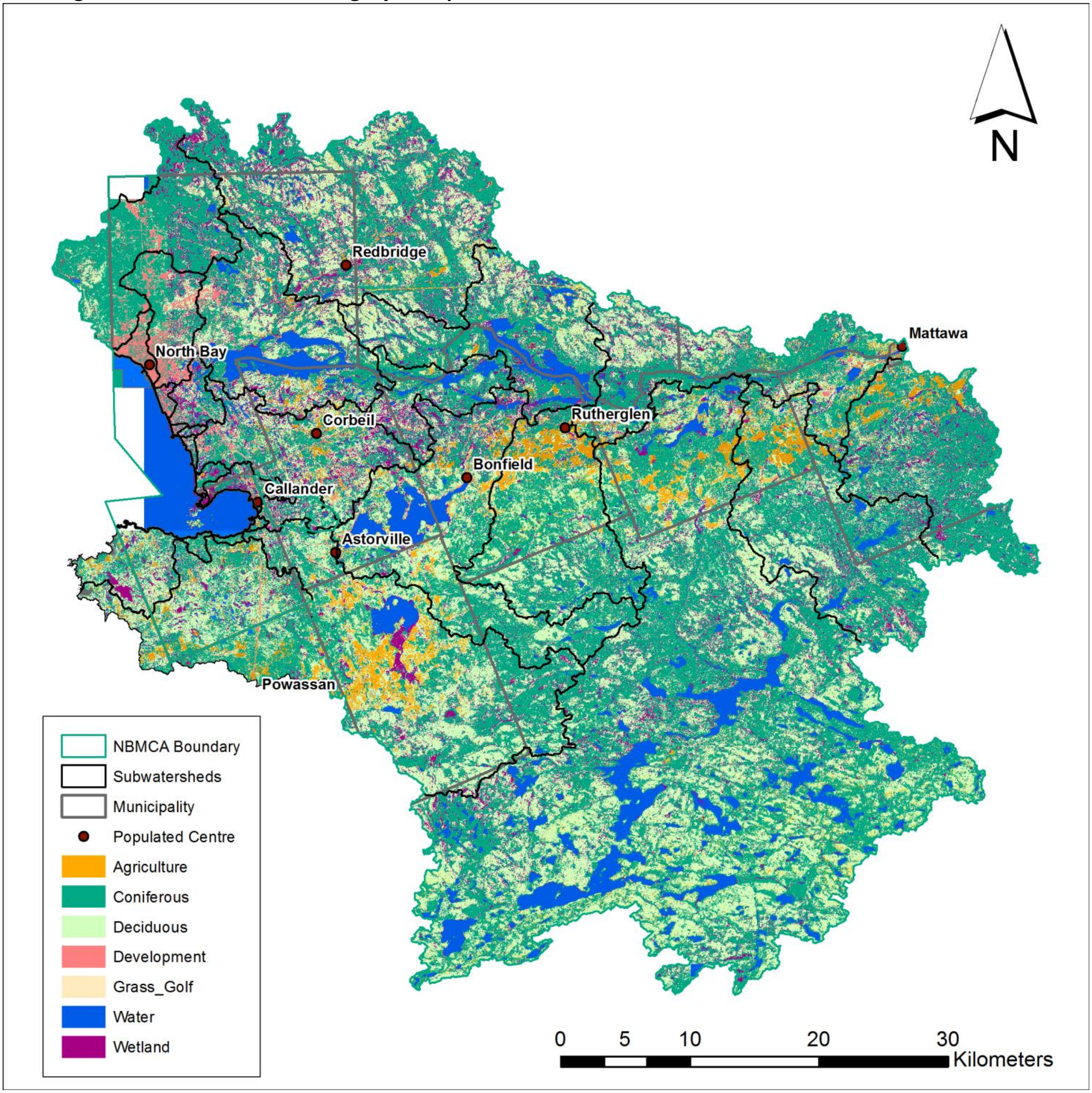
development envelope (North Bay has endorsed "Smart Growth" principles). The City's population projections are contained in a separate supporting background document. North Bay has recently constructed a new water filtration plant on Trout Lake and provides tertiary sewage treatment at a plant located on Lake Nipissing. The Official Plan recognizes that Source Water Protection Planning was underway but timing prevented the incorporation of SWP recommendations into the new plan.

Figure 12.8 Pre-1990 Forest Resource Inventory (FRI) Land Classifications for the NBMCA



Land uses recognized in North Bay's rural area include aggregate and mineral extraction, restricted industrial uses, highway commercial, waterfront commercial, rural institutional and limited residential uses not requiring municipal water and sewer services. North Bay intends to maintain or improve Trout Lake's existing water, aesthetic and fisheries quality. Strict policies apply in the Trout Lake watershed including prohibition of new lot creation with frontage on Trout Lake or on a stream flowing into Trout Lake (capacity for a limited number of "minimal

Figure 12.9 2011 Orthoimagery Interpretation of FRI Land Classifications for the NBMCA



impact" lots has been recognized on the Trout Lake shoreline). Larger setback distances from shorelines or streams flowing into Trout Lake have been created; removal of natural vegetation within the setback zone are restricted; and storm water management policies have been established to minimize flow, erosion, siltation and nutrients from reaching the lake. Strict controls have been established over lot design features through Site Plan Controls and North

Bay also promotes environmental education. North Bay regulates septic pump outs on the Trout Lake shoreline and along inflowing streams. Second tier development is controlled by prohibiting new lot creation within 300 meters of the Trout Lake shoreline.

City of North Bay land uses are set out in Official Plan Schedules 1 - Urban Area and Schedule 2 - Rural Area plans as illustrated in Figures 12.10 and 12.11.

North Bay's Official Plan reflects current provincial policy statements related to natural heritage features and natural hazards. Regulatory flood elevations and floodplain mapping are generally available within the urban service boundaries of North Bay. Floodplain and water management interests in rural areas are regulated through a Development Constraint Policy. The North Bay escarpment is identified as a constraint due to steep slopes. Provincially Significant Wetlands are recognized in the Duchesnay Creek, Chippewa Creek, Parks Creek, La Vase River and Gauthier Creek Watersheds. City of North Bay Environmental Constraint Overlay Mapping is present in Figure 12.12.

In the 1980's North Bay reclaimed significant waterfront lands on Lake Nipissing adjacent to its Central Business District. Additional lands have been reclaimed from railway ownership and the community is transforming waterfront and rail lands into a central park with the redevelopment of surrounding brownfields. This development is stimulating the rejuvenation of the central core. The plan to reclaim the Lake Nipissing shoreline and provide public access adjacent to the CPR rail yard was completed by the North Bay-Mattawa Conservation Authority.

North Bay has addressed the sequence of development within the urban service boundary through a staging plan. Population growth projections are provided in a separate study entitled City of North Bay Population, Housing and Employment Forecast Update 2006 – 2031: Final Report (Watson and Associates, 2009). This study suggests that North Bay should make provisions for up to an additional 2,500 people over a 25 year planning horizon which will primarily be accommodated within the urban area. Residential growth in the rural area is expected to be limited. North Bay has adjusted growth plans to avoid Provincial Significant Wetlands and it has identified a number of Community Improvement Planning Areas to stimulate new areas of growth.

The primary Staging Area for Growth in North Bay, identified on Schedule 9 of the Official Plan (see Figure 12.13), is confined to the edge of exist urban area. This reflects the City's primary goal to grow through infilling, intensification and reclamation of brownfields in already serviced areas. Stage 2 planning areas, which depend on the extension of municipal services, are immediately adjacent to the Stage 1 areas. Stage 2 areas located above the North Bay escarpment include the Cedar Heights Planning Area (primarily residential growth), the continued expansion of Airport Hill Planning Area (primarily residential) and the creation of a new Industrial Park north of the North Bay Airport.

Figure 12.10 City of North Bay Urban Area Land Use Plan – (Official Plan Schedule 1)

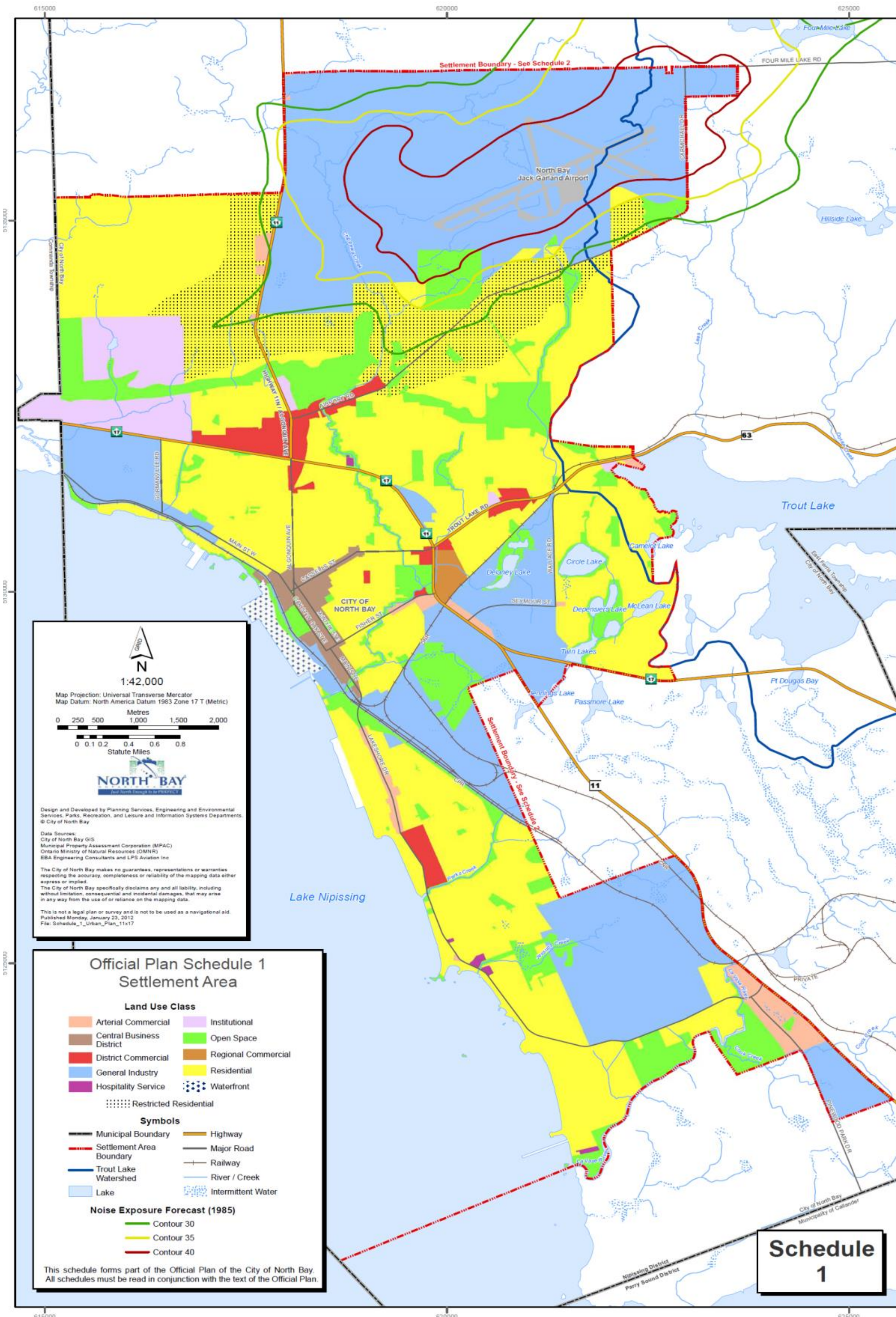


Figure 12.11 City of North Bay Rural Area Land Use Plan – (Official Plan Schedule 2)

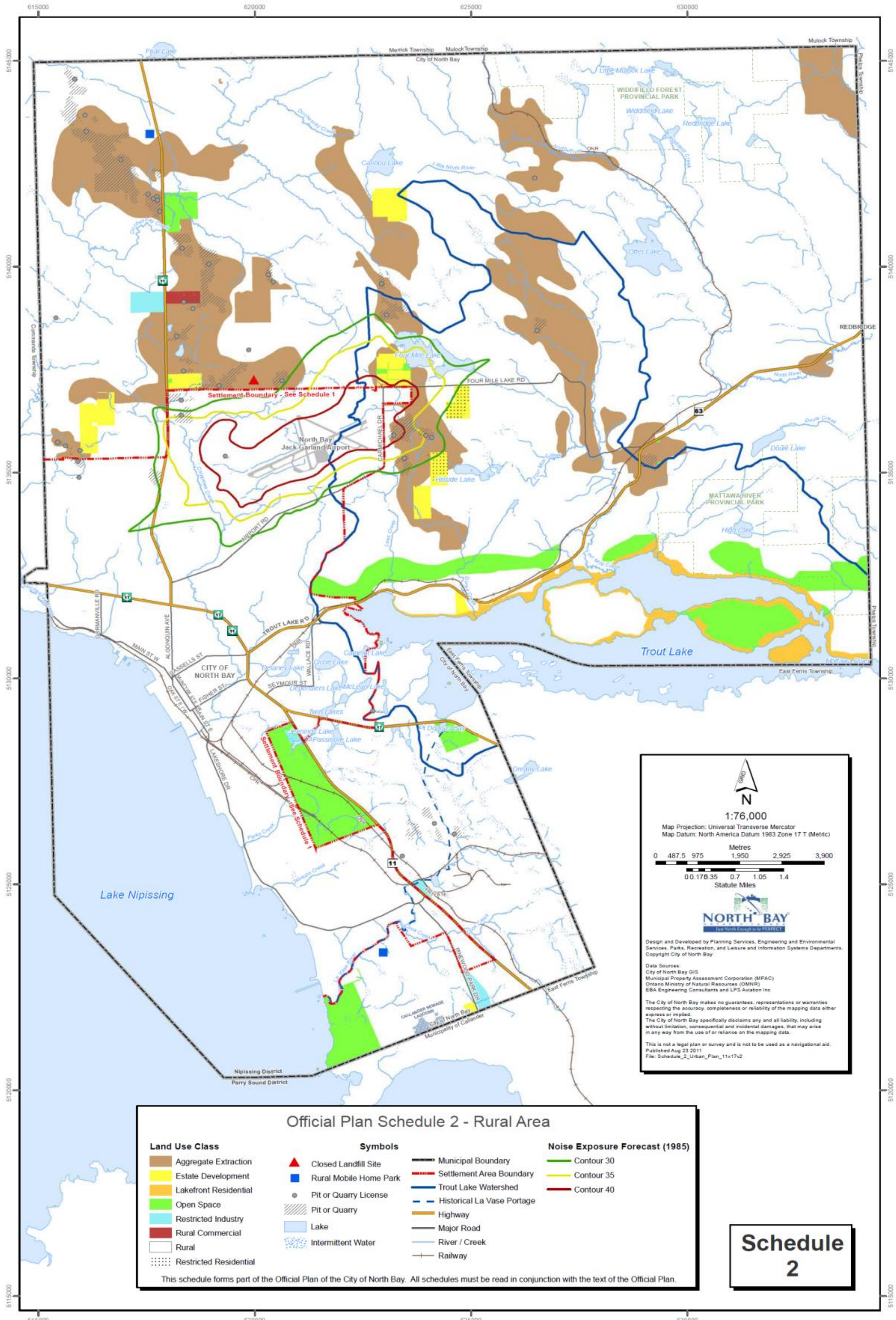


Figure 12.12 City of North Bay Environmental Constraint Overlay (Official Plan Schedule 3A)

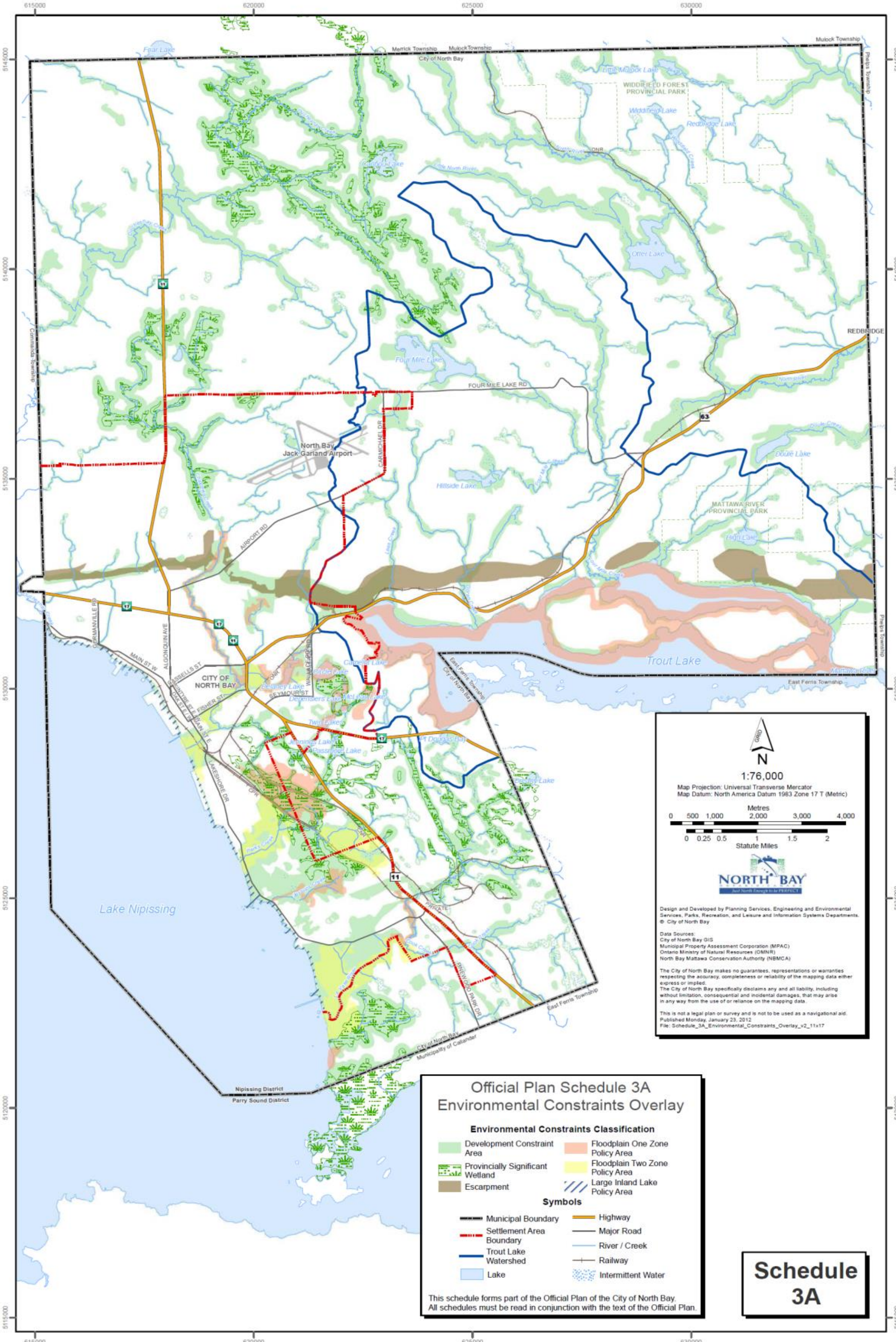
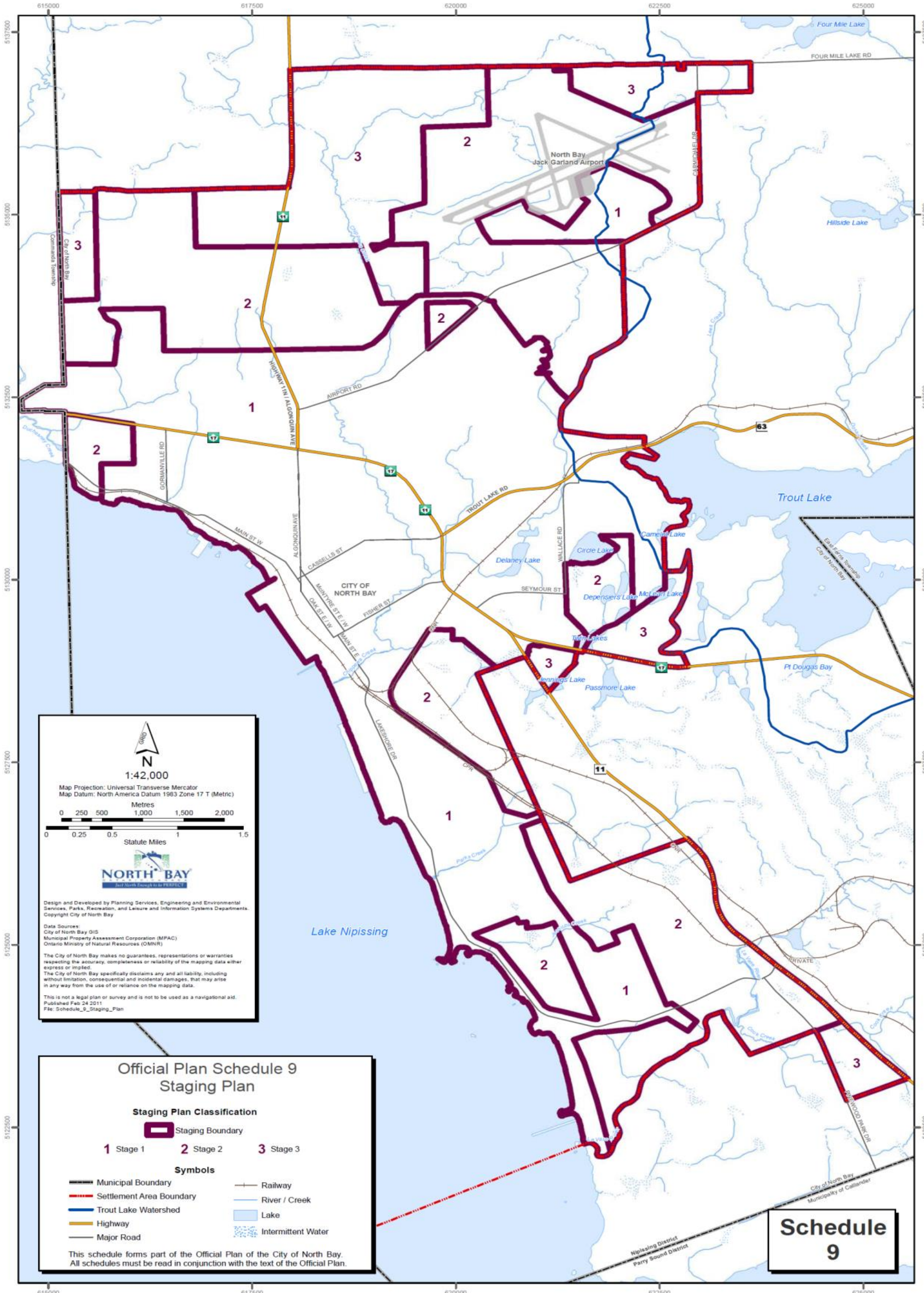


Figure 12.13 City of North Bay Urban Growth Staging Areas (Official Plan Schedule 9)



Stage 2 areas below the North Bay escarpment are located south of Circle Lake (primarily residential) and in various parts of West Ferris. An industrial area is identified east of the railway corridors in Laurier Woods/Old Callander Road area. Another Stage 2 area includes the remaining lands within the urban service boundary at the south end of the City (the exception is a small Stage 3 Industrial area south of the Decaire Road/Pinewood Parkway intersection). Within this zone residential growth is projected closer to Lake Nipissing and industrial growth is projected in the vicinity of railway lines. Development is expected to begin to encroach into Stage 2 areas within the planning horizon of this watershed plan. Stage 3 growth areas are not likely to develop within the timeframe of this planning exercise and are not analyzed.

Land use changes in North Bay detected by comparing pre-1990 Forest Resources Inventory (FRI) images to 2011 orthoimagery include:

- Increased coniferous forest cover and decreased wetland areas in the rural area
- Only limited agricultural uses exist in North Bay and many are infilling in with natural vegetation/trees;
- Unserviced rural industrial/Institutional sites (such as the Nordefibre property, Psychriatric Hospital Site and Dupont Site) are growing in or changing in vegetative cover;
- Previously open rural areas including former pits west of Highway 11 North, former Miller Paving Site, former Marsh Drive Landfill Site and Guy Landscaping Pit off of Northmount are growing in with successional vegetative growth;
- New pits or pit expansions are evident around the periphery of the Airport including Pioneer Pit (northwest of Airport), Canor Pit (north of the Airport) and Siegmiller/Bruman Pit (east of the Airport);
- Vegetation may be screening development around the Trout Lake shoreline which appears less intensive in the latter image;
- The outer urban boundaries of North Bay have not significantly changed over the period of analysis. It is noted that the images does not show recent servicing at the east end of the North Bay Airport completed in 2012;
- New growth/development is detected at the following locations:
    - New North Bay General Hospital site
    - University property
    - Airport Hill is expanding south and east/Kenwood Hills expanding east
    - Connaught extension north of Trout Lake Road expanding north
    - Kingsway infilling north of ONR
    - Home Depot Site
    - Growth in West Ferris east of Booth and south of Bunting
    - Infilling in West Ferris Industrial Park and at the Omischl sport complex

Anticipated Future Growth:

An interview with municipal planning staff in November 2012 identified some supporting background information. The City of North Bay Population, Housing and Employment Forecast Update, 2006 – 2031 was prepared by Watson and Associates in 2009 and is available on line. The City also prepared an Airport Industrial Community Improvement Plan in 2010. Capital works have been approved to extend services into several Stage 2 Planning Areas. Water and sewer services are being installed east of the North Bay Airport to service the Industrial Park and a sanitary sewer service is being extended into the Pinewood Parkway Drive area to facilitate Highway Commercial development (the area already has water servicing). A funding application to extend water and sewers above the North Bay escarpment near Nipissing University did not obtain approval and timing of growth into this area is being reevaluated.

Areas with Plans of Subdivision at various stages of approval are presented in Figure 12.14. Areas most likely to development within the planning horizon of the City of North Bay Official Plan (until 2031), identified through the interview, are highlighted in Figure 12.15. It is estimated that approximately 30% of residential growth in the next few decades will occur above the North Bay escarpment and 70% will be below. Commercial growth is expected to concentrate in the Central Business District and along Pinewood Parkway Drive and Industrial growth is anticipated to locate at the North Bay Airport. A range of mixed uses could materialize around the Central Waterfront Park. A Highway 11 North corridor is expected to experience industrial expansion for “dry” uses not requiring municipal water and sewers.

The use of total population as an indicator of North Bay’s growth was discussed in the interview. North Bay is averaging 119 new housing starts per year (all densities between 1999 and 2009 as reported by Watson and Associates, 2009) and employment growth is also occurring in North Bay while population statistics remain flat. North Bay’s total population is flat lined by a decline in the number of persons per household and Watson and Associates indicate that this trend will continue. The 2009 Watson and Associates report projects that North Bay’s persons per household stat will decline to 2.17 people per household by 2031 (North Bay had 2.7 persons per household in the 2011 Census). Consequently North Bay is projected to continue to grow and diversify economically within the planning period but growth may not be fully represented through future total population numbers.

12.5.1.2 Callander

Callander is the second largest community within the NBMCA that has an urbanized center. It has a total population of 3,864 (2011 Census) or 5.5% of the total watershed population. Callander is also one of the fastest growing municipalities within the NBMCA watershed. Callander’s Official Plan came into effect in 2011 and guiding principles include protecting and enhancing the natural environment and natural heritage features; managing growth using

Figure 12.14 Areas within North Bay at Various Stages of Planning Approval

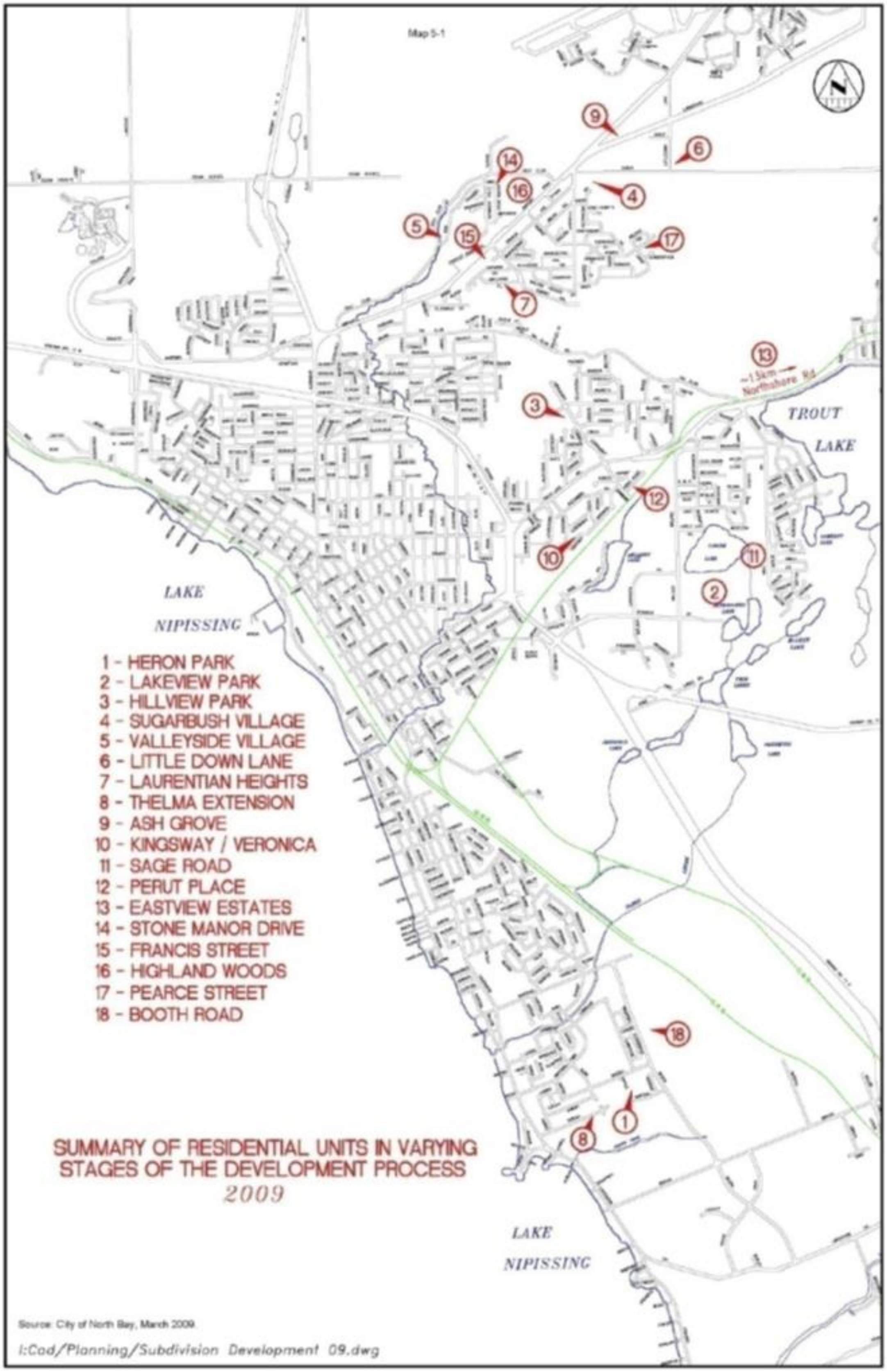
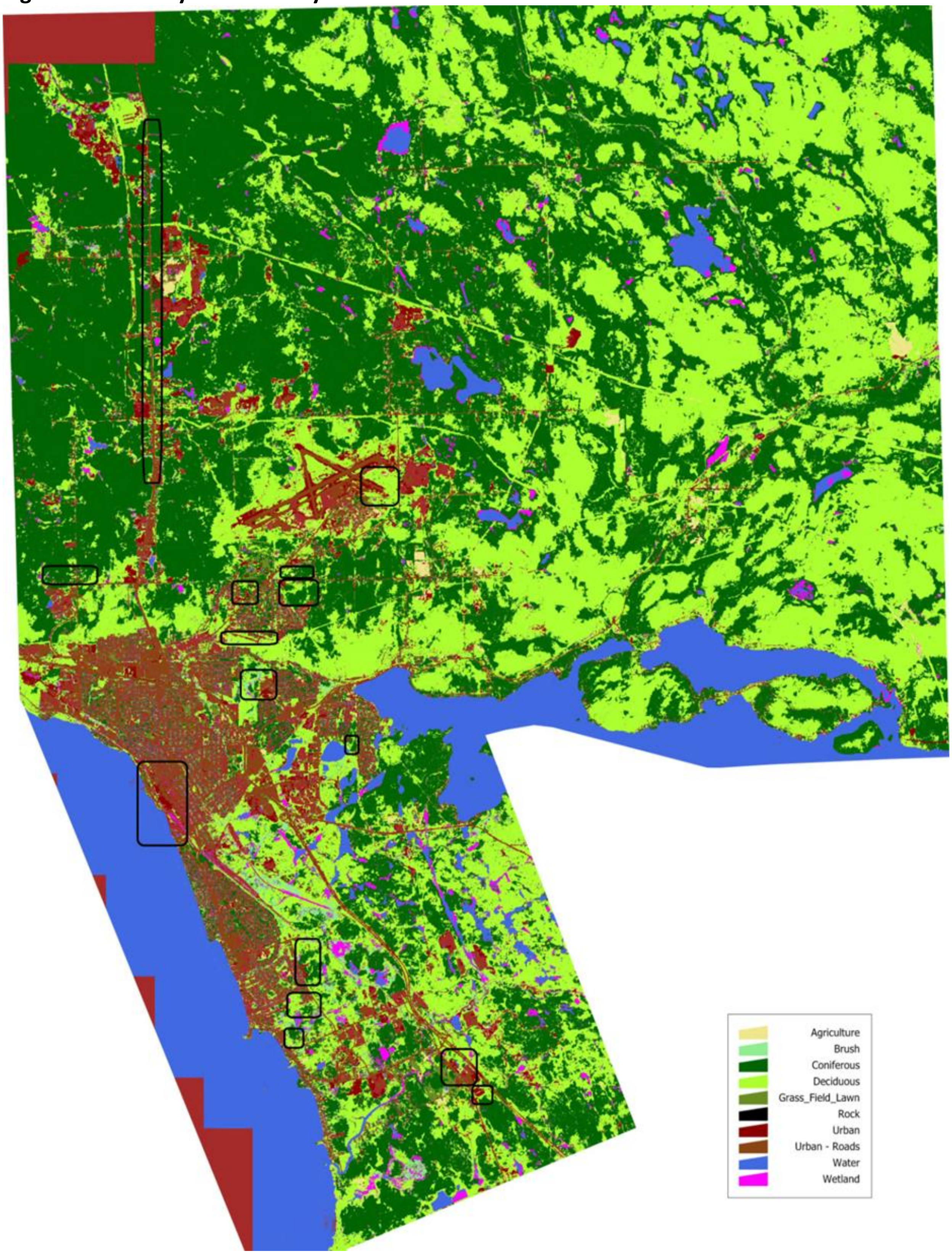


Figure 12.15 City of North Bay Most Probable Growth Areas to 2031



Source: Growth Areas identified by City of North Bay Planning Department overlaying 2011 orthoimagery interpreted by the North Bay-Mattawa Conservation Authority, 2012.

service capacity and staging; protecting the shoreline of Lake Nipissing and maintaining the rural character of the rural area. The new Official Plan suggests that Callander will grow to a population of just over 4,500 by 2026. The annual projected growth rate is 20 units per year. Ninety percent of this growth will occur in Callander's Stage 1 area. Within the Stage 1 area 75% of the growth will rely on the provision of new services and 20% will be through intensification and redevelopment within the existing serviced envelope. The remaining growth is expected to be rural. Urban and rural land uses within the Callander Planning Area are identified in Figures 12.16 and 12.17 and staging within Callander's Settlement Area is identified in Figures 12.18.

Residential growth in the rural area will be limited to infilling along existing roadways. Resource development potential for forestry, mining and aggregates are recognized in the Official Plan. Callander also recognizes a mix of permanent and seasonal uses along the rural portion of the Lake Nipissing shoreline. The conversion of seasonal uses to permanent uses is identified as a threat to the water quality of Callander Bay.

Callander requires full municipal services within its urban service boundary and has its own water filtration plant which sources water from Callander Bay. Sewage treatment is provided through lagoons located on Cranberry Road (in North Bay) which discharge to Callander Bay. Callander's Official Plan identifies that the Callander sewage system is at capacity with committed development. An Environmental Assessment is being completed to create additional capacity. A Technical Memorandum by Meridian Planning Consultants (2008) suggests that sanitary sewer capacity can be recovered from the existing system by reducing infiltration. Callander's Official Plan was approved before Source Water Protection Plans were completed however Source Water Protection policies derived from preliminary findings have been incorporated. The protection of Lake Nipissing will be pursued by encouraging a culture of environmental sustainability within the community, by improving sewage treatment and by addressing storm water management issues. Special controls have been placed on shoreline and waterfront development. Callander recognizes the Callander Bay Marsh as being Provincially Significant. Callander acknowledges the need to stimulate employment growth and has employment development designations scattered throughout the settlement area. Callander is also planning improvements to its public waterfront area in the near term.

Callander has comprehensive environmental protection policies for natural heritage features including groundwater, sensitive fish habitat, deer wintering areas and significant wetlands. Policies are included for municipal storm water management and protection of surface water quality. Inland flood and erosion zones, steep slopes and organic soils are conceptually designated as Environmental Protection Areas in "A" series schedules and the Official Plan links environmental protection areas with potential wildlife habitat and corridors. Schedule "B" distinguishes Environmental Protection Areas as hazard lands and environmentally sensitive areas and acknowledges that floodplains are not all reflected on Official Plan schedules.

Figure 12.16 Municipality of Callander Urban Land Use Plan (Official Plan Schedule A-1)

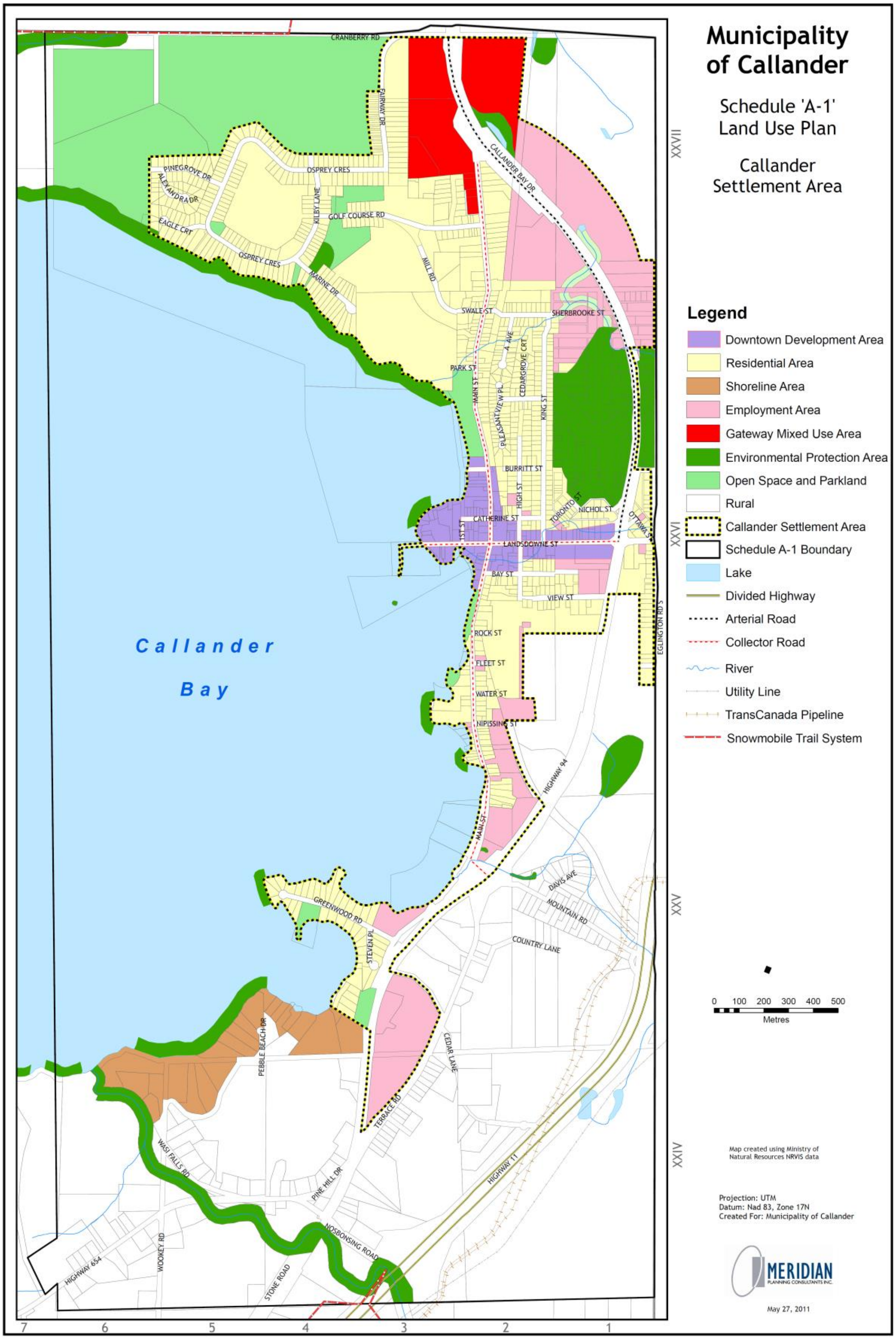


Figure 12.17 Municipality of Callander Rural Land Use Plan (Official Plan Schedule A)

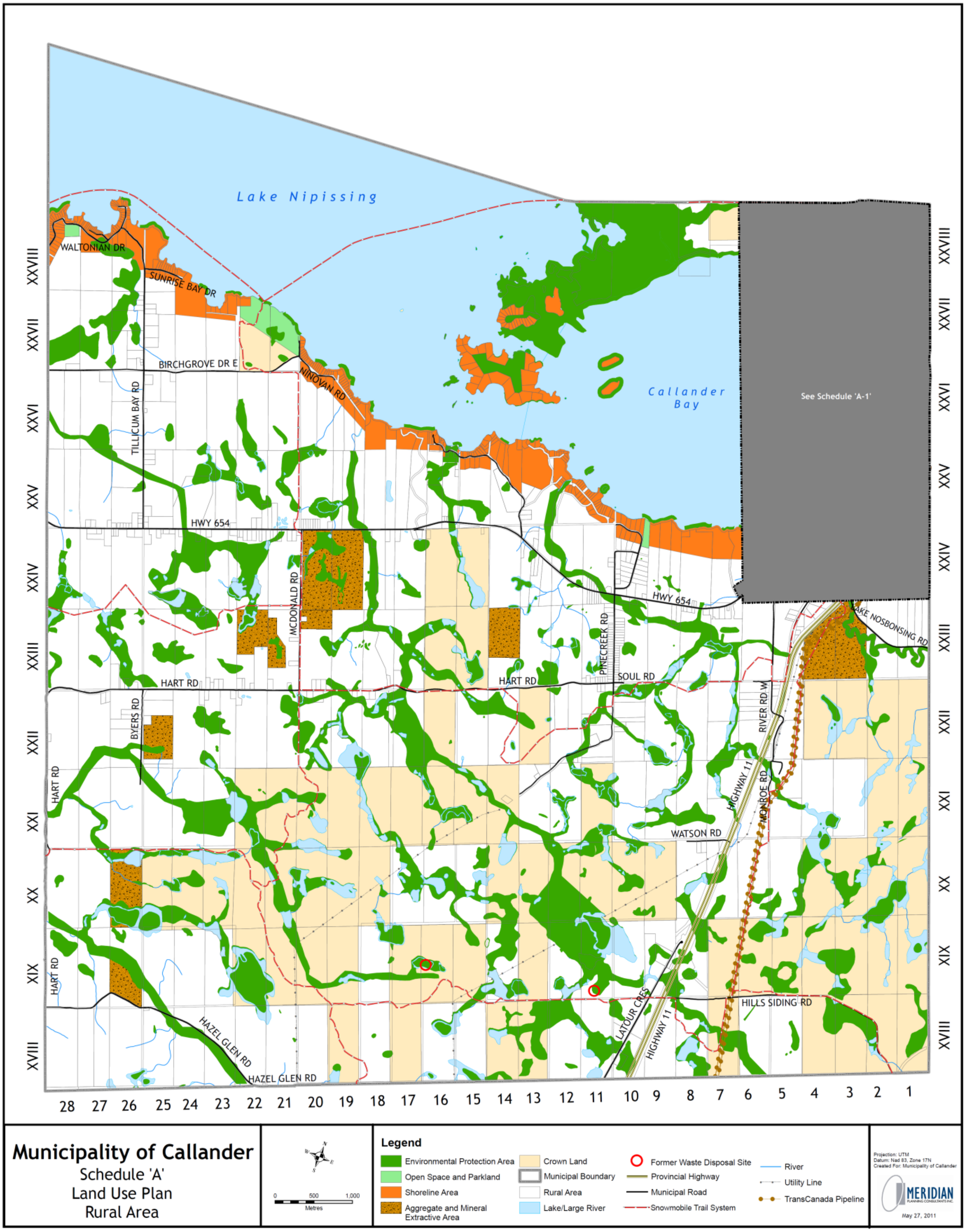
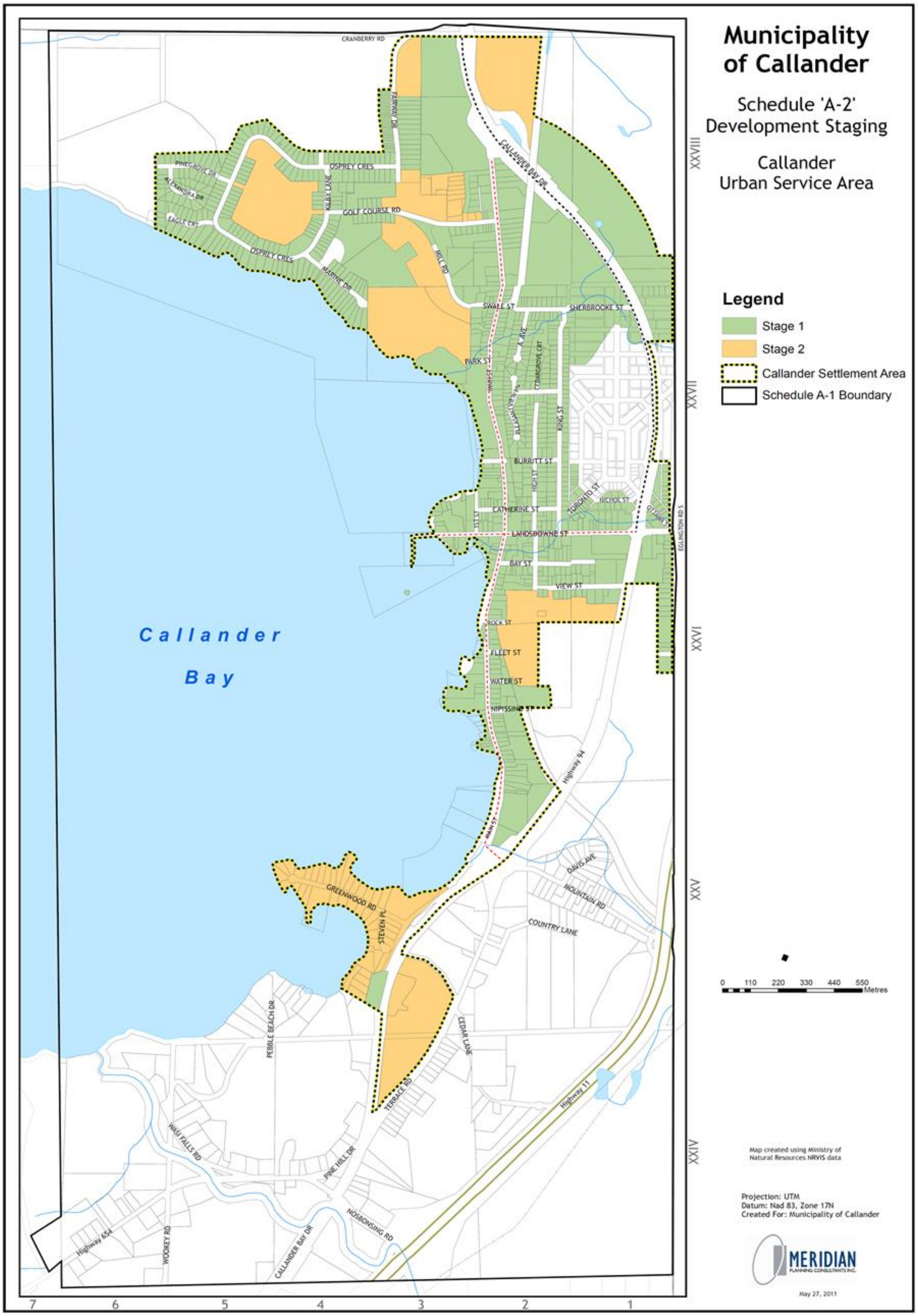


Figure 12.18 Municipality of Callander Settlement and Staging Areas (OP Schedule A-2)



Because floodplain mapping is not available in rural areas, Callander indicates that hazard land information must be generated by studies to support individual development applications and as new information is made available zoning schedules will be altered without Official Plan amendment. The floodplain of Lake Nipissing is subject to the provincial large inland lake policy which is permissive of filling within the floodplain with appropriate approvals. Callander states that the placement or removal of fill in the (lake) flood plain is identified through site plan control and based on advice and direction from the NBMCA.

The Official Plan recognizes the sensitivity of Callander Bay and Lake Nipissing to development pressure, and distinguishes between the south shore of the main Lake Nipissing water body and the shoreline of Callander Bay. Callander Bay is considered over capacity and new shoreline development must meet strict development criteria. The municipality endorses enhanced septic setbacks, use of phosphorous removal septic systems, frequent septic re-inspections, creation of shoreline buffers to protect 90% of the natural vegetation within 20 m of the shoreline and management of storm water drainage by encouraging infiltration along the Callander Bay shoreline. Callander has designated the entire municipality as a Site Plan Control Area which is applied to specific uses of the land including any development of lands adjacent to Lake Nipissing shoreline and development fronting on any watercourse with identified fish habitat.

Land use changes in Callander detected by comparing pre 1990 Forest Resources Inventory (FRI) mapping to 2011 orthoimagery mapping prepared by the NBMCA include:

- Increase in coniferous forest cover within the Callander Settlement Areas as well as along the south shore of Lake Nipissing, except for in the northwesterly quadrant of the township;
- Farms on north side of 654 west of an old school (retirement home) shows expansion of grassed areas. Discussions determined that this area is actively farmed as a cattle operation;
- Reduction in coniferous forest cover is evident in Himsworth Crown Game Preserve;
- Subtle reversal of deciduous/coniferous forested areas in south end of township;
- Increased detection of wetland in the northwestern quadrant but reduced detection of wetland in southern half of the municipality;
- Osprey Links Golf Course and new development on its periphery does not appear on the older mapping but it is very evident at north end of settlement area on the 2011 image;
- South shore of Lake Nipissing – overall development seems less intensive – lots appear to be filling in with vegetation;
- New shoreline development is evident along south shore of Callander Bay – west of Wasi Falls - and on Smith Island at mouth of Callander Bay.

Anticipated Future Growth:

The interview with municipal planning staff in December 2012 identified that Callander is aware that it is attracting regional growth in all age categories. The municipality plans to improve core area retail and service opportunities and to enhance its waterfront to encourage further growth. Callander is working to create additional sewage capacity to accommodate new growth. The municipality recognizes the need to diversify housing options in the community including more affordable options. Past development has mainly focused on the upper scale lower density market. The settlement area has ample developable lands to meet growth projections for the foreseeable future. Areas most likely to develop in the next couple of decades are located in the northern half of the settlement area. Lands near the old Smith mill site have excellent growth potential but waterfront constraints will restrict the creation of waterfront lots due to environmental constraints including provincially significant fish spawning areas. Infilling around the Osprey Links Golf Course is expected to continue. A business and residential growth area identified at the northern entrance into Callander from North Bay is expected to experience growth. The potential for growth in the Callander Bay watershed in the next 25 years is high from both infilling and new development north and northwest of the downtown. The biggest environmental impacts are likely to be in the form of urban stormwater runoff to Callander Bay.

Rural growth and land use changes are restrictive to preserve the rural character. A handful of active full-time farmers continue to exist in the municipality and farming is viewed to be stable or slowly declining. There is a growing hobby farming interest, primarily from people who are interested in keeping horses. Callander doesn't have high class agricultural lands and consequently no provincial restrictions exist on agricultural land. There is a resurgence of farming interest in agricultural lands in northwest quadrant of the municipality. This area was formerly farmed but active farming has been abandoned for some time and the area has started to fill in with brush and drainage is being affected by a lack of drain maintenance. This area is a low lying and often floods at wet times of the year.

A number of properties in the rural area hold aggregate licenses and several are active on a small scale. A new pit and quarry application has been processed for the Himsworth Crown Game Preserve which may have higher production rates if approved. Crown land is abundant in the rural area and is subject to management pursuant to the Nipissing Forest Management Plan. There has not been any recent forestry activity in Callander in part because of poor forestry industry market conditions.

Callander Bay has restrictive planning policies that limit new lot creation. A slow conversion of seasonal uses to permanent uses is occurring over time and large waterfront homes are slowly being built. Some are on new lots. An older plan of subdivision with frontage on Callander Bay exists. This plan received all approvals but servicing of the land with roads has not been advanced. Lot uptake on Grand Trunk Island, which has been substantially subdivided, has been slow due to a Provincially Significant Wetland designation which restricts waterfront uses. Rural residential growth is slow but steady. Most of the future growth in Callander is expected to be channeled into Settlement Area boundaries.

13.5.1.3 Mattawa

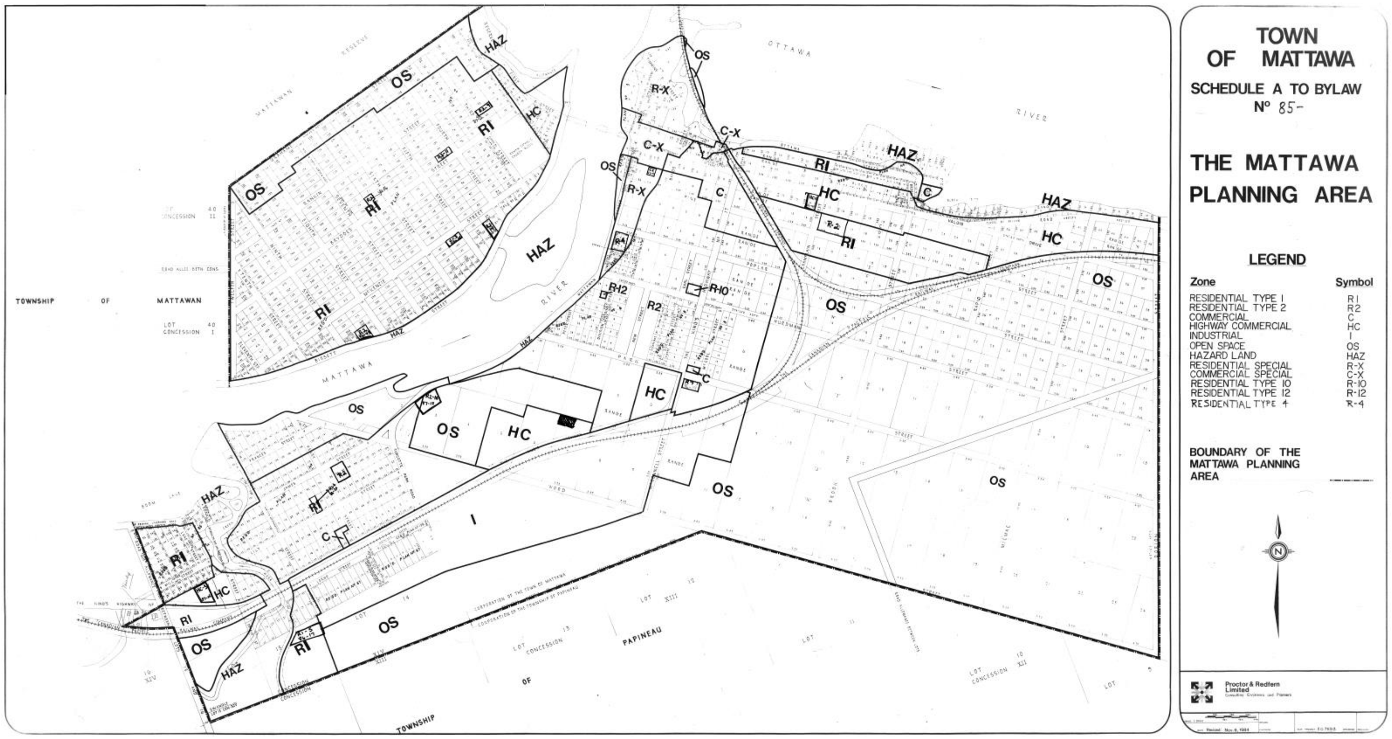
The Town of Mattawa has a population of 2,023 (2011 Census) which is the third largest urban community within the NBMCA and has 2.9 % of the total watershed population. Mattawa is preparing to overhaul it Official Plan, its current plan was approved in 1991 and was based on a planning horizon of 10 years. Mattawa's Official Plan sets out principles to preserve the character of the community, recognizes that the majority of Mattawa inhabitants are employed in the lumber and wood products industry or in tourism and that the town serves a service role for the surround area and for travelers.

Mattawa's population was 2,490 in 1990 when the Official Plan was prepared and a trend of declining population was noted at the time. The Mattawa Official Plan projected community growth and set out policies to support a design population of 3,000. Mattawa set an objective to maintain sufficient serviced land to accommodate residential, commercial, recreational and industrial expansion. Mattawa expected diversification of its economy. Mattawa municipal water is sourced from an alluvial aquifer under the town which is described in detail in the Groundwater Section. Sewage Treatment is provided through lagoons on the north bank of the Mattawa River in Mattawan Township west of the town. Mattawa's rural area makes up approximately 40 % of its total area south of the railway lines. Mattawa supports limited rural growth but prohibits rural subdivisions. The Planning Area of the Town of Mattawa is presented in Figure 12.19

Mattawa has recognizes lands along Highway 17 through a Highway Commercial designation where service and tourist commercial uses are encouraged. An industrial development block south of the CPR line adjacent to the Highway 17 corridor is recognized. Mattawa experiences flooding from both the Mattawa and Ottawa Rivers and floodplain lands are designated as Hazard Land or Open Space. The floodplain of both the Mattawa and Ottawa Rivers are supported by detailed floodplain mapping and regulatory flood elevations are established for these areas. It is noted that the NBMCA does not have regulations on the Ottawa River.

The current Mattawa Official Plan does not reflect recent provincial policy statements and it is outdated in many areas. It lacks many modern planning instruments including Site Plan Controls. It is presumed that the Official Plan will be updated shortly to address these issues.

Figure 12.19 Town of Mattawa Planning Area



Land use changes in Mattawa detected by comparing pre 1990 Forest Resources Inventory (FRI) images to 2011 orthoimagery include:

- Only a portion of Mattawa within the NBMCA jurisdiction was mapped for analysis purposes, the area that Mattawa covers is fairly small and most of Mattawa shows up as being urbanized.
- Due to resolution developed areas have vegetation and ground cover details visible on the newer image that makes development look less intense.
- Otherwise limited changes are detected between the two images.

Anticipated Future Growth:

An interview with Mattawa municipal planning staff occurred in January 2013. Mattawa has encountered significant construction activity in the past 5 years which has helped to sustain the local economy. Mattawa is receiving new development interests and a new Industrial Park at the east end of the town has recently been established. Mattawa has close ties to the surrounding townships and it even started extending urban services to homes in Mattawan Township along the Mattawa River but services have been withdrawn as people opted to go on private services to avoid municipal billing. The area is experiencing high interest in waterfront development which includes the Mattawa and Ottawa Rivers. There are limited urban expansion possibilities within the boundaries of the Town of Mattawa as the urban service area is almost fully built out to serviceable portions of the community.

In the Mattawa region there is a rural demand for larger land parcels and many people from the south are buying large recreational properties or invest in seasonal properties (on water)(some expensive places have been build – the "Muskoka" effect is evident on a small scale). People buying and moving to the area are often retiring. Land prices in Mattawa are low compared to southern Ontario and immigrants can used freed up equity to enhance living/enjoyment/quality of life. Due to the downturn in the forestry sector, more split families are evident in town where one wage earner leaves the community to work out of town for weeks or months at a time. This has strained the social structure of the community. Families affected by the down turn in the forest industry are staying in Mattawa hoping for better times or stay because there are limited other affordable options available.

With respect to tourism and use of parks in the area, Mattawa reports that Sid Turcotte Park, a local operator in the town, has been very successful. New owners are investing in the facility and have recently added municipal services to cabins and trailer sites. Mattawa does not have many "Mom and Pop" type cabin/campground operation and the "drive by" operations catering to the tourism market on Highway 17 seem to be surviving okay. Samuel de Champlain Provincial Park seems to have a growing interest from people from Southern Ontario with more diverse ethnic backgrounds that are interested in the outdoor camping experience. The park attracts people interested in "roughing it" at a modest price. The Canadian Ecology Center offers more luxurious accommodations and has carved out niches markets of people interested in environmental education and eco-tourism. They are catering to larger youth and adult groups.

Future growth and development initiatives in the Town of Mattawa are difficult to assess until the Official Plan is updated.

12.5.2 Rural Municipalities

Most of the organized municipalities within the NBMCA are rural in nature and while some have hamlets, they all currently depend on private water supply and waste water disposal servicing. Rural municipalities include East Ferris, Bonfield, Chisholm, Calvin, Papineau/Cameron, Mattawan and Powassan. Calvin, Papineau/Cameron and Mattawan have developed a joint Official Plan for a planning area called East Nipissing. While Powassan has an urbanized center, most of Powassan is outside the NBMCA's area of jurisdiction including its urban area. The Integrated Watershed Management Plan is assessing several watersheds (Wasi, Boulder, Bear and Windsor) which partially drainage through Powassan and consequently policies affecting Powassan rural areas have been included below.

Land use changes identified by comparing pre-1990 Forest Resources Inventory (FRI) images to 2011 orthoimagery mapping developed by the NBMCA were very similar in all rural municipalities. Consequently observations are summarized for all rural municipalities as follows (note: observations for individual municipalities are available):

- Overall coniferous forest cover is increasing (previously deciduous forests are now mixed forests) however the trend is not universal and isolated areas have encountered a reduction of coniferous growth;
- In general wetland areas have declined which may suggest that the 2011 imagery was taken at a time of drought/low water. Again this is not universal and there are isolated areas which appear to be wetter. Each municipality provides a different level of service when dealing with beavers/beaver dams and some wetland characteristics observed may be due to beaver management activities (some municipalities are actively removing beavers and beaver dams on a continuous basis while others only react when problems are identified);
- Changes to some vegetative categories were difficult to assess because new imagery has less sensitivity to distinguish between some vegetative cover types. Consequently beaver meadows, grassed farmland and cultivated farm land are all mapped as agriculture in the more recent image. This lack of distinction was also noted for deciduous and alder forests which are all mapped as deciduous forests in the 2011 image.
- Despite the above, cultivated and grassed farmland appears to be declining slightly at the fringes of rural settlement. Overall the decline in agricultural lands are minimal;
- There was no identification of recent forestry activity on patented land or on crown land within the boundaries of member municipalities. There is evidence of previously harvested areas in southern Papineau. This area has grown up into a mix forest. Cutting on Crown land is assessed in Section 13;
- In almost all cases urban and developed areas on the 2011 image seemed less intense in part due to a higher resolution which detects vegetation within development envelopes and in part due to the maturing of forest cover in urban/developed areas. Shorelines have more vegetation evident possibly due to management activities to establish shoreline vegetative buffers.
- Roads and utility corridors across the NBMCA seem similar in both images. The exceptions noted are the Trans Canada Pipeline corridor which has filled in with vegetation and the abandoned CN rail corridor which is less evident in the 2011 image (from North Bay through Chisholm Township.

Growth and land use trends in rural municipalities are profiled in the following sections.

12.5.2.1 East Ferris

The Municipality of East Ferris has a total population of 4,512 (2011 Census) and is the largest rural municipality within the NBMCA jurisdiction and second largest overall. It has the second fastest growth rate within the NBMCA after Callander. The East Ferris Official Plan was approved by the Province in 2004 and a 5-year review is currently in progress. East Ferris has an objective to maintain a 10-year supply of approved lots to accommodate residential growth. The municipality anticipates an annual growth rate of between 1 to 1.6% (70 to 80 people/ annum) and projects a population of 5,882 by 2017. The East Ferris Official Plan Land Use and the Natural Heritage Features Schedules are presented in Figures 12.20 and 12.21.

East Ferris has set out planning principles to concentrate development in the Hamlets of Corbeil, Astorville and Derland (on private services) while allowing dispersed rural development along roadways which preserves its rural nature. East Ferris acknowledges close ties to North Bay with many of its resident depending on the regional center for employment and commerce. East Ferris is balancing rural residential growth and home based businesses, with resort, service commercial, building and construction supply, transportation services, light manufacturing and dry industries uses (not requiring municipal servicing). The types of uses encouraged in Hamlets include low density residential, local and service commercial, institutional uses and community facilities. Commercial uses which cater to local needs are also encouraged along major roadways.

The Municipality of East Ferris also recognizes the potential for growth along the shoreline of Lake Nosbonsing and Trout Lake and strict policies exist for these areas. Recreational vehicle parks are recognized and generally permitted along shorelines provided that strict planning criteria are met. East Ferris has two rural estate residential subdivisions, outside of hamlet areas, which have remaining capacity. New rural estate subdivisions will only be considered on a phased in basis to protect the uptake of existing rural subdivision lots.

East Ferris promotes Official Plan policies that encourage economic development and that create an “open for business” atmosphere. As well as maintaining a reserve or approved residential lots, East Ferris states it will create a reserve of larger parcels for industrial use.

Land uses on both Lake Nosbonsing and Trout Lake are controlled through a Resort Recreational District - Lakeshore Protection Policy. Development on Trout Lake and on eastern Lake Nosbonsing must meet minimum lot size criteria and strict environmental controls. Controls include increased septic system setbacks, establishment of a shoreline vegetative buffer, filing proof of regular septic pump outs, use of best available phosphorous removal septic treatment technologies and careful screening of non-residential development proposals. The shorelines of both lakes are designated as site plan control areas. New lot creation is prohibited on the

Figure 12.20 Municipality of East Ferris Land Use Plan (Official Plan Schedule "A")

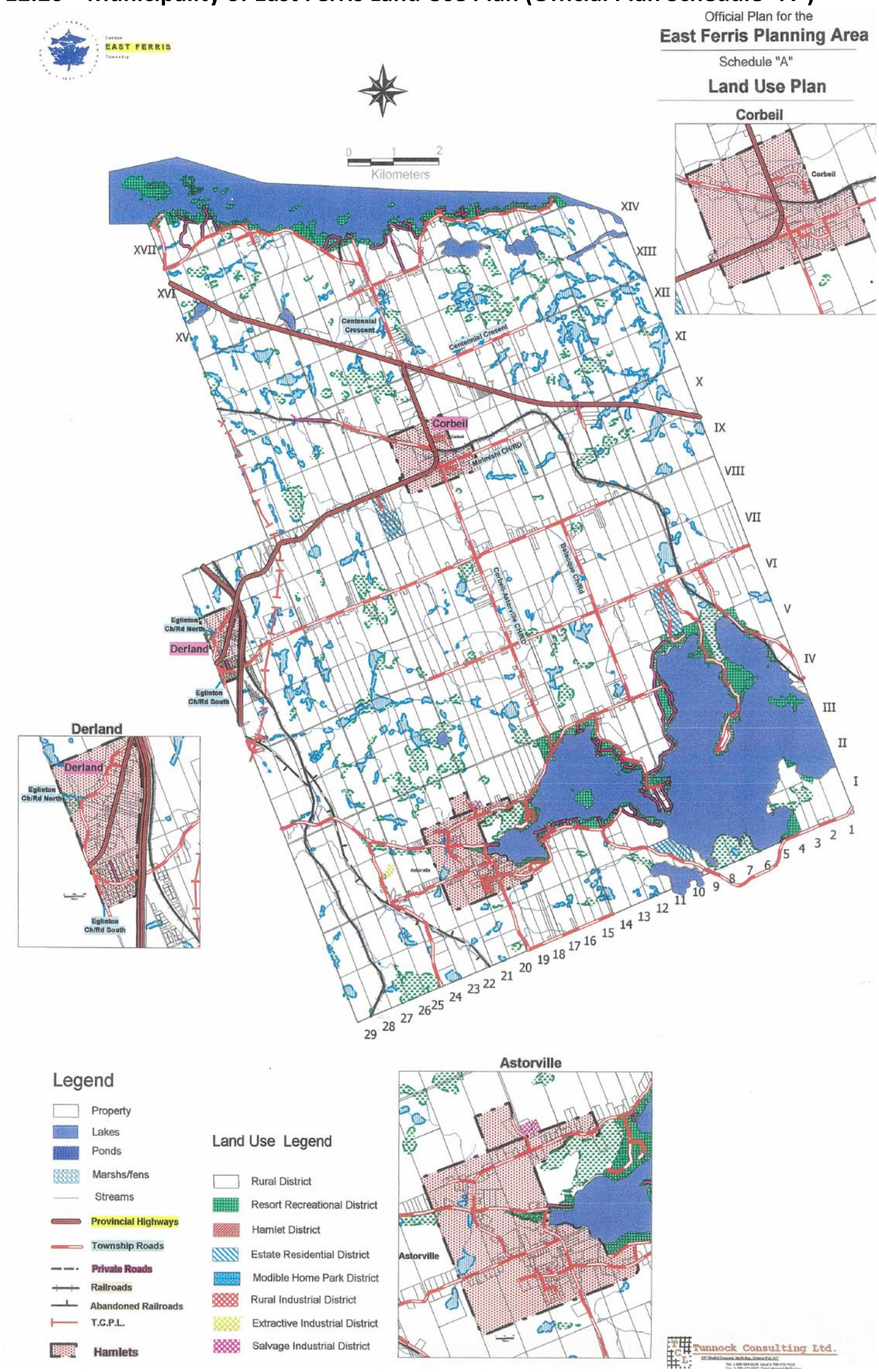
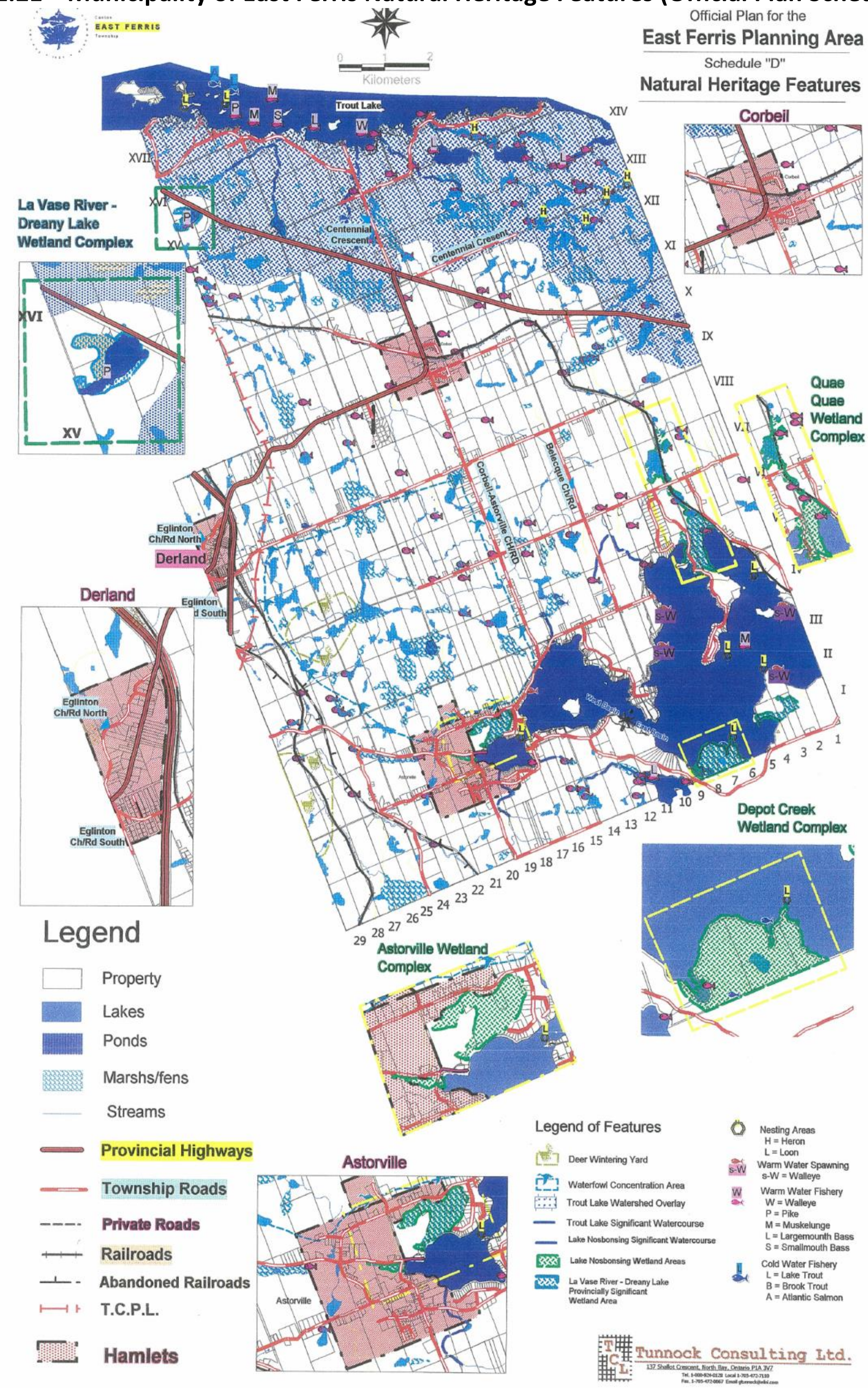


Figure 12.21 Municipality of East Ferris Natural Heritage Features (Official Plan Schedule D)



Note: This plan mistakenly show the Trout Lake watershed as the La Vase/Dreany Provincially Significant Wetland western portion of Lake Nosbonsing unless septic systems can be located more than 300 m from the shoreline. It is the intention of these policies to maintain Trout Lake as an oligotrophic water body and the eastern half of Lake Nosbonsing as a mesotrophic water body. The western half of Lake Nosbonsing is considered eutrophic and at capacity. Specific lake management issues include shoreline conversion from seasonal to permanent, problems with private road access and general water quality impacts from shoreline development.

The East Ferris Official Plan identifies natural heritage features within its boundaries. The La Vase River/Dreany Lake Wetland Complex as recognized a provincially significant wetland and several other wetlands in the township as identified as locally significant. Other recognized natural heritage features include deer wintering areas, waterfowl staging and nesting areas and fish habitat. Development in the vicinity of natural heritage features may be considered if supported by an Impact Assessment Study. East Ferris recognizes several types of hazard lands including floodplains, steep/unstable slopes and organic soils. Floodplains along major waterway systems are supported by regulatory floodplain mapping. Compliance with recent Provincial Policy Statements is expected from the current OP review.

Development in Hamlets of Astorville, Corbeil and Derland are controlled through the Hamlet District Policy. It is the intent of East Ferris to focus growth in Hamlets without stimulating the need for urban services. The Township acknowledges that a large number of approved undeveloped lots exist within Hamlets. Within a Hamlet the minimum lot size is 0.6 hectares and new lots can be created through Consent or Plan of Subdivision. Commercial and institutional uses are encouraged in Hamlets if they front on a major roadway. These uses are expected to cater to local needs as well as the travelling public/tourists. Light industry may be considered in Hamlets if uses can be compatibly integrated. East Ferris is open to considering communal servicing. It is noted that NBMCA regulations do not apply in the Burford Creek/Callander Bay drainage areas within East Ferris.

Anticipated Future Growth:

An interview with municipal planning staff in November 2012 identified that East Ferris is primarily growing through individual severances of one or two lots on large land parcels in the rural area intended for residential development. East Ferris is averaging approximately 10 new lots per year through consent. New Plans of Subdivisions in East Ferris are rare. The population of East Ferris is primarily increasing through the immigration of younger families, many are moving from North Bay, attracted to a lower cost of living, the opportunity to have a larger lot and because there is more freedom to establish home based businesses. The completion of the four lane highway from Toronto has increased demand for seasonal properties but the supply of seasonal properties is dwindling as cottages convert to permanent residential uses. Most shoreline development pressures are experienced on Lake Nosbonsing.

Economic growth in East Ferris is primarily being achieved through new home based business startups. There are still a handful of full time farmers in East Ferris and existing farm activity seems to stable. There is a growing interest in hobby farming were employment is not dependent on the farming operation. The larger rural lots are attractive to raise horses, poultry or to have a large garden for personal consumption. Limited forestry activity occurs in the township (any change in forest cover is not due to forestry operations) and only one pit/quarry exists in East Ferris. East Ferris has limited aggregate reserves. The Municipal Council is very motivated to stimulate economic development and municipal assets are being studied to determine what might be offered for development. Growth is expected from the continued expansion of home based businesses and on two brownfields that have development potential (former gas stations at the intersection of Highway 94 and 17 and near Astorville across from Perron's Building Supply).

East Ferris is expected to continue to benefit from its close proximity to North Bay and growth rates for the foreseeable future should be maintained. Most growth is expected in the residential sector as East Ferris serves a bedroom community to the regional center. This growth will continue to put pressure on the shorelines of its two main water bodies. Seasonal uses will decline and permanent uses increase. The four laning of Highway 17, which is likely beyond the horizon of existing planning exercises, will have a large impact on East Ferris from changing traffic patterns.

12.5.2.2 Bonfield

The Township of Bonfield has a total population of 2,016 (2011 Census) and is the second largest rural municipality within the NBMCA's jurisdiction. Bonfield is completing a new Official Plan and the latest Draft was posted in August 2012. The old Official Plan, which is still in effect, is out dated. The new Draft Plan projects that Bonfield will reach a population of 2,094 (also quantified as 837 housing units) by 2031 (an increase of 43 housing units over 2011). The following discussion is based on the draft plan which is subject to change until it is approved.

The Township of Bonfield Draft Official Plan Schedule A Land Use Designation Plan is presented in Figure 12.22. The Draft Official Plan Schedule B Natural and Cultural Heritage Features is presented in Figure 12.23.

The Bonfield Draft Official Plan sets out guiding principles to maintain the rural character of the municipality and to only allow development that does not require municipal water and waste water servicing. Concentrated development will be encouraged within the Hamlets of Bonfield and Rutherglen through Plans of Subdivision. Infilling will be encouraged in rural areas through rural estate subdivisions and consents. The Draft Plan identifies the need for policies to be welcoming to tourists and seasonal residents while meeting the needs of permanent residents. Agricultural, forestry, mineral extraction and recreational uses are encouraged within rural areas while commercial, industrial and public service uses are promoted in Hamlets. Bonfield has adopted provincial Growth Plan for Northern Ontario themes including the economy, communities, infrastructure, the environment and Aboriginal peoples.

Schedules for the Hamlets of Bonfield and Rutherglen are presented in Figures 12.24 and 12.25. Permitted uses in Hamlets include residential, local-serving commercial, conservation and public recreation uses as well as institutional and light industrial uses. Bonfield states that all development must be serviced by private water and sewage treatment systems but the door is left open to consider other options based on the preparation of a Servicing Options Report. The Hamlet of Bonfield is divided into a Residential Focus Area and a Community Core Focus Area. Commercial, institutional and public recreational uses are permitted in the Community Core Focus Area. The Hamlet of Rutherglen has a Residential Focus Area and an Employment Focus Area where commercial and light industrial uses will be considered in the latter area.

Growth in Bonfield is being stimulated by permitting small businesses to operate within a residential uses; by supporting community functionality through the provision of needed roads and infrastructure; by conforming local economic development efforts with regional economic plans; by recognizing and protecting environmental resources such as ANSIs, Conservation Reserves and shorelines; and by identifying key natural resources (such as sand and gravel deposits) needed to meet long term township needs. Bonfield has adopted a vision statement from its 2003 Economic Development Strategic Plan which strives to balance the protect natural resources and wilderness areas with economic interests and a healthy, connected and equitable social environment. Bonfield identifies guiding principles to meet Northern Ontario Growth Plan themes.

Within the rural area Bonfield intends to maintain a rural setting of predominantly agricultural and low density residential uses. Permitted uses include agricultural, forestry, conservation and public recreation, golf courses, institutional, industrial and commercial (servicing the surrounding community), lower density residential, hunting, trapping and wildlife management as well as uses which support agricultural. New rural residential infilling will be permitted through consent or subdivision. Ribbon development is discouraged. Bonfield has established new policies to permit secondary dwelling units or temporary garden suites in Hamlet and rural areas. Community and roof top gardens are promoted to provide alternative food sources for residents. New policies are being contemplated to encourage the planting of trees in Hamlet areas.

A Recreational Area Designation protects shorelines of major water bodies. Specific policies have been drafted for Lake Nosbonsing, Lake Talon and Kaibuskong Bay which are considered important community resources. The Township states it intends to maintain and improve the quality of water, aesthetics and fisheries of these water bodies. The Township recognizes that

Figure 12.22 Township of Bonfield Draft Official Plan Land Use Designation Plan (Schedule A)

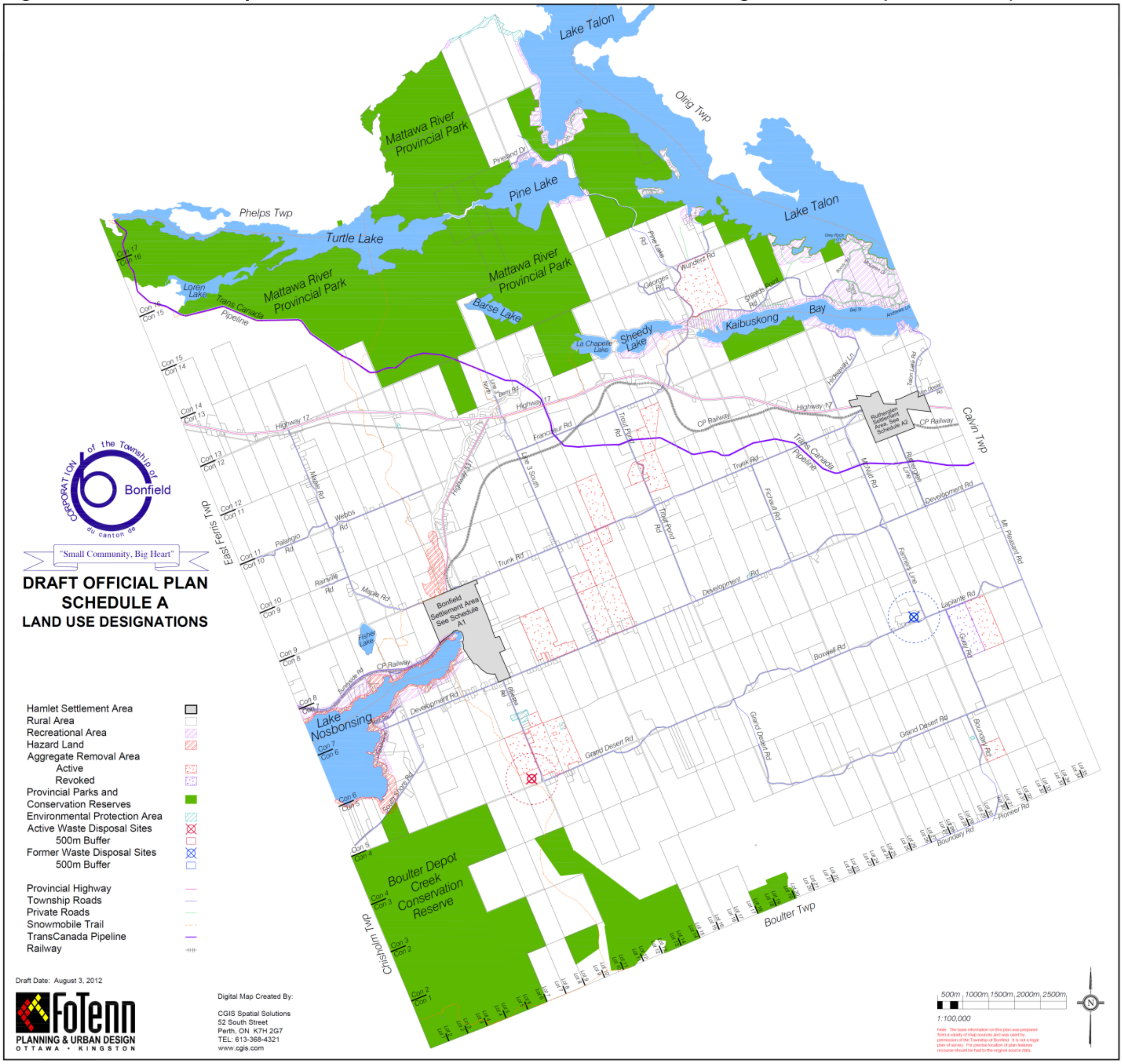


Figure 12.23 Township of Bonfield Draft Official Plan Natural and Cultural Features (Schedule B)

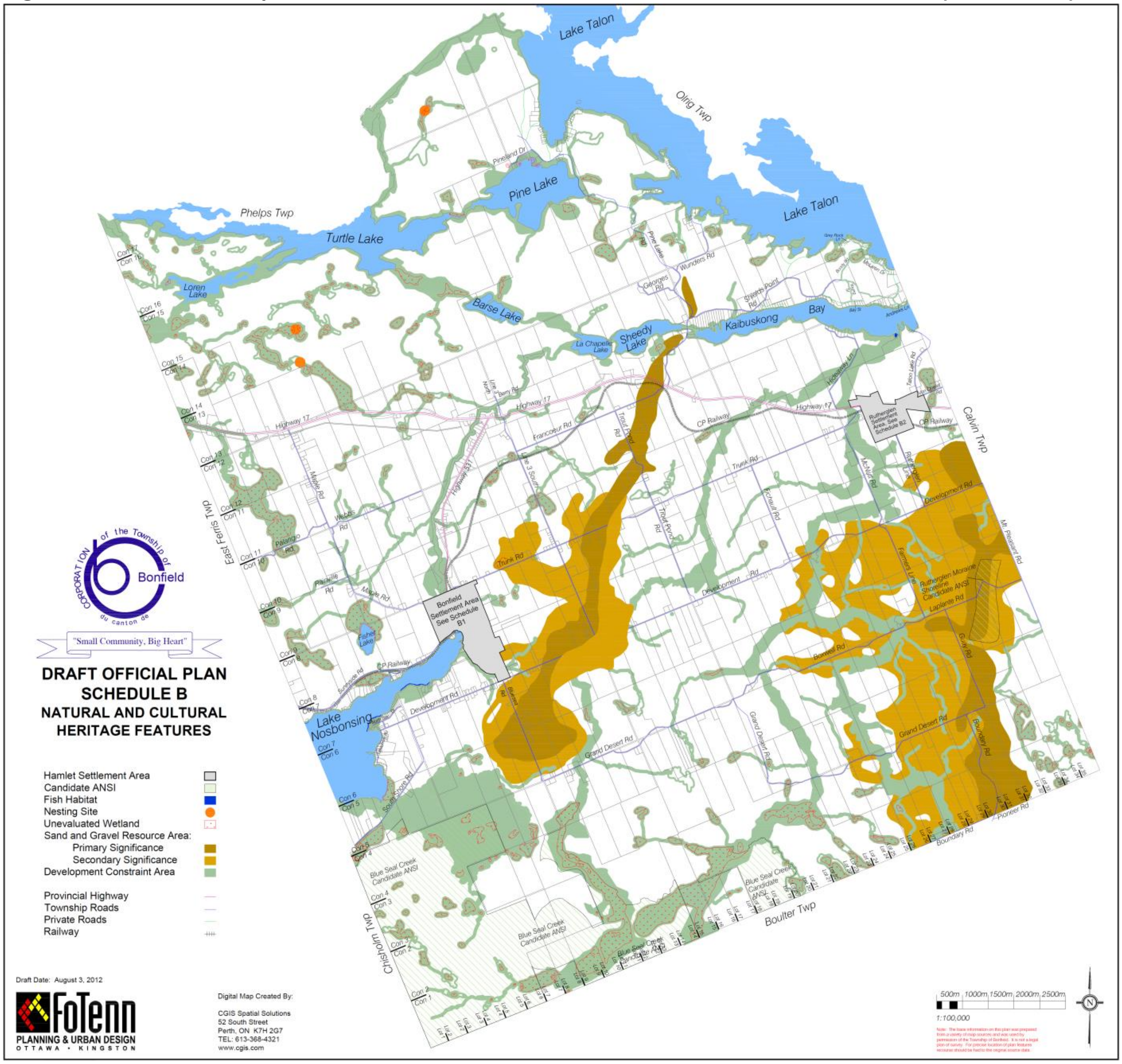


Figure 12.24 Hamlet of Bonfield (Draft Official Plan Schedule A1)

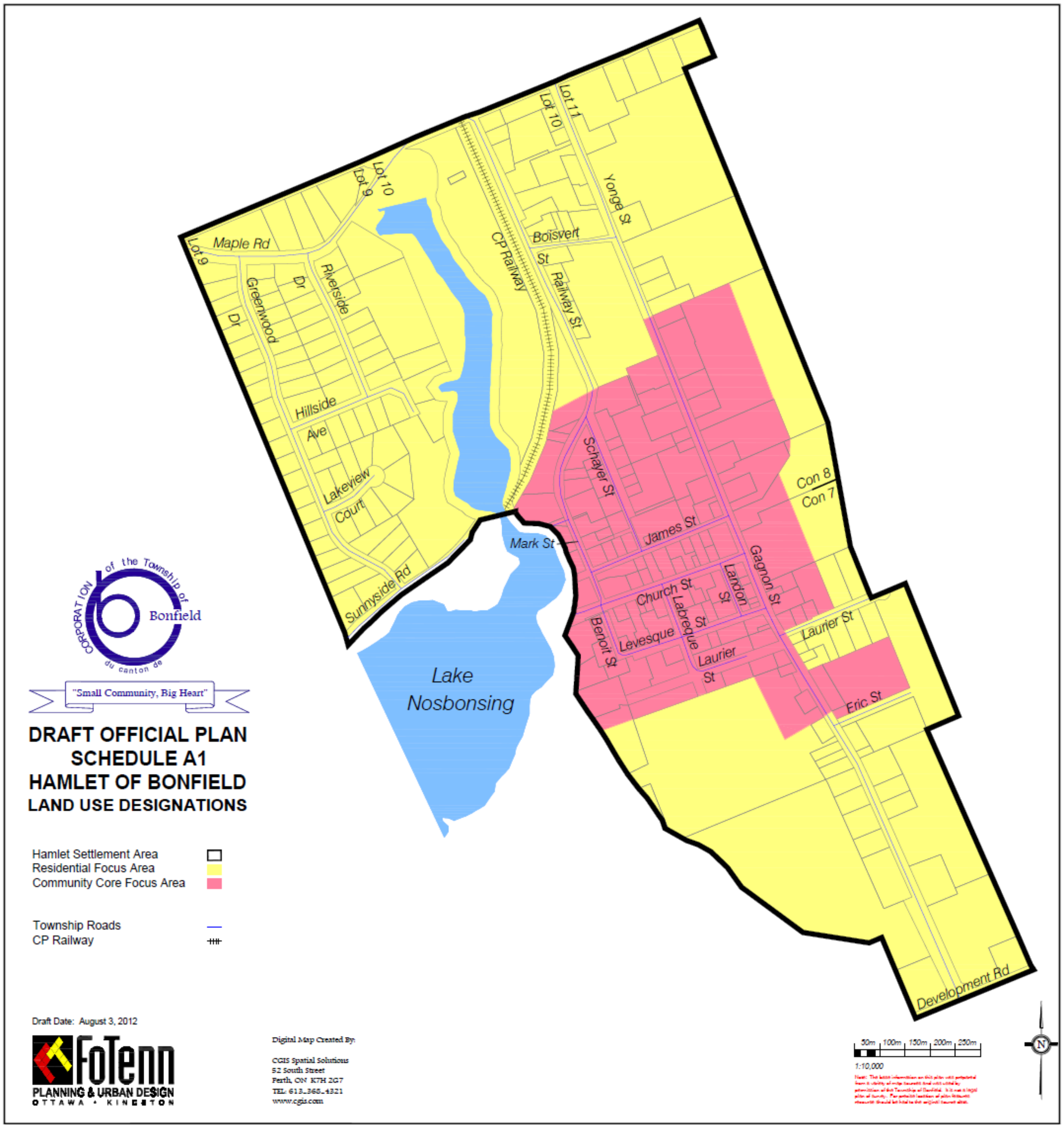
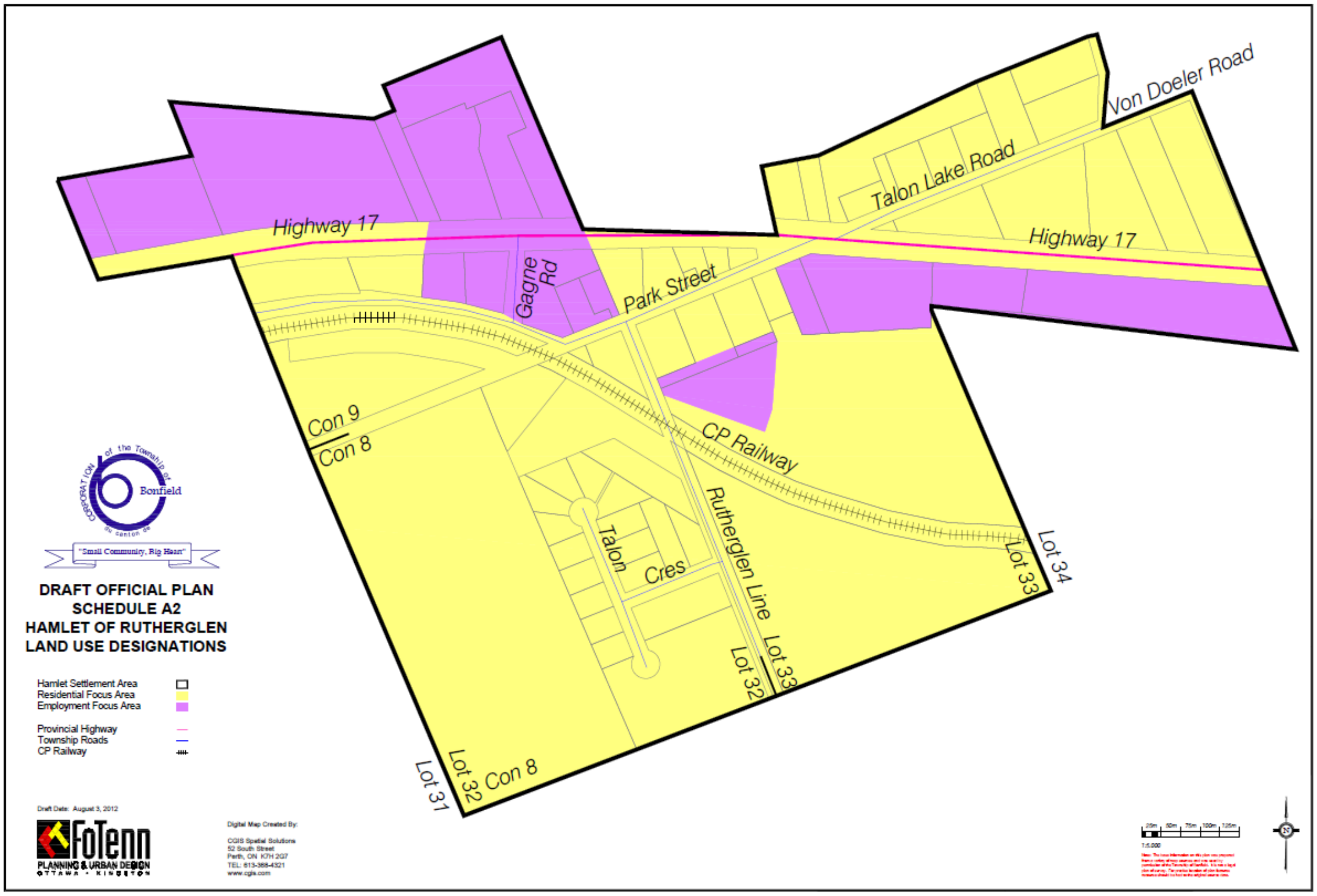


Figure 12.25 Hamlet of Rutherglen (Draft Official Plan Schedule A1)



limited development capacity remains on its lakes and polices have been established for lakes with capacity and for lakes at full capacity. Where lakes still have capacity, new septic systems and major structures must meet strict setback requirements and owners will be subject to a new proposed bylaw to regulate septic pump outs. Bonfield also has introduced new polices to establish permanent shoreline buffers and to require the use of silt control features during construction. When lakes are deemed to be at capacity new lots will only be considered if septic systems are located more than 300 m from the shoreline or septic discharges can be directed to a different watershed. A study is required to demonstrate that new development does not increase phosphorous loading to the lake. Lake development will also be subject to NBMCA approval, provincial review and the application of principles contained in the provincial Lakeshore Capacity Assessment Handbook.

Lake Nosbonsing and Lake Talon have known regulatory flood elevations and floodplain areas are designated as Hazard Land. Flood prone areas within the rest of the municipality are protected through a Development Constraint Area designation, which establishes a 45 m setback from hazardous features unless reduced by a site inspection carried out by the NBMCA.

Bonfield has a Natural Heritage policy which protects natural heritage features including ANSIs, endangered and threatened species, fish habitat and nesting areas. Bonfield has two identified candidate ANSIs: Blueseal Creek Hill Candidate ANSI and the Rutherglen Moraine Shoreline Candidate ANSI. Proposed development or site alteration within 120 m of a Natural Heritage feature or within 50 m of an Earth Science ANSI must be supported by an Environmental Impact Study. While no Provincially Significant Wetlands have been identified in Bonfield, the Township has established a wetland policy. Development may only be permitted near a wetland if it is demonstrated that the natural features and ecological functions are not negatively impacted through an Environmental Impact Study.

Anticipated Future Growth:

An interview with municipal planning staff in December 2012 identified that Bonfield is averaging about 10 new housing starts per year. In 2012 there were 14 new building permits issued. New development is scattered throughout the township. Limited growth is occurring in hamlets. On Lake Talon and Lake Nosbonsing Bonfield issued between 1 to 2 building permits per year mostly for permanent homes. Bonfield does not have Class 1, 2 or 3 agricultural lands and traditional agricultural operations are slowly declining. Some fields are starting to grow in. Some fields have been planted with trees and a tree farm operation has been established at the east end of the township. There is a gradual shift to hobby farming with interest in buying land where they can own horses (5 is the maximum number of horse a single owner can have before they need to have a nutrient management plan). There is growing interest in the Township in horse riding, jumping and horse shows. Many rural properties have outdoor show jumping facilities and some people are put up large indoor riding shelters. Shows (both English and Western) are held throughout the summer at the Agridome and many Bonfield residents participate in horse shows and events held across the province.

Bonfield has significant aggregate reserves (in esker deposits) as well as many aggregate license holders. Aggregate mining is a significant activity within the township and with substantial reserves this activity is likely to increase in the future. The Miller Group has opened a large pit in central Bonfield which has significant reserves. Eskers are attractive because of a low water table and pits are not restricted by depth. Consequently significant excavations can be made. A number of smaller aggregate operations also exist within the township. The Township gives higher priority to aggregated operation (half load are sometimes waived in the spring). Aggregates are favoured over groundwater within the esker complexes. One bottled water operation has purchased lands in southern Bonfield for a possible water bottling plant (not within an esker formation).

Bonfield experiences a significant seasonal population shift which swells the community by 50 to 100% in the summer. Of the 925 residential properties within the township approximately 150 are seasonal dwellings mostly on lakes. Additionally there are vacant waterfront properties that are used for camping or have trailers and there are several trailer parks within the region. Bonfield serves as an economic and supply hub for the seasonal population outside of the township. There is a permanent population in Boulter Township; the permanent population is estimated to be equal to or greater than Lauder Township. Lakes in Boulter are heavily used in the summer for unofficial camping and trailering. Boulter is also heavily logged with logging trucks travelling through Bonfield but forestry as an activity in Bonfield Township is limited.

To a small extent Bonfield is experiencing what it describes and the “Muskoka affect” where people are moving to the area to build big home on lakes which are used year round. This is in part attributed to the completion of the Four Laning of Highway 11 between Toronto and North Bay. Bonfield experiences limited new seasonal housing starts. A new drag strip, expected to open in 2013, will attract tourist to the area and provide local entertainment.

Bonfield seem poised to continue growing at current rates. It is more independent than other rural communities that have close ties to North Bay, Callander or Mattawa and some of this growth is likely to be service oriented. Bonfield has significant resources that are under development pressure including lakes and aggregates. Bonfield also has active rural community that offers a desirable country life style. Most of the future growth in Bonfield will be in the rural area and on shorelines of lakes.

12.5.2.3 East Nipissing Planning Area

The East Nipissing Planning Area encompasses the Townships of Calvin, Mattawan and Papineau-Cameron. The Official Plan for these townships was only recently created relative to other municipalities within the NBMCA. The Planning Area was created in 1998 and the planning horizon identified in the Official Plan is 20 years or to 2018. The Plan has gone through one 5-year review with modifications approved by the Province in January 2010. This planning areas has a combined population of 1,708 (568 in Calvin Township, 162 in Mattawan Township and 978 in Papineau-Cameron Township) based on 2011 Census data. The planning area was experiencing positive growth when the original Plan was written (population was reported to be 1,650 in 1997) and a target population of 2,560 was identified for 2018 assuming a slow growth scenario at the time. This projection was based on the expectation that 178 new jobs would be created by 2005 (new employment was expected in the forest industry and from the establishment of the Canadian Ecology Center).

The East Nipissing Official Plan identifies that the planning area has close ties to the forestry industry. Tembec and Columbia Forest Products are identified as dominant local employers (both operations are now closed). Farming is also an important land use primarily in Calvin Township. The Official Plan identifies the importance of linear corridors through the Planning Area including Highway 17, the CPR, TransCanada Pipeline, Bell Fiber Optics and recreational corridors for snowmobiling as well as the Mattawa and Ottawa Rivers which form waterway corridors. Three quarters of the Planning Area is in Crown ownership and resource harvesting on Crown land is considered important to the local economy. The Planning Area is endowed with significant recreational lands including Samuel De Champlain Provincial Park, Mattawa River Provincial Park, Eau Clare Gorge Conservation Area and is has close proximity to Algonquin Provincial Park. The Official Plan identifies that parkland supports a healthy tourism industry within the planning area.

The Official Plan sets out policies to maintain a rural landscape. The planning area contains no hamlet areas and consequently commercial uses such as convenience stores are permitted at major intersections (municipalities rely on North Bay and Mattawa for commercial and economic services). Low density residential development is encouraged through infilling along the existing municipally maintained roads by way of consent. The East Nipissing Official Plan recognizes pressure for waterfront development on the Mattawa River, Ottawa River and on smaller inland lakes. A second "garden suite" unit can be provided on a rural lot to meet independent living needs of the disabled or the elderly. Home based businesses are encouraged. The planning area encourages consolidation of existing smaller lots to meet the minimum rural lot size requirements.

The East Nipissing Planning Area has identified an "Employment Area" west of Mattawa between Highway 17 and the Mattawa River which is intended for concentrated light industrial commercial and institutional uses. New "Employment Area" uses will be subject to servicing and compatibility assessments. Highway 17 is the main thoroughfare through the planning area and industrial and commercial development are encouraged to locate along this corridor (value added "dry" uses are encouraged such as salvage yards, sawmills, planing mills, veneer mills, mines, smelters, and mineral aggregate crushing or processing operations) . All development must rely on private water and waste water treatment, although communal servicing may be considered. The plan states that municipalities within the planning area are willing to assume ownership of communal works once a Certificate of Approval is issued.

New lot creation on rivers and lakes are generally permitted within the East Nipissing Planning Area subject to strict conditions. New development may be approved on inland lakes (including Papineau, Smith, Crooked Chutes, Earls) if water quality (within the limit of a lake's capacity) and fish habitat are not adversely affected and natural heritage features are protected. It is the policy of East Nipissing to protect shoreline vegetation. Impact Assessment Studies may be required and new lot creation is mainly expected through Plans of Subdivision. The Official Plan identifies the need to increase public accesses to water bodies within the planning area and municipalities are encouraged to accept lands which provide public lake access through parkland dedications.

The East Nipissing Official Plan also contains policies related to energy, air quality, water quality and water quantity. Energy and air quality policies promote the development of a number of renewable energy uses including solar, wind, biomass, geothermal and small hydro up to 20 megawatts. Water quality and quantity protection strategies include enhanced requirements for setbacks along shorelines, identification and protection of groundwater recharge and discharge areas and the management of stormwater. Other initiatives identified includes establishment of development capacities for inland lakes, undertaking routine monitoring, encouraging septic pump outs and applying new septic technologies that reduce phosphorous loading.

The East Nipissing Official Plan contains resource management policies that recognize the importance of agricultural lands, aggregates, mineral resources, forestry, natural heritage features, and water resources. East Nipissing uses an "Influence Area" to protect pits and quarries from incompatible encroachment and to maintain setbacks from waste disposal areas. Mineral resources are protected through a development constraint overlay which covers a significant portion of the planning area. A "Water Resources Protection Strategy" recognizes the importance of studying and collecting environmental data that may assist in land use planning decisions. The Plan recognizes the need to develop a comprehensive water resource protection strategy for the region which would include protection of local aquifers. The plan also identifies the need for the province to consult with municipalities before crown land is sold or transferred. There is significant local interest in the management of the Nipissing Forest.

The East Nipissing Official Plan also contains a "Natural and Human-made Hazards" policy. Flood elevations are available for most large water bodies including the Mattawa and Ottawa Rivers where development is present. Hazard lands not on major systems are protected by a 45 m setback from shorelines/high water marks which may be relaxed based on the written opinion of the NBMCA. No new buildings are permitted within the floodplain except minor structures considered low impact such as docks, boathouses, gazebos and storage sheds. Building expansions within the floodplain will be considered on a site-by-site basis.

Individual Official Plan Schedules have been created for each township within the Planning Area. Schedule A1 for the Papineau portion of Papineau-Cameron is presented in Figure 12.26. Schedule A2 for Mattawan Township is presented in Figure 12.27. Schedule A3 for Calvin Township is provided in Figure 12.28.

Future Growth and Land Use Change:

To better assess changing land use trends in the municipalities that make up the East Nipissing Planning Area Stantec interviewed municipal staff of the Townships of Calvin, Papineau-Cameron and Mattawan in December 2012 and January 2013. Each municipality is discussed separately. Growth and Land use change for the planning area is summarized at the end.

Calvin Township

The Clerk Treasurer of Calvin Township was interviewed in January 2013. The Township is seeing some new lot creation and in recent years the number of applications for new lots through consent has increased (numbers were not provided). Hundred acre parcels are being split into larger lots which have been selling fairly quickly. Farmers are selling some of their land to generate income or to retire. The trend is for farmers to age and not have family members interested in taking over the operations causing the number of farmers as well as the intensity of farming to gradually decline. There is one milk operation left in the township which is for sale. Those farms that are taken over by younger operators do not operate in the same way – less intensively – more like a hobby farm. Livestock numbers in the township have declined and the number of payouts the Township makes for livestock wolf kills has noticeably declined.

People moving into the township are looking for larger land plots with space and/or privacy. Some properties are being purchased by people from the southern Ontario (described as being

Figure 12.26 East Nipissing Official Plan Land Use Plan for Papineau Township (Schedule A1)

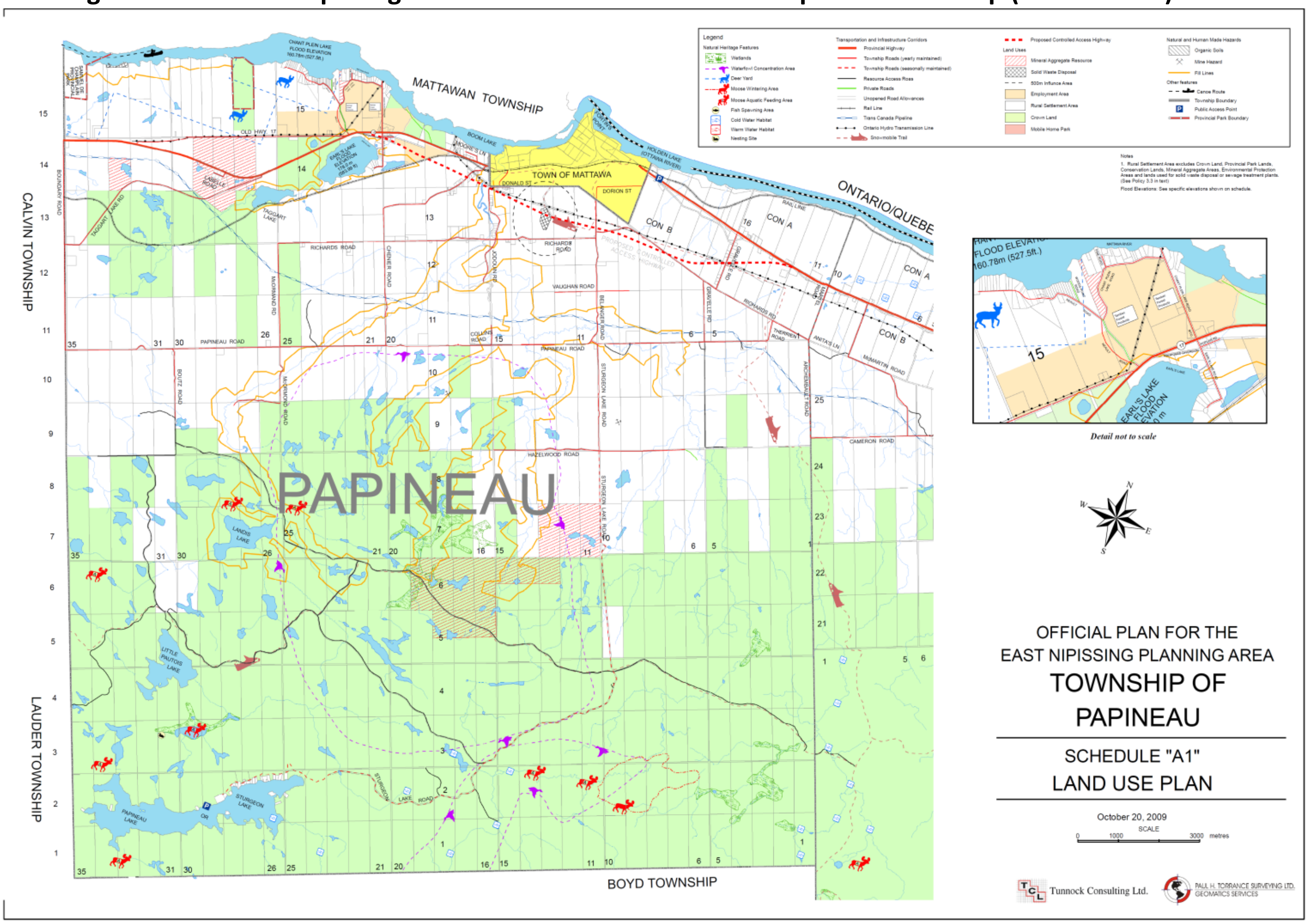


Figure 12.27 East Nipissing Official Plan Land Use Plan for Mattawan Township (Schedule A2)

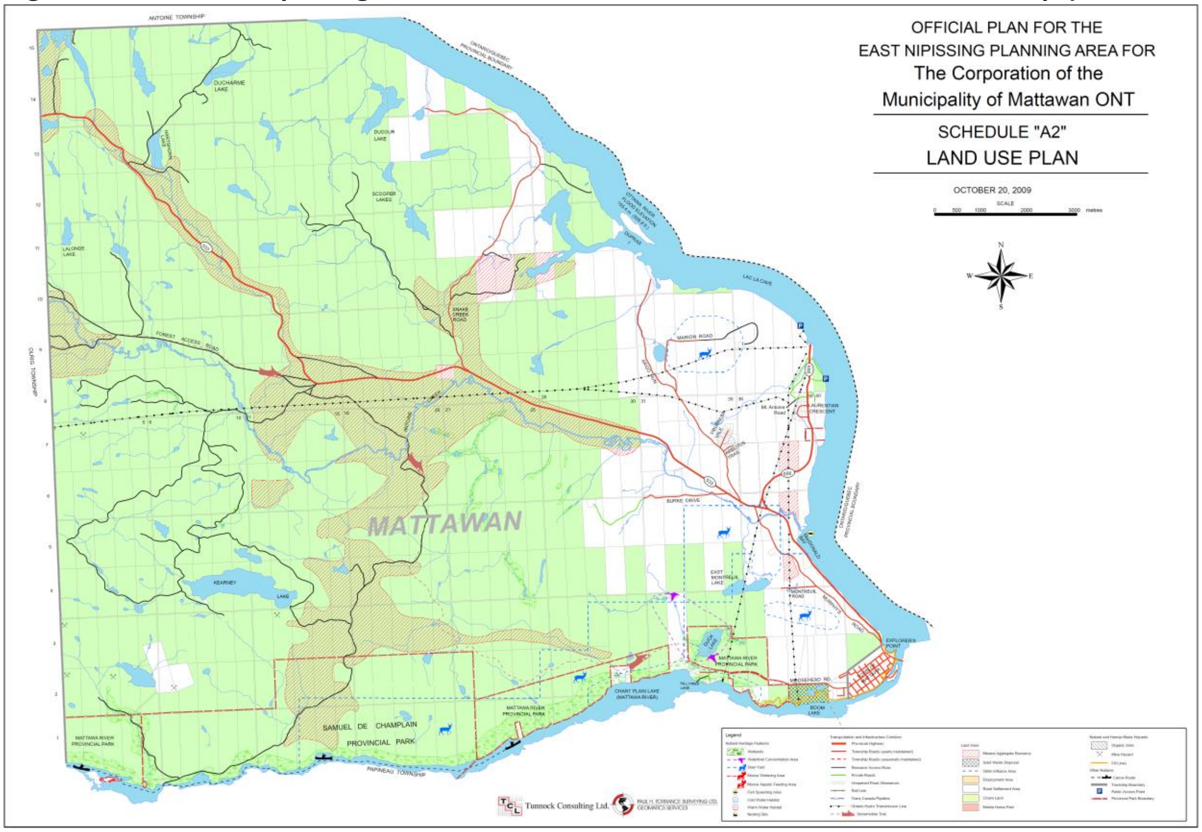
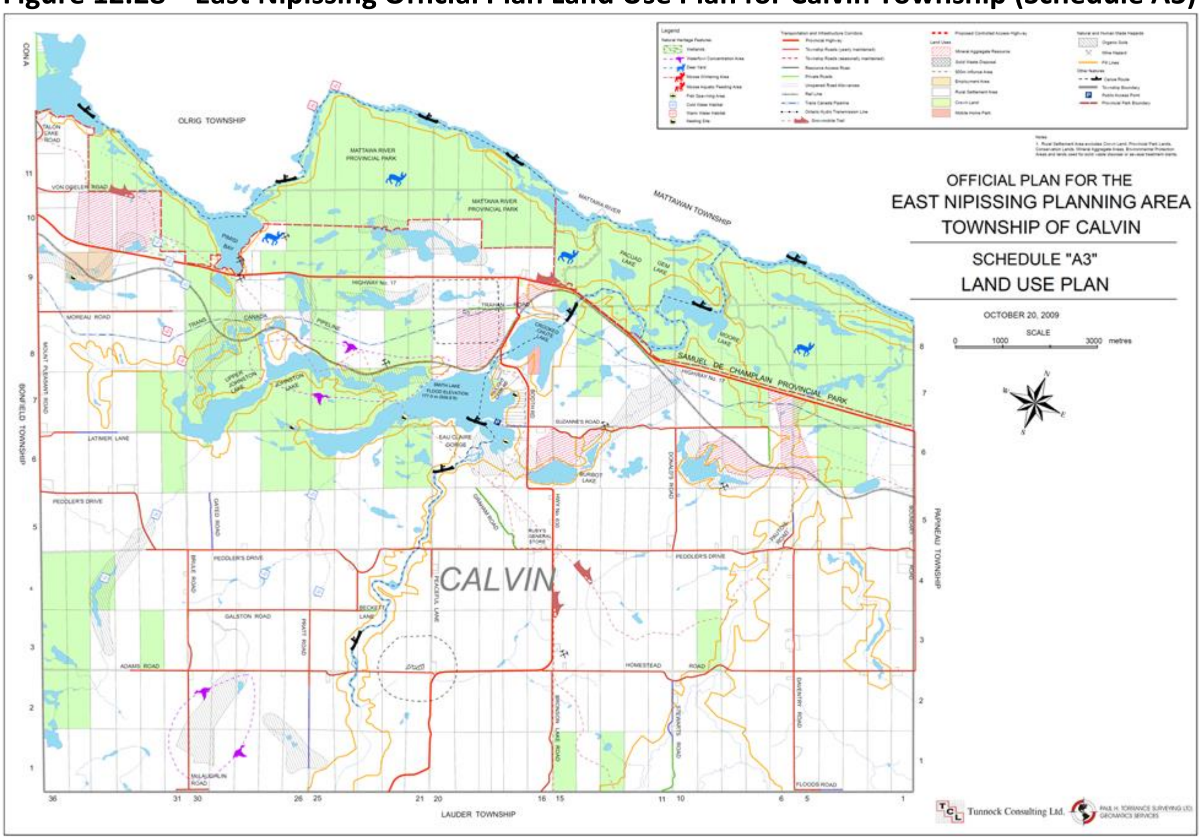


Figure 12.28 East Nipissing Official Plan Land Use Plan for Calvin Township (Schedule A3)



partially retired from Toronto area) who use the lands seasonally and are interested in eventually retiring to the area and building on their recreational properties. They may be bringing an interest in eco-tourism to the area – one is looking at setting up Yerts which is a rustic type of tourist accommodation.

Calvin has five major aggregate licensed areas all in the northwest corner of the township which are currently mostly inactive. There are other parts of the township that have aggregate reserves but no active interest in these sites exists at this time. Most operations are pit operations. The township receives less than $5,000/year from aggregate royalties.

Some of the planning initiatives identified to stimulate growth/growth retention such as allowing home based businesses or temporary garden suites has not proven to be as popular as was thought when they were established. The elderly are mainly moving to urban centers with retirement facilities. The new Highway 17 four lane alignment isn't a concern in Calvin because it mainly follows the existing route. The township is concerned about inheriting sections of the old highway and incurring new maintenance costs.

Papineau-Cameron

The Municipal Clerk of Papineau-Cameron Township was interviewed in January 2013. The township averages 6 to 8 new lot applications per year through consent in former Papineau Township and 10 to 12 new lots per year for Papineau-Cameron as a whole. More new lots are created in Papineau. Papineau-Cameron completed an Official Plan review in 2012 and one outcome was the determination that employment lands have not attracted new business development. The Bonfield Economic Development Corporation has taken ownership of the former Tembec property at the corner of Nault Road and Highway 17 and is marketing it to a new forestry startup business. The Algonquins of Ontario have claimed Crown land parcels within the East Nipissing Employment Area. Gin Cor (an established business in the employment zone) is talking to the Algonquins as they have an interest in some of the land that the Algonquins have claimed. Papineau-Cameron is encouraged that the Town of Mattawa is about to redo its Official Plan. This is viewed as a positive for job creation and economic development. Papineau-Cameron plans to zone Employment Area land parcels so that new businesses will not encounter excessive delays. Papineau-Cameron is also preparing a Community Improvement Plan to encourage existing businesses make improvements. Papineau-Cameron is considering improvements to street scape facades and signage to improve the Township's image.

Farming has been declining as a land use in Papineau-Cameron for a long time. There are still several historic family farms in the township (two within located the NBMCA watershed). A family farm has recently been subdivided into smaller parcels. Hobby farming is now popular in the Township and there is a growing interest in owning horses. A U Pick operation opened in

2012 to market strawberries to the community and this operator is currently looking at greenhouse options.

Logging on Crown land along the southern Papineau Township boundary has been carried out recently and older cut areas near Papineau Lake are growing up into a mixed forest. Forest access roads through southern Papineau-Cameron provide important access to lands in and on the fringes of Algonquin Park. Logging is still occurring but logs are now hauled to distant markets. Past cutting occurred on private land within the Township but good quality timber stands on private property have been substantially depleted. The Jeanveau Saw Mill in Mattawa is the only local plant that remains operational.

Papineau-Cameron has considerable aggregate reserves and the aggregate industry has benefited from recent highway reconstruction activity. Papineau-Cameron received approximately $7,500 in aggregated royalties in 2012. Active pits in Papineau are located west of Taggart Lake. Papineau-Cameron observed a staking rush prior to 2006 as potential aggregate mining areas were taken up to grandfather them from formal applications under the Aggregate Resources Act came (which into effect in the region in 2007). Some aggregate reserves have obtained licenses without proper consideration of setbacks from neighbouring uses. The Township is concerned that peripheral properties will be impacted by aggregated operation when they go into production.

In terms of changing population dynamics Papineau-Cameron is witnessing people from southern Ontario buying land and/or retiring in the area but are also seeing younger families moving into the Township. Younger families are moving to the area for a change in life style. Some people moving back are people that grew up in the area but have worked outside of the region for most of their career. Young families moving into the Township often find it difficult to obtain local employment and in many cases commuting to North Bay for work is the only option.

Mattawan

The Clerk of Mattawan Township was interviewed in January 2013. Mattawan Township had approximately 10 new lots created through consent between 2009 and 2011. Mattawan disputes that their population is growing. There has been limited new development west of the lagoons on the Mattawan side of the Mattawa River (minimal infilling west of the lagoons is occurring) which implies that most of the growth in Mattawan is not within the NBMCA's jurisdiction. The NBMCA however provides planning advisory services for the entire township.

Some of the observations about vegetation may be the impact of blow downs in 2006 and last year. The area seems to be encountering a higher incident of wind storms that are toppling large swaths of trees. One large blow down areas was identified in Mattawan Township north of the NBMCA boundary. The pipeline is mainly grassed and the large voltage hydro lines have been grubbed and vegetation has been removed to avoid problems with vegetation blowing down along the lines causing power outages.

In Mattawan Township there is one off the grid ecotourism operation that seems to be doing well. There are also traditional snowmobiling and a growing interest in four wheelers and trail riding and the possibility of developing jet skiing on the Ottawa River (being promoted by the Bonfield-Mattawa EDC). The impression is that the Mattawa Ski Hill will not open soon, costs are too high. The Bonfield Mattawa Economic Development Corporation is a good source of information on area tourism. Mattawan is currently dealing with a new aggregate operation application (from Jeanveau who has road maintenance contracts in the area).

East Nipissing Summary

Municipalities in the East Nipissing Planning Area have been significantly affected by local economic conditions. This area has traditionally been highly reliant on public and resource sector employment. Public sector jobs have steadily declined as regionalization takes place and public sectors face downsizing. The forest industry, a traditional dominant economic sector, has encountered economic hard times with most mills in the area have closed. Despite economic conditions municipalities continue to experience new lot creation which is helping to maintain the rural population base. People have adapted by finding work outside of the Mattawa economic area which they commute to. Led by the Bonfield Mattawa Economic Development Corporation, efforts are underway to diversify Mattawa and areas economy and to capitalize on local resources in new ways. This includes finding new niche forestry opportunities as well as new outdoor recreation and ecotourism opportunities. Growth and land use change in East Nipissing is dependent on the recovery of traditional resource sectors and/or innovation to find new ways to take advantage of the local resource base. If successful new business opportunities will help establish local employment opportunities that will create stability and independence and if not the area may evolve to become a popular retirement area and a bedroom community to North Bay.

12.5.2.4 Chisholm

The Township of Chisholm has recently completed a new Official Plan which was approved by the Township in March 2012 and awaits provincial approval. Chisholm Township is a rural municipality with a total population of 1,263 (2011 Census). Chisholm identifies that it has the potential to grow by as much as 400 people in the 20-year horizon of the plan (by 2032) if the municipality can provide a range of economic, housing and social opportunities. The Official Plan lays out a vision to protect the natural environment; to encourage economic development; to conserve natural resources; to protect agricultural areas and "the character of developed and undeveloped areas". The Official Plan identifies that residents of Chisholm enjoy an exceptional quality of life due to the quality of the natural environment, the people, agricultural and rural areas, open scenic countryside, woodland areas, lakes and rivers. Chisholm has unique landforms and a rich history founded on agriculture and resource based industries. The plan is founded on a principle of sustainability which is defined as the sustaining of the environment, the economy and the socio-cultural fabric of the community. Schedule A of the Township of Chisholm Land Use Plan is presented in Figure 12.29. Schedule B of the Official Plan – Natural Heritage Features is illustrated in Figure 12.30.

Chisholm has adopted development policies to create new lots primarily through consent which is the main way that growth is occurring in the township. Based on historical trends Chisholm has established a target of 15 new lots per year. The absolute number lots that can be created are restricted by the original lot size. Larger parcels have a higher new lot creation allowance. New lots are also permitted though an infilling policy along existing roadways provided that minimum frontage and lots sizes are met. New lots will primarily rely on the supply of private water and waste water disposal systems. Chisholm has left the door open to consider communal servicing if supporting information and sureties can be supplied. Chisholm permits home occupations and home industries as long as such uses do not occupy more that 30% of the gross floor area of the dwelling or they support the agricultural industry of the area which includes the processing or transportation of local agricultural crops. Retail sales of locally grown products are also permitted as an accessory use to a dwelling.

Chisholm has some unique policies within the region such as encouraging hunting, fishing and eco-tourism by permitting small scale accommodation uses with a maximum of 15 guest rooms. The township has also adopted policies to promote agricultural research and agri-tourism. The Chisholm Official Plan recognizes and sets minimum standards for hobby farms and large scale alternative energy projects on agricultural lands.

Chisholm has developed land use policies for shoreline areas adjacent to Wasi, Graham and Mink Lakes and the Wasi River to minimize development impacts and to maintain the scale and character of existing shorelines. This policy, in recognition of the eutrophic state of Wasi Lake and Callander Bay, will only permit new lots to be created on Wasi Lake or the Wasi River provided that septic systems are set back a minimum of 300 m from the edge of the shore.

New lots on Graham Lake are restricted by a 5 ha minimum lot size and by the requirement for severed and retained lots to have frontage on a publicly maintained roadway (the lake is landlocked). Chisholm intends to apply East Ferris policies to Mink Lake and Lake Nosbonsing as these water bodies are primarily within the jurisdiction of the municipality of East Ferris. A 30 m setback will generally be applied along these waterways to protect riparian vegetation. Lakeshore road allowances may be closed and sold to abutting property owners if strict criteria are met.

Figure 12.29 Township of Chisholm Draft Official Plan Land Use Plan (Schedule A)

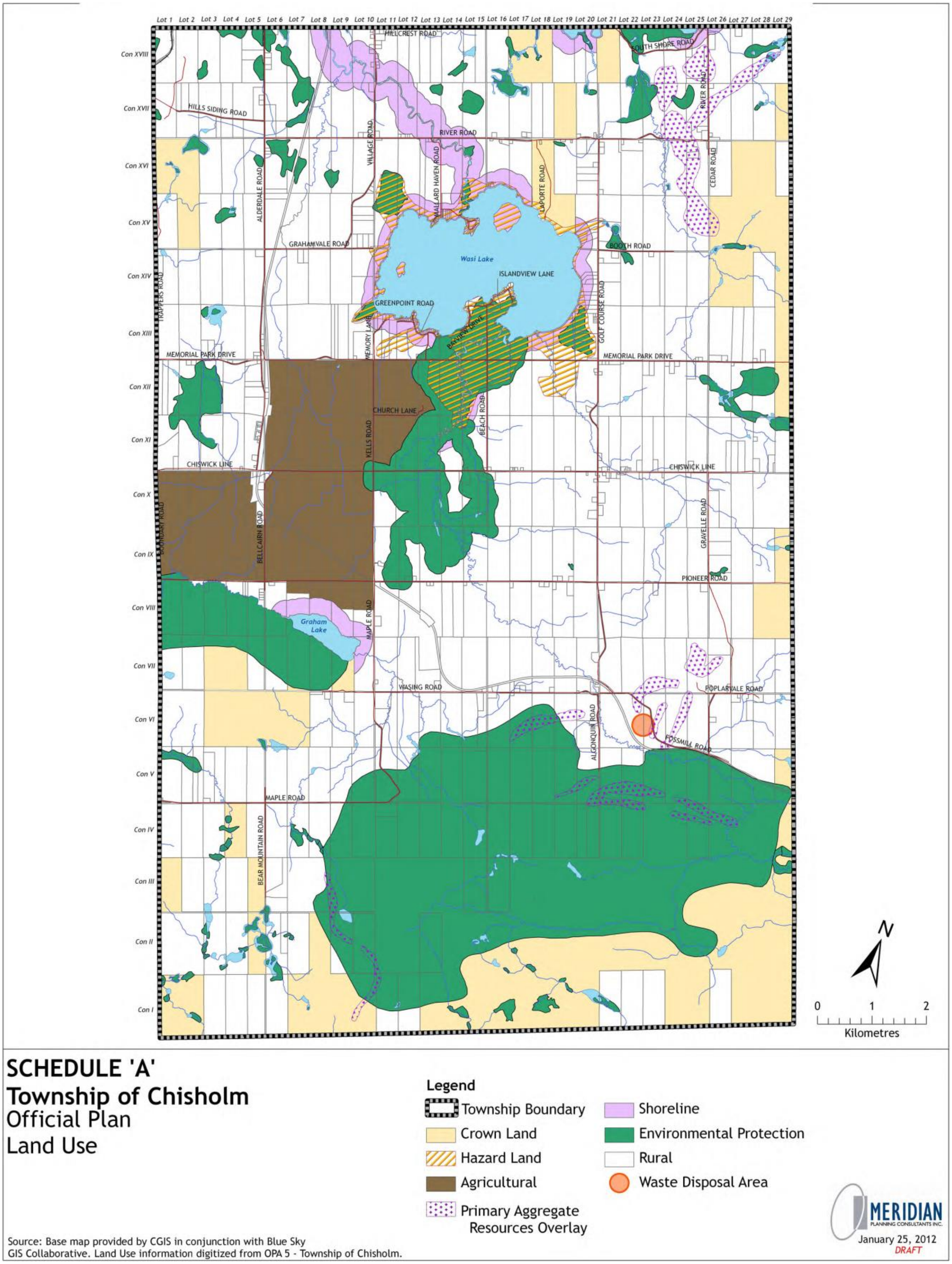
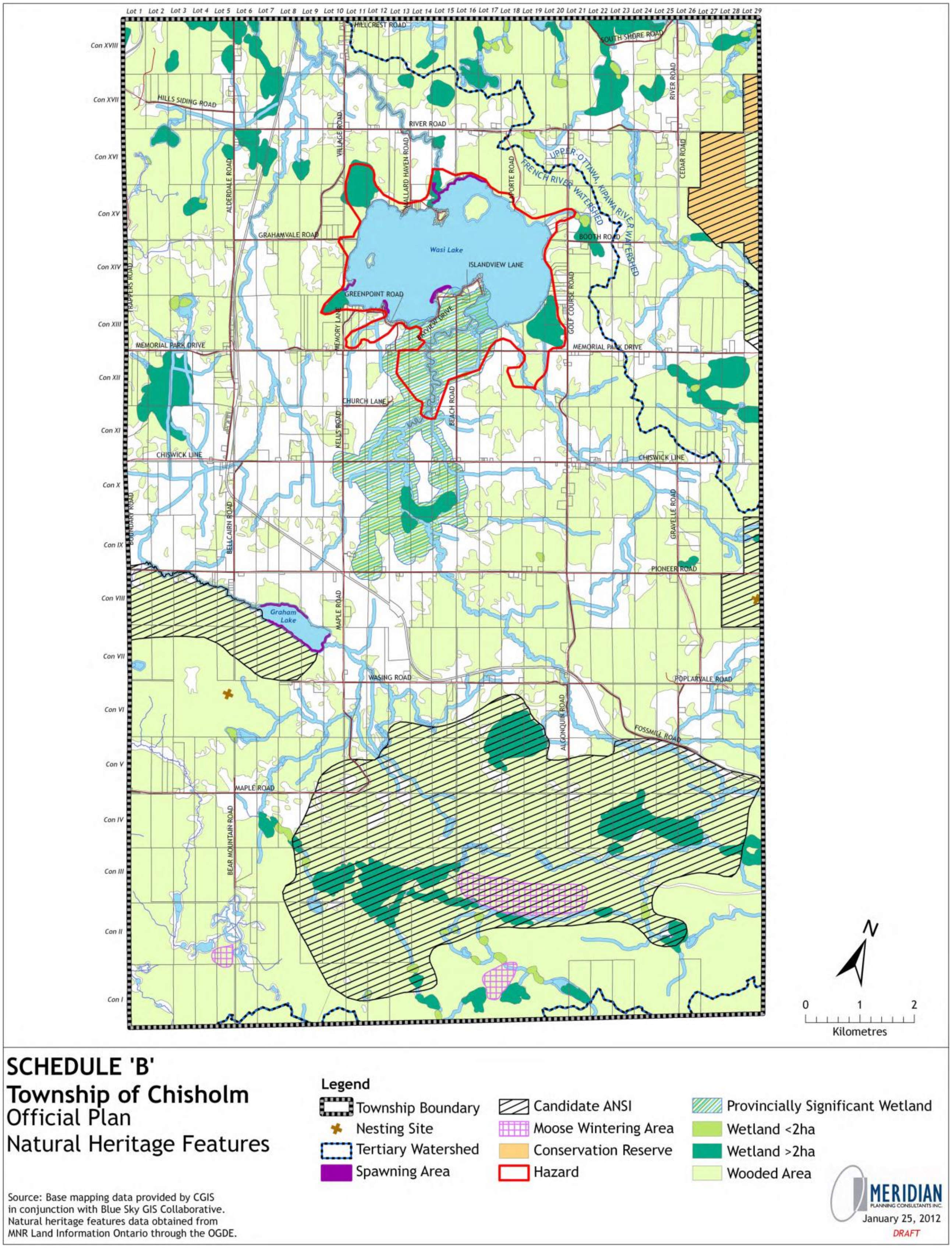


Figure 12.30 Township of Chisholm Draft Official Plan Natural Heritage Features (Schedule B)



Chisholm has established an Environmental Protection designation which applies to natural heritage features including provincially significant or large wetland areas (over 2 ha), Areas of Natural or Scientific Interest (ANSI), areas with significant habitat (including fish habitat) or areas identified when processing development applications. Natural heritage features are protected through setback zones. Any land use changes proposed within a setback zone may require an Environmental Impact Study. Chisholm recognizes two candidate ANSIs; Genesse Moraine and Graham Lake Hill, both which are tied to post glacial water levels and drainage features.

Chisholm Township has also created environmental policies to protect development from floodplains, unstable lands and areas with hazardous slopes and to protect natural heritage systems and features, water quality, sensitive areas and hydrogeological resources from development. Chisholm recognizes a number of environmental features not protected by Environmental Protection Policies including remaining lakes, rivers and streams not affected by the policy, fish habitat, woodlands and valley lands, and areas with significant wildlife habitat. The significance of groundwater aquifers to supply drinking water is recognized within the Water Resource Management policy and large developments may be required to prepare supporting Water Resource Management Reports. Larger developments may also be required to supply Stormwater Management Reports. Regulatory flood elevations are recognized for Wasi Lake, Graham Lake and Lake Nosbonsing and must be calculated for other areas. Generally development within floodplains is prohibited. Development application near floodplains, steep slopes or hazardous sites may be required to supply supporting technical reports and studies. In general the Township has provided itself with the ability to ask for any number of supporting studies if warranted to support a development application. Also the entire township is designated as a Site Plan Control Area.

Future Growth and Land Use Change

The Clerk Treasurer of Chisholm Township was interviewed in December 2012. Chisholm averages between 6 and 12 new lots per year and a recent trend has been to severe lots with significant acreages. People moving to Chisholm are often seeking larger land parcels for a variety of reasons. There is a growing interest in hobby farming and in owning horses. Two large horse complexes have opened in the Township which offers stabling, riding and/or riding lessons. There are many home based business that have established in Chisholm including a new general store in Alderdale and Amish run businesses that offer handmade furniture, small sheds and pallets or framing/construction services. Chisholm once had as many as 30 milking operations but this has declined to only a couple. It was noted that traditional beef operations are declining as farmers age, wish to retire and no family member is willing to take over the operation. Chisholm has limited prime Class 1 to 3 farmland near Alderdale. Farmers that continue to operate will take over abandoned surrounding fields to cut hay. There is some limited crop farming as well as limited tillage. Agricultural land uses in the remoter parts (south east quadrant) of the township are being abandoned.

The Amish community began moving into the area approximately 10 years ago and this population is increasing as more families move to the area and from generational growth. The Amish tend to have large families and farming interests include sheep and horses used for transportation. Approximately 25 Amish families and 1 Mennonite family now live in Chisholm. The Amish are very industrious and bring craftsmanship skills to the township including wood working and construction/building skills.

In terms of logging and aggregates these uses are relatively minor in the township. No visible cutting is occurring on private lands and most aggregate operations are small or dormant. The Township owns several pits within the municipality. The Township receives about $5,000 per year in royalties from aggregate operations. Logging in surrounding unorganized townships is unknown. Boulter is a popular recreation area for Chisholm Township residents in all seasons. No population base lives in Boulter along the Chisholm boundary. The curtailment of the CN rail operations through the township has improved the desirability of some areas of the township including Alderdale.

Wasi Lake has many seasonal uses around its shores but the impact of the seasonal population in Chisholm is not that evident due to the relatively small size of the lake and the tendency of people to travel out of the township for business and supplies (if roads are busier traffic is restricted to the north east quadrant which is less visible to year round residents). The lodges on Wasi Lake seem to be surviving – one lodge is undertaking renovations. The township is concerned about the quality of Wasi Lake due to its shallowness. The township is gradually implementing site plan controls around the shoreline which will create a vegetative buffer in the future. Chisholm will be impacted by the Source Water Protection Plan to protect Callander Bay and this means stricter development rules and septic system re-inspections – which will likely have financial implications for the township. The Township will have an education role. Some of the outcomes of this work will help to protect Wasi Lake and the Wasi River.

Chisholm is an agricultural based community with some of the highest rated agricultural lands in the region and this has attracted new farming interests to the area. The Amish community is growing within the township and this is changing agriculture practices, affecting demographics (as more youth are present) and also diversifying the economy as new Amish business have been established. Agriculture is expected to continue to grow in the township as well as home and farm based businesses to generate positive population growth in the township for the foreseeable future.

12.5.2.5 Powassan

While the Municipality of Powassan is a member municipality of the North Bay-Mattawa Conservation Authority, most of the Powassan planning area is outside of the NBMCA jurisdictional boundaries. The western fringes of the Wasi River watershed extend into Powassan. Also streams draining through the Municipality of Callander to Lake Nipissing originate in Powassan. Callander watersheds are partially outside of the NBMCA's regulatory area but are included within the Integrated Watershed Management Plan study area. The assessment of watershed management issues for these systems necessitates the need to consider relevant rural area policies contained in the Powassan Official Plan.

The Municipality of Powassan has a new Official Plan which received provincial approval in October 2005. The new Official Plan consolidated older Plans from the former Towns of Powassan and Trout Creek and the Township of South Himsworth (which amalgamated in 2001). The Municipality of Powassan has a total population of 3,379 (2011 Census). Powassan's Official Plan indicates that approximately 1,175 people live in the serviced portion of the former Town of Powassan. The Trout Creek Settlement Area not serviced and is outside of the IWMP study area. Powassan identifies that it will grow by 25 persons per annum. The planning horizon, established in 2003 is for 20 years, or to 2023. Powassan indicates that growth will mainly occur within the former urban service area of the Town of Powassan (which is also outside of the IWMP study area). New lot creation in the rural areas will generally be discouraged.

The Powassan rural area includes agricultural, residential, industrial and open space uses. Within the IWMP study area the primary use is isolated pockets of agricultural lands were sufficient soil exists. These lands generally have poor drainage and are surrounded by wetlands and outcrops of bedrock. Study area lands east of Highway 11, which includes the Himsworth Crown Game Preserve, is protected as a wildlife sanctuary or is used as a golf course (High View). Lands along the eastern boundary of Powassan within the Graham Creek watershed are mainly upland areas near the watershed boundary. The Powassan Official Plan has set a goal to limit rural growth and to maintain its natural environment and rural character. Rural growth is restricted to infilling along municipally maintained roads. Powassan restricts rural growth to a maximum of 15 new lots per year. Seasonal uses may be permitted on lakes within the municipality; however no lakes exist within the study area.

Powassan has adopted general policies for aggregate and mineral resources, agricultural uses, crown land, environmental protection, fish habitat, forestry, earth and life science areas, natural hazards, wetlands and wildlife habitat. Bedrock resources, identified within the IWMP study area, are protected for long term resource extraction use. Exist agricultural uses are generally protected from non-compatible use encroachment. Graham Hill Earth Science area south of Graham Lake, which extends into Powassan is identified and protected as an Area of Natural and

Scientific Interest. Extensive “Class 1” fish habitat areas are identified within the study area and a fisheries protection zone has been established adjacent to streams within the study area. The Municipality can require an Environmental Impact Assessment Report to support development near sensitive features. Hazard lands are defined as areas subject to flooding and/or erosion/areas with steep slopes, unstable soils, organic soils or unstable bedrock. Within the study area floodplains are not delineated and development applications must be accompanied by supporting technical studies. The Municipality of Powassan prohibits new development within identified floodplains. Powassan uses an “Influence Area” to establish buffers around incompatible uses, manmade hazards or to protect against noise and vibration.

Future Growth and Land Use Change

Powassan is not experiencing new development within the municipal service area but is experiencing grow pressure in rural areas. Powassan is witnessing many of the same trends observed in other municipalities in its rural areas but with some subtle differences. Residential development is occurring on large rural lots (preferentially greater than 5 acres) and mainly higher end housing is being constructed (identified as in the $250,000 to $450,000 range) by more mature/affluent families (identified as families with kids that are 10+ years of age or by people that are at or nearing retirement). People are moving into the rural area from North Bay or from the former Town of Powassan. Many people commute to North Bay for work (four lane highways make this convenient). There is interest in horses/hobby farming but most of the rural demand is driven by a desire for privacy, space and a slower pace of life. There is evidence of people moving in from southern Ontario and using property seasonally or as a location to retire but the trend would not be considered the “Muskoka effect” because the Municipality does not have lakes or experience waterfront development.

Powassan is experiencing a decline in farming and some abandon fields are starting to infill with alder or are transitioning into wetlands due to a lack of drain maintenance. Fields abandon by retired farmers may be cut by neighbouring farmers because of the high price of hay (farmers are cutting hay on any accessible field to get cheaper hay for their own use or to sell it). Powassan does not have Amish families within its boundaries but Amish located in Chisholm are making an important contribution to the economy through their business interests. Powassan is the business center for Chisholm and benefits from product sales (furniture was specifically mentioned) and from construction services. Powassan does not have any Class 1, 2 or 3 Agricultural lands. There are not many “managed forest stand” in the township (farmers are not converting their fields to tree plantations). Also some farmers are severing lands to derive retirement funds (described as severing off two ten acre lots and keeping 80 acres).

Discussions on different resource sector economies suggest that Powassan is not dependent on the forest industry. They have one hardwood finishing plant that once had up to 200 employees but now has 50 to 60 employees. Historically there was cutting on private lands within the municipality but with current market conditions there hasn't been much evidence of private cutting lately. Powassan doesn't have very much Crown land within their boundaries. The only issue with logging affecting their roads was east of Trout Creek by trucks hauling out of Laurier Township. Aggregate extraction is an important component of the local economy. The perception is that more quarrying/crushing is occurring with time. There have been several run of the river hydro installations installed on South River in the last 20 years (land use mapping shows new flooded areas on the South River). Powassan does not have a tourism industry per se but Powassan acts as a supply center for tourists/seasonal populations travelling through or located peripheral to the municipality.

With respect to the headwater issues for Boulder/Windsor/Bear Creeks, the area is described as a swampy area that has little development/development pressure. Few changes are expected in the northern portions of the township in the foreseeable future.

12.5.3 Summary of Watershed Growth and Land Use Trends

Future growth and land use changes within the NBMCA are subject to a complex set of factors. Change is driven by regional social, demographic and economic trends, changes to government policy, evolving energy costs, advancements and impacts of new technology, increasing globalization and the ability of regions to determine its own destiny. It is beyond the scope of this plan to consider the many external influences that may affect the region in the future. Stantec has attempted to identify regional factors likely to influence growth and land use change within the NBMCA over the next 15 to 25 years.

Watershed management pressures in the next planning horizon of the NBMCA are tied to the regional economy, to population dynamics and land use policies of municipalities. This summary identifies a range of regional factors and draws on information supplied by member municipalities in the previous sections.

In assessing growth and land use change it is important to recognize that the NBMCA has a diverse range of population densities. In 2011 the NBMCA had a total calculated population of 69,850. Population densities ranged from greater than 500 people per km^2 in urban areas to vast areas that are unpopulated. As outlined in Section 13, 78.5% of the NBMCA watershed population is urban and lives on less than 2% of the land base. Land uses are evolving relatively quickly in urban areas. Management efforts tend to focus on protecting people and property from extreme events and natural hazards that are often exacerbated by development impacts. The remaining 21.5% of the NBMCA watershed population is spread across approximately 40% of the total land base in a rural setting. This population has an average density of approximately 12 people per km^2 and land use changes tend to evolve slowly. The remainder of the NBMCA land base, which makes up over 50% of its jurisdiction, is wilderness and Crown land. This area has received minimal watershed management interest by the NBMCA in the past. The focus of watershed management in rural and wilderness areas tends to be on resource protection.

At existing growth rates the watershed population will increase by 5,000 to 10,000 people over the next 25 to 30 years. Trends identified through municipal interviews suggest that the highest growth will be concentrated at the fringe of the regional center. Remoter areas will experience growth in spurts during resource sector boom periods. The regional center is the hub of regional economic activity and is isolated from resource sector boom and bust cycles due to its economic diversity. Economic growth however is not translating into sustained population growth in the regional center. The trend of population stability in the regional center is likely to continue. Population stability results from a net outflow of youth and young adults and a decline in the numbers of persons per households. Rural areas experience an out migration of the elderly primarily to larger urban centers but this is counterbalanced by youth immigrating in from the regional center and from external immigration, mainly from southern Ontario. Rural immigration is spurred by a relatively low cost of land/low cost of living/slower pace of life as well as the opportunity to have a bigger land parcels with less land use restrictions including freedom to operate a home based business. As municipalities with urban areas tend to restrict rural growth, demand is being met in neighbouring rural municipalities. There are also people from southern Ontario buying land in the region with the intention of using it in retirement or for recreational purposes on a seasonal basis. The continuation of these transformations will sustain the regional population but values and resource management expectations may be affected.

Land use trends in the rural area are experiencing subtle changes over time. Traditional farming is experiencing a long term decline as traditional family farms are slowly being replaced by smaller hobby farms, which are not true agricultural operations. Forestry activity which once occurred on private land and crown land is now primarily undertaken on Crown land due to poor market conditions and the depletion of private stands. Poor forestry market conditions have closed local mills, caused harvested logs to be exported from the region for processing and has increased the levels of unemployment in remote areas. Remoter municipalities are being challenged to recover or replace lost businesses to keep their local economies afloat. The region has scattered aggregate reserves that will undoubtedly be exploited in the coming years in municipalities with ample reserves. Aggregate reserves are largely located in headwater areas and aggregate extraction and surficial groundwater protection are likely to be competing interests in the future.

Rural municipalities are experiencing gradual infilling along existing roadways. Areas with higher demand have ease of access and close proximity to the regional hub. This demand is influenced by highway improvements, the cost of fuel and possible land sensitivities and restrictions (such as species at risk restrictions). Area lakes will continue to be pressured by shoreline development. The conversion of seasonal to permanent uses poses the greatest threat to area lakes as most lakes are at capacity and new lot creation is restricted. It is observed that the stock of seasonal waterfront properties will decline as seasonal uses convert to permanent. Future seasonal demand may be met by rural properties that do not have water frontage.

The following factors may influence future regional growth and land use outcomes (listed from negatives to positives):

- A lack of regional governance/oversight makes it difficult to define and address a host of regional issues on a broad scale;
- Most urban residents are unaware of the importance of the regional resource base to the regional economy or its management needs;
- Municipal economic development approaches are fragmented within the region, economic development opportunities are often narrowly defined or strategies may be primarily focused on big wins;
- Traditional agriculture is being replaced by hobby farming. There is a decline in cattle and an increase in horse and sheep farms. Horses are kept as pets, for competition and for recreational pleasure and business opportunities;
- The forestry industry is in recovery but new innovation in forest products is needed to regenerate local business opportunities;
- Population dynamics will likely see a number of observed trends continued including:
    - Movement of the elderly from rural to urban centers;
    - Repopulation of the rural area with immigrants mainly from southern Ontario;
    - The rural population may increasingly become seasonal;
    - An outmigration of youth and young adults from the regional center. A small portion of this out migration is to the fringes of the regional economic center attracted to a lower costs of living and a slower pace of life;
    - As the population ages and the number of people entering retirement increases the seasonal depopulation in the winter may increase as the retired population travels or moves to southern accommodation;
    - Regional population growth is increasingly becoming dependent on immigration that includes new nontraditional cultures. New cultures are slow to move to the region because of a lack of necessary support factors. North Bay has recognized the need to support people with diverse ethnic backgrounds that may choose to move to the area but currently there is no regional strategy;
- Seasonal populations are significant to the region. This population is currently illusive in terms of size, location, economic impact to the region and growth dynamics. The economic importance of the seasonal population is not recognized by any economic development strategy in part because it is undefined. This seasonal population may

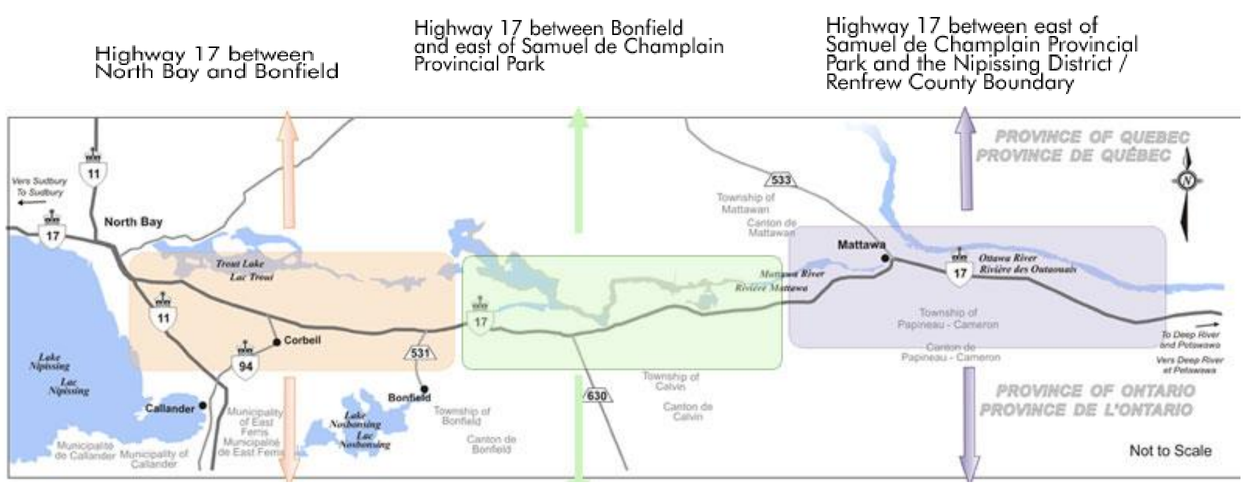
bring different values to watershed communities and may redefine future resource management needs;

- A new watershed management integration philosophy to improve management successes by better understanding social and economic trends in a watershed may also have an inverse relationship in that social and economic successes may be tied to a better understanding/appreciation/relationship with the regions environment and resources (i.e. regional growth and development may be dependent on transitioning to a green economy);
- Successfully integrating business and environmental interests in a sustainable way is a challenging concept;
- Regional growth and management success may be intricately intertwined with interests of First Nation Communities.

12.6 Provincial Plans for Highway Realignment/Four Laning and By-Pass Construction

The Ontario Ministry of Transportation is currently completing a Route Planning, Preliminary Design and Class Environmental Assessment for the Highway 17 corridor between North Bay and the Nipissing District eastern boundary. The work is being undertaken in three parallel studies which are at slightly different stages in study processes. The three study areas are North Bay to Bonfield, Bonfield to Samuel De Champlain Park and Samuel de Champlain Park to the Nipissing District/Renfrew County Boundary as illustrated in Figure 12.31.

Figure 12.31 MTO Study Areas for the Highway 17 Corridor – North Bay to Nipissing District Boundary



Source: Special Web Site set up for all 3 Projects at: www.highway17routeplanning.ca

Studies are examining the need for highway improvements of which a divided four lane with restricted access is being considered for all segments as the preferred alternative. Studies are following the Class Environmental Assessment (EA) for Provincial Transportation Facilities (2000) process for Group 'A' projects. The anticipated need for highway improvements is driven by increasing traffic volumes and the provinces desire to meet future traffic operations and highway safety standards. The needed traffic volumes to justify highway improvements are many years away.

A public open house was held in November 2012 at which the Ontario Ministry of Transportation released preferred routing for the westerly most planning areas. The prefer routes for the North Bay to Bonfield has been provided in Appendix B. Ramp options were also presented for public input and preferred ramp alternatives will not be released until 2013. The Bonfield to Champlain Park and Mattawa segment of the Highway 17 Highway Improvement Planning is behind the western study and routes have been narrowed to short list of preferred alternatives. The selected route is not expected to be released until late spring 2013. Alternatives being evaluated in the central and easterly studies are listed in Appendix B.

There will be a significant time gap between the province selecting its preferred route and new highway being constructed. A time gap is needed for MTO to acquire right-of-way and for projected highway traffic volumes to materialize. It is recognized that the new preferred highway alignment will have economic implications for the region. The impacts and benefits of opening a new economic corridor are part of the evaluation criteria being used to evaluate alternatives. Preferred highway alignments and new development opportunities that may result need to be monitored carefully in the context of development and land use changes that could affect subwatershed management interests. Until all of the current planning initiatives are completed it is difficult to anticipate what impacts are likely to occur or when they might be realized.

The Provincial Government also has plans to construct a limited access by-pass through North Bay (Highway 11/17) and has acquired most of the right-of-way. The preferred route identified in the 1970s was refined in 2008 to ensure the design met modern standards. The construction of this new highway will also have "development implications" in its vicinity. Landlocked lands along the existing highway corridor will gain access to local roadways and new local roads are planned to link communities on either side of the bypass corridor (primarily in the Chippewa Creek watershed) which also will potentially open new development opportunities. The preferred route passes east of the Northgate Shopping Mall and ties into the existing alignment near O'Brien Street. The timelines for bypass construction are not available and would currently be beyond 5 years based on Capital budgets. The alignment of the North Bay bypass route is also provided in Appendix B.

13.0 Regional Economy, Labour Force and Resource Based Sectors

13.1 Introduction

Economic characterization of the NBMCA was originally completed in the first Watershed Plan Background Inventory Report (NBMCA 1982) and an updated assessment has been included in the Drinking Water Source Protection Watershed Characterization Assessment Report (NBMCA, 2008). Economic and socio-economic information for the City of North Bay is available in "*City of North Bay Population Housing and Employment Forecast Update, 2006 – 2031*" (Watson and Associates, 2009). Economic information for the eastern half of the NBMCA is available in a document entitled *"Community Profile 2010 for Mattawa Voyageur Country"* prepared by the Mattawa Bonfield Economic Development Corporation. Regional economic information is available from a number of sources including the Blue Sky Region Agricultural Economic Sector Profile for Nipissing and Parry Sound Districts. The NBMCA watershed will be affected by the provincial 2011 Growth Plan for Northern Ontario which is being developed by the Province to guide economic development in the north. Recent labour force data has been obtained from Statistics Canada. At the time of writing 2011 Census labour force data had not yet been released and consequently most of the assessment had to rely on 2006 Census data.

Recent theory holds that watershed management can be made more effective by evolving strategies to be more assimilative or integrated with other interests including economic and socio-economic interests. This approach recognizes and operates on the premise that ecology, economy and society are interconnected (Conservation Ontario, 2010). The philosophy is that business and society are more apt to comply with and support watershed management strategies if they are aware of and understand the reasoning behind them. It is also incumbent on those who are developing watershed management strategies to be more adept of business and societal interests and trends.

Watershed management strategies must be viewed as being an asset to the community and not as a hindrance to growth and development. This is achieved by better framing watershed management activities in social and economic terms. From a social and economic perspective watershed strategies seek to minimize risk, protect property and enhance the quality of life. Watershed management initiatives should always be evaluated in terms of their community benefits and these community benefits need to be promoted as part of the watershed management implementation strategy.

Southcott (2003) has identified important northern Ontario economic characteristics. North Bay is one of five large northern Ontario communities that have diversified economies and serve as regional centers for health, education, and other services to surrounding communities. Smaller communities are largely resource based or single industry towns that have limited economic diversity and a high dependency on the natural resources of the area. Resource dependent communities are vulnerable to a number of factors that are less of a concern in the larger centers. Factors that can impact on small communities include resource depletion, changing world commodity prices, changing corporate policies, boom and bust cycles in resource sector industries, and evolving exchange rates and government trade policies (Southcott, 2003). Small community dependency on external forces is viewed as a barrier to the development of an entrepreneurial culture and causes a higher reliance on social sector programs. Nipissing District, however, has the lowest percentage of primary resource sector employment compared to all other districts in Northern Ontario (Southcott 2003).

Despite a lower dependency of the regional economy on regional resources, the resource sector, which includes hydroelectricity, agriculture, forestry and mining, has the highest potential to impact on watershed management interests. Agriculture, forestry and mining (in this area mining is primarily focused on aggregate extraction) are the primary resource sector activities operating in greater than 90% of the NBMCA's area of jurisdiction not in urban areas (< 2%) or protected by parks designations (< 8% - not including Algonquin Park which allows forestry). The following dissertation consequently emphasizes key resource sector economic activities that rely on the regional natural environment to survive.

13.2 Regional Economy:

The City of North Bay is the economic hub of a region for both commerce and employment that includes the NBMCA area of jurisdiction. North Bay is one five regional centers identified in the Growth Plan for Northern Ontario 2011. The Growth Plan for Northern Ontario is a 25-year plan released in March 2011 to guide provincial decision making and investment in the north. This plan has not identified the geographic region that regional centers influence however the plan indicates that Regional Growth Plans will be developed for each center in the future. North Bay defines its regional economy as a trading area of 112,000 people (City of North Bay, 2012), which is approximately the population within a 100 km radius of the City and include a significant portion of Nipissing District and the northeast part of Parry Sound District. It is estimated that 62.5 % of the regional economy centered in North Bay is within the NBMCA's area of jurisdiction based on population.

13.2.1 Labour Force

The economy of the area can be characterized in terms of its labour force. Labour force statistics from the 2011 Census were not available at the time of preparation and 2006 statistics have been used. The 2006 Census indicates that member municipalities had a total population of 71,867 of which 58,950 were over the age of 14. Statistics were generated from a 20% sample size. Of the 2006 population 15 years or older, 36,135 or 61.4% were considered participants in the labour force of which 56.4% were actively employed. Both labour force rates (participation and employment) were below provincial averages. In part participation and employment rates are affected by the older watershed population which has more people not in the labour force. Average unemployment in the region stood at 7.8 % which was higher than the Ontario average (note that unemployment has increased since 2006). Unemployment is highest in eastern portions of the NBMCA watershed. General labour force characteristics for NBMCA municipalities in 2006 are presented in Table 13.1.

Table 13.1 General Labour Force Characteristics for NBMCA Municipalities and Ontario 2006

	Bonfield	Callander	Calvin	Chisholm	East Ferris	Mattawa	Mattawan	North Bay	Papineau Cameron	Powassan	NBMCA	Ontario
Total Population, aged 15 and older	1,680	2,740	490	1,105	3,420	1,590	125	44,320	875	2,605	58,950	9,819,420
In the labour force	1,045	1,750	260	680	2,210	820	95	27,185	525	1,565	36,135	6,587,575
Employed	1,005	1,660	215	635	2,080	640	95	25,095	460	1,450	33,335	6,164,245
Unemployed	45	95	45	45	130	180	-	2,085	70	120	2,815	423,335
Not in the labour force	635	985	225	425	1,210	775	35	17,135	345	1,035	22,805	3,231,840
Participation Rate	62.2	63.9	53.1	61.5	64.6	51.6	76.0	61.3	60.0	60.1	61.4	67.1
Employment Rate	59.8	60.6	43.9	57.5	60.8	40.3	76.0	56.6	52.6	55.7	56.4	62.8
Unemployment Rate	4.3	5.4	17.3	6.6	5.9	22.0	-	7.7	13.3	7.7	7.8	6.4

Source: Statistic Canada 2006 Census - Profiles for Census subdivisions

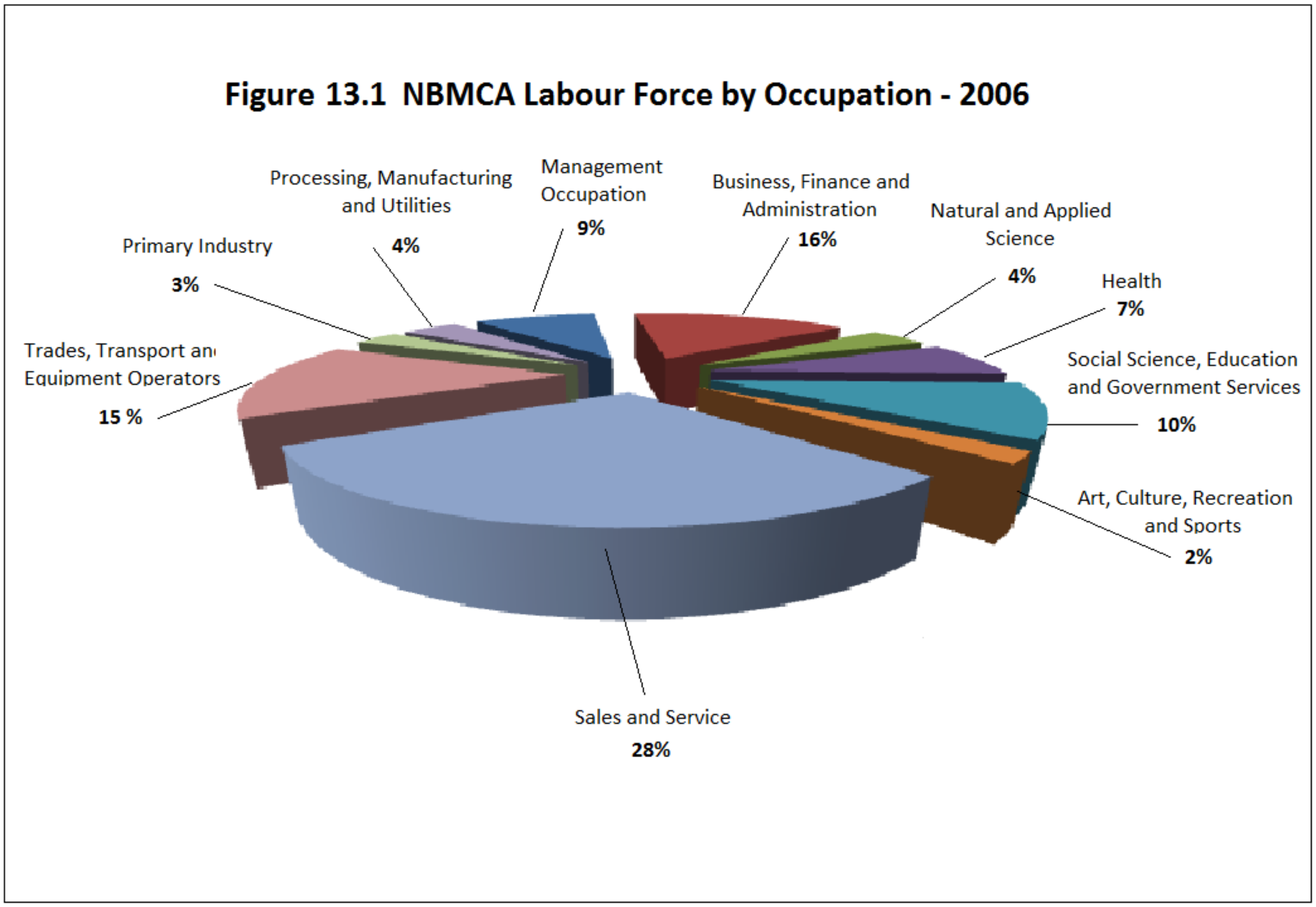
Statistics Canada breaks out the labour force into 10 key occupational categories. Labour force statistics for the ten occupational areas within the NBMCA are summarized in Table 13.2 and Figure 13.1. Within the NBMCA the largest occupational sectors are Sales and Service (28%) followed by Business Finance and Administration (16%) and Transport Trade/Equipment Operations (15%). Regionally a higher percentage of people work in the primary resource, trades and manufacturing/utilities sectors in rural areas. The City of North Bay dominates all occupational sectors with the exception of primary industrial jobs, which encompasses agriculture, oil and gas extraction, logging and forestry, mining, fishing, and trapping.

Table 13.2 NBMCA Labour Force Occupation Breakdown – 15 Year and Older, 2006

Municipality	Management	Business Finance Administration	Natural/Applied Science	Health	Public Service Social/Education	Arts Culture Sports	Sales and Service	Equipment/Trades Transportation	Primary Industries	Processing Manufacturing
Bonfield	90	185	55	70	65	10	195	175	80	100
Callander	210	235	60	170	180	25	415	305	65	50
Calvin	-	10	-	20	20	-	55	55	40	45
Chisholm	-	55	65	60	25	15	135	150	70	35
East Ferris	195	375	95	150	225	45	495	515	30	70
Lauder (unorganized)										
Mattawa	40	80	15	40	35	-	290	130	65	90
Mattawan	10	20	-	-	-	-	15	-	15	15
North Bay	2,555	4,695	1,250	1,780	2,690	510	8,195	3,850	405	725
Papineau Cameron	15	-	10	-	20	-	50	100	45	40
Phelps (unorganized)										
Powassan	115	155	40	120	190	10	355	325	110	115
NBMCA Total	3,230	5,810	1,590	2,410	3,450	615	10,200	5,605	925	1,285
Percent	9%	16%	4%	7%	10%	2%	28%	15%	3%	4%

Source: Statistics Canada, 2006 Community Profiles

The Blue Sky Region Agricultural Economic Sector Profile 2009 includes data for Nipissing and Parry Sound Districts (Blue Sky Region also includes the City of Greater Sudbury and Sudbury District) for all Industrial Sectors and supplies data on how the regional economy is fairing



Source: Developed from data obtained from Statistics Canada, 2006 Community Profiles

compared to neighbouring economic regions. 2006 employment by North American Industry Classification System (NAICS) sectors for Blue Sky Districts are profiled in Table 13.3.

This table illustrate that the north is disproportionately reliant on resource sector jobs including forestry and mining. The table indicates that Nipissing and Parry Sound are also very reliant on public sector jobs. In terms of sector growth the natural resource, manufacturing and transportation experienced declining numbers of jobs and while health care and social services, education, professional services and wholesale trade sectors experienced increased number of jobs (Ontario Federation of Agriculture, 2009). This report also indicates that the economic down turn in 2008 has had a significant impact on employment in the North which affected job losses in the resource sector and in transportation and warehousing.

The Blue Sky Region Agricultural Economic Sector Profile 2009 also provides statistics for educational achievement and household income for the Blue Sky Region and its Districts. Table 13.4 provides data on levels of education achieved within the Blue Sky Region. This table indicates that approximately 15% of the population between the ages of 25 to 64 had a University certificate or degree and 27% had a college or non-university certificate or diploma.

Table 13.3 2006 Employment by NAICS Industrial Sectors for Blue Sky Region and Districts

NAICS Industrial Sector *	Ontario		Northern Ontario Region		Blue Sky Region		Sudbury District		Greater Sudbury		Nipissing District		Parry Sound District	
	# jobs	%	# jobs	%	# jobs	%	# jobs	%	# jobs	%	# jobs	%	# jobs	%
All industries	6,473,735	100%	366,020	100%	145,165	100%	4,555	100%	79,830	100%	41,090	100%	19,690	100%
Agriculture	101,210	1.6%	3,070	0.8%	860	0.6%	120	2.6%	160	0.2%	315	0.8%	265	1.3%
Fishing, hunting and trapping	1,355	0.02%	375	0.1%	45	0.0%	0	0.0%	20	0.0%	15	0.0%	10	0.1%
Forestry and logging	11,780	0.2%	6,955	1.9%	790	0.5%	150	3.3%	110	0.1%	400	1.0%	130	0.7%
Mining and oil and gas extraction	25,445	0.4%	13,395	3.7%	6,500	4.5%	175	3.8%	5,725	7.2%	530	1.3%	70	0.4%
Utilities	50,215	0.8%	3,510	1.0%	1,135	0.8%	40	0.9%	510	0.6%	395	1.0%	190	1.0%
Construction	384,780	5.9%	22,275	6.1%	10,375	7.1%	365	8.0%	5,145	6.4%	2,605	6.3%	2,260	11.5%
Manufacturing	899,670	13.9%	32,525	8.9%	10,240	7.1%	605	13.3%	4,775	6.0%	2,955	7.2%	1,905	9.7%
Wholesale trade	307,465	4.7%	9,575	2.6%	4,965	3.4%	100	2.2%	3,020	3.8%	1,265	3.1%	580	2.9%
Retail trade	720,235	11.1%	46,135	12.6%	18,930	13.0%	560	12.3%	10,270	12.9%	5,430	13.2%	2,670	13.6%
Transportation and warehousing	307,475	4.7%	20,765	5.7%	7,880	5.4%	415	9.1%	3,650	4.6%	2,700	6.6%	1,115	5.7%
Information and cultural industries	172,800	2.7%	5,335	1.5%	2,240	1.5%	40	0.9%	1,220	1.5%	640	1.6%	340	1.7%
Finance and insurance	316,170	4.9%	8,355	2.3%	3,575	2.5%	75	1.6%	2,195	2.7%	990	2.4%	315	1.6%
Real estate and rental and leasing	126,440	2.0%	4,795	1.3%	2,320	1.6%	10	0.2%	1,140	1.4%	705	1.7%	465	2.4%
Professional, scientific and technical services	471,620	7.3%	12,715	3.5%	5,890	4.1%	110	2.4%	3,530	4.4%	1,650	4.0%	600	3.0%
Management of companies and enterprises	8,440	0.1%	105	0.03%	40	0.0%	0	0.0%	15	0.0%	10	0.0%	15	0.1%
Administrative and support services	314,005	4.9%	16,410	4.5%	6,975	4.8%	190	4.2%	3,800	4.8%	2,165	5.3%	820	4.2%
Educational services	433,485	6.7%	30,030	8.2%	12,015	8.3%	300	6.6%	7,045	8.8%	3,345	8.1%	1,325	6.7%
Health care and social assistance	611,745	9.4%	47,650	13.0%	17,990	12.4%	420	9.2%	9,915	12.4%	5,335	13.0%	2,320	11.8%
Arts, entertainment and recreation	140,830	2.2%	6,945	1.9%	2,850	2.0%	10	0.2%	1,555	1.9%	615	1.5%	670	3.4%
Accommodation and food services	414,975	6.4%	28,830	7.9%	11,330	7.8%	310	6.8%	5,610	7.0%	3,645	8.9%	1,765	9.0%
Other services (except public administration)	303,510	4.7%	18,135	5.0%	7,290	5.0%	185	4.1%	4,230	5.3%	2,030	4.9%	845	4.3%
Public administration	350,070	5.4%	28,185	7.7%	10,930	7.5%	380	8.3%	6,190	7.8%	3,340	8.1%	1,020	5.2%

Source: Ontario Federation of Agriculture, 2009

Table 13.4 Total Population 25 to 64 Years of Age by Highest Education Certificate 2005

	Ontario		Northern Ontario Region		Blue Sky Region		Sudbury District		Greater Sudbury		Nipissing District		Parry Sound District	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Total population	6,638,330	100%	400,705	100%	166,035	100%	12,245	100%	86,485	100%	45,320	100%	21,985	100%
No certificate, diploma or degree	899,530	14%	76,170	19%	28,320	17%	3,140	26%	13,475	16%	7,585	17%	4,120	19%
Certificate, diploma or degree	5,738,800	86%	324,525	81%	137,720	83%	9,105	74%	73,010	84%	37,735	83%	17,870	81%
High school certificate or equivalent	1,660,665	25%	101,075	25%	42,305	25%	3,255	27%	21,200	25%	11,175	25%	6,675	30%
Apprenticeship or trades certificate or Diploma	581,125	9%	51,405	13%	21,110	13%	1,940	16%	10,545	12%	5,720	13%	2,905	13%
College, CEGEP or other non-university certificate or diploma	1,461,630	22%	102,635	26%	45,395	27%	2,710	22%	24,845	29%	12,710	28%	5,130	23%
University certificate, diploma or degree	2,035,370	31%	69,395	17%	28,895	17%	1,200	10%	16,420	19%	8,130	18%	3,145	14%
University certificate or diploma below bachelor level	309,945	5%	11,300	3%	4,105	2%	205	2%	2,185	3%	1,250	3%	465	2%
University certificate or degree	1,725,425	26%	58,095	14%	24,800	15%	995	8%	14,240	16%	6,880	15%	2,685	12%
Bachelor's degree	1,057,200	16%	36,230	9%	15,095	9%	635	5%	8,610	10%	4,275	9%	1,575	7%
University certificate or diploma above bachelor level	209,345	3%	10,615	3%	4,435	3%	150	1%	2,435	3%	1,280	3%	570	3%
Degree in medicine, dentistry, veterinary medicine or optometry	47,815	1%	1,650	0.4%	780	0.5%	45	0.4%	420	0.5%	240	0.5%	75	0.3%
Master's degree	351,925	5%	8,000	2%	3,675	2%	155	1%	2,205	3%	915	2%	400	2%
Earned doctorate	59,140	1%	1,560	0.4%	805	0.5%	10	0.1%	565	0.7%	170	0.4%	60	0.3%

Source: Ontario Federation of Agriculture, 2009

Approximately 25% of the population reported their highest educational attainment was a high school certificate and 17% of the population reported they did not have a certificate/diploma or degree. Generally the opportunity to have advanced levels of education in the north is below the provincial average.

The Blue Sky Region Agricultural Economic Sector Profile 2009 also includes statistics for household income for the Blue Sky Region and its Districts. Table 13.5 shows the distribution of household income by category. Generally the level of income in Northern Ontario is below the provincial average with Parry Sound and Nipissing Districts averaging approximately $60,000 per year compared to the Province of Ontario average of $78,000/year.

Table 13.5 Household Income 2005 for Private Households

Household income in 2005 of private households	Ontario		Northern Ontario Region		Blue Sky Region		Sudbury District		Greater Sudbury		Nipissing District		Parry Sound District	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%
All households	4,555,025	100%	305,465	100%	126,150	100%	8,855	100%	64,960	100%	35,140	100%	17,195	100%
Under $10,000	198,235	4%	14,175	5%	5,615	4%	395	4%	2,965	5%	1,615	5%	640	4%
$10,000 to $19,999	398,830	9%	37,580	12%	15,135	12%	1,055	12%	7,040	11%	4,810	14%	2,230	13%
$20,000 to $29,999	408,130	9%	32,785	11%	13,750	11%	1,010	11%	6,335	10%	4,275	12%	2,130	12%
$30,000 to $39,999	447,475	10%	34,085	11%	14,760	12%	1,140	13%	6,825	11%	4,430	13%	2,365	14%
$40,000 to $49,999	419,525	9%	30,870	10%	13,105	10%	985	11%	6,505	10%	3,635	10%	1,980	12%
$50,000 to $59,999	385,555	8%	25,835	8%	10,925	9%	850	10%	5,340	8%	3,120	9%	1,615	9%
$60,000 to $69,999	356,990	8%	23,800	8%	9,870	8%	725	8%	5,035	8%	2,690	8%	1,420	8%
$70,000 to $79,999	324,835	7%	20,695	7%	8,220	7%	555	6%	4,205	6%	2,280	6%	1,180	7%
$80,000 to $89,999	282,910	6%	18,440	6%	7,345	6%	545	6%	4,150	6%	1,760	5%	890	5%
$90,000 to $99,999	238,720	5%	14,585	5%	6,070	5%	465	5%	3,200	5%	1,730	5%	675	4%
$100,000 and over	1,093,810	24%	52,590	17%	21,345	17%	1,135	13%	13,350	21%	4,780	14%	2,080	12%
Median household income	$60,455		NA		NA		$48,092		$55,008		$46,788		$46,180	
Average household income	$77,967		NA		NA		$58,240		$68,117		$58,119		$60,267	

Source: Ontario Federation of Agriculture, 2009

The Mattawa-Bonfield Economic Development Corporation has published employment mobility statistics that illustrates where people are choosing to live relative to where they work. The Economic Development Corporation reported that the majority of Mattawa-Bonfield residents who work outside of this region commute to North Bay, East Ferris and Temiskaming for work. In 2006 41.9 % of workers in the Mattawa-Bonfield region commuted outside of the region for employment purposes. Non-residents commuting into the Mattawa-Bonfield Area are mainly traveling from Callander, East Ferris and North Bay. In 2006 14.1% of the labour force working in the Mattawa-Bonfield region commuted to the area from outside of the region for employment purposes.

Of those communing out of the Mattawa-Bonfield region for employment the occupational areas that workers were traveling to are listed as:

- Mining and oil and gas extraction
- Agriculture, forestry, fishing and hunting
- Construction
- Wholesale trade
- Transportation and warehousing
- Finance and insurance
- Real estate and rental and leasing
- Professional, scientific and technical services
- Administrative and support, waste management and remediation services
- Health care and social assistance
- Public administration

Similarly those living outside of the Mattawa-Bonfield region travelling to the region for employment are primarily in the following occupational sectors:

- Manufacturing
- Educational services
- Other services (except public administration)

The primary employers in the Mattawa-Bonfield Area in 2010 as identified by the Mattawa-Bonfield Economic Development Corporation are listed in Tables 13.6 and 13.7. It is noted that some employment sectors may be absent such as education. North Bay's top employers are largely public sector employers which include:

- North Bay Regional Hospital
- School Boards
- Canadian Forces Base
- Ontario Northland Commission
- Provincial Government

The City of North Bay stopped reporting major employers in mid-2000 due to difficulty in properly identifying full time, part time and contract workers.

More recent labour market information for Nipissing and Parry Sound Districts have been reported by the Labour Market Group which is a local not-for-profit organization funded by the Ontario Ministry of Training Colleges and Universities. In April 2012 the Labour Market Group published "Local Labour Market Plan Report". This plan primarily examines private sector labour market trends of the region on a short-term basis.

The Local Labour Market Plan identifies that small and medium sized enterprises of fewer than 100 employees dominate the local labour market. Enterprises with fewer than 100 employees experienced a 1.4% rate of growth in 2011 over 2010. Enterprises with 0 to 4 employees made up 71.8 % of the labour market in Nipissing District. The largest growth between 2010 and 2011 were business with 0 employees (self-employed) which grew by 8.7%. In total 350 new

Table 13.6 Primary Private Sector Employers within the Mattawa Bonfield Area

Name	Product or Service	Sector	No. of Employees (approximate)
Janveaux Forest Products	Forestation	Forestry	90
Algonquin Nursing Home	Retirement Services	Retirement	78
Tembec Industries	Forestry and Lumber	Forestry	50
Columbia Forest Products Ltd.	Veneer sheets	Forestry	50
GinCor	Dump box installation	Service	50
Gin Cor Industries	Manufacturing	Manufacturing	45
Otto Holden Dam	Generating station	Hydro	26
Pioneer	Highway maintenance	Construction	15
Gagnes Food Friends	Hardware, Building Supplies, Groceries, Gas, Fuel	Retail	10
Crevier Gas and First Spike Restaurant	Restaurant, Gas Bar, Country Style	Retail and service	8
Bonfield Kwik-Way	Restaurant, Gas Bar, Country Style	Retail and service	6

Source: McSweeney & Associates from the Town of Mattawa, Township of Bonfield, Papineau-Cameron Township, Mattawan Township and Municipality of Calvin 2010.

Table 13.7 Primary Public Sector Employers within the Mattawa Bonfield Area

Name	Sector	No. of Employees (approximate)
Mattawa General Hospital	Health Care	82
Corporation Town of Mattawa	Municipal Government	17
Corporation of the Township of Bonfield	Government	15
Township of Calvin	Government	12
The Corporation of the Township of Papineau-Cameron	Government	7

Source: McSweeney & Associates from the Town of Mattawa, Township of Bonfield, Papineau-Cameron Township, Mattawan Township and Municipality of Calvin 2010.

jobs were created in the small to medium sized sector in Nipissing District in 2011 over 2010. The summary of employment in the small and medium size sector is presented in Table 13.8. The top five low to medium employment sectors are identified in Table 13.9.

Table 13.8 Comparison in the Small/Medium Sized Enterprise Employment 2010/2011 for Nipissing District

	0	1-4	5-9	10-19	20-49	50-99	Small/Medium Total
Total 2010	2,028	2,741	4,066	4,890	6,662	4,723	25,110
Total 2011	2,204	2,734	4,253	5,141	6,615	4,513	25,460
Percent Change	8.7	-0.3	4.6	5.1	-0.7	-4.4	1.4

Source: Labour Market Group, 2012

Table 13.9 Top 5 Small to Medium Employment Sector Categories in Nipissing District 2011

NAICS	0	1-4	5-9	10-19	20-49	50-99	Small/ Medium Total	%	Rank
722 – Food Services and Drinking Place	36	80	284	656	725	527	2,307	9.06	1
238 – Specialty Trade Contractors	158	261	317	320	380	198	1,635	6.42	2
541 – Professional, Scientific and Technical Services	250	192	253	319	237	67	1,318	5.18	3
621 – Ambulatory Health Care Services	32	286	265	311	167	139	1,201	4.72	4
445 – Food and Beverage Stores	24	60	301	119	152	282	937	3.68	5

Source: Labour Market Group, 2012

13.3 Primary or Resource Sector Industries

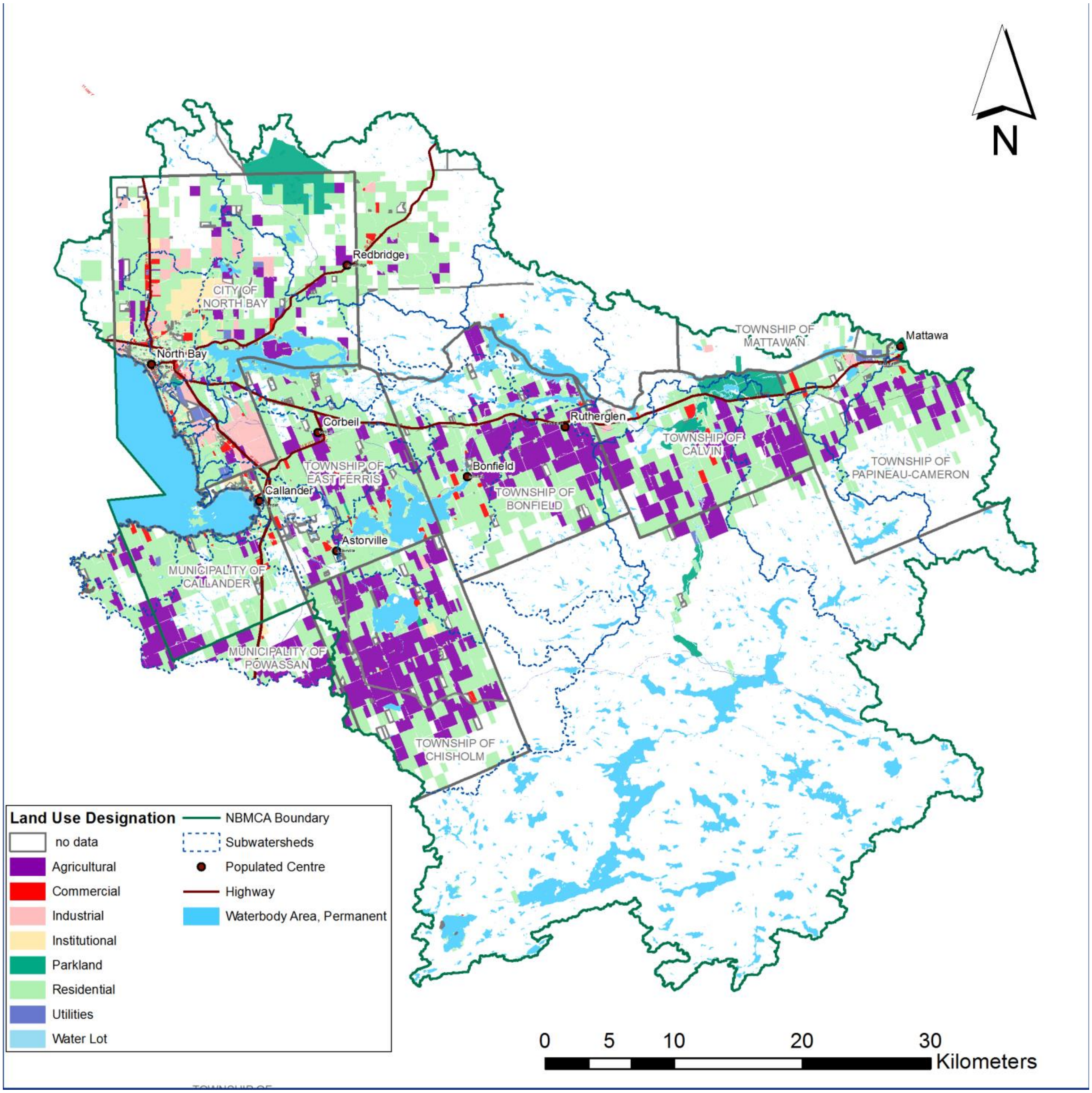
Primary or Resource Sector Industries in the region are dominated by agriculture, mining, and forestry. These uses are primary uses in rural landscapes that have the potential to influence watershed responses. . Industry characteristics and trends thus are important to assess for watershed management planning assessment purposes.

13.3.1 Agriculture

Most agricultural information for the region is derived from the Agricultural Census which is completed in conjunction with the general Canadian Census completed every 5 years. The 2011 Agricultural Census was not fully released by Statistics Canada at the time of preparation. The Ontario Ministry of Agriculture Food and Rural Affairs (OMAFRA) has released 2011 Agricultural Census statistics for various Ontario Districts. In 2011 OMAFRA reported that Nipissing District had 247 *Census Farms* that actively farmed a total of 32,018 hectares. Parry Sound District was reported to have 326 *Census Farms* actively farming 51,950 hectares (OMAFRA, 2011). A Census Farm is defined as an agricultural operation that produces agricultural products intended for sale (Statistics Canada 2013). Agricultural land uses within the NBMCA as identified by MPAC is shown in Figure 13.2

In comparison to farm sizes in Ontario, 2011 Agricultural Census data released by OMAFRA indicates that Nipissing District has fewer small farms. 28.7% of the farms in Nipissing District are less than 53 hectares (131 acres), 44.1% are between 53 and 161 hectares (131 and 398 acres) and 27.1 % are larger than 161 hectares (398 acres) (OMAFRA 2011). In 2011 the average farm size in Nipissing District was 129 hectares or 319 acres which is larger than the provincial average of 99 hectares or 244 acres (Statistics Canada 2011). The average age of farmers in Nipissing District in 2011 was 53.2 compared to the Ontario average of 54.5 years. In 2010, of all farmers in Nipissing District, 54.1 % had off farm jobs or businesses compared to 47.8 % in Ontario also (Statistics Canada 2011).

Figure 13.2 Location of Agricultural Land Uses within the NBMCA



Source: Municipal Property Assessment Corporation, 2012

In comparison to farm sizes in Ontario, 2011 Agricultural Census data released by OMAFRA indicates that Parry Sound District also has fewer small farms. 41.7 % of the farms in Parry Sound District are less than 53 hectares (131 acres), 38.6 % are between 53 and 161 hectares (131 and 398 acres) and 19.3 % are larger than 161 hectares (398 acres) (OMAFRA 2011). In 2011 the average farm size in Parry Sound District was 95.6 hectares or 236 acres which is slightly smaller than the provincial average of 99 hectares or 244 acres (Statistics Canada 2013).

The average age of farmers in Parry Sound District in 2011 was 58.0 years compared to the Ontario average of 54.5 years. In 2010, of all farmers in Parry Sound District, 55.2 % had off farm jobs or businesses compared to 47.8 % in Ontario (Statistics Canada 2012). In Ontario the average farm size is increasing while total number of farms is declining. Farm sizes are in part increasing by farmers renting or leasing additional land. 2006 "Census Farm" information for north central regions as wells as for the province are presented in Table 13.10. The changing dynamics of farm sizes between 1996 and 2006 for north central Ontario and the province is presented in Table 13.11. The changing dynamics of farm ownership between 1996 and 2006 for north central Ontario and the province in 2006 is presented in Table 13.12.

Table 13.10 Number of Census Farms in Nipissing, Parry Sound Districts and in Ontario

	1996	2001	2006	Change # 1996-06	Change % 1996-06
Ontario	67,520	59,728	57,211	-10,309	-15%
Northern Ontario	2,915	2,635	2,479	-436	-15%
Blue Sky Region	1,031	955	864	-167	-16%
Greater Sudbury	172	159	160	-12	-7%
Sudbury District	135	120	94	-41	-30%
Nipissing District	299	284	272	-27	-9%
Parry Sound District	425	392	338	-87	-21%

Source: Ontario Federation of Agriculture, 2009

Table 13.11 Total Acreage of Census Farms in Nipissing, Parry Sound Districts and in Ontario

	1996			2001			2006		
	Total farms	Total acres	Average farm size	Total farms	Total acres	Average farm size	Total farms	Total acres	Average farm size
Ontario	67,520	13,879,565	206	59,728	13,507,357	226	57,211	13,310,216	233
Northern Ontario	2,915	1,025,190	352	2,635	1,012,026	384	2,479	1,022,060	412
Blue Sky Region	1,031	247,225	240	955	241,214	253	864	221,654	257
Greater Sudbury	172	25,457	148	159	25,414	160	160	22,892	143
Sudbury District	135	38,615	286	120	36,820	307	94	32,398	345
Nipissing District	299	87,657	293	284	83,170	293	272	83,747	308
Parry Sound District	425	95,496	225	392	95,810	244	338	82,617	244

Source: Ontario Federation of Agriculture, 2009

Table 13.12 Land Tenure of Census Farms in Nipissing, Parry Sound Districts and in Ontario

	1996				2006			
	Area owned		Area rented/leased		Area owned		Area rented/leased	
	Acres	%	Acres	%	Acres	%	Acres	%
Ontario	9,764,607	70%	4,114,958	30%	9,613,544	72%	3,696,672	28%
Northern Ontario	808,816	79%	216,374	21%	755,642	74%	266,418	26%
Blue Sky Region	211,112	85%	36,113	15%	182,059	82%	39,595	18%
Greater Sudbury	21,952	86%	3,505	14%	20,386	89%	2,506	11%
Sudbury District	31,439	81%	7,176	19%	25,969	80%	6,429	20%
Nipissing District	72,993	83%	14,664	17%	66,483	79%	17,264	21%
Parry Sound District	84,728	89%	10,768	11%	69,221	84%	13,396	16%

Source: Ontario Federation of Agriculture, 2009

The number of farms by industrial grouping in Nipissing and Parry Sound Districts are presented in Table 13.13. This table suggests that the number of beef and dairy operations in the region have declined while oil seed, grains and other crops are increasing as well as sheep and goat operations. The numbers of farms within Nipissing and selected Parry Sound agricultural census areas are listed in Table 13.14. Table 13.14 indicates that less than 10% of farms in Parry Sound District and slightly greater than half the farms in Nipissing District are within the study area.

Table 13.13 Selected Farming by Industry Grouping by District - 2011 Census

Farm Industry Grouping	# of Farms Nipissing 2006	# of Farms Nipissing 2011	# of Farms Parry Sound 2006	# of Farms Parry Sound 2011
Other Crop Farming	114	118	139	162
Beef Cattle Ranching and Farming	81	49	85	46
Other Animal Farming	46	36	62	64
Oil Seed and Grain Farming	5	18	4	11
Greenhouse, Nursery and Floriculture	8	9	18	9
Sheep and Goat Farming	4	6	6	12
Vegetable and Melon Farming	5	5	6	9
Fruit and Tree Nut Farming	4	3	4	3
Hog and Pig Farming	4	2	5	2
Poultry and Egg Production	1	1	9	8
Total	272	247	338	326

Source:2011 Agricultural Census, Statistics Canada

Table 13.14 Selected Farming by Industry Grouping by Census Area - 2011 Census

Farm Industry Grouping	Callander 2011	Chisholm 2011	Bonfield 2011	Nipissing Dist South* 2011	Nipissing Dist North** 2011	Powassan 2011	West Nipissing 2011
Other Crop Farming	7	12	18	26	14	27	48
Beef Cattle Ranching and Farming	4	5	8	7	2	12	27
Other Animal Farming	3	10	5	6	6	6	9
Oil Seed and Grain Farming	1	1	0	0	0	1	17
Greenhouse, Nursery and Floriculture	1	1	2	0	2	0	4
Sheep and Goat Farming	0	3	0	2	0	2	1
Vegetable and Melon Farming	0	0	0	1	2	0	2
Fruit and Tree Nut Farming	0	0	0	1	0	1	2
Hog and Pig Farming	0	0	0	0	0	0	2
Poultry and Egg Production	2	0	0	0	1	2	0
Total	18	32	33	43	27	51	112

(grey) Parry Sound District; (yellow) Nipissing District

* includes Calvin, Papineau-Cameron, Lauder and Boulter Townships (which are all in one Agricultural Census Division)
** includes North Bay, East Ferris, Phelps, Mattawan and Mattawa (which are all on one Agricultural Census Division)

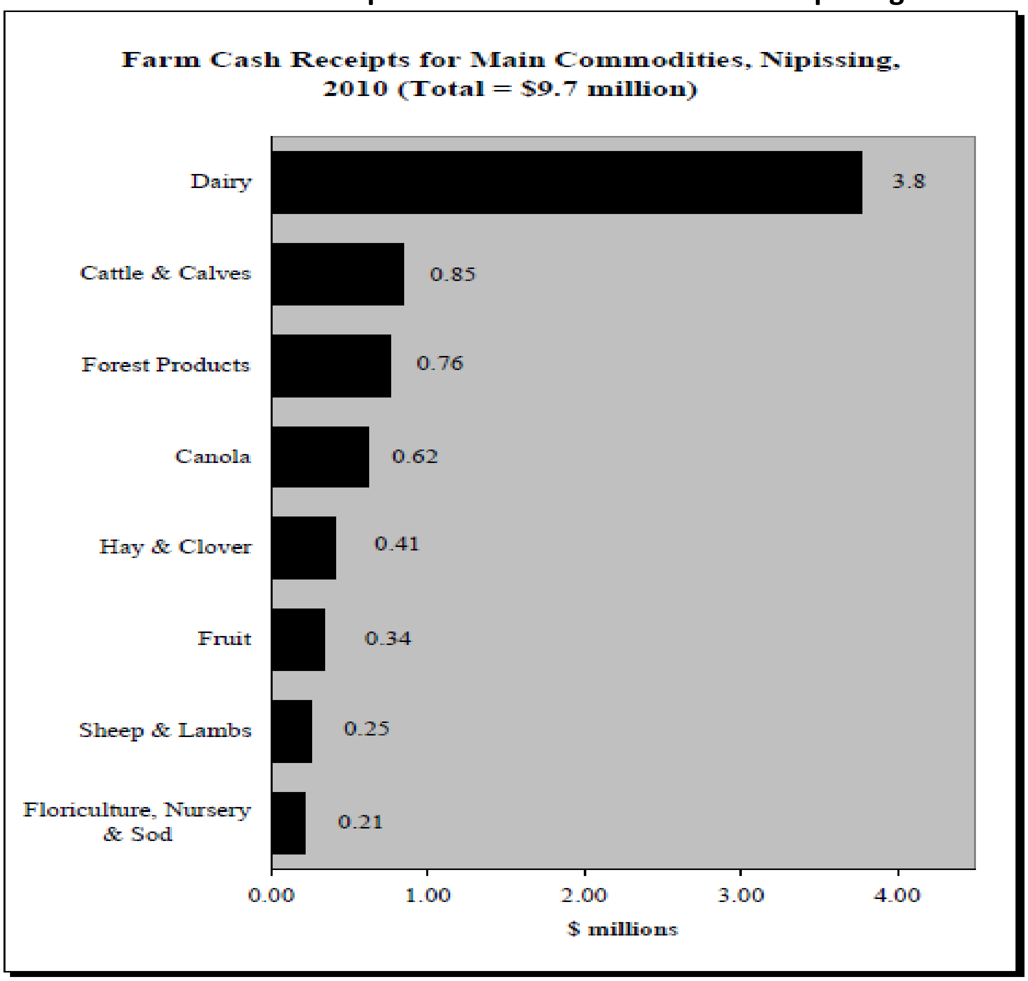
Source: 2011 Agricultural Census, Statistics Canada

Of all farmland in Nipissing District in 2011, 43.6 % or 13,969 hectares were classified as croplands, 30.0 % or 9,620 were Christmas trees, woodlands and wetlands, 14.5 % or 4,641 hectares was natural pasture, 6.5 % or 2,095 hectares were tame or seeded pasture and 5.2 % or 1,664 hectares were reported as “other” (OMAFRA, 2011). Dominant crops reported are hay (9,774 ha), oats for grain (1,076 ha) and soybeans (796 ha). Total livestock reported included 5,363 cattle and calves, 1,712 sheep and 192 pigs. Total poultry reported included 2,275 hens and chickens and 181 turkeys. In Nipissing District fields are rarely left fallow. In 2011 there were 9 farms reporting greenhouses which is an increase from 8 greenhouse operations reported in 2006. 76.9 % of all agricultural operations in Nipissing are beef and dairy operations, grow other crops (mainly hay) or raise other animals (mainly horses).

To manage operation, farmers often rely on hired farm labour. In Nipissing District in 2011, 2,273 weeks of hired farm labour were reported which was split evenly between full-time and seasonal work. In 2011 in Nipissing District, 67.6% of all farm operations reported gross farm receipts below $25,000/year and 80.1% reported gross farm receipts below $50,000/year (OMAFRA, 2011). Gross farm receipts are defined as receipts for all products sold as well program payment and custom work receipts before expenses (Statistics Canada 2012). In 2011 in Nipissing District, 51.4 % of farm capital assets were valued between $200,000 and $499,999 while 27.9 % were valued between $500,000 and $999,999 (OMAFRA, 2011).

Agricultural production in Nipissing District in 2010 was valued at $ 9.7 million (OMFARA 2011). The breakout of farm cash receipts for main commodities in Nipissing District in 2010 is presented in Figure 13.3.

Figure 13.3 2010 Farm Cash Receipts for Various Commodities in Nipissing District



Source: OMAFRA, 2011

13.3.2 Extractive – Aggregates

As of January 1, 2007 the NBMCA's area of jurisdiction became subject to the Aggregate Resources Act and all aggregate producers were required to comply with this Act and its Regulations. Existing operators were required to apply for a license but were exempted from public notice and consultation requirements. To obtain a license, owners were required to file technical reports that cover a number of technical assessments including progressive and final rehabilitation. Prior to 2007 pit owners did not always rehabilitate lands disturbed by extractive activities and many disturbed sites are evident within the NBMCA area of jurisdiction.

In 2010 the Ontario Ministry of Natural Resources released an assessment of aggregate production and supply rates in the Province in *"State of the Aggregate Resource in Ontario Study" (SAROS)* (MNR, 2010) which included a number of background papers. This study lists recent production rates for local municipalities as well as for Nipissing and Parry Sound Districts and Northeastern Ontario. It also projected future supply and demand in Northeastern Ontario based on a number of variables including population growth. A list of all licensed Aggregate Operators within the NBMCA published by Gravel Watch Ontario is provided in Appendix C.

Aggregates have a wide range of uses in Ontario, however new construction is the primary use. Aggregates are used directly in construction and are also used to manufacture construction related products including concrete, concrete building products and asphalt. Road construction consumes most of the aggregates produced in the region. The MNR SAROS Study reports that it takes:

- 18,000 tonnes of aggregates to construct 1 km of 2 lane highway
- 250 tonnes of aggregate to construct a 2,000 sq. ft. home
- 1000 – 4500 tonnes of aggregates to construct 1 kilometer of new water main.

Annual aggregate production rates for Ontario are reported by The Ontario Aggregate Resource Corporation (TOARC). At the time of assessment, 2010 data was available and preliminary data for 2011 had been released. Data indicates that within the NBMCA area of jurisdiction all recent aggregate production has been on patented land under Aggregate Licenses. (Aggregates can also be extracted from wayside pits using a Wayside Permit or on Crown land through an Aggregate Permit).

Lands affected by aggregate licenses within the NBMCA are illustrated in Figure 13.4. Aggregate production rates for municipalities within the NBMCA for 2010/2011 have been summarized in Table 13.15.

Table 13.15 indicates that over half of the NBMCA aggregate production occurs in North Bay. Within NBMCA municipalities aggregate producers generate approximately 81% of total production in Nipissing District; 5.6 % of total production in Northeastern Ontario; and 0.6% of total production in Ontario. A majority of aggregates are extracted from pits. Proportionally there are more aggregate reserves within the NBMCA than in Ontario suggesting that higher extraction rates are possible. In Ontario, however, hauling costs and government policies that promote close-to-market aggregate production make it unlikely that aggregates will be exported from the region in any large quantities (Canadian Institute for Environmental Law and Policy, 2011).

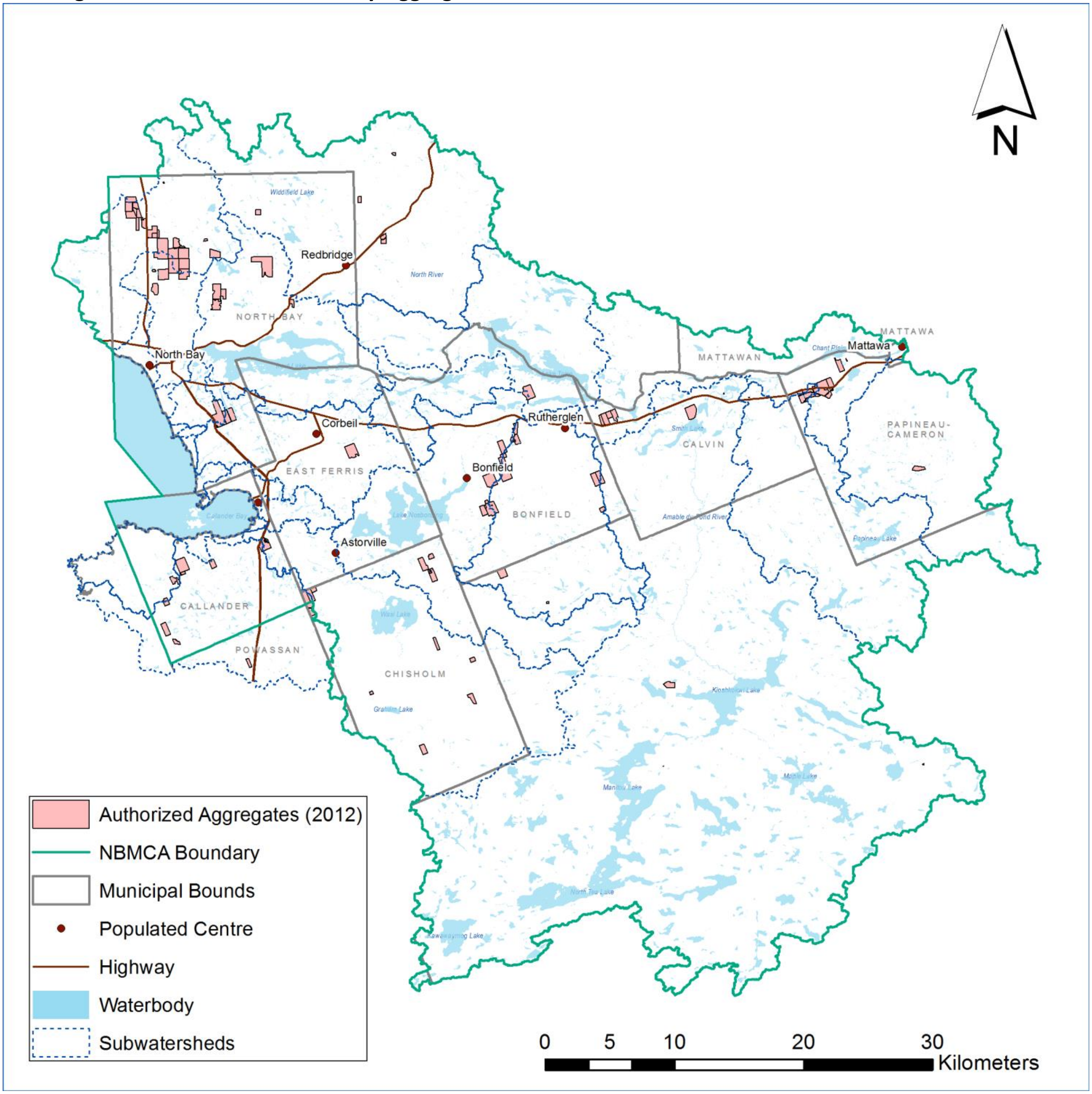
In Ontario aggregate production is gradually increasing over time. Production is significantly affected by economic activity. In Nipissing District short term production rates have declined since the onset of the 2008 recession. Table 13.15 indicates that in both 2010 and 2011 annual production rates in Nipissing District were approximately 1.1 million tonnes. This is down slightly from production levels in Nipissing reported in 2007 (1.3 million tonnes) and for both 2008 and 2009 (1.2 million tonnes for each year) (TOARC, 2010).

Within the North Bay District MNR administrative region there were 147 licensed aggregate operators as of 2011 of which 116 were Pits, 6 were Quarries and 25 were Pits & Quarries (information from TORAC is summarized based on MNR regions). Total production within North Bay MNR District was 1,288,241 tonnes in 2011 of which 64.9% was sand and gravel, 34.2 % was crushed stone and 0.9 % was other stone products. Crushed stone as a percentage of total aggregates production is steadily increasing in Ontario. In 2011, 147 licensed operations in North Bay MNR District affected 7195.3 hectares of land of which 945 hectares were considered disturbed. During 2011, an additional 29.1 hectares were disturbed and 26.7 hectares were rehabilitated to increase the disturbed area footprint to 947 hectares (The Ontario Aggregate Resource Corporation, 2011).

The SAROS Report (MNR 2010) identifies that there are primary and secondary aggregate sources in Ontario. Primary aggregates are taken directly from pits and quarries while secondary aggregates are sourced from recycled aggregates or substitute materials. In Ontario 93% of all aggregates come from primary sources and in Northeastern Ontario this percentage is even higher. The per capita use of aggregates is also higher in Northern Ontario compared to Southern Ontario. In Northeastern Ontario there are about 28 tonnes of aggregates used per capita annually which is double the provincial average.

SAROS (MNR 2010) identified net importers and exporters of aggregated in Ontario regions by compared aggregate consumption and production rates. In the decade of the 2000 annual aggregate production in Northeastern Ontario averaged 15 million tonnes while consumption averaged about 13 million tonnes indicating the area is a net exporter. Aggregate deficits exist in east central and west central Ontario. Producers within the NBMCA are not likely to supply

Figure 13.4 Lands affected by Aggregate Licenses within the NBMCA



these markets (with the possible exception of specialty quarried stone products) due to prohibitive hauling costs. SAROS predicts that production and consumption rates will steadily increase over time. In the next 20 years annual production rates will increase to 16 million tonnes in Northeastern Ontario while annual consumption is expected to increase to 15 million

Table 13.15 Recent Aggregate Production Rates for the NBMCA and other Jurisdictions Relative to Total Maximum Allowable per All Approved Licenses (metric tonnes)

Municipality/Jurisdiction	2010 Total Aggregate Production	2011 Total Aggregate Production	2010 Maximum Approved/All Licenses	2010 Approved Pit	2010 Approved Quarry	2010 Approved Pit & Quarry	2010 Total # of Licenses
Bonfield	26,147.05	31,008.09	1,540,000	1,540,000	0	0	11
Callander	34,210.80	34,412.95	1,914,000	1,614,000	0	300,000	9
Calvin	33,984.69	41,103.96	1,310,000	310,000	0	1,000,000	5
Chisholm	39,973.07	36,604.50	1,632,000	1,632,000	0	0	11
East Ferris	-	-	20,000	0	0	20,000	1
Lauder (unorganized)	-	-	0	0	0	0	0
Mattawa	-	-	0	0	0	0	0
Mattawan	5,624.60	5,331.50	60,000	60,000	0	0	1
North Bay	548,084.93	563,801.12	14,320,000	6,900,000	2,000,000	5,420,000	17
Papineau/Cameron	112,597.28	109,361.16	2,220,000	1,220,000	0	1,000,000	8
Phelps (unorganized)	-	-	0	0	0	0	0
Powassan	87,354.67	68,544.06	1,910,000	1,910,000	0	0	10
NBMCA Total	**887,977.09**	**890,167.34**	**24,926,000**	**15,186,000**	**2,000,000**	**7,740,000**	**73**
Nipissing District	1,089,925.56	1,100,475.56					
Northeastern Ontario*	15,800,000.00	15,800,000.00					
Ontario	161,000,000.00	159,000,000.00	2,253,727,476	1,630,557,712	374,393,224	248,361,540	N/A
NBMCA Percent of Ontario	0.6%	0.6%	1.11%	0.93%	0.53%	3.12%	
* estimate from SAROS, 2009							

Source: The Ontario Aggregate Resource Corporation (TOARC), 2010 and 2011. License Information has been summarized from Gravel Watch Ontario Website for 2010 (http://www.gravelwatch.org/gravel_stats.htm)

tonnes. The amount of secondary aggregate used in both Ontario and Northeastern Ontario is also expected to increase. One of the largest secondary aggregate sources in the regions is derived from recycled asphalt.

The direct and indirect value as well as the employment implication of aggregate production within the NBMCA is difficult to ascertain. An 11.5 cent/tonne royalty paid to municipalities which would total approximately $100,000/year based on recent production rates within the NBMCA. In 2007 the Ontario Aggregate Industry reported that aggregate production in Ontario contributed the following (data from SAROS Paper 3, 2009):

- $1.6 billion in Gross Domestic Product
- $827 million in direct labour income
- 17,000 fulltime jobs
- $2.9 billion in gross output
- $78 million in taxes

13.3.3 Extractive – Peat

Information concerning the horticultural production of peat suggests that the commercial harvesting of peat using modern dry mining techniques is not present within the NBMCA. Peat forms over time in a wetland environment when plants such as sphagnum moss build up and decompose to create a rich organic deposit (Eco Issues, accessed in 2013). Horticultural peat is harvested from bogs using a dry mining technique which includes large scale drainage of water, stripping, drying and vacuuming with specialized heavy equipment. A peat resource is gradually depleted in layers and it takes years to exhaust sizable peat deposits using commercial dry harvesting techniques. Research is underway to determine if bogs mined using this technique can be rejuvenated by leaving an organic layer to regenerate wetland plant growth. Peat can also be used as a fuel which has recently been studied by the Province (Gleeson, 2006).

The harvesting of peat is exempt from the both the Mining Act and the Aggregate Resources Act in Ontario and there is disagreement as to whether peat harvesting constitutes an extractive activity or agricultural activity (Eco Issues, accessed in 2013). In 2001 the Municipal Act was amended to give municipalities control peat over extraction activities using Site Plan Controls. In 2004 the Conservation Authorities Act was amended to give Conservation Authorities more power to control peat extraction activities. The NBMCA has issued one permits for peat extraction activity (Bruman Construction has obtained a permit to mine peat at its Carmichael Drive operation).

Peat deposits as a resource within the NBMCA is obscure. Peat is presumed to be occasionally harvested on an ad hoc basis and is used in a raw form. Peat is added to soils with low organic content to create topsoil used in landscaping. No additional production or locational information is available.

13.3.4 Forestry

Forestry, mainly undertaken on crown land, is the primary activity on about two thirds of the NBMCA land base. Forest management and harvesting in Ontario is organized on the basis of Forest Management Units. Each Forestry Management Unit has an operating Authority that holds a Sustainable Forest License to manage and harvest forest resources on Crown land. Northern and central parts of the NBMCA are located within the Nipissing Forest Management Unit and the southern portion of the NBMCA watershed is located within the Algonquin Forest Management Unit. A small corner of the NBMCA is located within the French/Severn Forest Management Unit south of Chisholm Township. Forest Management Units cover huge administrative areas that are considerably larger than the NBMCA's area of jurisdiction. While private logging occurs on patented lands, most timber harvested within the NBMCA that supplies commercial mills in Northeastern Ontario is derived from Crown land. The location of the NBMCA relative to Forest Management Units in Northeastern Ontario is presented in Figure 13.5. It is noted that the NBMCA mainly falls within the Nipissing and Algonquin Forest Management Units and the following discussion concentrates on these two areas.

The forest industry, while remaining a significant economic force in Northern Ontario, has suffered from recent economic hardship which has led to mill closures within the region. The following footnote is extracted from the 2009 Blue Sky Region Agricultural Economic Sector Profile, prepared by Harry Cummings and Associates in December 2009:

[7] One of the sectors particularly hard hit in the region in recent years is the forest product industry. Since 2006, a number of firms in northern Ontario have experienced contraction and/or closure. The primary reasons associated with the downturn include weak demand/poor market conditions (e.g. declining demand for newsprint, downturn in the U.S. housing market), and the rapid rise and appreciation of the Canadian dollar (Statistics Canada, June 2009; Statistics Canada, January 2009). Despite the downturn in the forestry sector, the industry remains an important element of the regional economy and experts suggest that the future potential of the sector may be linked to capitalizing on opportunities such as promoting value-added opportunities and working more closely with Aboriginal populations (Moazzami, 2006).

([7] Note: the Blue Sky Region encompasses the City of Greater Sudbury and the Districts of Parry Sound, Nipissing and Sudbury).

The Nipissing Forest

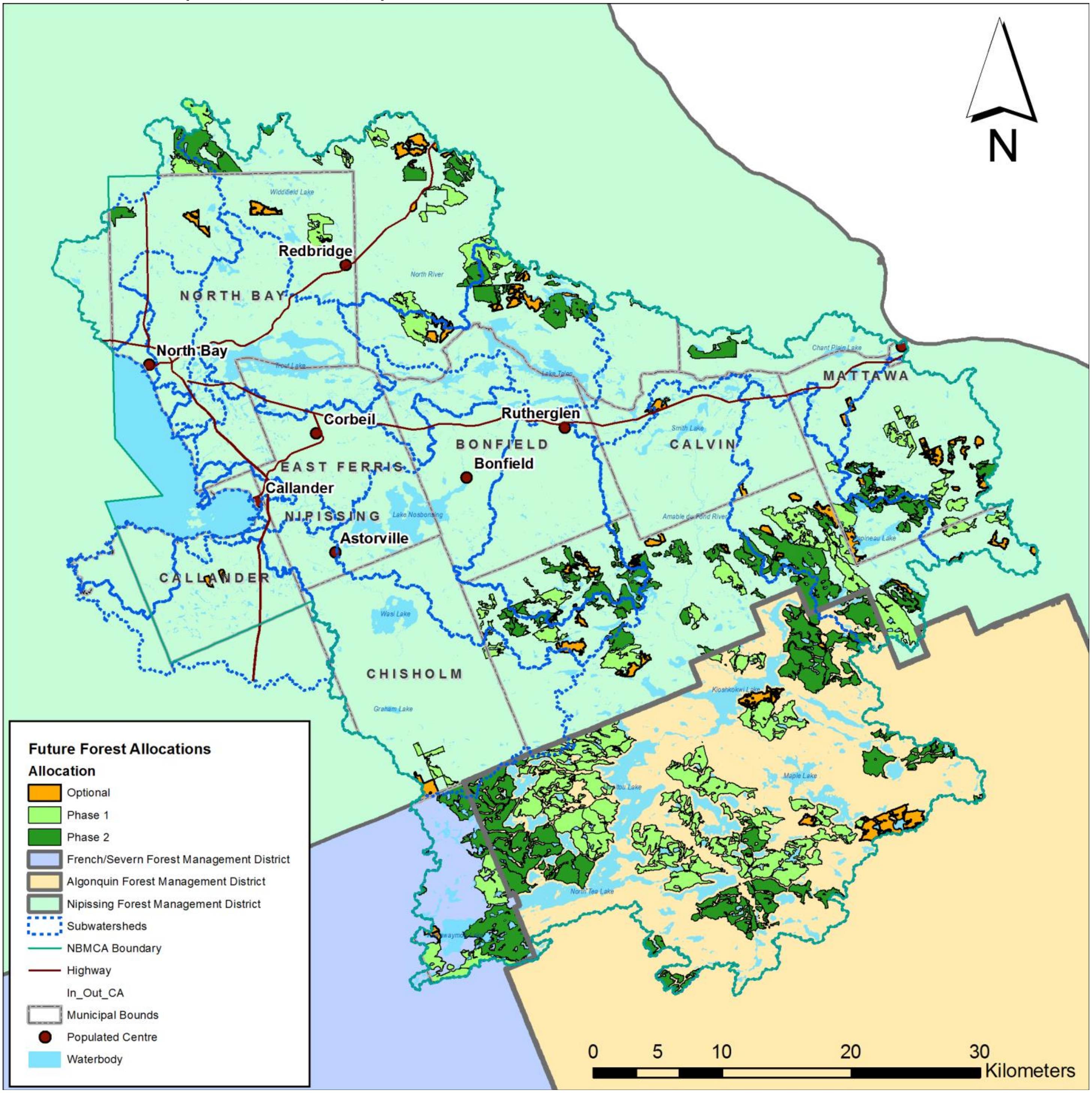
The Nipissing Forest covers a 19,500 km^2 area and is administered and managed by a private company called Nipissing Forest Resources Management Inc. The Company has 5 shareholders (R. Fryer Forest Products Ltd., Goulard Lumber (1971) Ltd., Tembec Industries Inc., Hec Clouthier and Sons Inc., and Grant Forest Products Inc.). This company is based in Callander Ontario and their web site is www.nipissingforest.com. The Nipissing Forest Authority reports Forest management activity within the Nipissing Forest is guided by a forest management plan.

Current forest management activity in the Nipissing Forest is guided by the Nipissing Forest 2009 – 2019 Forest Management Plan. A forest management plan is prepared by a planning team with representatives from forest management companies and the province. Plans are prepared with the assistance of a Local Citizens Committee comprised of stakeholders and with considerable public consultation.

The 2009 – 2019 Nipissing Forest Management Plan considers long term management direction and provides guidance for access, harvest, renewal and tending activities. The Nipissing Forest Management Plan applies to a large area that extends north and west of the NBMCA and extracting NBMCA watershed statistics is difficult. Harvesting is planned in 5 year increments and current harvesting is following the Phase I Allocation Plan which covers the 2009 to 2014 period. A Phase 2 allocation is tentatively established and will be adjusted based on demand and market conditions in 2013.

Forest management strategies strive to balance social, economic and biological interests. Biological interests include consideration of future forest conditions, spatial wildlife habitat, old growth forests, emulation of natural disturbances, climate change, utilization and harvest sustainability, aboriginal interests and resource based tourism. Harvesting is restricted in Provincial Parks and Conservation Reserves. Annual quotas for different species are identified for selected areas and using a number of different harvesting techniques. Harvest quotas and allocation of specie composition considers the demands of as many as 20 different processing facilities mainly in northeastern Ontario and northwestern Quebec. Preference is given to mills in Ontario. Processing facilities supplied by the Nipissing Forest are listed in Table 13.16. These

Figure 13.5 Forest Management Unit Areas and Phase 1 (2009/10 – 2014/15)/Phase 2 (2015/16 – 2019/20) Allocation Areas



facilities use Nipissing Forest wood to produce pulp and paper, veneer, softwood lumber, oriented strandboard, fuel wood, pallets and specialty products. The areas planned for harvest in the 2009 – 2019 Nipissing Forest Management Plan are identified in Figure 13.3 above. Most of the harvest occurs in unorganized areas.

The Algonquin Forest

The Algonquin Forest is managed by the Algonquin Forestry Authority which is an Agency of the Crown with offices in Huntsville and Pembroke Ontario. The activities of the Algonquin Forestry Authority are overseen by a Board of Directors made up of representatives of communities that surround Algonquin Provincial Park. The Algonquin Forest Authority web site is http://www.algonquinforestry.on.ca

Forest management activity in Algonquin Park is currently guided by the 2010 – 2020 Forest Management Plan for Algonquin Park. Algonquin Provincial Park is subject to an umbrella of management plans that protect sensitive zones which have wilderness, recreation, research, or historical features where forestry activities are prohibited. Approximately two thirds of the Park is open for forestry activity. Most of the protected zones are in the southern half of the park and the majority of the upper Amable du Fond River watershed is open for forest management activity. Forests are managed to protect the wilderness experience along lakes and streams through a number of mechanisms including landscape plans.

Table 13.16 Forest Processing Facilities supplied in whole or in part from the Nipissing Forest

Mill	Community in Ontario, *unless otherwise noted*
Abitibi Bowater	Iroquois Falls
Ben Hokum & Son Ltd.	Killaloe
Columbia Forest Products Ltd.*	Rutherglen, Hearst
Domtar Corp	Espanola, Nairn Centre, Elk Lake
Goulard Lumber (1971) Ltd.*	Sturgeon Falls
Grant Forest Products Inc.	Engelhart, Timmins
H & R Chartrand Lumber Ltd.	Noelville
Herb Shaw & Sons Ltd.	Petawawa
Liskeard Lumber Ltd.	Elk Lake
Northern Pressure Treated Wood Ltd.	Kirkland Lake
Precut Hardwood*	North Bay
R. Fryer Forest Products Limited	Monetville
St.Marys Paper Corp.	Sault Ste. Marie
Tembec Industries Inc.*	Mattawa, Kenogami
AbitibiBowater.	Quebec
Les Industries Davidson Inc.	Quebec
Les Industries L.P.B. Inc.	Quebec
Maibec Industries	Quebec
Smurfit-Stone	Portage, Quebec
Tembec Inc. (Temiskaming)	Temiskaming, Bearn, Quebec
Temlam (Ville-Marie)	Ville-Marie, Quebec

* Mills considered local/several mills are now closed
Source: 2009 – 2019 Forest Management Plan – Nipissing Forest

The 2010-2020 Forest Management Plan for Algonquin Park identifies detailed harvest, renewal and tending activities for the first 5 years (Phase 1) and proposes similar activities for the second 5 year period (Phase 2). The existing plan considered input from Parks Ontario, local Algonquin First Nations and the Algonquin Park Local Citizen's Committee. Finalization of the second phase of the harvest will be undertaken in 2014 for the 2015 to 2020 period. Planned harvest areas identified in the 2010 – 2020 Forest Management Plan for Algonquin Park are presented in Figure 13.3 above.

Most of the wood harvested in Algonquin Provincial Park supplies mills in central and eastern Ontario including Huntsville, Whitney, Madawaska, Killaloe, Pembroke, Eganville and Palmer Rapids. In total 12 mills receive part or most of their supply from Algonquin Provincial Park with another 5 to 10 mills receiving periodic shipments. The Algonquin Forest sustains 330 people employed in wood related activities and another 1220 people are indirectly employed in mills supplied by the Algonquin Forest. In 2009-2010 the value of the wood harvested from the Algonquin Forest is reported as $16.2 million. This wood supply is used to produce hardwood lumber products including furniture, flooring and crating; softwood lumber products including construction lumber, paneling and finishing products; utility poles; pulp and paper; oriented strandboard and fuel wood.

Conclusion

Forest management activity within the NBMCA on crown land has been ongoing since the NBMCA came into existence. Recent forest management practices are focused on sustainability and follow long term strategies designed to protect long term forestry interests and meet quantitative and qualitative biological, social and economic objectives. Time ranges considered for management indicators are defined as short-term (10 years) medium-term (20 years) and long-term (100 years). The Forest Management Plan for the Algonquin Forest has 39 management objectives and 251 indicators. The Algonquin Forestry Authority recently reported that 94% of sustainable forestry management objectives are currently being met. The evolving impact of forest management on watershed management activities is unknown.

13.4 Regional Tourism, Parks and Water Control Structures

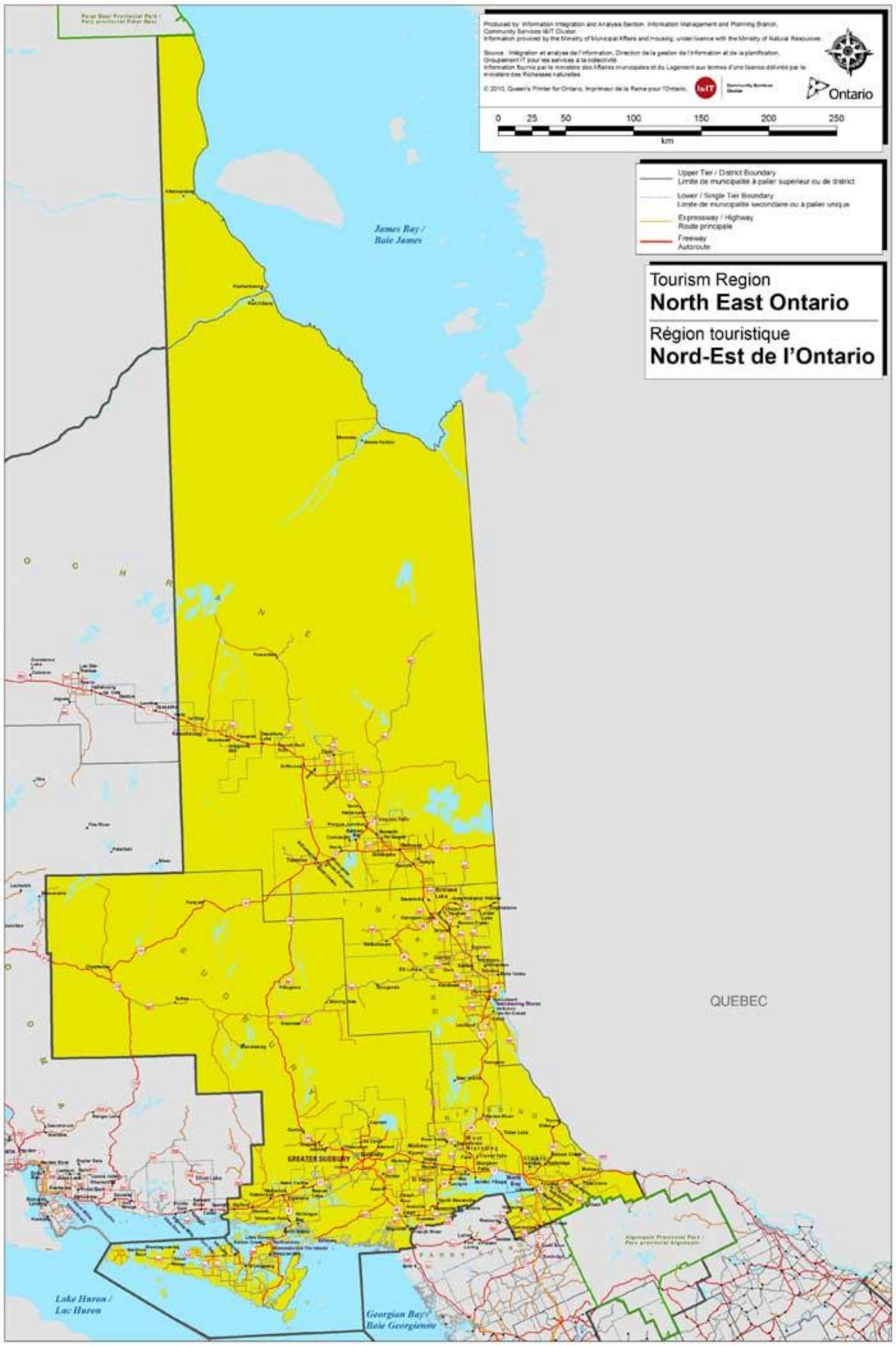
13.4.1 Tourism/Lodges/Resorts/Eco-tourism

The tourism market is undergoing relatively rapid change and the provincial approach to support the tourism industry in Northern Ontario is also in transition. Recommendation from a 2009 Ontario Competitiveness Study chaired by Greg Sorbara has resulted in an overhaul of way tourism is managed in Ontario. A new Regional Tourism Organization, created for Northern Ontario, has split the region into three areas due to its large size. The NBMCA is located in Regional Tourism Organization Area 13A set up for North East Ontario (the NBMCA's area of jurisdiction also extends into the northern fringes of RTO 12 which is mainly wilderness). The new organizational approach has the goal of better coordinating marketing programs based on target markets and visitor demographics. Emphasis is placed on visitors that stay in non-private roofed facilities from outside the region with greater promotion of pleasure trips (Regional Tourism Organization 13, 2011). Stantec has completed a regional tourism assessment from tabular information provided by the Ontario Ministry of Tourism Culture and Sport for years 2006 to 2010. The data is supplied through Statistics Canada and is available on Ontario Ministry of Tourism Culture and Sport - Current Performance Interactive Tool available on their website. This section also explores recent trends in the tourism market and considers how new opportunities such as eco-tourism and adventure tourism may be interlinked with NBMCA management interests. The new North East Ontario Regional Tourism Organization Area (RTO 13a) is illustrated in Figure 13.6.

In 2010 North East Ontario is reported to have experienced 3.63 million overnight and same-day visits which was about 3.5% of the total Ontario tourism market. This was an increase from 2009 which had 3.48 million visits. Most of the increase was caused by an increase in visitors from Ontario however, as a percentage; the largest increase was from Americans visiting Ontario North East Ontario (up 27.8% over 2009). Of the 3.63 million visits in 2010, 2.07 million were reported to be overnight visits and 1.56 million were same-day visits. The origin and spending habits of people visiting Ontario's North East as well as Nipissing and Parry Sound Districts are summarized in Table 13.17.

Table 13.17 indicates that Nipissing and Parry Sound Districts, in terms of visitor origin, is highly dependent on the Canadian domestic market and in particular the Province of Ontario. In Nipissing District 90.9 % of all visitors originate in Ontario and in Parry Sound Distirct the percent is even higher (93.5 %). Nipissing and Parry Sound Districts receive proportionately fewer US visits compared to North East Ontario, in part due to geography. Of those from the US visiting Nipissing District in 2010 most originated in boarder states and the states with the highest points of origin included Ohio, Pennsylvania and New York. Nipissing and Parry Sound Districts receive proportionately more visitors from overseas markets of which Germany, UK, the Netherlands and, in 2010 included Australia, are the major point of origin. In reviewing other years, overseas point of origin that stand out also include France, Switzerland and other European countries. In 2010 North East Ontario received a total of 23,100 visitors from overseas of which 76 % visited Nipissing District. In terms of visits from other provinces in 2010, Nipissing District experienced 40,531 overnight and same-day visits from Quebec (note that Quebec same-day visitations are very high in Nipissing) while Parry Sound District received only 2,070 visits from Quebec. The dominant points of origin of visitors to Parry Sound District were Alberta and British Colombia (18,368 visitations combined). The primary markets supporting tourism in the NBMCA, thus, are from Ontario and the US however visitors from Quebec and

Figure 13.6 Regional Tourism Organization Area 13A – North East Ontario



Source: Ontario Ministry of Tourism Culture and Sport web site

Europe also make up significant market components (Ministry of Tourism, Culture and Sport, accessed in June 2013).

In terms of visitor spending in 2010, an estimated $204 million was spent on overnight and same-day visits in Nipissing District which accounted for 31% of total spending in North East Ontario. On average in Nipissing District each visitor generates approximately $184 in spending.

Table 13.17 Visitor Origin and Spending Nipissing, Parry Sound Districts and North East Ontario, 2010

2010 Stats North East Ontario	Total Visits	Origin of Visitor			
		Ontario	Other Provinces	USA	Overseas
Overnight	2,068,300	1,822,200	82,400	141,400	22,300
Same-day	1,559,000	1,505,300	42,100	10,800	800
Total	3,627,300	3,327,500	124,500	152,200	23,100
Percent	100.0%	91.7%	3.4%	4.2%	0.6%
Total Spending	$ 670,777,193	$ 567,107,500	$ 42,518,652	$ 46,224,514	$ 14,926,528
Spending/Visit	$ 184.92	$ 170.43	$ 341.52	$ 303.71	$ 646.17
Nipissing Dist					
Overnight	741,300	674,094	20,594	35,638	10,975
Same-day	485,257	440,270	29,828	8,483	6,677
Total	1,226,557	1,114,363	50,422	44,120	17,652
Percent	100.0%	90.9%	4.1%	3.6%	1.4%
Total Spending	$ 204,953,234	$ 177,710,887	$ 8,385,122	$ 12,591,600	$ 6,265,626
Spending/Visit	$ 167.10	$ 159.47	$ 166.30	$ 285.39	$ 354.95
Parry Sound Dist*					
Overnight	1,071,541	990,226	22,008	43,831	15,477
Same-day	307,413	299,567	-	5,625	2,221
Total	1,378,954	1,289,793	22,008	49,456	17,698
Percent	100.0%	93.5%	1.6%	3.6%	1.3%
Total Spending	$ 165,586,571	$ 135,955,473	$ 5,338,874	$ 19,941,741	$ 4,350,483
Spending/Visit	$ 120.08	$ 105.41	$ 242.59	$ 403.23	$ 245.82
* not entirely in North East Ontario					

Source: Ontario Ministry of Tourism Culture and Sport - Current Performance Interactive Tool

Visitors from the US and Overseas markets in both Nipissing and Parry Sound Districts outspend domestic visitors by a considerable margin. In 2010 of those that stay overnight, the average length of stay in Nipissing District was 3.4 days of which those originating in Ontario stayed an average of 3.2 days, those from other provinces stayed an average of 3.4 days, those from the US stayed an average of 5.8 days and those from Europe stayed an average of 6.6 days (Ministry of Tourism, Culture and Sport, accessed in June 2013).

In 2010 most people visiting Nipissing and Parry Sound Districts that stayed overnight were traveling for pleasure or visiting friends and relatives. In North East Ontario 77.3 % of overnight visitors are traveling for pleasure. 69.5 % of the trips were to visits friends and relatives. Table 13.18 provides data on the main purpose of trips reported in North East Ontario as well as Nipissing and Parry Sound Districts in 2010. In terms of time of year, most visitors travel in the July to September period followed by October to December. Of all visitors, 37.5 % of visitors travelling to Nipissing District travel in the July to September period (includes same day trips). Most of the international visits to the region occurred in the July to September or 3rd Quarter window in 2010.

Table 13.18 Main Purpose of Trips in Nipissing, Parry Sound Districts and North East Ontario, 2010

Main Purpose of Trip (Person Visits)	North East Ontario	Nipissing District	Parry Sound District*
Pleasure	1,599,000	636,716	1,016,035
Visit Friends/Relatives	1,437,700	457,675	315,631
Business	229,500	42,150	8,191
Meetings	800	563	-
Conventions & Conferences	79,600	12,761	2,254
Other Business	149,100	28,825	5,937
Other Personal	360,900	90,017	39,097
* not entirely in North East Ontario			

Source: Ontario Ministry of Tourism Culture and Sport - Current Performance Interactive Tool

In terms of activities that people participate in when visiting in the region, outdoor sports/activities are the most often cited activity in 2010. 2010 activity numbers for people visiting the region are presented in Table 13.19. While fishing is reported as the most popular activity in North East Ontario, boating surpasses fishing in both Nipissing and Parry Sound Districts. Outside of outdoor activities, the next most popular activities are visiting National and Provincial Parks, Museums/Art Gallaries and Historic Sites.

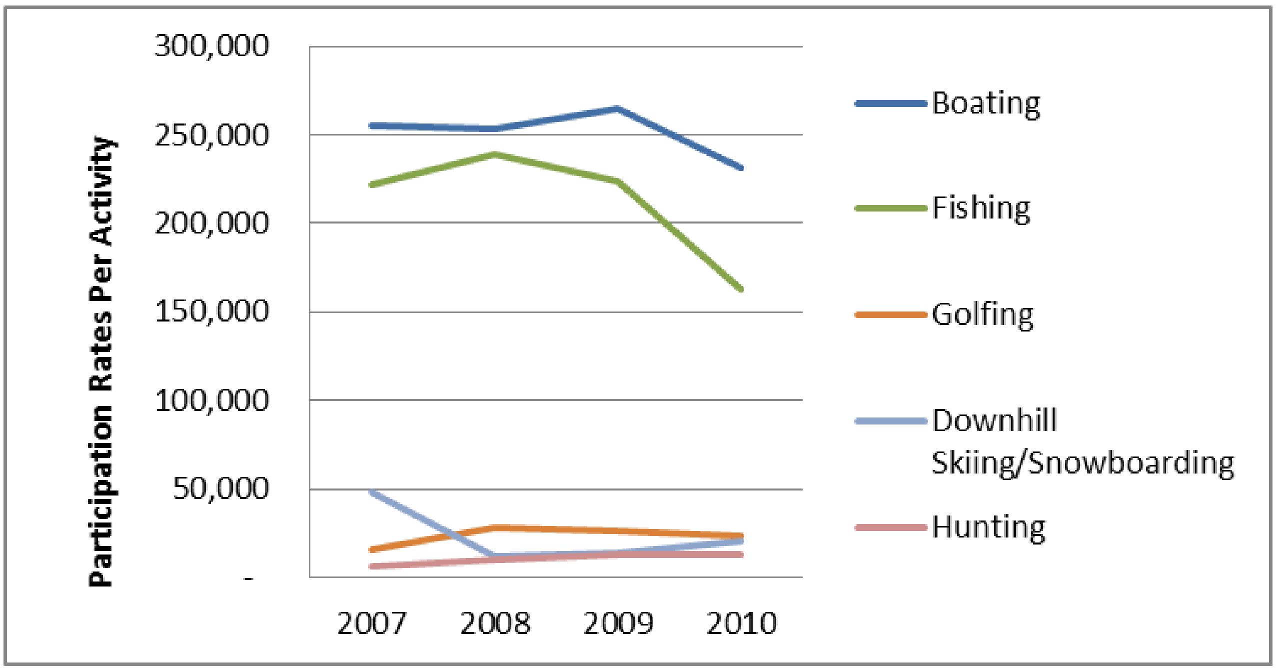
Table 13.19 Activities Participated in when in Nipissing, Parry Sound Districts and North East Ontario, 2010

Activities Participated (Person Visits)	North East Ontario	Nipissing District	Parry Sound District*
Festivals/Fairs	77,400	18,833	21,214
Cultural Performances	138,900	48,293	18,285
Museums/Art Galleries	175,300	87,440	25,400
Zoos/Aquariums/Botanical Gard	36,300	4,644	9,546
Sports Events	122,600	32,319	12,541
Casinos	47,200	18,311	17,853
Theme Parks	38,900	7,560	16,437
National/Provincial Nature Parks	244,100	195,718	108,191
Historic Sites	160,700	87,551	69,423
Any Outdoor/Sports Activity	1,097,300	526,614	881,242
Boating	467,000	231,211	533,910
Golfing	48,900	23,750	53,742
Fishing	503,900	163,012	489,822
Hunting	63,700	12,489	9,308
Downhill Skiing/Snowboarding	35,900	20,863	56,235
* not entirely in North East Ontario			

Source: Ontario Ministry of Tourism Culture and Sport - Current Performance Interactive Tool

The mainstay of tourism in the North East of Ontario, as highlighted in Table 13.19 has historically been heavily dependent on outdoor opportunities and landscapes. The traditional northern Ontario tourism market is facing new challenges as the global market place, new technology and the way technology is used is affecting regional tourism. In undertaking interviews with member municipalities for the Land Use Change assessment in Section 12 it was reported that tourist establishments that were reinvesting in their facilities seem to be viable operations but those that were not investing seem to be facing economic hardship. Also new opportunities and attractions that offer alternative experiences have been slow to develop in the region. Traditional tourism is being affected by evolving demographics, evolving public expectations and interests, rapidly evolving technology and information availability as well as the globalization of the competitive tourism market place (Ontario Ministry of Tourism Culture and Sport, 2013). Recent participation rates in various outdoor/sports activities in Nipissing District tracked by the province are presented in Figure 13.7

Figure 13.7 Trends in Various Outdoor/Sport and Activity participation rates – Nipissing District 2007 – 2010



Source: Ontario Ministry of Tourism Culture and Sport - Current Performance Interactive Tool

Some new emerging opportunities branded as eco-tourism, sustainable tourism, adventure tourism and ethical tourism (Ron Mader, 2012) has potential linkages to NBMCA management interests. Eco-tourism can interpret as cultural, ecological, historic and natural features to enhance regional experiences and build on opportunity diversity. Adventure tourism combines physical activity, cultural exchange or interaction and engagement with nature to create thrills based on risk that may challenge strength or cognitive thinking by causing people to step out of their comfort zone. The region has a rich opportunities base for new experiences, based on the watershed features and Parks/Conservation lands identified within various sections of this background report.

Recent tourism market dynamics can be explored to help identify emerging trends as well as new directions the market may be heading. In Ontario 50 % of the tourism market is now over the age of 45 (Deloitte, 2009a). Older tourists are more apt to seek higher quality destination experiences which may include spa facilities, higher quality cuisine, electronic devices such as larger flat screen TV's and high quality bedding rather than rustic conditions. Older tourists are also being marketed packaged value opportunities offered on an international stage. Ontario's outbound travel is rapidly expanding as inbound travel (Deloitte, 2009) and destination loyalty are declining (Deloitte 2009b). Traditional tourism experiences are losing their appeal with older clientele.

Youth make up approximately 20% of the global tourism market (Deloitte, 2009b). Modern youth are inclined to seek experiences that offer some form of adventure. The "Soft Outdoor Adventure Enthusiasts" is typically between the age of 18 and 44 years and is more affluent than the average Canadian. Ontario has been slow to respond to the outdoor adventure market and currently most adventure experiences are found in other provinces. 34% of Ontarian adults claim to be outdoor enthusiast which is the lowest percentage of all provinces in Canada (Canadian Tourist Commission, 2003) possibly due to a lack of provincial opportunities.

Historically tourist market areas were defined based on driving distances and the international market was almost exclusively considered visitations from the US. Tourism markets now seem to be limitless. Competitiveness is now measured in terms of cost of flights, food and accommodation in different foreign currencies (Conference Board of Canada, 2011). Algonquin Provincial Park, as an example, has a large German tourism base (Ontario Competitiveness Study, 2009) and Europe is identified as having a strong appetite for North American Native cultural experiences (The Canadian Tourism Commission, not dated). In Ontario the type of outdoor experiences sought by this diversified international base can best be met in Northern Ontario (Deloitte, 2009b). This fact has been recognized in the new management strategies developed for Northern Ontario and many international points of origin identified above are considered overseas target markets.

Tourism markets within the NBMCA region now not only compete with other regional markets in Ontario but compete globally. The internet and more sophisticated communication and marketing tools have revolutionized tourism marketing. People's interests are tracked by their internet use habits and direct marketing is being applied to advertise and influence individual choices. Technology has also created real time transparency with instantaneous ranking of user satisfaction through such websites as Trip Advisor. If an outfit is offering good or bad experiences it is soon exposed to everyone. The tourism landscape is evolving rapidly and regional tourism market is struggling to remain current.

As tourism evolves to take advantage of new opportunities there is risk that new stresses will be exerted on the regions resource base. Traditional tourism continues to be an important part of the regional economy; however, it is being pushed to evolve in new directions. It is being challenged to meet new demands from an aging population, to meet adventure interests of youth and to appeal to a bourgeoning international (largely European) interest in new world experiences. Eco-tourism and adventure tourism are new potential growth areas. The NBMCA can be a resource for the development of new regional eco-tourism opportunities but it also must monitor the use of resource features to ensure they are managed sustainably and with the long term interests of local communities in mind. The region has excellent potential to develop new tourism experiences based on inherent natural and cultural features that are sought domestically and internationally.

13.4.2 Provincial Parks and Conservation Areas

Protected parks and preserves/reserves within the NBMCA's jurisdiction have been identified in the Drinking Water Source Protection: Watershed Characterization Report, 2008. Additional details have been obtained from provincial fact sheets for individual properties available at www.ourOntario.ca as well as from the NBMCA website and land assessment records for lands owned by the NBMCA. Parks and protected area have been established to protect regional and sometimes provincially significant resource features. Often features are water based. Parks are supported by plans that often balance protection with controlled public access to both water and land based resources within their protected zones.

In total there are 21 Provincial Parks/Reserves and Conservation Areas/Preserves within the NBMCA (including the 2 properties owned by the NBMCA outside of their jurisdictional boundaries) ranging in size from less than 1 hectare (Eva Wardlaw Park) to more than 60,000 hectares (the portion of Algonquin Park that is within the NBMCA). Within the NBMCA boundaries a total of 870.4 km^2 of land are protected as provincial or regional parkland/preserve/reserve which have restricted land uses and protected resource features. Protected parkland represents 29% of the total NBMCA land base which is an impressive percentage. This total includes Algonquin Provincial Park which makes up approximately 73.8% of the total protected park area. Algonquin Park is also the only park area which permits forest harvesting activity under strict controls and consequently watershed management impacts are similar to other unprotected Crown land within the NBMCA (see Figure 13.5 Forest Management Unit Areas and Phase 1 (2009/10 – 2014/15)/Phase 2 (2015/16 – 2019/20) Allocation Areas). A summary of Parks and Protected Area characteristics within the NBMCA is presented in Table 13.20. The location of parks and protected areas is presented in Figure 13.8.

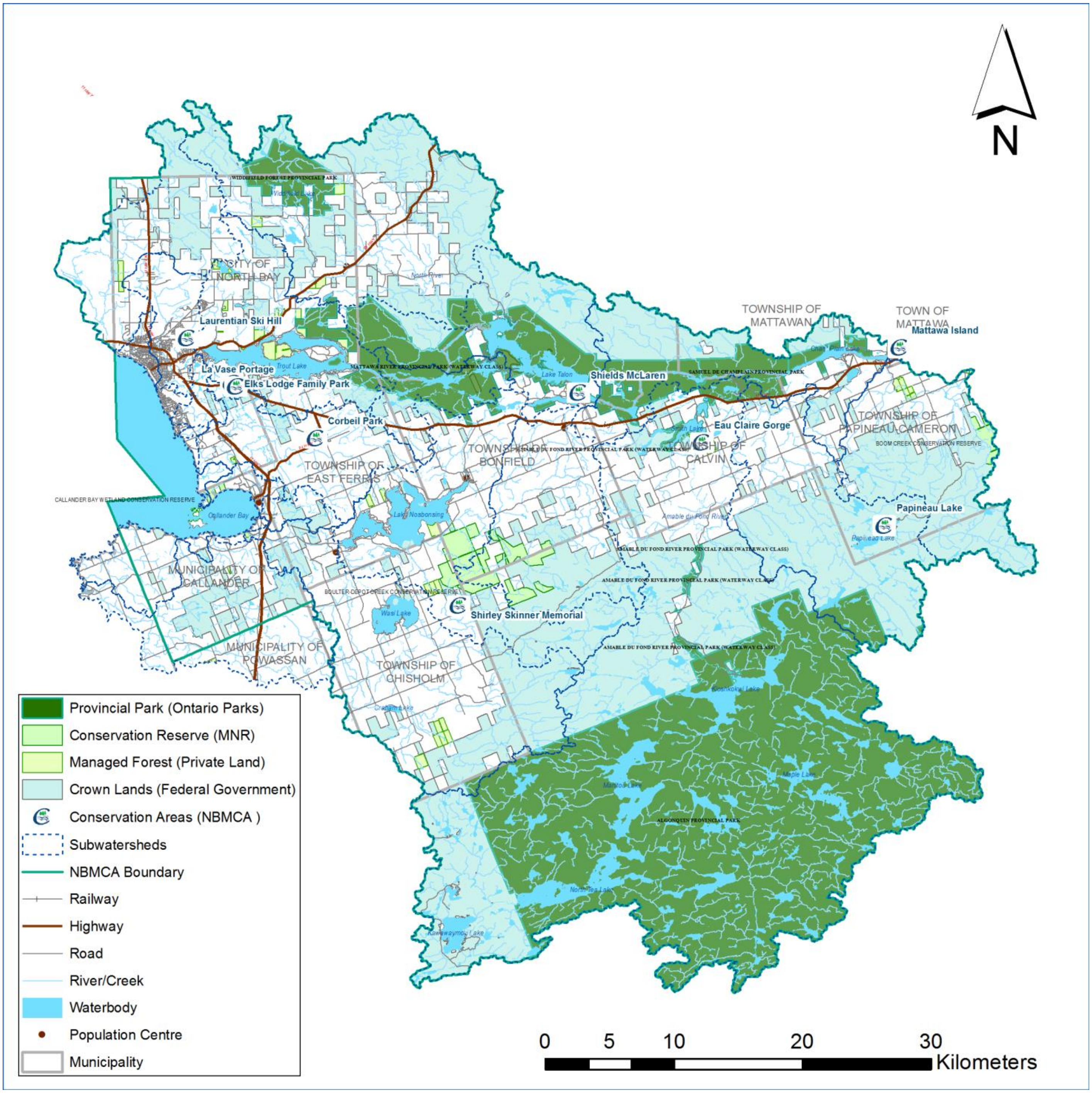
Table 13.20 Parks and Protected Areas within the NBMCA Area of Jurisdiction

Park/Conservation Area Designation & Name	Total Park Area	Park Area within NBMCA	Protected Feature
Provincial Parks	Km^2	Km^2	
Algonquin Provincial Park	7723	642.40	Natural Environment Park
Samuel de Champlain Provincial Park	25.5	22.91	Natural Environment Park
Amable du Fond River Provincial Park	7.29	7.29	Amable du Fond River
Mattawa River Provincial Park + extension	141.43	141.43	Mattawa River
Widdifield Forest Provincial Park	21.69	21.69	Old Growth Forest
Provincial Conservation Reserves			
Boom Creek Old Growth Forest	3.10	3.10	Old Growth Forest
Boulter-Depot Creek Conservation Reserve	23.48	23.48	Moraine/Esker
Callander Bay Wetland Conservation Reserve	3.18	3.18	PS Wetland
Conservation Areas			
Corbeil Conservation Area	0.40	0.40	Flood Plain
Eau Claire Gorge Conservation Area	1.62	1.62	Water Cascade
Elks Lodge Conservation Area	0.01	0.01	Public Beach/Water Access
Eva Wardlaw Conservation Area	0.00	0.00	Public Beach/Water Access
La Vase Portage Conservation Area	0.46	0.46	La Vase Portage
Laurentian Escarpment Conservation Area	0.48	0.48	North Bay Escarpment
Laurier Woods Conservation Area + addition	1.01	1.01	PS Wetland
Mattawa Island Conservation Area	0.04	0.04	Public Beach/Water Access
Papineau Lake Conservation Area	0.05	0.05	Water Access
Powassan Mountian Conservation Area	0.02	0	Powassan Mountain
Protected Natural Environment Areas			
J P Webster Nature Preseve	1.11	0	Endowment lands
Shields McLaren Nature Preserve	0.56	0.61	Endowment lands
Shirley Skinner Memorial Nature Preserve	0.20	0.20	Endowment lands
Total Area Protected	**7954.66**	**870.38**	

13.4.3 Water Control Structures and Hydro Electric Power Production

There are 10 public or major water control structures within the NBMCA (Turtle Lake Dam, Lake Talon Dam, Hurdman Dam, Amable du Fond run-of-the-river power generation station as well as 3 spill structures on Moore Lake, Lake Kioshkokwi and Club Lake, Lake Nosbonsing Spill Dam, Canadore College Pond Dam, and Parks Creek Backflow Protection Dam). Eight water control structures are design to maintain recreational/navigational water levels with one having hydro power production capabilities. One is a backflow protection structure and one is a flow through power production structure. Thus in total two water control structures within the NBMCA have hydroelectric power producing capacity (Hurdman Dam and Amable du Fond Run of the River). These structures are described in more detail below and dam locations are illustrated in Figure 13.9. Many of the above structures were inventories in the Conceptual Water Balance Study completed by Gartner Lee Associates, 2008. Stantec has added additional information when more details are available.

Figure 13.8 Location of Parks and Protected Areas within the NBMCA



The Trout/Turtle Lake control structure is a concrete spill dam located at the outlet of Turtle Lake (Turtle Lake Dam) designed to maintain the recreational/navigational water levels of the Trout/Turtle Lake basin at 202.2 m above mean sea level (amsl). The dam has 3 X 14 foot wide gates or bays that can each accept 4 stop logs for a total of 12 stop logs. The sill elevation of stop log bays is 201.06 m amsl and top of stop log elevation when in place is 202.29 m amsl.

The dam has 23 and 33 foot wide side wing walls set at an elevation of 202.77 m amsl (Aqua Resources Inc. 2010a).

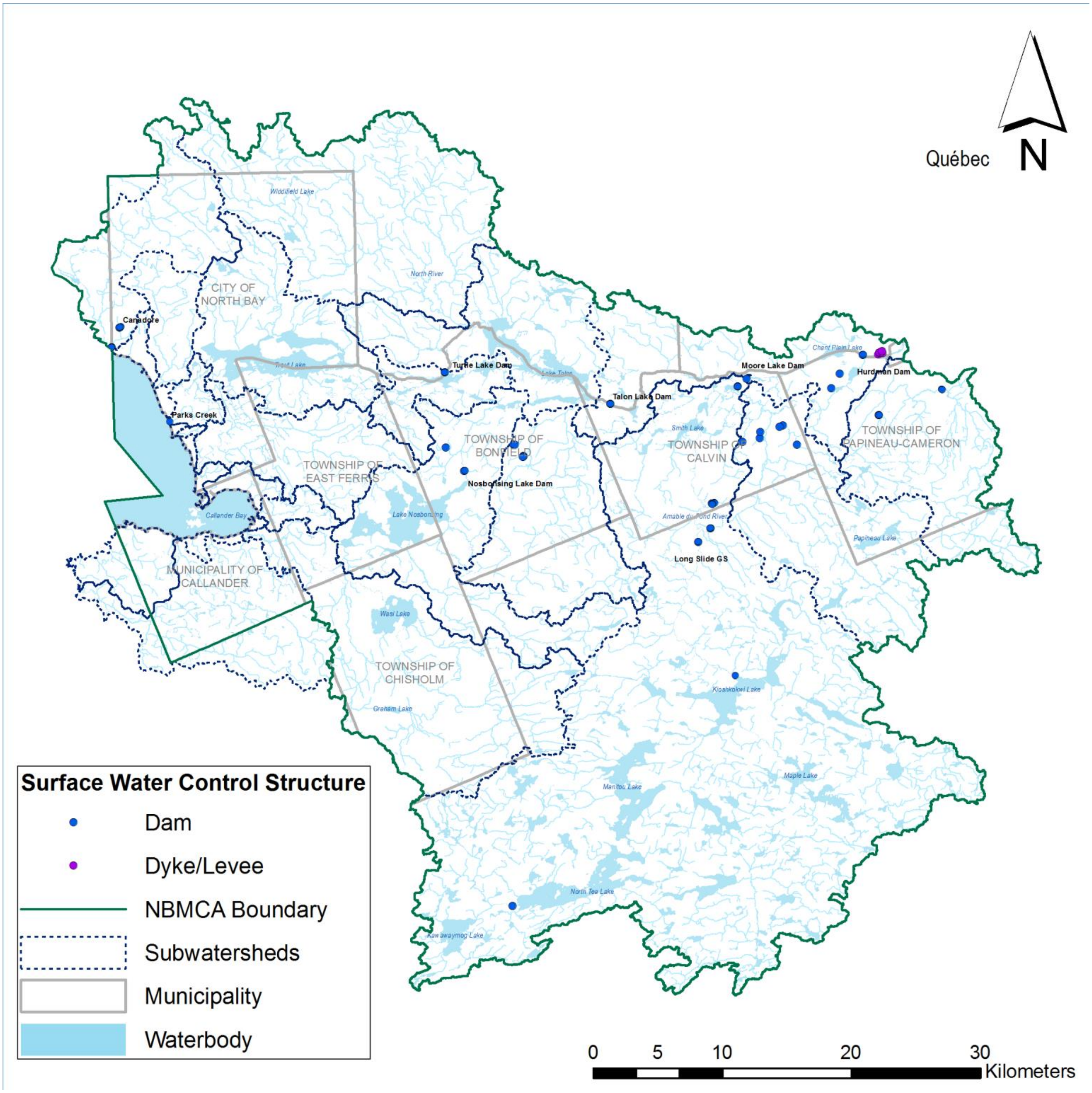
A blasted channel between Trout and Turtle Lakes allows water to flow freely between these water bodies. Considerable analysis of the operation and impact of City of North Bay withdrawals from this basin has recently been completed in the Trout/Turtle Lake Hydrologic Impact Study/Tier 2 and Tier 3 Reports (Aqua Resources, 2010). The Turtle Lake Dam is owned, maintained and operated by the Ontario Ministry of Natural Resources. Log settings follow MNR District general operating guidelines. MNR has completed a dam failure analysis for this structure (Acres International, 2001).

A concrete water control structure controlling the level of Lake Talon, located at Talon Chutes at the outlet of Boivin Lake, is designed to maintain Lake Talon recreational/navigational water levels at 193.8 m amsl. The dam is described as having 5 gates containing a total of 39 stop logs and a side weir set at the regulated elevation (Blake Dawdy, 1988). This dam is owned, maintained and operated by the Ontario Ministry of Natural Resources and operations are guided by District general operational guidelines. MNR has completed a dam failure analysis for this structure (Acres International, 2001).

Hurdman Dam is a hydro/water level control structure owned maintained and operated by Algonquin Power based in Oakville Ontario. The dam is located 3.2 kilometers upstream from the Mattawa River confluence with the Ottawa River and it controls recreational/navigation levels on Lake Chant Plein. Algonquin Power operates 41 hydro generating facilities in total. Hurdman Dam is a reinforced concrete overflow structure that has a main spillway with a length of 45.5 m and a crest elevation of 159.25 m. There are overflow saddle dams with a combined total length of 62 m and a crest elevation of 160.40 m that provide additional spillway capacity (normal water levels for Lake Chant Plein are reported to be 159.40 m.a.s.l.). There is a small hydro generating station that has a flow capacity in the range of 8.0 to 9.5 m^3/s (Acres International, 2001) The power plant has a capacity to generate 570 kilowatts of electricity (Algonquin Power web site, 2013). MNR has completed a dam failure analysis for this structure (Acres International, 2001).

The spill dam controlling level of Lake Nosbonsing has been described in the Lake Nosbonsing Watershed Management Plan, 1992. The dam is a low relief concrete structure located in the Town of Bonfield which is owned, maintained and operated by the Ontario Ministry of Natural Resource. It is described as a 14 foot wide spillway with stop logs and a long overflow weir. Lake Nosbonsing water levels are maintained for recreation/navigation at 236.8 m amsl (Northland Engineering, 1992). The Ontario Ministry of Natural Resources follows general District operations guidelines to operate this structure. MNR has completed a dam failure analysis for this structure (Acres International, 2001).

Figure 13.9 Water Control Structures within the NBMCA



There are four water control structures within the Amable du Fond River watershed, three are MNR recreational/navigational water level control structures and one is a run-of-the-river power generation plant. Long Slide Power, of Port Colborne, Ontario, operates the run-of-the-river generating station on the Amable du Fond River described as weir, intake and tailrace on the

Amable du Fond River, located at 2923 Highway 630 S, RR #2, Mattawa, Ontario, adjacent to part of Lot 27, Concession 9, Township of Lauder. The Plant Operator lives at the above address. This facility has no storage capability and its generating capacity of less than 1 megawatt (Ontario Waterpower Association Membership Directory, 2011). Three MNR recreation water level control dams, one in Samuel de Champlain Provincial Park on Moore Lake and two in Algonquin Provincial Park on Lake Kioshkokwi and Club Lake. Moore Lake and Lake Kioshkokwi are spill structures described as “non-operating weir” owned and operated by the Ontario Ministry of Natural Resources. Little information is available for the Club Lake structure. No other details for these dams are available.

The Canadore/Nipissing Education Complex main campus on College Drive operates a low relief recreational water control spill structure on a tributary of Duchesnay Creek. No structural or operating information is available for this dam.

The NBMCA owns and maintains a back flow water control structure at the mouth of Parks Creek in the City of North Bay between Lakeshore Drive and Lake Nipissing. This structure is designed to stop Lake Nipissing flood waters from entering the Parks Creek system which can cause basement flooding in adjacent the low lying urbanized portion of West Ferris area. The structure has 3 X 3.1 m wide stop log bays that can each accept 11 steel logs. The structure is designed to control backflow water levels between 194.6 m (sill elevation) and 197.45 m (1:100 year flood elevation of Lake Nipissing is 197.25 m amsl including wind set-up and wave uprush). The dam is equipped with electric pumps to expel Parks Creek flows when the dam is closed. A portable diesel pump is also available to assist with pumping. The Parks Creek Backflood Control Structure is supported by an Operational Manual prepared by Totten Sims Hubicki.

Several MNR water control structures have been evaluated for their downstream failure impacts by the Province.

14.0 Subwatershed Characterization/Existing Management Structure

14.1 Introduction

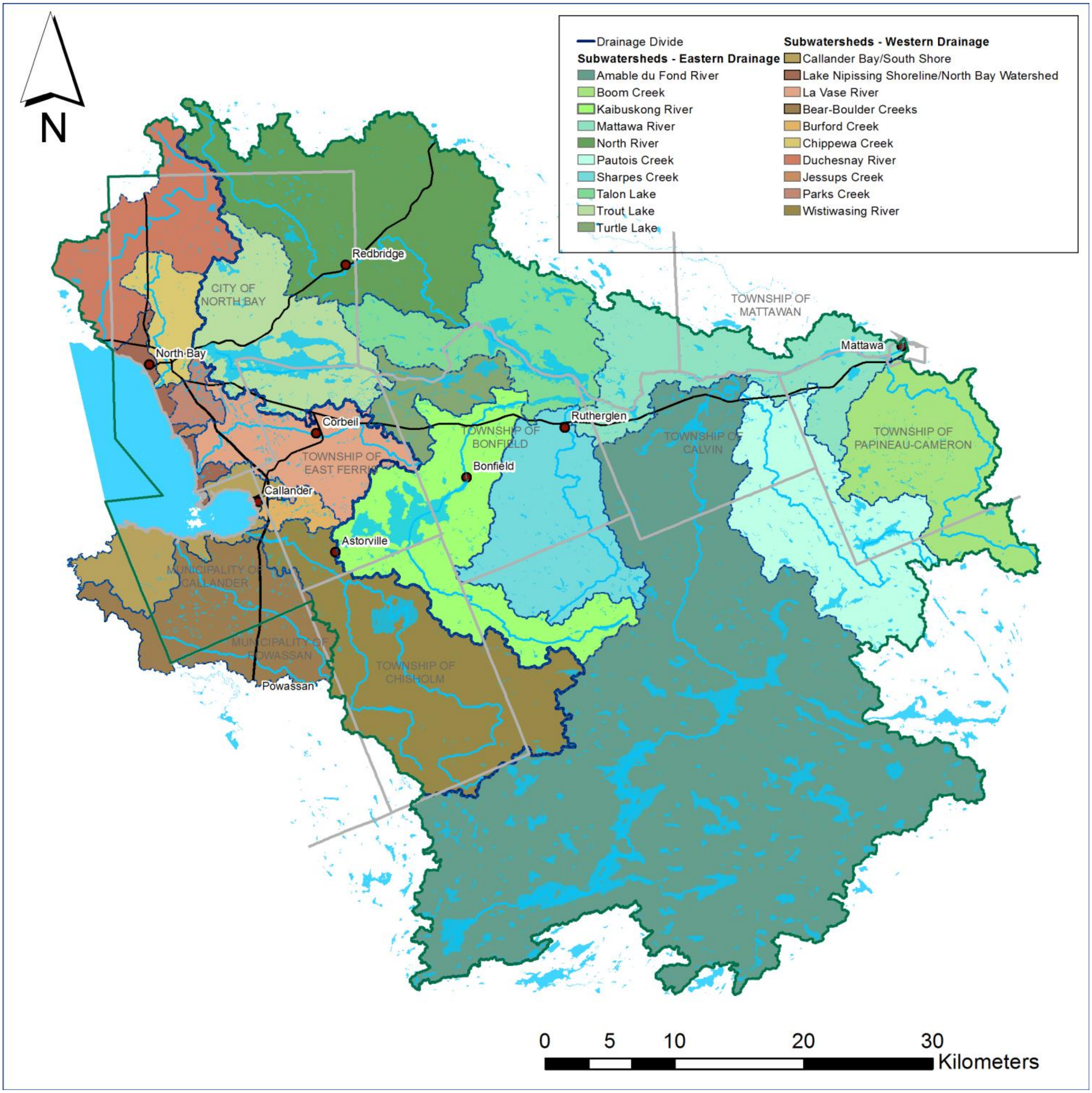
The North Bay-Mattawa Conservation Authority area of jurisdiction and its approach to management are based on watersheds. A watershed is a discrete physical area where all surface water moves towards a common outlet. As outlined in Section 6, watersheds exist in a drainage hierarchy. At a continental scale the NBMCA is located within the St Lawrence River primary watershed. The Ottawa River and Lake Huron basins form secondary watersheds within the St. Lawrence system. Within these secondary watersheds the Mattawa River and Lake Nipissing systems are defined as tertiary watersheds. Tertiary watersheds can be further divided into quaternary watersheds. For Integrated Watershed Management purposes the NBMCA has defined subwatershed planning areas based on quaternary watersheds or, in some instances, quaternary watersheds have been separated into sub-quaternary basins. Thus specific NBMCA basin features, functions and past management issues have been characterized at a quaternary scale or finer. This scale is appropriate for defining individual basin management needs. Individual basin management needs can be aggregated, prioritized and integrated into a comprehensive strategy at a tertiary scale. This section summarizes characteristics for individual subwatersheds as illustrated in Figure 14.1. To facilitate a broader understanding of watershed management in a hierarchical sense, management characteristics of higher order systems are summarized in the following paragraphs.

The French River/Lake Nipissing/Sturgeon River watershed is not subject to any formal comprehensive management structure that assesses and coordinates management activities on a watershed basis. Management of this tertiary basin is overseen by a host of government departments and regional agencies and is largely carried out on an ad hoc basis. Water levels in the Sturgeon River/Lake Nipissing/French River basin have coordinated oversight and Lake Nipissing has a Fisheries Management Plan. Stakeholders include the Federal Government (who own dams at the outlet of Lake Nipissing), the Province as well as regional agencies, municipalities and First Nations located within the Lake Nipissing watershed. The study area within the Lake Nipissing watershed totals 700.97 km^2 (not including any area of Lake Nipissing) which represents 5.7 % of the total Lake Nipissing catchment area (which totals 12,300 km^2) and 3.7 % of the greater Sturgeon River/Lake Nipissing/French River tertiary basin (which has a total area of 19,100 km^2). The study area includes 37.3 kilometers of Lake Nipissing shoreline which represents 2.6 % of the total Lake Nipissing shoreline (Lake Nipissing has 1414 km of total shoreline including island shorelines). While the NBMCA study area within the Lake Nipissing basin may be small in terms of area, it contains a majority of the tertiary watershed population. The characterization of Lake Nipissing in following sections has been restricted to the immediate shoreline of Lake Nipissing adjacent to study area subwatersheds.

At a secondary basin scale part of the study area falls within the Great Lakes watershed which is under the purview of International Joint Commission (IJC) (the IJC shares management responsibilities for the Great Lakes with other stakeholders including the Province of Ontario and individual US States within the Great Lakes basin).

The International Joint Commission is established at a federal level to prevent and resolve disputes over the use and quality of Canada/US boundary waters (source: IJC website). One of the major IJC roles is to oversee an international agreement on Great Lakes Water Quality. The intent of the Great Lakes Water Quality Agreement is to restore and maintain the chemical, physical and biological integrity of the Great Lakes Basin ecosystem (link to the agreement is provided below). As part of this treaty the IJC has set out general guidelines for point and non-point sources of pollution. Non-point pollution sources are defined as pollutants emanating

Figure 14.1 Subwatershed Management Planning Areas



from land use activities. The treaty targets the reduction of phosphorous, sediments, toxic substances and microbiological contaminants contained in drainage from urban and rural lands (including waste disposal sites) within the Great Lakes basin. The IJC has set specific basin management targets for phosphorous to minimize eutrophication problems and prevent Great

Lakes degradation. The IJC's role also extends to management of water levels and control of invasive species such as sea lamprey and zebra mussels. Compliance with the IJC guidelines is not enforced through legislation. However, the NBMCA, in fulfilling its mandate within the Lake Nipissing watershed must be conscious of and contribute towards the overall management objectives set out for the Great Lakes. More information is available at: http://www.ijc.org/rel/agree/quality.html

Within the Ottawa River "secondary watershed" the study area totals 2,295 km^2 which makes up 1.6 % of the total Ottawa River watershed area (its total area is 146,300 km^2). The Ottawa River watershed is not an international boundary water system and consequently it is managed through interprovincial regulation. This system is not subject to a comprehensive management framework; however, it does have water level regulation oversight. The Ottawa River Regulation Planning Board coordinates the management of principal reservoirs within the Ottawa River basin to protect against flooding and to coordinate interests for various water uses including hydroelectricity production. The Mattawa River's mean annual discharge to the Ottawa River averages approximately 30 m^3/s which, relative to 2000 m^3/s mean annual flow at the Carillon dam near the Ottawa River outlet (flows the Otto Holden Dam, upstream of Mattawa on the Ottawa River, average 684 m^3/sec - HYDAT database 1952 – 1994), is relatively small. Water levels at the Mattawa River outlet in the Town of Mattawa are mainly influenced by the management of the Ottawa River system that includes the operation of the Otto Holden dam located upstream of Mattawa. A water level gauge on the Ottawa River near the mouth of the Mattawa River mainly measures the fluctuation of the Ottawa River and consequently this gauge has not been assessed in detail below (data has been used for calculating subwatershed basin characteristics).

14.1.1 Subwatershed Characterization Criteria

Each NBMCA subwatersheds has been assessed based on a comprehensive set of evaluation criteria as described below. Evaluations are derived from the body of technical reports and studies listed in each section, from information contained in other section of this report or as otherwise referenced. Criteria include an evaluation of subwatershed water basin factors, water quantity and quality, resource features, previously identified management activities and stress factors. The accuracy of the evaluation is reliant on the degree to which the information base has been developed and often the supporting information is rudimentary. Characterizations are a "snap shot in time" intended to create a foundation upon which management strategy decisions can be made. Often information is has been extrapolated from a single sampling point in a watershed (such as hydrology or water quality) or information for the entire subwatershed is not fully developed (such as the evaluation of wetland or assessment of habitats including habitat for Species at Risk). In some cases locational information, considered sensitive, is protected as confidential (such as Species at Risk or heritage information). Characterizations should be considered as a starting point from which more research and refinement can be completed. For example watersheds that do not have significant wetlands identified may not have had all wetlands evaluated and interpretation should be cautious to conclude that none are present. Also some resource protection information, such as Species at Risk, is evolving rapidly and any assessment provided will quickly become out dated. Management strategies that rely on evaluations herein must be sensitive to dynamic nature of subwatersheds and should identify monitoring strategies to keep up on when conditions are encountering change or when new important information is developed that may influence management decisions.

Subwatersheds are assessed based on the same criteria as defined by each heading. The rationale or consideration given for each ranking is further described as follows:

General Description – a synthesis of information concerning the drainage system mainly sourced from supporting studies. In some cases information is derived from other sections of this report or as otherwise referenced.

Supporting Studies – a list of all technical documents from which information contained in the assessment has mainly been derived.

Data Available – major sources of data used for interpretation in this section.

Major Water Bodies – larger water bodies that have individual management concerns – concerns are detailed where larger water bodies exist. Smaller water bodies are listed.

Development Pressure – summation of information derived from interviews with municipalities which is summarized in Section 12.

Fishing Pressure – summary of fisheries information available in supporting studies.

Recreation Pressure – identification of major parks and trails with assessment of utilization if available. Consideration of recreational use of water bodies also included when available.

Watershed Drainage Characteristics/Slope/Efficiency – summary of information from Section 6.

Runoff/Estimated Water Balance (if system gauged) – summary of HYDAT data/information in Section 8 for gauged systems plus consideration of water balance assessment data provided in Appendix A. All data from this section has been summarized in Appendix D.

Water Use – based on ground and surface water use information provided in Sections 5 & 8.

Hazards Identification – summary of Flood and Erosion Information provided in Section 8.

Floodplain Regulation – summary of Policies applied based on input from NBMCA.

Water Quality Indicators – summary of Information provided in Supporting Studies listed, from Section 9 or as referenced.

Developed/Settled Areas as % of watershed – Based on information derived from interviews with municipal staff, calculations from supporting studies or estimates from subwatershed maps.

Significant Features – summary of information provided in Section 10.

Previously Identified Management Issues – summation of issues identified in Supporting Studies or provide through NBMCA/Stakeholder Input. Some issues may no longer be relevant.

Headwater Management Concerns - a synthesis of information with a focus on headwaters derived from Supporting Studies or provide through NBMCA/Stakeholder input.

Drinking Water Source Protection Constraints – identification of areas affected by a Drinking Water Source Protection Plan.

Management/Stewardship – existence of overseeing Committees or Stakeholder Groups.

Vulnerability/Sensitivity to Climate Change – Ranking are developed from Evaluation Charts found in Appendix E. Sensitivity to climate change (Appendix E.1) is an aggregate scoring of the degree to which climate change is expected to impact on a subwatershed based on climate change factors derived from Section 7 (i.e. the subwatershed is rated as having high or low sensitivity to evolving hydrologic conditions). Vulnerability to climate change (Appendix E.2) is an aggregate scoring of the degree to which existing stresses are already present or developing which may be further exacerbated by an evolving climate (i.e. The subwatershed already is subject to extreme flow conditions and an evolving climate may worsen these conditions).

Vulnerability to Future Land Use Change – interpreted from municipal interviews (summarized in Section 12) and based on the Evaluation Chart found in Appendix F.

14.2 Subwatershed Characterizations

14.2.1 Duchesnay Creek Subwatershed

General Description

The Duchesnay Creek subwatershed mainly drains from the North Bay-Mattawa highlands and discharges to Lake Nipissing near Duchesnay Falls where the stream cascades down the North Bay escarpment. This subwatershed has a total area of 101.65 km^2 which is the second largest NBMCA subwatershed draining to Lake Nipissing. Hydrologic data suggests that the Duchesnay Creek watershed is one of the wettest subwatersheds within the NBMCA as it is subject to higher than average precipitation. This basin also experiences extreme variations in flow. The headwaters drain from a sizable glaciofluvial overburden deposit that contains a surficial groundwater aquifer which has an undetermined significance. The surface of this glacial fluvial formation has been fairly heavily mined and most accessible aggregates are now depleted. The upper reaches of Duchesnay Creek support a cold water fishery and a provincially significant wetland. A couple of historic point pollution sources which affected water quality no longer exist (Nordfibre and North Bay Regional Mental Health Centre). The watershed is traversed by Highway 11 North which has strip development along its route and which provides access to several concession roads that support low density rural land uses. Nipissing University and the new North Bay Regional Health Center are located in its lower reaches. A majority of this watershed however is undeveloped. Since the formation of the NBMCA this subwatershed has received minimal attention and basin specific information is either limited or not available. The Duchesnay Creek subwatersheds shape and drainage patterns are illustrated in Figure 14.2 and watershed features are highlighted in Figure 14.3.

Supporting Studies

Gartner Lee Limited, **Source Water Protection Planning – *North Bay-Mattawa Source Water Protection Area Conceptual Water Budget***, prepared for the North Bay-Mattawa Conservation Authority, April 2008.

M. M. Dillon***, North Bay-Mattawa Floodplain and Fill Line Mapping***, prepared for the North Bay-Mattawa Conservation Authority, October 1975.

NBMCA, ***Watershed Plan: Volume 1 - Background Inventory Document***, 1982.

Totten Sims Hubicki, ***North Bay Escarpment Resource Inventory and Digital Mapping***, prepared for the North Bay-Mattawa Conservation Authority and the City of North Bay, 1999.Waterloo

Hydrogeologic Inc, in association with Tunnock Consulting Ltd., ***NBMCA Groundwater Study Report***, January, 2006.

Data Available

- Historic flow data from Duchesnay Creek gauge near mouth (1956 – 1982)
- Data from Provincial Water Quality Monitoring Stations
    - Downstream Nordfibre (1968 – 1994 & 2007- present)
    - Upstream Nordfibre (1968 – 1994)
    - Highway 11 North (1973 – 1976)
- Snow course data – North Bay Regional Mental Health Center (1988 – 2012)
- Wetland Evaluation – Duchesnay Creek Wetland (1996)

Figure 14.2 Duchesnay Creek Subwatershed Basin Characteristics

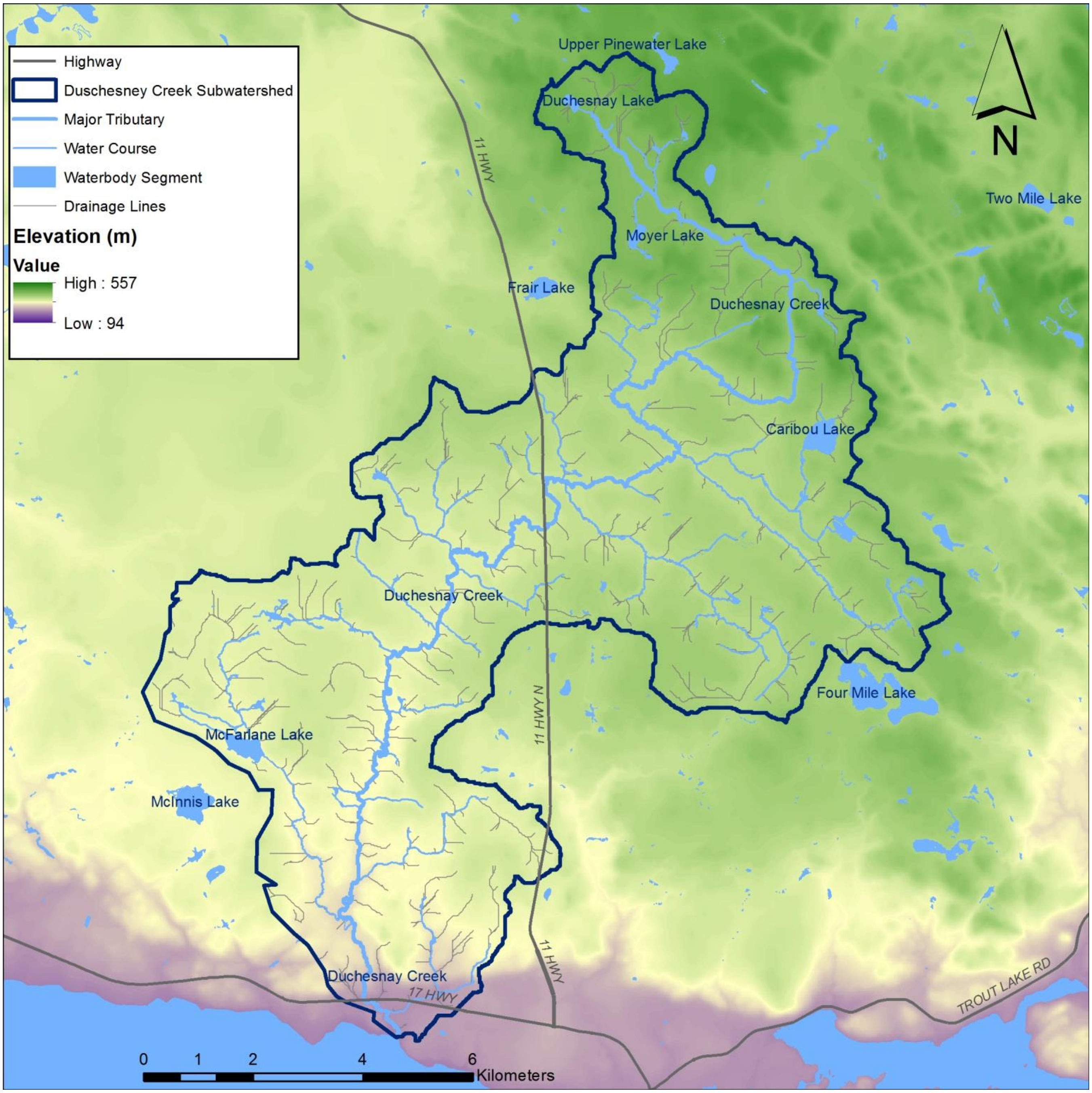
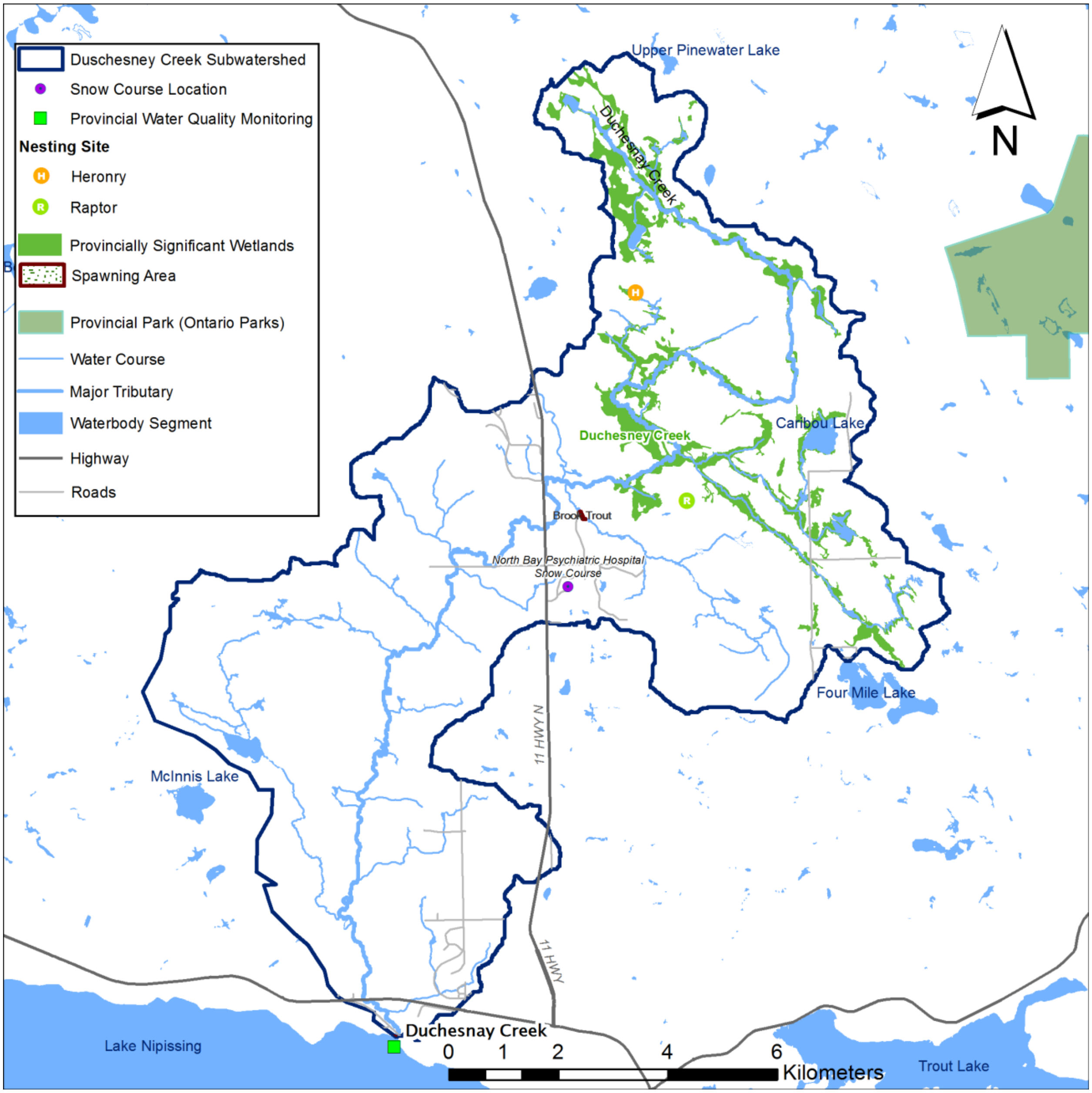


Figure 14.3 Duchesnay Creek Subwatershed Features



Major Water Bodies

- None
- Minor lakes includes Duchesnay Lake, Moyer Lake, Caribou Lake, McFarlane Lake

Development Pressure

- Expansion of the University/College Complex including new residences (continual)
- Urban Growth into Cedar Heights (mid to long term – i.e. next 10 to 20 years)

- Lower reach development of former Nordefibre Property and surrounding area (long term (i.e. 20+ years))

Fishing Pressure

- Undefined

Recreational Pressure

- High recreational use of Duchesnay Falls trail system and Nipissing/Canadore Property
- Black Forest – City Park (low utilization)

Watershed Drainage Characteristics/Slope/Efficiency

- The Duchesnay Creek subwatershed has minimal surface water which makes up 1.9 % of total basin area but has a high percentage of wetland area (total wetland area 13.2% of the watershed))
- Duchesnay Creek has a moderate main channel slope, a moderate drainage density and a moderate basin relief in comparison to other subwatersheds.
- The Duchesnay Creek subwatershed has moderate/high drainage efficiency

Runoff/Estimated Water Balance (if system gauged)

- Subject to extreme variation between high flows and low flows
- Estimated water balance for Duchesnay Creek Gauge as follows (for period of records):

Station ID	Station Name	Record Period	Gauged Area[1] sq km	Estimated Actual Evapotransiration[2] (mm)	Mean Annual Surplus[3] (mm)	Projected Total Precip[4] (mm)	NB Airport TP (mm) for same period
02DD006	Duchesnay River near North Bay	1956 - 1982	100	530	519	1049	961.6
				Red = PE - AE likely restricted by lack of precipitation			

Highest Recorded Flow 43.6 m^3/s on Jun 30, 1957 (26 X mean annual)
Mean Annual Flow 1.65 m^3/s (1956 – 1982)
Lowest Recorded Flow 0.006 m^3/s on Jul 28, 1964

Water Use

- There are no current permits to take water in the Duchesnay Creek subwatershed

Hazards Identification

Section of Subwatershed	Flood Plain/Fill Line Mapping	Regulatory Event	Regulatory Level Available	Source/Date	Channelization
Lower	Flood Plain Mapping	Timmins Storm	Variable	Dillon, 1978	None

- The Duchesnay Creek subwatershed, where flood plain mapping does not exist, is fully supported by fill line mapping

Floodplain Regulation

- Lower Duchesnay Creek, where flood lines exist is regulated under the One Zone Floodplain Policy
- Upper Duchesnay Creek, where fill lines define hazards, is regulated as a Development Constraint Area

Water Quality Indicators

- Meso-eutrophic Stream (Average Total Phosphorous = 25 µg/L)
- Neutral to slightly acidic pH
- Slight sign of road salt impact (increasing chlorides, conductivity)
- Overall water quality is improving – major pollution point sources have closed
- Water temperatures in lower reaches (at monitoring station) exceeds cold water habitat criteria (water routinely exceeds 20° C in the summer)
- Dissolved Oxygen is excellent (monitoring station is located below Duchesnay Falls)

Developed/Settled Areas as % of watershed

- Very low – less than 10% of the subwatershed is developed

Significant Features

- Nesting Sites
- Brook Trout Spawning
- Provincially Significant Wetland
    - Duchesnay Creek Wetland
- Potential or known Species at Risk

Previously Identified Management Issues

- Minor Erosion has been identified
- Degraded Water Quality – from point source discharges (uses no longer exist)
- Duchesnay Falls access/protection
- North Bay Escarpment Hazardland Identification/Protection

Headwater Management Concerns

- Wetland Protection
- Fisheries Protection

Drinking Water Source Protection Constraints

- There are no drinking water source protection constraints in the Duchesnay Creek subwatershed

Management/Stewardship

- None

Vulnerability/Sensitivity to Climate Change

- Vulnerability to Climate Change is ranked as Moderate
- Sensitivity to Climate Change is ranked as High

Vulnerability to Land Use Change

- Vulnerability to Land Use Change is ranked as Low – vulnerability is confined to lower tributaries that have development potential

14.2.2 Chippewa Creek Subwatershed

General Description

The Chippewa Creek subwatershed originates above the North Bay escarpment and descends from uplands into urban North Bay through a distinct valley. It flows through the heart of the City and discharges to Lake Nipissing at the southern edge of the North Bay waterfront. The entire subwatershed is within City of North Bay boundaries and 50 % of the basin is within the City's urban settlement area. Most of the lower watershed is developed and Chippewa Creek has considerable stormwater infrastructure that relies on the creek as an outlet. This 37.77 km^2 watershed has been subjected to numerous studies; basin management issues are relatively well understood and substantial work has already been completed to mitigate the more serious human/environmental conflicts.

Chippewa Creek originates in a thick glaciofluvial outwash plain which contains a surficial groundwater aquifer and which has excellent recharge/discharge properties. Infiltration is more restricted in lower reaches by thinner overburden and hardened urban surfaces (roofs and pavement). The upper watershed supports a cold water fishery and, with the exception of several large open areas (North Bay Airport, the former Marsh Drive landfill and several aggregate operations) it remains primarily forested. A wetland complex, mainly adjacent to headwater streams, is ranked as Provincially Significant. Chippewa Creek has five distinct tributaries of which the two main tributaries; Eastview and Johnson Creeks; serve as major storm water outlets for urban areas. This watershed reacts rapidly to storm events and the lower watershed has flood prone areas upstream of points of constriction that can encounter flood damages. Flood risks are gradually being reduced, however pockets of development in main channel flood fringe are still vulnerable to major event flooding. At times of high flows the channel is subject to scouring and exposed stream banks are subject to erosion. Erosion control work has been carried out to stabilize major erosion sites through property acquisition, channelization and the armouring of vulnerable stream banks with stone. Siltation however is still an issue, some erosion is still occurring in headwater areas, which poses a limiting factor to aquatic habitat. Chippewa Creek has also had historic water quality problems caused by cross connections, stormwater runoff and impacts from the former Marsh Drive Landfill site, located in the headwaters. Management efforts have significantly reduced erosion and improved overall water quality. The NBMCA and the City have focused on reducing flood damages in the lower watershed which required the purchase and removal of homes and business within the floodway and eliminating constriction points. Lower stream channel capacities have been increased and tributaries have been channelized to help contain flows to the floodway where possible. Properties purchased for flood and erosion protection have been reclaimed as a parkway along the creek. This parkway is under continual improvement most recently by the work of the ECOPATH committee. Chippewa Creek attracts considerable urban debris which causes maintenance issue. A significant portion of NBMCA's management efforts since its inception has focused on flood and erosion damages along Chippewa Creek. The Chippewa Creek subwatershed shape and drainage patterns are illustrated in Figure 14.4 and watershed features are highlighted in Figure 14.5.

Supporting Studies

Aquafor Beech Limited, ***Lees Creek and Golf Club Creek Tributary Subwatershed/Stormwater Management Plans***, prepared for the City of North Bay, 2001.

Hunter, Kim, A Water Quality Analysis of Chippewa Creek, prepared for the North Bay-Mattawa Conservation Authority as part of University of Waterloo Geography Course, 1992.

M.M. Dillon, ***Chippewa Creek Preliminary Engineering Study: Flood and Erosion Control***, 1977.

M.M. Dillon, ***Effect of the July 24 – 25, 1977 Storm on Chippewa Creek, North Bay***, prepared for the North Bay-Mattawa Conservation Authority, 1977.

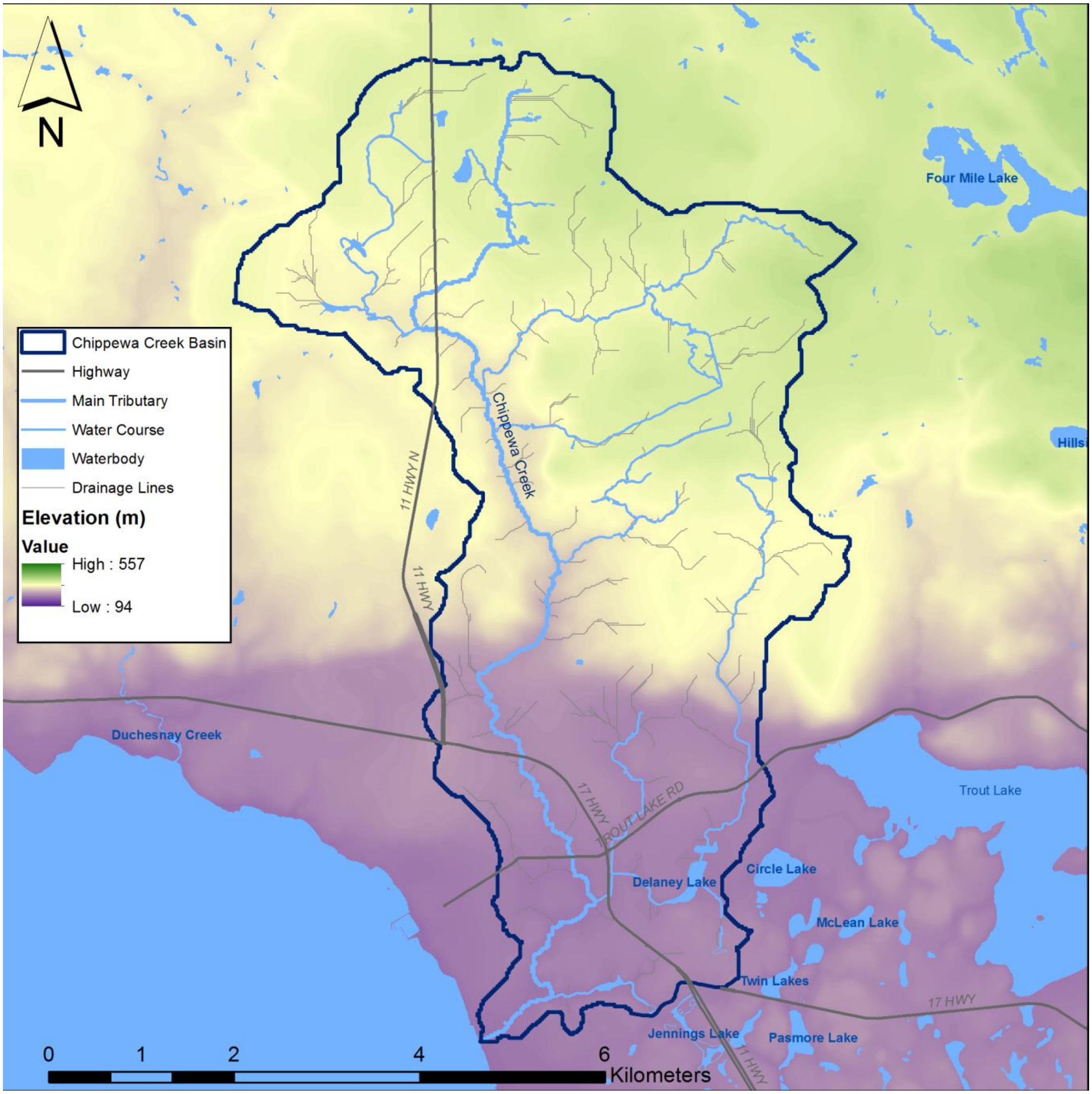
Northland Engineering, ***Chippewa Creek Flood and Erosion Control Program – Phase II***, 1984.

Northland Engineering and Beak Consulting Ltd., ***Lake Nipissing Pollution Control Plan - Phase I***, prepared by the City of North Bay and Ontario Ministry of Environment, 1989.

Northland Engineering, ***Chippewa Creek Flood and Erosion Control Program – Phase II***, 1984

NBMCA, ***Chippewa Creek Flood Damage Reduction Program: Johnson Creek Channelization – Environmental Study Report***, 1988.

Figure 14.4 Chippewa Creek Subwatershed Basin Characteristics



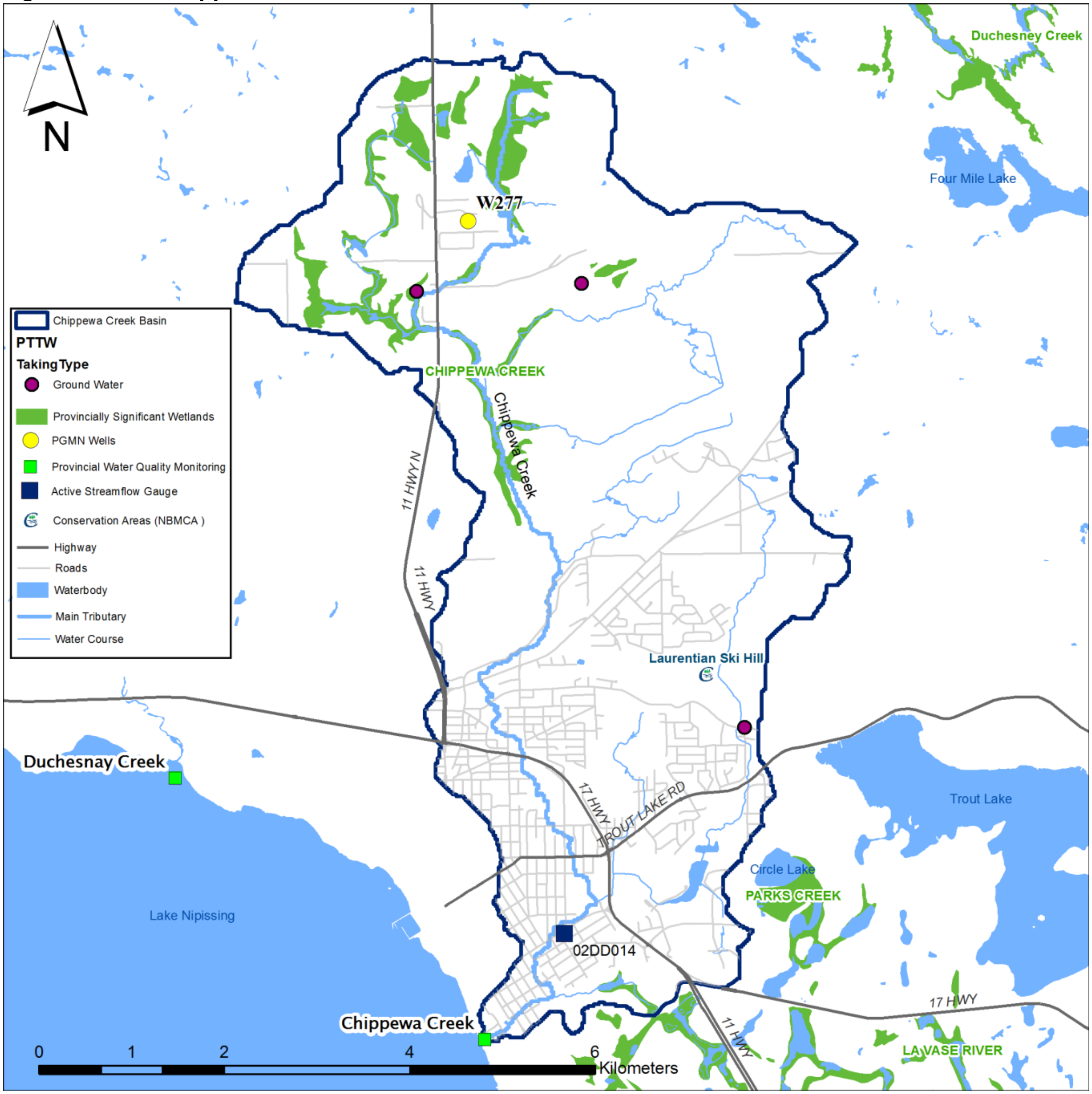
NBMCA, ***Chippewa Creek Flood Damage Reduction Program: Rechannelization of the Eastview Tributary of Chippewa – Environmental Impact Statement***, 1989.

NBMCA, ***Chippewa Creek Parkway Master Plan***:

- Volume 1: Inventory Information, July 1985.
- Summary, 1986.

NBMCA, North Bay Escarpment Erosion Report, 1997

Figure 14.5 Chippewa Creek Subwatershed Features



NBMCA, ***Watershed Plan: Volume 1 - Background Inventory Document***, 1982.

Proctor & Redfern Limited, ***Chippewa Creek Watershed Management Study Final Report***, 1996.
Smith, Charlene, Effects of Urban Stormwater Runoff on the Receiving Waters of Chippewa Creek, 1983.

Stantec Consulting Ltd**.**, ***Class Environmental Assessment: Chippewa Creek Flood Mitigation Measures – Fisher Street to John Street***, 2008

Tilton, Phillip, Chippewa Creek Watershed Forest Description, 1994.

Totten Sims Hubicki, ***North Bay Escarpment Resource Inventory and Digital Mapping***, prepared for the North Bay-Mattawa Conservation Authority and the City of North Bay, 1999.

Various Authors, Marsh Drive Landfill Annual Reports, (1995 – 2011).

Data Available

- Provincial Water Quality Monitoring Stations:
  - Memorial Drive near mouth (1968 – 1994, 2007- present)
  - Golf Club Road (1973 – 1994)
- HYDAT Flow Gauge at Fisher Street (1972 – present)
- Data gathered for the Chippewa Creek Watershed Management Study (1996)
- Provincial Ground Water Monitoring Network – Trans Canada Site (2003 – present)
- Climatic data from the North Bay Airport (1939 – present)
- Wetland Evaluations: - Upper Chippewa Creek Wetland Complex (1995)
  - Orsy's Swamp Wetland (1993)

Major Water Bodies

- None
- Minor water bodies include Delaney Lake

Development Pressure

- Relatively high development potential – 5 of 16 growth areas identified by the City of North Bay are within or partially within the Chippewa Creek subwatershed including 4 above the escarpment and 1 below the escarpment. The North Bay Airport forms a large open area in the upper watershed and peripheral infilling is occurring over time. Several areas have been identified for new growth which may have implications for Eastview and Johnson Creek tributaries as well as the Golf Club Creek tributary. Any change to these systems could impact flooding and erosion in the lower main channel.
- Several transportation driven changes may also impact development. Should the North Bay bypass be constructed within the planning horizon – this may open new development opportunities within the lower Chippewa Creek watershed. The construction of a new roadway between Marsh Drive and Four Mile Lake Road may impact development in the Chippewa Creek headwaters including growth of a major Industrial Park on the north side of North Bay Airport.

Fishing Pressure

- Unknown

Recreational Pressure

- Acquired lands along the creek have been developed into a linear park/trail/bikeway system which has moderate use – highest use is between Thompson Park and Lees Park/Kate Pace Way intersection.
- NBMCA maintains the Laurentian Escarpment Conservation Area adjacent to its office on Janey Ave.
- The NBMCA jointly owns 117 acres of land in the Laurier Woods area with the Friends of Laurier Woods. The Conservation Area features a provincially significant wetland and is a popular bird watching area. This property overlaps into the Parks Creek subwatershed.

Watershed Drainage Characteristics/Slope/Efficiency

- The Chippewa Creek subwatershed has minimal surface water (1.0% of basin area) which is lowest in all subwatersheds studied. Wetland make up 7.4% of total basin area)
- The main channel of Chippewa Creek has a steep gradient; the watershed has high basin relief and is rated as having moderate drainage density.
- The Chippewa Creek basin is rated as having moderate/high drainage efficiency. The drainage efficiency would be increased by extensive stormwater drainage infrastructure in the lower watershed.

Runoff/Estimated Water Balance (is system gauged)

- Rapid response to storm events exacerbated by storm sewer flows
- Subject to extreme variation between high flows and low flows
- Estimated water balance for Chippewa Creek Gauge as follows (for period of records*):

Station ID	Station Name	Record Period	Gauged Area km^2	Estimated Actual Evapotransiration (mm)	Mean Annual Surplus (mm)	Projected Total Precip (mm)	NB Airport TP (mm) for same period
02DD014	Chippewa Creek at North Bay	1974 - 2011	37.3	535	516	1051	1035.8

* Gartner Lee (2010) reported a Chippewa Creek mean annual water surplus of 504 mm for a 1975 – 2005 period and apportioned the surplus as 316 mm/yr to overland flow and 188 mm/yr to groundwater recharge. This study also reports annual average precipitation (1027 mm) and evapotranspiration (523 mm) for this station for the same period.

Highest Recorded Flow	11.6 m^3/s on Apr 09, 1980 (19 X mean annual flow)
Mean Annual Flow	0.61 m^3/s (1974 – 2011)
Lowest Recorded Flow	0.000 m^3/s on Aug 18, 1975* (*= multiple 0 events)

Water Use

- There are ground and surface Permits To Take Water issued for the Golf Club Creek tributary (used for golf course irrigation) and groundwater Permits To Take Water in the headwaters at the former Marsh Drive Landfill Site and adjacent to the main tributary on Highway 11 North (TransCanada Pipeline).

Hazards Identification

Lake or Tributary	Flood Plain/Fill Line Mapping	Regulatory Event	Regulatory Level Available	Information Source/Date	Channelization
Lower Main	Flood Plain Mapping	1:100 yr	Yes	Northland Engineering, 1984	Yes
East View	Flood Plain Mapping	1:100 yr	Yes	Northland Engineering, 1984	Yes
Johnston	Flood Plain Mapping	1:100 yr	Yes	Northland Engineering, 1984	Yes
Delaney L	Flood Plain Mapping	1:100 yr	205.98 m	Northland Engineering, 1984	
Golf Club	TBD	TBD	N/A	N/A	
Upper Main	Flood/Fill Line Mapping	Timmins Storm	N/A	Dillon, 1978	

- The Chippewa Creek subwatershed, where flood plain mapping does not exist, is fully supported by fill line mapping

Floodplain Regulation

- Lower Chippewa Creek, where flood lines exist is regulated under the One Zone Floodplain Policy with the exception of the following Two Zone Floodplain Policy areas:
    - Chippewa Creek main channel between Thompson Park and Lake Nipissing
    - Johnson Creek and Eastview Creek at the Northgate Square Shopping Mall bounded by Trout Lake Road, Highway 11 and 17 and the Ontario Northland Railway
    - The flood plain spillway between Delaney Lake and Circle Lake
- Upper Chippewa Creek, where only fill lines exist, is regulated as a Development Constraint Area

Water Quality Indicators

The following characteristics are evident for Chippewa Creek at the Memorial Drive and Golf Club Road PWQMN monitoring stations:

- Borderline Oligotrophic Stream (TP = 23 µg/L).
- Neutral to slightly alkaline pH
- Sign of road salt impacts (increasing chlorides, conductivity)
- Overall water quality is improving – storm sewer cross connection reduced and Marsh Drive Landfill impacts are being managed by City of North Bay
- Water temperatures in lower reaches (below escarpment) exceeds cold water criteria (ie routinely exceeds 20° C in the summer)
- Dissolved oxygen is excellent

Developed/Settled Areas as % of watershed

The Chippewa Creek subwatershed is about 40% developed with urban development in the central and lower reaches plus rural development in the headwaters. This basin also has large devegetated areas at the North Bay Airport and at pits and quarries in the headwaters.

Significant Features

- Provincially Significant Wetland
  - Upper Chippewa Creek Wetland Complex
- Laurentian Escarpment Conservation Area
- Potential or known Species at Risk

Previously Identified Management Issues

- Flooding/Structural Flood Damage/Risk to Life
- Erosion/Structural Erosion Damage
- Stormwater Bacteriological Loading to Creek
- Degraded Water Quality from urban runoff and former Marsh Drive Landfill impacts
- Comprehensive Basin Management
- Parkway Development along watercourse in urban area
- Creek Debris
- North Bay Escarpment Hazardland Identification/Protection

Headwater Management Concerns

- Wetland Protection
- Fisheries Protection
- Stream Bank Erosion
- Abandon Pit and Closed Landfill Rehabilitation

Drinking Water Source Protection Constraints

- There are no drinking water source protection constraints in the Chippewa Creek subwatershed

Management/Stewardship

- No formal management structure in place.
- Chippewa Creek Parkway has Ecopath Committee oversight.

Vulnerability/Sensitivity to Climate Change

- Vulnerability to Climate Change is ranked as High

- Sensitivity to Climate Change is ranked as High

Vulnerability to Land Use Change

- Vulnerability of Land Use Change is ranked as Moderate (gradual urbanization and intensification expected).

14.2.3 Parks Creek Subwatershed

General Description

The Parks Creek subwatershed is a small, flat, shallow relief basin described to have complex and sometimes inconsistent flow patterns. This 14.01 km^2 basin has a number of small lakes and wetlands that offer significant storage capacity within the watershed. The Parks Creek Wetland Complex is provincially significant and the Laurier Woods Conservation Area is a popular birding and hiking area that provides public access to both terrestrial and wetland environments. Uplands have sparse soils and vegetation seems to have recurring early successional growth. This basin has been assessed in detail as part of the Parks Creek Watershed Flood Damage Reduction Study. Headwaters and the lower watershed are within the urban settlement area boundaries of the City with the central watershed is located within the City's rural area. Parks Creek is reported to receive flood spill waters from Chippewa Creek during extreme events (from Delaney to Circle Lake). The lower watershed is traversed by transportation corridors which are elevated in wet areas. These linear features act to regulate flows as they have undersized or no flow through openings (water filters though coarse rock rubble). Urban expansion in Parks Creek headwaters is slated within the City's planning horizon and industrial growth may affect the central watershed in the vicinity of the old Callander Road. The lower reaches of the Parks Creek within the urban settlement area are almost fully developed. Storm water conveyance infrastructure is sporadic in the lower watershed and storm water drainage to the creek is largely through overland flow systems. Minor flooding is caused by stormsewer surcharging. Storm sewers, where they exist, are reported to have continuous base flow even in winter as they convey sump pump discharges from homes. The lower main channel of Parks Creek, due to its low relief, can flood from Lake Nipissing. The NBMCA maintains a backflood protection structure at the mouth of Parks Creek to prevent Lake Nipissing from flooding homes along the creek. When the structure is closed Parks Creek is pumped over the dam to Lake Nipissing. Parks Creek also is reported to have maintenance issues in the West Ferris Planning District as ice and sediment can buildup to restrict channel capacity. Winter ice is occasionally removed from the main channel in its lowest reaches to ensure that full channel capacity is available for the spring freshet. Procedures governing the need for ice removal have been developed by Totten Sims Hubicki. The Parks Creek Subwatershed shape and drainage patterns are illustrated in Figure 14.5 and basin features are presented in Figure 14.6.

Supporting Studies

NBMCA, ***Parks Creek Watershed Environmental Assessment, A Preliminary Assessment of Management Issues***, Draft Document, 1991.

NBMCA, ***Watershed Plan: Volume 1 - Background Inventory Document***, 1982.

Northland Engineering, ***West Ferris Floodplain Management Study***, 1982.

Totten Sims Hubicki Associates, ***Parks Creek Watershed Flood Damage Reduction Study Environmental Study Report***, prepared for the North Bay-Mattawa Conservation Authority, 1992. This study has a number of supporting background reports including:

- Exhibit A – Public Involvement
- Exhibit B – Water Quality Report
- Exhibit C – Biological Background Data
- Exhibit D – Archaeological Background Report
- Exhibit E – Hydrology Report
- Exhibit F – Hydraulics Report

Totten Sims Hubicki Associates. ***Parks Creek Channel Maintenance Report***, prepared for the North Bay-Mattawa Conservation Authority, 1993 (revised 1995).

Data Available

- Water Quality Data 1 Provincial Water Quality Monitoring Station
    - (Lakeshore Drive Bridge) (1972 – 1976)
- Provincial Groundwater Monitoring Network – Marshall Park (2003 – present)
- Wetland Evaluation – Parks Creek Wetland Complex (1993)

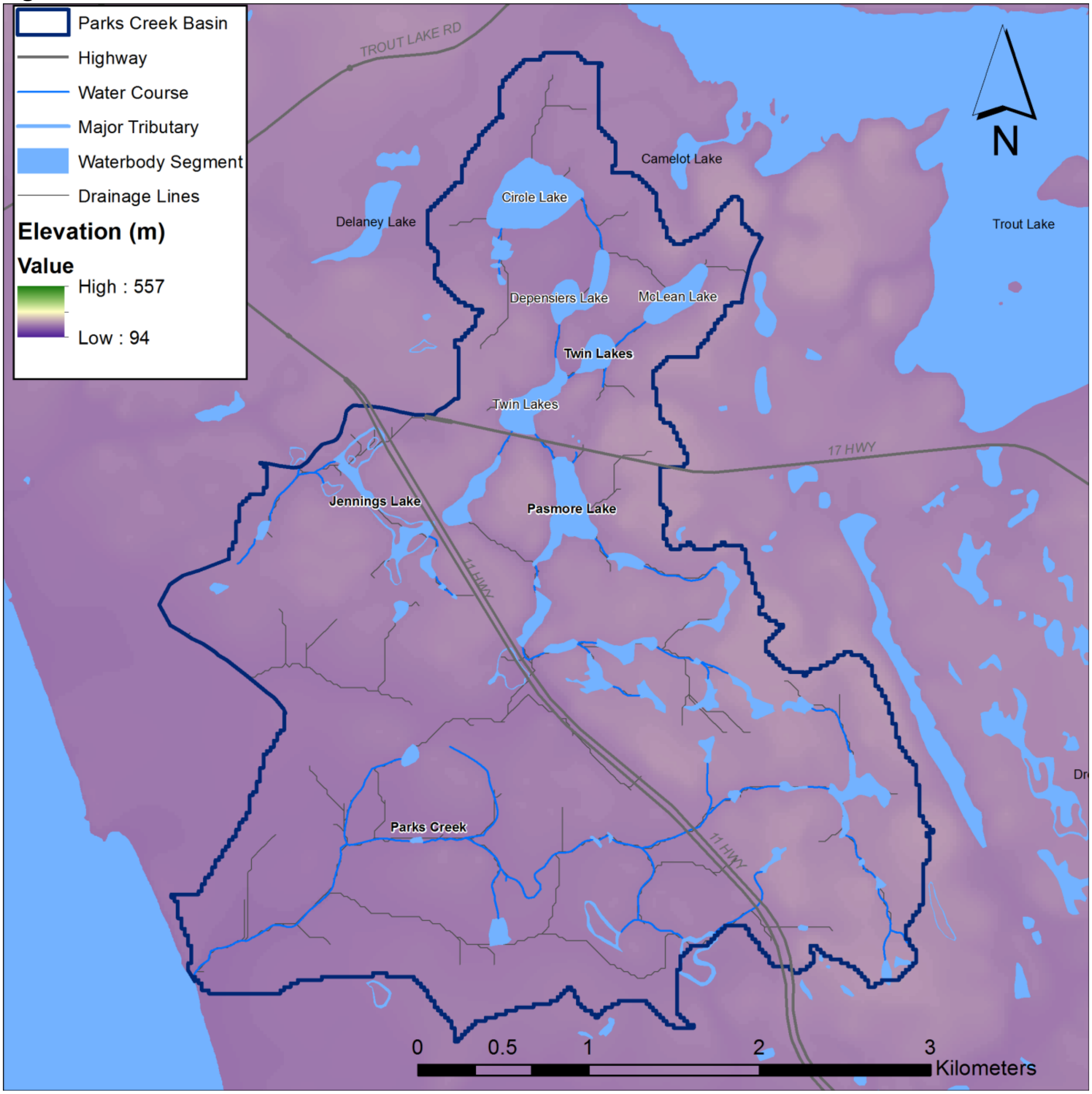
Major Water Bodies

- None
- Minor water bodies are Circle, McLean, Depensiers, Twin Line, Passmore, Jennings Lakes.

Development Pressure

- The City has identified one new residential growth area south of Circle Lake.
- Residential expansion is expected on the east side of Booth Road in the West Ferris Planning District.
- Industrial growth south of Laurier Woods accessed from the Old Callander Road.
- A new Highway 17 highway intersection with Highway 11 is proposed in the eastern Parks Creek Watershed which may reopen interest to connect West Ferris to Highway 11 using the Marshall Avenue ROW. Construction of this intersection is likely beyond the planning horizon of this plan (more than 20 years away).

Figure 14.6 Parks Creek Subwatershed Basin Characteristics



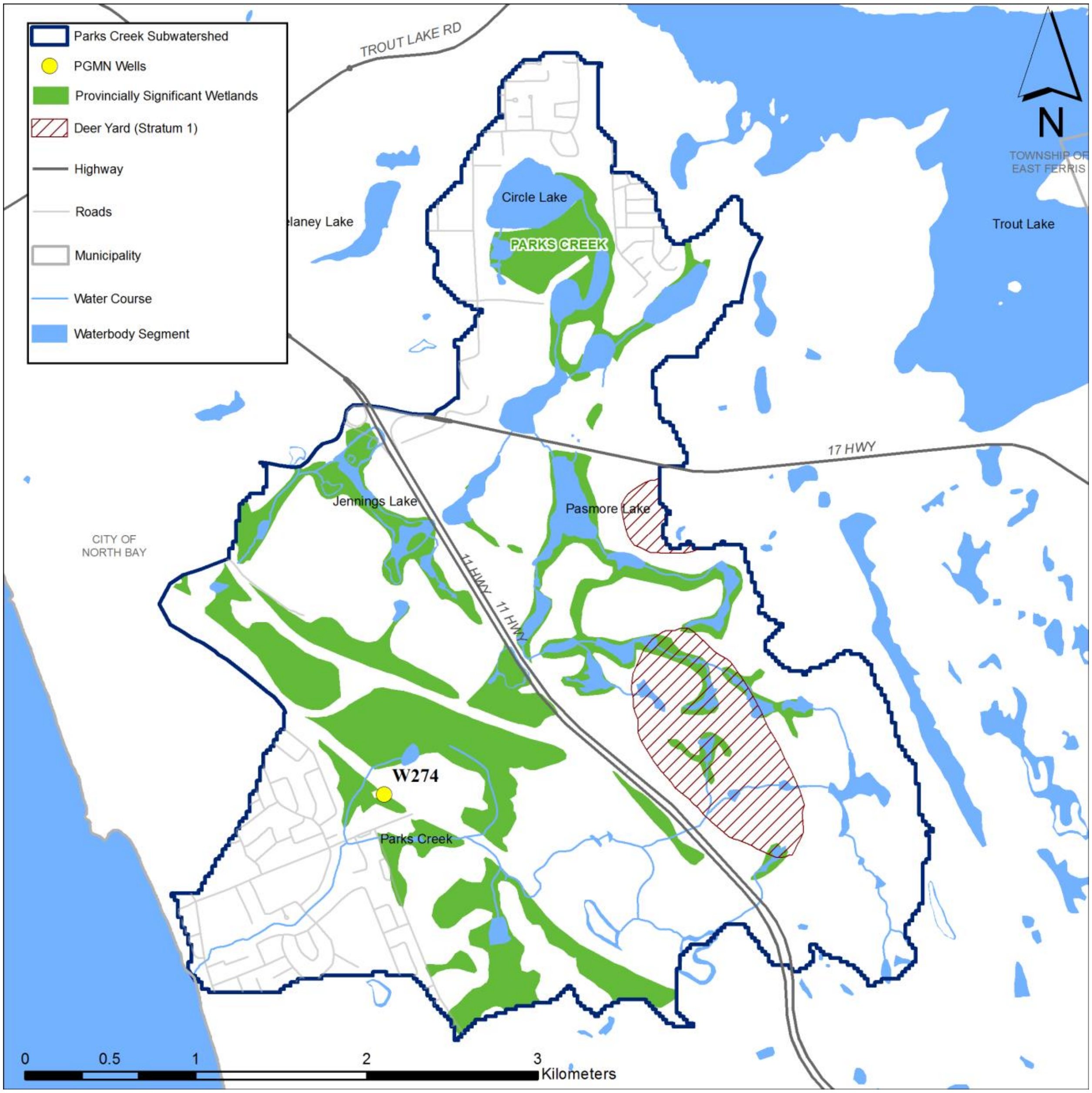
Fishing Pressure

- Limited

Recreational Pressure

- The NBMCA jointly owns 117 acres of land in the Laurier Woods area with the Friends of Laurier Woods. The Conservation Area features a provincially significant wetland and is a popular bird watching area. This property overlaps with Chippewa Creek.

Figure 14.7 Parks Creek Subwatershed Features



- Eva Wardlaw Park is a 0.7 acre park at the mouth of Parks Creek and offers public access to Lake Nipissing.
- Kate Paceway is a popular 12.8 km trail system that connects the North Bay waterfront to Callander. This trail system crosses through the Parks Creek watershed near Booth Road.

Watershed Drainage Shape/Slope/Efficiency

- The Parks Creek subwatershed has a moderate total water surface area (6.9%) and a significant amount of wetlands (wetlands makes up 29.2% of total basin area)

- Parks Creek has low basin relief, a moderate main channel slope and a high drainage density
- The Parks Creek subwatershed has moderate/low drainage efficiency

Runoff/Estimated Water Balance (is system gauged)

- The Parks Creek system is not gauged and water balance information cannot be accurately assessed.

Water Use

- There are no permits to take water issued fort his subwatershed

Hazards Identification

Lake or Tributary	Flood Plain/Fill Line Mapping	Regulatory Event	Regulatory Level Available	Information Source/Date	Channelization
Lower Main Channel	Flood Plain Mapping	1:100 yr	Yes	Totten Sims Hubicki, 1992	
Passmore L	Flood Plain Mapping	1:100 yr	202.14 m	Northland Engineering, 1982	
Twin Line L	Flood Plain Mapping	1:100 yr	203.11 m	Totten Sims Hubicki, 1992	
Depensier L	Flood Plain Mapping	1:100 yr	203.11 m	Totten Sims Hubicki, 1992	
Circle L	Flood Plain Mapping	1:100 yr	203.12 m	Totten Sims Hubicki, 1992	
McLean L	Flood Plain Mapping	1:100 yr	203.10 m	Totten Sims Hubicki, 1992	

- The Parks Creek subwatershed, where flood plain mapping does not exist, is fully supported by fill line mapping

Floodplain Regulation

- The Parks Creek subwatershed, where flood lines exist, is regulated under the One Zone Floodplain Policy with the exception of the following Two Zone Floodplain Policy areas:
  - Within the regulatory flood plain of lower Parks Creek between the CPR line and Lake Nipissing

- The Parks Creek subwatershed, where only fill lines exist, is regulated as a Development Constraint Area

Water Quality Indicators

Totten Sims Hubicki, 1992, summarized the water quality for Parks Creek as follows:

- Parameters exceeding the PWQO in 1992 included total phosphorus, iron, lead, nickel, zinc, total coliform bacteria, and fecal coliform bacteria.

- Iron exceeds PWQO thought out the watershed with values increasing from upstream to downstream.
- Zinc and total phosphorous values are similar to those observed in historical data.
- Bacterial counts are high though out the watershed, increasing towards urban stations.

More recent water quality data for Parks Creek is limited and it is not possible to update the trend analysis. Water quality is poor in part due to natural conditions.

Developed/Settled Areas as % of watershed

The Parks Creek subwatershed is about 25% developed with development restricted to headwaters and lower reaches of the Creek between the CPR mainline and Lake Nipissing.

Significant Features

- Provincially Significant Wetland
  - Parks Creek Wetland Complex
- Laurier Woods Conservation Area
- Deer Habitat
- Archaeological Significance along ancient portages
- Potential or known Species at Risk

Previously Identified Management Issues

- Flooding/Flood Damages from both Lake Nipissing Backflooding and Parks Creek Flooding in the lower main channel
- Flood spillway discharge from Chippewa Creek into Parks Creek headwaters
- High water table/wet basements/Lack of stormwater conveyance in West Ferris/use of sanitary and storm sewers for sump discharges
- Lower Channel ice accumulations/maintenance
- Sedimentation at mouth of Creek (creek mouth was once used for navigation)
- Degraded Water Quality
- Comprehensive Basin Management
- Creek Debris
- Protection of Laurier Woods

Headwater Management Concerns

- Headwater Urbanization
- Wetland Protection
- Headwater Lake Protection
- Stormwater Management

- Inter-basin flood spillage from Chippewa Creek

Drinking Water Source Protection Constraints

- There are no drinking water source protection constraints in the Parks Creek subwatershed

Management/Stewardship

- None

Vulnerability/Sensitivity to Climate Change

- Vulnerability to Climate Change is ranked as Low
- Sensitivity to Climate Change is ranked as High (lower channel has significant potential flood damages)

Vulnerability to Land Use Change

- Vulnerability to Land Use Change is rated as Low

14.2.4 Jessups Creek Subwatershed

General Description

The Jessups Creek subwatershed is the smallest subwatershed planning area under consideration by the NBMCA, and it has the distinction of being the watershed with the highest near term urbanization potential by proportion. This flat, low relief basin is not well recognizable by the community due to its small size and relatively obscure drainage features. It is best observed from Booth Road which cuts across the center of the watershed and at Lakeshore Drive. This 1.31 km^2 system is characterized as having a large central wetland complex (.31 km^2 in size) which is surrounded by bedrock knobs and sandy lacustrine uplands. Wetland features have formed behind a manmade dyke and beaver dams and wetland storage features at the fringes of this watershed have already been encroached by urbanization. Urbanization is expanding from the north and west and industrial growth may encroach from Birches Road on its southern flank. Urbanization and stormwater runoff have are significant basin management issues over the next 20 to 25 years. Growth concerns have been examined in the Jessups Creek Subwatershed and Stormwater Management Study prepared by Aquafor Beech Ltd., on behalf of the City of North Bay in 2000. This study examined comprehensive management issues including watershed hydrology, water quality, terrestrial resources, aquatic resources and heritage features. It recommends the construction of 7 stormwater detention ponds to preserve basin hydrology and water quality. One stormwater management pond has already been constructed by the City. The creeks outlet to Lake Nipissing has been channelized and historic dredging is evident along the main channel east of Booth Road. Channelization was recommended in the West Ferris Floodplain Management Study completed by Northland Engineering in 1982. The Jessups Creek subwatershed shape and drainage patterns are illustrated in Figure 14.8 and subwatershed features are illustrated in Figure 14.9.

Figure 14.8 Jessups Creek Subwatershed Basin Characteristics

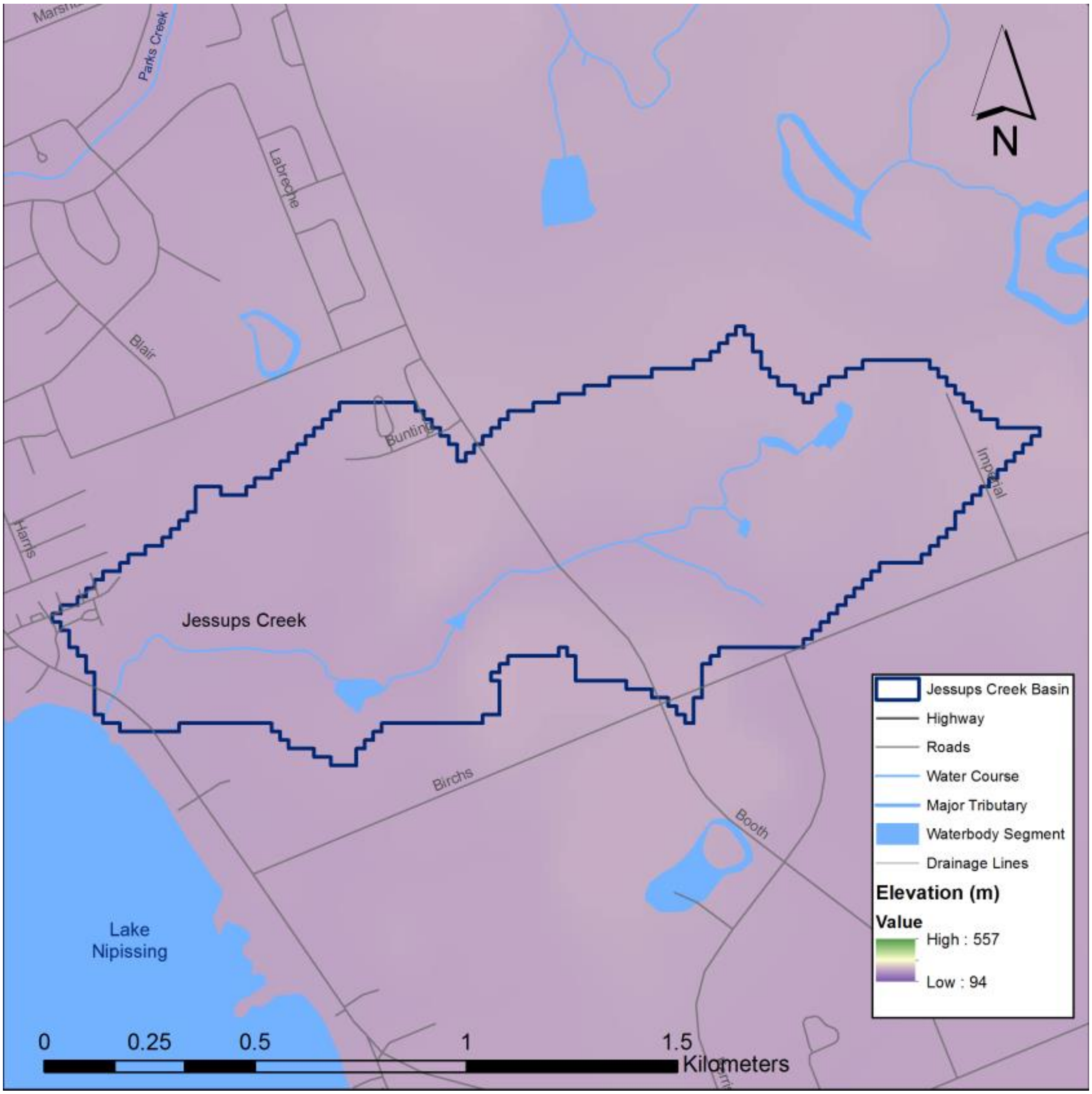
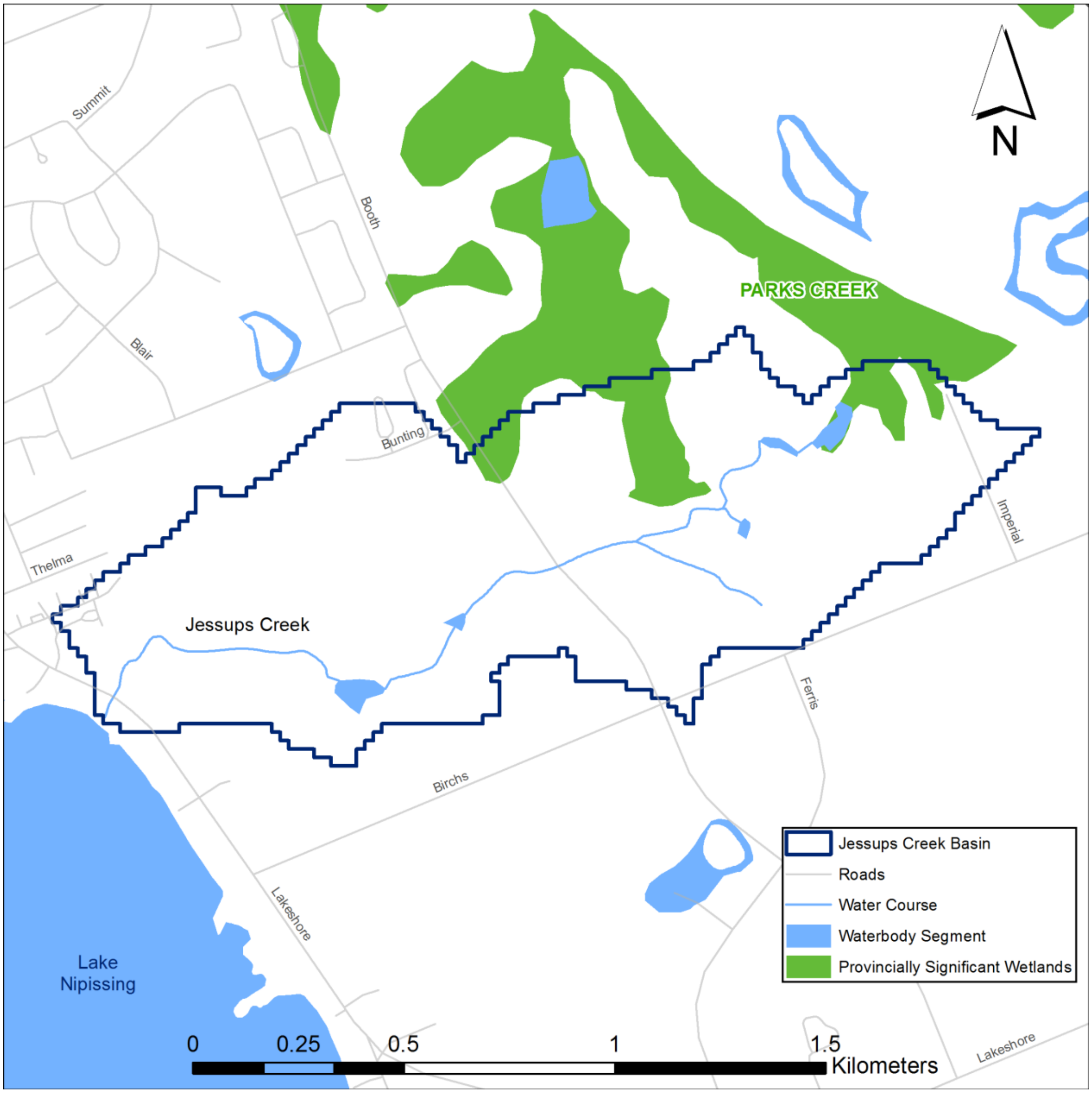


Figure 14.9 Jessups Creek Subwatershed Features



Supporting Studies

Aquafor Beech Limited in Association with Northland Engineering, Beak International Inc., and Settlement Surveys Ltd., Final Report***, Jessups Creek Subwatershed and Stormwater Management Plan***, prepared for the City of North Bay, June 2000.

Gartner Lee Limited, **Source Water Protection Planning – *North Bay-Mattawa Source Water Protection Area Conceptual Water Budget***, prepared for the North Bay-Mattawa Conservation Authority, April 2008.

NBMCA, ***Watershed Plan: Volume 1 - Background Inventory Document***, 1982.

Northland Engineering, ***West Ferris Floodplain Management Study***, 1982.

Waterloo Hydrogeologic Inc, in association with Tunnock Consulting Ltd., ***NBMCA Groundwater Study Report***, January, 2006.

Data Available

- Provincial Water Quality Monitoring Station – Lakeshore Drive (1973 – 1998)
- Data collected for the Aquafor Beech Study 1999.
- Wetland Evaluation, Jessups Creek Wetland (1993)

Major Water Bodies

- None
- Minor water bodies - none

Development Pressure

- Residential growth is likely south of Massey Drive and west of Booth Road up to the edge of the Jessups Creek Wetland Complex
- Residential expansion is occurring at the western fringes of the watershed with access from Birchs Road
- Large blocks of land on the watersheds southern fringes could be subdivided within the next 20 to 25 years
- Industrial growth is possible at the southeastern fringes of the watershed accessed from Birchs Road

Fishing Pressure

- None – bait fish exist within the wetland and bait licenses have been issued for this wetland complex in the past

Recreational Pressure

- Kate Paceway is a popular 12.8 km trail system that connects the North Bay waterfront to Callander. This trail system crosses through the Jessups Creek watershed along Booth Road.

Watershed Drainage Shape/Slope/Efficiency

- The Jessups Creek subwatershed has a low percentage of open water (1.1%); but 28.2% of the watershed is wetland areas
- Jessups Creek has a low basin relief, a relatively high main channel slope for its size and a moderate drainage density.

- Jessups Creek is rated as having moderate/high drainage efficiency which is reduced by beaver dams and a manmade impoundment

Runoff/Estimated Water Balance (is system gauged)

- The Jessups Creek system is not gauged and water balance information cannot accurately be assessed.

Water Use

- No permits to take water have been issued for the Jessups Creek subwatershed

Hazards Identification

Lake or Tributary	Flood Plain/Fill Line Mapping	Regulatory Event	Regulatory Level Available	Information Source/Date	Channelization
Main Channel	Flood Plain Mapping	1:100 yr	Yes	Northland Engineering, 1982	Yes

Floodplain Regulation

- The Jessups Creek subwatershed, where flood lines exist, is regulated under the One Zone Floodplain Policy

Water Quality Indicators

Aquafor Beech, 2000, provided the following water quality information for Jessups Creek:

- Eutrophic stream (TP = 50 µg/L in 1999) (n = 6)
- Neutral to slightly acidic pH (n=3)
- No chloride data but conductivity is high
- No trend information is available
- No DO or temperature information – stream does not have cold water habitat
- Signs of sewage contamination as E Coli levels are elevated at mouth
- Naturally high iron and elevated heavy metals (aluminum, cobalt, copper, zinc)

The stream has naturally poor water quality

Developed/Settled Areas as % of watershed

The Jessups Creek subwatershed is approximately 10% developed with development restricted to the mouth and north of the creek west of Booth Road. Limited rural density development exists along Birchs Road. This subwatershed is completely within the City of North Bay's urban settlement area and urbanization could reach 25 % of the watershed area in next 25 years.

Significant Features

- No significant features have been identified
- Potential or known Species at Risk

Previously Identified Management Issues

- Flood Damages at mouth near Lake Nipissing
- Stormwater Management
- Lower Creek Channelization and mid Creek Channelization within wetland
- Sedimentation of Creek Mouth
- Degraded Water Quality
- Wetland Protection

Headwater Management Concerns

- Watershed Development
- Stormwater Management

Drinking Water Source Protection Constraints

- There are no drinking water source protection constraints in the Jessups Creek subwatershed

Management/Stewardship

- None

Vulnerability/Sensitivity to Climate Change

- Jessups Creek Vulnerability to Climate Change is ranked as Low
- Jessups Creek Sensitivity to Climate Change is ranked as Moderate

Vulnerability to Land Use Change

- Jessups Creek vulnerability to Land Use change is ranked as Low on the basis that it is only subject to residential development however this subwatershed may see substantial urbanization within the planning horizon

14.2.5 La Vase River Subwatershed

General Description

The La Vase River subwatershed is a low relief poorly drained basin that originates in East Ferris and drains through southern North Bay. The entire La Vase River basin has limited overburden and poorly developed soils. The La Vase River basin has been subject to a comprehensive basin management study and watershed issues are relatively well defined. This 90.76 km^2 watershed is located in the Mattawa lowlands and has low water yield and extreme variations in flows. The upper La Vase is modestly undulating with upland remaining predominantly forested and low areas, which have historically been farmed, remaining as fields. Farming persists in the upper watershed and fields are primarily used to grow hay. Rural residential development lines roadways.

The central watershed, which largely remains undeveloped, is dominated by bedrock outcrops surrounded by wetlands. Many wetlands in this basin have been evaluated and the largest near Dreany Lake is provincially significant. The watershed has high potential to harbour species at risk. Although the watershed has limited aggregate potential, shallow bedrock quarrying has been undertaken near the east end of Birchs Road.

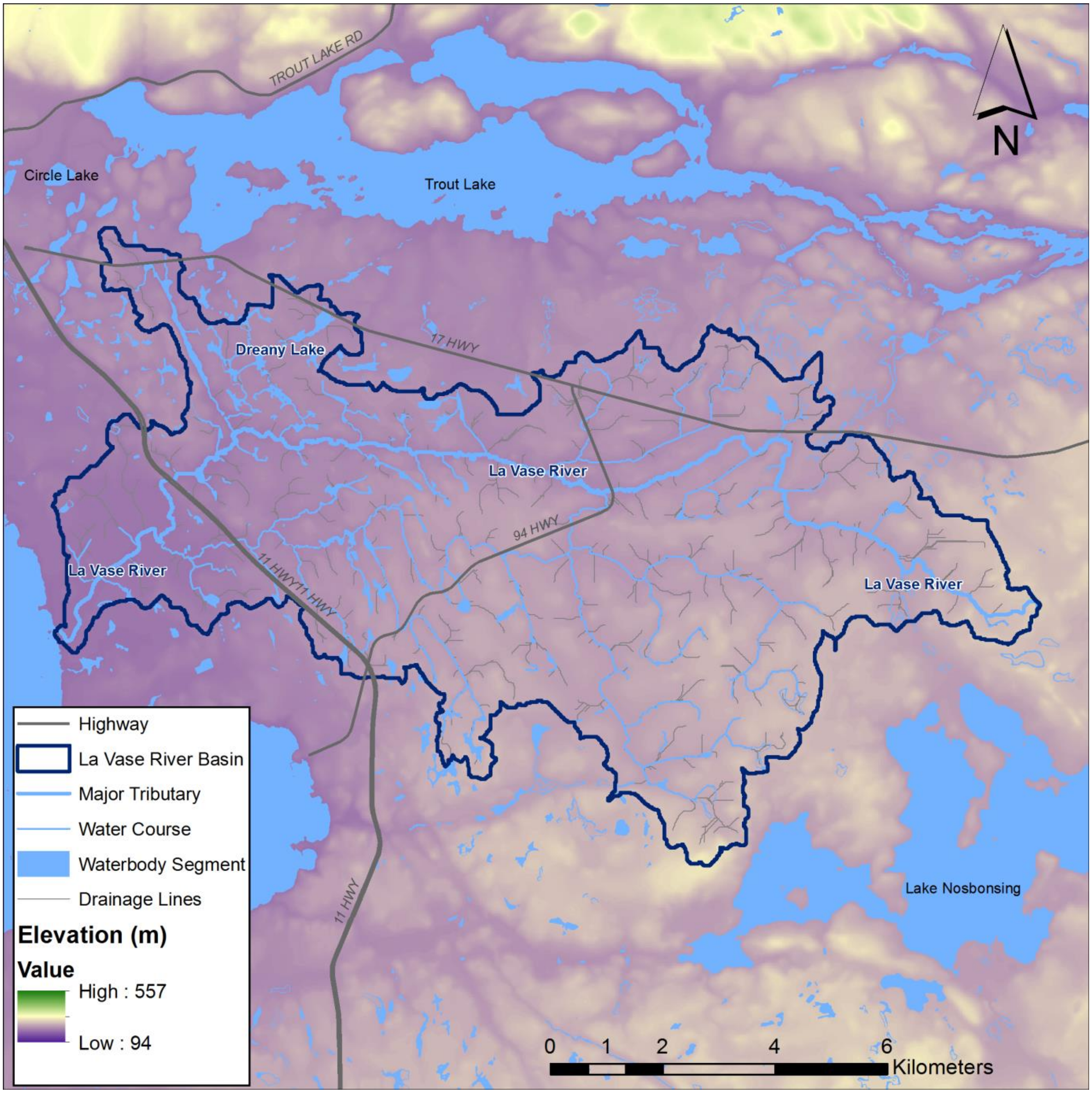
The lower La Vase supports limited rural residential uses and patches of urbanization including several commercial/ industrial areas. Poor drainage and flooding along the lower La Vase has limited urban encroachment. The lower reaches are also subject to back flooding from Lake Nipissing. Cooks Creek, a main tributary that flows through the Pinewood Golf Course, has a floodplain that has limited impact to development. The mouth and lower La Vase River once served as a popular boat launch/docking area with extensive motorized watercraft usage. Boat wakes significantly altered the river's morphology transforming it from a narrow deep river, in part drowned by Lake Nipissing, to a shallower wide river with reduced navigability. The NBMCA has addressed lower La Vase stream bank erosion by undertaking stream bank stabilization work. The popularity of the river for navigation has declined with the development of the North Bay waterfront, and the impact of boat wakes has declined.

This watershed is perhaps best known for its heritage significance. Nipissing Junction, a location where a significant canoe route, railways and a major highway all intersect attests to the importance the La Vase system has played to continental transportation. As well as the use of the La Vase River as a historic canoe route, the La Vase River provided a convenient corridor for the development of the CPR continental railway line and the La Vase River mouth was the site of Fort or *"House La Ronde"*, the first building in North Bay. The foundation of this first building has been located on Bothwells Island at the Rivers mouth. The La Vase River subwatershed shape and drainage patterns are illustrated in Figure 14.10 and subwatershed features are illustrated in Figure 14.11.

Supporting Studies

Dawdy, Blake F., ***La Vase River Flood Hazards & Floodway Study***, prepared for the North Bay-Mattawa Conservation Authority, 1998.

Figure 14.10 La Vase River Subwatershed Basin Characteristics

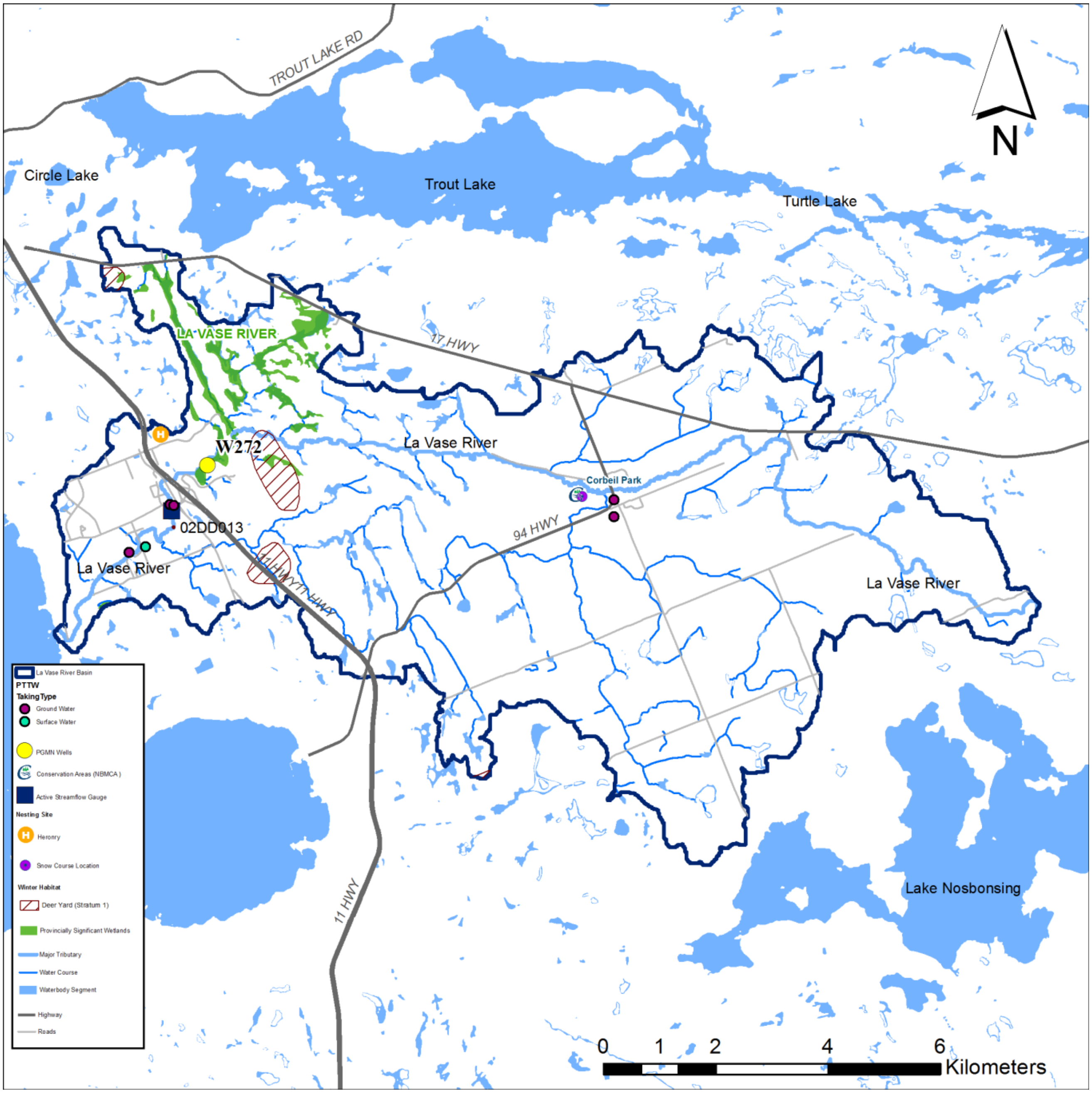


Gartner Lee Limited, **Source Water Protection Planning – *North Bay-Mattawa Source Water Protection Area Conceptual Water Budget***, prepared for the North Bay-Mattawa Conservation Authority, April 2008.

M. M. Dillon Ltd., ***Report on Erosion Control and Bank Stabilization Study – La Vase River***, prepared for the North Bay-Mattawa Conservation Authority, 1975.

NBMCA, ***La Vase River Erosion Control Project***, work completed by Young Canada Works, 1979

Figure 14.11 La Vase River Subwatershed Features



NBMCA, ***The La Vase River/Callander Bay Study***, 1989.

NBMCA, ***La Vase River Watershed Inventory Document Final Report***, 1997.

NBMCA, ***La Vase Portage Conservation Area Master Plan***, 1997.

NBMCA, ***Watershed Plan: Volume 1 - Background Inventory Document***, 1982.

Northland Engineering Ltd., ***West Ferris Floodplain Management Study***, 1982.

Totten Sims Hubicki Associates, ***La Vase River Watershed Management Study Final Report***, Prepared for the North Bay-Mattawa Conservation Authority, 1997.

Totten Sims Hubicki Associates, ***Floodline Mapping Study: La Vase River and Tributary at Corbeil,*** Prepared for the North Bay-Mattawa Conservation Authority, 1998.

Waterloo Hydrogeologic Inc, in association with Tunnock Consulting Ltd., ***NBMCA Groundwater Study Report***, January, 2006.

Data Available

- There are 3 longer term Provincial Water Quality Monitoring Stations (plus data for three other stations that existed for 1 year)
    - 1 km east of Highway 11 (1973 – 1992)
    - Riverbend Road (1968 – 1992)
    - River Mouth (1973 – 1994)
- Stream Flow Data at La Vase River Gauge, Lakeshore Drive, (1974 – present)
- Provincial Groundwater Monitoring Network – Fabrene (2003 – present)
- Snow course data – Corbeil Conservation Area (1987 – present)
- Inventory Data collected for La Vase Watershed Management Study (1997).
- Wetland Evaluations, various years.

Major Water Bodies

- None
- Minor water bodies – Dreany Lake

Development Pressure

- Residential growth along Lakeshore Drive
- Commercialization near Pinewood Parkway Drive with the extension of sanitary sewers into the area.
- Rural development outside of the City of North Bay urban settlement area and in the Municipality of East Ferris
- Although probably beyond the time lines of this planning exercise, the new alignment of the Highway 17 four laning has the potential to have a large impact on the La Vase River watershed

Fishing Pressure

- Limited

Recreational Pressure

- Kate Paceway is a popular 12.8 km trail system that connects the North Bay waterfront to Callander. This trail system crosses through the La Vase River watershed between Pinewood Parkway Drive and Riverbend Road.
- La Vase Portage is now being restored as a publicly accessible recreational portage. The La Vase Portage Conservation Area has been established at the northern terminus that links with the Trout Lake Watershed (as well as the Elk's Lodge Family Park on Dugas Bay).
- Corbeil Conservation Area is located in Corbeil

Watershed Drainage Shape/Slope/Efficiency

- The La Vase River subwatershed has a low percentage of open water (2.95%); but it has a fairly high percentage of wetland area (12.6%)
- The La Vase River has a relatively flat main channel slope and the watershed has moderate drainage density and low basin relief
- Basin calculations suggest the watershed has Moderate/High drainage efficiency, however drainage efficiency is reduced by limited soil cover and extensive bedrock in combination with extensive beaver activity in the central watershed which results in abundant wetlands.

Runoff/Estimated Water Balance (if system is gauged)

- Relatively delayed response to storm events and high volumes of runoff are possible
- Basin is subject to extreme high and low flow conditions
- Estimated water balance for La Vase River Gauge as follows (for period of records*):

Station ID	Station Name	Record Period	Gauged Area km^2	Estimated Actual Evapotransiration (mm)	Mean Annual Surplus (mm)	Projected Total Precip (mm)	NB Airport TP (mm) for same period
02DD013	La Vase River at North Bay	1974 - 2011	70.4	535	412	947	1035.8

* Gartner Lee (2010) reported a La Vase River water mean annual water surplus of 375 mm for period 1975 – 2005 and also apportioned the surplus as 282 mm/yr to overland flow and 93 mm/yr to groundwater recharge. This study also reports and annual precipitation (924 mm) and estimated annual evapotranspiration (549 mm) for this station for the same period.

Highest Recorded Flow	24.5 m^3/sec on Apr 1, 1998 (26 X average flows)
Mean Annual Flow	0.923 m^3/sec (1974 – 2011)
Lowest Recorded Flow	0.006 m^3/sec on Sep 22, 2011

Water Use

- There are active ground water taking permits issued within the La Vase River subwatershed for Nipissing Manor in Corbeil and the Fairview Trailer Park on Riverbend Road as well as a surface water taking permit for the Pinewood Park Golf Course (used for golf course irrigation)

Hazards Identification

Lake or Tributary	Flood Plain/Fill Line Mapping	Regulatory Event	Regulatory Level Available	Information Source/Date	Channelization
Main Channel - North Bay	Flood Plain Mapping	1:100 yr	Yes	Northland Engineering, 1982	
Cooks Creek	Flood Plain Mapping	1:100 yr	Yes	Northland Engineering, 1982	
Main Channel - East Ferris	Flood Plain Mapping	1:100 yr	Yes	Totten Sims Hubicki, 1998	

- The La Vase River subwatershed, where flood plain mapping does not exist, is fully supported by fill line mapping

Floodplain Regulation

- The La Vase River subwatershed, where flood lines exist, is regulated under the One Zone Floodplain Policy with the exception of the following Two Zone Floodplain Policy area:
  - Within the regulatory flood plain of lower La Vase River between Riverbend Road and Lake Nipissing
- Upper La Vase River including Cooks Creek, where flood lines have not been defined, is regulated under a Development Constraint Area Policy

Water Quality Indicators

Totten Simms Hubicki, 1997, has provided water quality information which is interpreted as follows for the La Vase River:

- Mesotrophic to Eutrophic stream (TP ranges between 40 and 80 µg/L prior to 1990 (TSH) but a decline is noted after 1990 and general water quality is rated as poor)
- Neutral to slightly acidic pH - most data is between 6.5 and 7.0 pH (TSH)
- Chlorides and conductivity are not reported – Iron exceeds PWQO suggesting high conductivity
- No general trend data was available for assessment – Total Phosphorous is reported to be trending lower
- Limited DO and Temperature data was available – stream does not have cold water habitat (summer water temperatures routinely are above 20° C)
- A number of contaminant point sources are identified including Pinewood, Nipissing Manor and Fabrene Lagoons, Trailer Park on Riverbend Road, East Ferris Landfill
- Periodic PWQO exceedances of heavy metals other than iron (nickel, lead, copper, zinc). Iron levels are reported to always exceed the PWQO.

Developed/Settled Areas as % of watershed

The La Vase River subwatershed is less than 10% developed with development focused near the mouth, near Corbeil and in the headwaters. Rural low density development dominates in headwater areas. Watershed urbanization in North Bay is expected to increase slightly in next 25 years through infilling and through the extension of new services. Extension of sanitary sewers into the Pinewood Parkway Drive area will reduce existing loading from lagoons but will stimulate new development that will generate new stormwater runoff concerns.

Significant Features

- Provincially Significant Wetland:
  - La Vase River-Dreany Lake Wetland Complex
- Nesting Sites
- Deer Habitat
- Potential or known Species at Risk
- Archaeological Significance along the La Vase Portages and at the Mouth of the River

Previously Identified Management Issues

- Flooding/Flood Damages near mouth from both Lake Nipissing and the La Vase River. River flooding may be impacted by ice damming
- Erosion of Stream Banks/Structural Works to Repair Erosion/reestablishment of Watercraft Speed Controls in lower reaches
- Sedimentation of lower river and at mouth of River (limits navigation potential)
- Degraded Water Quality
- Heritage Features including management of La Vase Portage and Fort or House La Ronde
- Comprehensive Basin Management including beaver management; monitoring of point sources, programs to keep livestock out of streams, septic re-inspections and control of boat grey water discharges.

Headwater Management Concerns

- Wetland Protection
- Headwater Rural Development
- Stormwater Management
- Agricultural Runoff
- Protection of Species at Risk

Drinking Water Source Protection Constraints

- There are no drinking water source protection constraints in the La Vase River subwatershed

Management/Stewardship

- None

Vulnerability/Sensitivity to Climate Change

- La Vase River subwatershed Vulnerability to Climate Change is ranked as Moderate
- La Vase River subwatershed Sensitivity to Climate Change is ranked as High

Vulnerability to Land Use Change

- La Vase River subwatershed Vulnerability to Land Use Change is ranked as High

14.2.6 Lake Nipissing Shoreline/North Bay Subwatershed

General Description

The Lake Nipissing Shoreline/North Bay subwatershed is a series of many small catchments flowing through North Bay (and a small portion of Callander) not captured in other subwatersheds but which drain to Lake Nipissing. This subwatershed includes several identifiable drainage areas including Pinewood Parkway Creek and Gauthier Creek. This 17.5 km^2 catchment has limited water surface area (1.3%) and is heavily urbanized. This subwatershed is supported by a number of studies. Near shore water quality is impacted by sewage treatment plant, subwatershed and catchment area discharges that have been subject to remedial actions. Risks caused by the lake to its immediate shoreline have also been studies and management programs have been established. Shoreline issues include potential property damages caused by lake flooding, waves and ice; the dynamic nature of beaches and the movement of sand by wind and waves within and between headlands; and the water quality of the immediate shoreline which affects the recreational use of the waterfront including swimming. Most of the catchment is comprised of small overland or piped storm water conveyance systems. Pinewood Parkway Creek, at the northern end of the catchment is large enough to have a definable floodplain and associated flood damages.

A primary management concern with this subwatershed has been the quality of the stormwater that is conveyed to Lake which can contribute bacterial loading to public beaches during the swimming season. This issue was examined in detail in the North Bay Waterfront Lake Nipissing Pollution Control Plan (completed in 2 Phases – report completed in 1991) which concluded that urban stormwater was contributing bacteriological contamination that exceeded provincial guidelines at public beaches after rainfall events. A number of management programs were implemented including a program to find and fix cross connections (sanitary discharges to storm sewers) and to divert dry weather flows from storm sewers. A rainfall rule was established to discourage swimming at public beaches for a 24 hour period after heavy rainfall events. Some public swimming areas are monitored throughout the swimming season by the North Bay and Parry Sound District Health Unit and recent beach closures on the Lake Nipissing in North Bay have been rare. Pinewood Parkway Creek has several pockets of development that are subject to flooding if conveyance systems capacities are exceeded. This subwatershed originates above the North Bay escarpment and has the potential to be impacted by upper escarpment development in the future. The timing of development above the escarpment is uncertain and is likely beyond the scope of this planning exercise.

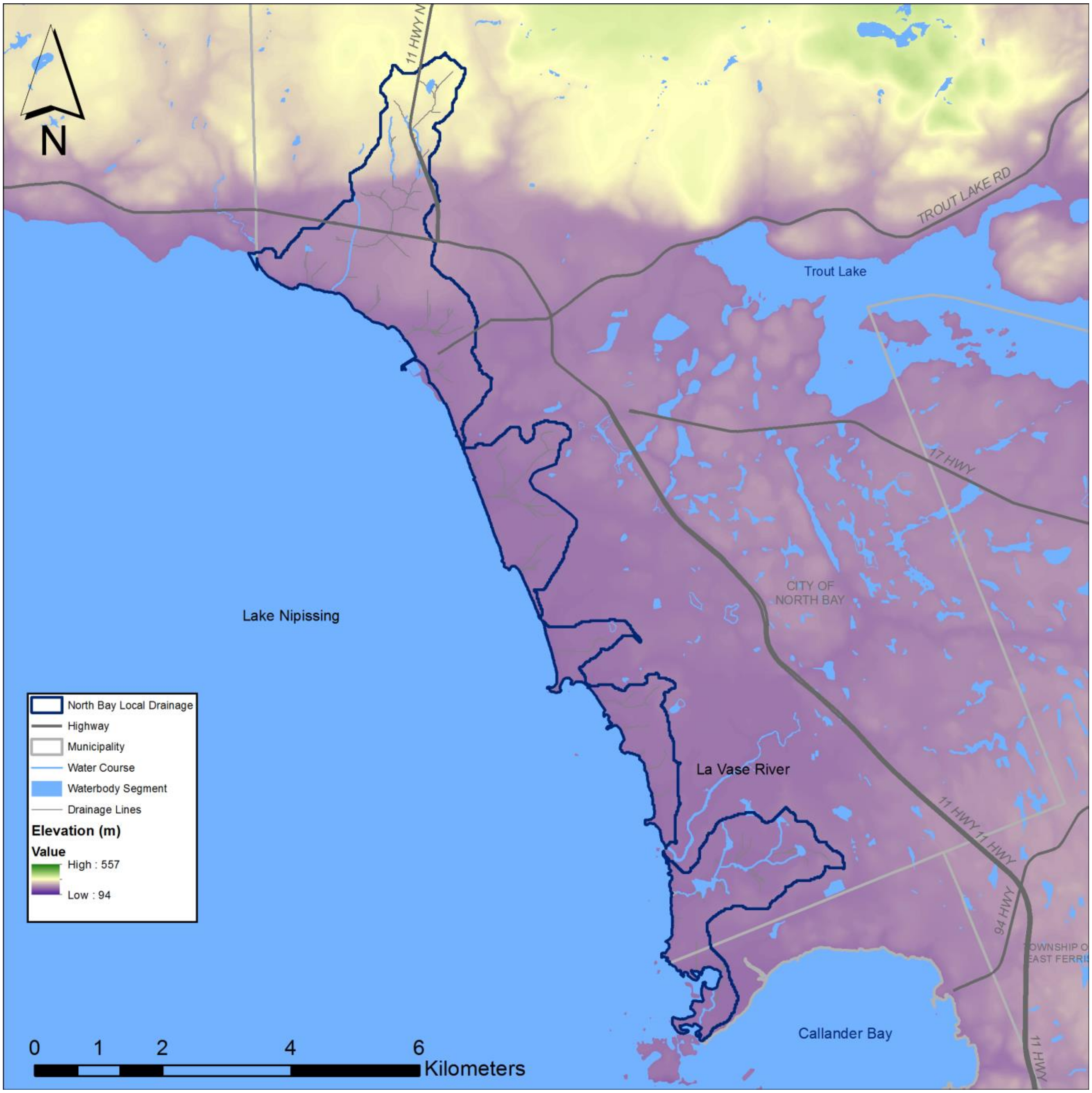
The Lake Nipissing shoreline in North Bay is on the windward side of Lake Nipissing and it has direct exposed to prevailing winds. Lake Nipissing's flood elevation has an allowance for lake seiche (wind tilt) and wave uprush. During high water events (above elevation 196.6 m amsl) properties and structures along the North Bay shoreline are vulnerable to damage from flooding, waves and ice. Flood damages assessed after the 1979 flood by Acres International in *"Sturgeon River/Lake Nipissing/French River Watershed Management Plan"*, 1992 and by the NBMCA in the *"Report of Lake Nipissing Flood Survey Responses"*, 1979 indicate that most of the flood damages in 1979 occurred in the West Ferris Area of the City of North Bay. Other shoreline management issues stem from the completion of the "*North Bay Waterfront and Shoreline Development Plan"*, 1983 which led to the development of the North Bay waterfront to improve public access to Lake Nipissing. Littoral movements of beach sand within different littoral reaches have been examined in technical studies. The accumulation of beach sand within various reaches can shift after heavy winds and when absent the lack sand exposes private properties to higher risk during high water events. The littoral movement of sand on either side of the North Bay waterfront may have been impacted by the development of the marina basin which traps sediment. Marina dredging at the North Bay waterfront is now subject to guidelines aimed at maintaining a littoral sand balance. Guidelines have also been developed for waterfront property owners to help protect their shorelines from the ravages of the Lake. The North Bay - Lake Nipissing shoreline also has isolated shoals which are identified as significant walleye spawning areas. The Lake Nipissing Shoreline North Bay subwatershed drainage shape is illustrated in Figure 14.12 and watershed features are illustrated in Figure 14.13.

Supporting Studies

Acres International Ltd, ***Sturgeon River/Lake Nipissing/French River Watershed Management Plan***, prepared for the Sturgeon-Nipissing-French Water Management Advisory Board and the Ministry of Natural Resources, 1992.

Acres International Ltd, ***Lake Nipissing/French River Operational Guidelines,*** prepared for Public Works and Government Services Canada, 1995.

Figure 14.12 Lake Nipissing Shoreline North Bay Subwatershed Basin Characteristics

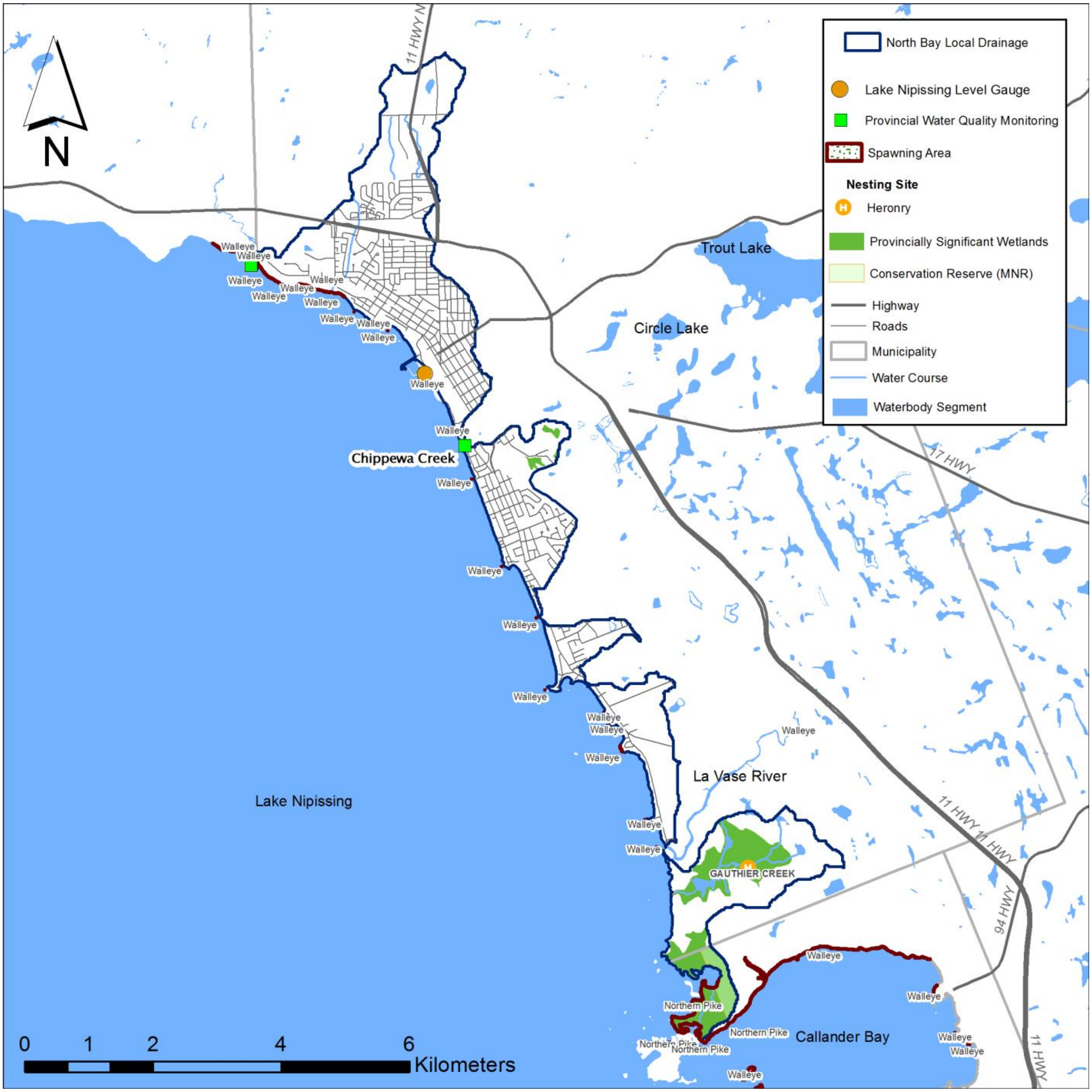


Baird & Associates, ***Development of a Shoreline Management Strategy***, prepared for the North Bay-Mattawa Conservation Authority, 1991.

Baird & Associates, Proctor and Redfern, McNeely Engineering, ***Marathon Beach Environmental Assessment Report***, prepared for the City of North Bay, February 1994.

Baird & Associates, ***Storm Surge in Lake Nipissing Draft Report***, prepared for the North Bay-Mattawa Conservation Authority, November 1994.

Figure 14.13 Lake Nipissing Shoreline North Bay Subwatershed Basin Features



MacLaren Plansearch and Lavalin, ***Flood Reduction Study of the Sturgeon River/Lake Nipissing/French River System, Summary***, report to Ontario Ministry of Natural Resources and Environment Canada, September 1981. Background Reports are also available:

- Technical Volume 1: Background Studies, September 1981.
- Technical Volume 2: Analysis of Existing System and Development of a Management Plan, September 1981.

Moore George and Associates, ***North Bay Waterfront Development and Shoreline Management Plan***, prepared for the North Bay-Mattawa Conservation Authority, 1983.

NBMCA, ***North Bay Waterfront Development Study: Background Information***, 1982.

NBMCA, ***Report on Lake Nipissing Flood Survey Responses***, 1979.

NBMCA, ***The La Vase River/Callander Bay Study***, 1989.

NBMCA, ***Watershed Plan: Volume 1 - Background Inventory Document***, 1982.

Northland Engineering, ***City of North Bay Water Pollution Control Feasibility Study Draft***, March 1989.

Northland Engineering Ltd, Beak Consultants Ltd, and Paul Theil Associates, ***Lake Nipissing Pollution Control Plan Phase I***, prepared for the City of North Bay and the Ontario Ministry of the Environment, November 1989.

Northland Engineering Ltd, ***Lake Nipissing Pollution Control Plan Phase II***, prepared for the City of North Bay and the Ontario Ministry of the Environment, June 1991.

Northland Engineering Ltd., ***Pinewood Creek Catchment: Draft 2***, September 1997.

Northland Engineering Ltd, ***West Ferris Floodplain Management Study***, 1982.

Ontario Ministry of Environment, ***The Chemical Water Quality of Lake Nipissing 1988 – 1990***, prepared by MOE Dorset Research Center, February 1992.

Ontario Ministry of Environment, ***The Chemical Water Quality of Lake Nipissing 2002 – 2002***, prepared by the MOE Dorset Environmental Science Inland Lake Group, December 2010.

Ontario Water Resource Commission, ***Water Pollution Survey of the City of North Bay***, December, 1965,

S. A. Kirchhefer Ltd, ***Review and Implementation of Recommendations of the Sturgeon River, Lake Nipissing, French River System***, prepared for the Ontario Ministry of Natural Resources, March 1984.

Totten Sims Hubicki, ***North Bay Escarpment Resource Inventory and Digital Mapping***, prepared for the North Bay-Mattawa Conservation Authority and the City of North Bay, 1999.

Data Available

- Water Quality data from 2010 MOE Report that identifies 26 sampling locations in main part of Lake Nipissing of which 3 are in close proximity to the North Bay shoreline and 1 is in Callander Bay (Data was collected between 2003 and 2004)
- HYDAT Water Level Gauge at Government Dock (Kings Landing) at North Bay Waterfront (1933 – present)
- Wetland Evaluations - Gauthier Creek Marsh (1992)
  - Callander Bay Marsh (1993)

Major Water Bodies

- Lake Nipissing
- Minor water bodies – None

Development Pressure

- Most of the North Bay Lake Nipissing shoreline, between the mouth of the La Vase River and Kinsmen Beach, is developed. Most of the development pressure along the waterfront is from redevelopment. Historic redevelopment trends include new residential development on previous residential lots and large scale condo development on larger land parcels.
- Development above the North Bay escarpment has the potential to impact Pinewood Parkway Creek.

Fishing Pressure

- Significant on Lake Nipissing – beyond the scope of the current study

Recreational Pressure

- Lake Nipissing is used extensively for Navigation/Boating in the summer and for snowmobiling/ice fishing in the winter period.
- The North Bay Waterfront and many City parks on the shoreline of Lake Nipissing provide beach access and public swimming
- Eva Wardlaw Conservation Area provides access to Lake Nipissing (owned by NBMCA)
- Kate Paceway is a popular 12.8 km trail system that connects the North Bay Waterfront to Callander. This trail system crosses through the Lake Nipissing Shoreline study area at the North Bay waterfront and in parts of West Ferris.

Watershed Drainage Shape/Slope/Efficiency

- Basin characteristics have not been examined in detail (not a distinct watershed). The Lake Nipissing shoreline in North Bay has a low percentage of open water (1.3%) not including any portion of Lake Nipissing). The drainage area is rated as having a moderate drainage density.

Lake Level Information (if system is gauged)

- The 1:100 year flood plain of Lake Nipissing is calculated to be 197.25 m.a.s.l. including wind tilt and wave uprush.
- The reported normal summer elevation of Lake Nipissing is 195.83 m.a.s.l. (Acres, 1981)(Northland Engineering, 1982)
- The summer operating range of Lake Nipissing is 195.75 to 195.95 m.a.s.l. between May 15th and October 1st every year.
- The lake is drawn down over the winter period. The lake drawn down target is 194.5 m.a.s.l. between March 15th and April 15th. Historic practice is to stay slightly above this level if normal or light freshet conditions are expected. Also winter drawdown can be inhibited by the discharge capacity of Lake Nipissing Dams at low water elevations.
- HYDAT reports that the highest recorded daily water level at the North Bay water level gauge was 196.935 m.a.s.l. on June 23, 1947.
- HYDAT reports that the lowest recorded daily water level at the Lake Nipissing at North Bay water level gauge was 194.307 m.a.s.l. on Apr 20, 1975

Water Use

- No permits to take water have been issued for the Lake Nipissing subwatershed

Hazards Identification

Lake or Tributary	Flood Plain/Fill Line Mapping	Regulatory Event	Regulatory Level Available	Information Source/Date	Channelization
Lake Nipissing	Flood Plain Mapping	1:100 yr	197.25 m*	MacLaren Plansearch Inc, 1982	
Pinewood Parkway Cr	Elevations only	1:100 yr	Yes	Northland Engineering, 1997	

*** The MacLaren Plansearch 1:100 yr flood level for Lake Nipissing includes wind tilt and wave uprush. The 1:100 yr static elevation calculated by MacLaren in 1982 was 196.94 m. Recent work completed by Public Works and Government Services Canada for the reconstruction of the Big Chaudière Dam on Lake Nipissing identified 196.8 m as the 1:1000 yr static flood elevation. This elevation is lower than the MacLaren 1:100 yr static elevation (which correlates with the 1947 flood level reported at the Lake Nipissing North Bay HYDAT gauge and is the highest elevation on record).**

- The Lake Nipissing/North Bay Shoreline subwatershed, where flood plain mapping does not exist, is fully supported by fill line mapping

Floodplain Regulation

- The Lake Nipissing floodplain in the municipalities of North Bay and Callander is regulated pursuant to the Provincial Large Inland Lake Policy
- The Pinewood Parkway Creek floodplain, where flood elevations exist, is regulated under the One Zone Floodplain Policy
- The upper Lake Nipissing/North Bay Shoreline subwatershed, where fill lines have been developed, is regulated under the Development Constraint Area Policy

Water Quality Indicators

- Recent water quality data for drainage systems flowing to Lake Nipissing is not available. Bacteriological loading data from stormsewer discharges in the 1980's and 1990's was collected by the City of North Bay as part of their sewer system find and fix program.
- Lake Nipissing in the vicinity of North Bay is considered Mesotrophic (based on MOE stations IG1, IG10 and IG11). The three year mean seasonal values for Total Phosphorous display significant spatial and temporal variations across the Lake (MOE 1992). The immediate shoreline of Lake Nipissing near North Bay may be influenced by the discharge of treated effluent from the North Bay Sewage Treatment Plant as well as creek and stormsewer discharges. In 2003-2003 Total Phosphorous for stations near North Bay (stations IG1, IG10 and IG11) ranged between 10 and 38 µg/L with a combined mean value (17.83 µg/L) that was higher than in 1988 – 1990 (combined mean was 13.33 ug/L). A decoupling of Total Phosphorous and Chlorophyll yields was noted (MOE, 2010).
- Neutral to slightly alkaline pH - data for the North Bay shoreline is reported between 6.7 and 7.5 pH; mean values are above 7.0 pH. (MOE, 2010)
- Low chlorides and conductivity – Chlorides range between 3.0 and 5.5 mg/L and Conductivity is reported ranging between 64 and 87 µS in the vicinity of North Bay (MOE, 2010); mean values were slightly lower than in 1988 - 1990.
- Long term trends suggest Total Phosphorous loading has declined from the 1970's, a trend observed across Ontario, and which may in part be due to changes in sampling techniques. Further research is required to identify why chlorophyll yields, which were reported in 1992 to be increasing, have now declined despite slightly higher nutrients.
- DO and Temperature data are suitable for a warm water habitat – Wind mixes the lake top to bottom and the lake does not stratify near North Bay.

Developed/Settled Areas as % of watershed

The watershed is approximately 50 to 60 % developed.

Significant Features

- Walleye Spawning
- Nesting Sites
- Provincially Significant Wetlands
  - Gauthier Creek Marsh
  - Part of Callander Bay Marsh
- Potential or known Species at Risk
- Archaeological Significance along the lakefront near the mouth or the La Vase River

Previously Identified Management Issues

- Flooding/Flood Damages along the North Bay shoreline and Pinewood Parkway Creek
- Wave Damage/Beach Erosion/Property Damage during high water and wind
- Ice Damage to shoreline structures/Warf
- Degraded Bathing Water Quality/Beach Closures
- Stormwater/Creek discharge bacteriological loading
- Interference with/public concern with littoral sand migration along the shoreline near the North Bay waterfront
- Interference with Beach Dynamics
- Expansion of Waterfront/Marathon Beach Infilling
- Navigation/supply of Marina slips
- Recreation and Public Access
- Management of Lake Nipissing Water Levels
- North Bay Escarpment Hazardland Identification/Protection

Headwater Management Concerns

- Wetland Protection
- Stormwater Management
- Flood Storage (Pinewood Parkway Creek)

Drinking Water Source Protection Constraints

- There are no drinking water source protection constraints in the Lake Nipissing Shoreline North Bay subwatershed

Management/Stewardship

- The operation of Dams on Lake Nipissing by Public Works Canada is overseen by a Watershed Management Advisory Committee led by the Ontario Ministry of Natural Resources which the NBMCA has representation on.

- Lake has a community group organization: Lake Nipissing Partners in Conservation

Vulnerability/Sensitivity to Climate Change

- Lake Nipissing Shoreline/North Bay subwatershed Vulnerability to Climate Change is ranked as Moderate
- Lake Nipissing Shoreline/North Bay subwatershed Sensitivity to Climate Change is ranked as High

Vulnerability to Land Use Change

- Lake Nipissing Shoreline/North Bay subwatershed Vulnerability to Land Use Change is ranked as Moderate

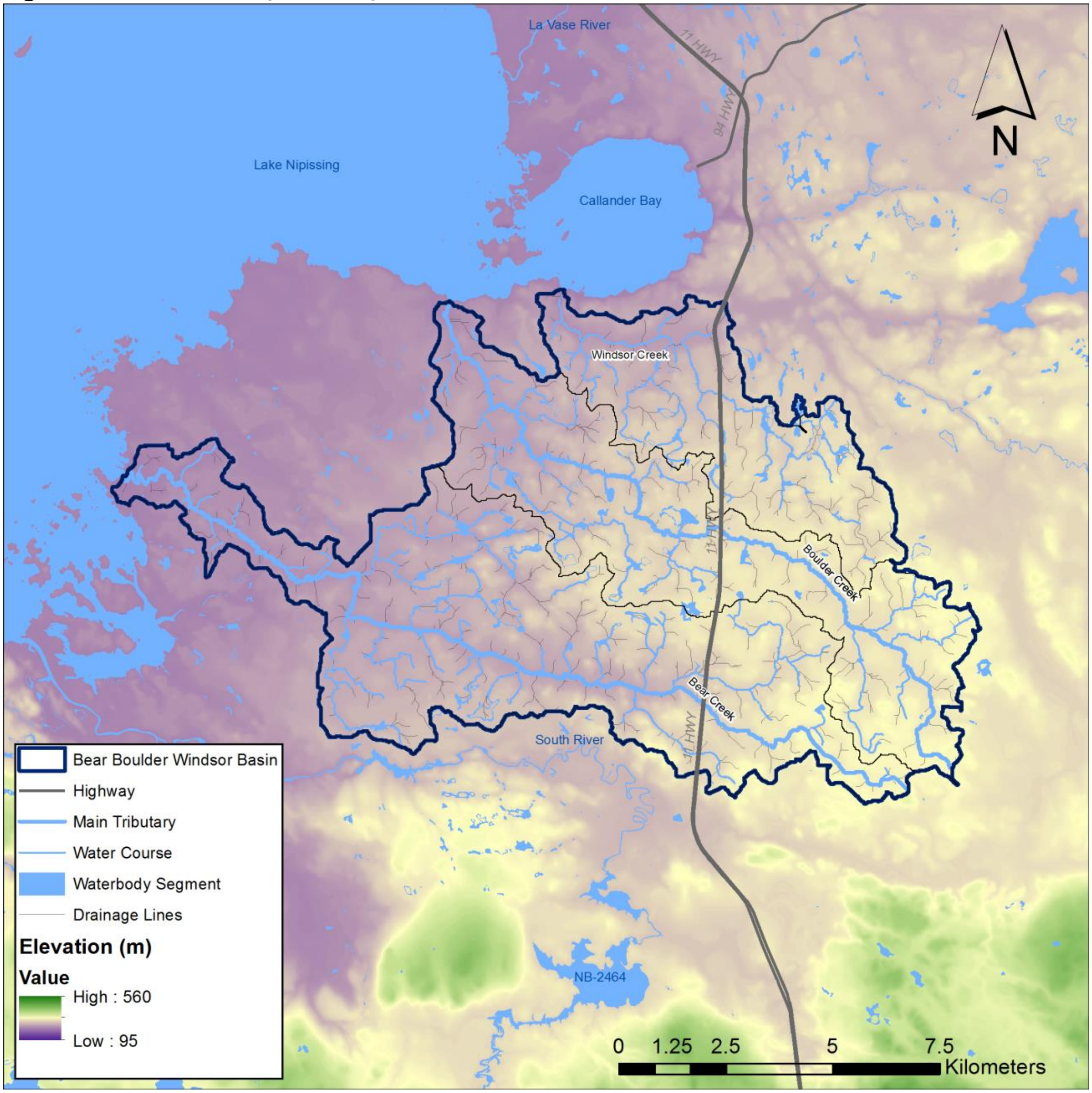
14.2.7 Windsor/Boulder/Bear Creeks Subwatershed

General Description

The Windsor/Boulder/Bear Creek subwatershed is a compendium of three drainage systems that flow through the Municipality of Callander and empty to Lake Nipissing/Callander Bay. These drainage systems (in whole or in part) where added to the NBMCA's area of jurisdiction when the NBMCA expanded to include the Municipality of Callander in 2003. The combined drainage area of all three systems is included within the Integrated Watershed Management Strategy as a study area. These watersheds, which have pockets of low density rural development/grassland/ agricultural areas, originate within the municipalities of Powassan/East Ferris and Chisholm. Bear Creek flows from the Municipality of Callander and through Nipissing Township before emptying into South Bay of Lake Nipissing. All watersheds have relatively similar basin characteristics. Watersheds are long and narrow and watercourses tend to be slow moving. In aggregate these basins have a total subwatershed area of 126.8 km^2 (Windsor 60.7 km^2, Boulder 41.5 km^2, Bear 24.6 km^2) and have minimal open water. Headwaters are mainly exposed bedrock areas intermingled with wetlands. These watersheds have extensive forest cover – the Windsor Creek subwatershed is reported by Hutchinson to have 39 % forest cover). These drainage systems near Lake Nipissing are narrow and drain through lacustrine deposits. Terrain near Lake Nipissing is flat with rolling hills of exposed bedrock where historic Lake Nipissing swept them clean of sediment.

These watersheds have limited basin specific information available and most watershed characteristics are derived from regional studies including Source Water Protection Reports prepared for Callander Bay. Windsor Creek is included in the Intake Protection Zone -3 delineation for the Municipality of Callander water intake and consequently some limited monitoring has taken place. The shape of the three drainage basins of Windsor, Boulder and Bear Creeks are illustrated in Figure 14.14 and basin features are highlighted in Figure 14.15.

Figure 14.14 Windsor/Boulder/Bear Subwatershed Basin Characteristics



Supporting Studies

Gartner Lee Limited, Source Water Protection Planning – ***North Bay-Mattawa Source Water Protection Area Conceptual Water Budget***, prepared for the North Bay-Mattawa Conservation Authority, April 2008.

Hutchinson Environmental Sciences Ltd, ***Callander Bay Subwatershed Phosphorous Budget***, prepared for the North Bay-Mattawa Conservation Authority, February 2011.

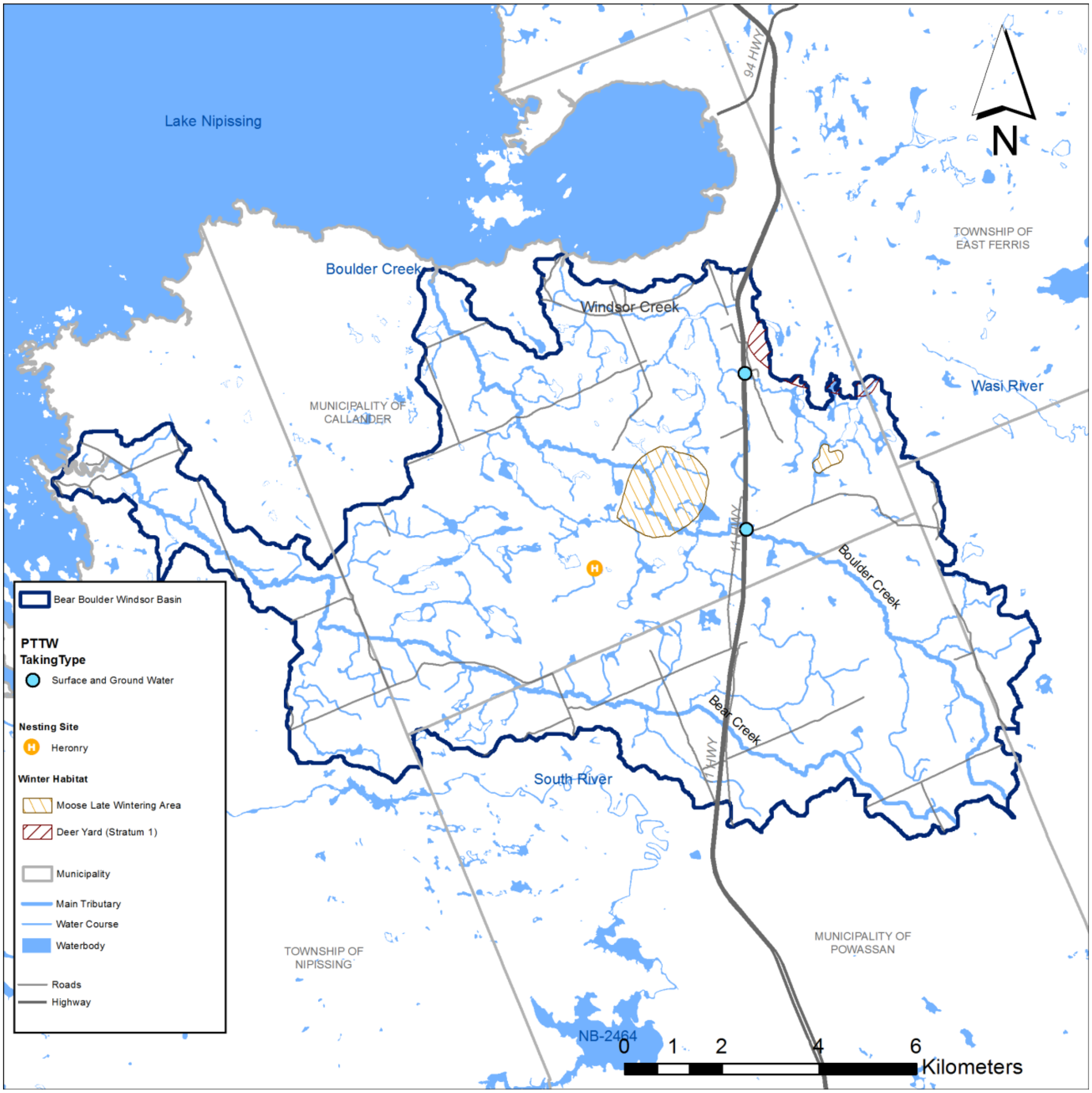
Hutchinson Environmental Sciences Ltd, ***Callander Drinking Water Source Protection Technical Studies Update***, prepared for the North Bay-Mattawa Conservation Authority, May 2010.

Waterloo Hydrogeologics Inc. in association with Tunnock Consulting Ltd, ***NBMCA Groundwater Study Report***, January, 2006.

Data Available

- No long term basin specific data is available

Figure 14.15 Windsor/Boulder/Bear Subwatershed Features



Major Water Bodies

- None
- Minor water bodies – None

Development Pressure

- Rural Residential/Limited Agricultural/Hobby farm development along roadways in Callander
- Development pressure in Nipissing Township is unknown

Fishing Pressure

- Unknown – Bear Creek is considered cold water habitat

Recreational Pressure

- None identified

Watershed Drainage Shape/Slope/Efficiency

- These watersheds have a very low percentage of open water (3.0 %)(Hutchison 2011 calculated 4.7% for Windsor); but have abundant wetland areas (15.9% of total combined watershed area) (Hutchinson 2011 reported 40% wetlands for the Windsor Creek basin)
- The Windsor/Boulder/Bear subwatershed have medium to high main channel slopes low to moderate basin relief and low drainage densities
- Basin calculations suggest that all watersheds are efficiently drained (longer narrow watersheds).

Runoff/Estimated Water Balance (if system is gauged)

- None of the streams are gauged
- Watershed runoff characteristics are generally not known.
- Hutchinson Environment (2010) has developed hydrologic information for Windsor Creek as follows (watershed area may not be comparable):

Tributary ID	Period of Data	Watershed Area	Mean Discharge	Discharge Volume	Depth of Runoff
Windsor Cr	May–Aug 2009	28.8 km^2	0.16 m^3/s	1.7 m^3 X 10^6	70 mm/4 mths

Water Use

- Two unevaluated permits to take water have been issued for the Windsor/Boulder/Bear subwatershed

Hazards Identification

- No Hazard land information has been developed for this subwatershed

Floodplain Regulation

- The floodplain of streams within this subwatershed, as flood lines and fill lines have not been defined, is regulated under the Provincial One Zone Policy. Policy interpretation may require an independent floodplain study. Policy interpretation in Nipissing and Powassan (outside of the NBMCA's core area) would be the responsibility of the Province.

Water Quality Indicators

Limited water quality data is available. The following information is summarized from Hutchinson (2011) for Windsor Creek:

Tributary ID	Parameter	Year	Number of Samples	Mean μ/L	Min μ/L	Max μ/L
Windsor Cr	Total Phos	2010	5	**64**	**49**	**108**

- 15% of the Total Phosphorous Loading to Callander Bay is from the Windsor Creek subwatershed (Hutchinson, 2011)
- Based on limited data Windsor Creek would be classified as Mesotrophic

Developed/Settled Areas as % of watershed

The Windsor/Boulder/Bear Creek subwatershed is less than 10% developed with rural development restricted to roadways. Watershed rural development is expected to increase slightly in next 25 years. There is potential for aggregate extraction uses to increase.

Significant Features

- Himsworth Crown Game Preserve
- Nesting Sites
- Deer Habitat
- Moose Wintering Habitat
- Potential or known Species at Risk

Previously Identified Management Issues

- Total Phosphorous Loading to Callander Bay from Windsor Creek (Hutchinson, 2011)
- Bear Creek is a cold water fishery. NBMCA has stocked it and possibly other streams within this basin in past years (cold water species stocked)

Headwater Management Concerns

- Wetland Protection
- Fisheries Protection – Bear Creek
- Aggregate Extraction

Drinking Water Source Protection Constraints

- Within this subwatershed Windsor Creek (only) is affected by the Source Protection Plan developed for the Municipality of Callander Drinking Water system which source water from Callander Bay. Best management practices and restriction are identified for the greater contributing area which includes all drainage systems entering Callander Bay including Windsor Creek.

Management/Stewardship

- None for entire watershed.
- Drinking Water Source Protection is overseen by a local Source Protection Committee

Vulnerability/Sensitivity to Climate Change

- Windsor/Boulder/Bear subwatershed Vulnerability to Climate Change is ranked as Low
- Windsor/Boulder Sensitivity to Climate Change is ranked as Low and Bear is ranked as Moderate (due to cold water habitat)

Vulnerability to Land Use Change

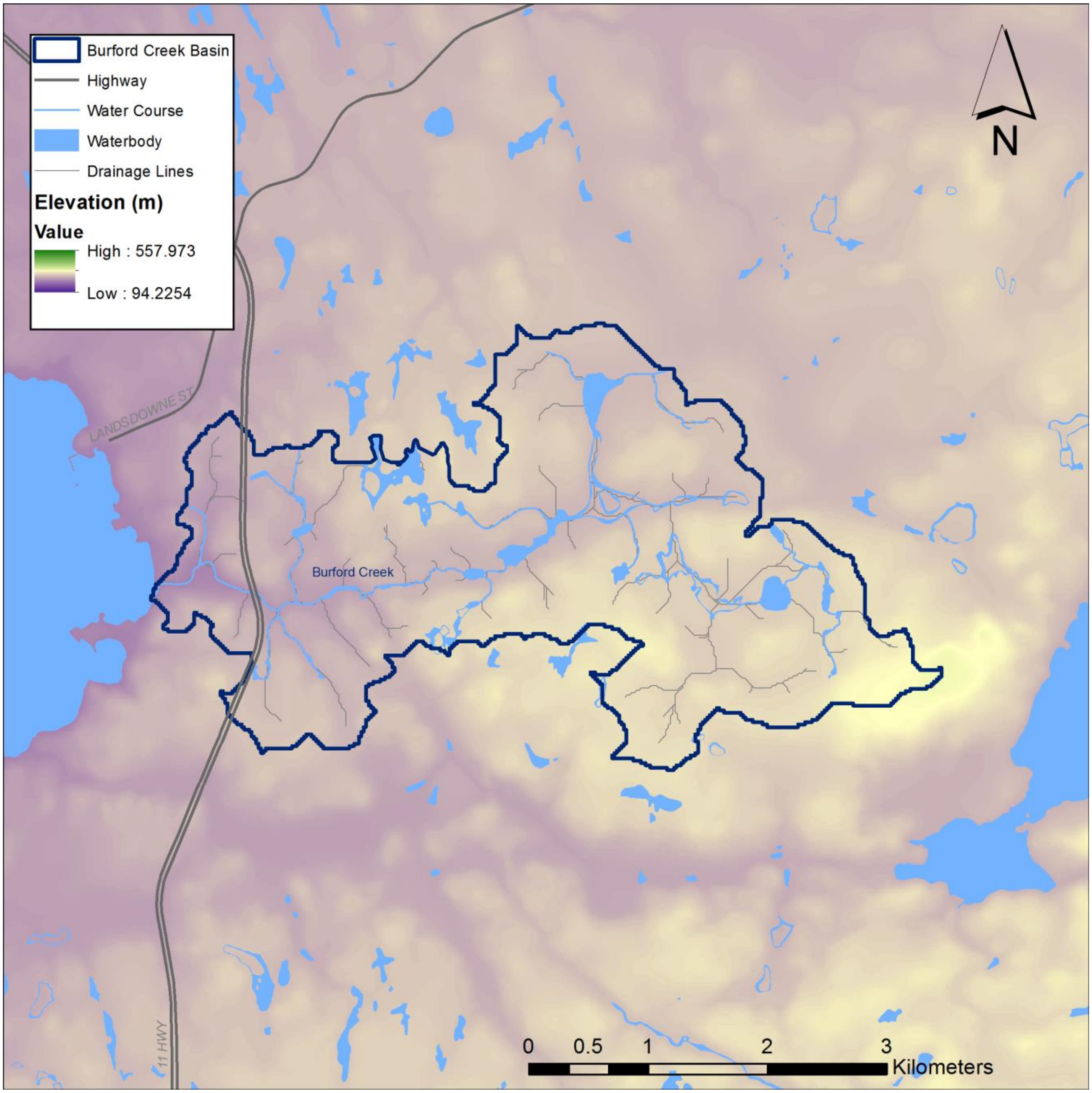
- Windsor/Boulder/Bear subwatershed Vulnerability to Land Use Change is ranked as Low

14.2.8 Burford Creek Subwatershed

General Description

The Burford Creek subwatershed is a smaller drainage system that mainly drains from the Municipality of East Ferris and which briefly drains through Callander settlement area before discharging to Callander Bay. It forms part of the Callander Bay watershed and is part of the Callander Drinking Water Source Protection Area. This system has a total watershed area of 12.89 km^2. The basin is mainly forested, has relatively steep gradients in undulating terrain. The stream is moderately swift as it descends through the Callander settlement area to Callander Bay. The watershed has moderate to high drainage efficiency with considerable bedrock outcrops, extensive wetland areas and thin soil cover. It originates in a small thickened glacial contact deposit in its headwaters near Lake Nosbonsing. Headwaters are unsettled with peripheral agricultural and rural residential uses in East Ferris. The central watershed has extensive wetland coverage. There are several small open water areas that could either be classified as ponds or open water marsh. The portion of the Burford Creek watershed in the Municipality of East Ferris is outside of the NBMCA's core area of jurisdiction but is within the NBMCA Drinking Water Source Protection Area. Basin specific information for this system is limited compared to other watersheds. The Burford Creek subwatershed shape and drainage patterns are illustrated in Figure 14.16 and basin features are illustrated in Figure 14.17.

Figure 14.16 Burford Creek Subwatershed Basin Characteristics

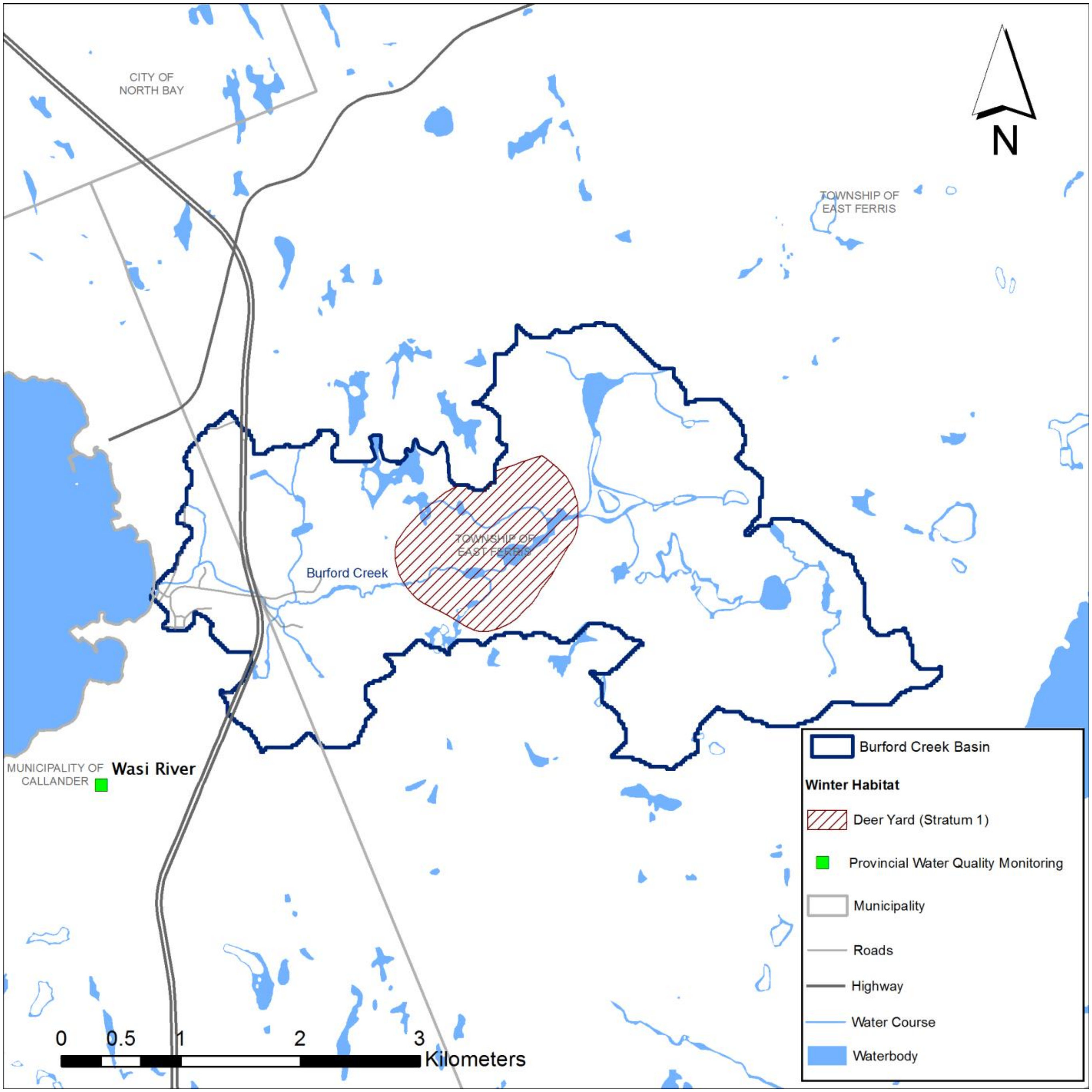


Supporting Studies

Gartner Lee Limited, Source Water Protection Planning – ***North Bay-Mattawa Source Water Protection Area Conceptual Water Budget***, prepared for the North Bay-Mattawa Conservation Authority, April 2008.

Hutchinson Environmental Sciences Ltd, ***Callander Bay Subwatershed Phosphorous Budget***, prepared for the North Bay-Mattawa Conservation Authority, February 2011.

Figure 14.17 Burford Creek Subwatershed Features



Hutchinson Environmental Sciences Ltd, ***Callander Drinking Water Source Protection Technical Studies Update***, prepared for the North Bay-Mattawa Conservation Authority, May 2010.

Waterloo Hydrogeologics Inc in association with Tunnock Consulting Ltd., ***NBMCA Groundwater Study Report***, January, 2006.

Data Available

- No long term basin specific data is available.

Major Water Bodies

- None
- Minor water bodies – Several larger ponds/open water wetlands that do not have names

Development Pressure

- Limited Rural Residential development in Callander and East Ferris.
- Burford Creek briefly flows through the Callander Urban Service Area before reaching Callander Bay

Fishing Pressure

- Unknown – Burford Creek is considered to be a warm water aquatic habitat stream

Recreational Pressure

- None identified

Watershed Drainage Shape/Slope/Efficiency

- Burford Creek has limited open water areas (5.0 %)(Hutchison 2011 also calculated 4.9%); but it has abundant wetland areas (19.1 % of total watershed) (Hutchinson 2011 reported 36.3% wetland area for Burford Creek)
- Burford subwatershed has high basin relief, high main channel steepness and high drainage density (Burford is the steepest subwatershed in the Lake Nipissing basin)
- Basin calculations suggest that this watershed has medium to high drainage efficiency.

Runoff/Estimated Water Balance (if system is gauged)

- Burford Creek is not gauged and long term data is not available
- Hutchinson Environment (2010) has developed hydrologic information (watershed area is not the same)

Tributary ID	Period of Data	Watershed Area	Mean Discharge	Discharge Volume	Depth of Runoff
Burford Cr	May–Aug 2009	12.7 km^2	0.11 m^3/s	1.16 m^3 X 10^6	90 mm/4 mths

Water Use

- No permits to take water have been issued for the Burford Creek subwatershed

Hazards Identification

- No hazard land information has been developed for this subwatershed

Floodplain Regulation

- The floodplain of Burford Creek, where flood lines have not been defined, is regulated under the Provincial One Zone Policy. Policy interpretation may require an independent floodplain study. Policy interpretation in the Municipality of East Ferris would be the responsibility of the Province.

Water Quality Indicators

Limited water quality data is available. The following information is summarized from Hutchinson (2011) for Burford Creek:

Tributary ID	Parameter	Year	Number of Samples	Mean µ/L	Min µ/L	Max µ/L
Burford Cr	Total Phos	2010	5	**37**	**22**	**47**

- 5 – 6 % of the Total Phosphorous Loading to Callander Bay is from the Burford Creek subwatershed (Hutchinson 2011)
- Based on limited data Burford Creek would be classified as Mesotrophic

Developed/Settled Areas as % of watershed

The Burford Creek subwatershed is mainly undeveloped with rural development restricted to areas with roadway access near the lower main channel and near Derland. Limited watershed development is expected in next 25 years.

Significant Features

- Deer Habitat
- Potential or known Species at Risk

Previously Identified Management Issues

- Total Phosphorous Loading to Callander Bay

Headwater Management Concerns

- Wetland Protection
- Headwater Development
- Stormwater Management
- Agricultural Runoff
- Protection of Species at Risk

Drinking Water Source Protection Constraints

- This subwatershed is affected by the Source Protection Plan developed for the Municipality of Callander Drinking Water system which source water from Callander Bay. Best management practices and restriction are identified for the greater contributing area which includes all drainage systems entering Callander Bay including the Burford Creek subwatershed.

Management/Stewardship

- None specific for the subwatershed
- Drinking Water Source Protection is overseen by a local Source Protection Committee

Vulnerability/Sensitivity to Climate Change

- Burford Creek subwatershed Vulnerability to Climate Change is ranked as Low
- Burford Creek Sensitivity to Climate Change is ranked as Low

Vulnerability to Land Use Change

- Burford Creek subwatershed Vulnerability to Land Use Change is ranked as Very Low

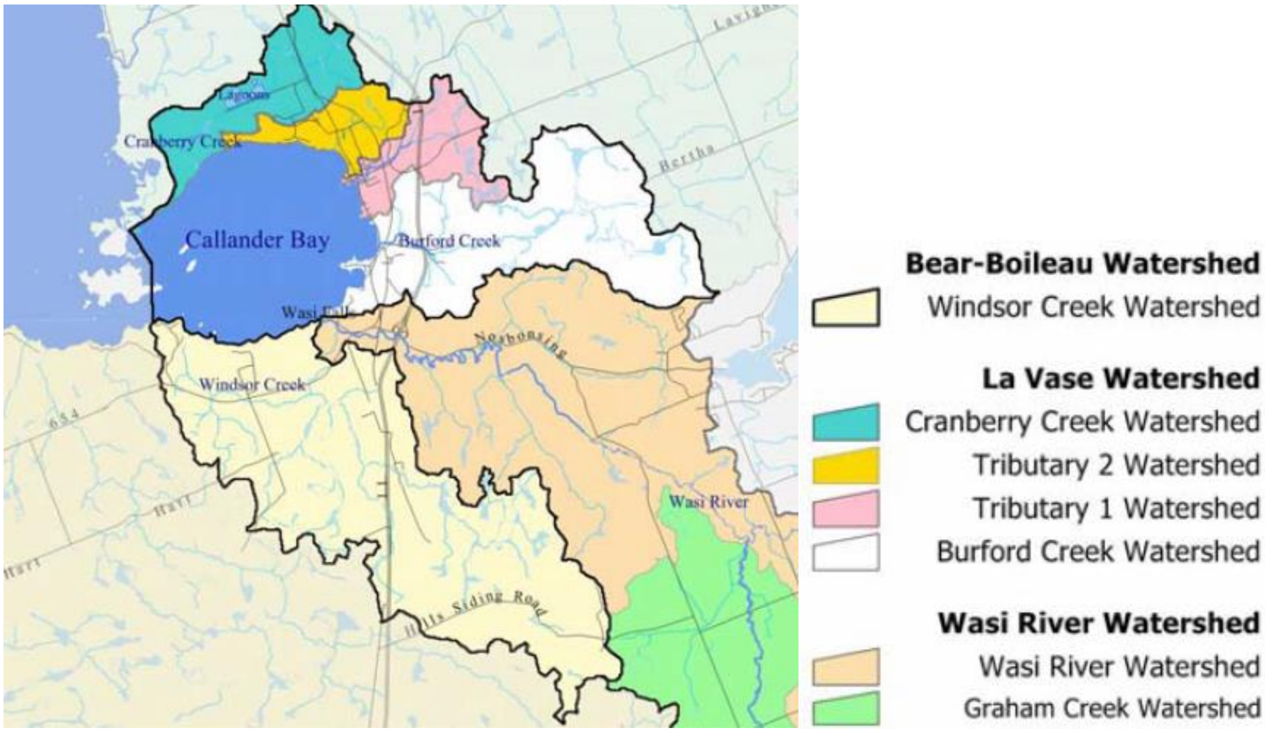
14.2.9 Callander Bay/South Shore Subwatershed

General Description

The Callander Bay/South Shore subwatershed is the compendium of the remaining small drainage systems not included in other subwatershed draining through the Municipalities of Callander, East Ferris and a small portion of North Bay to Callander Bay or to the south shore of Lake Nipissing. The south shore of Lake Nipissing within the study area extends from the mouth of Callander Bay to the mouth of Bear Creek including lands draining from the Municipality of Callander and part of Nipissing Township. Management interests are focused on the lands that drain to Lake Nipissing, the immediate shoreline of the lake and; from those systems that directly affect it; the management of Callander Bay. This subwatershed includes several catchments that have been identified in the Callander Drinking Water Source Protection Area including Cranberry Creek which flows though the Callander Bay Marsh (also referred to as Callander Creek), Tributary 1 (northern Callander settlement area including Osprey Links Golf Course) and Tributary 2 (central Callander settlement area including Derland) as defined by Hutchinson, 2011. These drainage areas are illustrated in Figure 14.18.

The Callander Bay/South shore subwatershed has a total area of 64.86 km^2 (not including Lake Nipissing) and has moderate relief (note that the south shore of Callander Bay has a relatively abrupt shoreline). The land portion of this subwatershed has minimal open water but

Figure 14.18 Small Callander Bay Drainage Areas as Defined in the Source Water Protection Plan



Source: Excerpted from Hutchinson, 2011 (not fully shown)

considerable wetland coverage. Most management efforts are focused on improving the water quality of Callander Bay which is considered mesotrophic. Callander Bay management concerns are mainly driven by it being the source of the municipal water for the Municipality of Callander. Callander Bay has encountered recent algal blooms that have been dominated by Cyanobacteria species (commonly known as blue green algae) which can create health concerns if water containing cyanotoxins are consumed. Limited environmental or land use issues have been identified for the south shore of Lake Nipissing within the Municipality of Callander. By implication management issues identified for the North Bay Lake Nipissing shoreline may also have relevance to this subwatershed. Historically Callander Bay was a popular lumbering area with a major mill on the north shore and a jack ladder at Wasi Falls.

Management concern identified in the Callander Official Plan for this subwatershed includes stormwater management and the impact of shoreline development on Callander Bay. Callander Bay is interpreted to be at capacity and policies in the Callander Official Plan discourage new shoreline lot development on Callander Bay with private services. The Municipality of Callander has limited underground stormwater infrastructure (limited to Main Street and the Osprey Links subdivision (Hutchinson, 2010) and most urban stormwater reaching Callander Bay is through overland flows. Cranberry Creek drains the Callander Sewage Lagoons to Callander Bay when discharged. Most of the nutrient loading to Callander Bay, however, is from Callander Bay's largest receiving subwatershed – the Wasi River System.

Callander Bay has a total water surface area of 12.06 km^2 (which is 1.38 % of the total Lake Nipissing water surface area) and it reaches a depth of 10.2 m at its deepest point. It is sheltered from the main lake and has a more limited fetch. Callander Bay does not stratify in the summer and has naturally high nutrient levels due to its geology, naturally high loading from surrounding subwatersheds, and isolation from the main lake. Currents in Callander Bay were investigated by Northland Engineering in 1993 to help determine the best location for the Callander municipal water intake. A water quality model developed to predict the zones of the lake that would be affected by bacteriological loading (from the Wasi River and Cranberry Creek – which is the lagoon outfall) determined that the existing location is most isolated from these loading points. The Callander Bay/South Shore subwatershed shape is illustrated in Figure 14.18 and basin features are illustrated in Figure 14.20.

Supporting Studies

Acres International Ltd, ***Sturgeon River/Lake Nipissing/French River Watershed Management Plan***, prepared for the Sturgeon-Nipissing-French Water Management Advisory Board and the Ministry of Natural Resources, 1992.

Acres International Ltd, ***Lake Nipissing/French River Operational Guidelines,*** prepared for Public Works and Government Services Canada, 1995.

AECOM, ***Paleolimnology of Callander Bay***, Lake Nipissing, prepared for the North Bay-Mattawa Conservation Authority, October 2009.

Gartner Lee Limited, Source Water Protection Planning – ***North Bay-Mattawa Source Water Protection Area Conceptual Water Budget***, prepared for the North Bay-Mattawa Conservation Authority, April 2008.

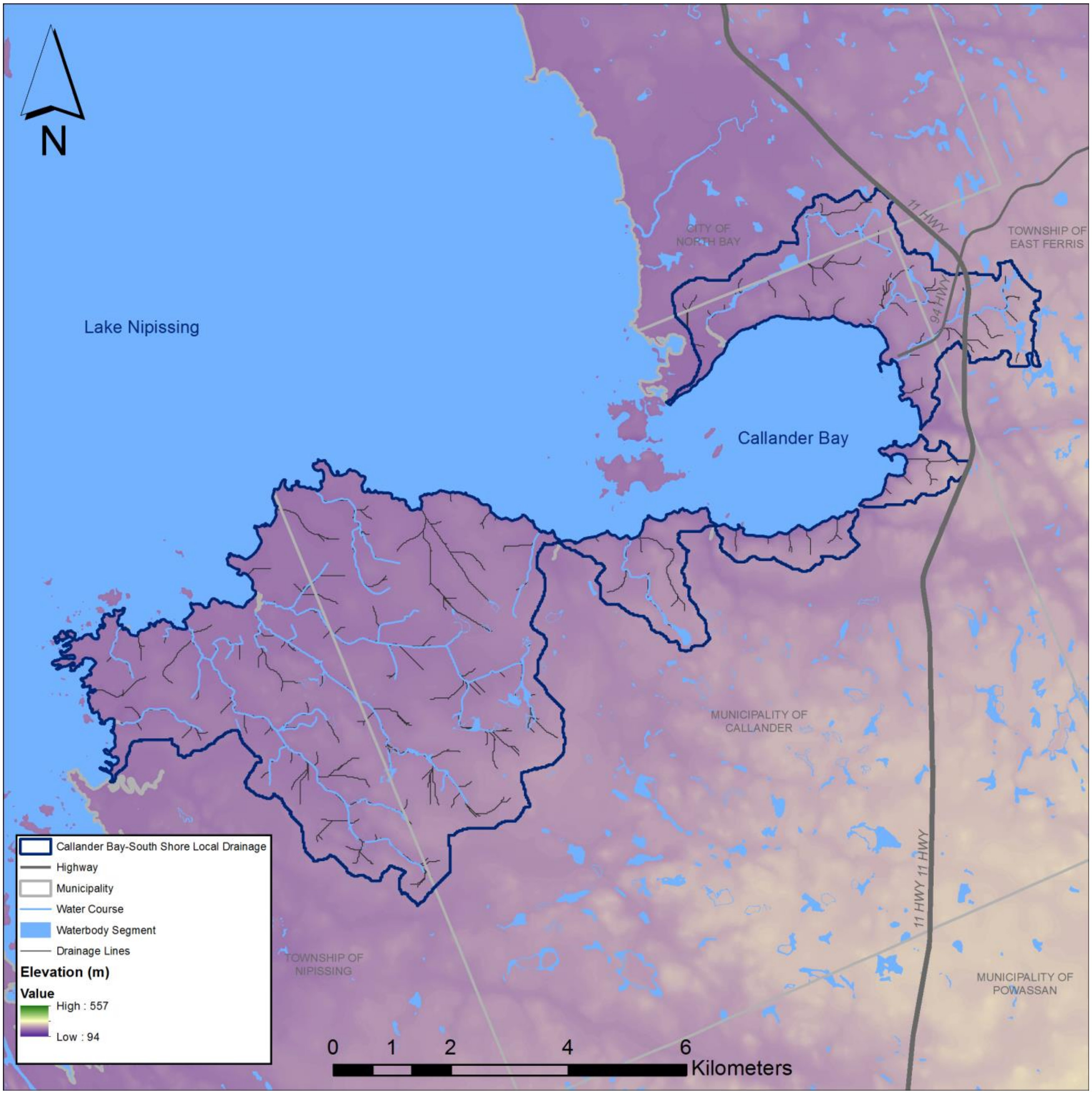
Hutchinson Environmental Sciences Ltd, ***Callander Bay Subwatershed Phosphorous Budget***, prepared for the North Bay-Mattawa Conservation Authority, February 2011.

Hutchinson Environmental Sciences Ltd, ***Callander Drinking Water Source Protection Technical Studies Update***, prepared for the North Bay-Mattawa Conservation Authority, May 2010.

MacLaren Plansearch and Lavalin, ***Flood Reduction Study of the Sturgeon River/Lake Nipissing/French River System, Summary***, report to Ontario Ministry of Natural Resources and Environment Canada, September 1981. Background Reports are also available:

- Technical Volume 1: Background Studies, September 1981.
- Technical Volume 2: Analysis of Existing System and Development of a Management Plan, September 1981.

Figure 14.19 Callander Bay/South Shore Subwatershed Basin Characteristics



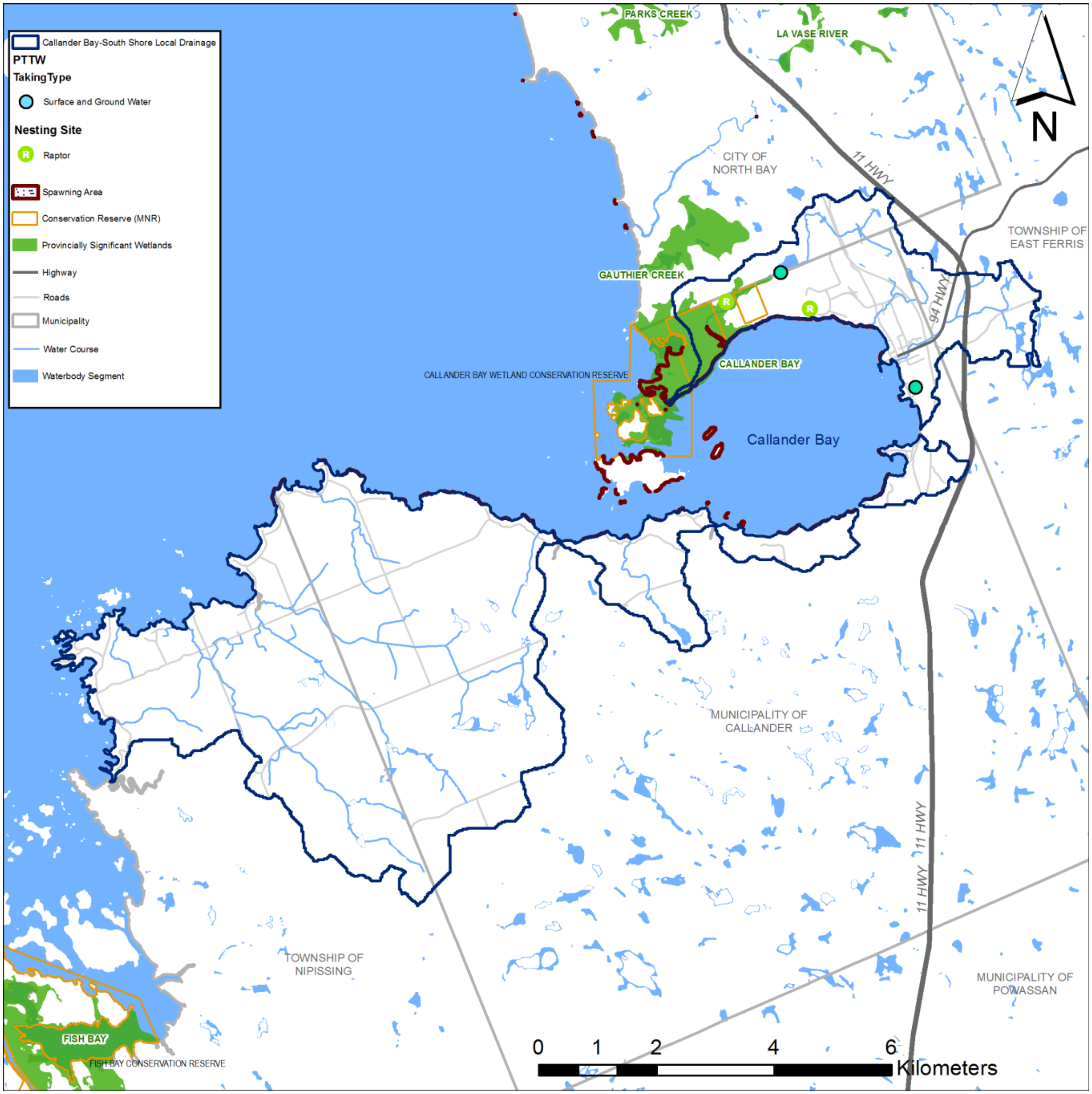
NAR Environmental, ***Callander Bay Water Quality Review***, prepared for the Lake Nipissing Partners in Conservation, 2002.

NBMCA, ***The La Vase River/Callander Bay Study***, 1989.

Northland Engineering Ltd., ***Callander Bay Water Quality Model,*** December, 1993.

Ontario Ministry of Environment, ***The Chemical Water Quality of Lake Nipissing 1988 – 1990***, prepared by MOE Dorset Research Center, February 1992.

Figure 14.20 Callander Bay/South Shore Subwatershed Features



Ontario Ministry of Environment, ***The Chemical Water Quality of Lake Nipissing 2002 – 2002***, prepared by the MOE Dorset Environmental Science Inland Lake Group, December 2010.

S. A. Kirchhefer Ltd, Review and Implementation of Recommendations of the Sturgeon River, Lake Nipissing, French River System, prepared for the Ontario Ministry of Natural Resources, March 1984.

Waterloo Hydrogeologics Inc in association with Tunnock Consulting Ltd., ***NBMCA Groundwater Study Report***, January, 2006.

Data Available

- Water Quality data from 2010 MOE Report that identifies 26 sampling locations in main part of Lake Nipissing of which 3 are in close proximity to the North Bay shoreline and 1 is in Callander Bay (Data was collected between 2003 and 2004)
- HYDAT Water Level Gauge at Government Dock (Kings Landing) at North Bay Waterfront (1933 – present)
- Callander Bay current data/water quality model from 1993 developed by Northland Engineering
- Data gathered in support of the Callander Bay Source Water Protection Plan and follow up studies identified above
- Wetland Evaluation – Callander Bay Marsh (1993)

Major Water Bodies

- Lake Nipissing/Callander Bay
- Minor water bodies – None

Development Pressure

- Significant expansion of the urban area within Callander settlement area in the Tributary 1 and Tributary 2 basins is expected in the next 25 year including continued development in the Osprey Links subdivision and infilling in the downtown
- Significant sections of the Callander Bay shoreline and the south shore shoreline are developed. Development is expected to continue along the Callander Bay/South shore waterfront from new development on existing vacant lots and from conversion of seasonal uses to permanent uses. There are number of resorts along the shoreline within this subwatershed. The number of Resorts is expected to slowly decline.
- Steady rural growth in this subwatershed is expected through rural residential infilling and expansion of hobby farms especially adjacent to the south shore.

Fishing Pressure

- Significant – Callander Bay is part of Ministry of Natural Resources Fisheries Management Zone 11.

Recreational Pressure

- Callander Bay/Lake Nipissing is used extensively for Boating/Sailing/Fishing in the summer and for snow mobility/ice fishing in the winter period. Resorts along the shoreline are sustained by these water related activities

- The Municipality of Callander provides park and beach access to Lake Nipissing including beaches used for public swimming
- Kate Paceway is a popular 12.8 km trail system that extends from the North Bay Waterfront to Callander's municipal boundary. This trail system ends at Cranberry Road at the edge of the Osprey Links development.
- Callander Bay Marsh has been protected as a Provincial Conservation Reserve. A trail has been developed along the Cranberry Road by the Municipality that provides access to the wetland.

Watershed Drainage Shape/Slope/Efficiency

- Basin characteristics have not been investigated in detail (not a distinct watershed). The drainage area has 1.6% water coverage which is ranked as low as well as a low drainage density.

Lake Level Information (if system is gauged)

- The 1:100 year flood plain of Lake Nipissing is calculated to be 197.25 m.a.s.l. including wind tilt and wave uprush.
- The reported normal summer elevation of Lake Nipissing is 195.83 m.a.s.l. (Acres, 1981)(Northland Engineering, 1982)
- The summer operating range of Lake Nipissing is 195.75 to 195.95 m.a.s.l. between May 15th and October 1st every year.
- The lake is drawn down over the winter period. The lake drawn down target is 194.5 m.a.s.l. between March 15th and April 15th. Historic practice is to stay slightly above this level if normal or light freshet conditions are expected. Also winter drawdown can be inhibited by the discharge capacity of Lake Nipissing Dams at low water elevations.
- HYDAT reports that the highest recorded daily water level at the North Bay water level gauge was 196.935 m.a.s.l. on June 23, 1947.
- HYDAT reports that the lowest recorded daily water level at the Lake Nipissing at North Bay water level gauge was 194.307 m.a.s.l. on Apr 20, 1975

Water Use

- Permits to Take Water (surface water) have been issued to the Municipality of Callander to draw water from Callander Bay for municipal drinking and to the Osprey Links Golf Course for irrigation.

Hazards Identification

Lake or Tributary	Flood Plain/Fill Line Mapping	Regulatory Event	Regulatory Level Available	Information Source/Date	Channelization
Lake Nipissing	Flood Plain Mapping	1:100 yr	197.25 m*	MacLaren Plansearch Inc, 1982	

*** The MacLaren Plansearch 1:100 yr flood level for Lake Nipissing includes wind tilt and wave uprush. The 1:100 yr static elevation calculated by MacLaren in 1982 was 196.94 m. Recent work completed by Public Works and Government Services Canada for the reconstruction of the Big Chaudière Dam on Lake Nipissing identified 196.8 m as the 1:1000 yr static flood elevation. This elevation is lower than the MacLaren 1:100 yr static elevation (which correlates with the 1947 flood level reported at the Lake Nipissing North Bay HYDAT gauge and is the highest elevation on record).**

- No hazard land information exists for sub-basins draining to Lake Nipissing in this subwatershed

Floodplain Regulation

- The Lake Nipissing floodplain in the Municipalities of Callander and Nipissing is regulated pursuant to the Provincial Large Inland Lake Policy. Policy interpretation in Nipissing would be the responsibility of the Province.
- The floodplain of systems flowing to Lake Nipissing in this subwatershed, where flood lines have not been defined, is regulated under the Provincial One Zone Policy. Policy interpretation may require an independent floodplain study. Policy interpretation in East Ferris and Nipissing would be the responsibility of the Province.

Water Quality Indicators

- Limited water quality data if available for small systems draining to Lake Nipissing with the exception of information for the small tributaries draining to Callander Bay identifies as Cranberry Creek, Tributary 1 and Tributary 2 in Source Water Protection documentation. Cranberry Creek receives periodic discharges from the Callander municipal waste water treatment facility (in spring and fall). Specific data for these systems was not reported but the contribution of Total Phosphorous to Callander Bay from these three systems is estimated to be between 6 and 7 % of total loading (Hutchinson, 2011)
- Lake Nipissing off of the south shore of the Municipality of Callander, west of Callander Bay is rated as mesotrophic (using the Canadian Framework for the Management of Phosphorus in Freshwater Systems 2004). Callander Bay is meso-eutrophic and considered at capacity by MOE. A study prepared for the Lake Nipissing Partners in Conservation by NAR Environmental concluded:

While Lake Nipissing was classified as mesotrophic or moderately enriched (TP ranging from 10 to 20 ug/L), Callander Bay reported eutrophic or enriched conditions with TP greater than 20 ug/L and the occurrence of periodic algal blooms. High concentrations of chlorophyll a (11.3 ug/L), a surrogate measured of phytoplankton productivity, were recorded in the bay. Concentrations of chlorophyll a greater than 10 ug/L are classified as excessive. Water clarity, as measured by secchi disc visibility was also low. As the bay is too shallow to thermally stratify during the summer months, dissolved oxygen depletion in the bottom waters was not encountered during the survey period.

Recent sampling through MOE's Lake Partners Program (at 2 Callander Bay stations) indicates that Total Phosphorous averaged 24 µg/L (2007 – 2010)(based on 85 samples).

- Neutral to slightly alkaline pH - data for Callander Bay/south shore are reported to range between 7.1 and 8.1 pH(at MOE Station IG 9) (MOE, 2010)
- Low chlorides and conductivity – Chlorides range between 5.6 and 7.8 mg/L and Conductivity is reported as ranging between 74 and 108 µS in Callander Bay (MOE Station IG 9). Chlorides and Conductivity in Callander Bay are slightly higher than at stations near Deep Water Point and South Bay (MOE, 2010).
- A paleolimnological assessment completed by AECOM in 2009 for an 80 cm core pulled from the Callander Bay basin, which was determined to represent a period of approximately 360 years, suggests that natural Total Phosphorus levels in Callander Bay before the influence of settlement was interpreted to be approximately 16 µg/L. Between 1850 and 1950 as the area settled total phosphorous increased to an interpreted average of 20 µg/L. In the late 1940/early 1950's phosphorous loading fairly abruptly increased to an interpreted value of 30 µg/L where is has remained relatively constant since the 1950s. It has been suggested that a change in the management of water levels of Lake Nipissing after 1951 may have factored into this change (water levels have been managed at a lower level). Water quality data suggests that the model may slightly overestimate actual Total Phosphorus levels.
- DO and Temperature data are suitable for a warm water habitat – Wind mixes the lake top to bottom and Lake Nipissing does not stratify within the study area.

Developed/Settled Areas as % of watershed

The watershed is approximately 35 % developed and the watershed has potential to reach 40% development over the next 25 years.

Significant Features

- Significant Walleye Spawning including shoals off of Wasi Falls
- Nesting Sites
- Callander Bay Wetland Complex is a Provincially Significant Wetland
- Potential or known Species at Risk

Previously Identified Management Issues

- Drinking Water Source Protection
- Algal blooms/Blue-green Algae causing aesthetic impacts, and potentially producing toxins/restrictions to water potability
- Nutrient Enrichment/Bacteriological Loading/Beach Closures
- Ice Damage to shoreline structures/Warf
- Invasive Species - Spiny Water Flea
- Stormwater Management
- Septic System Re-inspection
- Navigation/Sailing/supply of Marina slips
- Recreation and Public Access
- Fishery

Headwater Management Concerns

- Wetland Protection
- Headwater Development
- Stormwater Management
- Agricultural Runoff

Drinking Water Source Protection Constraints

- This subwatershed is affected by the Source Protection Plan developed for the Municipality of Callander Drinking Water system which source water from Callander Bay. The Callander Bay Source Water Protection Plan includes policy and action strategies within the 1 km intake protection zone which affects Callander Bay and the immediate Callander Bay shoreline adjacent to the downtown. Best management practices and restriction are also identified for the greater contributing area which includes all drainage systems entering Callander Bay including Cranberry Creek, Tributary 1 and Tributary 2.

Management/Stewardship

- The operation of Dams on Lake Nipissing by Public Works Canada is overseen by a Watershed Management Advisory Committee which the NBMCA has representation on.
- Drinking Water Source Water Protection in Callander Bay is being overseen by a local Source Protection Committee
- Lake has a community group stakeholders organization: Lake Nipissing Partners in Conservation

Vulnerability/Sensitivity to Climate Change

- Callander Bay/South Shore Vulnerability to Climate Change is ranked as High
- Callander Bay/South Shore Sensitivity to Climate Change is ranked as High

Vulnerability to Land Use Change

- Callander Bay/South Shore subwatershed Vulnerability to Land Use Change is ranked as High

14.2.10 Wistiwasing (Wasi) River Subwatershed

General Description

The Wistiwasing (Wasi) River subwatershed is a large gently sloped basin that is predominantly rural. This system drains from Chisholm Township and through the Municipalities of East Ferris and Callander before discharging to Callander Bay at Wasi Falls. This 234.38 km^2 subwatershed has three main tributaries: Chiswick Creek, the main Wasi River and Graham Creek. The headwaters of the Wasi River basin are shadowed by the Almaguin Ridge and a substantial portion of this subwatershed is underlain by thick ice contact/glaciofluvial deposits that are interpreted to have high infiltration rates (Gartner Lee, 2008) . Consequently the Wasi basin has a low water yield compared to other gauged systems within the NBMCA. This system has a short period of hydrologic record that suggests a water yield of 407 mm/year above the gauge near Astorville (2008 – 2012). The Wasi River subwatershed has had considerable research completed and management issues seem fairly well defined.

The management of the Wasi system is dominated by concerns for poor water quality which is due to the basin's propensity to have naturally high nutrient levels. Identified anthropogenic inputs include agricultural milking/livestock/ use of fertilizers and dumping of liquid waste water (discussed in Section 13) as well as septic loading from systems within 300 m of open water. This watershed has poor capability to attenuate anthropogenic nutrient inputs. This system is encountering a trend of declining water quality which is counter to the trend of other subwatersheds. Nutrient enrichment is deterring the aesthetic and recreation quality of the Wasi River, its tributaries, Wasi Lake and Callander Bay.

The Wasi River Watershed Management Study, completed by the NBMCA in the mid-1980's, examined basin water quality, flooding, erosion and fisheries concerns. The Wasi system historically encountered flooding of agricultural lands, in part from bridge restrictions, which prompted agricultural drainage improvement work. The channelization of Graham Creek destabilized the system and caused extensive siltation at Wasi Falls, which is one of the main walleye spawning grounds on Lake Nipissing. Remediating stream bank erosion in agricultural areas was a main focus of the study.

Wasi Lake, a major water body within the system, is a modest, shallow, nutrient enriched lake that sustains a natural population of sauger which is a close relative to walleye. Poor water quality and oxygen depletion affects the aesthetic attractiveness of the lake and threatens the fishery (the lake is at severe risk of fish kills at times of oxygen depletion). In summer Wasi Lake is used for fishing and boating, it has a public beach and supports two tourist resorts. The lake is used for ice fishing in the winter. One controversial recommendation was to build a permanent outlet control structure on Wasi Lake to maintain a higher water level (to protect fisheries and stabilize fluctuating water levels). A number of follow up studies have been prepared that examined control structure details and there appears to be confusion over its purpose and conflict over a higher regulatory level. The study also recommended that a weir be constructed on Graham Lake which would possibly lower water levels by 0.5 m to prevent upstream flooding of agricultural lands. Both Wasi and Graham Lakes provide important water detention and storage roles. The Wasi system has numerous wetlands which were identified to have significant ecological value and to also influence hydrology (summer diurnal fluctuation in flow was determined to be caused by biological activity in headwater wetlands). Water quality management recommendations focused on agricultural loading and septic systems. Many recommendations in the Wasi River Watershed Management Study remain outstanding. The Wistiwasing (Wasi) River subwatershed basin shape and drainage patterns are illustrated in Figure 14.21 and basin features are illustrated in Figure 14.22.

Supporting Studies

AECOM, ***Paleolimnology of Callander Bay***, Lake Nipissing, prepared for the North Bay-Mattawa Conservation Authority, October 2009.

Baldwin, Faith, ***Sediment and Solute Dynamics Above and Within a Channelized Reach in a Small Agricultural Watershed: The Graham Creek***, submitted in partial fulfillment of the requirement of a degree in Honours Geography, Nipissing University, May 1986.

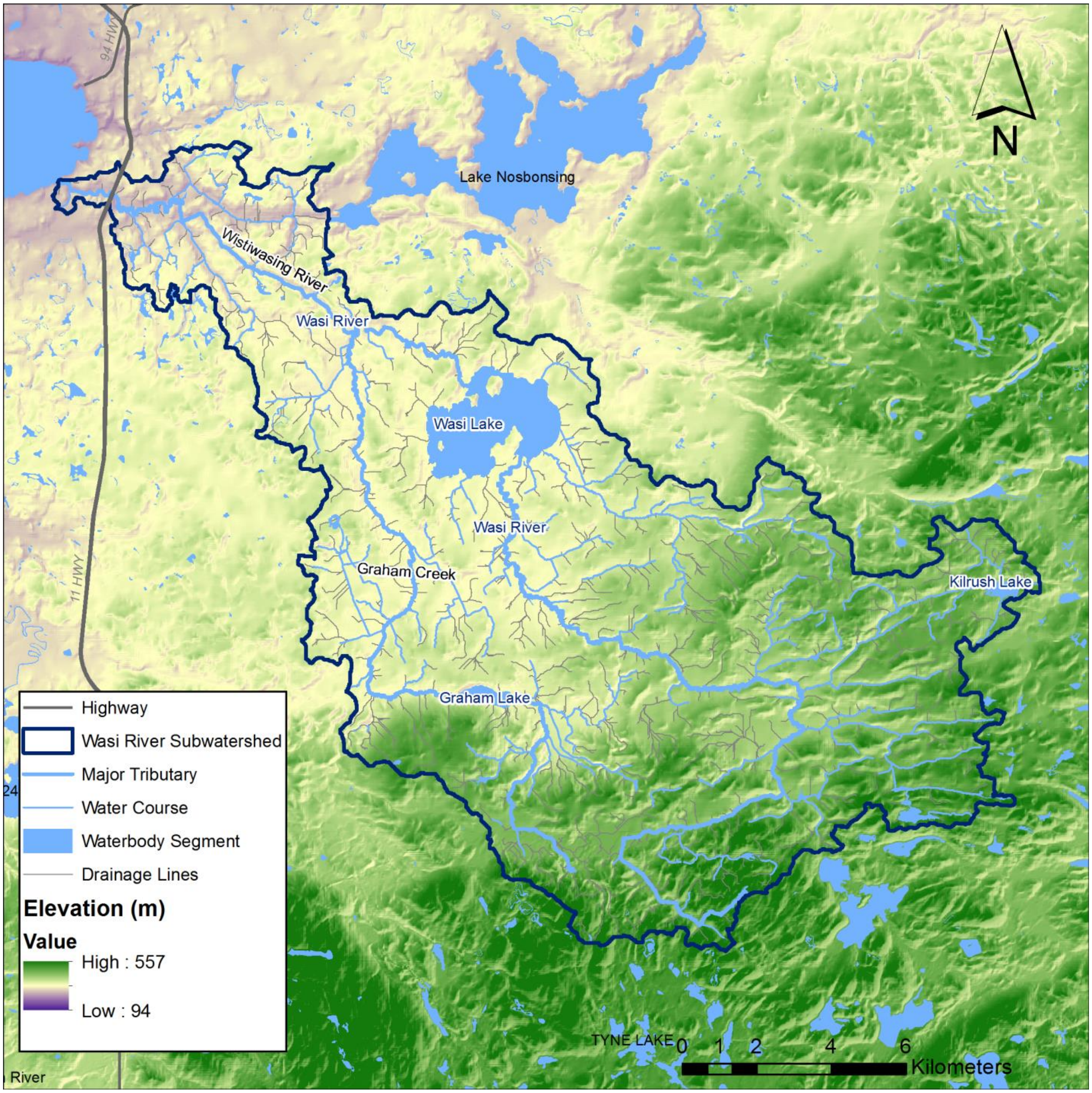
Gartner Lee Limited, Source Water Protection Planning – ***North Bay-Mattawa Source Water Protection Area Conceptual Water Budget***, prepared for the North Bay-Mattawa Conservation Authority, April 2008.

Hutchinson Environmental Sciences Ltd, ***Callander Bay Subwatershed Phosphorous Budget***, prepared for the North Bay-Mattawa Conservation Authority, February 2011.

Hutchinson Environmental Sciences Ltd, ***Callander Drinking Water Source Protection Technical Studies Update***, prepared for the North Bay-Mattawa Conservation Authority, May 2010.

Marshall Macklin Monahan, ***Project Evaluation Report, Wasi Lake Outlet: Final Draft***, prepared for the Ministry of Natural Resources – North Bay District, May 2007.

Figure 14.21 Wistiwasing (Wasi) River Subwatershed Basin Characteristics



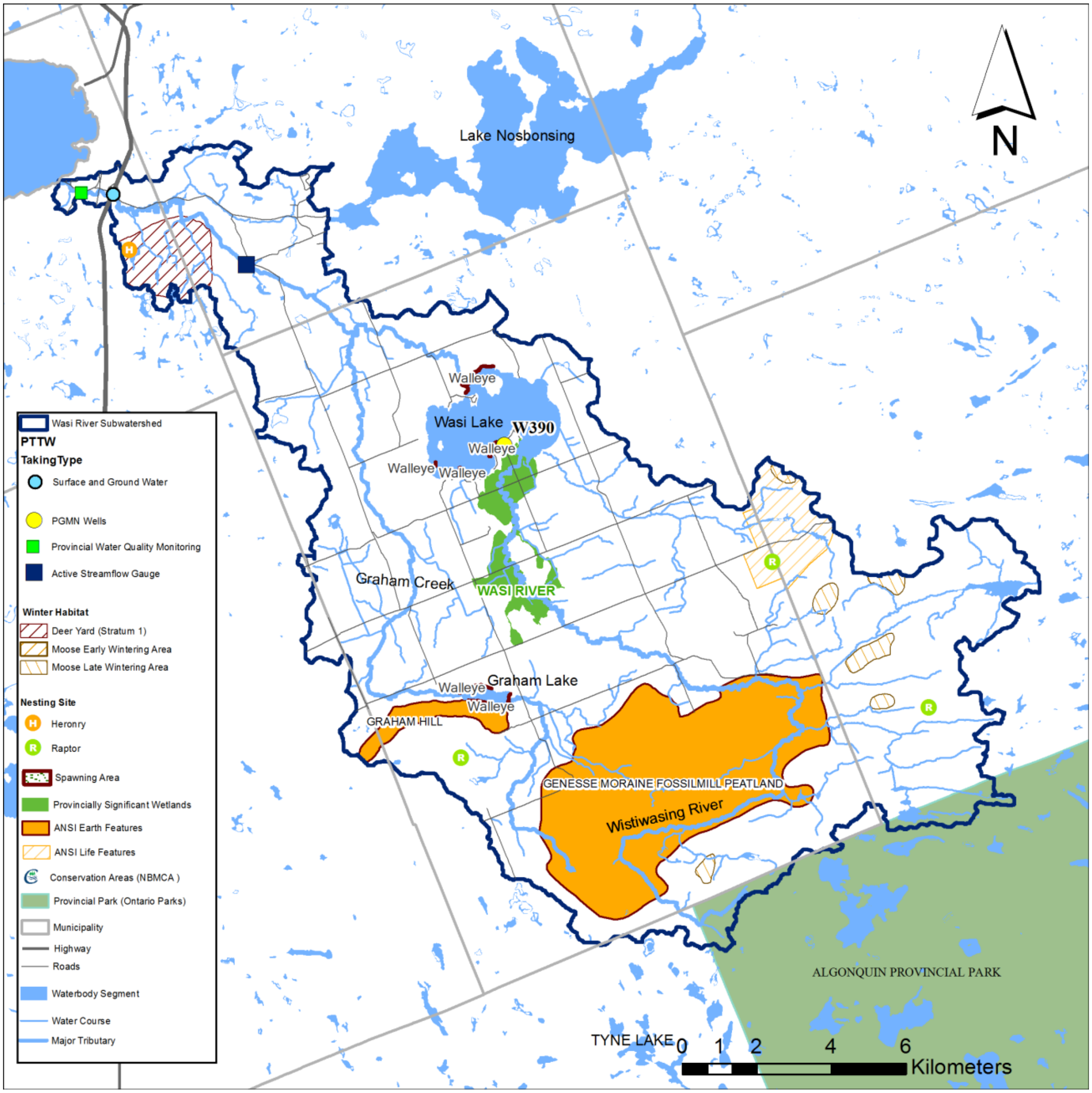
NBMCA, ***Wasi Sanitary System Survey: Summary of Results***, December 1991.

NBMCA, Wasi Watershed Wetland Inventory: Preliminary Report, Experience Program 1986.

NBMCA, ***Watershed Plan: Volume 1 - Background Inventory Document***, 1982.

Northland Engineering Ltd., ***Wasi Lake Outlet Water Control Structure***, prepared for the North Bay-Mattawa Conservation Authority, December 1991.

Figure 14.22 Wistiwasing (Wasi) River Subwatershed Features



The Environmental Application Group Ltd/A.J. Robinson and Associates Inc, ***Wistiwasing River Management Study: Final Report, Management Strategy and Master Drainage Plan***, prepared for the North Bay-Mattawa Conservation Authority, 1986. This study is supported by several background studies:

- Background Technical Report #1 Limnology and Water Quality
- Background Technical Report #2 Wetland Resources
- Background Technical Report #3 Fisheries Resources
- Background Technical Report #4 Hydrology
- Background Technical Report #5 Physical Controls

Waterloo Hydrogeologics Inc in association with Tunnock Consulting Ltd., ***NBMCA Groundwater Study Report***, January, 2006.

Data Available

- Provincial Water Quality Monitoring Stations:
  - Graham Creek at River Road (1984 – 1992)
  - Wistiwasing River at 10th Side Road (1984 – 1992)
  - Wasi River at Highway 564 (1984 – present)(sampling now done by NBMCA)
- Provincial Groundwater Monitoring Network – Chisholm (2003 – present)
- HYDAT Flow Gauge at Astorville (2008 – present)
- Data gathered for the Wistiwasing River Management Study (1986)
- Data gathered for a water control structure on Wasi Lake (various reports)
- Data gathered in support of the Callander Bay Drinking Water Source Protection Plan and follow up studies identified above
- Wetland Evaluations – various years

Major Water Bodies

- Wasi Lake

" Wistiwasing Lake is a shallow (4m), warm, dystrophic, brown-water lake fed by the upper Wasi River and Chiswick Creek and drained by the lower Wasi River. The lake has a surface area of 5.7 km^2 and a volume of 17 X 10^6 m^3. Physiographically the lake is simple, consisting of a large central basin surrounded by extensive littoral areas: almost 30% of the lake's extent is < 2 m in depth. As a consequence of its small volume, the lake water turns over quickly; estimated retention time is about 90 days. The lake outflow is controlled by an abandoned beaver dam, which extends approximately 50 m across the Wasi River, and raises Wistiwasing Lake more than 0.75 m above river stage.

Wistiwasing Lake is too shallow to stratify. However, small temperature gradients may develop between surface and deep water in summer…. Because of the large surface area exposed to insolation and rapid surface heating, these temperature differences do not persist in the face of light winds, and the lake mixes frequently, probably every few days on average, This lake has probably never been oligotrophic because of the drainage from till portions of the watershed, The management objective is clearly to control nutrient enrichment to the point that recreational values can be maintained rather than to try to attain an oligotrophic character which the lake never had."
Source: Environmental Applications Group, 1986

Marshall Macklin Monahan in 2007 identified that Wasi Lake had 160 properties with water frontage (both seasonal and permanent) and two commercial resorts. Wasi Lake is reported to have a mean annual total phosphorous concentration of **37.1 µg/L** (2007–

2009) and is considered eutrophic. This lake is considered to be at capacity by the Ontario Ministry of the Environment.
- Minor water bodies – Graham Lake

Development Pressure

- The Wasi watershed is experiencing slow growth. Gradual infilling of rural residential and uptake of hobby farming. Trends in agricultural practices are likely to have the biggest impact in the watershed in the next 20 to 25 years. Wasi has considerable aggregate reserves but forecasted mining activity in this subwatershed is undetermined.

Fishing Pressure

- Unknown

Recreational Pressure

- Wasi Lake has two commercial resort operations. Wasi Lake is also used by the residents of the area for boating and fishing. There is a public beach on the south shore of Wasi Lake – beach bacteriological loading information is not available.

Watershed Drainage Shape/Slope/Efficiency

- The Wasi River subwatershed has low open water areas (4.2%) but relatively high wetland area (9.4%) (Hutchinson, 2011 identified total wetland area at 19%).
- The Wasi River has a relatively flat main channel slope, moderate drainage density and average basin relief.
- The watershed is rated as having moderate to high drainage efficiency.

Lake Level Information (if system is gauged)

- Wasi Lake does not have an outlet control structure and consequently this has not been inventoried in Section 13 of this Background Report
- The 1:100 year floodplain for Wasi Lake is reported by MNR to be 265.67 m amsl not including any freeboard for a natural flow condition. A sandbag dam, which was removed, would have increased the 1:100 year flood levels slightly (Marshall Macklin Monahan, 2007)
- The MNR reported that the preferred summer normal elevation for Wasi Lake is 264.65 m amsl (Marshall Macklin Monahan, 2007)
- The invert of the natural outlet which controls the Wasi Lake outflows was reported by MNR to be 264.40 m amsl (MMM, 2007).

Runoff/Estimated Water Balance (if system is gauged)

- The Wasi River has the lowest water yields of all gauged systems within the NBMCA (note that the period of record for the Wasi gauge is fairly short)
- Estimated water balance for Wasi River Gauge as follows (for period of records):

Station ID	Station Name	Record Period	Gauged Area km^2	Estimated Actual Evapotransiration (mm)	Mean Annual Surplus (mm)	Projected Total Precip (mm)	NB Airport TP (mm) for same period
02DD024	Wasi River near Astorville	2007 - 2011	211.5	545	407	952	1069.0

Highest Recorded Flow	25.5 m^3/sec on Apr 1, 1998 (9 X average flows)
Mean Annual Flow	2.73 m^3/sec (2007 – 2011)
Lowest Recorded Flow	0.154 m^3/sec on Aug 31, 2010 (6% of average flows)

Water Use

- No Permits to Take Water have been issued for this subwatershed

Hazards Identification

	Flood Plain/Fill Line Mapping Studies	Regulatory Event	Regulatory Level Available	Source/Date	Channelization
Main River	**N/A**	**1:100 yr**	**N/A**		
Wasi Lake	**Flood Plain Mapping**	**1:100 yr**	**265.67 m**	**Marshall Macklin Monahan, 2007**	
Graham Creek	**N/A**	**N/A**	**N/A**		**Yes**
Graham Lake	**Elevation Only**		**278.38 m**	**A. J Robinson, 1986 pg 49**	

- The Wasi River subwatershed is supported by fill line mapping to the southern boundary of Chisholm Township

Floodplain Regulation

- The Wistiwasing River subwatershed, where flood lines or flood elevations exist, is regulated under the One Zone Floodplain Policy
- The Wistiwasing River subwatershed, where flood lines have not been defined, is regulated based on fill lines as Development Constraint Areas

Water Quality Indicators

- Considerable sampling of the Wasi System has been carried out as part of the Callander Bay Subwatershed Phosphorous Budget. The follow are average total phosphorous levels for the various outlets:

Outlet	Period	Mean Total Phosphorous	n	Source
Chiswick Creek	2009 – 2010	48 µg/L	15	Hutchinson, 2011
Upper Wasi @ Wasi L	2009 – 2010	55 µg/L	15	Hutchinson, 2011
Wasi Lake	2007 – 2009	37.1 µg/L	N/A	Hutchinson, 2011
Graham Creek	2009 – 2010	53 µg/L	13	Hutchinson, 2011
Wasi at Lake Nipissing	2003 – 2011	43 µg/L	56	PWQMN

(All readings are very high and all system are considered eutrophic)

- Neutral to slightly Alkaline pH at the PWQMN station near Wasi River mouth reported an average pH of 7.55 pH (range of 6.06 – 9.5)(PWQMN 1968 - 2011). Wasi Lake is slightly acidic with pH ranging between 6.3 and 6.8 during 1985/1986 (Environmental Applications Group, 1986)
- Low chloride and conductivity – Chlorides averaged 4.8 mg/L and range between 1.58 and 67 mg/L and Conductivity ranged between 55 and 104 µS near Wasi Rapids in 1984/85 (Environmental Applications Group, 1986)
- Nutrient levels in this system are increasing over time.
- DO near the Wasi River outlet (at PWQMN station) ranged between 5.6 and 16.78 mg/L which is suitable for warm water habitat (borderline DO exists for warm water species at warmest time of the year). A trend of declining DO is noted near the river mouth. DO and Temperature for Wasi Lake gathered for the Wasi River Watershed Study indicates that the lake experience clinograde conditions in the summer in deeper waters. DO can become limiting to aquatic life at all depths except for the immediate surface waters (three severe events were recorded in July and August 1985). Conditions fall below the level considered acceptable for the protection of aquatic organisms. The length of time these conditions persist is unknown. Fish survive by staying at the surface but the benthic community is not mobile and may be impaired by anoxia. Conditions seem to set up rapidly under calm conditions. No winter data was available.

Developed/Settled Areas as % of watershed

The watershed is approximately 19 % developed and development is very low density. Agricultural uses are prevalent in the middle watershed.

Significant Features

- Walleye Spawning
- Nesting Sites
- Area of Natural and Scientific Interest
    - Boulter Township Life Science – Provincially Significant
    - Graham Hill Earth Science – Provincially Significant
    - Genesee Moraine and Fossmill Peatland Earth Science – Provincially Significant

- Deer Yard
- Wintering/Moose Calving Area
- Provincially Significant Wetland
    - Upper Wasi River Swamp
- Potential or known Species at Risk

Previously Identified Management Issues

- Drinking Water Source Protection
- Nutrient Enrichment
- Bacteriological Loading/Beach Closures
- Water Levels on Wasi Lake and Graham Lake and need for Control Structures
- Agricultural Drainage
- Septic System Re-inspection
- Wetland Protection
- Fishery Protection in Wasi Lake
- Blue Green Algae

Headwater Management Concerns

- Wetland Protection
- Fisheries Protection (cold water habitat)
- Sustainable Forest Management Practices

Drinking Water Source Protection Constraints

- This subwatershed is affected by the Source Protection Plan developed for the Municipality of Callander Drinking Water system which source water from Callander Bay. Best management practices and restriction are identified for the greater contributing area which includes all drainage systems entering Callander Bay including the Wasi River subwatershed.

Management/Stewardship

- Drinking Water Source Protection is overseen by a local Source Protection Committee
- Wasi Lake has lakefront property owner association – Wasi Lake Property Owners and Friends

Vulnerability/Sensitivity to Climate Change

- Wasi River subwatershed Vulnerability to Climate Change is ranked as High
- Wasi River subwatershed Sensitivity to Climate Change is ranked as High

Vulnerability to Land Use Change

- Wasi River subwatershed Vulnerability to Land Use Change is ranked as High

14.2.11 North River Subwatershed

General Description

The North River is a large moderately sloped subwatershed that is predominantly forest covered. It is the second largest subwatershed in the Mattawa River system after the Amable du Fond system. This system originates in Mulock and French Townships and flows through the City of North Bay and Phelps Townships to discharges to the Upper Mattawa River near Lake Talon. The North River has considerable sinuosity. The upper North River system drains ice contact sediments and the Balsam Creek headwaters are mainly mapped as bedrock but it also has thicker glaciofluvial/sand deposit. The North River main channel near its mouth has steep gradient as the river descends from the northern uplands into the low lands.

In 1999 a new natural environment Provincial Park was established in the North River headwaters: The Widdifield Forest Provincial Park. This park protects a provincially significant Life Science ANSI due to the presence of the remnants of an old growth forest (reported to have species up to 170 years old). The watershed's outlet is located within the Mattawa River Provincial Park. This 247.77 km^2 subwatershed has two major basins: the main North River system and Balsam Creek. The North Bay fish hatchery utilizes springs in the Balsam Creek headwaters and this area has also been protected as an Area of Natural and Scientific Interest. This watershed has sparse development, the major center being Redbridge. The North River system has pockets on Crown land that are within the Nipissing Forest Management Harvesting Plans within the next harvest cycle. The North River subwatershed can only be characterized from general information as it has not been subject to focused research, in part because it is mostly unorganized with limited development. The North River subwatershed basin shape and drainage patterns are illustrated in Figure 14.23 and basin features are illustrated in Figure 14.24.

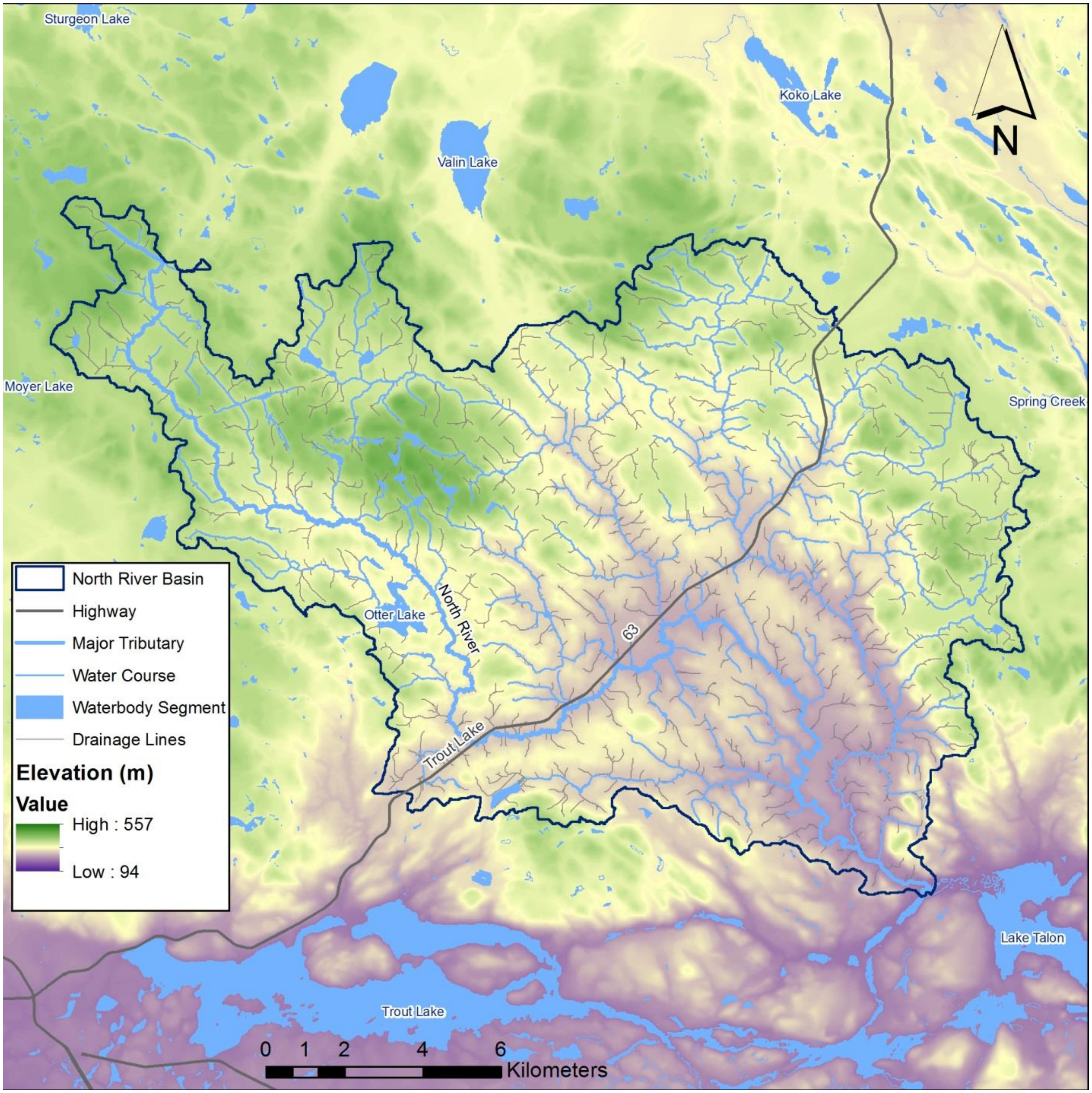
Supporting Studies

Gartner Lee Limited, Source Water Protection Planning – ***North Bay-Mattawa Source Water Protection Area Conceptual Water Budget***, prepared for the North Bay-Mattawa Conservation Authority, April 2008.

NBMCA, A Preliminary Investigation of the Factors Affecting Erosion in the North Bay-Mattawa Watershed, 1980.

NBMCA, Background Information for the Otter lake Master Plan, (1979)

Figure 14.23 North River Subwatershed Basin Characteristics

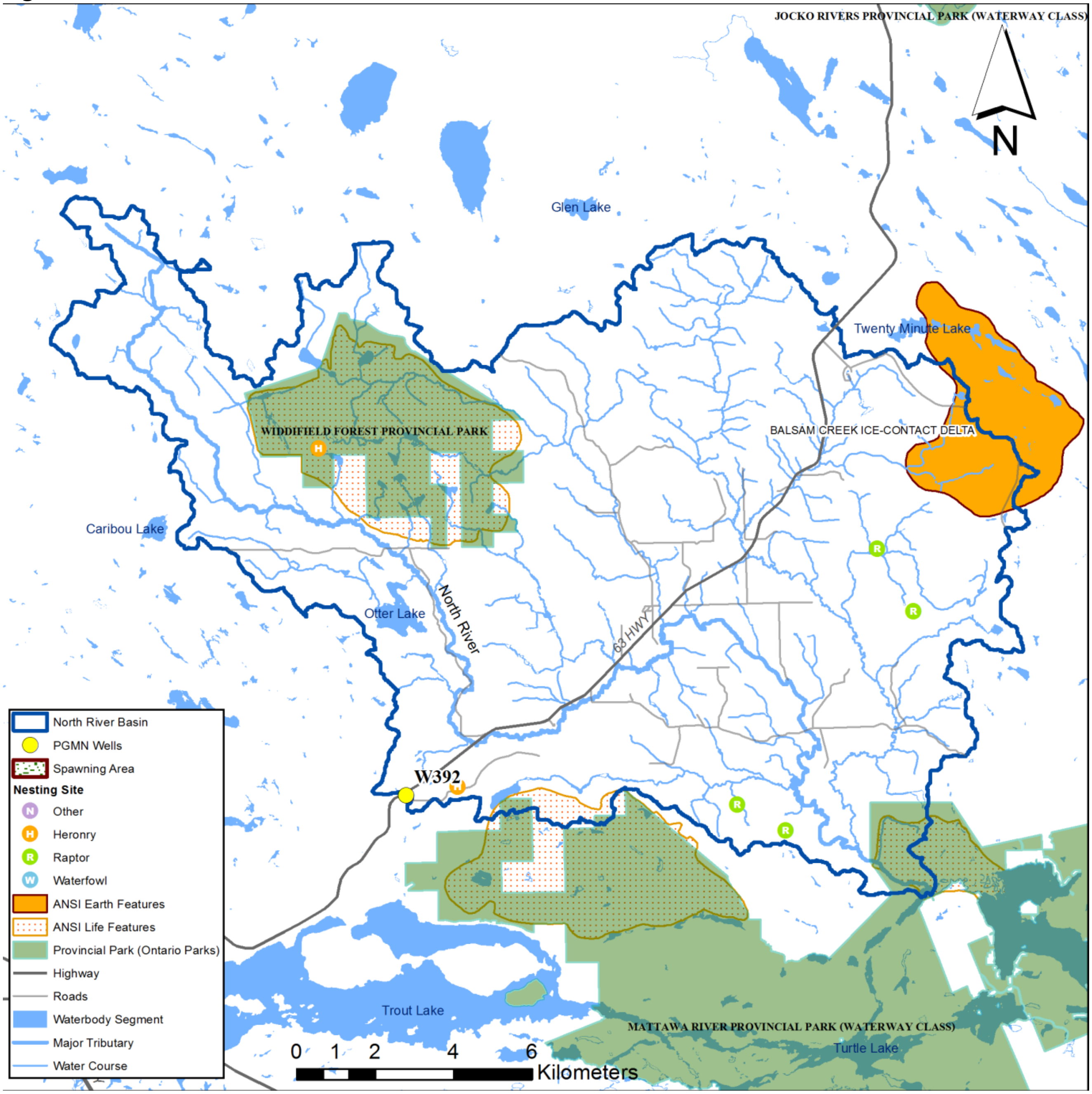


NBMCA, History of Widdifield Station and Otter Lake, 1979.

NBMCA, ***Watershed Plan: Volume 1 - Background Inventory Document***, 1982.

Waterloo Hydrogeologics Inc in association with Tunnock Consulting Ltd., ***NBMCA Groundwater Study Report***, January, 2006.

Figure 14.24 North River Subwatershed Features



Data Available

- Limited to Otter Lake Background Report

Major Water Bodies

- None
- Minor water bodies – Otter Lake, Redbridge Lake, Widdifield Lake, Little Mulock Lake, Two Mile Lake, Doule Lake, O'Kane Lake, Thirty Acre Lake

Development Pressure

- Phelps Township is encountering growth but growth rates are unknown

Fishing Pressure

- Unknown/most of the North River system is considered a cold water fishery that would be highly fished for brook trout.

Recreational Pressure

- Other than informal trails at Otter Lake, there are no formally established recreational areas in this subwatershed. The extensive crown land in this subwatershed is likely used informal for recreation pursuits including hunting, fishing, camping, four wheeling and snowmobiling

Watershed Drainage Shape/Slope/Efficiency

- The North River subwatershed has very low percentage of open water (1.6 %) and 5.8% wetland area
- The North River has moderate stream relief, average drainage density as well as average watershed relief.
- The watershed is rated as having moderate to high drainage efficiency.

Runoff/Estimated Water Balance (if system is gauged)

- No runoff/flow information is available

Water Use

- There is one Surface Water Permits To Take Water issued in this subwatershed for the purpose of Aquaculture (North Bay Fish Hatchery)

Hazards Identification

- No floodplain information has been developed for this subwatershed
- This subwatershed is fully supported by fill line mapping

Floodplain Regulation

- The North River subwatershed, where fill lines have been defined, is regulated as a Development Constraint Area in North Bay.

Water Quality Indicators

- Limited water quality data is available – Otter Lake has data available

Developed/Settled Areas as % of watershed

The watershed is less than 10% developed and development is low density.

Significant Features

- Nesting Sites
- Area of Natural and Scientific Interest
    - Widdifield Forest – Provincially Significant Life Science ANSI
    - Balsam Creek Esker – Locally Significant Earth Science ANSI
    - Rice Bay Delta Blue Mountain Complex – Provincially Significant Life Science ANSI
    - Doule Forest – Locally Significant Life Science ANSI (only the fringe of this protected area touches into the North River Watershed)
- Potential or known Species at Risk

Previously Identified Management Issues

- Privatization/Protection of Otter Lake
- Forestry/Protection of Old Growth Forests

Headwater Management Concerns

- Wetland Protection
- Fisheries Protection (cold water habitat)
- Sustainable Forest Management Practices

Drinking Water Source Protection Constraints

- There are no drinking water source protection constraints in the North River subwatershed

Management/Stewardship

- None

Vulnerability/Sensitivity to Climate Change

- North River subwatershed Vulnerability to Climate Change is ranked as Low
- North River subwatershed Sensitivity to Climate Change is ranked as Moderate

Vulnerability to Land Use Change

- North River subwatershed Vulnerability to Land Use Change is ranked as Moderate

14.2.12 Trout Lake Subwatershed

General Description

The Trout Lake subwatershed is dominated by Trout Lake which is the central watershed feature. The Trout Lake watershed consists of many small independent drainage basins that feed directly to the lake. The Trout Lake subwatershed total drainage area is 131.7 km^2. The northern half of the Trout Lake subwatershed, which originates above the North Bay-Mattawa escarpment, is characteristically well drained with steep basin gradients and swift flowing streams. Streams flowing from the North Bay escarpment include Armstrong Creek, Lees Creek, Dorans Creek, Four Mile Creek, Hogans Creek and High Creek. The southern half of the Trout Lake subwatershed is comparatively flat with low relief, poor drainage and most drainage courses are not named. The southern watershed has limited soil cover and abundant wetland areas. Trout Lake is a deep oligotrophic lake that harbours a cold water fishery including an introduced Atlantic salmon species (Ouananiche) that has successfully self-propagated. Trout Lake's surface area (22.2 km^2) is 17.8 % of the total basin area. This subwatershed has been subject to considerable research. Research has focused on the impacts of shoreline development and protection of the City of North Bay's drinking water source. Despite being on the immediate fringes of the regional center, the watershed has minimal development. The City of North Bay has attempted to limit urban growth into this basin – to protect its water supply. The east end of the basin is protected by the Mattawa River Provincial Park.

The Trout Lake subwatershed is the most studied watershed within the NBMCA area of jurisdiction. This watershed has abundant information available and watershed issues are rather complex due to the level of detail available. The degree to which this basin has been investigated has led to a high level of management/ management scrutiny and a good understanding of the status of most resource features. The Trout Lake subwatershed basin shape and drainage patterns are illustrated in Figure 14.25 and basin features are illustrated in Figure 14.26.

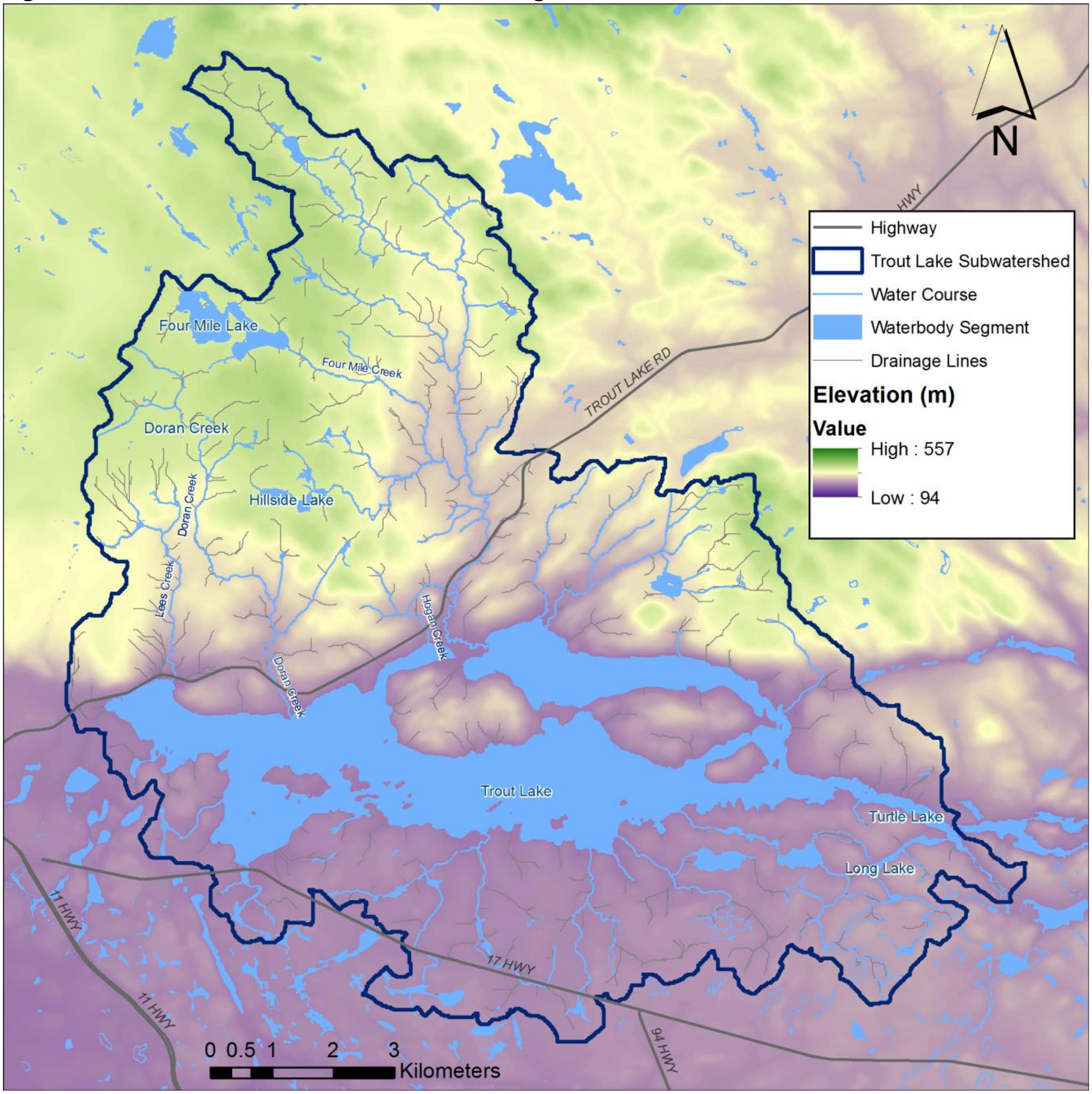
Supporting Studies

AECOM Canada Ltd, ***Surface Water Vulnerability and Threats Assessment for Drinking Water Source Protection for the City of North Bay***, prepared for the North Bay Mattawa Conservation Authority, 2010.

Aquafor Beech Limited in association with Northland Engineering Ltd and Beak International Inc, ***Lees Creek and Golf Club Creek Tributary: Subwatershed/Stormwater Management Plans***, prepared for the City of North Bay, Sept 2001.

Aquafor Beech Limited, Final Report: Delaney Bay Spills Contingency Plan, prepared for the City of North Bay, November 2001.

Figure 14.25 Trout Lake Subwatershed Drainage Characteristics

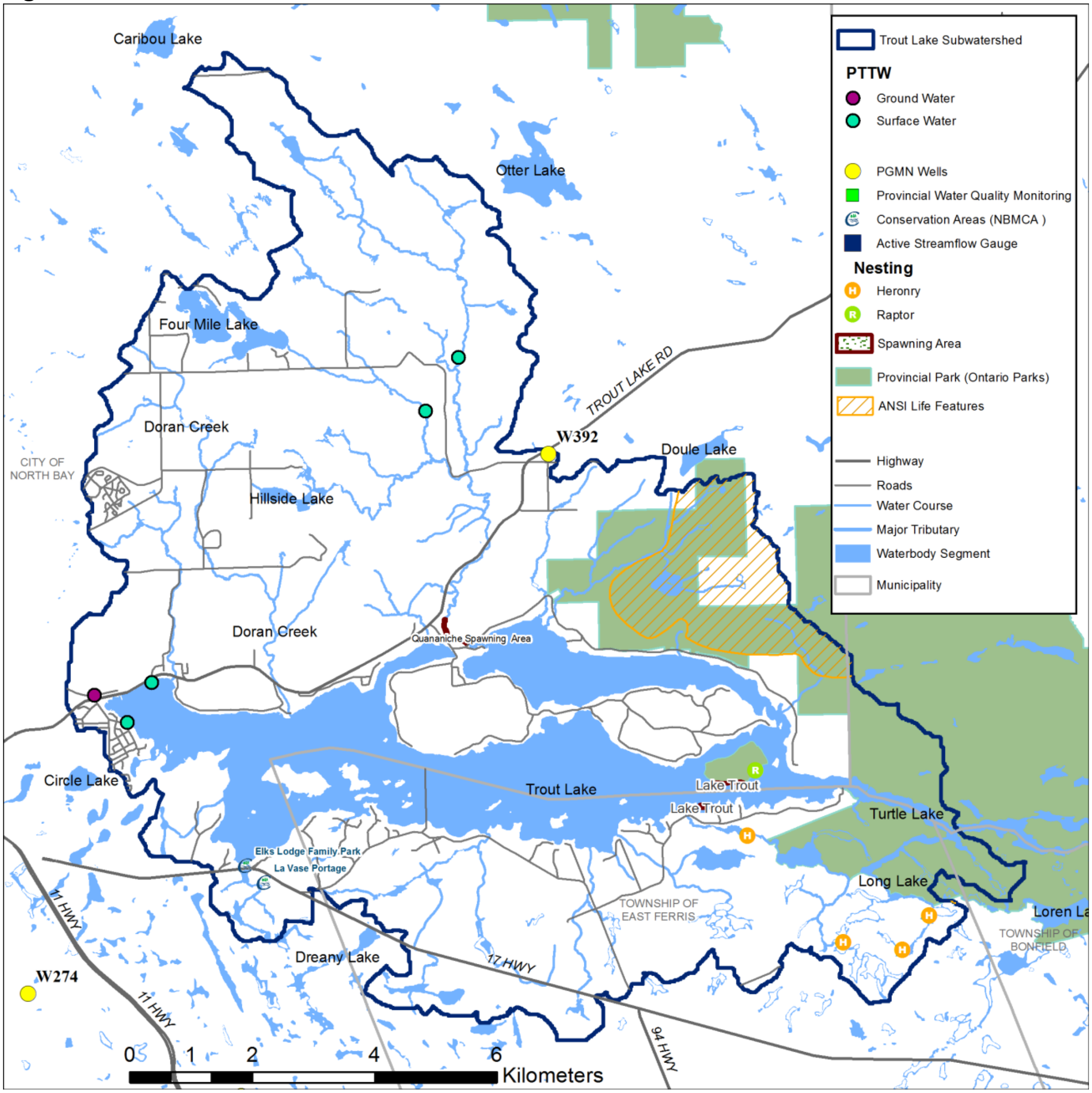


AquaResource Inc, ***Trout/Turtle Lake Subwatershed Climate Change Hydrological Impact Assessment: Memorandum***, prepared for the North Bay-Mattawa Conservation Authority, March 8, 2010a.

AquaResource Inc, ***Trout/Turtle Lake Tier Two Subwatershed Stress Assessment and Tier Three Local Area Risk Assessment***, prepared for the North Bay–Mattawa Conservation Authority, February 2010b.

CH2M Hill, ***Trout Lake Treatability Study, Conventional Treatment versus Membrane Filtration***, prepared for the City of North Bay, 2003.

Figure 14.26 Trout Lake Subwatershed Features



City of North Bay, Class Environmental Assessment to Service Anita Avenue, North Bay, Ont. With Sanitary Sewer Servicing: General Inventory Information, 1993.

Conestoga Rovers & Associates Ltd (CRA), Ecoplans Ltd, ***Trout Lake Watershed Management Study: Detailed Report***, prepared for the North Bay-Mattawa Conservation Authority, September 1988. This study has a number of Background Reports including:

- Phase I Data Collection and Synthesis
- Watershed Hydrology and Shoreline Development
- Part A: Existing Watershed Conditions
- Part B: Key Watershed Activities

- Part C: Management Strategies
- Summary and Implementation

Dawdy, Blake F., Lees Creek Floodline Mapping, Prepared for North Bay-Mattawa Conservation Authority, 1988.

Dawdy, Blake F., Four Mile Lake Regulatory Floodlines, prepared for the North Bay-Mattawa Conservation Authority, 1988.

Desormeau, Lise V., The Water Quality of Lees Creek – A Preliminary Study, Canadore College, 1984.

Fitchko, Jerry, Eakins, Robert J., and Glasgow, Alan R., Return of the Ouananiche to Trout Lake, near North Bay, Ontario, (unpublished), 1996

Gartner Lee Limited, **Source Water Protection Planning – *North Bay-Mattawa Source Water Protection Area Conceptual Water Budget***, prepared for the North Bay-Mattawa Conservation Authority, April 2008.

Gartner Lee Limited, Letter Report Re: ***Water Quality Modeling and Assessment: Trout Lake***, prepared for List Planning Ltd, April 24, 2002.

Gartner Lee Limited, ***Tier One Water Budget and Water Quantity Stress Assessment for Trout Lake Subwatershed***, prepared for the North Bay-Mattawa Conservation Authority, 2008.

Gartner Lee Limited, ***Trout Lake Surface Water Vulnerability Study for Source Water Protection***, prepared for the North Bay-Mattawa Conservation Authority, February 2007.

Green, Scott, and Marc-Andre Beaupre, Silt Spill! (A whole lake experiment) Trout Lake, North Bay, Ontario, Ecole Secondaire Algonquin, 1995.

Miller Environmental Services Inc., ***Trout Lake Parasite Study: Final Report***, prepared for the City of North Bay, 2000.

M. M. Dillon, ***North Bay-Mattawa Floodplain and Fill Line Mapping***, prepared for the North Bay-Mattawa Conservation Authority, October 1975.

NBMCA, North Bay Escarpment Erosion Report, 1997

NBMCA, Trout Lake Rainwater Water Quality Analysis for Phosphorous -1987.

NBMCA, ***Watershed Plan: Volume 1 - Background Inventory Document***, 1982.

Northland Engineering Ltd and Beak Consultant Ltd, ***Trout Lake Pollution Control Planning Study***, prepared for the Ontario Ministry of Environment, City of North Bay and Township of East Ferris, March 1989. This Study has a number of background reports including:

- Supporting Document #1 – Sewage Disposal Systems Inventory and Analysis
- Supporting Document #2 – Limnology and Hydrology Analysis
- Supporting Document #3 – Mitigating and Remedial Management Strategy
- Discussion Paper Control Measures
- Summary

Ontario Ministry of the Environment, ***The Water Quality of Trout Lake North Bay***, prepared by Northeastern Region and Laboratory Services Branch, 1979.

Ontario Ministry of the Environment, ***Trout Lake Study: Preliminary Evaluation of the Water Quality of Trout Lake***, Nipissing District, 1973.

Ontario Ministry of the Environment, ***Trout Lake - 1989 Secchi Disc-Chlorophyll A Self Help Program,*** 1989.

Ontario Ministry of Natural Resources, Letter - Subject: ***Trout Lake Water Quality Data***, written by Phil Brennan, Nipissing Area Supervisor, 1996.

Rees, David L., The Trout Lake Reservoir: A Water Balance Study, University of Ottawa, 1974.

Totten Sims Hubicki, ***North Bay Escarpment Resource Inventory and Digital Mapping***, prepared for the North Bay-Mattawa Conservation Authority and the City of North Bay, 1999.

Trout Lake Conservation Association, Level One: An Environmental Manual for the Trout Lake Watershed, 1990.

Waterloo Hydrogeologics Inc in association with Tunnock Consulting Ltd., ***NBMCA Groundwater Study Report***, January, 2006.

Data Available

- Provincial Groundwater Monitoring Network – Feronia (2003 – present)
- Water Quality data from numerous sources including:
    - Ontario Ministry of the Environment Reports, 1973, 1979, 1989
    - Ontario Ministry of Natural Resources, 1996.
    - Municipal Studies: North Bay and East Ferris – Pollution Control Plan 1989
    - City of North Bay – Studies related to Protection/Treatment of Trout Lake water
    - NBMCA/Drinking Water Source Protection Studies – work completed by staff/contract staff/students (numerous years), CRA, 1988, AquaResource, 2007, 2008, 2010

- Water Balance/Hydrology data
  - Rees, 1974
  - CRA, 1988
  - Northland Engineering 1989
  - Gartner Lee 2008
  - AquaResource 2010a, 2010b
- Fisheries
  - MNR limnological data
  - Fitchko et. al.
- Wetland Evaluations, various years

Major Water Bodies

- Trout Lake

  Trout Lake, a headwater lake of the Mattawa River, is a long deep lake that is directly connected to Turtle Lake and water levels are controlled by the dam on Turtle Lake. The lake is made up of a number bays of which Four Mile Bay is considered a separate non-interacting basin (MOE, 1979). The major inflow, Four Mile Creek, enters Four Mile Bay at its western end and consequently this bay is more rapidly flushed. The main lake has no major drainage system (other than Four Mile Bay). Trout Lake proper and Four Mile Bay have distinct chemical properties and are essentially different lakes that are hydrologically linked.

  The main body of Trout Lake which includes One Mile Bay has a total watershed area of 29.0 km^2, a water surface area of 18.4 km^2 (Northland Engineering, 1989), a mean depth of 17.21 m (MOE, 1979) and a maximum depth of 69 meters. It has an estimated volume of 28.1 X 10^7 m^3 (Northland Engineering, 1989) and an estimated flushing rate of 7.7 years (MOE, 1979). Water balance information for the main basin suggests that more water enters this basin from direct rainfall than from runoff. Annual consumptive water taking from this basin accounts for 22 % of total main lake water volume. Water is withdrawn from the hypolimnion of Delaney Bay (Miller Environmental, 2000). Withdrawals are counterbalanced by inflows from the watershed and from water movement between basins (through flow reversal).

  Four Mile Bay has a watershed area of 48.0 km^2, a water surface area of 3.8 km^2 (Northland Engineering, 1989), a mean depth of 15. 62 m and it is 34 m deep at its deepest point (MOE, 1979). It has an estimated volume of 5.0 X 10^7 m^3 (Northland Engineering, 1989) and an estimated flushing rate of 1.9 years (MOE, 1979). Water balance calculations show that most water entering this basin flows from its watershed.

The lower reaches of Four Mile Creek are utilized by Ouananiche for spawning and the spawning grounds are protected as a fish sanctuary.

- Minor water bodies – Four Mile Lake, Hillside Lake, High Lake, Long Lake

Development Pressure

- The Trout Lake subwatershed is experiencing shoreline development pressures as well as growth within its drainage basin. Trout Lake is considered to be close to capacity and new lot creation is expected to be limited within the planning horizon (new lot creation is strictly regulated). The conversion of vacant and seasonal uses to permanent uses is likely the biggest potential shoreline impact to be encountered. Watershed development is also expected from new low density rural residential lot creation and from serviced industrial development near the North Bay Airport. This watershed also has fairly extensive aggregate reserves that will be highly sought in the coming planning horizon.

Fishing Pressure

- Due to its close proximity to the major regional center Trout Lake, its tributaries and its minor lakes are subject to relatively high fishing pressure. The Lake Trout fishery in Trout Lake is restricted due to a limited natural population. Stocking of salmonid species have been curtailed to help protect natural stocks. The fishing pressure on Ouananiche is unknown.

Recreational Pressure

- The Trout Lake watershed is subject to relatively high recreational pressure due to its close proximity to the regional center. Trout Lake has several Marinas, a Trailer Park, numerous boat launches, numerous public beaches and is used extensively for boating, fishing, swimming, sailing, and canoeing in the ice free seasons and for snowmobiling and ice fishing in the winter.
- The NBMCA maintains a public beach/access on Dugas Bay – Elks Lodge Family Park
- La Vase Portage is now being restored as a publicly accessible recreational portage. A Conservation Area has been established at the northern terminus in the Trout Lake Watershed.
- The Mattawa River Provincial Park extends into the Trout Lake watershed and includes Camp Island which is used extensively for day use swimming/boating and informal camping

Watershed Drainage Shape/Slope/Efficiency

- The Trout Lake watershed has a very high percentage of open water (17.5 % - highest of all subwatersheds). The wetland areas are mainly restricted to southern half of the watershed (wetlands make up 5.6% of total watershed)

- The slope of the main channel, which would follow Four Mile Creek, is high, the watershed has a moderate drainage density and basin relief is moderate to high. There is considerable variation between north and south watersheds.
- The watershed is rated as having average drainage efficiency.

Lake Level Information

- Trout Lake water levels/outflows are not reported on a continuous basis.
- The Trout/Turtle Lake basin is maintained by MNR within a maximum and minimum water level range of 202.24 m amsl and 201.78 m amsl and a reported optimum level of 202.22 m amsl (AguaResources, Feb 2010).
- Trout Lake has a regulatory flood elevation of 202.69 m amsl (Timmins)(Dillon, 1978).

Runoff/Estimated Water Balance

- A Water Balance for the Trout/Turtle Lake Basin has been developed to consider the impact of consumptive water use as part of the Drinking Water Source Protection Plan.

Basin	Period of Data	Watershed Area	Estimated Surplus	Estimated AE	Projected TP
Trout/Turtle Lake Watershed	1975 - 2005	176 km^2	385 mm	568 mm	953 mm

Water Use

- Surface Permits to Take Water have been issued for municipal drinking water and industrial cooling (from Trout Lake) as well as agricultural irrigation from Four Mile Creek)
- Water taking from Trout Lake has been subject to considerable analysis

Hazards Identification

	Flood Plain/Fill Line Mapping Studies	Regulatory Event	Regulatory Level Available	Source/Date	Channelization
Main Lake	Flood Plain Mapping	Timmins Storm	202.69 m	Dillon 1978	
Lees	Flood Plain Mapping	Timmins Storm	Yes	Dillon 1978, B. Dawdy 1988	
Four Mile Cr	Flood Plain Mapping	Timmins Storm	Partial	Dillon 1978, B. Dawdy 1988	
Four Mile Lake	Fill Line Mapping	Timmins Storm	360.88 m	Dillon, 1978	
Hillside Lake	Flood Plain Mapping	Timmins Storm	357.04 m	Dillon, 1978	
Doran Cr[1]	Fill Line Mapping	N/A	N/A	Dillon, 1978	

1. Flood Plain Mapping available for Hazelton Subdivision

- The Trout Lake subwatershed fully is supported by fill line mapping

Floodplain Regulation

- The Trout Lake subwatershed, where flood lines or flood elevations exist, is regulated under the One Zone Floodplain Policy
- The Trout Lake subwatershed, where flood lines have not been defined, is regulated based on Fill Lines as Development Constraint Areas

Water Quality Indicators

- Trout Lake, the main water body in the Trout Lake subwatershed is oligotrophic, biologically unproductive and has low concentrations of nutrients. Four Mile Bay is limnologically isolated and has distinctiveness from the main lake by having lower alkalinity and higher colour and nutrients. Four Mile Creek experiences elevated total phosphorous loading during the summer which ranks it as meso-eutrophic (data is presented below).
- Due to its depth Trout Lake thermally stratifies during the open water season and the lake experience turnover in May and in November each year
- Recent nutrient data for the Trout Lake subwatershed are as follows:

System	Parameter	Season	Period	# Stations	Number of Samples	Mean µg/L	Max µg/L	Min µg/L
Trout Lake	Total Phos	Spring	1975 - 2011	8	188	**5.6**	20.0	1.0
Trout Lake	Total Phos	Summer	1975 - 2011	8	88	**7.8**	36.0	2.0
Four Mile Cr.	Total Phos	Spring	2002 – 2011	4	22	**8.9**	12.6	6.8
Four Mile Cr.	Total Phos	Summer	2002 – 2011	4	20	**20.5**	32.0	8.0

- The main body of Trout Lake and Four Mile Bay display the following comparative water chemistry characteristics as reported by AECOM, 2010.

Parameter	unit	Year/Period	Trout Lake (main)	Four Mile Bay
Total Phosphorous	µg/L	1996 – 2005	5.6	7.6
pH		1986	7.24 – 7.57	7.00 – 7.32
Chlorides	mg/L	1986	10.7 – 11.8	3.45 – 5.1
Conductivity	µmhos/cm	1986	84.3 – 91.4	48.8 – 51.3
Colour	TCU	1986	6.5 – 9.5	11 – 13.5
Alkalinity		1986	12.0 – 18.0	7.4 – 9.0

(All levels are considered low or normal)

- The long term nutrient status of Trout Lake is stable.
- Temperature and Dissolved Oxygen levels in Trout Lake, Four Mile Bay and in northern watershed streams are suitable to support cold water fisheries. Four Mile Lake is classified as a warm water fishery.

Developed/Settled Areas as % of watershed

The watershed is less than 10% developed with low density rural development and shoreline development. Urbanization accounts for less than 1% of the total watershed area.

Significant Features

- Lake Trout Spawning
- Ouananiche Spawning
- Nesting Sites
- Area of Natural and Scientific Interest
    - Doule Forest Life Science – Locally Significant
- Archaeological Significance along the Mattawa River/Trout Lake shoreline and the La Vase Portage
- Potential or known Species at Risk

Previously Identified Management Issues

- Drinking Water Source Protection
- Water Quality Protection
- Recreational Quality Protection
- Septic System Re-inspection
- Lake Trout rehabilitation
- Ouananiche Protection
- Camp Island/Public Use/Native Heritage Values/Protection
- Stormwater Management
- Aggregate Extraction
- Siltation
- Archaeological Significance along the Mattawa River Camp Island and at Portages

Headwater Management Concerns

- Rural Development
- Industrial Development
- Aggregate and Peat Extraction
- Stormwater Management
- Fisheries Protection (cold water habitat)
- Pit Rehabilitation
- Protection of Species at Risk

Drinking Water Source Protection Constraints

- This subwatershed is affected by the Source Protection Plan developed for the City of North Bay Drinking Water system which source water from Trout Lake. The Trout Lake Source Water Protection Plan includes policy and action strategies within the a 1 km intake protection zone which affects Delaney Bay of Trout Lake and its immediate shoreline. There are no best management practices or restriction identified for the greater contributing area.

Management/Stewardship

- Drinking Water Source Protection is being overseen by a local Source Protection Committee
- Informal Stakeholders Committee meets annual to review data and to coordinate annual field data collection
- Trout Lake has a lakeshore owners association (Trout Lake Conservation Association)
- Friends of the Mattawa River Provincial Park and Camp Island

Vulnerability/Sensitivity to Climate Change

- Trout Lake subwatershed Vulnerability to Climate Change is ranked as Moderate
- Trout Lake subwatershed Sensitivity to Climate Change is ranked as Moderate

Vulnerability to Land Use Change

- Trout Lake subwatershed Vulnerability to Land Use Change is ranked as Moderate

14.2.13 Turtle Lake Subwatershed

General Description

The Turtle Lake subwatershed is a relatively isolated basin that is often lumped in with the Trout Lake watershed for analysis purposes. It has a total watershed area of 45.08 km^2 that includes Pine Lake and Turtle Lake within its catchment. This subwatershed is dominated by these two central lakes which divides the watershed into northern and southern halves, similar to Trout Lake. This subwatershed is almost completely undeveloped – a small portion of the Loren Lake basin is accessible from Highway 17 and a small portion of the watershed at its eastern end is accessed from Pine Lake Road. A substantial portion of this drainage system is within the boundaries of the Mattawa River Provincial Park which is classed as a waterway park. A waterway park is applied to river corridors that provide canoeists with high-quality recreation and historical river travel. As a standalone subwatershed this basin has received limited study. Most data available is for the Trout/Turtle Lake basin and data separation is often difficult. The watershed has limited soil cover and the northern watershed does not reach the North Bay-

Mattawa escarpment but has significant relief. The southern watershed is relatively flat, poorly drained with extensive wetlands. The Turtle Lake subwatershed drainage patterns are illustrated in Figure 14.27 and basin features are identified in Figure 14.28.

Supporting Studies

AquaResource Inc, ***Trout/Turtle Lake Subwatershed Climate Change Hydrological Impact Assessment: Memorandum***, prepared for the North Bay-Mattawa Conservation Authority, March 8, 2010a.

AquaResource Inc, ***Trout/Turtle Lake Tier Two Subwatershed Stress Assessment and Tier Three Local Area Risk Assessment***, prepared for the North Bay–Mattawa Conservation Authority, February 2010b.

Gartner Lee Limited, **Source Water Protection Planning – *North Bay-Mattawa Source Water Protection Area Conceptual Water Budget***, prepared for the North Bay-Mattawa Conservation Authority, April 2008.

Gartner Lee Limited, Letter Report Re: ***Water Quality Modeling and Assessment: Trout Lake***, prepared for List Planning Ltd, April 24, 2002.

Gartner Lee Limited, ***Tier One Water Budget and Water Quantity Stress Assessment for Trout Lake Subwatershed***, prepared for the North Bay-Mattawa Conservation Authority, 2008.

M. M. Dillon, ***North Bay-Mattawa Floodplain and Fill Line Mapping***, prepared for the North Bay-Mattawa Conservation Authority, October 1975.

Northland Engineering Ltd and Beak Consultant Ltd, ***Trout Lake Pollution Control Planning Study***, prepared for the Ontario Ministry of Environment, City of North Bay and Township of East Ferris, March 1989. There are a number of background reports – the main one with data for Turtle Lake is:

- Supporting Document #2 – Limnology and Hydrology Analysis

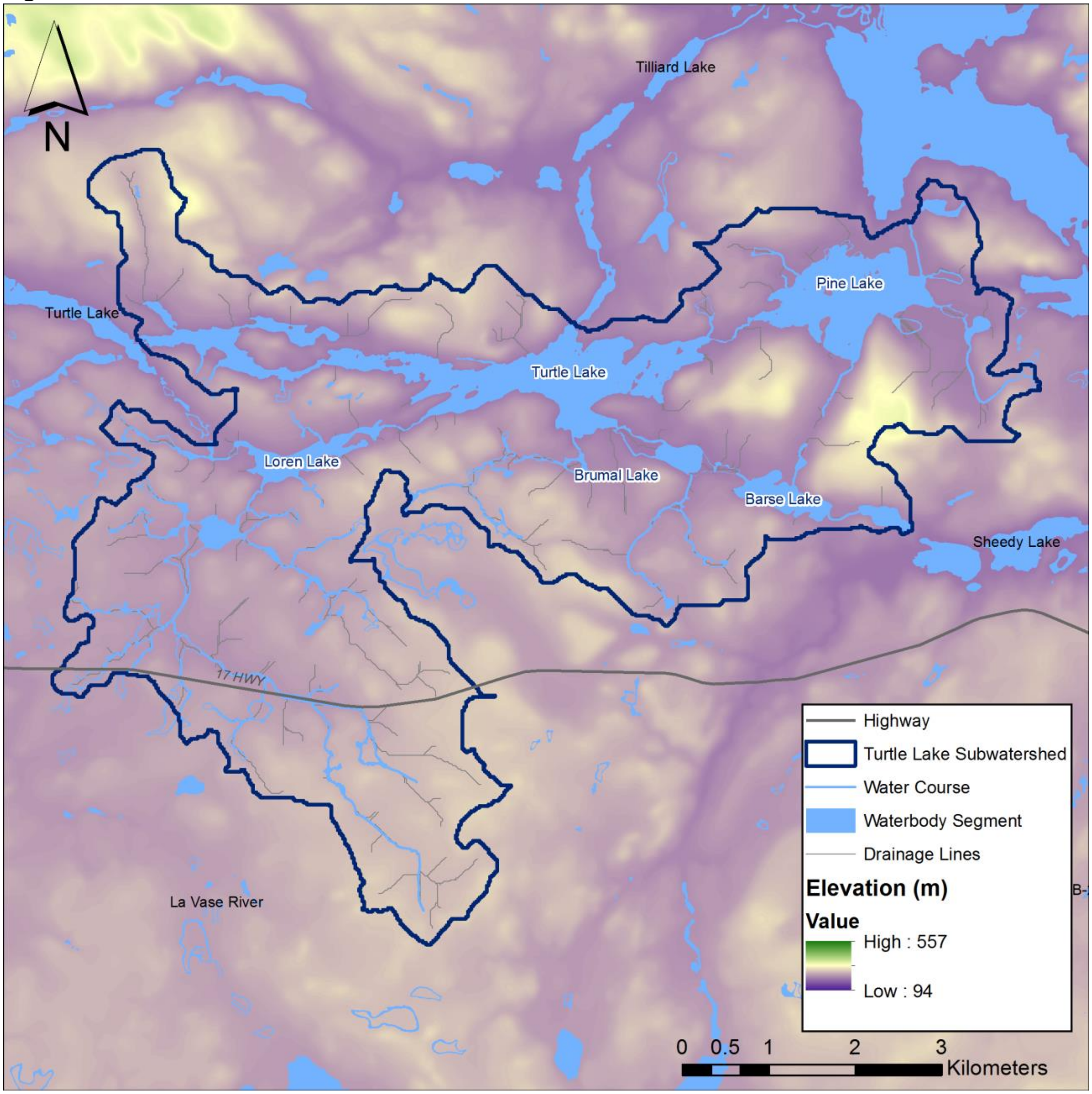
NBMCA, ***Watershed Plan: Volume 1 - Background Inventory Document***, 1982.

Waterloo Hydrogeologics Inc in association with Tunnock Consulting Ltd., ***NBMCA Groundwater Study Report***, January, 2006.

Data Available

- Hydrologic Data is available in the Trout Lake Pollution Control Study
- Turtle Lake Dam information is provided in Trout/Turtle Lake Tier Two Subwatershed Stress Assessment and Tier Three Local Area Risk Assessment

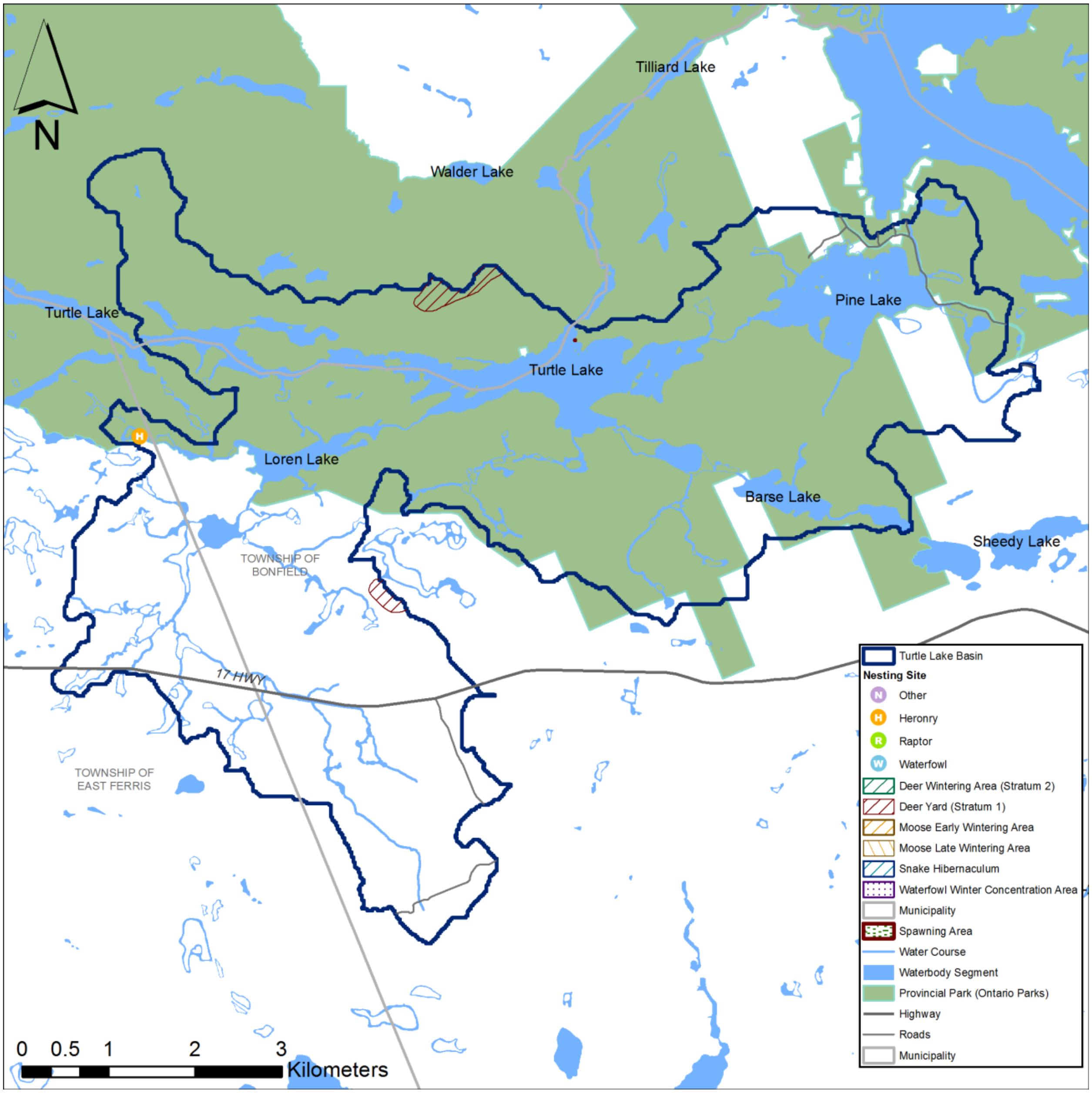
Figure 14.27 Turtle Lake Subwatershed Basin Characteristics



Major Water Bodies

- <u>Turtle Lake</u>
  Turtle Lake is a long narrow lake controlled by the Turtle Lake dam. Most of Turtle Lake's inflows are derived from Trout Lake which is directly connected. Turtle Lake has a number bays including Cherries Bay which is isolated from the main lake. The largest drainage areas are the Loren Lake basin and Pine Lake basin which make up over half of the watershed. Turtle Lake has one lot which has a seasonal cottage on it. New lot creation is not possible because most of the shore and the immediate watershed is Crown and the shoreline is protected as a Provincial Park.

Figure 14.28 Turtle Lake Subwatershed Features



Turtle Lake has a surface area of 12.99 km^2, a maximum depth of 57.9 m and an estimated volume of 2.4 X 10^7 m^3 (Northland Engineering, 1989).

The Northland Engineering water balance model for 1987 (one year was selected from a period of 10 years) shows the following for Turtle Lake:

Year 1987	1,000,000 m^3	% of Total
Total Inflow from Trout Lake	26.20	62.7
Total Inflow from Turtle Lake Watershed	12.81	30.7
Total rainfall directly to Turtle Lake	2.74	6.6

Year 1987	**1,000,000 m^3**	**% of Total**
Total Discharge from Turtle Lake Dam	38.79	92.9
Total Evaporation from Lake	2.32	5.6
Change in Water Storage	+ 0.63	1.5

In 1987 most of the water (62.7%) entering Turtle Lake came from Trout Lake and this is despite several months where water flowed in reverse (from Turtle Lake into Trout Lake – the net effect from City water takings).

- Pine Lake

  Limited data is available for Pine Lake. This water body has shoreline development on the south shore and along the north shore. There are roughly 10 lots in total. The remainder of the Lake is Crown and is within the Mattawa River Provincial Park. The Mattawa River Canoe Route has a portage between Pine Lake and Lake Talon (Portage Pin de Musique). No other watershed development exists within the Pine Lake watershed
- Minor water bodies – Loren Lake, Brumal Lake, Barse Lake, Froggy Lake

Development Pressure

- Limited

Fishing Pressure

- Unknown – Turtle Lake has a cold water habitat ranking and Pine Lake is considered to be a warm water fishery

Recreational Pressure

- The Turtle Lake-Pine Lake corridor is part of the Mattawa River Canoe Route and this route is fairly well used during the open water season for canoeing and informal camping. Turtle Lake is also accessible from Trout Lake and thus is used for day trip boating, fishing and boat access overnight camping. Winter use is unknown.

Watershed Drainage Shape/Slope/Efficiency

- The Turtle Lake subwatershed has a high percentage of open water (13.5 %). Wetland areas are mainly restricted to southern half of the watershed (9.2% of total area)
- The main channel of Turtle Lake, which would follow Loren Creek, has an average slope and the watershed has high drainage density and moderate to high basin relief. There is considerable difference between the northern and southern watersheds.
- The watershed is rated as having average drainage efficiency.

Lake Level Information

- Turtle Lake water levels/outflows are not reported on a continuous basis.
- The Trout/Turtle Lake Dam is maintained by MNR within a maximum and minimum water level range of 201.78 m to 202.24 m amsl with a reported optimum level of 202.22 m amsl (AguaResources, Feb 2010).
- Regulatory flood elevations for Turtle Lake and Pine Lake have not been calculated.

Runoff/Estimated Water Balance

- A Water Balance for the Trout/Turtle Lake Basin has been developed to consider the impact of consumptive water use as part of the Drinking Water Source Protection Plan.

Basin	Period of Data	Watershed Area	Estimated Surplus	Estimated AE	Projected TP
Trout/Turtle Lake Watershed	1975 - 2005	176 km^2	385 mm	568 mm	953 mm

Water Use

- There are no Permits To Take Water issued for this subwatershed

Hazards Identification

- No Floodplain mapping has been completed for the Turtle Lake subwatershed. The flood elevation of Turtle Lake could be interpreted from the flood elevation of Trout Lake
- The Turtle Lake subwatershed is fully supported by fill line mapping

Floodplain Regulation

- Areas with identified flood elevations are regulated under the Provincial One Zone Policy
- Areas supported by Fill Line Mapping are regulated as Development Contraint Areas

Water Quality Indicators

- Water Quality data is not available

Developed/Settled Areas as % of watershed

The watershed is virtually undeveloped and has limited development potential. Highway 17 Four Laning cuts through the southern portion of the Loren Lake basin but its impact is uncertain and its timing is likely beyond the planning horizon of this plan.

Significant Features

- Walleye Spawning
- Nesting Sites

- Deer Yard
- Potential or known Species at Risk
- Archaeological Significance along the Mattawa River and at Portages

Previously Identified Management Issues

- Water Level management/operation of the Turtle Lake dam
- Issues associated with managing the Trout/Turtle Lake basin driven by issues on Trout Lake
- Mattawa River Provincial Park Protection

Headwater Management Concerns

- Rural Development in Lauren Lake Watershed
- Wetland Protection

Drinking Water Source Protection Constraints

- Drinking Water Source Protection Strategies identified for Trout Lake do not affect the Turtle Lake subwatershed

Management/Stewardship

- Substantial portion of the subwatershed is within a Provincial Park designation
- Friends of the Mattawa River Provincial Park and Camp Island

Vulnerability/Sensitivity to Climate Change

- Turtle Lake subwatershed Vulnerability to Climate Change is ranked as Low
- Turtle Lake subwatershed Sensitivity to Climate Change is ranked as Low

Vulnerability to Land Use Change

- Turtle Lake subwatershed Vulnerability to Land Use Change is ranked as Very Low

14.2.14 Kaibuskong River Subwatershed

General Description

The Kaibuskong River subwatershed is a long narrow headwater basin that discharges to Kaibuskong Bay of Lake Talon. Lake Nosbonsing is the central watershed feature perched in a shallow depression in the Mattawa River headwaters in close proximity to the major divide between the Ottawa River and the Great Lakes basins. The subwatershed headwaters are dominated by Depot Creek which originates in Guilmette Lake in the Almaguin Highlands and drains through thick overburden deposits in Boulter/Chisholm Township. The Kaibuskong River basin has a total drainage area of 181.88 km^2 and is the third largest subwatershed in the Mattawa River system. The central/lower watershed is settled with considerable agricultural areas and Lake Nosbonsing is rimmed by shoreline development. Depot Creek, a cold water stream, encountered severe erosion during Hurricane Hazel that caused significant sedimentation to Lake Nosbonsing. This basin has similarities to the Wasi River system and Lake Nosbonsing is the most biologically productive large water body within the Mattawa River system.

Lake Nosbonsing is a shallow warm water lake that has high recreational use and it supports a modest tourism industry. The Hamlet of Astorville is located at its western terminus and the Hamlet of Bonfield is located at its eastern terminus. The lake was studied by the Ministry of Environment in the late 1980's followed by the Lake Nosbonsing Watershed Management Plan completed by the NBMCA in the early 1990's. The Lake Nosbonsing Watershed Management Plan identified that Lake Nosbonsing has approximately 650 residential, seasonal or vacant lots of which less than half were used year-round (the lake is reported to have 688 lots in total). The Plan separates the lake into eastern and western basins using Shields Point as the dividing line. The western basin, not subject to flushing of Depot Creek, has poorer quality and the Astorville Basin, at the southwest end of the lake, due to its relative isolation, has the poorest water quality of all basins. The lake supports a productive warm water fishery with walleye, pike, and perch being popular angling species and the lake sustains fairly heavy fishing pressure.

Remedial activities completed by MOE to survey and repair septic systems and to carry out a pollution control program in the Hamlet of Bonfield had noticeable water quality improvements in the 1970's. Subsequent lake and watershed management controls adopted by East Ferris and Bonfield have helped to maintain water quality at current levels which is considered stable. The Kaibuskong River subwatershed drainage characteristics are illustrated in Figure 14.29 and basin features are identified in Figure 14.30.

Supporting Studies

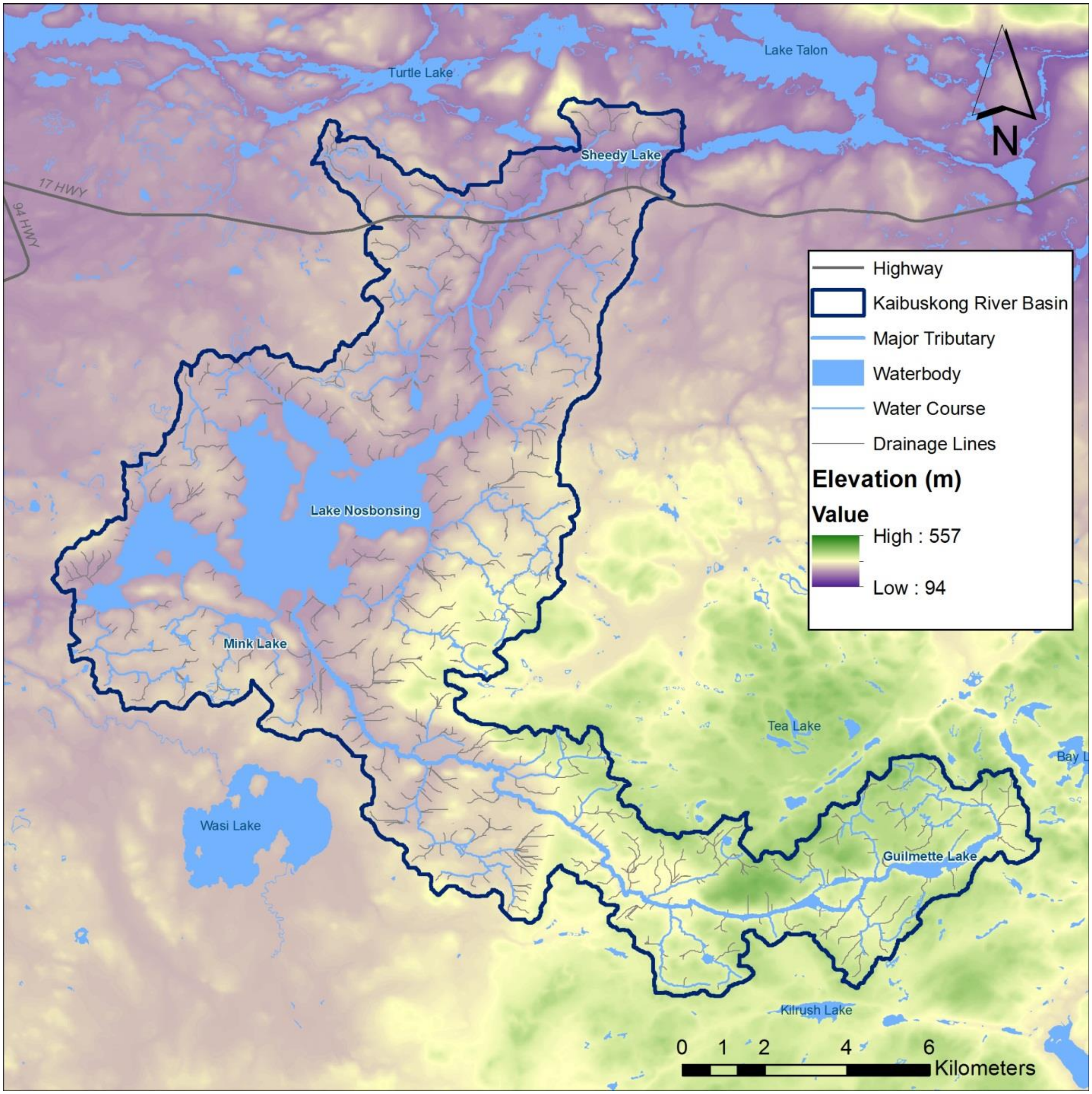
Dawdy, Blake F., Letter Report Re: Regulatory Flood Elevations – Kaibuskong River at Sheedy Lake, prepared for the North Bay-Mattawa Conservation Authority, 1993.

Gartner Lee Limited, **Source Water Protection Planning – *North Bay-Mattawa Source Water Protection Area Conceptual Water Budget***, prepared for the North Bay-Mattawa Conservation Authority, April 2008.

NBMCA, "Draft" Astorville Basin of Lake Nosbonsing Sedimentation Study. 1983.

NBMCA, Lake Nosbonsing Watershed: A Need for Basin Management, 1989.

Figure 14.29 Kaibuskong River Subwatershed Basin Characteristics



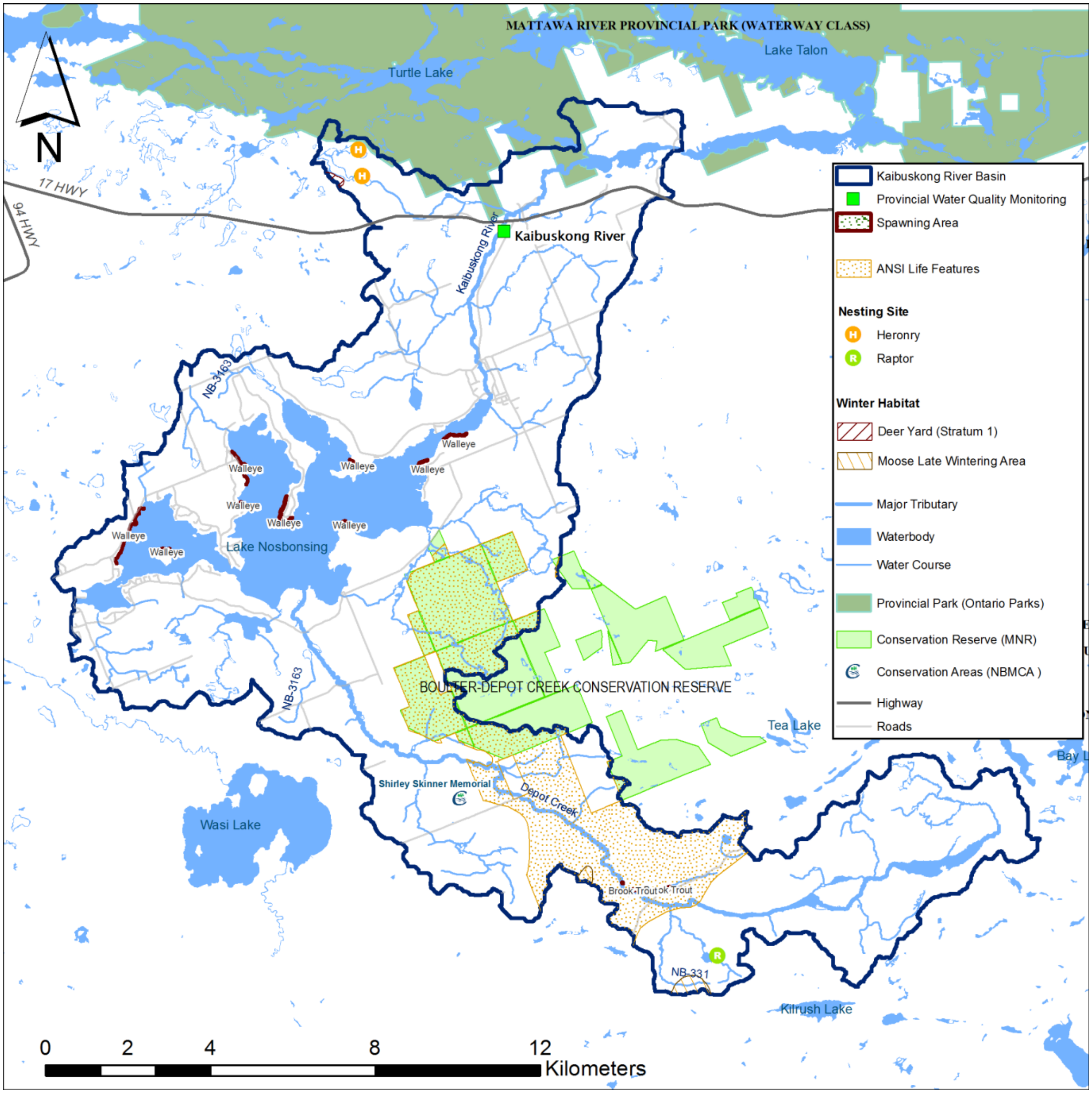
Northland Engineering Ltd., ***Lake Nosbonsing Floodplain Mapping***, prepared for the North Bay-Mattawa Conservation Authority, 1982.

Northland Engineering Ltd and Beak Consultant Ltd, ***Lake Nosbonsing Watershed Management Plan***, prepared for the North Bay-Mattawa Conservation Authority, 1993. This plan is supported by one background report:

- Lake Nosbonsing Watershed Management Plan – Background Inventory and Analysis, 1992.

NBMCA, Watershed Plan: ***Volume 1 - Background Inventory Document***, 1982.

Figure 14.30 Kaibuskong River Subwatershed Features



Ontario Ministry of the Environment, ***The Water Quality of Lake Nosbonsing, Nipissing District 1975 – 1980,*** 1983.

The Junior Conservationist Award Program, Lake Nosbonsing Watershed Study, 1985

Waterloo Hydrogeologic Inc, in association with Tunnock Consulting Ltd., ***NBMCA Groundwater Study Report***, January, 2006.

Data Available

- Continuous Flow data for this watershed is not available
- Provincial Water Quality Monitoring Station:
    - Kaibuskong River (1972 – present)
- Snow course data – Shirley Skinner Conservation Area (2006 – present)
- Water Quality Lake Nosbonsing Spring Phosphorous data (2003 – present)
- Water Quality Astorville Bay Total Phosphorous – Lake Partners Program (2002 – present)
- Wetland Evaluations, various years

Major Water Bodies

- Lake Nosbonsing
  Lake Nosbonsing is a shallow (5.5 m), warm, turbid lake that is made up of a series of embayments that are isolated by points that jut into the lake. The lake has a surface area of 17.8 km^2 and a total volume of 9.89 X 10^7 m^3 (Northland Engineering, 1992). Physio-graphically the lake is complex, with a series of isolated basins ranging in depths from 6.1 m in the Astorville Basin to 14.3 m in Maple Cover. Open water areas have complicated bathymetry. Each basin has distinct characteristics which includes different rates of flushing and wind exposures. Northland Engineering estimated a flushing rate of 0.32 years for the Astorville Basin, 1.71 years for the West Basin and 0.81 years for the East Basin (which has 80% of the lakes volume). Lakes outflow are controlled by a low relief dam within the Town of Bonfield as further described in Section 13. Bays in Lake Nosbonsing can start to stratify in the summer but stratification breaks down after strong wind events. Oxygen depletion at depth is present at peak summer especially in western basins were clinograde conditions can set up during calm periods. Oxygen depletion beneath the ice has also been observed. Lake Nosbonsing is mesotrophic and historically the Astorville basin has been meso-eutrophic (this basin is showing signs of improvement). The lake is thought to be most threatened by the conversion of vacant and seasonal properties to permanent uses. New lot creation is prohibited at the western end of the lake and is strictly controlled in the eastern basin. Predicted deterioration from property conversions and lag time impacts from existing development have not been observed.
  Minor water bodies – Guilmette Lake, Sobie Lake, Twin Lakes, Mink Lake, La Chapelle Lake, Sheedy Lake.

Development Pressure

- The Kaibuskong River subwatershed is experiencing slow rural residential growth and the transformation of traditional agriculture into hobby farming where the stabling of horse is popular. Shoreline conversion of vacant and seasonal uses to permanent uses is expected to slowly increase the intensity of development along shorelines. Shoreline development impacts will be minimized by stricter development controls. This watershed also has fairly extensive aggregate reserves that may be sought within the coming planning horizon. Forest stands in the headwaters of Depot Creek are within the Nipissing Forest Management Harvesting Plans next harvest cycle.

Fishing Pressure

- Recent fishing pressure information was not available. Fisheries analysis carried out for Lake Nosbonsing in the 1990's indicated fishing pressures for Walleye, Pike and Perch were high but not considered over exploitive.

Recreational Pressure

- The Kaibuskong River subwatershed has significant recreational pressure with pressure mainly on Lake Nosbonsing which has approximately ten commercial operations that rent cabins/cottages camping sites or trailer sites or offer marina services. Lake Nosbonsing is a popular summer tourist area. The lake is heavily used for boating and fishing. In the winter the lake is used for snowmobiling and ice fishing. Crown land in the Depot Creek watershed, especially in the vicinity of accessible small lakes, is popular for informal camping, hunting, fishing and off-road motorized recreation. Horseback riding is also increasing in popularity within the basin.
- NBMCA has a Conservation Area in Bonfield which mainly serves a local park function
- NBMCA has a Conservation Reserve knows as the Shirley Skinner Memorial Nature Reserve in the Depot Creek Watershed

Watershed Drainage Shape/Slope/Efficiency

- The Kaibuskong River subwatershed has a high percentage of open water (12.1 %) primarily due to Lake Nosbonsing . Total estimated wetland area is 7.4 %)
- The main channel of the Kaibuskong River/Lake Nosbonsing/Depot Creek has a relatively flat slope, the watershed has a moderate drainage density and moderate basin relief
- The Kaibuskong River subwatershed has a low to moderate drainage efficiency.

Lake Level Information

- Kaibuskong River flows are not monitored on a continuous basis.
- Lake Nosbonsing water levels are maintained for recreation/navigation at 236.8 m amsl (Northland Engineering, 1992).
- Regulatory flood elevations for Lake Nosbonsing is 237.6 m amsl (Northland 1982)
- Flood levels have also been calculated for the Kaibuskong River below the Lake Nosbonsing dam and near Sheedy Lake (Dawdy, 1993) .

Runoff/Estimated Water Balance

- Recent water balance data is not available
- Northland Engineering calculated an annual average Lake Nosbonsing watershed (above the Lake Nosbonsing Dam) runoff rate of 652.09 mm/year between 1964 and 1990 (this runoff rate would be higher than all runoff rates for gauged systems within the NBMCA)
- Northland Engineering estimated an annual average Lake Nosbonsing watershed evapotranspiration rate of 484.9 mm/year between 1964 and 1990 (this evapotranspiration rate is lower than rates suggested by Gartner Lee, 2008 in the Source Water Protection Planning – North Bay-Mattawa Source Water Protection Area Conceptual Water Budget.
- The above data suggest a watershed annual average precipitation rate of 1136.99 mm (1964 – 1990)

Water Use

- There are no Permits To Take Water issued for this subwatershed

Hazards Identification

	Flood Plain/Fill Line Mapping Studies	Regulatory Event	Regulatory Level Available	Source/Date	Channelization
Lake Nosbonsing	Flood Plain Mapping	Timmins Storm	237.6 m	Northland, 1982	
Upper Kaibuskong	Flood Plain Mapping		Yes		
Kaibuskong River at Outlet of Sheedy Lake	Floodplain elevation	N/A	101.0 m[1]	B. Dawdy, 1993	

1. Not a geodetic elevation

- The Kaibuskong River subwatershed is fully supported by fill line mapping

Floodplain Regulation

- Kaibuskong River subwatershed, where flood lines exist, is regulated under the One Zone Floodplain Policy
- Kaibuskong River subwatershed, where fill lines exist, is regulated as a Development Constraint Area

Water Quality Indicators

The following characteristics are evident for the Kaibuskong River at the Highway 17 PWQMN monitoring station:

- Borderline Mesotrophic Stream (TP = 20 µg/L)
- Neutral to slightly acidic pH – ranges between 6.47 and 7.75 (n = 32)
- Low chlorides – data ranges between 1.0 – 37.0 mg/L (n= 212)(increasing trend noted)
- Conductivity range 40 – 150 µS/cm (n= 246)
- Overall water quality has improved since monitoring began however it is currently stable or starting to decline slightly
- Water temperatures in lower reaches (at monitoring station) exceeds cold water criteria
- Dissolved Oxygen levels range from 3.4 to 15.2 mg/L suggesting less than optimum conditions can occur for warm water species at warmest times of the year.

Developed/Settled Areas as % of watershed

Approximately 63% of the Kaibuskong River subwatershed is forested, 18% is developed with residential, agricultural or other land uses, 12% is open water, and approximately 7 % is wetland area. The watershed is likely to encounter slow rural growth and shoreline intensification around Lake Nosbonsing within the planning horizon. Highway 17 Four Laning cuts through the northern portion of the basin but its impact is uncertain and its timing is likely beyond the planning horizon of this plan.

Significant Features

- Walleye Spawning Lake Nosbonsing
- Brook Trout Spawning – Depot Creek
- Nesting Sites
- Deer Yard
- Area of Natural and Scientific Interest
    - Boulter Township Life Science ANSI – Provincially Significant
- Potential or known Species at Risk

Previously Identified Management Issues (mainly for Lake Nosbonsing)

- Preservation of Tourism Industry
- Degradation of Water Quality - Eutrophication
- Recreational Quality
- Bacteriological Loading/Beach Closures
- Fishing Pressure
- Septic Re-inspection
- Servicing of Hamlet of Bonfield
- Stream Bank Erosion on Depot Creek
- Washouts and Siltation

- Blue Green Algae

Headwater Management Concerns

- Rural Development
- Agricultural Runoff
- Fisheries Protection (cold water habitat)
- Sustainable Forest Management Practices

Drinking Water Source Protection Constraints

- There are no Drinking Water Source Protection constraints in the Kaibuskong River subwatershed

Management/Stewardship

- None

Vulnerability/Sensitivity to Climate Change

- Kaibuskong River subwatershed Vulnerability to Climate Change is ranked as High
- Kaibuskong River subwatershed Sensitivity to Climate Change is ranked as Moderate

Vulnerability to Land Use Change

- Kaibuskong River subwatershed Vulnerability to Land Use Change is ranked as Very High

14.2.15 Lake Talon Subwatershed

General Description

The Lake Talon subwatershed, the midpoint in the Mattawa River system, not only received drainage from its own watershed but receives inflows from the North River, Trout and Turtle Lakes and the Kaibuskong River systems. The total basin area draining to the Lake Talon dam totals 876.4 km^2 and makes up 38.2 % of the total Mattawa River basin including the Amable du Fond. Within the Lake Talon subwatershed Lake Talon is the dominant feature and this planning area has similarities to Trout Lake and Turtle Lake subwatershed in that its watershed is mainly made up of many independent basins that drain directly to the lake which is the lowest point in the basin. Most of the Lake Talon drainage is on the north side of the Lake and in the upper Mattawa River/Walder Creek basin. Limited watershed with direct drainage to Lake Talon exists on the south side of the Lake. This 130.1 km^2 subwatershed has relatively limited development and road access is isolated to a few small areas. A high proportion of this watershed is Crown, and most Crown land is located within the Mattawa River Provincial Park. Timber stands on crown land not within park boundaries are ear marked by the Nipissing Forest Management

Harvesting Plans for harvesting in the existing and next harvest cycles. The mouth of the upper Mattawa River forms a delta that is drowned by Rice Bay which is considered provincially significant both as a wetland and as a Life Science ANSI (Area of Natural and Scientific Interest). Limited information is available for the Lake Talon subwatershed.

Lake Talon is a large lake that has several bays of which one is distinct. The larger main water body, occupying part of the Mattawa River fault, is an oligotrophic deep cold water system that supports a Lake Trout fishery. Kaibuskong Bay, which receives its inflows from the Kaibuskong River and Sharpes Creek systems, is by comparison shallower, warmer and it supports more prolific aquatic vegetative growth. The Kaibuskong meets the main lake near Boivin Lake and waters become thoroughly mixed at Talon Chutes. Lake Talon has rather limited shoreline development for its size, most development is scattered along the southwestern shore or along Rice Bay. Most of the northern shoreline is unorganized Crown land with a few patented lots that only have boat access. The southern side of the lake is accessed from Pine Lake Road and from Rutherglen. Rice Bay, at the north end of the lake is accessed from Redbridge following Songis Road. Lake Talon water levels are controlled by the Talon Lake dam which is described in Section 13. Limited information is available for Lake Talon. More data may be available from Nipissing University which has a research station on Shields Bay. The Lake Talon subwatershed basin shape and drainage characteristics are illustrated in Figure 14.31 and basin features are illustrated in Figure 14.32.

Supporting Studies

Dawdy, Blake, Letter Report Re: Lake Talon Flood, prepared for the North Bay-Mattawa Conservation Authority, February 1988.

Gartner Lee Limited, **Source Water Protection Planning – *North Bay-Mattawa Source Water Protection Area Conceptual Water Budget***, prepared for the North Bay-Mattawa Conservation Authority, April 2008.

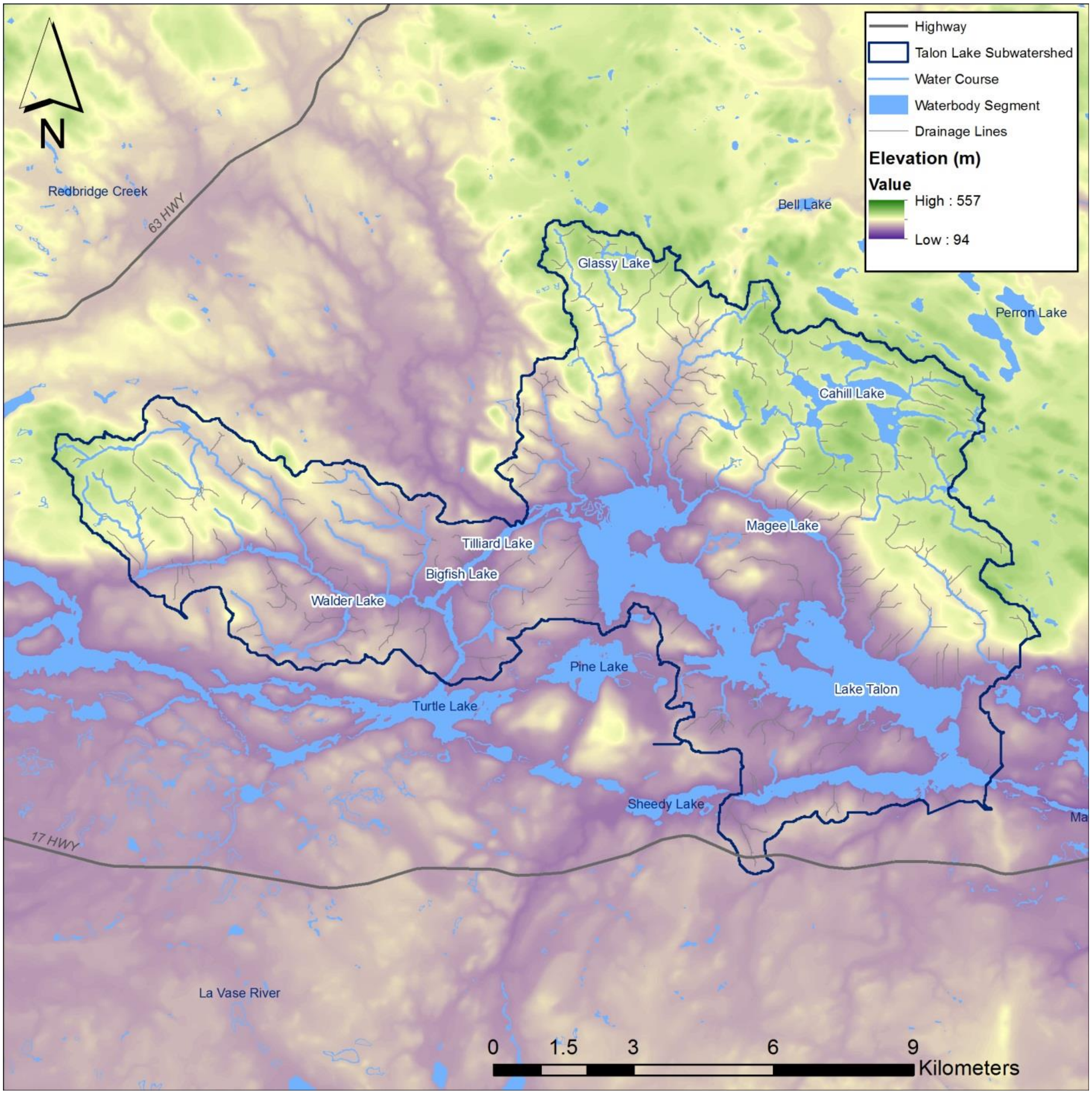
The Anglers Atlas of Ontario, Lake Talon, Northeastern Series, 1983. (available on line at: www.anglersatlas.com/mapsearch/download/25386/3153/

Waterloo Hydrogeologic Inc, in association with Tunnock Consulting Ltd., ***NBMCA Groundwater Study Report***, January, 2006.

Data Available

- Wetland Evaluations, various years

Figure 14.31 Lake Talon Subwatershed Basin Characteristics

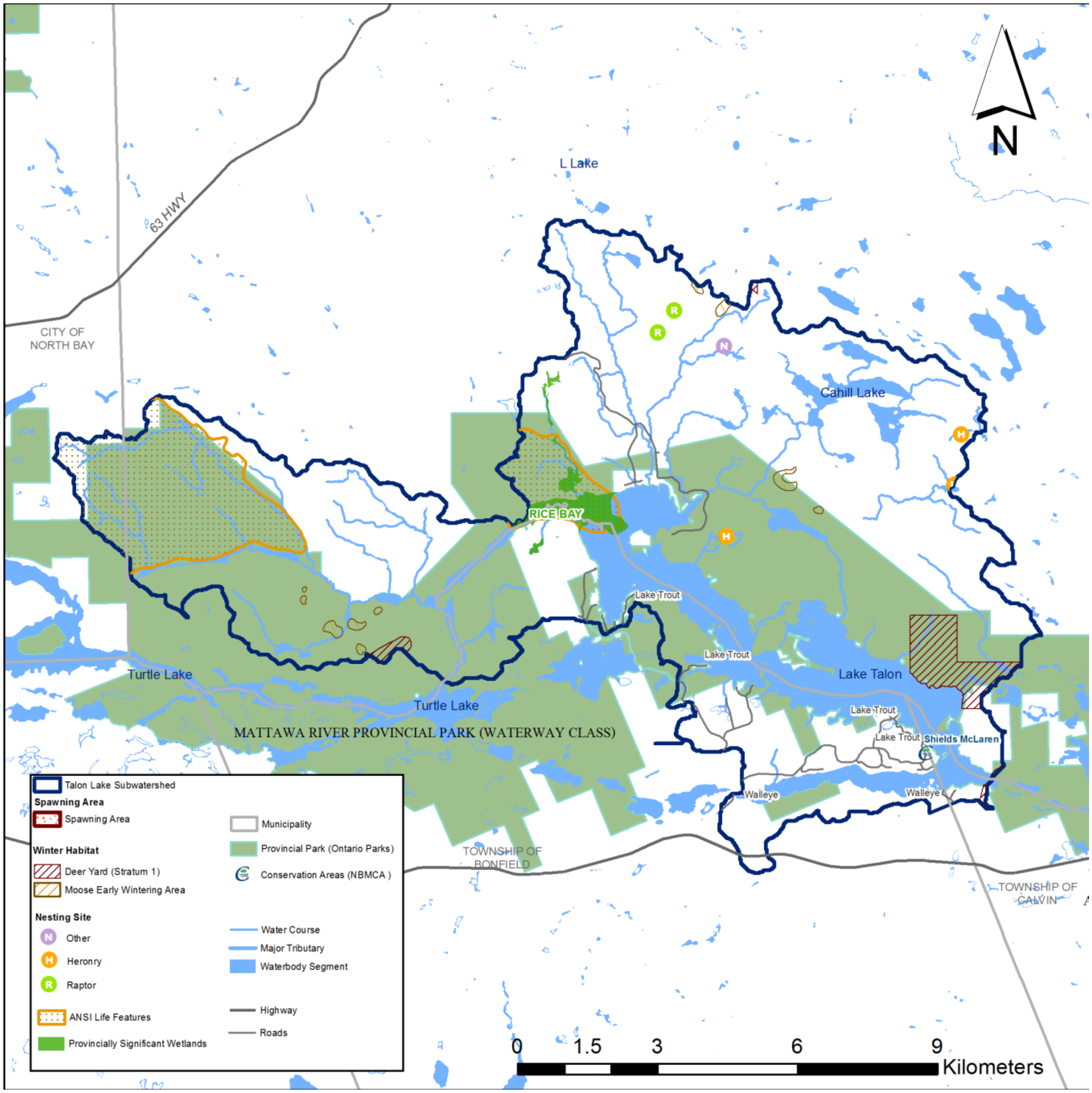


Major Water Bodies

- Lake Talon

Both Lake Talon and Kaibuskong Bay are linear water bodies with the main lake being wider and having several distinct bays. Lake Talon has a total surface area 14.04 km^2 a mean depth of 12.8 m and it is 194 m deep at its deepest point (The Anglers Atlas, 1983). Limited water quality data is available. Water quality information reported by the Lake Talon Conservation Association, collected through the Lake Partners Program, should be partitioned between

Figure 14.32 Lake Talon Subwatershed Features



the main lake and Kaibuskong Bay due to distinct water quality characteristics. A station identified as Grasswells (main lake) is reported to have an average Secchi Disc reading of 4.2 m and an average Total Phosphorous level of 8.13 µg/L (n=3) which is indicative of an oligotrophic system. Kaibuskong Bay is reported to have an average Secchi Disc reading of 3.0 m and an average Total Phosphorous level of 22.93 µg/L (n=3) suggesting it is meso-eutrophic. Additional data for Kaibuskong Bay is required to confirm this trophic status. No lake capacity information is available for Lake Talon.

- Minor water bodies – Werewolf Lake, Moosegrass Lake, Walder Lake, Whitethroat Lake, Bigfish Lake, Tilliard Lake, L Lake, Round Lake, Glassy Lake, Dinner Lake, Magee Lake, Olmstead Lake, Cahill Lake, Teasdale Lake, Bushtrail Lake, Turcotte Lake, Green Lake, Boivin Lake.

Development Pressure

- Lake Talon is encountering slow shoreline conversion of vacant or seasonal properties to permanent residential uses. The impact of development on the lake is unknown.
- The Lake Talon watershed is subject to rural growth pressures in developed areas which are limit to areas south of main lake in Bonfield and Calvin Townships.

Fishing Pressure

- Information is not available.

Recreational Pressure

- Recreational pressure is considered to be light to moderate. The Lake Talon Conservation Association web site identifies 4 resorts with lake access (Camp Conewango (Rice Bay), Country Cabins & Campground and Lake Talon Campground and Marina (both at Richards Landing) and Von Doeler's Ranch which offers horse riding and advertises that they have 2 cabins on Lake Talon). Boat launches are available at Richards Landing and at Camp Conewango. Camp Conewango advertises numerous recreational opportunities including ATVing and Snowmobiling and is connected to the Voyager Multi Use Trail system. Lake Talon is part of the Mattawa River Canoe Route and the Upper Mattawa River is used as a canoe route alternative if the portage from McCool Bay to Pine Lake using Portage Pin de Musique is not selected. Crown land around Lake Talon and along the upper Mattawa River is part of the Mattawa River Provincial Park and this park is popular for canoeing/kayaking, fishing and overnight camping.
- NBMCA has a Conservation Reserve knows as the Shields McLaren Nature Reserve at Shields Point.

Watershed Drainage Shape/Slope/Efficiency

- The Lake Talon subwatershed has a high percentage of open water (14.4 %). As well as Lake Talon, this subwatershed has many small lakes. This subwatershed has minimal wetland area (4.8%) – most wetlands are long narrow systems that follow watercourses
- The main channel slope that follows Lake Talon and the Mattawa River has a relatively flat slope, the subwatershed has moderate drainage density and average basin relief
- The subwatershed is rated as having moderate to high drainage efficiency.

Lake Level Information

- Lake Talon outflows are not monitored on a continuous basis.
- Lake Talon water levels are maintained for recreation/navigation at 193.8 m amsl (Blake Dawdy, 1988).
- Regulatory flood elevations for Lake Nosbonsing is 195.52 m amsl which includes a 0.3 m allowance for wind set up (Blake Dawdy, 1988)
- Flood levels for other parts of the Lake Talon subwatershed are not available

Runoff/Estimated Water Balance

- Water balance calculations for the Lake Talon subwatershed is not available however water balance and flow information is available for the Mattawa River gauge at Bouillon Lake which only has a small watershed area below Talon Chutes. The total watershed area for the gauge is 951.5 km^2 (Gartner Lee, 2008) and thus 92.1 % of the drainage to this gauge is fed from Lake Talon. Water balance and flow information for the Mattawa River gauge at Bouillon Lake is as follows:

Station ID	Station Name	Record Period	Gauged Area km^2	Estimated Actual Evapotransiration (mm)	Mean Annual Surplus (mm)	Projected Total Precip (mm)	NB Airport TP (mm) for same period
02JE020	Mattawa River at Bouillon Lake	1971 - 1998	951.5	535	515*	1050	1002.9

* This water surplus suggests that the upper Mattawa River has water balance similarities to Chippewa Creek. Gartner Lee 2008 identified an annual water surplus of 431 mm which is apportioned to runoff (225 mm) and recharge (206 mm) for the same period. Gartner Lee also identifies an annual stream flow (500 mm) and a base flow (227 mm). Gartner Lee points out that the water surplus and stream flows should be equal.

Highest Recorded Flow	176 m^3/sec on Apr 25, 1985 (11 X average flows)
Mean Annual Flow	15.4 m3/sec (1971 – 1998)
Lowest Recorded Flow	0.714 m^3/sec on Aug 15, 1978 (5% of average flows)

Water Use

- There are no Permits To Take Water issued for The Lake Talon subwatershed

Hazards Identification

	Flood Plain/Fill Line Mapping Studies	Regulatory Event	Regulatory Level Available	Source/Date	Channelization
Lake Talon	**Elevation Only**	**1:100 yr**	**195.52 m**	**B. Dawdy, 1988**	

- The Lake Talon subwatershed is fully supported by fill line mapping

Floodplain Regulation

- Lake Talon subwatershed, where flood elevations exist, is regulated under the One Zone Floodplain Policy

- Lake Talon subwatershed, where fill lines exist, is regulated as a Development Constraint Area

Water Quality Indicators

- Other than data reported for Lake Talon above, no other information is available

Developed/Settled Areas as % of watershed

Most of the Lake Talon subwatershed is forested. Open water makes up 14.4 % and approximately 6.5% of the Lake Talon subwatershed is developed as agricultural, residential or commercial and less than 5% of the watershed is wetland (total wetland area is not available). The watershed is likely to encounter minimal rural growth and gradual conversion of vacant or seasonal uses to permanent uses. Lake Talon could also encounter new shoreline lot creation.

Significant Features

- Walleye Spawning
- Lake Trout Spawning
- Nesting Sites
- Deer Yard
- Moose Habitat
- Significant Wetland
    - Rice Bay Wetland Complex – Provincially Significant
- Area of Natural and Scientific Interest
    - Rice Bay Delta Blue Mountain Complex Life Science ANSI – Provincially Significant
    - Doule Forest Life Science ANSI – Locally Significant
- Potential or known Species at Risk
- Archaeological Significance along the Mattawa River and at Portages

Previously Identified Management Issues

- Unknown

Headwater Management Concerns

- Upstream basin Withdrawals in Trout Lake causes low flows in upper Mattawa River during period when the discharge from the Turtle Lake Dam ceases
- Sustainable Forest Management Practices

Drinking Water Source Protection Constraints

- There are no Drinking Water Source Protection constraints in the Lake Talon Subwatershed

Management/Stewardship

- Substantial portion of the subwatershed is within a Provincial Park designation
- Friends of the Mattawa River Provincial Park and Camp Island
- Lake Talon has a lakefront owners association (Lake Talon Conservation Association)

Vulnerability/Sensitivity to Climate Change

- Lake Talon subwatershed Vulnerability to Climate Change is ranked as Low
- Lake Talon subwatershed Sensitivity to Climate Change is ranked as Moderate

Vulnerability to Land Use Change

- Lake Talon subwatershed Vulnerability to Land Use Change is ranked as High

14.2.16 Sharpes Creek Subwatershed

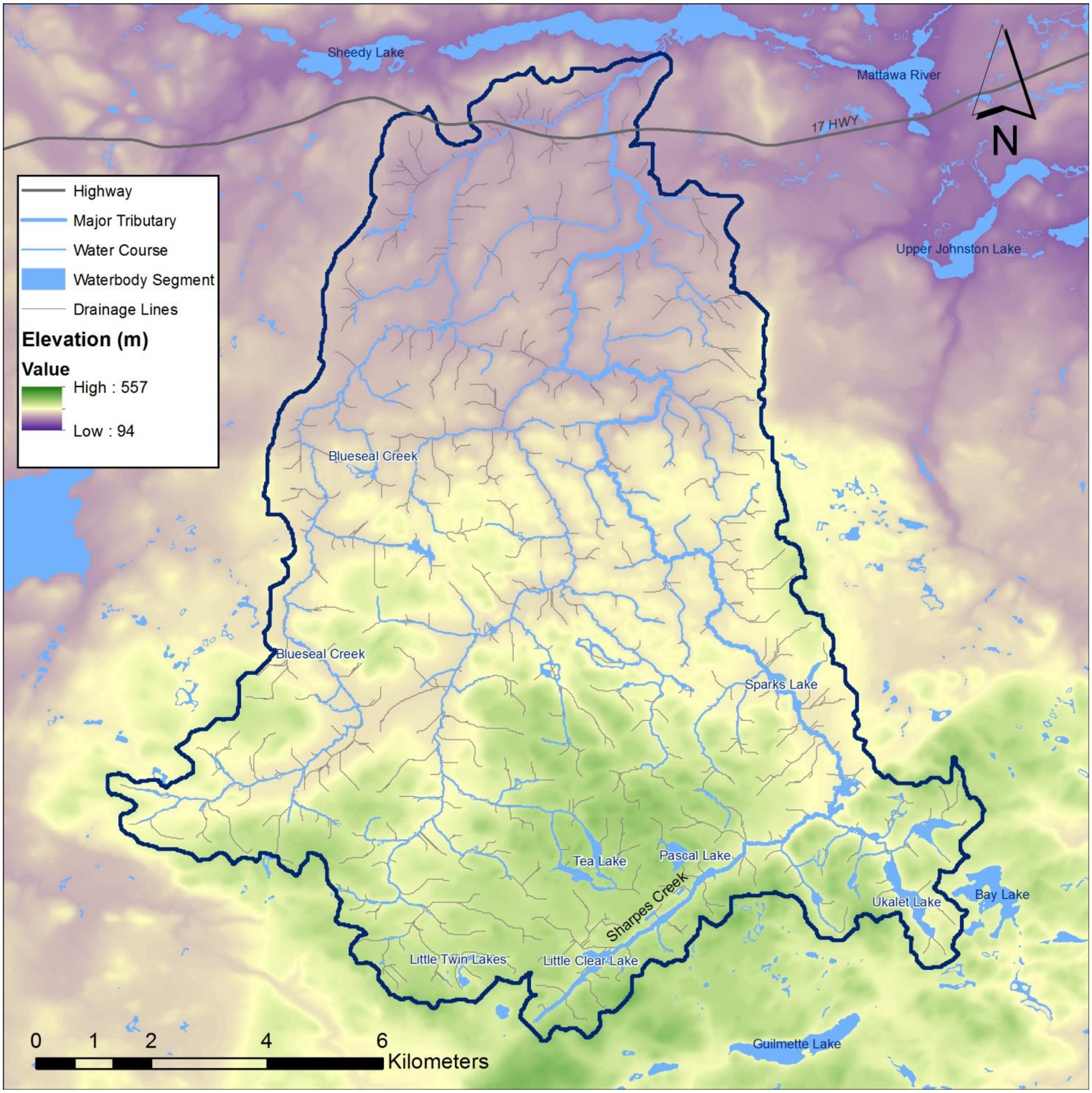
General Description

The Sharpes Creek subwatershed is centrally located within the NBMCA and it drains to Kaibuskong Bay of Lake Talon near Rutherglen. Blueseal Creek is a major tributary of this system. This 136.88 km^2 basin has no major water body but it does have a few small headwater lakes which are mainly kettle lakes. Both Sharpes and Blueseal Creeks have sizable headwater wetlands. The lower watershed has a sizable glaciolacustrine plain that has the second highest agricultural ratings within the NBMCA after Chisholm Township and which sustains a vibrant Bonfield Township agricultural community. Esker formations form the eastern and western watershed boundaries of this system and the southern boundary is demarked by the Boulter Township Esker Complex. This basin is consequently rimmed by thick overburden that has high aggregate potential and which contains the largest regional surficial aquifers within the NBMCA. The Sharpes Creek headwaters are mainly located in Boulter Township which is predominantly Crown land. Large sections of the headwaters are protected by ANSI designations and any unprotected forest stands are earmarked for harvesting through the Nipissing Forest Management Harvesting Plan. The Sharpes Creek subwatershed has never been subject to an independent basin study and consequently limited basin specific information is available. The Sharpes Creek subwatershed basin shape and drainage patterns are illustrated in Figure 14.33 and basin features are illustrated in Figure 14.34.

Supporting Studies

Gartner Lee Limited, **Source Water Protection Planning – *North Bay-Mattawa Source Water Protection Area Conceptual Water Budget***, prepared for the North Bay-Mattawa Conservation Authority, April 2008.

Figure 14.33 Sharpes Creek Subwatershed Drainage Characteristics



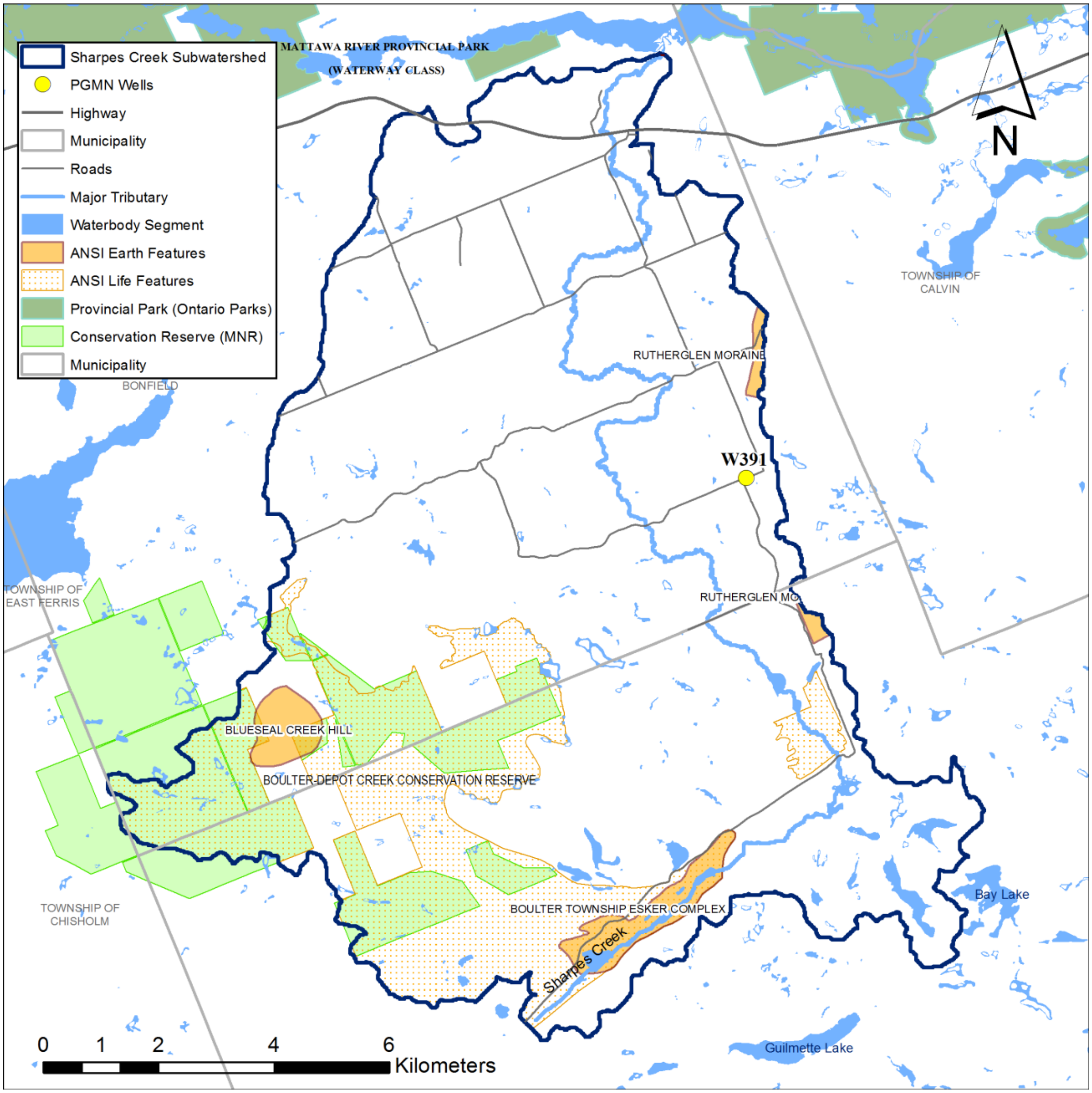
NBMCA, ***Watershed Plan: Volume 1 - Background Inventory Document***, 1982.

Waterloo Hydrogeologic Inc, in association with Tunnock Consulting Ltd, ***NBMCA Groundwater Study Report***, January, 2006.

Data Available

- Provincial Ground Water Monitoring Network
    - Grand Desert (2003 – 2011)

Figure 14.34 Sharpes Creek Subwatershed Features



Major Water Bodies

- None
- Minor water bodies – Tea Lake, Loon Lake, Sparks Lake, Pascal Lake, Turtle Lake, Pond Lake, Little Clear Lake, Ukalet Lake.

Development Pressure

- The Sharpes Creek subwatershed is experiencing rural residential, agricultural and hobby farming growth mainly on the glaciolacutrine plain in Bonfield Township.

- The watershed has extensive aggregate reserves along its watershed boundaries and these reserves are expected to be mined at a fairly steady rate within the next planning horizon with the largest impact expected between Bonfield and Rutherglen
- Headwater logging activity is expected to continue throughout the next planning horizon

Fishing Pressure

- Information is not available. Both Sharpes and Blueseal Creeks are considered cold water streams

Recreational Pressure

- Crown land and small lakes in Boulter township are used extensively for hunting, fishing camping and off road pursuits
- A large portion of the Sharpes Creek headwaters are designated as the Boulter Depot Creek Nature Reserve.

Watershed Drainage Shape/Slope/Efficiency

- The Sharpes Creek subwatershed has a low percentage of open water (2.0 %) with a higher percentage of wetlands (6.2%) mainly within the headwaters.
- Stream relief is average for Mattawa River basins, the watershed has average drainage density and average basin relief
- The Shapes Creek subwatershed is rated as having average drainage efficiency.

Runoff/Estimated Water Balance

- The watershed is not gauged and hydrologic information is not available.
- Surficial geology, headwater wetland and cold water habitat suggest that streams have relatively high base flow conditions.

Water Use

- There are no Permits To Take Water issued for the Sharpes Creek subwatershed

Hazards Identification

- There is no floodplain mapping available for the Sharpes Creek subwatershed
- The Sharpes Creek subwatershed is supported by fill line mapping to Boundary Road between Bonfield and Boulter Townships

Floodplain Regulation

- Sharpes Creek subwatershed, where fill lines exist, is regulated as a Development Constraint Area

Water Quality Indicators

- No water quality information is available

Developed/Settled Areas as % of watershed

The lower third of the watershed is settled. Agriculture uses take advantage of richer lacustrine deposits left by post glacial lakes. Rural residential and hobby farming are also popular in this portion of the basin.

Significant Features

- Area of Natural and Scientific Interest
  - Boulter Township Life Science ANSI – Provincially Significant
  - Rutherglen Moraine Shoreline and Kame Earth Science ANSI – Provincially Significant (2 sites)
  - Blueseal Creek Hill Earth Science ANSI - Provincially Significant
  - Boulter Township Esker Complex Earth Science ANSI - Provincially Significant
- Potential or known Species at Risk

Previously Identified Management Issues

- Undefined

Headwater Management Concerns

- Wetland Protection
- Fisheries Protection (cold water habitat)
- Sustainable Forest Management Practices

Drinking Water Source Protection Constraints

- There are no Drinking Water Source Protection constraints in the Sharpes Creek subwatershed

Management/Stewardship

- None

Vulnerability/Sensitivity to Climate Change

- Sharpes Creek subwatershed Vulnerability to Climate Change is ranked as Moderate
- Sharpes Creek subwatershed Sensitivity to Climate Change is ranked as Low

Vulnerability to Land Use Change

- Sharpes Creek subwatershed Vulnerability to Land Use Change is ranked as Moderate

14.2.17 Amable du Fond River Subwatershed

General Description

The Amable du Fond River is the largest and most southerly subwatershed within the Mattawa River basin with the majority of its drainage area being located in Algonquin Provincial Park. This 964.41 km^2 watershed makes up 42% of the Mattawa River system and combined Pautois Creek (a tributary) it form almost exactly half of the Mattawa River watershed. The Amable du Fond basin has two distinct areas; headwaters located in the Algonquin/Almaguin highlands and the lower watershed, below the Lake Kioskokwi dam which descend from the highlands and drains through the Mattawa Lowland where it discharges into the lower Mattawa River.

The headwaters form a large wilderness area with abundant lakes and wetlands that are almost entirely within Algonquin Park. The headwaters extend into Ballantyne Township on the west fringes of the watershed which is beyond Algonquin Park boundaries. The upper watershed has restricted public access and is primarily within the Algonquin Forest Management Unit (Ballantyne Township is within the French Severn Forest Management Unit). Consequently the upper watershed is extensively logged in a progressive manner that follows sustainable harvest practices (headwaters are accessible by logging roads). Algonquin Provincial Park is accessed from Kiosk (off of Highway 630) and the Amable du Fond headwaters are used extensively for wilderness canoe tripping. The upper Amable du Fond River is also accessible from South River via Kawawaymog Lake (which is identified as the headwater lake of the Amable du Fond River system). The headwaters have abundant lakes and streams, many are cold water habitats and the highest point within the NBMCA is located in the Amable du Fond headwaters (512 m amsl).

The lower watershed is well drained and has fewer lakes and wetlands than the upper watershed. The western boundary of the Amable du Fond River watershed drains from the Rutherglen esker/kame complex that has good aggregate reserves and groundwater resource potential. The Amable du Fond River below Lake Kioskokwi is fairly swift as it descends from the highland and displays lengthy boulder rapids and occasional cascades and gorges that make the River aesthetically attractive. The river has good public access from Highway 630 and is popular for angling. Areas of crown land along the lower Amable du Fond River are protected as part of the Amable du Fond River Provincial Park and the Eau Claire Gorge Conservation Area is protected by the NBMCA near Eau Clare in Calvin Township. The Amable du Fond River enters the lower Mattawa River in Samuel de Champlain Provincial Park and thus this subwatershed has abundant parkland (over two thirds of the watershed is protected by Park designations). Settlement, which is dominated by rural and agricultural uses are mainly located adjacent to lower reaches in Calvin Township were development pressures are relatively low. Despite its size and the availability of flow and water quality data, this watershed has not been studied in detail and subwatershed management issues are not well understood. The Amable du Fond

River subwatershed basin shape and drainage patterns are illustrated in Figure 14.35 and basin features are illustrated in Figure 14.36.

Supporting Studies

Gartner Lee Limited, **Source Water Protection Planning – *North Bay-Mattawa Source Water Protection Area Conceptual Water Budget***, prepared for the North Bay-Mattawa Conservation Authority, April 2008.

NBMCA, Eau Claire Gorge Inventory, 1977.

NBMCA, Fish Habitat Reclamation Study – Amable du Fond River, Student Summer Employment Project, 1982.

NBMCA, Smith Lake and Crooked Chutes Shoreline Management Study, May 1987.

NBMCA, ***Watershed Plan: Volume 1 - Background Inventory Document***, 1982.

Waterloo Hydrogeologic Inc, in association with Tunnock Consulting Ltd., ***NBMCA Groundwater Study Report***, January, 2006.

Data Available

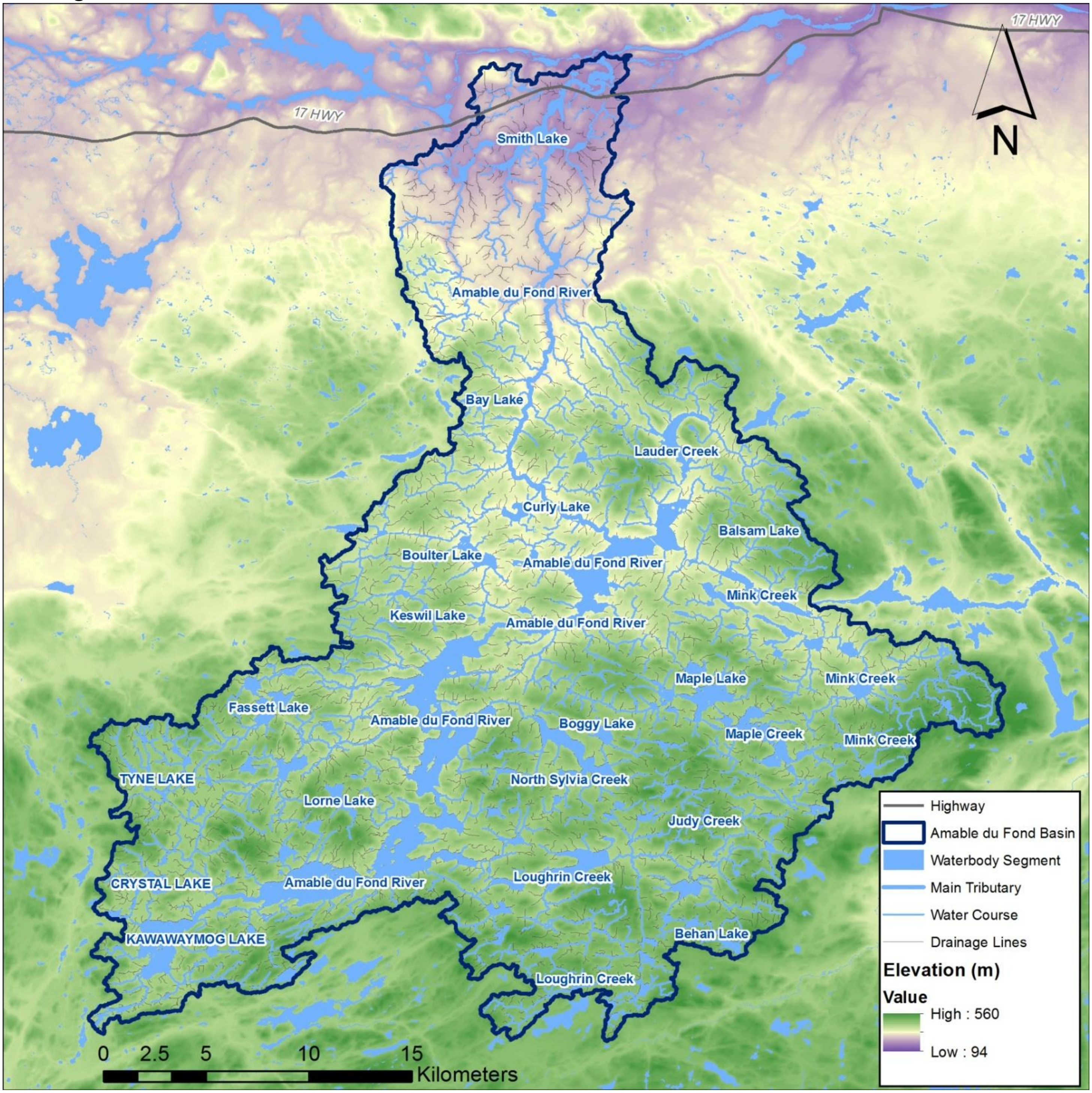
- Historic flow data from:
  - Amable du Fond River at Samuel de Champlain Park (1972 – 1995)
  - Amable du Fond River at Kiosk (1995 – present)
- Provincial Water Quality Monitoring Station
  - Amable du Fond River at Highway 17 (1972 - present)

Major Water Bodies

- All major water bodies are located in the upper watershed, most being in Algonquin Provincial Park. Specific information for these water bodies are unavailable. Major lakes include: Kawawaymog Lake (outside of the park), North Tea Lake, Manitou Lake, Lake Kioskokwi.

- Minor water bodies – The upper watershed above the Lake Kioskokwi dam has as many as one hundred small and medium size lakes which are too numerous to list. Minor water bodies below the Lake Kioskokwi dam include: Boulter Lake, Curly Lake, Bay Lake, Green Lake, Upper Johnston Lake, Lower Johnston Lake, Smith Lake, Crooked Chutes Lake, Burbot Lake, Pacaud Lake, Hen Lake and Moore Lake.

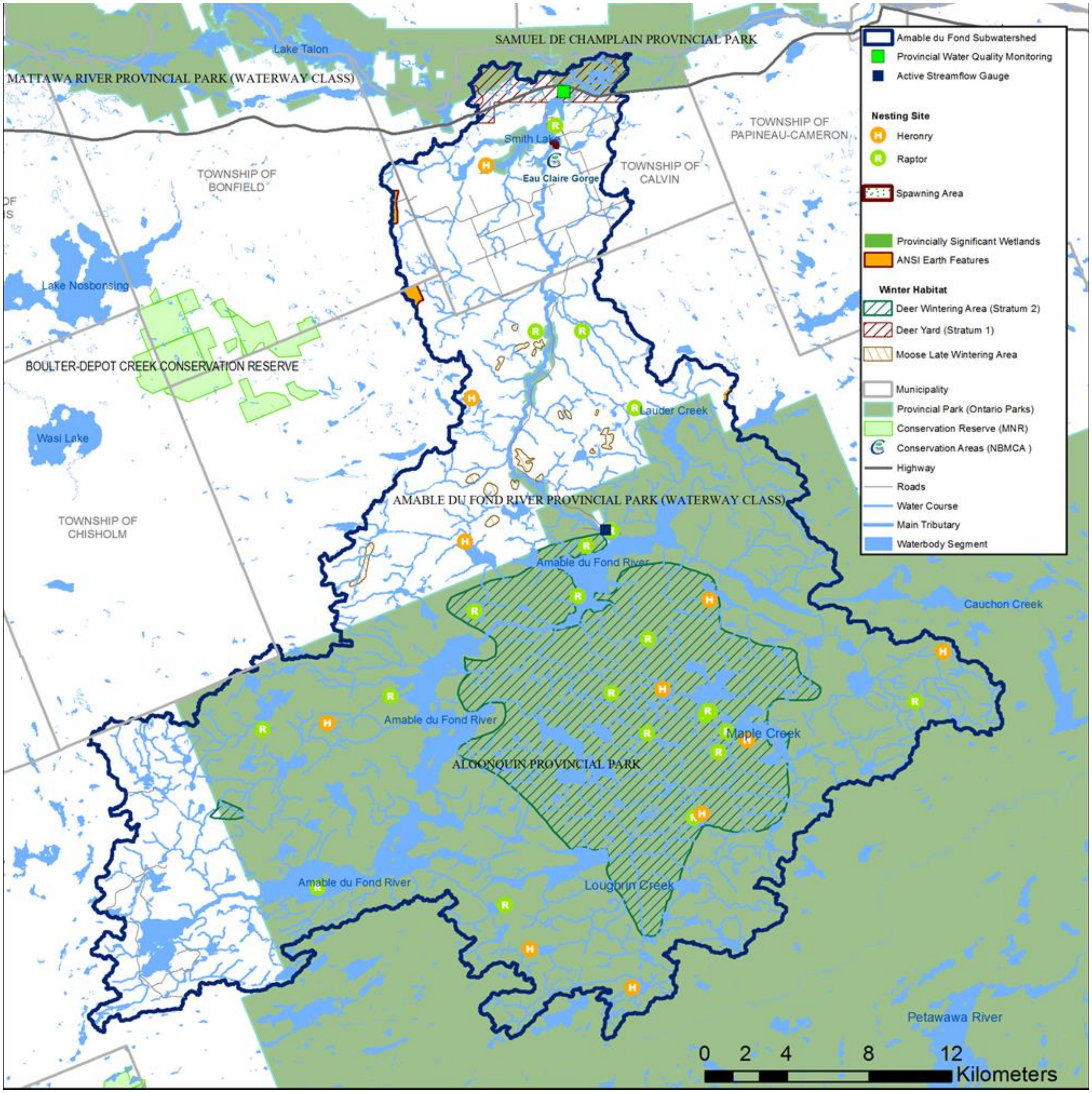
Figure 14.35 Amable du Fond River Subwatershed Basin Characteristics



Development Pressure

- The lower Amable du Fond River subwatershed is experiencing slow rural residential, agricultural and hobby farming growth in Calvin Township. There are isolated glaciolacustrine deposits that have higher agriculture value.

Figure 14.36 Amable du Fond River Subwatershed Features



- The Rutherglen esker/kame complex has abundant sorted sand and gravel deposits that may be targeted for extraction within the next few decades. There is also a large approved aggregate site north of Smith Lake.
- The headwaters in Algonquin Park as well as small Crown land pockets in Lauder and Boulter Township are earmarked for logging in the existing or next harvest cycle. There is

a small area adjacent to Highway 17 east of Pimisi Bay – one of the few areas near the Highway – that is identified as an optional harvest area.

- Highway 17 fourlaning will cross the northern edge of the subwatershed and impacts are dependent on the final alignment and positioning of interchanges. Highway 17 improvements are likely beyond the planning horizon of this study.

Fishing Pressure

- Angling along the lower Amable du Fond River is attractive due to ease of access from Highway 630. A NBMCA study identified stream bank erosion as an issue that could affect the fishery of the lower main channel. Smith Lake and Crooked Chutes lakes have warm water fisheries and experience angling pressure from tourist operations on Smith Lake.
- Algonquin Park is popular for angling, especially for cold water species in the summer, as opportunity, abundance and success rates are high due to restricted access and lack of winter exploitation. Higher angling pressures are encountered on the southern side of Algonquin Park south of the Amable du Fond River watershed.

Recreational Pressure

- Algonquin Park is a world class destination for wilderness canoeing and camping. Utilization rates for the north or west sides of the park are not available.
- Crown land and small lakes in Lauder and other unorganized townships outside of the Algonquin Park are used extensively for hunting, fishing camping and off road pursuits
- The Eau Claire Gorge Conservation Area is a popular day use hiking park in the spring summer and fall that receives considerable traffic from people travelling on the Trans-Canada Highway.
- Samuel de Champlain Provincial Park is a highly utilized family oriented camp ground that has over 200 tent and RV sites. The Park has Fur Trade Museum as well as the Canadian Ecology Center that offers outdoor/environmental education opportunities.
- There are two Tourist Camps on Smith Lake.

Watershed Drainage Shape/Slope/Efficiency

- The Amable du Fond subwatershed has a relatively high percentage of open water (11.8 %). Most of the open water areas are in Algonquin Park. Wetlands make up an estimated 6.2% of total watershed area.
- The slope of the main channel is low, the watershed has a medium drainage density and the basin has relatively low basin relief for its size.
- The subwatershed is rated as having average drainage efficiency.

Runoff/Estimated Water Balance

- Hydrologic information is available for the entire Amable du Fond subwatershed which includes the Pautois Creek subwatershed at a gauge in Samuel de Champlain Provincial Park that operated between 1972 and 1995. A second gauge in Kiosk established by the NBMCA has monitored the upper portion of the Amable du Fond subwatershed since 1995. The Amable du Fond subwatershed has a total area of 964.41 km^2 and the Pautois Creek subwatershed has a total area of 175.78 km^2 which combine to total 1140.19 km^2. The Samuel de Champlain Provincial Park gauge has a reported watershed drainage area of 1130 km^2. The Kiosk gauge has a drainage area of 706 km^2.

Station ID	Station Name	Record Period	Gauged Area km^2	Estimated Actual Evapotransiration (mm)	Mean Annual Surplus (mm)	Projected Total Precip (mm)	NB Airport TP (mm) for same period
02JE019	Amable du Fond at Champlain PP	1972 - 1995	1130	535	449	984	1013.9
02JE019	Amable du Fond at Kiosk	2006 - 2011	706	545	513	1058	1106.0

Samuel de Champlain PP Gauge (1130 km^2)

Highest Recorded Flow	138 m^3/sec on Apr 24, 1985 (8 X average flows)
Mean Annual Flow	16.1 m^3/sec (1972 – 1995)
Lowest Recorded Flow	1.48 m^3/sec on Sept 5, 1975 (9% of average flows)

Kiosk Gauge (706 km^2)

Highest Recorded Flow	54.3 m^3/sec on Apr 26, 2008 (4.6 X average flows)
Mean Annual Flow	11.5 m^3/sec (2006 – 2011)
Lowest Recorded Flow	1.44 m^3/sec on Oct 12, 2011 (8 % of average flows)

Water Use

- There are no Permits To Take Water issued for this subwatershed

Hazards Identification

	Flood Plain/Fill Line Mapping Studies	Regulatory Event	Regulatory Level Available	Source/Date	Channelization
Main River	**N/A**	**N/A**	**N/A**		
Smilth Lake	**Elevation Only**	**1:100 yr**	**176.96 m**	**B. Dawdy, 1988**	

- The Amable du Fond River subwatershed is supported by fill line mapping north of Algonquin Park

Floodplain Regulation

- The Amable du Fond River subwatershed, where flood elevations exist, is regulated under the One Zone Floodplain Policy
- The Amable du Fond River subwatershed, where fill lines exist, is regulated as a Development Constraint Area

Water Quality Indicators

The Amable du Fond River PWSMN monitoring station, located on Highway 17 (above the Pautois Creek inflows), demonstrates the following recent (2003 – 2011) water chemistry:

- Oligotrophic Stream (TP = 9.4 µg/L)(n=37)
- Neutral to slightly acidic pH (6.31 – 7.83) (n=32)
- Very low chlorides 1.2 – 2.8 mg/L (n = 37)
- Low Conductivity 37 – 70 µS/cm (n=37)
- Water temperatures exceeds cold water criteria (Highest summer temperature 27 ^{o}C)
- Dissolved oxygen is border line for cold water species (6.5 – 13.6 mg/L) (n = 29)
- Overall water quality is stable or improving slightly

Developed/Settled Areas as % of watershed

Less than 5 % of the watershed is developed. The rate of land use change is slow.
The watershed is heavily logged with most logging occurring in Algonquin Park and in Lauder Township.

Significant Features

- Nesting Sites
- Deer Wintering Area - Samuel de Champlain Park
- Moose Wintering and Calving area – Algonquin Provincial Park
- Walleye Spawning – Smith Lake
- Area of Natural and Scientific Interest
    - Rutherglen Moraine Shoreline and Kame Earth Science ANSI – Provincially Significant (2 sites)
- Logging Heritage Features
- Potential or known Species at Risk

Previously Identified Management Issues

- Protection of Eau Claire Gorge
- Lower main channel Stream Bank Erosion
- Defining Floodplains on small Lakes in Lower watershed that have development potential
- Public Access to Smith Lake
- Small hydro production on main river

Headwater Management Concerns

- Sustainable Forest Management Practices

Drinking Water Source Protection Constraints

- There are no Drinking Water Source Protection Constraints within the Amable du Fond River subwatershed

Management/Stewardship

- No comprehensive management structure in place
- Most of the headwaters are managed as part of Algonquin Provincial Park
- Logging in most of the headwaters is under the management of the Algonquin Forestry Authority

Vulnerability/Sensitivity to Climate Change

- Amable du Fond River subwatershed Vulnerability to Climate Change is ranked as Moderate
- Amable du Fond River subwatershed Sensitivity to Climate Change is ranked as Moderate

Vulnerability to Land Use Change

- Amable du Fond River subwatershed Vulnerability to Climate Change is ranked as Moderate

14.2.18 Pautois Creek Subwatershed

General Description

The Pautois Creek subwatershed is a large Amable du Fond River tributary that originates at the edge of the Algonquin/Almaguin highland and discharges to Moore Lake at Samuel de Champlain Provincial Park. This 175.78 km^2 subwatershed primarily originates from three mid-sized headwater lakes that are relatively isolated but easily accessed from settlement areas. Of the three headwater lakes, Papineau and Thompson Lakes are larger and identified as cold water lakes, while Little Pautois Lake is smaller and is identified as a warm water lake. Little Pautois Lake has a sizable wetland on its fringes. Pautois Creek is identified as a cold water system which supports brook trout and several studies that assess fish habitat are available. A small section of the upper Pautois Creek subwatershed flows from Algonquin Provincial Park (Thompson Lake is on the Park boundary). The southern half of this subwatershed is mainly Crown land which is heavily logged (both inside and outside of the park boundaries). Significant timber harvesting occurs in this drainage basin which is split between two different Timber Management Units of which the Nipissing Forest Management Unit is the more dominant. A significant portion of the upper subwatershed is identified within the existing or next cutting cycles. The lower Pautois Creek subwatershed, draining through Calvin and Papineau

Townships, has settled areas with agriculture being the dominant land use. This subwatershed has limited research available and basin management issues are not well understood. The Pautois Creek subwatershed basin shape and drainage patterns are illustrated in Figure 14.37 and basin features are illustrated in Figure 14.38.

Supporting Studies

Gartner Lee Limited, **Source Water Protection Planning – *North Bay-Mattawa Source Water Protection Area Conceptual Water Budget***, prepared for the North Bay-Mattawa Conservation Authority, April 2008.

NBMCA, Fish Habitat Reclamation Study: Pautois Creek, 1982.

NBMCA, Papineau Lake Master Plan, August 1979.

NBMCA, Papineau Township 1988 Lake and Stream Studies to Support a Brook or Rainbow Trout Population, 1988.

NBMCA, ***Watershed Plan: Volume 1 - Background Inventory Document***, 1982.

Waterloo Hydrogeologic Inc, in association with Tunnock Consulting Ltd., ***NBMCA Groundwater Study Report***, January, 2006.

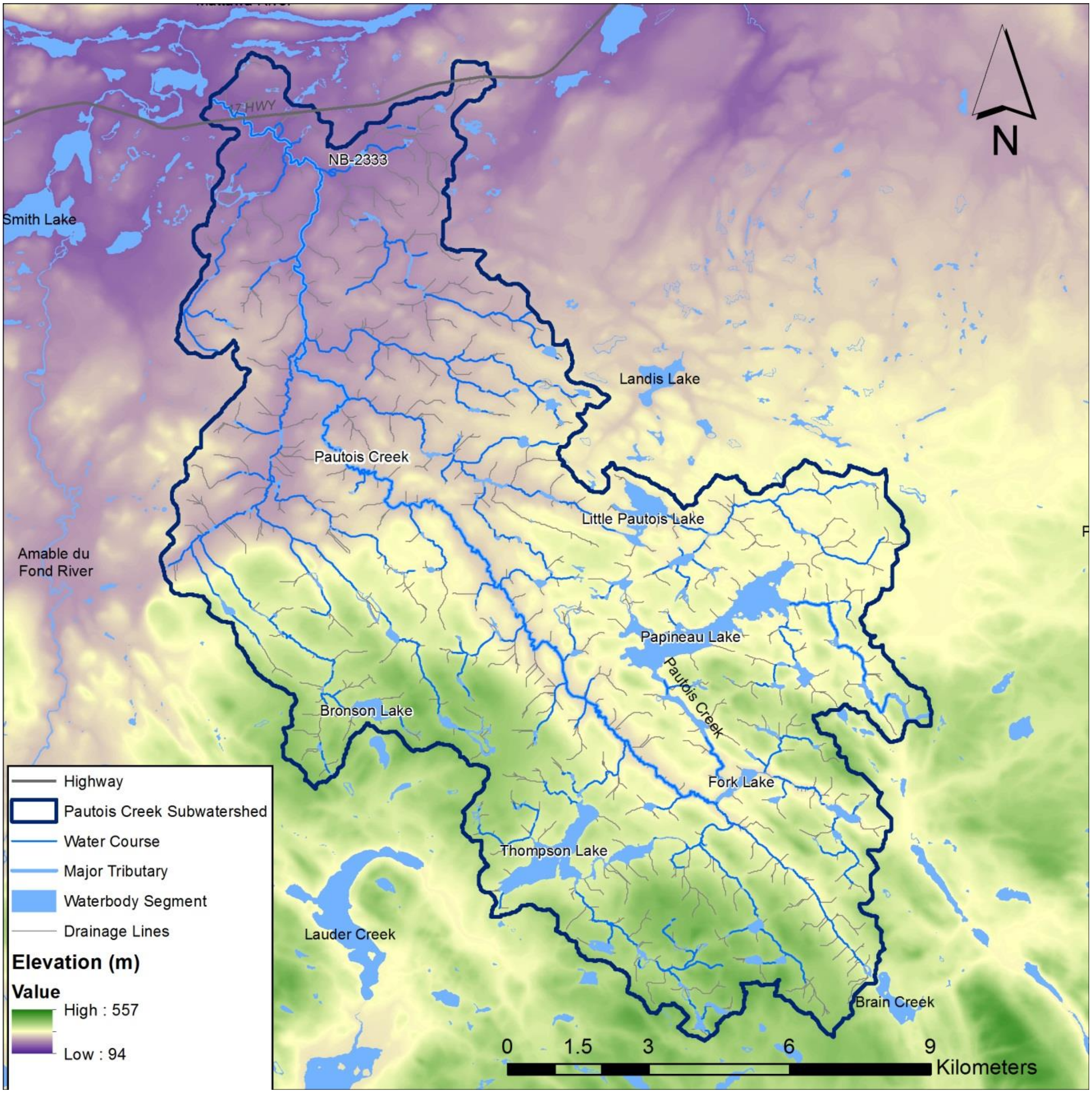
Data Available

- No basin specific data is available.

Major Water Bodies

- None
- Minor water bodies – Papineau Lake (also called Sturgeon Lake)
  Papineau Lake is a 2.28 km^2 cold water lake with a mean depth of 9 m and a maximum depth of 24.4 m. The lake is reported to have neutral to slightly acidic pH, low Alkalinity and TDS, and one secchi disc reading of 4.9 m. Papineau Lake thermally stratifies in the summer and has suitable habitat in the hypolimnion to support cold water species of fish. The lake is reported to have native lake trout and lake whitefish and has been stocked with rainbow trout and brook trout. Habitat within the hypolimnion may be subject to stress in late summer.
  Other minor water bodies include Little Pautois Lake, Little Sturgeon Lake, Sears Lake, Fork Lake, Thompson Lake, Little Thompson Lake, Crookstick Lake, Little Crookstick Lake, Bronson Lake.

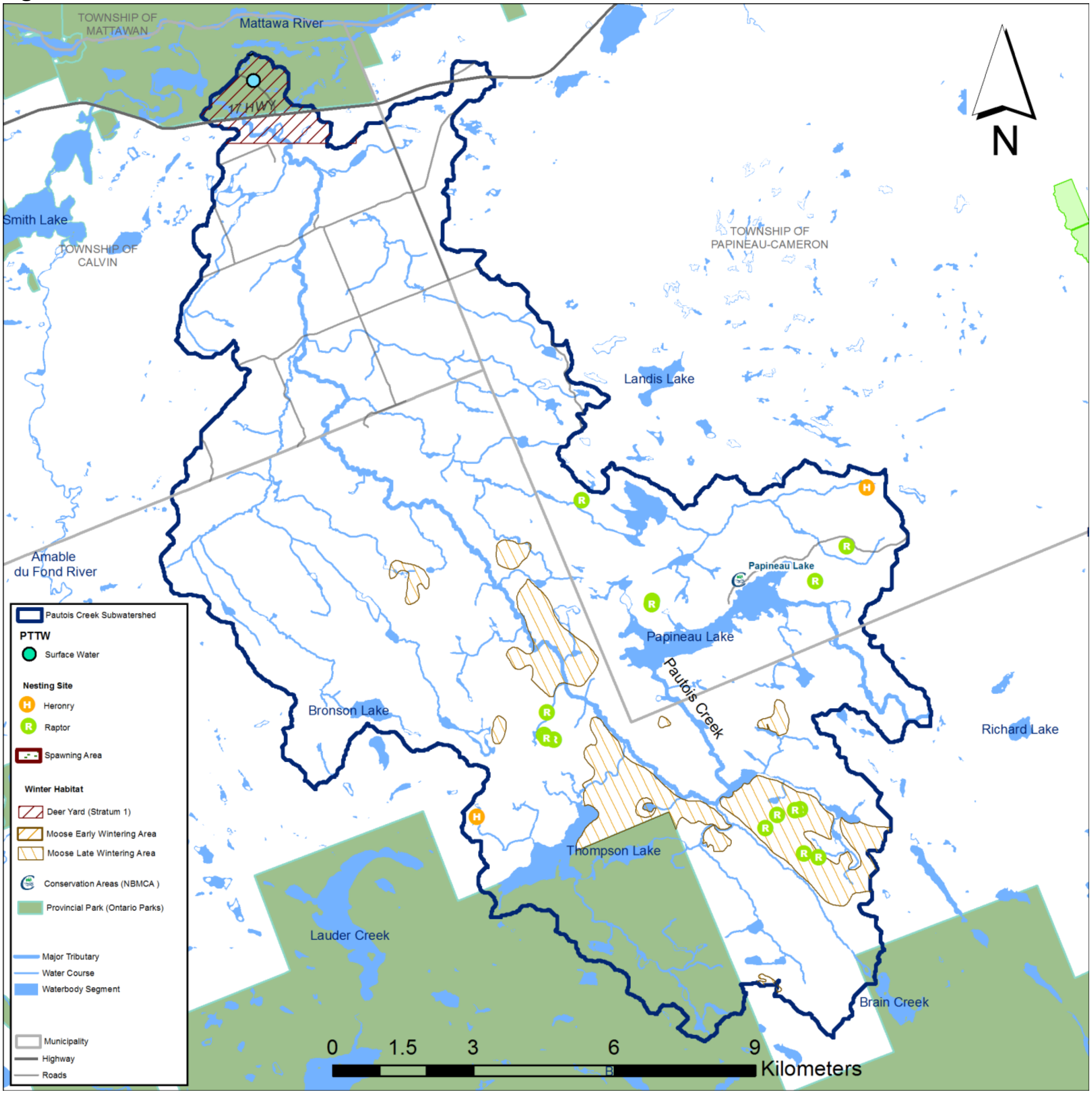
Figure 14.37 Pautois Creek Subwatershed Basin Characteristics



Development Pressure

- The Pautois Creek subwatershed has modest glaciolacustrine deposits which are exploited for agricultural land uses within eastern Calvin Township. This area has low development pressure. Slow rural residential and hobby farming growth can be expected within the planning horizon.

Figure 14.38 Pautois Creek Subwatershed Features



- The upper watershed is encountering fairly heavy logging activity which is expected to continue throughout the next planning horizon.
- As Highway 17 four laning is expected to cut across a small portion of the Pautois Creek subwatershed following the same route as the current Highway 17 (highway to be widened) and the impacts are expected to be minimal. Highway 17 interchange locations, which are unknown, could increase development pressures however improvements are likely beyond the planning horizon of this study.

Fishing Pressure

- Information is not available.

Recreational Pressure

- The small lakes in Lauder and Papineau Townships are used by the local community for fishing, informal camping, hunting and off road pursuits. Papineau Lake has modest shoreline development
- The NBMCA maintains the Papineau Lake Conservation Area that provides Public Access to Papineau Lake but use of this site is unknown
- The portions of this subwatershed in Samuel de Champlain and Algonquin Provincial Park are not primary park use areas.

Watershed Drainage Shape/Slope/Efficiency

- The Pautois Creek subwatershed has both a moderate percentage of open water (4.9 %) and a moderate percentage of wetlands (7.7 %) Pautois Creek has an average main channel slope, an average drainage density and an average basin relief for its size.
- The Pautois Creek subwatershed is rated as having moderate to high drainage efficiency.

Runoff/Estimated Water Balance

- The watershed is not gauged and hydrologic information is not available.

Water Use

- One groundwater Permit to Take Water has been issued in Samuel de Champlain Provincial Park for communal water supply purposes

Hazards Identification

- There is no flood plain mapping available for the Pautois Creek subwatershed
- The Pautois Creek subwatershed is fully supported by fill line mapping

Floodplain Regulation

- Pautois Creek subwatershed, where fill lines exist, is regulated as a Development Constraint Area

Water Quality Indicators

- No water quality information is available

Developed/Settled Areas as % of watershed

Approximately 10 % of the subwatershed is developed. Limited change is expected in the next planning horizon.

Significant Features

- Deer Yard
- Moose Wintering Areas
- Nesting Areas
- Potential or known Species at Risk

Previously Identified Management Issues

- Public Assess/Water Levels on Papineau Lake (Papineau has no outlet control structure)

Headwater Management Concerns

- Use of Headwater Lakes for recreation
- Fisheries Protection (cold water habitat)
- Sustainable Forest Management Practices/split jurisdiction between two Forest Management Units

Drinking Water Source Protection Constraints

- There are no Drinking Water Source Protection Constraints within the Pautois Creek subwatershed

Management/Stewardship

- None

Vulnerability/Sensitivity to Climate Change

- Pautois Creek subwatershed Vulnerability to Climate Change is ranked as Moderate
- Pautois Creek subwatershed Sensitivity to Climate Change is ranked as Moderate

Vulnerability to Land Use Change

- Pautois Creek subwatershed Vulnerability to Land Use Change is ranked as High

14.2.19 Boom Creek Subwatershed

General Description

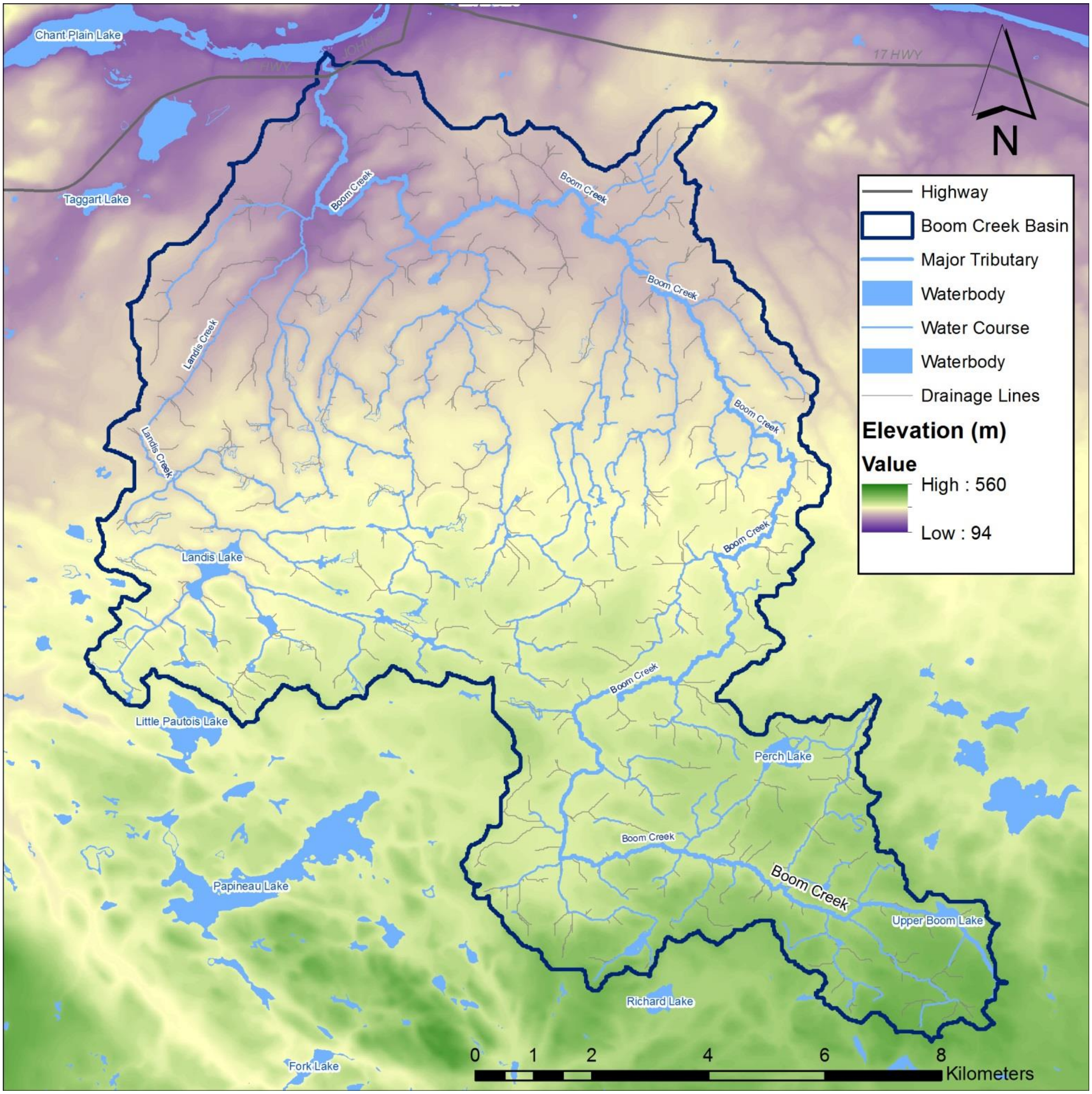
The Boom Creek subwatershed forms the eastern edge of the NBMCA which originates at the fringes of the Algonquin highlands and drains through the Mattawa lowlands before discharging to the Lower Mattawa River just above the Town of Mattawa. The watershed predominantly has thin soil cover over bedrock. Lacustrine deposits are isolated to lower watershed depressions and a glaciofluvial formation forms a large sandy plain south of the Papineau settlement area. Within it's the narrow lower creek valley lacustrine deposits are overlain by alluvial deposits which also support linear wetlands. This 137.86 km^2 subwatershed has no significant water body, has a low percentage of surface water area (1.75% of the watershed is surface water) but has a relatively high percentage of wetlands (total wetland areas is not available). This watershed displays an annular drainage pattern were streams form concentric rings in shallow soil areas (common on batholiths). Underlying geology impedes drainage and forms a complicated drainage pattern that includes long curved wetlands. Coniferous forests/plantations dominate the sandy plain south of the settlement area. Boom Creek drainage seems to be impeded by the sandy plain which backs up drainage to form a large wetland on its south side. The esker/kame complex in central Papineau may have considerable thickness and a sizable regional surficial aquifer; however, supporting information is not available. The coniferous forest on the esker extends east into former Cameron Township (out of the watershed). This coniferous forest sitting on the Boom Creek watershed boundary has old growth forest affinities that have been protected by the Boom Creek Conservation Reserve. The lower watershed is settled with sparse development dominated by agriculture and rural residential uses. The headwaters of this system have been subject to extensive historic logging and a fairly youthful forest is evident. Select areas are identified for harvest in the current and next harvesting cycles. A large portion of the identified stands are considered optional and will only be cut if dedicated areas become inaccessible. This watershed has limited information available and watershed management issues are largely unknown/ unexplored. The Boom Creek Watershed basin shape and drainage patterns are illustrated in Figure 14.39 and basin features are illustrated in Figure 14.40.

Supporting Studies

Gartner Lee Limited, **Source Water Protection Planning – *North Bay-Mattawa Source Water Protection Area Conceptual Water Budget***, prepared for the North Bay-Mattawa Conservation Authority, April 2008.

NBMCA, Papineau Township 1988 Lake and Stream Studies to Support a Brook or Rainbow Trout Population, 1988.

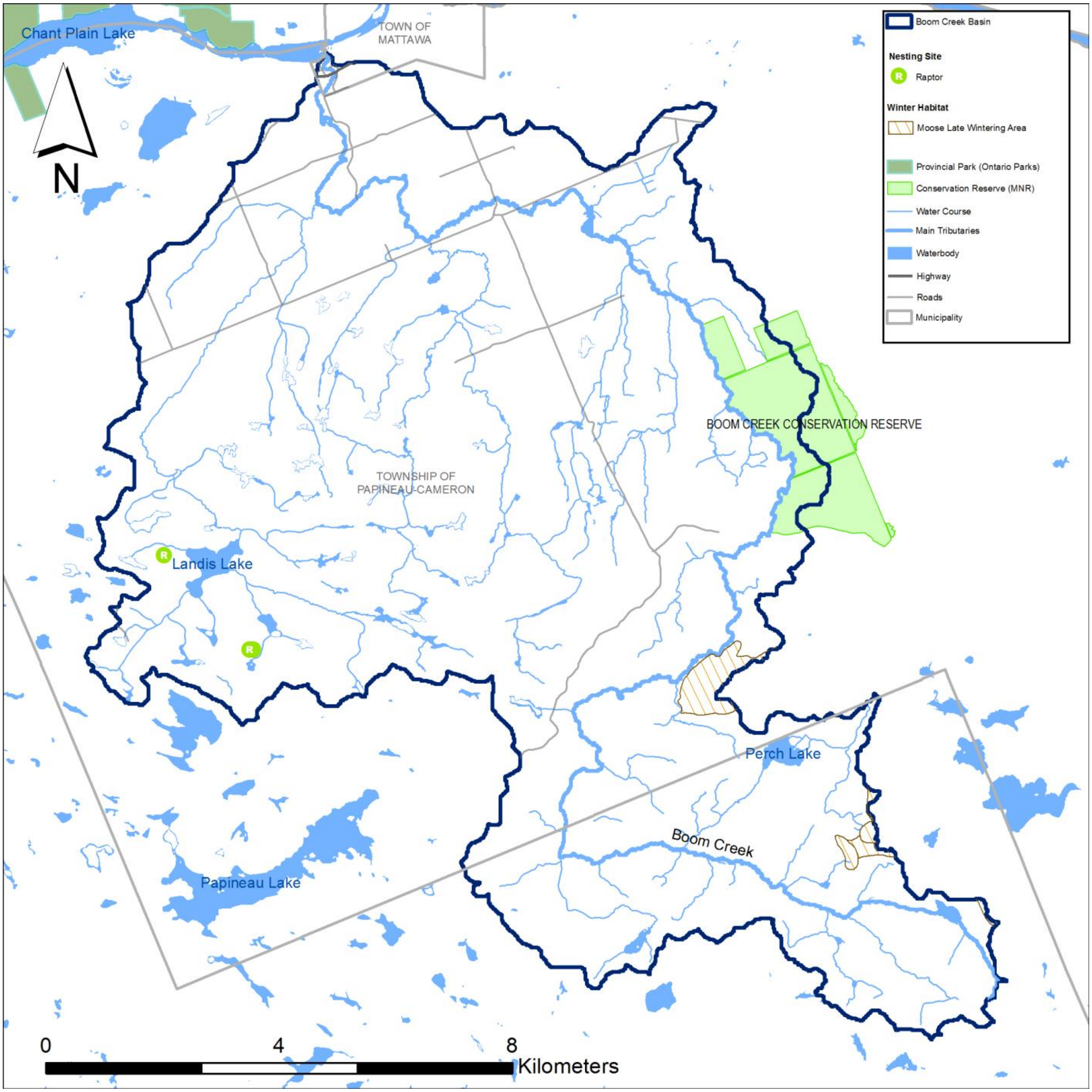
Figure 14.39 Boom Creek Subwatershed Basin Characteristics



NBMCA, ***Watershed Plan: Volume 1 - Background Inventory Document***, 1982.

Waterloo Hydrogeologic Inc, in association with Tunnock Consulting Ltd., ***NBMCA Groundwater Study Report***, January, 2006.

Figure 14.40 Boom Creek Subwatershed Features



Data Available

- No basin specific data is available.

Major Water Bodies

- None
- Minor water bodies Landis Lake, Perch Lake, Upper Boom Lake

Development Pressure

- The Boom Creek subwatershed has relatively low development pressure. Slow rural residential and hobby farming growth can be expected within the planning horizon. Larger family farms may be broken up if successional generations are not available to take over farm operations.
- The upper watershed is encountering fairly modest logging activity which is expected to continue throughout the next planning horizon (much of the harvestable timber has already been depleted).
- Highway 17 four laning will cut across the lower Boom Creek subwatershed and the impacts are dependent on the location of exit ramps which have not yet been determined. Highway improvements are likely beyond the planning horizon of this study.

Fishing Pressure

- Information is not available.

Recreational Pressure

- Crown land south of the Papineau settlement area is popular for recreational use by the local community for fishing, informal camping, hunting and off road pursuits, however, most users travel through the Boom Creek subwatershed on route to other destinations.

Watershed Drainage Shape/Slope/Efficiency

- The Boom Creek subwatershed has a low percentage of open water (1.8 %) but has a higher percentage of wetlands (12.1%). This watershed has poor drainage in the central watershed were annular flow patterns exist.
- The Boom Creek main stream has a moderate channel slope; the watershed has average drainage density and average to high basin relief for its size.
- The subwatershed is rated as having average to high drainage efficiency despite the annual flow pattern (the rating is mainly based on basin shape).

Runoff/Estimated Water Balance

- The watershed is not gauged and hydrologic information is not available.

Water Use

- There are no Permits to Take Water issued for the Boom Creek subwatershed

Hazards Identification

- There is no flood plain mapping available for the Boom Creek subwatershed
- The Boom Creek subwatershed is fully supported by fill line mapping

Floodplain Regulation

- Boom Creek subwatershed, where fill lines exist, is regulated as a Development Constraint Area

Water Quality Indicators

- Routine water quality monitoring has not been carried out for this system
- Limited data available shows low conductivity and dissolved oxygen and temperature ranges that would be suitable for cold water species however the stream, including Landis Lake, is rated as warm water habitat in the provincial data base.

Developed/Settled Areas as % of watershed

Approximately 10 % of the subwatershed is developed. Limited change is expected in the next planning horizon. Modest forestry activity is expected in the southern watershed within the planning horizon.

Significant Features

- Moose Wintering Areas
- Nesting Areas
- The Boom Creek Old Growth Forest is protected through a provincial Conservation Reserve
- Potential or known Species at Risk

Previously Identified Management Issues

- Suitability of the Creek for fish stocking

Headwater Management Concerns

- Wetland Protection
- Sustainable Forest Management Practices

Drinking Water Source Protection Constraints

- There are no Drinking Water Source Protection Constraints within the Boom Creek subwatershed

Management/Stewardship

- None

Vulnerability/Sensitivity to Climate Change

- Boom Creek subwatershed Vulnerability to Climate Change is ranked as Low
- Boom Creek subwatershed Sensitivity to Climate Change is ranked as Low

Vulnerability to Land Use Change

- Boom Creek subwatershed Vulnerability to Climate Change is ranked as Moderate

14.2.20 Lower Mattawa River Subwatershed

General Description

The Lower Mattawa River subwatershed, comprised of the lowest reaches of the Mattawa River system below Lake Talon, includes many small catchments not attached to other subwatersheds. The Mattawa River Fault is a defining feature of this subwatershed and lands draining to it on the north side have steep gradients while lands to the south, in the Mattawa lowlands, are comparatively flat but with considerable relief. This 143.4 km^2 basin received most inflows from two major upstream sources: the upper Mattawa River system that enters this basin at Talon Chutes and the Amable du Fond River system which enters this subwatershed at its mid-point. Boom Creek, a minor contributor (estimated to contribute approximately 6% of total inflows), enters the system only a few kilometers from above its outlet. This basin discharges into the Ottawa River in the Town of Mattawa at the lowest surface elevation within the NBMCA's area of jurisdiction (153.8 m). Most research in this basin has centered on the Town of Mattawa's drinking water source which is sourced in rich alluvial deposits under the town.

The lower Mattawa River subwatershed has a number of unique characteristics that make this basin distinct. While the mouth of the basin, surrounded by the Town of Mattawa, is mainly urbanized, upstream the basin becomes increasingly rugged and remote. The richness of the Mattawa River's history and mystic seems preserved in the upper portions of this basin where access is limited. The river offers significant flow diversity including long flat open water stretches, short reaches of rapids, cascades and waterfalls and long narrow cannons with spectacular scenery. The aura of the subwatersheds geologic past and of people that have used the Mattawa River over centuries and millennia seem to be preserved along the rugged shorelines. The lower Mattawa River is highly used as a canoe route and the ruggedness of the land west of Lake Chant Plein, which has restricted basin settlement, continues to offer a variety of wilderness experiences. A significant portion of this subwatershed is within one of two

Provincial Park designations and background research for park formation purposes is available. Park Management Plans offer significant waterway and land protection within this subwatershed. The Canadian Ecology Center has identified many interpretive features within the basin. The lower Mattawa River subwatershed however has not been subject to watershed management assessment and subwatershed management issues remain obscure. This subwatershed is also more reliant on the success of watershed management activities in upper subwatersheds. The Lower Mattawa River subwatershed basin shape and drainage pattern are illustrated in Figure 14.41 and basin features are illustrated in Figure 14.42.

Supporting Studies

Dawdy, Blake F., Letter Report Regarding Earl's Lake Estates Cut and Fill Operations, prepared for the North Bay-Mattawa Conservation Authority, 1987.

Dennis Consultants, ***Mattawa Wells First Engineer's Report***, prepared for the Town of Mattawa, 2001.

Gartner Lee Limited, **Source Water Protection Planning – *North Bay-Mattawa Source Water Protection Area Conceptual Water Budget***, prepared for the North Bay-Mattawa Conservation Authority, April 2008.

NBMCA, Mattawa Island Conservation Area Master Plan, 1978.

NBMCA, Papineau Township 1988 Lake and Stream Studies to Support a Brook or Rainbow Trout Population, 1988.

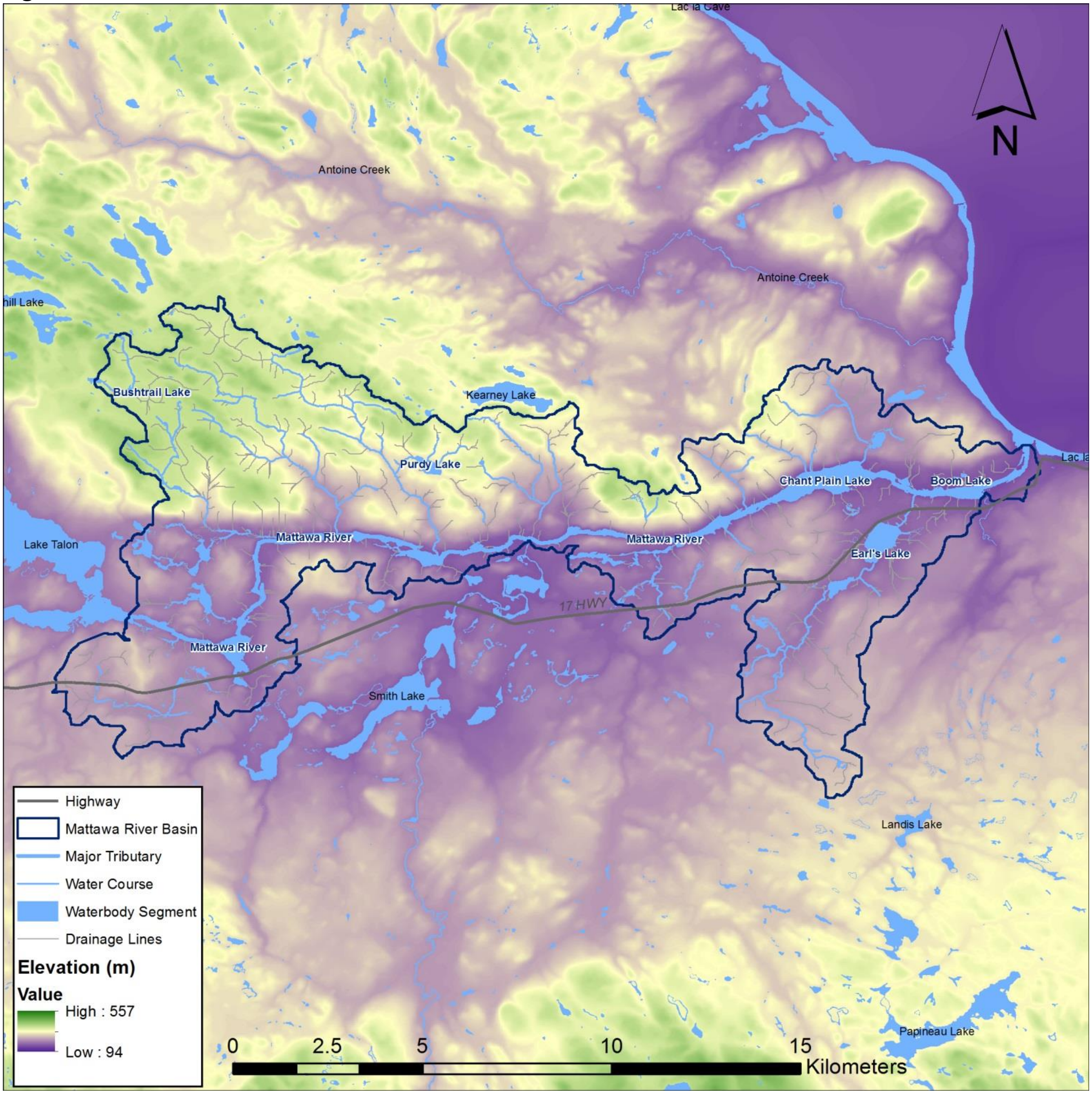
NBMCA, ***Watershed Plan: Volume 1 - Background Inventory Document***, 1982.

Waterloo Hydrogeologic Inc, in association with Tunnock Consulting Ltd., ***NBMCA Groundwater Study Report***, January, 2006.

Waters Environmental Geosciences Ltd, ***Technical Assessment Report Groundwater Risk Assessment Town of Mattawa***, prepared for the North Bay-Mattawa Conservation Authority, 2009a.

Waters Environmental Geosciences Ltd, ***Technical Assessment Report Groundwater Vulnerability Assessment Town of Mattawa***, prepared for the North Bay-Mattawa Conservation Authority, 2009b.

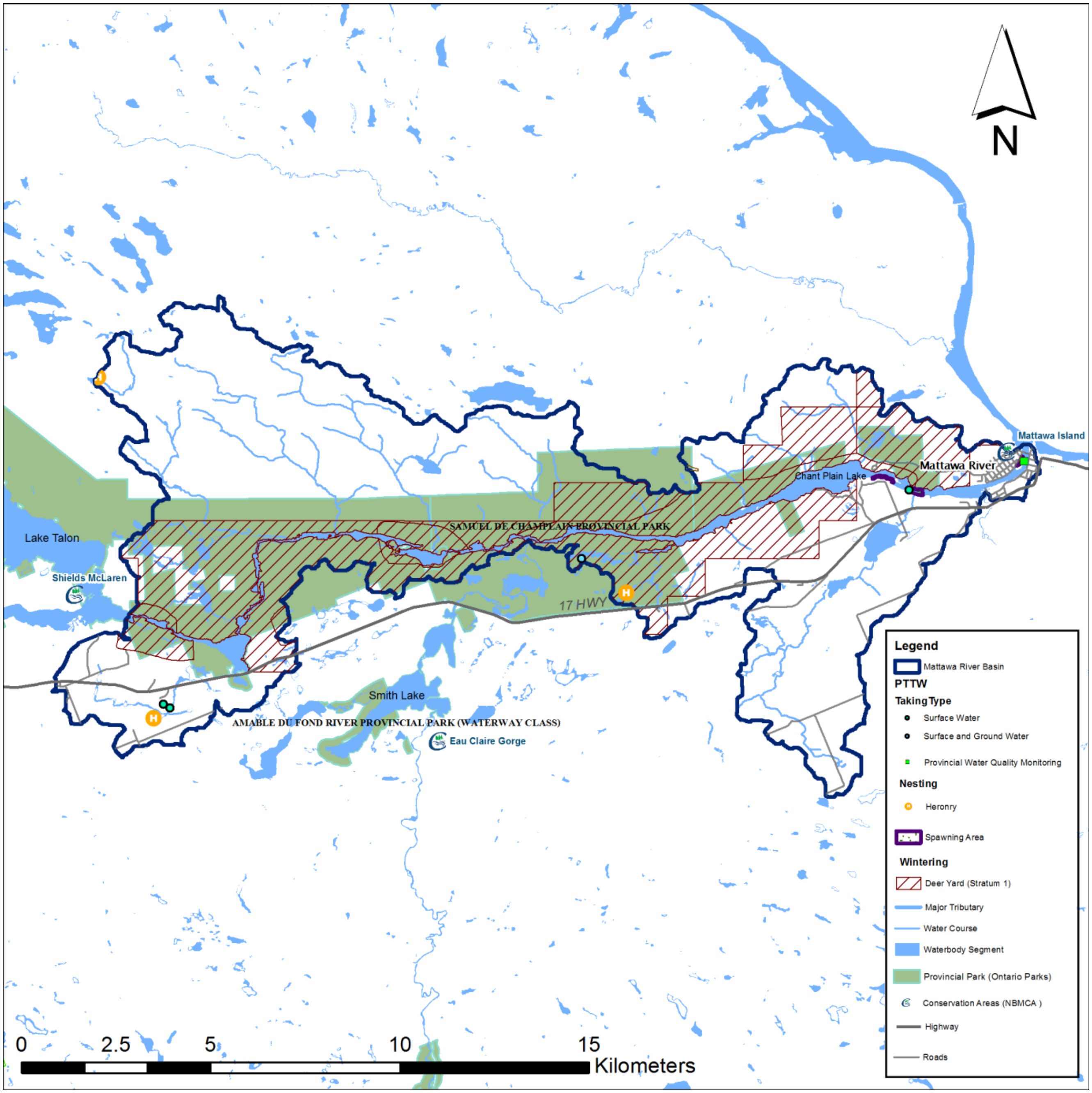
Figure 14.41 Lower Mattawa River Subwatershed Basin Characteristics



Data Available

- Provincial Water Quality Monitoring Stations:
  - Highway 533 Bridge, Mattawa (1968 – present)
  - Upstream of (Hurdman) Dam (1968 – 1871)
- Stream Flow Data:
  - Mattawa River Bouillon Lake (1971-1998)
  - Mattawa River at Rutherglen (1962 – 1971)

Figure 14.42 Lower Mattawa River Subwatershed Features



Major Water Bodies

- None
- Minor water bodies Lake Chant Plein, Lunch Lake, James Lake, Brucite Lake, Wright Lake, Pimisi Bay, Bouillon Lake, Long Lake, Purdy Lake, Duck Lake, Taggart Lake, Earls Lake

Development Pressure

- Development pressures within the Lower Mattawa River subwatershed are largely restricted to near the Town of Mattawa. There is relatively high pressure for shoreline development on the Mattawa River in (former) Papineau and Mattawan Townships. Small accessible lakes such as Earls, Taggart and Pimisi are also candidates for new development. An area west of the Town of Mattawa and north of Highway 17 is slated for industrial development which will see potential expansion of existing uses and new uses which will likely be linked to forestry. Slow rural residential and hobby farming growth can be expected in the planning horizon in northern Papineau.
- Minimal forestry activity is expected as most of the forested lands are protected by Provincial Park designations. A modest cut area is identified near Purdy Lake within the next harvest cycle.
- There is potential for increased aggregate mining within this subwatershed west of Taggart Lake and west of Pimisi Bay (pits have excellent access to the highway) which is largely dependent on construction activity including the 4 laning of Highway 17.
- Highway 17 four laning will cut across this subwatershed at three separate locations. Highway improvements are likely beyond the planning horizon of this study.

Fishing Pressure

- Information is not available.

Recreational Pressure

- The lower Mattawa River is a popular white water canoe route with wilderness camping opportunities. This water system is within the Mattawa River Provincial Park which is a waterway park. Pimisi Bay is a major public access point to the canoe route.
- Samuel de Champlain Provincial Park is partially within the lower Mattawa River watershed although the camping areas are mainly within the Amable du Fond subwatershed. The Canadian Ecology Center is within the Lower Mattawa basin.
- There are several tourist resorts within this subwatershed including resorts on Pimisi Bay, Lake Chant Plein and Mattawa River in Mattawa
- The mouth of the Mattawa River at Explorers Point is a popular urban Park with a Marina on the Ottawa River near the mouth. The Ottawa River is used for boating and the Mattawa River also has some watercraft use in Mattawa and on Lake Champlain.
- The NBMCA owns the Mattawa Island Conservation Area near the mouth of the Mattawa River which is mainly a day use/picnicking/swimming park.

Watershed Drainage Shape/Slope/Efficiency

- The Lower Mattawa River system has low open water area (6.3 %) and a low percentage of wetlands (3.8% which is the lowest percent of all subwatersheds). This watershed is well drained in its northern reaches.
- The slope of the main channel is relatively flat; the basin has average drainage density and a low basin relief for its size.
- The subwatershed is rated as having high drainage efficiency.

Runoff/Estimated Water Balance

- Hydrologic information for the Mattawa River Gauge at Bouillon Lake is available in the Lake Talon subwatershed assessment
- Hydrologic information for an old gauge located downstream of the outlet of the Amable de Fond River – referred to at Rutherglen – can be examined to determine basin hydrologic characteristics for the broader watershed (note the watershed area for this basin has been estimated to be the combination of the area above Bouillon Lake and above the Amable du Fond River)(also precipitation in the 1960's based on records from the North Bay Airport were below normal compared to other decades – the Rutherglen gauge has recorded approximately 6 m^3/sec lower flows than the combined Mattawa River at Bouillon Lake and Amable du Fond River at Samuel de Champlain Provincial Park gauges).

Station ID	Station Name	Record Period	Gauged Area km^2	Estimated Actual Evapotransiration (mm)	Mean Annual Surplus (mm)	Projected Total Precip (mm)	NB Airport TP (mm) for same period
02JE014	Mattawa River at Rutherglen	1962 - 1971	2082	530	387	917	892.0
				Red = PE - AE likely restricted by lack of precipitation			

<u>Mattawa River - Rutherglen Gauge (2082 km^2)</u>

Highest Recorded Flow	209 m^3/sec on Jul 22, 1970 (8 X average flows)
Mean Annual Flow	25.6 m^3/sec (1962 – 1971)
Lowest Recorded Flow	1.93 m^3/sec on Sept 8, 1964 (7.5% of average flows)

Water Use

- There are several Permits to Take Water Issued in The Lower Mattawa subwatershed including surface water permits for Columbia Forest Product (log irrigation) and Samuel de Champlain Provincial Park (camp ground water supply) and ground water permits for the Town of Mattawa municipal drinking water system

Hazards Identification

	Flood Plain/Fill Line Mapping Studies	Regulatory Event	Regulatory Level Available	Source/Date	Channelization
Lake Champlain	Elevation only	1:100 yr	160.78 m	Hurdman Dam Feasibility Study, No Date	
Mattawa River	Flood Plain Mapping	Timmins Storm	156.48 m	Dillon, 1978	
Mattawa River[1]	Flood Plain Mapping	1:100 yr	156.4 m in Mattawa	Proctor and Redfern, 1982	
Earl's Lake	Elevation Only	1:100 yr	178.0 m	Northland, 1988	
Taggart Lake	N/A	N/A	N/A		

1. In the Town of Mattawa

- The Lower Mattawa subwatershed is supported by fill line mapping in areas without flood plain mapping

Floodplain Regulation

- The Lower Mattawa River subwatershed, where floodlines exist, is regulated under the One Zone Floodplain Policy with the exception of the following Two Zone Floodplain Policy areas:
  - ➢ Within the regulatory flood plain of Lower Mattawa River in the Town of Mattawa (the flood fringe is defined as lands between the elevations of 155.45 m and 156.48 MASL).
- Areas without flood plain mapping or regulatory flood elevations are regulated based on fill lines as Development Constraint Areas

Water Quality Indicators

The following characteristics are evident for the Mattawa River at the Highway 533 PWQMN monitoring station:

- Mesotrophic River (TP = 11 µg/L) (range 2.0 – 20 µg/L) (n = 37)
- Neutral to slightly acidic pH – ranges between 6.64 and 7.64 (n = 12)
- Very low chlorides – ranges between 2.2 – 3.9 mg/L (n= 37)
- Conductivity is low – ranges between 27 – 74 µS/cm (n= 38)
- Overall water quality has improved since monitoring began and continues to experience gradual improvement.

- Water temperatures exceeds cold water criteria (summer maximum temperatures can reach 25^{o} C)
- Dissolved Oxygen levels range from 7.89 to 29.3 mg/L which is good for a warm water system.

Developed/Settled Areas as % of watershed

Headwaters east of Rutherglen are largely developed as is the Town of Mattawa, north Papineau and a small portion of Mattawan Township. Approximately 15 % of the subwatershed is settled. This subwatershed could see industrial and highway commercial development in (former) Papineau Township as well as rural residential growth and hobby farming. Highway 17 four laning and placement of interchanges may have a large impact on the west end of Mattawa/north Papineau. New interchanges potentially will open up access to new areas for development. However the development of this highway is likely beyond the planning horizon of this strategy.

Significant Feature

- Nesting Areas
- Deer Yard
- Walleye Spawning
- Potential or known Species at Risk
- Archaeological Significance along the Mattawa River

Previously Identified Management Issues

- Flooding in Town of Mattawa
- Flooding on small lakes near Mattawa with development potential
- Source Water Protection Town of Mattawa
- Fish Habitat of small inflowing streams in Papineau
- Bacteriological loading at Mattawa Island and other public beaches
- Hydro production on both the Ottawa and Mattawa Rivers affecting water levels

Drinking Water Source Protection Constraints

- This subwatershed is affected by the Source Protection Plan developed for the Town of Mattawa Drinking Water system which source groundwater from aquifers beneath the town. The Mattawa Source Water Protection Plan includes policy and action strategies that apply within well head protection zones on the north bank of the Mattawa River within the Town of Mattawa.

Headwater Management Concerns

- Limited Headwater Management Concerns

Management/Stewardship

- Substantial portion of the subwatershed is within a Provincial Park designation
- Friends of the Mattawa River Provincial Park and Camp Island

Vulnerability/Sensitivity to Climate Change

- Lower Mattawa River subwatershed Vulnerability to Climate Change is ranked as Moderate
- Lower Mattawa River subwatershed Sensitivity to Climate Change is ranked as Moderate

Vulnerability to Land Use Change

- Lower Mattawa River subwatershed Vulnerability to Land Use Change is ranked as High

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Appendices

Appendix A – Regional Water Balance Support Information
Appendix B – Provincial Highway Improvement Plans
Appendix C – Aggregate Producers within the NBMCA
Appendix D – Hydrologic Water Balance Estimates for Gauged Watersheds
Appendix E – Sensitivity/Vulnerability to Climate Change Evaluations
Appendix F – Future Land Use Change Vulnerability Evaluation Matrix

Appendix A – Regional Water Balance Support Information

A climatic water budget is a method of accounting for the gains and losses of water in a region. The method used in this report to compute a water budget for North Bay Airport was developed by Thornthwaite and Mather (1955) using air temperature and precipitation data.

Data from Environment Canada

Precipitation (P) and temperature (T) data was obtained from Environment Canada for the North Bay Airport (Station #6085700). The calculated parameters from Environment Canada included snowmelt, potential evapotranspiration (PE), actual evapotranspiration (AE) and the classification of precipitation as rain or snow. The definition of terms below is taken from the companion document entitled "Water Balance Tabulations for Canadian Climate Stations".

Precipitation (P)
Precipitation (P) is the accumulated precipitation (rain and snow) during the period.

Temperature (T)
Temperature (T) is average of the mean daily temperatures during the period.

Rain
Rain is the accumulated precipitation on days with a daily mean temperature greater than -1 ºC.

Snow Storage
Snow storage is the water equivalent of snow. It accumulates when T is less than -1 ºC. It is calculated by accumulating, over the winter, the precipitation on days with a mean temperature less than -1 ºC.

Snow Melt (Melt)
Snow melt (melt) is the accumulated daily melt. The melt is computed where there is snow on the ground and the daily temperature is greater than 0ºC and is computed as follows:

$$\text{Melt} = (1.88 + 0.007 \text{ X Precipitation}) \text{ X } (9 \text{ X Temperature}/5) + 1.27$$

Potential Evapotranspiration (PE)
Potential evapotranspiration (PE) is the amount of water that would be evaporated or transpired from a vegetated surface if there is sufficient moisture in the soil for the use of the vegetation (Thornthwaite and Mather, 1955). Potential evapotranspiration is given by:

$$\text{PE} = \text{Correction factor for length of day X } 0.533 \, (10 \text{ X Temperature / Heat Index})^{A}$$

The heat index calculated based on temperature. "A" is calculated based on the heat index.

Soil Water Holding Capacity (WHC) and Soil Storage
The water holding capacity (WHC) of the soil is the maximum amount of water that can be held in the capillaries of the soil for the use of the plants. The soil water holding capacity depends on the composition, structure, and depth of the soil and the type of vegetation surface.

The water budget values were computed based on a WHC value of 300 mm. The WHC was selected from the Ministry of Environment Stormwater Management Planning & Design Manual (2003) for a mature forest cover and a fine, sandy loam (Hydrologic Soil Group B).

Total Available Free Water (Rain + Melt)
When the total available free water (rain + melt) exceeds potential evapotranspiration (PE), the excess water is added to the soil storage until the WHC is reached. When PE exceeds the total available free water (rain + melt), water is drawn from the soil storage.

Actual Evapotranspiration (AE)
Actual evapotranspiration (AE) is the total evapotranspiration for the period. When the available free water equals or exceeds PE for the period, AE is set equal to PE. When the available free water is less than the PE, water is drawn from soil to meet evapotranspiration demands. The rate at which water can be drawn from soil is defined by a drying curve (assumed) and depends on the amount of water stored in the soil at the end of the previous period.

Moisture Surplus
The surplus water is the excess water after the evapotranspiration demands have been met (AE equals PE) and the soil storage has returned to the WHC level.

Moisture Deficit
The deficit is the amount by which the available water fails to meet the demand for water. It is computed by subtracting PE from AE for the period.

Over the long-term (30 years) the annual water budget equation can be expressed as:

Precipitation (Rain + Snow) – Actual Evapotranspiration = Surface Water Runoff

Assuming the following:
- changes in storage equal zero (surface water and groundwater),
- net consumptive use is zero,
- groundwater flow in and out are equal, and
- no major diversions.

When water is held in snowpack it is not available until it is melted. The above equation is only applicable on an annual basis when the water that is held in snowpack eventually melts and becomes available and the changes in storage reduce to zero. For this analysis, the amount of water that is potentially available in surface water runoff after evapotranspiration and melting has occurred was assumed to be:

Rain + Snowmelt – Actual Evapotranspiration = Surface Water Runoff

AVERAGE ANNUAL RATES OF CHANGE (1950-2010)

The annual water budget values for North Bay from 1950 - 2010 are shown in **Figures A1 to A4**. The average, annual rates of change, determined from the slope of the line, are as follows:

- Figure A1: Rain + Melt – 2.7 mm/year
- Figure A2: Actual Evapotranspiration (AE) – 0.7 mm/year
- Figure A3: Rain + Melt – Actual Evapotranspiration – 2.0 mm/year
- Figure A3: Temperature – 0.018 ºC/year

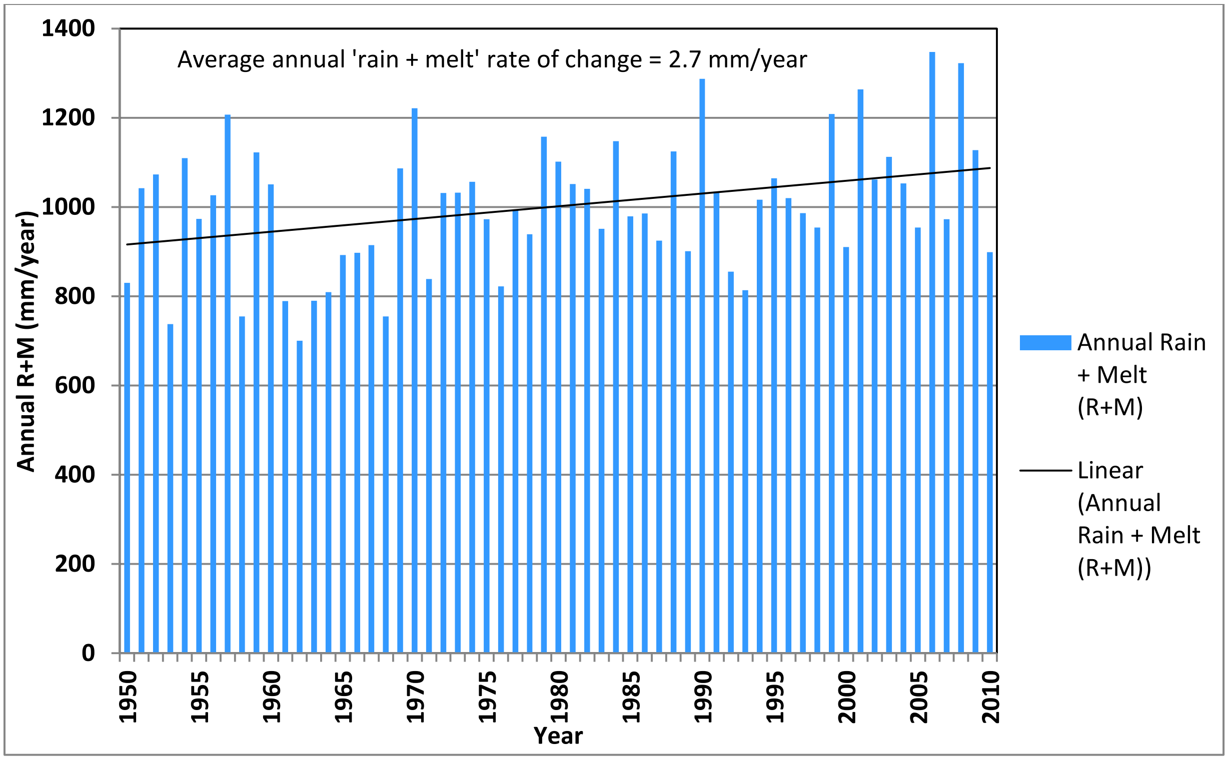

Figure A1: Annual 'rain + melt' (R+M) (1950 - 2010)

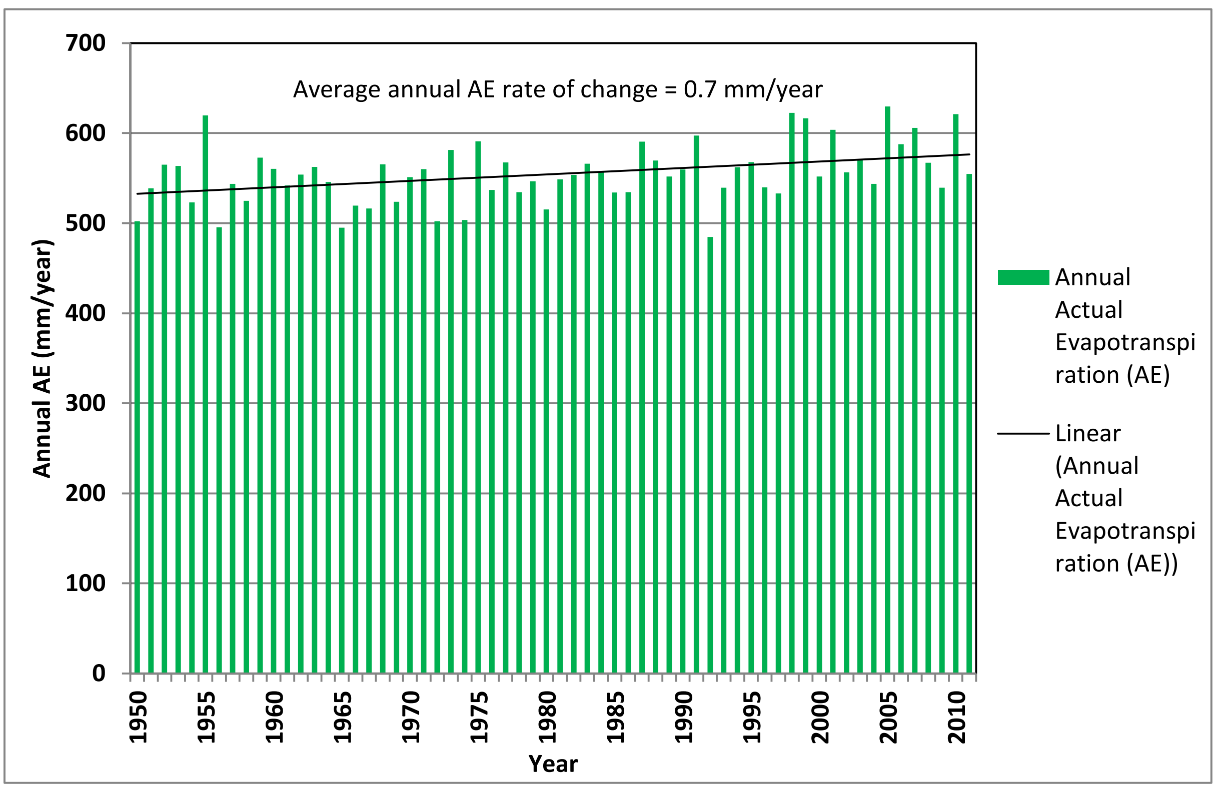

Figure A2: Annual actual evapotranspiration (AE) (1950 – 2010)

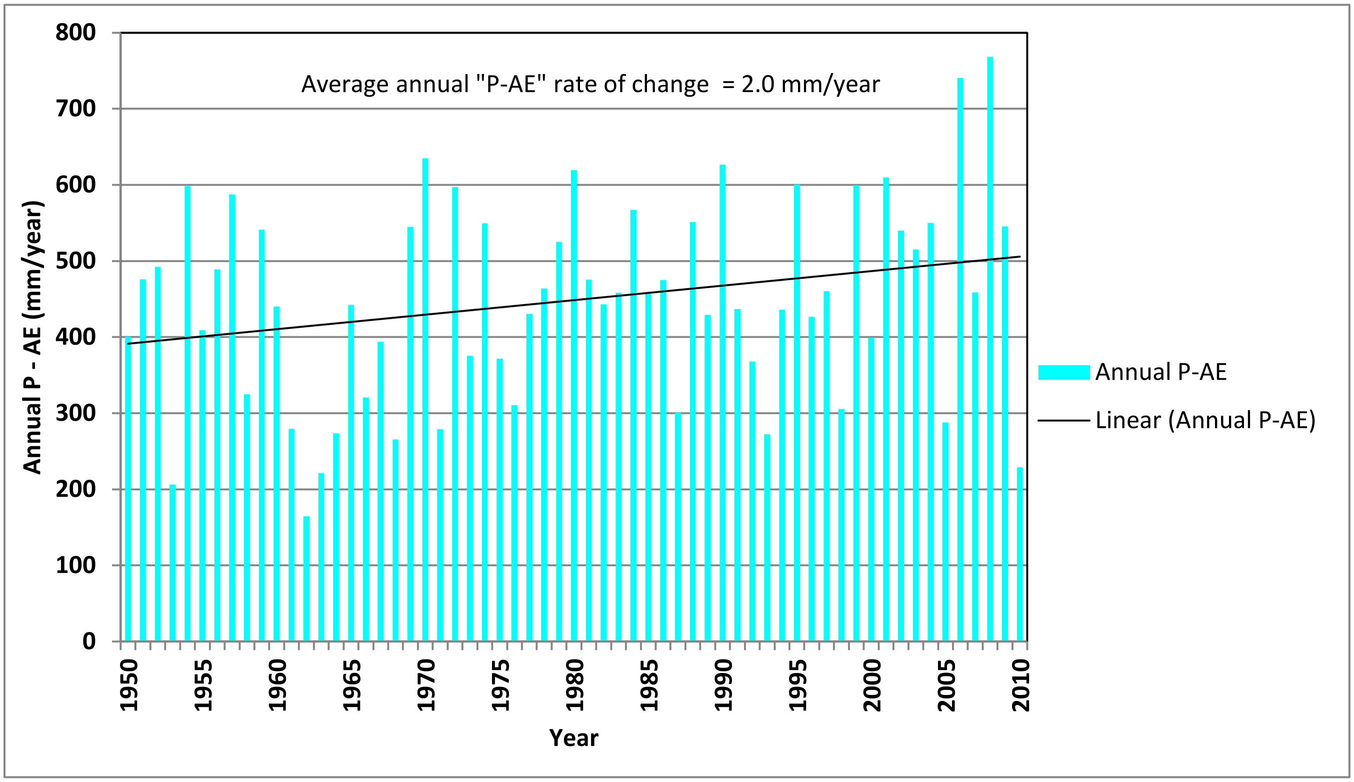

Figure A3: Annual "'rain + melt' - actual evapotranspiration" (R+M - AE) (1950 - 2010)

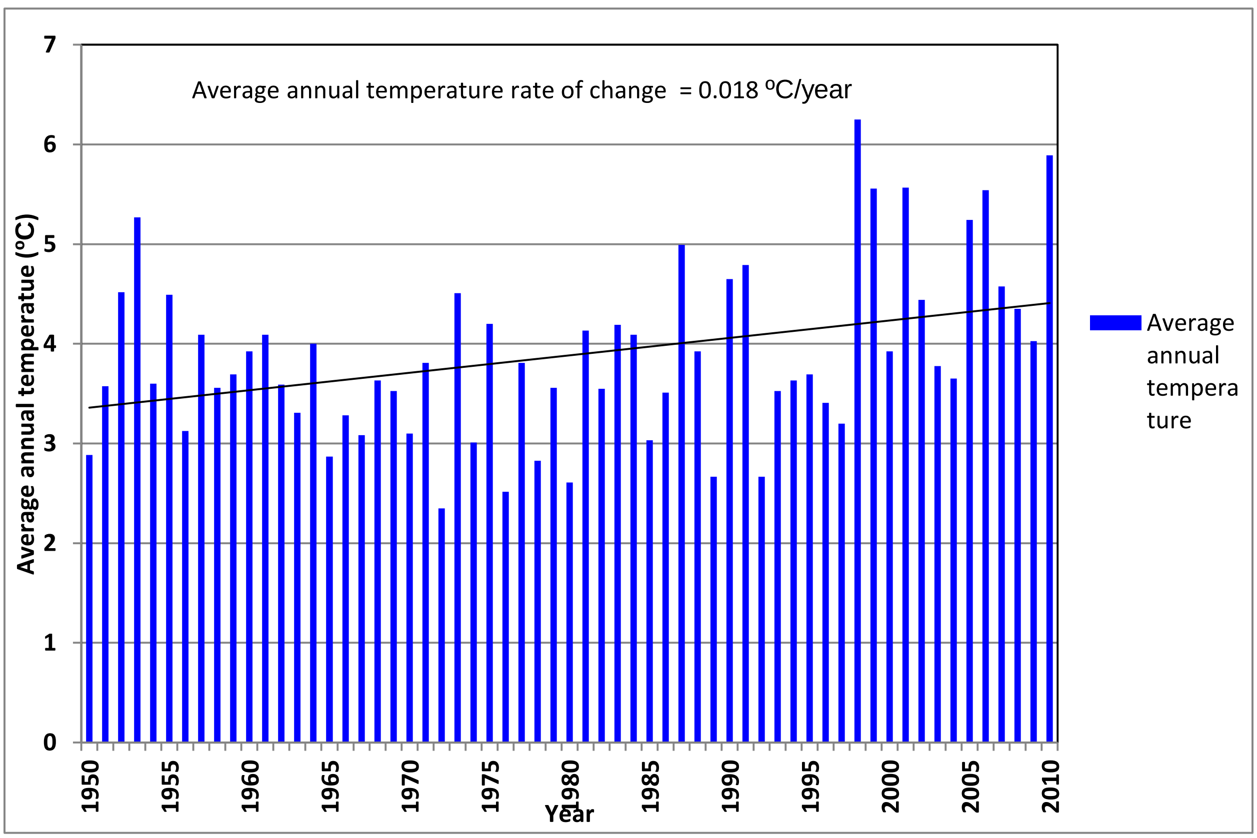

Figure A4: Average annual temperature (1950 – 2010)

AVERAGE ANNUAL AND MONTHLY WATER BUDGET VALUES (1981-2010)

Average monthly values calculated for the most recent climate normal period (1981-2010) are shown in Figures A5.

Figure A5 shows that Rain + Melt (R+M) and water surplus peak in March/April, drops off in the summer due to peak demands in evapotranspiration, and then rises again in October/November.

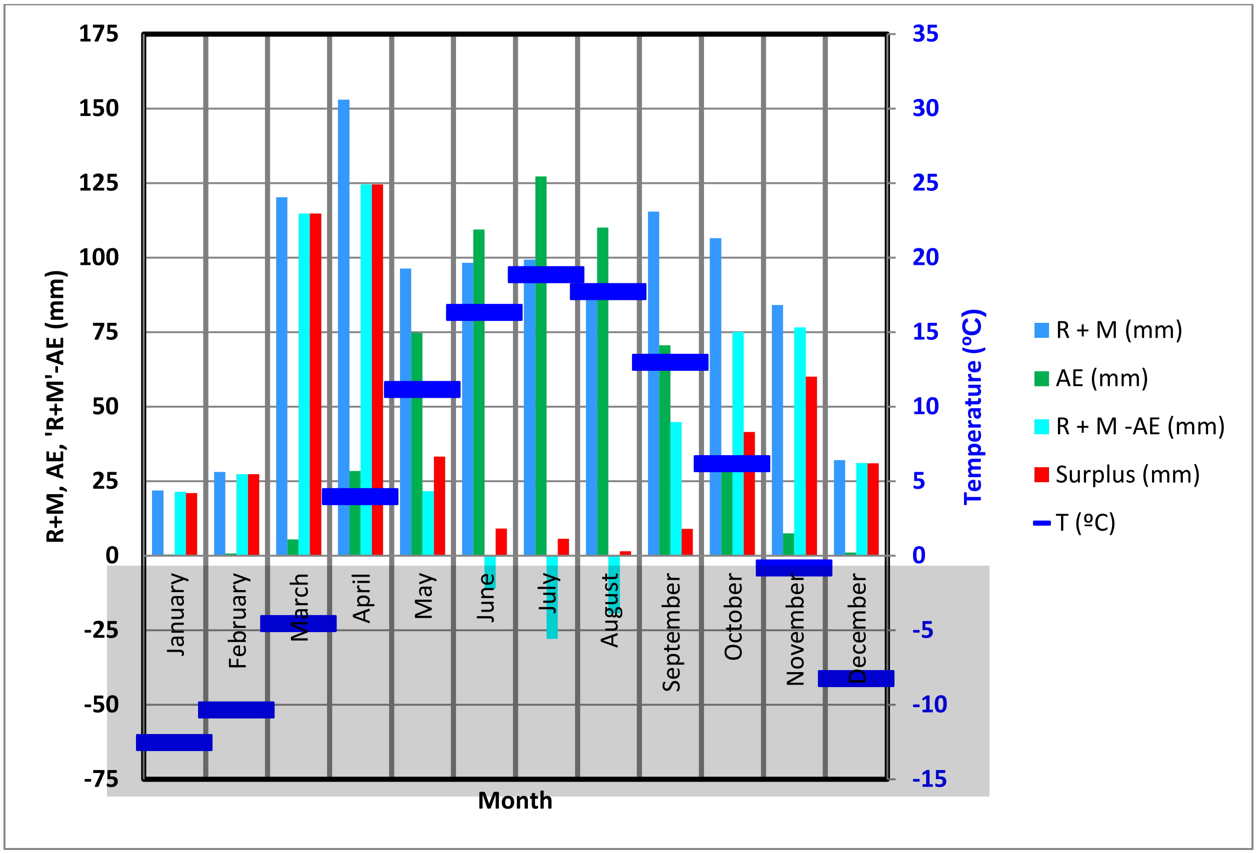

Figure A5: Average monthly available water values (1981 - 2010)

Table A1 shows the average annual and average monthly water budget values (1981-2010). Average, annual precipitation (and average, annual rain + melt) at North Bay is 1,045 mm. Average, annual actual evapotranspiration is 567 mm. The average potential surface water runoff (available water after evapotranspiration and soil infiltration) annually is 478 mm/yr.

Table A2 provides the average monthly and annual precipitation and temperature values for the two climate normal periods. Statistical t-tests were performed to determine if the differences in values between those two time periods are statistically significant. Bolded values are statistically significant (10% level of significance). Average precipitation has increased significantly for May and October. Average temperature has increased in April, July, August, September and December. Annual precipitation and temperature have significantly increased as well.

Table A1: Average annual and average monthly water budget values (1981-2010)

Month	Precipitation (P) (mm)	Rain + Melt (R+M) (mm)	Actual Evapotranspiration (AE) (mm)	P – AE (mm)	R+M – AE (mm)	Surplus	Temperature (T) (ºC)
January	68.9	21.8	0.4	68.5	21.5	21.0	-12.5
February	56.7	28.1	0.8	56.0	27.4	27.4	-10.4
March	64.9	120.2	5.5	59.5	114.7	114.8	-4.6
April	71.6	152.9	28.4	43.3	124.5	124.5	4.0
May	96.3	96.3	74.7	21.6	21.6	33.3	11.2
June	98.3	98.3	109.4	-11.2	-11.2	9.1	16.3
July	99.3	99.3	127.3	-27.9	-27.9	5.7	18.9
August	90.6	90.6	110.1	-19.5	-19.5	1.5	17.7
September	115.4	115.4	70.6	44.8	44.8	9.0	13.0
October	106.6	106.5	31.4	75.3	75.1	41.5	6.2
November	98.1	84.1	7.5	90.6	76.6	60.0	-0.8
December	77.8	32.1	1.0	76.8	31.1	31.0	-8.3
Annual	1044.6	1045.6	566.9	477.7	478.7	478.7	4.2

Table A2: Differences in precipitation and temperature between climate normal periods

Period	**1951-1980**		**1981-2010**		**Difference**	
Month	**Precipitation**	**Temperature**	**Precipitation**	**Temperature**	**Precipitation**	**Temperature**
January	63.6	-13.0	68.9	-12.5	5.2	0.4
February	55.7	-11.3	56.7	-10.4	1.0	0.9
March	61.8	-5.3	64.9	-4.6	3.2	0.8
April	62.3	3.1	71.6	4.0	9.3	**0.8**
May	69.4	10.6	96.3	11.2	**26.9**	0.6
June	85.1	15.7	98.3	16.3	13.2	0.6
July	102.4	18.3	99.3	18.9	-3.0	**0.6**
August	98.8	17.0	90.6	17.7	-8.1	**0.7**
September	115.9	12.2	115.4	13.0	-0.6	**0.8**
October	87.8	6.4	106.6	6.2	**18.8**	-0.2
November	86.7	-0.9	98.1	-0.8	11.4	0.1
December	75.5	-9.7	77.8	-8.3	2.3	**1.5**
Annual	964.9	3.6	1044.6	4.2	**79.7**	**0.6**

Legend

0.1	Values in bold are statistically significant (10% level of significance)

Tables A3 and A4 provides average monthly, seasonal and annual values for four climate normal periods and compares the past climate normal period (1950-1980) to the most recent one (1981-2010). Statistical t-tests were performed to determine if the differences in values between those two time periods are statistically significant. Values shown in bold were found statistically significant (10% level of significance). **Table A4** is the same as **Table A3** shows R+M and surplus.

The differences in the average water budget values between the climate normal periods were found to be statistically significant on an annual basis but not necessarily seasonal or monthly.

The amount of 'Rain + Melt – AE' and surplus is available earlier in the year now compared to the previous period. Values in the fall and winter for the most recent time period were significantly higher than those for the earlier period. Water surplus values for the most recent period in April were significantly lower than the previous one. Thus, the peak runoff still occurs in April however runoff for January, February and March have increased also and March has increased to almost match that for April; thus, the peak flow is shifting to earlier in the year.

Table A3: Average monthly water budget values by climate normal time period (P, AE, P-AE)

Note: Values in **Bold** are statistically significant (10% level of significance)

Period	1951-1980			1961-1990			1971-2000			1981-2010			Difference between time periods 1951-1980 and 1981-2010					
Month	Average Monthly Precipitation (mm)	Average Monthly Actual Evapotranspiration (mm)	Average Monthly P – AE (mm)	Average Monthly Precipitation (mm)	Average Monthly Actual Evapotranspiration (mm)	Average Monthly P – AE (mm)	Average Monthly Precipitation (mm)	Average Monthly Actual Evapotranspiration (mm)	Average Monthly P – AE (mm)	Average Monthly Precipitation (mm)	Average Monthly Actual Evapotranspiration (mm)	Average Monthly P – AE (mm)	Average Monthly Precipitation		Average Monthly Actual Evapotranspiration		Average Monthly P – AE	
January	63.6	0.1	63.5	60.6	0.2	60.5	67.6	0.2	67.3	68.9	0.4	68.5	5.2 mm	8%	**0.2 mm**	93%	5.0 mm	8%
February	55.7	0.3	55.5	51.4	0.5	50.9	51.8	0.8	51.0	56.7	0.8	56.0	1.0 mm	2%	**0.5 mm**	103%	0.5 mm	1%
March	61.8	3.5	58.3	64.3	4.4	59.9	66.2	5.1	61.1	64.9	5.5	59.5	3.2 mm	5%	**2.0 mm**	45%	1.2 mm	2%
April	62.3	24.8	37.5	66.7	25.7	41.0	67.2	26.1	41.1	71.6	28.4	43.3	9.3 mm	14%	3.6 mm	13%	5.8 mm	14%
May	69.4	71.5	-2.2	80.0	72.4	7.6	87.6	75.5	12.1	96.3	74.7	21.6	**26.9 mm**	33%	3.2 mm	4%	**23.8 mm**	244%
June	85.1	106.0	-20.9	91.6	104.7	-13.1	95.2	107.3	-12.1	98.3	109.4	-11.2	13.2 mm	14%	3.5 mm	3%	9.7 mm	61%
July	102.4	124.1	-21.7	96.6	125.5	-28.9	100.1	125.7	-25.6	99.3	127.3	-27.9	-3.0 mm	-3%	3.2 mm	3%	-6.2 mm	-25%
August	98.8	105.4	-6.6	101.9	105.9	-4.1	100.1	108.1	-8.0	90.6	110.1	-19.5	-8.1 mm	-9%	**4.7 mm**	4%	-12.8 mm	-98%
September	115.9	66.8	49.1	108.9	66.8	42.1	113.5	66.7	46.7	115.4	70.6	44.8	-0.6 mm	0%	**3.8 mm**	5%	-4.3 mm	-9%
October	87.8	33.0	54.8	89.3	32.0	57.3	97.6	30.8	66.9	106.6	31.4	75.3	**18.8 mm**	19%	-1.6 mm	-5%	**20.5 mm**	32%
November	86.7	7.7	79.0	87.4	7.3	80.2	89.9	6.9	83.0	98.1	7.5	90.6	11.4 mm	12%	-0.2 mm	-3%	11.6 mm	14%
December	75.5	0.9	74.6	75.5	0.8	74.7	70.9	0.8	70.0	77.8	1.0	76.8	2.3 mm	3%	0.2 mm	17%	2.2 mm	3%
Season	**Average Seasonal Precipitation (mm)**	**Average Seasonal Actual Evapotranspiration (mm)**	**Average Seasonal P – AE (mm)**	**Average Seasonal Precipitation (mm)**	**Average Seasonal Actual Evapotranspiration (mm)**	**Average Seasonal P – AE (mm)**	**Average Seasonal Precipitation (mm)**	**Average Seasonal Actual Evapotranspiration (mm)**	**Average Seasonal P – AE (mm)**	**Average Seasonal Precipitation (mm)**	**Average Seasonal Actual Evapotranspiration (mm)**	**Average Seasonal P – AE (mm)**	**Average Seasonal Precipitation**		**Average Seasonal Actual Evapotranspiration**		**Average Seasonal P – AE**	
Spring	193.5	99.8	93.6	211.0	102.5	108.5	221.1	106.7	114.3	232.9	108.5	124.3	**39.4 mm**	18%	8.7 mm	8%	**30.7 mm**	28%
Summer	286.2	335.4	-49.2	290.1	336.1	-46.0	295.4	341.1	-45.7	288.2	346.8	-58.5	2.0 mm	1%	**11.4 mm**	3%	-9.3 mm	-17%
Fall	290.4	107.6	182.9	285.7	106.1	179.6	301.0	104.4	196.6	320.1	109.5	210.7	**29.7 mm**	10%	1.9 mm	2%	27.8 mm	14%
Winter	194.9	1.2	193.6	187.5	1.4	186.1	190.2	1.8	188.4	203.4	2.2	201.3	8.6 mm	4%	**0.9 mm**	54%	**7.6 mm**	4%
Annual	964.9	544.0	420.9	974.2	546.0	428.2	1007.7	554.0	453.6	1044.6	566.9	477.7	**79.7 mm**	8%	**22.9 mm**	4%	**56.8 mm**	13%

Table A4: Average monthly and seasonal water availability by climate normal period ('R+M', 'R+M' – AE, Surplus)

Note: Values in **Bold** are statistically significant (10% level of significance)

Period	1951-1980			1961-1990			1971-2000			1981-2010			Difference between time periods 1951-1980 and 1981-2010 (mm / %)					
Month	Average Monthly Rain +Melt (mm)	Average Monthly (R+M) – AE (mm)	Average Monthly Surplus (mm)	Average Monthly Rain +Melt (mm)	Average Monthly (R+M) – AE (mm)	Average Monthly Surplus (mm)	Average Monthly Rain +Melt (mm)	Average Monthly (R+M) – AE (mm)	Average Monthly Surplus (mm)	Average Monthly Rain +Melt (mm)	Average Monthly (R+M) – AE (mm)	Average Monthly Surplus (mm)	Average Monthly Rain + Melt		Average Monthly Rain + Melt - Actual Evapotranspiration		Average Monthly Surplus (mm)	
January	9.7	9.6	8.9	10.8	10.7	9.5	15.4	15.1	14.7	21.8	21.5	21.0	**12.1 mm**	77%	**11.9 mm**	76%	**12.1 mm**	81%
February	13.7	13.4	10.1	19.0	18.5	18.1	27.2	26.5	26.3	28.1	27.4	27.4	**14.5 mm**	69%	**13.9 mm**	68%	**17.3 mm**	92%
March	87.8	84.3	76.3	109.8	105.5	98.0	115.6	110.5	110.0	120.2	114.7	114.8	**32.4 mm**	31%	**30.4 mm**	31%	**38.5 mm**	40%
April	192.7	167.9	165.3	164.9	139.2	135.7	151.8	125.7	125.2	152.9	124.5	124.5	**-39.8 mm**	-23%	**-43.4 mm**	-30%	**-40.7 mm**	28%
May	74.5	2.9	18.5	81.3	8.9	22.9	88.9	13.4	26.2	96.3	21.6	33.3	**21.8 mm**	26%	18.7 mm	152%	**14.8 mm**	57%
June	85.1	-20.9	7.4	91.6	-13.1	7.5	95.2	-12.1	8.0	98.3	-11.2	9.1	13.2 mm	14%	9.7 mm	61%	1.6 mm	20%
July	102.4	-21.7	6.9	96.6	-28.9	8.0	100.1	-25.6	5.1	99.3	-27.9	5.7	-3.0 mm	-3%	-6.2 mm	-25%	-1.2 mm	20%
August	98.8	-6.6	6.1	101.9	-4.1	4.4	100.1	-8.0	5.8	90.6	-19.5	1.5	-8.1 mm	-9%	-12.8 mm	-98%	-4.6 mm	122%
September	115.9	49.1	16.1	108.9	42.1	13.7	113.5	46.7	15.2	115.4	44.8	9.0	-0.6 mm	0%	-4.3 mm	-9%	-7.1 mm	56%
October	87.4	54.4	32.6	88.9	57.0	34.0	97.5	66.7	38.1	106.5	75.1	41.5	**19.1 mm**	20%	**20.7 mm**	32%	8.9 mm	24%
November	69.8	62.1	47.9	70.5	63.2	47.7	75.8	68.8	55.1	84.1	76.6	60.0	**14.3 mm**	19%	**14.5 mm**	21%	**12.1 mm**	22%
December	25.5	24.7	19.2	28.9	28.1	23.9	25.7	24.9	23.0	32.1	31.1	31.0	6.5 mm	23%	6.4 mm	23%	**11.8 mm**	47%
	Average Seasonal Rain + Melt (mm)	Average Seasonal R+M – AE (mm)	Average Seasonal Surplus (mm)	Average Seasonal Rain + Melt (mm)	Average Seasonal R+M – AE (mm)	Average Seasonal Surplus (mm)	Average Seasonal Rain + Melt (mm)	Average Seasonal R+M – AE (mm)	Average Seasonal Surplus (mm)	Average Seasonal Rain +Malt(mm)	Average Seasonal R+M – AE (mm)	Average Seasonal Surplus (mm)	Average Seasonal Rain + Melt		Average Seasonal R+M – AE		Average Seasonal Surplus (mm)	
Spring	355.0	255.2	86.7	356.0	253.6	85.5	356.3	249.6	87.1	369.4	260.9	90.9	14.4 mm	4%	5.7 mm	2%	4.2 mm	5%
Summer	286.2	-49.2	6.8	290.1	-46.0	6.6	295.4	-45.7	6.3	288.2	-58.5	5.4	2.0 mm	1%	-9.3 mm	-17%	-1.4 mm	23%
Fall	273.2	165.6	32.2	268.4	162.3	31.8	286.7	182.3	36.1	305.9	196.5	36.8	**32.8 mm**	11%	**30.9 mm**	17%	4.6 mm	13%
Winter	49.0	47.7	12.7	58.7	57.3	17.2	68.3	66.5	21.3	82.0	79.9	26.5	**33.1 mm**	51%	**32.2 mm**	50%	**13.7 mm**	70%
Annual	963.3	419.3	415.3	973.2	427.1	452.7	1006.7	452.7	452.7	1045.6	478.7	478.7	**82.3 mm**	8%	**59.4 mm**	13%	**63.4 mm**	14%

Spring = March, April, May
Summer = June, July, August
Fall = September, October, November
Winter = December, January, February

Appendix B - Provincial Highway Improvement Plans

Figure B1 Selected Route Alignment for New Highway 17 Four Lane between North Bay (Highway 11) and Bonfield (Highway 531)

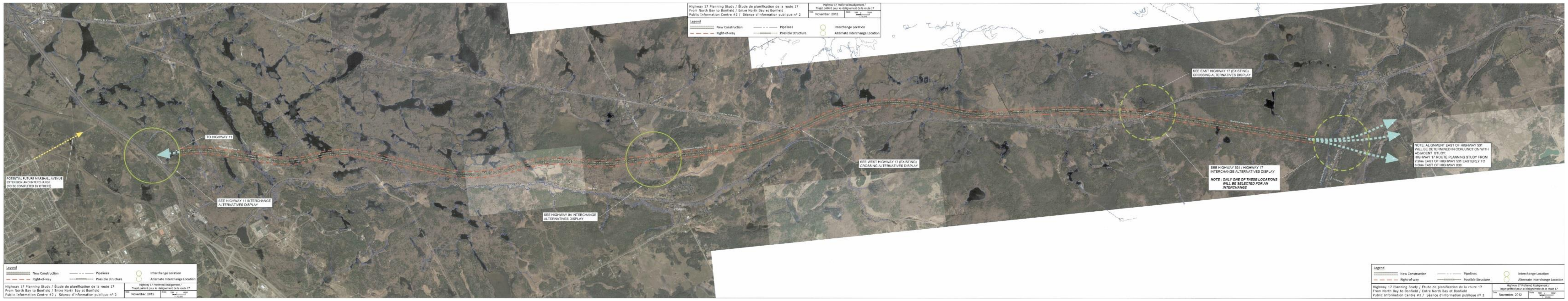

Figure B2 Selected Route Alignment for New Highway 17 Four Lane between Bonfield (Highway 531) and Columbia Forest Products

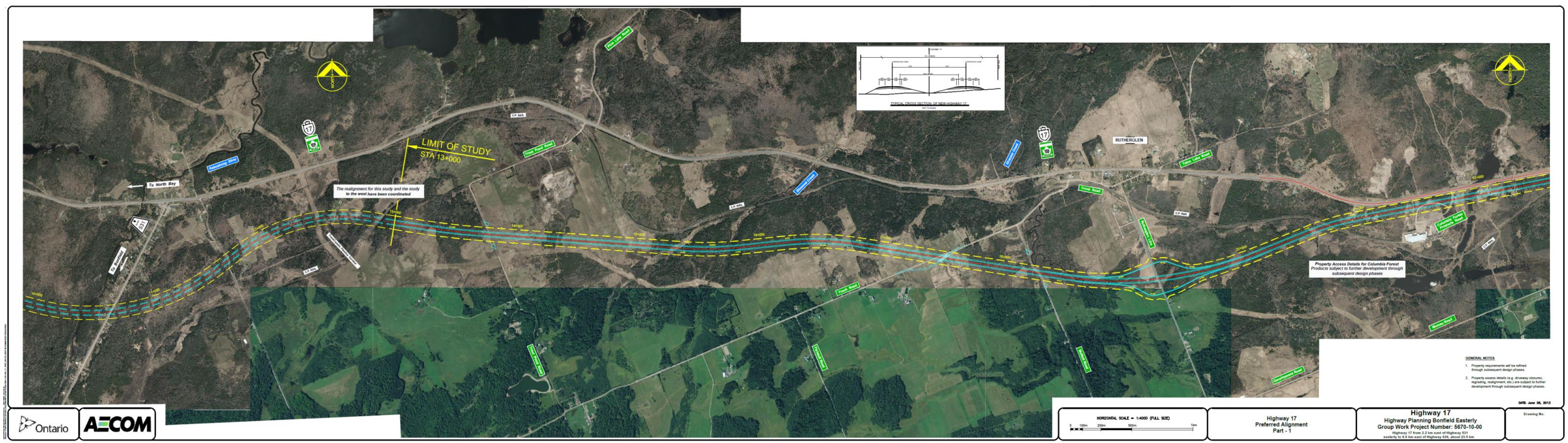

Figure B3 Selected Route Alignment for New Highway 17 Four Lane between Columbia Forest Products and Crooked Calvin/Papineau-Cameron Boundary

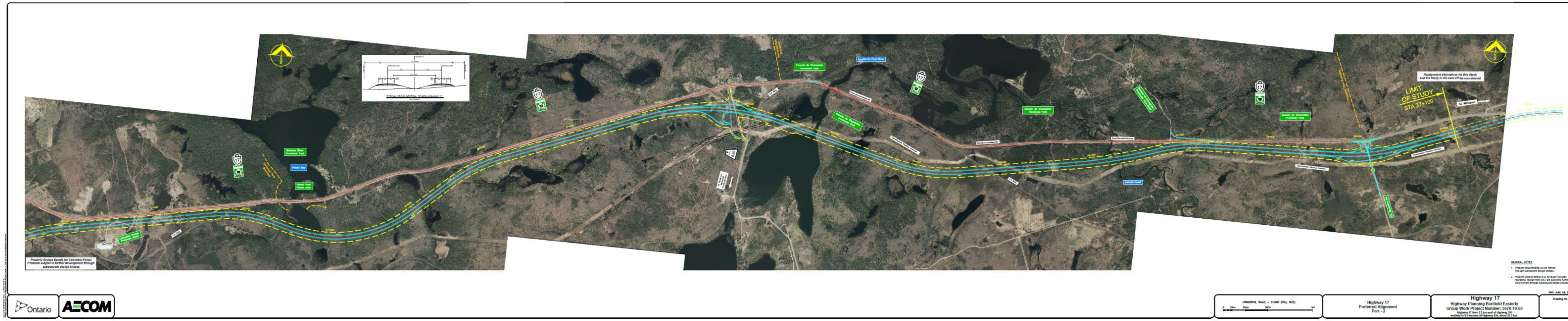

Figure B4 Selected Route Alignment for New Highway 17 Four Lane between Champlain Park and the Eastern Boundary of Nipissing District

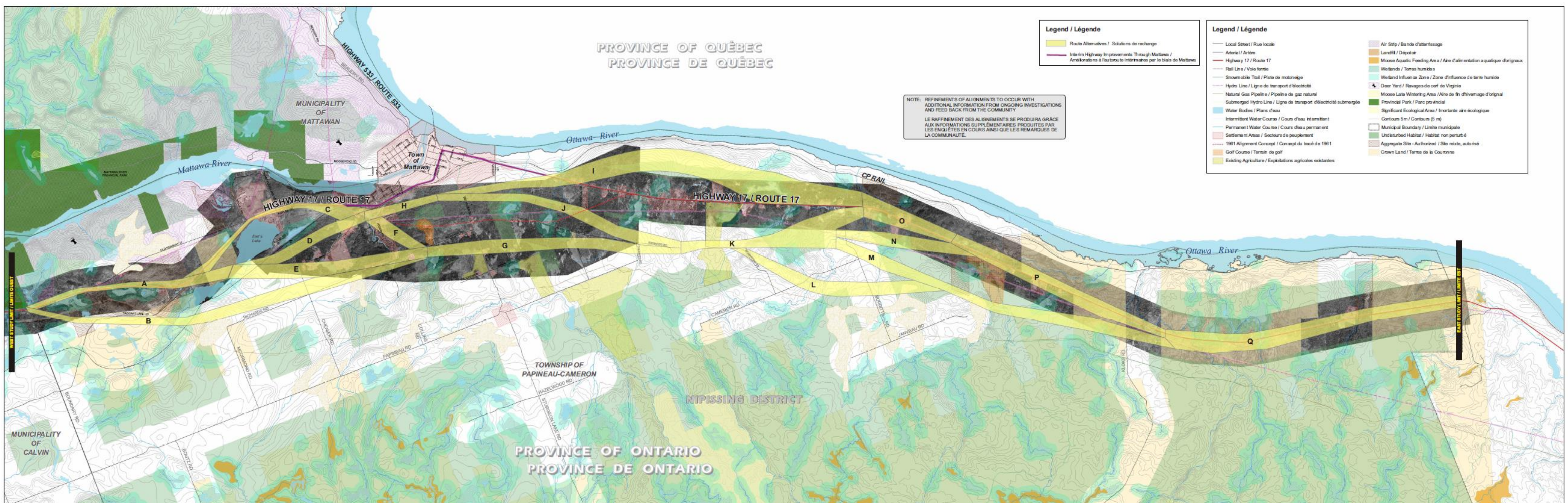

Figure B5 Future North Bay Highway 11/17 Bypass - Recommended Plan

FUTURE HIGHWAY 11/17, NORTH BAY, PHASE 1 FROM 1.5 km SOUTH OF HIGHWAY 17 SOUTH JUNCTION ON HIGHWAY 11 NORTHERLY 5.4 km GWP 5748-04-00	LEGEND NEW ROADWAY LIMIT OF NEW RIGHT-OF-WAY LIMIT OF EXISTING MTO RIGHT-OF-WAY	SCALE 0 200m 1:10000	Ministry of Transportation Ontario Stantec	RECOMMENDED PLAN	EXHIBIT 1

Appendix C - Aggregate Producers within the NBMCA

Sum of MAX ANNUAL TONNAGE	Column Labels			
Municipality/Owner	Pit & Quarry	Pit	Quarry	Total
BONFIELD TP		**1,540,000**		**1,540,000**
Allen Rudiger		20,000		20,000
Corporation of The Township of Bonfield		60,000		60,000
Daniel Hone		20,000		20,000
Dennis Brown		20,000		20,000
George Cook		20,000		20,000
Hoe North Construction Ltd.		20,000		20,000
James Savard		20,000		20,000
John Houle		20,000		20,000
Miller Paving Limited		1,300,000		1,300,000
Robert Amyotte		20,000		20,000
Victor Laplante		20,000		20,000
CALLANDAR	**300,000**	**1,614,000**		**1,914,000**
Bolton Backhoeing Ltd.		1,000,000		1,000,000
Evan Hughes	300,000			300,000
Gary Mote		20,000		20,000
James Barber		20,000		20,000
Jim Corbeil		20,000		20,000
Lloyd Yeates		14,000		14,000
Murray Byers		20,000		20,000
Neil Jones Construction Inc.		500,000		500,000
Wendy Carew		20,000		20,000
CALVIN TP	**1,000,000**	**310,000**		**1,310,000**
Edgar Poulin Construction & Rentals Ltd.		250,000		250,000
Lise Houle		20,000		20,000
Miller Paving Limited		20,000		20,000
RÚal & Carmen Ouellette		20,000		20,000
Torque Raceway Ltd.	1,000,000			1,000,000
CHISHOLM TP		**1,632,000**		**1,632,000**
Bolton Backhoeing Ltd.		1,000,000		1,000,000
Darren Young		20,000		20,000
Fernand Larochelle		20,000		20,000
Gerry Rose		20,000		20,000
Joe Periard		20,000		20,000
Marcel Point		20,000		20,000
Miller Paving Limited		320,000		320,000
Neil Jones Construction Inc.		20,000		20,000
Richard & Paulette Teal		20,000		20,000
Terry & Carole Tran		20,000		20,000
The Corporation of the Township of Chisolm		152,000		152,000
EAST FERRIS TP	**20,000**			**20,000**
Richard Champagne	20,000			20,000
MATTAWAN TP		**60,000**		**60,000**
Emile Janveaux Forest Products Ltd.		60,000		60,000
NORTH BAY	**5,420,000**	**6,900,000**	**2,000,000**	**14,320,000**
1167613 Ontario Limited		20,000		20,000
520710 Ontario Limited	20,000			20,000
786627 Ontario Limited	100,000			100,000
Bruman Leasing Ltd.	1,000,000			1,000,000
CD & G Transportation		20,000		20,000
D.B.C. AGGREGATES LTD.	400,000			400,000
DBC Aggregates Ltd.			1,000,000	1,000,000
Gap Construction Co. Ltd.		1,000,000		1,000,000
Gold Fleet Investments Ltd.		1,000,000		1,000,000
Henry's Excavating Limited		300,000		300,000
LEO ALARIE AND SONS CONSTRUCTION LTD	1,000,000	1,020,000		2,020,000
Miller Paving Limited	1,400,000	300,000	1,000,000	2,700,000
NORTHERN BRICK AND TILE LTD.		150,000		150,000
NORTHFIELD BLOCK & GRAVEL SUPPLY LTD.	500,000	20,000		520,000
PIONEER CONSTRUCTION INC.	1,000,000	2,050,000		3,050,000
RAN DON CRANE AND LEASING LIMITED		20,000		20,000
Terrance Fownes		1,000,000		1,000,000
PAPINEAU-CAMERON TP	**1,000,000**	**1,220,000**		**2,220,000**
1491239 Ontario Inc.	1,000,000			1,000,000
Armand Robitaille		40,000		40,000
Brian Decaire		1,000,000		1,000,000
Dumont Backhoe Services		20,000		20,000
JL Pilon Contracting		20,000		20,000
Mike Martel		100,000		100,000
The Corporation of the Township of Papineau-Cameron		20,000		20,000
Ward Resmer		20,000		20,000
POWASSON M		**1,910,000**		**1,910,000**
1167613 Ontario Limited		250,000		250,000
Cynthia Lawrence, Rosemarie Gale & Catharine Brown		20,000		20,000
Evan Hughes		1,000,000		1,000,000
Garry Keown		20,000		20,000
Jean Jardine		20,000		20,000
Kenneth Rich		20,000		20,000
Larry Ciglen/Steven Ciglen		500,000		500,000
Municipality of Powassan		20,000		20,000
Walter Brownlee		20,000		20,000
Whitmill Powassan Limited		40,000		40,000
NBMCA	7,740,000	15,186,000	2,000,000	24,926,000
Ontario	248,361,540	1,630,557,712	374,393,224	2,253,727,476

Source: Gravel Watch Ontario – data is available at http://www.gravelwatch.org/gravel_stats.htm

Appendix D - Hydrologic Water Balance Estimates for Gauged Watersheds

		Record	Gauged Area [1]	Estimated Actual	Mean Annual	Projected	NB Airport TP (mm)
Station ID	Station Name	Period	sq km	Evapotransiration [2] (mm)	Surplus [3] (mm)	Total Precip [4] (mm)	for same period
02DD006	Duchesnay River near North Bay	1956 - 1982	100	530	519	1049	961.6
02DD014	Chippewa Creek at North Bay	1974 - 2011	37.3	535	516	1051	1035.8
02DD013	La Vase River at North Bay	1974 - 2011	70.4	535	412	947	1035.8
02DD024	Wasi River near Astorville	2007 - 2011	211.5	545	407	952	1069.0
02JE020	Mattawa River at Bouillon Lake	1971 - 1998	951.5	535	515	1050	1002.9
02JE014	Mattawa River at Rutherglen	1962 - 1971	2082	530	387	917	892.0
02JE019	Amable du Fond at Champlain PP	1972 - 1995	1130	535	449	984	1013.9
02JE019	Amable du Fond at Kiosk	2006 - 2011	706	545	513	1058	1106.0

Red = PE - AE likely restricted by lack of precipitation

Footnotes
1. Watershed gauged areas have been calculated or updated from subwatershed mapping produced for IWMP
2. Actual Evaporation is estimated from Evapotranspiration rate mapping provided by North Bay-Mattawa Source Protection Area Conceptual Water Budget (Gartner Lee 2008) and adjusted for the period based on water balance information presented in Section 7
3. Data generated by HYDAT for updated gauged areas for period
4. Summation of Estimated Actual Evapotranspiration and Mean Annual Runoff

Appendix E – Sensitivity/Vulnerability to Climate Change Evaluations

	Appendix E.1		Sensitivity Scoring for Climate Change Impacts					
	Subwatershed	Evolving Freshet	Wetter Spring/ Fall	Deepening Summer Water Deficit	More Extreme Flow Conditions	More Intense Summer Storms	Overall Ranking	
1	Bear Creek	Low	Low	Moderate	Moderate	Low	**Moderate**	9
2	Boulder	Low	Low	Low	Low	Low	**Low**	5
3	Windsor	Low	Low	Low	Low	Low	**Low**	5
4	Burford Creek	Low	Low	Low	Low	Moderate	**Low**	7
5	Callander Bay/South Shore	Moderate	Low	Low	Low	High	**High**	13
6	Chippewa Creek	Moderate	Moderate	High	High	High	**High**	21
7	Duchesnay Creek	Low	Low	High	Moderate	Low	**High**	13
8	Jessups Creek	Low	Low	Low	Low	High	**Moderate**	11
9	Lake Nipissing/North Bay	Moderate	Low	Low	Low	High	**High**	13
10	La Vase River	Moderate	Low	High	High	Moderate	**High**	17
11	Parks Creek	Moderate	Moderate	Low	Low	High	**High**	15
12	Wistiwasing River	Moderate	Moderate	Moderate	Moderate	Low	**High**	13
13	Amable du Fond River	Low	Low	Moderate	Moderate	Low	**Moderate**	9
14	Boom Creek	Low	Low	Low	Low	Low	**Low**	5
15	Kaibuskong River	Moderate	Low	Low	Low	Moderate	**Moderate**	9
16	Mattawa River	Low	Low	Moderate	Moderate	Low	**Moderate**	9
17	North River	Low	Low	Moderate	Moderate	Low	**Moderate**	9
18	Pautois Creek	Low	Low	Moderate	Moderate	Low	**Moderate**	9
19	Sharpes Creek	Low	Low	Moderate	Moderate	Low	**Moderate**	9
20	Talon Lake	Low	Low	Moderate	Low	Low	**Low**	7
21	Trout Lake	Low	Low	High	Low	Low	**Moderate**	11
22	Turtle Lake	Low	Low	Moderate	Low	Low	**Low**	7
	Note Blue = Brook Trout							
	Effect	Earlier Freshet	Wetter Conditions	Dryer Conditions	More extremes	High rates of		
		More winter runoff			High/Low Flows	Rainfall		
	Concern	Flooding/Erosion	Higher flows	Low water/flows	Flooding/Erosion	Flooding in		
		Ice Damages/Daming	Erosion	Brook Trout Habitat	Low Water	Small systems or		
		Walleye Spawning			Brook Trout Habitat	with damages		
		Impact Sensitivity	Individual Scoring	Aggregate Ranking	Distribution			
		Low	1	5 to 8	6			
		Moderate	3	9 to 12	9			
		High	5	13+	7			

Appendix E.2 | **Subwatershed Indicators of Climate Change Vulnerability**

	Subwatershed	System has flood damage vulnerability	Floodplain has a Two Zone Designation	System Hazards have identifiable Risk to Life	System has many structures/crossings	Streams are highly susceptible to Erosion	Susceptible to Extreme Flow Conditions	Has Streams that Support Brook Trout	Lakes in system already have Habitat Limitations	Watershed has level sensitive spawning areas	Development on Lakeshores are at Capacity	Blue Green Algae affecting Water Use	Lakes/Waterways used for Navigtion	Contains Lakes important for Ice Fishing	High Percentage of Confirerous Forests	Total Score	Ranking
1	Bear Creek				✓			✓								2	Low
2	Boulder				✓											1	Low
3	Windsor				✓										✓	1	Low
4	Burford Creek					✓										1	Low
5	Callander Bay/South Shore	✓			✓					✓	✓	✓	✓	✓		7	High
6	Chippewa Creek	✓	✓	✓	✓	✓	✓	✓								7	High
7	Duchesnay Creek						✓	✓							✓	3	Moderate
8	Jessups Creek	✓														1	Low
9	Lake Nipissing/North Bay	✓			✓					✓			✓	✓		5	Moderate
10	La Vase River	✓	✓		✓		✓						✓			5	Moderate
11	Parks Creek	✓	✓	✓	✓											4	Low
12	Wistiwasing River				✓	✓		✓	✓	✓	✓	✓	✓	✓		9	High
13	Amable du Fond River				✓			✓					✓			3	Moderate
14	Boom Creek				✓										✓	2	Low
15	Kaibuskong River				✓				✓	✓	✓	✓	✓	✓		7	High
16	Mattawa River	✓	✓										✓		✓	4	Moderate
17	North River				✓			✓								2	Low
18	Pautois Creek				✓			✓							✓	3	Moderate
19	Sharpes Creek				✓			✓								2	Low
20	Talon Lake							✓	✓				✓	✓		4	Moderate
21	Trout Lake				✓			✓			✓		✓	✓		5	Moderate
22	Turtle Lake									✓			✓			2	Low

Aggregate Ranking	Ranking	Distribution
0 - 2	Low	10
3 to 5	Moderate	8
6 +	High	4

Appendix F - Future Land Use Change Vulnerability Evaluation Matrix

	Subsatershed	Urban Growth Expected	Rural Growth Expected	Decline/Shift in Agriculture	Aggregate Mining Activity	Forestry Impacts	Shoreline Development	Boating/Fishing Rec/Tourism Uses	Overall Score	
1	Bear Creek		☑	✓	✓				Low	4
2	Boulder		☑	✓	✓				Low	4
3	Windsor		☑	✓	✓				Low	4
4	Burford Creek								Very Low	0
5	Callander Bay/South Shore	☑	☑				☑	☑	High	8
6	Chippewa Creek	☑	☑		☑				Moderate	6
7	Duchesnay Creek	✓			☑	✓			Low	4
8	Jessups Creek	☑							Low	2
9	Lake Nipissing/North Bay	☑					☑	☑	Moderate	6
10	La Vase River	☑	☑	☑	✓			✓	High	8
11	Parks Creek	☑			☑				Low	4
12	Wistiwasing River		☑	☑	✓	✓	✓	✓	High	8
13	Amable du Fond River			✓	✓	☑	✓	✓	Moderate	7
14	Boom Creek		✓	☑	✓	☑			Moderate	6
15	Kaibuskong River		☑	☑	☑	✓	☑	☑	Very High	11
16	Mattawa River	✓			☑	✓	☑	☑	High	8
17	North River		☑		✓	☑			Moderate	5
18	Pautois Creek		☑	☑	✓	☑	✓		High	8
19	Sharpes Creek		☑	☑	☑	✓			Moderate	7
20	Talon Lake		✓	✓	✓	☑	☑	☑	High	9
21	Trout Lake	✓			☑		☑	☑	Moderate	7
22	Turtle Lake							✓	Very Low	1

Factor	Ranking/Score	
✓	Minor	1
☑	Major	2

Scoring	Ranking	Distribution
<2	Very Low	2
2 to 4	Low	6
5 to 7	Moderate	7
8 to 10	High	6
10+	Very High	1

* Algonquin Land Claim and Highway 17 4 Laning impacts assumed to be beyond the assessment time frame