

LAKE MAJOR WATERSHED

SOURCE WATER PROTECTION PLAN

EXECUTIVE SUMMARY

This Source Water Protection Plan (SWPP) describes the Lake Major watershed area and how the source water supply is managed through provincial, municipal and stakeholder governance; and outlines the risk assessment, the management plan and the monitoring program. Delineating the Lake Major watershed area boundary lays the foundation for source water protection planning for this area.

This SWPP's risk assessment indicates that under typical conditions and situations, the Lake Major watershed area provides a safe water supply to Dartmouth, Eastern Passage, Cole Harbour, Westphal, Lake Loon/Cherry Brook, North Preston and Montague Gold Mines area customers. The primary outcome of this SWPP is to establish and support the implementation of recommendations that help to manage current and evaluate future risks and impacts to the Lake Major water supply.

Halifax Water has set management objectives for implementing this SWPP including land acquisition, best management practices, public communication, education and awareness programs fostering stakeholder collaboration and cooperation, regulation and land-use by-law adherence, public roads and highway maintenance collaboration, controlled access and boundary maintenance, enforcement, adherence to pumping station maintenance schedules, chemical use management plans, emergency measures, and source water quality monitoring and evaluation. Monitoring includes maintaining a presence by way of patrolling, encouraging public reporting of unauthorized or suspicious activities, conducting raw water sampling, and liaising with various governing agencies and stakeholders to ensure a clean and safe drinking water supply.

Baseline monitoring indicates that Lake Major water quality is mainly impacted by stormwater run-off from public roadways and developed areas, recreational activities, , maintenance to utility pipes and poles, and natural disasters. However, with minimal treatment, Lake Major water quality meets GCDWQ and therefore provides a safe potable water supply to its customer's.

Among the recommendations arrived at in this SWPP are such that to maintain water quality for drinking water purposes, future land use development must be limited to compatible watershed uses; that the inherent risks identified in this SWPP must be effectively managed to reduce the impacts to water quality; a comprehensive source water quality monitoring program (SWQMP) must be sustained to provide data that will guide watershed protection and/or treatment process decision-making; the water budget for Lake Major must be calculated; and that the SWPP program continue to be assessed and evaluated to ensure water quality needs are being met.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	2
TABLE OF CONTENTS.....	3
LIST OF APPENDICES.....	6
LIST OF TABLES	6
LIST OF MAPS.....	6
LIST OF ABBREVIATIONS.....	8
1. INTRODUCTION	9
2. DESCRIPTION OF THE LAKE MAJOR WATERSHED.....	10
2.1 LAND FORM.....	10
2.1.1 Geology.....	10
2.1.2 Topography.....	12
2.1.3 Surficial Geology.....	12
2.1.4 Lake Major Hydrology and Environment	15
2.1.5 Soils	18
2.1.6 Climate.....	20
2.1.7 Freshwater.....	20
2.1.8 Flora and Fauna.....	20
2.1.9 Cultural Environment	21
MAP A: BEDROCK GEOLOGY	22
MAP B: SURFICIAL GEOLOGY.....	23
MAP C: SOIL.....	24
MAP D: HYDROLOGY AND ELEVATION.....	25
2.2 LOCATION, NATURAL LAND COVER, BUILT FORM AND OWNERSHIP.....	26
2.2.1 Location.....	26
2.2.2 Natural Land Cover	26
2.2.3 Built Form.....	26
2.2.4 Landownership	31
MAP E: WATERSHED AREAS.....	33
MAP F: LAND COVER	34
MAP G: LANDOWNERSHIP	35
MAP H: LANDOWNERSHIP - MONTAGUE MINES & N. PRESTON	36
2.3 DESIGNATION AS A PROTECTED WATER AREA	37
2.4 GOVERNANCE	37
2.4.1 Provincial Policies and Regulations.....	37
2.4.2 Management Committee	39
2.4.3 Municipal Land-use Planning Policies and By-laws	41
MAP I: PLAN AREA AND ZONING	66
MAP J: POLLING DISTRICTS AND PLAN AREA.....	67
3. RISK IDENTIFICATION AND ASSESSMENT	68
3.1 INHERENT RISK FACTORS	68
3.1.1 Forestry	69

3.1.2	<i>Mining, and Pits and Quarries</i>	70
3.1.3	<i>Recreation</i>	72
3.1.4	<i>Roads</i>	75
3.1.5	<i>Water Supply System Infrastructure</i>	79
3.1.6	<i>North Preston Wastewater Treatment Plant</i>	82
3.1.7	<i>Municipal Land-use Planning and Development Activities</i>	82
3.1.8	<i>Land-use Plan Zoning</i>	86
3.1.9	<i>Chemicals</i>	104
3.2	CRITICAL INFRASTRUCTURE THREATS AND HAZARDS.....	107
3.2.1	<i>Critical Infrastructure Threats and Hazards</i>	107
3.3	RISK ACTIVITIES SUMMARY	112
3.4	RISK ACTIVITIES PRIORITIZED	114
MAP K: LAKE MAJOR HRWC SERVICES AND DEVELOPMENT RISK AREAS		117
MAP L: DEVELOPMENT RISK AREAS IN COMMUNITIES		118
4.	MANAGEMENT PLAN	119
4.1	BACKGROUND.....	119
4.2	IMPLEMENTATION STRATEGY	119
4.2.1	<i>Land Acquisition Program</i>	120
4.2.2	<i>Best Management Practices</i>	120
4.2.3	<i>Public Communication, Education and Awareness</i>	121
4.2.4	<i>Watershed Advisory Board</i>	122
4.2.5	<i>Regulations and Land-use By-laws</i>	122
4.2.6	<i>Public Roads and Highways</i>	123
4.2.7	<i>Controlled Access and Boundary Maintenance</i>	124
4.2.8	<i>Enforcement</i>	125
4.2.9	<i>Lake Major Pumping Station and Water Supply Plant</i>	125
4.2.10	<i>Chemical, Biocide and Pest Control Use</i>	126
4.2.11	<i>Emergency Measures</i>	126
4.2.12	<i>Source Water Quality Monitoring</i>	126
4.3	CONTINGENCY (MITIGATION, PREPAREDNESS AND RESPONSE).....	127
4.3.1	<i>Accidental Fire within Residential Areas</i>	127
4.3.2	<i>Forest Management</i>	127
4.3.3	<i>Recreation</i>	128
4.3.4	<i>Mining, and Pits and Quarries</i>	130
4.3.5	<i>Transportation Routes</i>	131
4.3.6	<i>Boundary Maintenance</i>	132
4.3.7	<i>Public Communication, Education and Awareness</i>	132
4.3.8	<i>Commercial</i>	132
4.3.9	<i>Residential</i>	132
4.3.10	<i>Halifax Water Operations</i>	134
4.4	EMERGENCY RESPONSE MANAGEMENT FOR CRITICAL INFRASTRUCTURE.....	135
4.4.1	<i>Critical Infrastructure Management of Security Threats and Hazards Management</i>	135
4.4.2	<i>Backup Emergency Supply</i>	139
MAP M: PRIMARY WATER SUPPLY NATURAL WATERSHED AND DISTRIBUTION AREAS		141
5.	MONITORING AND EVALUATION	142

5.1	REPORTING	142
5.1.1	<i>Annual Reports</i>	142
5.1.2	<i>Public Reporting</i>	142
5.2	MEETINGS.....	142
5.2.1	<i>Scheduled Meetings</i>	142
5.2.2	<i>Watershed Committee Meetings</i>	143
5.3	PATROLLING	143
5.4	SOURCE WATER QUALITY MONITORING PROGRAM	143
5.4.1	<i>Baseline Sampling</i>	144
5.4.2	<i>Risk-Based Sampling</i>	159
5.4.3	<i>Activity-Based Sampling</i>	160
5.4.4	<i>Target-Based Sampling</i>	164
5.4.5	<i>Operational/Compliance Raw Water Sampling</i>	165
5.4.6	<i>Source Water Quality Monitoring Program Summary</i>	165
6.	ACKNOWLEDGEMENTS	166
APPENDIX 1: LAKE MAJOR WATERSHED PROTECTED WATER AREA DESIGNATION AND REGULATIONS		167
APPENDIX 2: LMWAB TERMS OF REFERENCE.....		168
APPENDIX 3: PROPERTIES EXEMPT FROM PROVISIONS IN NORTH PRESTON - LAKE MAJOR LUB.....		169
APPENDIX 4: TRIBUTARY AND LAKE WATER SAMPLING LOCATIONS, FREQUENCY AND PARAMETERS		170
APPENDIX 5: BATHYMETRY MAPS AND DATA OF THREE (3) OF FOUR (4) LARGEST LAKE MAJOR WATERSHED LAKES (MAJOR, EAST AND SPIDER)		171

LIST OF APPENDICES

APPENDIX 1: LAKE MAJOR WATERSHED PROTECTED WATER AREA DESIGNATION AND REGULATIONS	167
APPENDIX 2: LMWAB TERMS OF REFERENCE.....	168
APPENDIX 3: PROPERTIES EXEMPT FROM PROVISIONS IN NORTH PRESTON - LAKE MAJOR LUB.....	169
APPENDIX 4: TRIBUTARY AND LAKE WATER SAMPLING LOCATIONS, FREQUENCY AND PARAMETERS	170
APPENDIX 5: BATHYMETRY MAPS AND DATA OF THREE (3) OF FOUR (4) LARGEST LAKE MAJOR WATERSHED LAKES (MAJOR, EAST AND SPIDER).....	171

LIST OF TABLES

TABLE 1: LAKE MAJOR WATERSHED LAKES > 1HA	16
TABLE 2: LAKE MAJOR SOIL TYPES	19
TABLE 3: CANADIAN DAM ASSOCIATION CLASSIFICATION SYSTEM (2007).....	28
TABLE 4: LAKE MAJOR WATERSHED DAM SAFETY REVIEW (DSR) RESULTS	30
TABLE 5: BREAKDOWN OF LANDOWNERSHIP BY TYPE AND LAND AREA.....	31
TABLE 6: HRM LUB PLAN AREAS IN WATERSHED AND APPLICABLE BY-LAW ZONES AND DESCRIPTIONS.	45
TABLE 7: LAKE MAJOR - NORTH PRESTON MPS WATERSHED-SPECIFIC POLICY OUTLINE.....	53
TABLE 8: SHUBENACADIE LAKES MPS POLICIES RESPECTING THE LAKE MAJOR WATERSHED	57
TABLE 9: HRM REGIONAL AND HALIFAX COUNTY BY-LAWS	64
TABLE 10: RISKS ASSOCIATED WITH LANDOWNERSHIP AND PERMITTED LAND-USE ACTIVITY.....	92
TABLE 11: SUMMARY OF EXISTING AND POTENTIAL RISK ACTIVITIES	112
TABLE 12: SCALE OF AND PRIORITY RANKING OF EXISTING AND POTENTIAL RISK ACTIVITIES	114
TABLE 13: LAKE MAJOR DO RESULTS* (AVG. BY YEAR 2009 – 2016 MG/L)	145
TABLE 14: LAKE MAJOR pH RESULTS* (AVG. BY YEAR 2009 – 2016).....	145
TABLE 15: LAKE MAJOR SPECIFIC CONDUCTIVITY RESULTS* (AVG. BY YEAR 2009 – 2016 $\mu\text{S}/\text{CM}^2$)	147
TABLE 16: LAKE MAJOR TURBIDITY RESULTS* (AVG. BY YEAR 2009 – 2016 NTU).....	148
TABLE 17: LAKE MAJOR COLOUR RESULTS* (AVG. BY YEAR 2009 – 2016 TCU).....	150
TABLE 18: LAKE MAJOR TSS RESULTS* (AVG. BY YEAR 2009 – 2016 MG/L).....	151
TABLE 19: LAKE MAJOR E. COLI RESULTS* (AVG. BY YEAR 2009 – 2016 MG/L)	152
TABLE 20: LAKE MAJOR TOTAL PHOSPHORUS RESULTS* (AVG. BY YEAR 2009 – 2016 $\mu\text{G}/\text{L}$)	153
TABLE 21: LAKE MAJOR NITRATE RESULTS* (AVG. BY YEAR 2009 – 2016 $\mu\text{G}/\text{L}$).....	154
TABLE 22: LAKE MAJOR TOC RESULTS* (AVG. BY YEAR 2009 – 2016 MG/L).....	154
TABLE 23: LAKE MAJOR CHLORIDES RESULTS* (AVG. BY YEAR 2009 – 2016 MG/L)	155
TABLE 24: LAKE MAJOR TOTAL SULPHATE RESULTS* (AVG. BY YEAR 2009 – 2016 MG/L)	157
TABLE 25: LAKE MAJOR ARSENIC RESULTS* (AVG. BY YEAR 2009 – 2016 $\mu\text{G}/\text{L}$).....	158
TABLE 26: LAKE MAJOR ALUMINUM RESULTS* (AVG. BY YEAR 2009 – 2016 $\mu\text{G}/\text{L}$)	159

LIST OF MAPS

MAP A: BEDROCK GEOLOGY	22
MAP B: SURFICIAL GEOLOGY	23
MAP C: SOIL.....	24
MAP D: HYDROLOGY AND ELEVATION	25
MAP E: WATERSHED AREAS	33
MAP F: LAND COVER	34
MAP G: LANDOWNERSHIP	35
MAP H: LANDOWNERSHIP - MONTAGUE MINES & N. PRESTON	36
MAP I: PLAN AREA AND ZONING.....	66
MAP J: POLLING DISTRICTS AND PLAN AREA.....	67
MAP K: LAKE MAJOR HRWC SERVICES AND DEVELOPMENT RISK AREAS	117
MAP L: DEVELOPMENT RISK AREAS IN COMMUNITIES	118

LIST OF ABBREVIATIONS

C&D	Construction and Demolition
CCME	Canadian Council of the Ministers of Environment
CH/W	Cole Harbour / Westphal
CIP	Critical Infrastructure Protection
CMHC	Canada Mortgage and Housing Corporation
GCDWQ	Health Canada's Guidelines for Canadian Drinking Water Quality
GFULM	Generalized Future Land Use Map
HIAA	Halifax International Airport Authority
ISO	International Organization for Standardization
LE/PL	Lake Echo / Porter's Lake
LMWAB	Lake Major Watershed Advisory Board
LUB	Land Use By-law
MPS	Municipal Planning Strategy
MR	Mixed Resource
MRA	Mineral Resources Act
MU	Mixed Use
NP-LM	North Preston – Lake Major
OCIPEP	Office of Critical Infrastructure Protection and Emergency Preparedness
OHV	Off-Highway Vehicles
PWS	Protected Water Supply (Zone)
RMPS	Regional Municipal Planning Strategy
RW	Rural Wind
SOT	Summary Offense Ticket
SWPP	Source Water Protection Plan
SWQMP	Source Water Quality Monitoring Program
UW	Urban Wind
WAPA	Wilderness Area Protection Act
WGS	Waverley Game Sanctuary
WQGPAL	Water Quality Guidelines for Protection of Aquatic Life (CCME)
WSP	Water Supply Plant
WSRLL	Waverley-Salmon River Long Lake Protected Wilderness Area

1. INTRODUCTION

Halifax Water is responsible for monitoring and managing all activities that may impact water quality and quantity on eleven (including Lake Major) distinct source water supplies. Lake Major serves as the water supply for the communities of Dartmouth, Eastern Passage, Cole Harbour, Westphal, Lake Loon/Cherry Brook, North Preston and Montague Gold Mines.

The primary objective of the Lake Major Source Water Protection Plan (SWPP) is to comply with Nova Scotia Environment (NSE) requirements and to meet the needs of Halifax Water's customers. The primary focus of this SWPP is water quality.

This SWPP describes the watershed area and outlines the management of the source water area, risk assessment, implementation plan and the monitoring and evaluation program.

2. DESCRIPTION OF THE LAKE MAJOR WATERSHED

The following describes the Lake Major watershed in terms of land form, location, land cover, built form and landownership; and how the source water supply is managed through provincial, municipal and stakeholder governance.

The Lake Major Designated Protected Water Area (*PWA*) was used to formulate watershed area calculations throughout this SWPP as it is ~1% (85ha) larger than the Lake Major natural watershed area; i.e., the *PWA* is ~6944ha and the natural watershed area is ~6859ha. However, the boundary of the *PWA* does not completely enclose the natural watershed area, leaving ~169ha (~2.4%) of the natural watershed area outside of the protective limits of the *PWA* boundary. The Lake Major *PWA* was delineated by following property boundaries and roads as close as possible to the natural watershed area's highest points of land, rather than exactly following natural watershed area boundaries. This method of delineation eases boundary impacts on private parcels of land. The *PWA* is referred to as the watershed area unless otherwise stated. The SWPP accounts for all activities within the watershed area.

2.1 Land Form

The land formation of the Lake Major watershed is characterized by region-specific activities including geology, rock formation, erosion, topography, faults, climate, fresh water, soils, plants, animals, and cultural environment, as defined under the Nova Scotia Museum of Natural History's Theme Region 400 – Atlantic Interior¹. The natural and cultural land formations typical for the Lake Major watershed influences water quality in this area through naturally occurring elements found in the geology, soils, flora and fauna and water flow due to topography, climate, and cultural influences that have occurred over time. The following subsections describe how these influences may impact water quality in the watershed area. The four maps (Map A through Map D) following this section illustrate the bedrock geology, surficial geology, hydrology and soil of the watershed area described in this section.

2.1.1 Geology

Lake Major watershed area geology is made up of three geological rock formations: the Halifax and Goldenville formations, which are derived from the Meguma Group; and a third rock type, muscovite biotite monzogranite which is derived from an unknown rock formation. Only 36.19ha (~0.52%) of the Halifax Formation is found underlying the watershed area, while the majority, 4245.37ha (~61%) is underlain by the Goldenville Formation. The remaining 2661.72ha (~38%) of the watershed area sits on the muscovite biotite monzogranite (granite) rock type. *Map B: Surficial Geology* on page 23 illustrates these formations and their locations.

¹ Unless otherwise indicated, the technical information contained in section 2.2 was derived from: Davis, Derek and S. Browne. 1996. *The Natural History of Nova Scotia: Theme Regions*. NS Government and Nimbus. Website-accessible April 1, 2016, at <https://ojs.library.dal.ca/NSM/article/view/3775/3458>.

Meguma Group

The Meguma Group is the parent rock group from the Cambrian to Silurian age, which is divided into the Goldenville Formation (named after a mining area in eastern Nova Scotia where the strata are well exposed) and the Halifax Formation. The Goldenville Formation is made up of greywacke (a quartz-rich rock containing some clay); the Halifax Formation is made up of slates, often acid-bearing pyritic slate the source of acid rock drainage (ARD).

Greywacke

Greywacke is a rock type prevalent in eastern Nova Scotia, particularly on the northern border of Halifax and Guysborough counties. The surface is much like a plateau, with long, low ridges running east and west. Greywacke is the most prevalent rock type found in the Goldenville formation, which is the predominant geological formation underlying the Lake Major watershed, as illustrated on *Map B: Surficial Geology* on page 23. In this area, large, angular blocks of greywacke cover the ground, and the soil is usually thin and acidic. The intervening hollows are swampy and have their long axes generally oriented parallel to the strike of the strata; drainage is impeded by deposits of till from glacial drift. The river channels in the interior are shallow because the streams run down the tilted erosion plain across the fold axes and cut across layers of resistant strata.

Granite

The second most prevalent rock type underlying the watershed area is a group called “granite.” This common rock type for the Halifax area is recognizable by its coarse texture, which includes a whole range of related but different rock types. It presents itself in a variety of colours, textures, and compositions, most commonly containing large greyish or pink crystals of potash feldspar mixed with smaller crystals, and dominated by quartz and mica.

Slates and Drumlins

The least prevalent rock type in the watershed area is slate. It is the predominant rock type found in the Halifax Formation, which underlies approximately half of one percent of the watershed area. This rock type is also found in the Goldenville formation, the most predominant rock formation (described above). Slate presents a more interesting and varied topography than the areas of greywacke and granite. Slates weather relatively easily. In this geological Region (400), the surface of the slate areas has been planed off, and the resultant loose material has been carried away to form a deep glacial drift with a high percentage of silt and clay. The advancing glacier moved over the area like a bulldozer, scraped off the weathered material, carried it for a kilometre or so, and then, overloaded by the mass of material, dropped it and sometimes shaped it into drumlins.

Bedrock, where till is generally thin, surrounds the top two thirds of the watershed area above and along the northeast portion of Lake Major (see *Map B: Surficial Geology* on page 23). The southwest portion of the watershed area is characterized by thicker till,

punctuated by a drumlin on the west side of Lake Major in the Montague Gold Mines community, and another larger one on the extreme southeast edge of the watershed area, in the community of East Preston. Drumlin locations, prevalence and consistency are described in more detail in section 2.1.3: *Drumlins* on page 13

2.1.2 Topography

The watershed area is defined as an upland surface topography which slopes southeast or directly towards the Atlantic coast, specifically, Cole Harbour. The elevation decreases as the topography gets closer to the coast, where the river valleys are deep and cut far below the surface. Faults, especially east of Halifax frequently shatter the Meguma strata, which affect the coastline and the topography of inland areas. One of these faults extends from Cole Harbour and continues inland up the Lake Major valley. The two highest elevation points in the watershed area, both registering at 185m, are located in the East Lake sub-watershed area as illustrated on *Map D: Hydrology and Elevation* on page 25.

2.1.3 Surficial Geology

The surficial geology of Nova Scotia was formed by glaciation, the last of which – known as the Wisconsin glaciation period – started about 75,000 years ago and ended about 10,000 years ago, leaving behind a layer of sediment upon which current drainage patterns and soils developed. Within the last glaciation period, at least four phases of ice movement shaped the surficial geology that we see today. Naturally exposed bedrock resulting from the scouring action of glaciers are evident from the striations (grooves formed by ice) in the bedrock, distinctive erratics (boulders transported from far away rock sources) and surficial deposits left by passing or melting ice which formed the materials for most soils in Nova Scotia.

The surficial geology of the Lake Major watershed area is described under the subheadings below and illustrated on *Map B: Surficial Geology* on page 23. The surficial geology of the Lake Major watershed is described as lacking buffering characteristics for acid rain, especially along the northeast boundary where the thickness of the soil cover is nil and where there is a tendency for the rockland to be exposed. The surficial geology of the watershed area is illustrated on *Map B: Surficial Geology* on page 23.

Anthropogenic

Though considerable anthropogenic activity such as logging, residential development and gold mining has taken place in the watershed area, the surficial geology of the area indicates that there has been minimal land alteration within the watershed area. This deduction is based on Utting's (2011) definition of anthropogenic areas: “[a]rtificial or geological material that has been disrupted and redistributed by human activity; texture highly variable. Note that many areas of residential communities and till veneer are mapped as the original material because of the sporadic and shallow nature of the modification.”

The anthropogenic area within the Lake Major watershed as illustrated on *Map B: Surficial Geology* on page 23 consists of three small areas amounting to 4.02ha. These areas consist of a 0.88ha area, which is part of a larger quarry berm to prevent quarry water from flowing into the Lake Major watershed, and two (2) adjacent parcels amounting to 3.14ha, on Halifax Water land, that support the water supply plant and drying beds.

Alluvial

There are 64.05ha of alluvial deposits in the watershed area, which consist of gravel, sand, silt, minor clay and organic material. This material is deposited by active streams and rivers in channels and floodplains. The thickness of these is estimated from 1–10m.

There are 28 mapped instances of alluvial deposits in the Lake Major watershed (see *Map B: Surficial Geology* on page 23) with a mean size of 2.2ha, the largest of which is located at the top of Lake Major's headwater stream and covers 6.8ha. The second largest area of these deposits is situated in the wetland at the outlet of this stream that flows directly into Lake Major. A small drumlin is also located to the east of this area. Over a third of these deposits, amounting to 25.14ha, are located in the headwater stream, which formerly flowed from Soldier Lake, before Wing Dam #2 was installed at the Soldier Lake outlet (see more description in section 2.2.3: *Soldier Lake Dam* on page 28 and illustrations on *Map D: Hydrology and Elevation* on page 25).

An equal amount (24.6ha) of alluvial deposits is located in the headwater streams of East Lake. The remaining deposits are located along the headwater streams of Spider Lake (12.2ha); another 2.1ha area is just below the drumlin in Montague Gold Mines; and a single area runs along the stream that flows from the east into Long Lake.

Bedrock

The bedrock in the Lake Major watershed amounts to 3181.7ha (~46% of the watershed area) and is the predominant surficial geology feature in the East Lake sub-watershed area (see *Map C: Soil* on page 24) and in approximately one half of the northwest portion of the total watershed area (see *Map B: Surficial Geology* on page 23).

Drumlins

Drumlins are elongated landforms with long axes parallel to ice flow and are typically composed of up to three tills: a core of Hartlen Till (observed only at coastal sections), overlain by Lawrencetown Till, and in some areas, overlain by Beaver River Till. The latter till type is typical for the Lake Major watershed and is described further in the following subsections.

There are 13 drumlins in the watershed area amounting to 222.5ha. The largest drumlin is 109ha, the smallest is ~2ha and the mean drumlin size is 17.12ha. They are located in the Montague Mines area.

Glaciofluvial outwash

Glaciofluvial outwash consists of gravel and sand deposits. Sediments deposited by proglacial meltwater form outwash plains and terraces. Thickness estimated to be 1–30m.

There is one small glaciofluvial deposit area that amounts to ~1ha that is located between the Lake Major dam and Old German Road.

Hummocky Till

Hummocky till is Beaver River Till, a diamicton (poorly sorted till material of various sizes) with loose, sandy matrix and locally derived clasts. Surface topography is irregular with small mounds of till deposits. Sediments are derived from subglacial erosion and meltout processes. These deposits may represent areas occupied by stagnant ice. Thickness is estimated to be from 1–10m. There are 631.9ha of hummocky till areas scattered throughout the watershed area in 23 different locations (see *Map B: Surficial Geology* on page 23).

Till Blanket

Till blanket is also Beaver River till; see previous sub-section Hummocky Till for description. The difference is that till blanket is thicker, and is estimated to be 5–10m, which is thick enough to mask irregularities of the underlying bedrock.

There are 210.4ha of till blanket dotted around the watershed area, mostly in the lower portion. The largest portion (43.12ha) is located east of the wettest area of the lacustrine area close to the area dammed off from Soldier Lake. There is another area near Waverley just east of the 118 Hwy.

Till Veneer

Till veneer also consists of Beaver River till; the difference with till veneer is that it is thinner (as the term veneer suggests) and is estimated to be from 0.5–5m. Some areas, however, include exposed bedrock and thicker till deposits (>5m) of locally derived till.

Till veneer is the second-most predominant surficial geology feature in the watershed area, next to the bedrock feature, covering 1521.5ha (~22%) of the watershed area. The most prevalent area of till veneer is located in and around North Preston (see *Map B: Surficial Geology* on page 23).

Lacustrine (Wetlands)

Lacustrine areas are defined in the Nova Scotia Department of Natural Resources surficial geology data set layer as “*Sand, silt, clay and organic deposits. Sediments deposited from suspension in freshwater lakes, ponds and wetlands; includes shoreline material deposited or reworked by wave action. May be underlain by till or glaciolacustrine material (sand, silt and clay with some dropstones). Thickness estimated*”

from 1–5m.”² It is interesting to note that according to the surficial geology layer, there is supposed to be a drumlin north east of the quarry, however, it is marked wetland and appears to be a bog.

Altogether, 671.13ha (9.66%) of the watershed area has been identified as lacustrine or wetland areas. This figure was calculated from the Halifax Regional Municipality (HRM) GIS layers and the Nova Scotia Department of Natural Resources (DNR) surficial geology data set layer. The total wetland area was determined by incorporating all of the wetland areas defined (a total of 1069.6ha), subtracted by the overlap.

It is important to accurately identify wetland or lacustrine areas in the PWA because these areas are considered “Wetlands of Special Significance” (WSS) which provides wetlands with government policy protection (see section 2.4.1: *Nova Scotia Wetland Conservation Policy* on page 39).

Surface Water

The remaining surficial geology of the Lake Major watershed consists of 55 lakes totaling ~800.4ha (see *Table 1: Lake Major Watershed Lakes > 1ha* on page 16), and a few unidentified pools that amount to ~6.7ha, for a total surface water area (excluding streams and brooks) of 807.1ha (11.62%) of the watershed area. The length of streams and brooks inside the watershed area amounts to ~62km or 6.6ha. More details on the hydrology of the Lake Major watershed see section *Lake Major Hydrology and Environment* below and illustrated on *Map D: Hydrology and Elevation* on page 25.

2.1.4 Lake Major Hydrology and Environment

Freshwater hydrology is the study of all forms of water including snow, ice and liquid on the surface of the land, moisture in the air and the water in the ground between the soil particles and the rocks. The following subsections briefly describe the freshwater hydrology of the Lake Major watershed.

Hydrology

There are three major drainage areas in Nova Scotia and three major hydrological zones, as defined by Environment Canada, which are based on mean annual precipitation. Lake Major is situated at the top of the “Atlantic” watershed divide, one of four watershed divides in Nova Scotia whereby. As its name suggests water in the “Atlantic” divide flows toward the Atlantic Ocean. On the other side of this divide, water flows toward the Bay of Fundy or the Northumberland Strait; the fourth divide is Cape Breton.

Hydrology is heavily influenced by the underlying geology and type and depth of surficial overburden. Many of the streams are slow-flowing and interrupted by shallow, rocky ponds and lakes. Sub-parallel faults have created linear valleys which are followed

² “The Nova Scotia Wetland Vegetation and Classification Inventory is based on the freshwater and salt marsh wetlands from the Nova Scotia Wetlands and Coastal Habitats Inventory (2000) dataset.

by rivers and sometimes filled by lakes. Activities that occur in the upper portions or headwaters of a drainage area or watershed area will have an impact on water quality in downstream areas. All of these characteristics apply to the Lake Major watershed (see *Map D: Hydrology and Elevation* on page 25), particularly Lake Major itself.

Local anthropogenic alterations that have affected the hydrology of the Lake Major watershed since the settlement of the region have been primarily during the past century. The most prevalent being the Montague Gold mining industry; forestry activity; and the colonization of the lands surrounding Lake Major.

More recent changes include the construction of the Lake Major and East Lake dams (see section 2.2.3: *Water Supply System Infrastructures* on page 27 and *Map D: Hydrology and Elevation* on page 25); and a wing dam, located at the south end of Soldier Lake to prevent water flow from Soldier Lake to Lake Major.

Table 1: Lake Major Watershed Lakes > 1ha below lists the lakes within the watershed area that are over 1 hectare in size. In addition to those listed below, there are 32 more lakes under 1 ha in size amounting to ~8ha.

Table 1: Lake Major Watershed Lakes > 1ha			
Lake Name	Lake Area (ha)	Lake Name	Lake Area (ha)
Lake Major	376.94	Birch Lake	4.7
East Lake	99.17	Leonard Lake	4.3
Long Lake	64.92	Earnst Lake	4.04
Spider Lake	63.03	Duck Lake	3.4
Three Mile Lake	53.22	Chapman Lake	2.82
South Red Trout Lake	25.74	Fox Lake	2.8
Poor Trout Lake	23.38	Black Lake	2.76
Long Duck Lake	20.67	Round Lake	2.4
North Red Trout Lake	11.36	Duck Pond	2.12
Dudley Lake	8.46	Little Duck Lake	1.89
Frying Pan Lake	6.95	Connor Lake	1.78
Lookout Lake	5.54		

Bathymetry

Changes in water levels such as those previously described affect the bathymetry and the chemical consistency of the water. The maximum depths of the major lakes inside the Lake Major watershed are 65.0m for Lake Major, 44m for East Lake and 10m for Spider Lake (see *Appendix 5: Bathymetry Maps and Data of Three (3) of Four (4) Largest Lake Major Watershed Lakes (Major, East and Spider)* on page 171). The bathymetry of Long Lake, the third largest lake in the watershed, was not available.

Water Budget

Water budgets are based on input (e.g., precipitation) calculations and three output (evapotranspiration, runoff and infiltration) parameters. The net quantity of water available is the difference between the total precipitation and evapotranspiration.

The water budget for the Lake Major watershed is currently unknown. As reported in the Nova Scotia Watershed Assessment Project (NSWAP), there is a lack of water budget information.³ Water budgets are important not only for assessing the risk to available water now and in the future, but also to calculate the flushing rates of lakes. Flushing rates help to determine the rate of eutrophication, which is based on soil types, precipitation, evaporation, lake depth and land area.⁴ **It is recommended that the water budget for Lake Major be calculated to help evaluate future risks and impacts to the Lake Major water supply.**

The size and order of the watershed area, the nature of the bedrock, the vegetation present and the level of urbanization and annual precipitation levels highly influence the lakes' water levels. Therefore, in the event that precipitation levels in our region drop and urbanization of the watershed area increases, the Lake Major water system would be impacted, which would potentially reduce the water budget. Under such circumstances, in drought conditions for example, specific measures would need to be undertaken (see section 3.2.1: *Critical Infrastructure Threats and Hazards* on page 107).

Precipitation

Runoff rates are influenced by precipitation (described with respect to the Lake Major watershed in more detail in section 2.1.6: *Climate* on page 20). During high water discharge times, rock formations, such as exposed pyritic slate, can create water quality problems due to ADR. When pyritic slates are exposed to water and oxygen, sulphuric acid is produced which can lead to fish kills. Peat moss can also create acidic conditions in lakes. Moreover, increased acidity causes aluminum, cadmium, lead and other potentially toxic metals to leach into waterways.⁵

³ Hydrologic Systems Research Group. 2011. Nova Scotia Watershed Assessment Program (NSWAP) Part A – Initial Assessment, Summary Report; p. 13. Web-accessed May 2, 2016 at: https://www.novascotia.ca/nse/water.strategy/docs/Nova.Scotia.Watershed.Assessment.Program_Part-A_Phase-1_Summary.Report.pdf

⁴ Davis, Derek S. and Sue Browne, Editors, 1996. *Topics and Habitats: Natural History of Nova Scotia, Revised Edition, Volume I*. The Nova Scotia Museum, the Department of Education and Culture, Province of Nova Scotia: p. 153.

⁵ Davis, Derek S. and Sue Browne, Editors, 1996. *Topics and Habitats: Natural History of Nova Scotia, Revised Edition, Volume I*. The Nova Scotia Museum, the Department of Education and Culture, Province of Nova Scotia: p. 352.

Water Quality

Water quality is influenced by many natural factors in addition to cultural influences including bedrock geological composition, watershed size, topography, response to precipitation, vegetation and proximity to the ocean.

Factors known to commonly influence water quality in Nova Scotia surface waters are:

- climate related events (e.g. air temperature, precipitation, and seasonal flows);
- watershed characteristics (e.g. forest cover, amount of wetlands, land use, bedrock geology and soil type); and
- pollution sources (point and non-point).

In areas composed of bedrock, as in the north east corner of the Lake Major watershed, the conductivity of lakes and streams is generally low. Surface water within Theme Region 400 also tends to be low in dissolved solids, providing little buffering capacity. Combined with the low buffering capacities of the thin soils and tills associated with the quartzite, slate, and granite bedrock, much of the fresh water in this Region is susceptible to acidification. Surface waters in the Lake Major watershed are also dystrophic (water that is brown- or tea-coloured due to high concentrations of humic substances and organic acids suspended in the water). Water quality is discussed further in section 5.4: *Source Water Quality Monitoring Program* beginning on page 143.

Further, groundwater in this Region (400) is stored and transmitted through fractures and joints and along fault and contact zones in the bedrock. Groundwater quality tends to be low in dissolved minerals and, like the surface water, is susceptible to acidification from ARD and to discolouration from contact with naturally occurring minerals such as iron and manganese which are associated with granite and quartzite.

2.1.5 Soils

The major factors affecting soil development in this Region (400) are the resistant granite and quartzite bedrock, the undulating and often poorly drained terrain, and the influence of finer-textured tills transported by glacial action. Over most of the watershed area, strong scouring has left a thin, bouldery till cover on which humo-ferric podzols predominate, with considerable areas of gleysol, rockland, and peat. Coarse, bouldery, sandy loams have formed in granitic areas, while on quartzite the stony, sandy loams have slightly finer textures.

The soil characteristics that predominate over half (~56% or ~3919ha) of the watershed area, primarily in the northern and mid-southeast areas, are well-drained hummocky course-medium soils that are rapidly drained and susceptible to erosion. Another third of the watershed area (~32% or ~2212ha), is covered with imperfectly drained soils, especially around Spider Lake and between the Montague Mines and Cherry Brook areas. The remaining ~807ha (~12%) area is water.

Where soils developed from till over slates and schists, vigorous vegetative growth is prevalent, which is in marked contrast to that of the quartzite soils. The soils themselves

are usually very permeable, but drainage is often impeded by topography or underlying bedrock. Soils are strongly leached and very acidic. An important feature of the soils of this Region is the drumlin fields. Soils formed on drumlins are often better drained, finer textured, deeper, and somewhat more fertile. As earlier described, drumlins are featured in only two specific locations in the watershed area, leaving much of the remaining soil cover susceptible to leaching and very acidic. The soil types are described in *Table 2: Lake Major Soil Types* on page 19 and illustrated on *Map C: Soil* on page 24.

Table 2: Lake Major Soil Types						
Symbol	Soil Series	Description of Surface and Subsoil	Parent Material	Topography	Drainage	Area (ha)
Hx	Halifax	Brown sandy loam over yellowish sandy loam	Olive to yellowish –brown stony sandy loam till derived from quartzite	Gently undulating to gently rolling	Good to excessive drainage	3403.08
Bw	Bridge-water	Brown shaly loam over yellowish-brown shaly loam	Olive shaly loam till derived from Precambrian slates	Gently undulating to gently rolling	Good drainage	117.71
Wv	Wolfville	Dark reddish brown loam to sandy clay loam over strong-brown loam to sandy clay loam.	Reddish brown loam to sandy clay loam till derived from shale and sandstone	Gently undulating to gently rolling	Good drainage	85.42
Ga	Gibraltar	Brown sandy loam over strong-brown sandy loam	Pale-brown coarse sandy loam till derived from granite	Gently undulating to gently rolling	Good to excessive drainage	550.15
P	Peat	Brown 12" or more of semi-decomposed fibrous material over dark-brown fibrous material chiefly sphagnum	Organic material	Level to depressional	Poor drainage	148.85
R	Rockland		Areas where at least 60% of the land is exposed bedrock or the till is extremely stony	Variable	Variable	1810.87
Dv	Danesville	Dark grayish brown sandy loam over yellowish-brown sandy loam; mottled	Dark-brown sandy loam till derived from quartzite	Gently undulating to gently rolling	Imperfect drainage	58.89
ZZZ	Water					768.28

2.1.6 Climate

Due to the inland location of the watershed area, which is sheltered from climatic influences of the Atlantic by the coastal forest, the area experiences slightly warmer summers and cooler winters with much less wind exposure than its coastal neighbours. Variations in temperature and precipitation are influenced in part by distance from the Atlantic coast and by latitude.

Lake Major precipitation readings recorded in 2012 are: rainfall 1,685.5mm; and snowfall 88.4cm. The rainfall readings are higher than the mean value stated for the 400 Region by Davis and Browne (1996), which were between 1200 and 1600. Conversely, the snowfall amounts are almost half of the mean value stated by the same source, which ranged from 150cm near the coast to 250cm or more in higher areas and further inland. These changes in values indicate that temperatures are warmer than they were over ten years ago, based on the higher rainfall and lower snowfall amounts. With the onset of climate change, rainfall events have become more intense than in previous years such that higher amounts of precipitation fall in a shorter period of time. Such rainfall events have greater potential to cause erosion and sedimentation problems within local waterways than do rainfall events with lesser amounts of precipitation, especially in the watershed area, considering the soil and rock conditions described in previous subsections.

2.1.7 Freshwater

Drainage patterns in Region 400 are typically deranged such that surface water is retained in a disorganized series of streams, lakes, and bogs. A chain of lakes system, streams, and stillwaters occur in the interior, with low ridges following the trend of the underlying strata. Many of the streams are slow-flowing and interrupted by shallow, rocky ponds and lakes.

Surface waters are dystrophic (see section 2.1.4: *Water Quality* on page 18) throughout this Region (400). Primary productivity tends to be low and most lakes are oligotrophic. Surface water also tends to be low in dissolved solids, providing little buffering capacity. Combined with the low buffering capacities of the thin soils and tills associated with the quartzite, slate, and granite bedrock, much of the fresh water in this Region is susceptible to acidification. Surface water is less acidic in the drumlin areas.

Groundwater in this Region is stored and transmitted through fractures and joints and along fault and contact zones in the bedrock. It tends to be low in dissolved minerals but, like the surface water, is susceptible to acidification from ARD and to discolouration from contact with naturally occurring minerals such as the iron and manganese associated with granite and quartzite. The slates of the Halifax Formation tend to have a good overburden of till that somewhat buffers the natural sulphides that can contaminate ground and surface waters.

2.1.8 Flora and Fauna

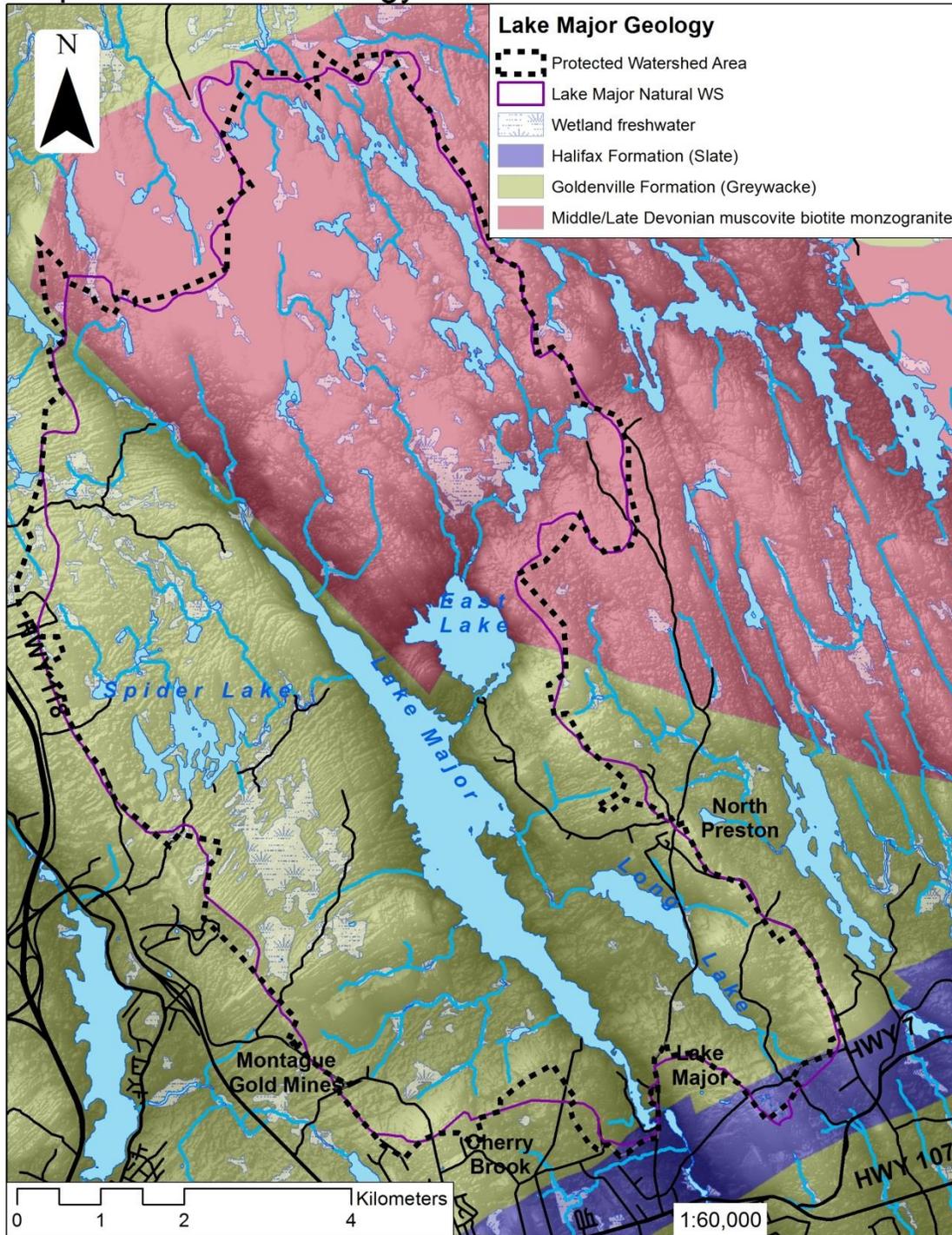
The main influences on regional vegetation are the inland climate with its warm summers, sandy and acid soils, mixed drainage and extensive disturbance by fire and

logging. Forest are made up of softwoods dominate tree species with, shade-intolerant hardwoods frequently occur alongside; pockets of shade-tolerant hardwoods are found on higher, better-drained sites.

2.1.9 Cultural Environment

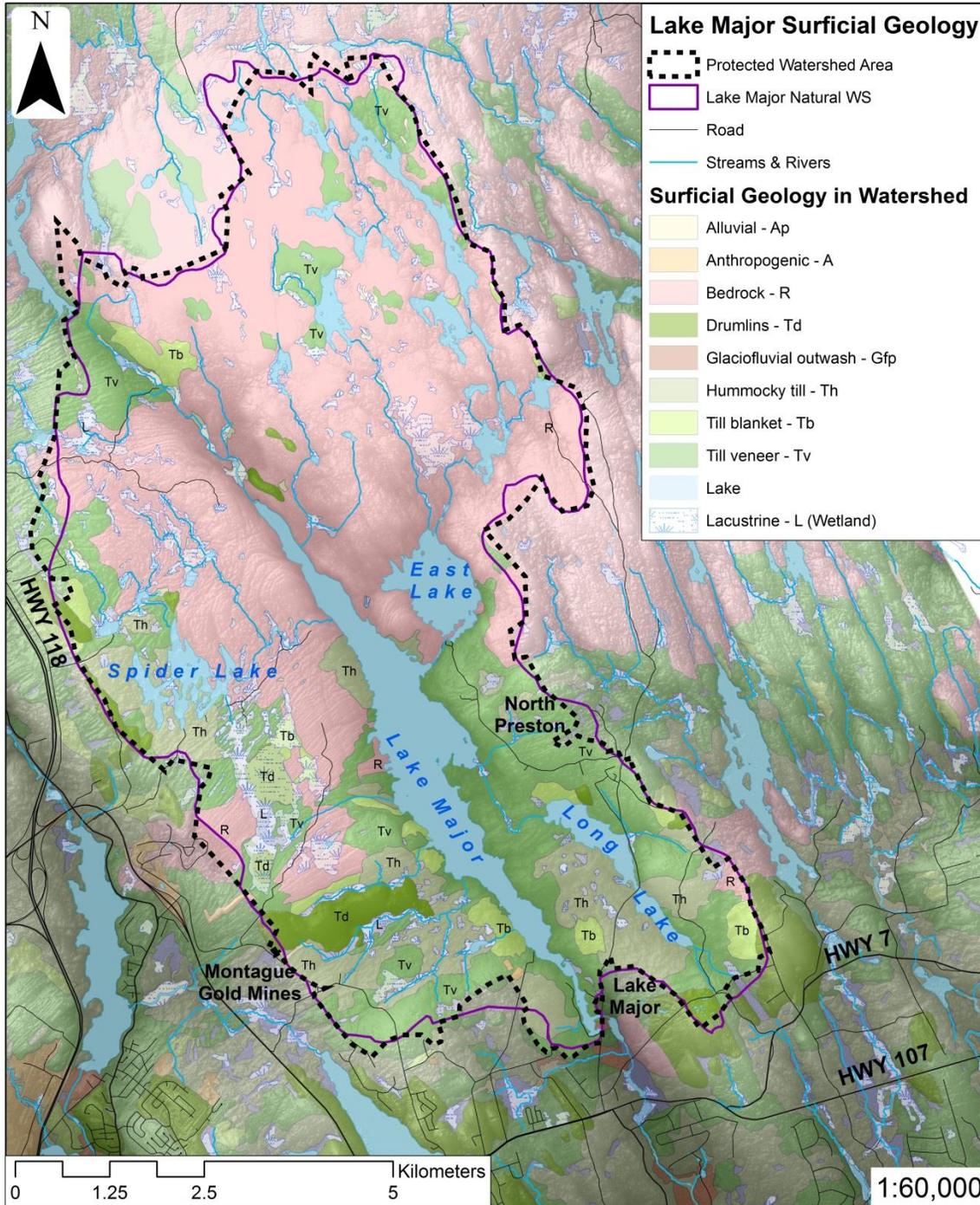
Metals and minerals that have been mined within the watershed area include gold and tin. Quarried materials include limestone, sand, gravel, and crushed rock. An active rock quarry is situated just inside the western boundary of the watershed area, not far from prospective mineral resource exploration areas that companies hold rights to for mineral exploration licenses. Peat resources underlie much of this land. Forestry and limited development are the other prevalent impacts associated by cultural influences, as described briefly in section 2.1.3: *Anthropogenic* on page 12.

Lake Major Watershed PWA SWPP 2016
 Map A: Bedrock Geology



* This map is for informational purposes only and should not be used for legal, engineering, or surveying purposes.

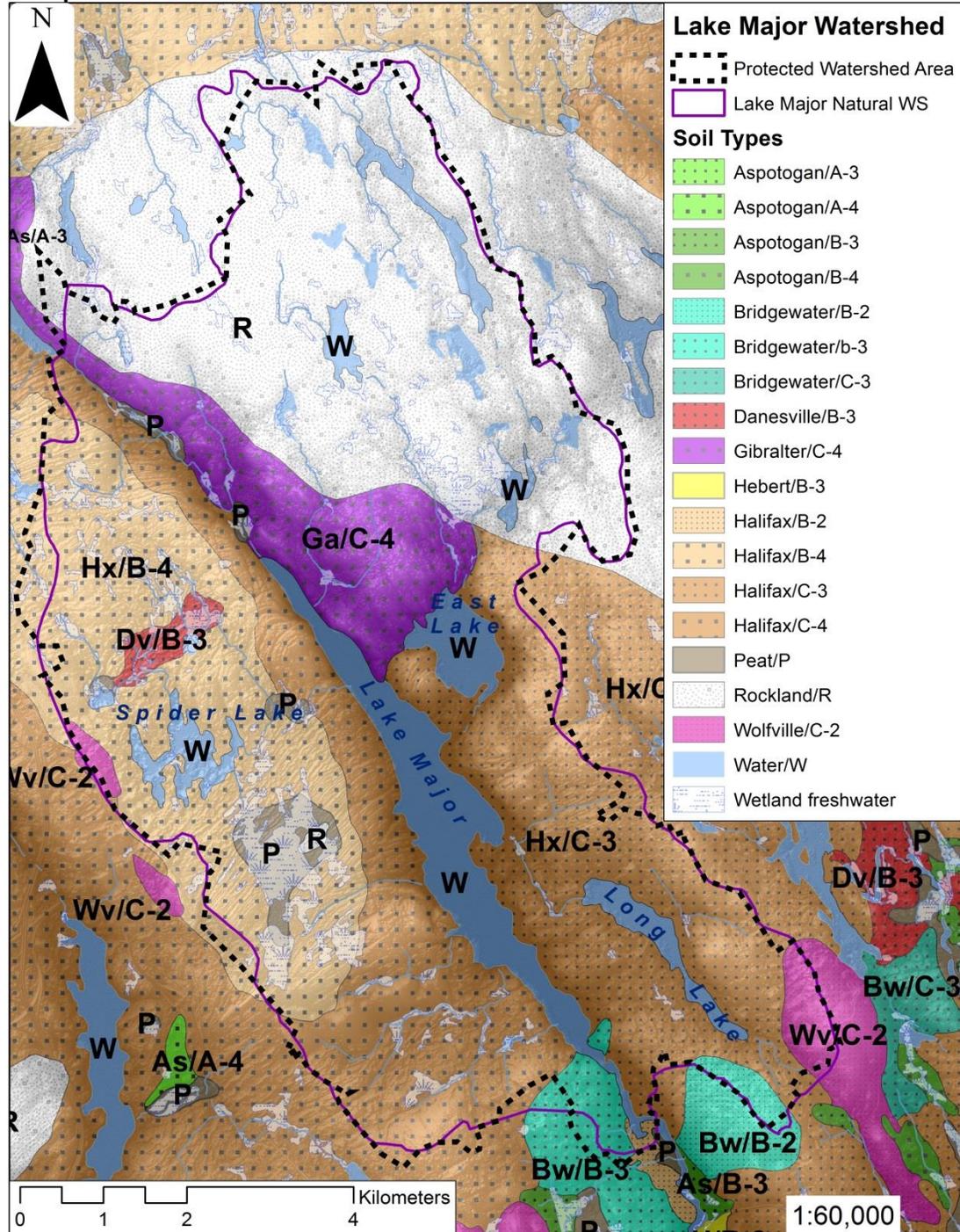
MAP B: SURFICIAL GEOLOGY
 Lake Major Watershed PWA SWPP 2016
 Map B: Surficial Geology



* This map is for informational purposes only and should not be used for legal, engineering, or surveying purposes.

MAP C: SOIL

Lake Major Watershed PWA SWPP 2016 Map C: Soil

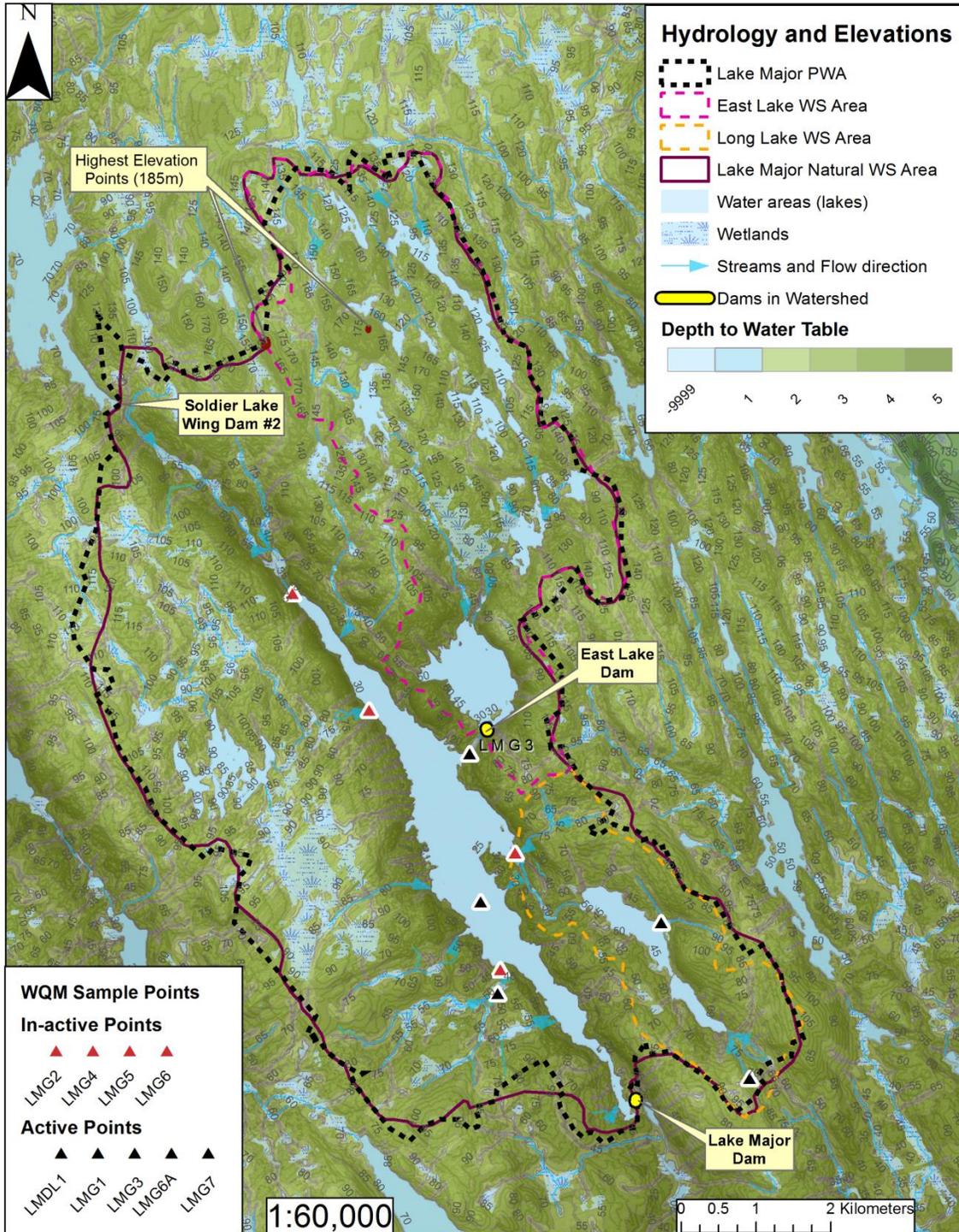


* This map is for informational purposes only and should not be used for legal, engineering, or surveying purposes.

MAP D: HYDROLOGY AND ELEVATION

Lake Major Watershed PWA SWPP 2016

Map D: Hydrology and Elevations



* This map is for informational purposes only and should not be used for legal, engineering, or surveying purposes.

2.2 Location, Natural Land Cover, Built Form and Ownership

Lake Major was chosen as a municipal water supply due to its large capacity and close proximity to the City of Dartmouth. Ownership plays an important role in maintaining the Lake Major watershed area's natural land cover while minimizing built form. The following subsections describe how these influences may impact water quality in the watershed area. The four maps (Map E through Map H) following this section illustrate the watershed area, land cover, and landownership described in this section.

2.2.1 Location

The Lake Major watershed is located east of the Bedford Basin, surrounded by the Waverly-Salmon River Long Lake (WSRLL) Wilderness Area, the Waverley Game Sanctuary (WGS), Highway 102 and the communities of Montague Gold Mines, Lake Loon/Cherry Brook, Lake Major, East Preston and North Preston. Lake Major itself is located at Latitude 44°45'00.000" N; longitude 63°30'00.000" W. The elevation of Lake Major is approximately 20m above sea level.

2.2.2 Natural Land Cover

The natural land cover of the watershed area amounts to 5942ha (~85.6%) and consists of 5005ha (~72%) natural forest area, 671.13ha (~9.66%) wetlands, 411ha (~5.9%) barren land, and 59.3ha (~0.85%) old fields or lands returning to forest. Surface water covers 813.7ha (~11.72%) of the watershed area and consists of 55 lakes including Lake Major, Long and East Lakes (see section 2.1.4: *Lake Major Hydrology and Environment* on page 15 and *Table 1: Lake Major Watershed Lakes > 1ha* page 16) and 62km of rivers and streams. The remaining 188ha (~2.7%) consists of 116.7ha (~1.7%) residential development, 25.4ha (~0.36%) gravel pit, 14.3ha (~0.2%) golf course, 16.3ha (~0.23%) road corridor, 13.1ha (~0.18%) power line corridor and 1.9ha (<1%) agricultural land. *Map F: Land Cover* on page 34 illustrates the watershed area land cover types just described.

2.2.3 Built Form

The watershed area also has undergone significant anthropogenic alterations to accommodate transportation corridors (roads and trails), utility lines (power, water, wastewater and stormwater), housing and other built forms. The subsections below briefly describe these built forms and the land area or length of corridor they occupy, some of which travel through, over or around the natural areas described above.

Transportation Corridors

There are approximately 20km of roads, streets, drives and lanes in the watershed area (see *Map F: Land Cover* on page 34). Of these roads, 6.33km are major collector roads, 7.5km are local streets and the remaining ~6km are categorized in the HRM GIS data as private "edge of travelled way" or "driveways". Most of these roadways are associated with the residential areas of North Preston, East Preston, Lake Loon/Cherry Brook, Lake

Major and Montague Gold Mines, except for the major collector road sections that connect these residential communities. HRM maintains half (approximately 10km) of the roadways, while the Nova Scotia Department of Transportation and Infrastructure Renewal (NSTIR) maintains 1.7km of roadway that primarily includes sections of Crane Hill and Upper Governor Roads contained within the watershed area. The remaining 8.2km are categorized as private roadways, including most of Simmonds Road, approximately half of the roads in North Preston and a small section of Wynder Lake Road. Most of these private roadways are maintained by HRM or private landowners in the winter months.

Water Supply System Infrastructures

The Lake Major Water Supply Plant (WSP), located at 341 Cherry Brook Road, Dartmouth, was commissioned in 1999 and provides approximately 32,000 service connections over an area of 84.6km² (8460 ha), see *Map K: Lake Major HRWC Services and Development Risk Areas* on page 117).

The Lake Major water supply distribution system infrastructure consists of:

- the Lake Major WSP;
- two (2) pump stations;
- four (4) reservoir chambers (excluding the water supply plant); and
- over 3000 hydrants with over 500m of pipe (excluding service connections, hydrant and standpipe leads).

In addition to the distribution system, Halifax Water is responsible for the operation and maintenance of two (2) dams within the Lake Major watershed; East Lake and Lake Major¹⁵. The license to operate these dams falls under the Annual Operating Permit (AOP) issued to Halifax Water by Nova Scotia Environment. A third dam managed by Nova Scotia Power Inc. (NSPI) located on Soldier Lake acts as a separation dam between the Soldier Lake watershed and the Lake Major watershed. The locations of the dam structures are illustrated on *Map D: Hydrology and Elevation* on page 25. See *Table 3: Canadian Dam Association Classification System* (2007) on page 28 which describes the Canadian Classification system for both dams owned by Halifax Water. The classification system is based on the consequences of failure in terms of life safety, environment and cultural impacts and infrastructure and economic impacts. The following sections briefly describe these dams; Lake Major and East Lake Soldier Lake.

Lake Major Dam

According to a dam safety review completed by a consultant hired by Halifax Water⁶, the Lake Major Dam was originally constructed in 1949 with minimal maintenance

⁶ Mecco Project 10129: 2012 Dam Safety Review; Halifax Water: Halifax/Dartmouth, NS. Final Report 2013; p. 120.

conducted throughout its service life. This dam contains the major storage reservoir for the Lake Major water supply with storage capacity of 5,250,000m³. Inflow into the system is partially regulated by the dam at the outflow of the East Lake watershed (see *Map D: Hydrology and Elevation* on page 25); the outflow or spillway channel runs under Lake Major Road. See *Table 4: Lake Major Watershed Dam Safety Review (DSR) Results* on page 30 for further details on the Lake Major Dam.

In 2015, Halifax Water awarded a contract for the design work to replace the Dam at Lake Major. The need for the Dam replacement became more evident after a rainstorm in December 2014, which necessitated emergency repairs to the fish ladder in January 2015. The emergency response was co-ordinated and supported by several Halifax departments, RCMP and the Halifax Regional Ground Search and Rescue.

East Lake Dam

The East Lake dam is a control structure that was constructed in 1974. The dam is located upstream and northeast of Lake Major, approximately 2 km northwest of the community of North Preston. See *Table 4: Lake Major Watershed Dam Safety Review (DSR) Results* on page 30 for further details on the Lake Major Dam. This reservoir provides additional storage to Lake Major (see *Map D: Hydrology and Elevation* on page 25).

Soldier Lake Dam

The Soldier Lake wing dam, first constructed in 1916 is located at the south end of Soldier Lake, is presently owned and operated by NSPI. The earth-fill embankment wing dam prevents water flow from Soldier Lake to the Lake Major watershed.

Details on the risks these systems present are described in section 3.1.5: *Water Supply System Infrastructure* on page 79.

Table 3: Canadian Dam Association Classification System (2007)⁷					
Reservoir	Dam Classification	Population at Risk	Incremental Losses		
			Loss of Life	Environmental and Cultural Values	Infrastructure and Economical
East Lake	Low	None	0	Minimal short-term loss; no long term loss	Low economic losses; area contains limited infrastructure or services.
Lake Major	High	Permanent	10 or fewer	Significant Loss or deterioration of important fish or wildlife habitat. Restoration or compensation in kind highly possible.	High economic losses affecting infrastructure, public transportation and commercial facilities.

⁷ Mecoc Project 10129: Halifax Water 2012 Dam Safety Review, Final Report 2013, Section 9., Table 3-1, p. 13

Table 4: Lake Major Watershed Dam Safety Review (DSR) Results

(see Map K: Lake Major HRWC Services and Development Risk Areas on page 117)

Reservoir	Structure	Type	Year Built	Location	Height (m)	Length (m)	Elevations (m)		Levels (m)		Comments	Class.
							Crest / Sill	Top of Core	Full Supply	Max. Flood		
East Lake	Dam/ Spillway	Concrete, stop log controlled	1974	Outlet of East Lake	4.0	32	29.26	NA	29.26	30.03		Low
	Freeboard Dam	Earth embankment with concrete core wall			1.2	44	30.48	30.18				
Lake Major	Dam/ Spillway	Rock filled timber crib		Outlet from Lake Major into Little Salmon River	2.8	44	19.85/19.40	NA	19.40	20.60	Considered to be in poor condition at time of DSR	High

North Preston Central Sewer and Water Supply Plant

In 1987, the Municipality of Halifax County, the Province and the community of North Preston partnered on a project to install central sewer and water services in North Preston. Construction of water and wastewater services was completed in 1989. The North Preston water system, which is within the watershed area, consisted of a municipal water intake pumping station and water treatment facility on Long Lake, a water tank reservoir at 857 Upper Governor Road and fire hydrants to improve fire-fighting capacity. The wastewater treatment plant is located outside of the Lake Major watershed with the receiving waters being Wynder (also spelled Winder) Lake. Four (4) lift stations and the majority of the central sewer system pipes are located within the Lake Major watershed (see *Map L: Development Risk Areas in Communities* on page 118).

To meet new government drinking water guidelines and customer service Halifax Water determined it would be more cost effective to decommission the North Preston-Long Lake WSP and extend the Lake Major water main to the community. Construction of the new water main began in August 2009 and was completed in September 2010.

2.2.4 Landownership

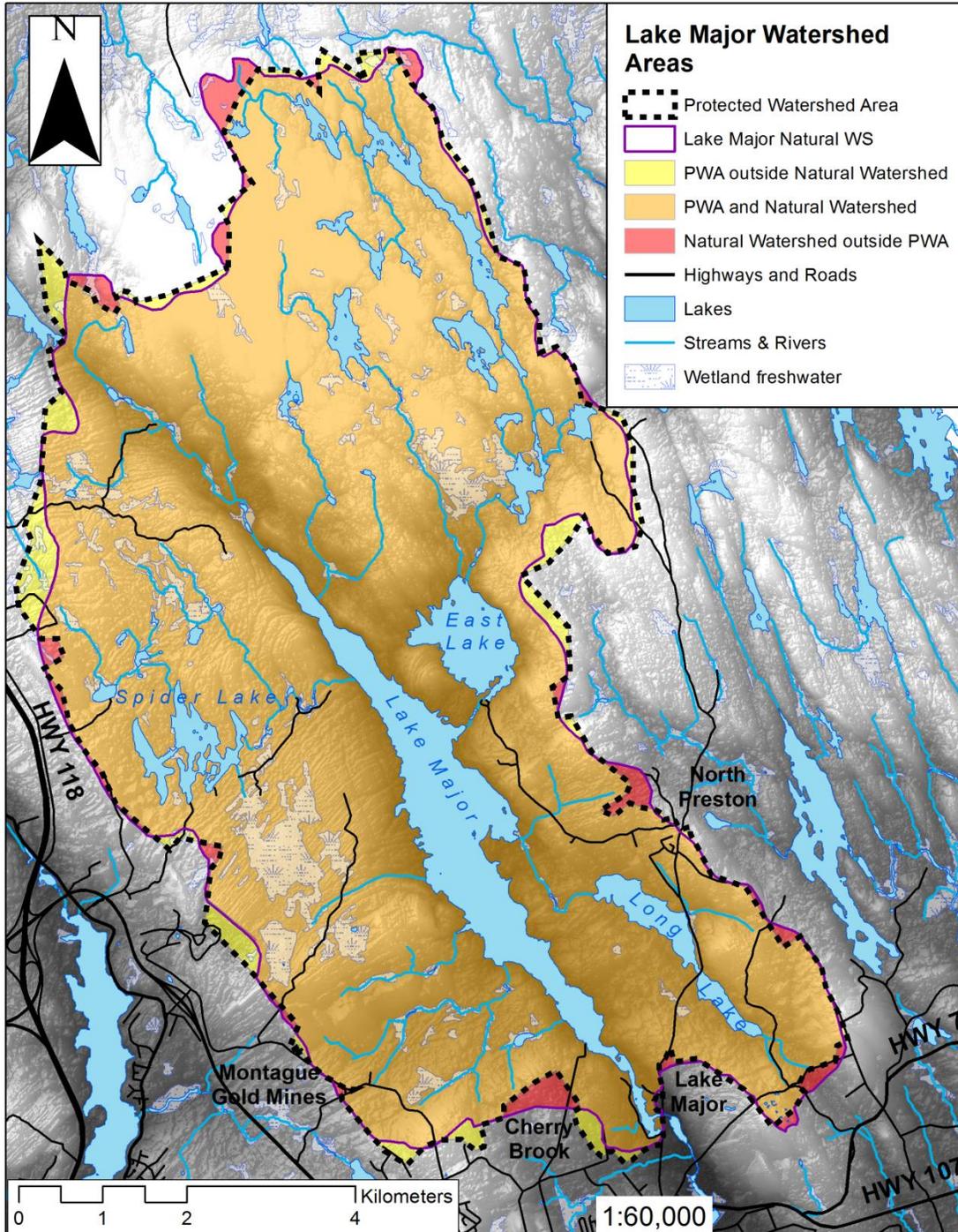
Landownership of the watershed area amounts to 6129.5ha (excluding 813.7ha (~11.72%) of surface water areas) of which: 2845.6ha (~41%) is provincial lands, 2592.8ha (~37.32%) is Halifax Water lands and 692ha (~10%) is other government and private lands. *Table 5* below outlines landownership of the watershed area and is further demonstrated in *Map G: Landownership* on page 35 and *Map H: Landownership - Montague Mines & N. Preston* on page 36.

Table 5: Breakdown of Landownership by Type and Land Area		
Government Level	Agency/Department	Area (ha)
Federal	CMHC	0.61
	DNR	634.11
Provincial	NS Environment	2162.04
	NS Other	49.50
Municipal	HRM	39.5
Individuals	Residential settlement areas	523.35
Utilities	Halifax Water	2592.8
	Nova Scotia Power	28.13
Business	Banking	0.25
	Developers/Finance	41.15
Industry	Golf Courses	14.43
	Quarry/Excavation/Sod/Contractors	41.44
Community NGO	Housing	0.68
	Medical	0.14
Faith	Church	1.34

Table 5: Breakdown of Landownership by Type and Land Area		
Government Level	Agency/Department	Area (ha)
Total Area		6129.47

MAP E: WATERSHED AREAS

Lake Major Watershed PWA SWPP 2016 Map E: Lake Major Watershed Areas

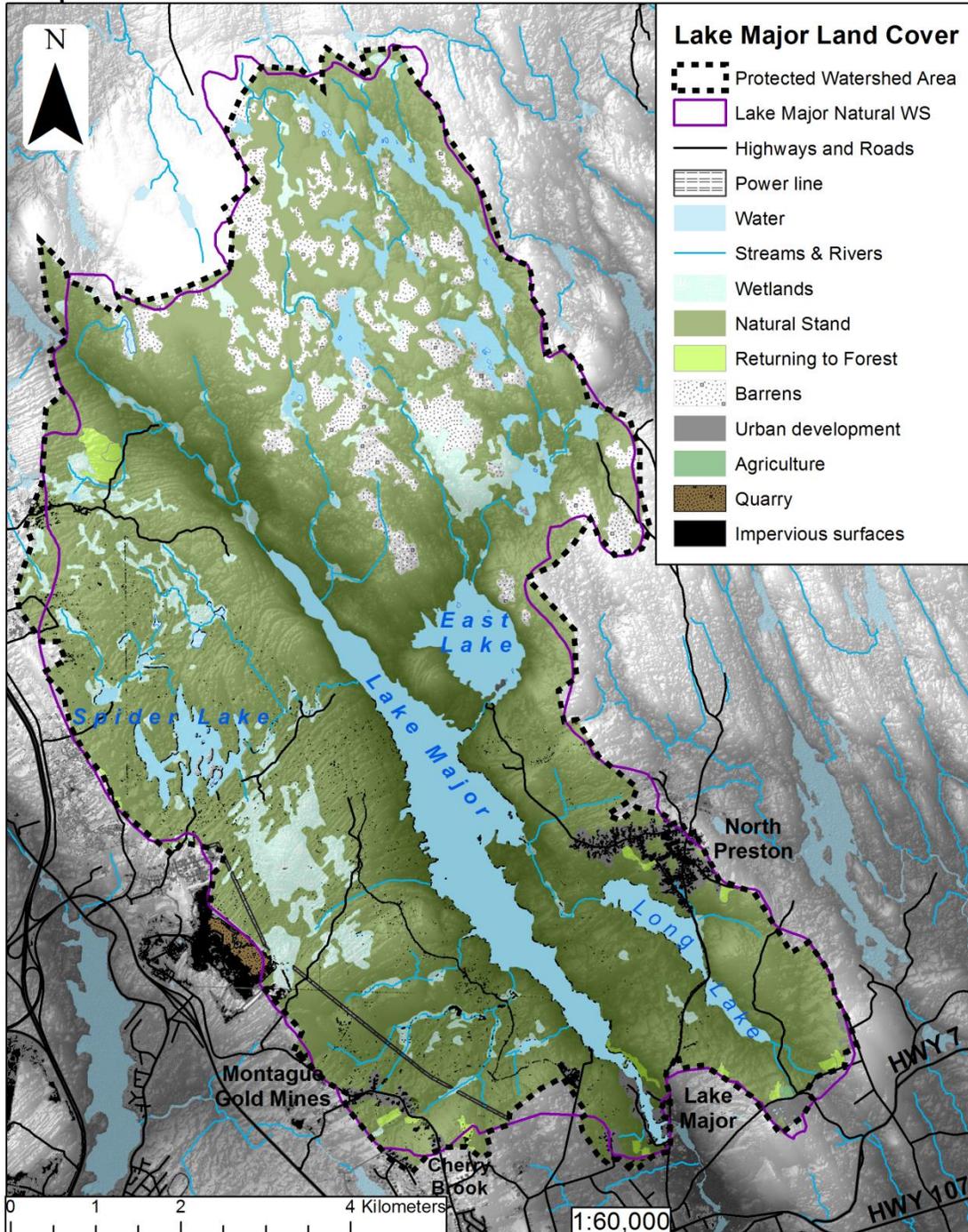


* This map is for informational purposes only and should not be used for legal, engineering, or surveying purposes.

MAP F: LAND COVER

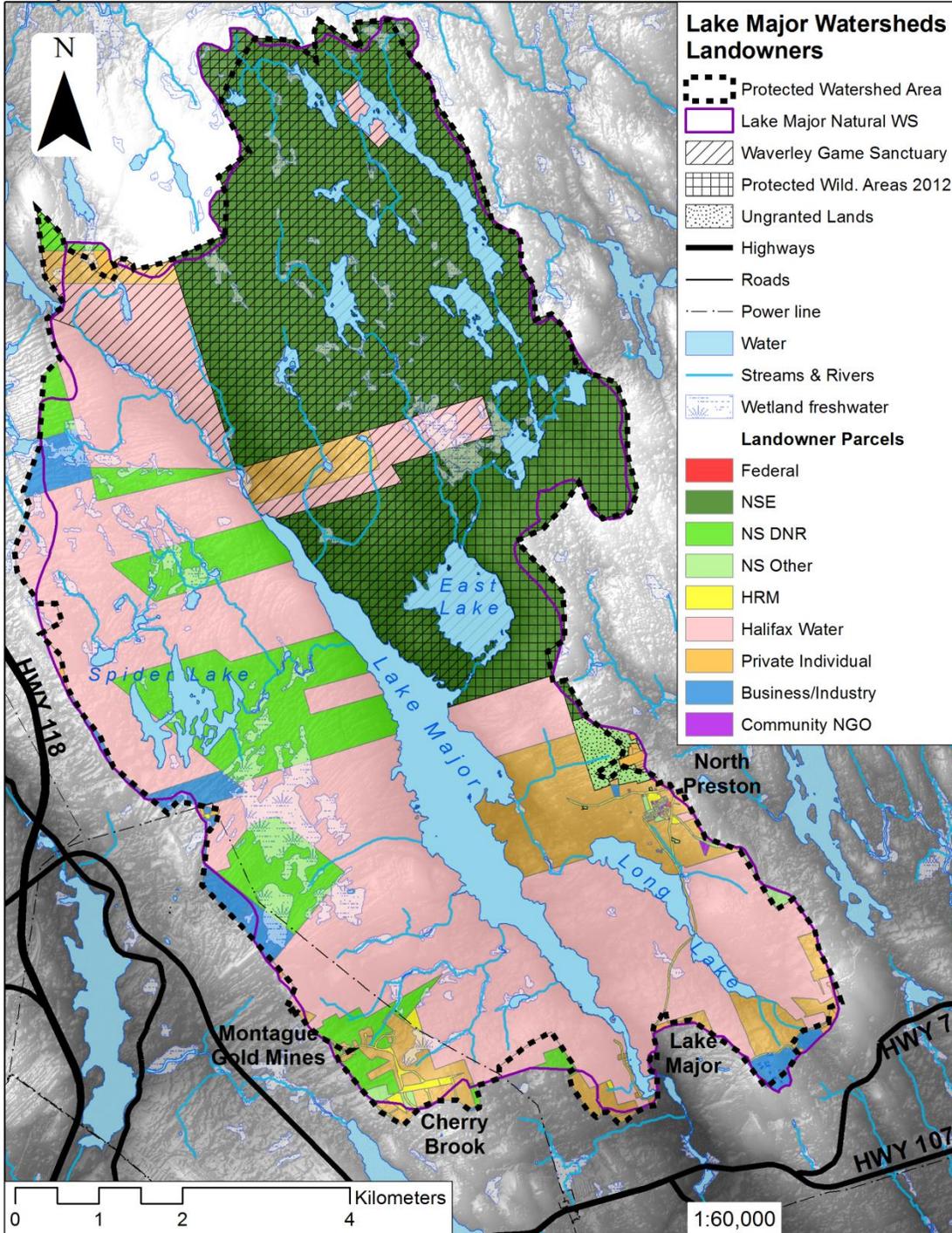
Lake Major Watershed PWA SWPP 2016

Map F: Land Cover



* This map is for informational purposes only and should not be used for legal, engineering, or surveying purposes.

Lake Major Watershed PWA SWPP 2016
 Map G: Landowners in PWA and Natural Watershed

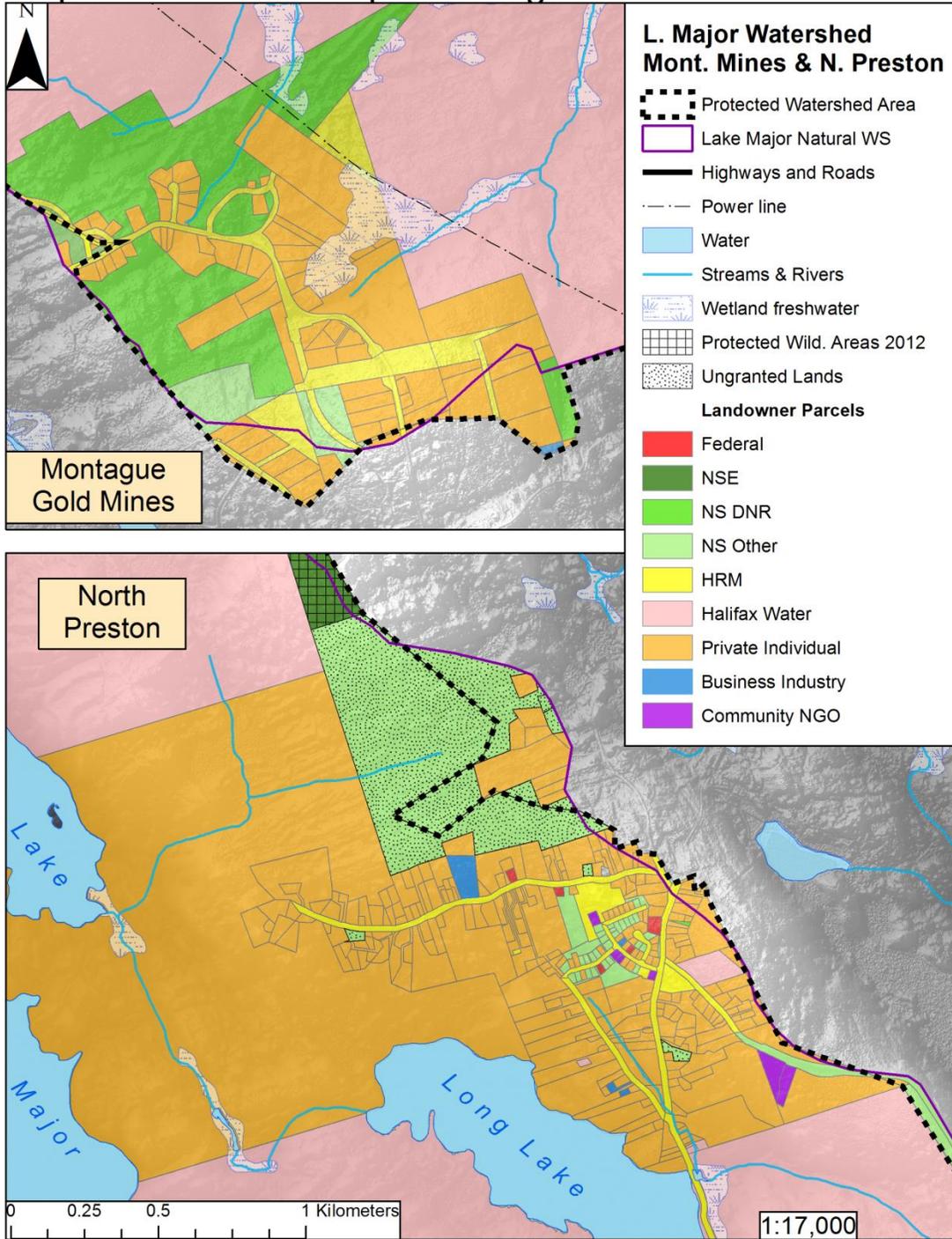


* This map is for informational purposes only and should not be used for legal, engineering, or surveying purposes.

MAP H: LANDOWNERSHIP - MONTAGUE MINES & N. PRESTON

Lake Major Watershed PWA SWPP 2016

Map H: Landownership - Montague Mines & N. Preston



* This map is for informational purposes only and should not be used for legal, engineering, or surveying purposes.

2.3 Designation as a Protected Water Area

The *Lake Major Watershed Protected Water Area (PWA)* was designated in 1986 as a result of the City of Dartmouth's request to the Minister of the Environment pursuant to subsection 16(1) of Chapter 500 of the Revised Statutes of Nova Scotia, 1989, the *Water Act* (see *Appendix 1: Lake Major Watershed Protected Water Area Designation and Regulations* on page 167). The Lake Major designated *Protected Water Area (PWA)* was delineated by following property boundaries and roads as closely as possible to the natural watershed area's highest points of land, rather than exactly following natural watershed boundaries. This method of delineation eases boundary impacts on private parcels of land. As a result, a small percentage (~ 2.4%) of the natural watershed area falls outside of the *PWA* designation.

On January 21, 1992, a motion was sent by the former City of Dartmouth to the Minister of Environment to enact regulations associated with the *Lake Major Watershed Protected Water Area Designation*. The *Lake Major PWA* regulations took effect July 10, 1992 (see *Appendix 1* on page 167) as per subsection 106 (6) of the *Environment Act* on.

The designation regulation sets requirements for Halifax Water to post signage throughout the *PWA*, to regulate fire, vehicles and vessels, lakes and watercourses, fishing, hunting, forestry, chemical application, landfills, construction of corridors, soil erosion and sedimentation controls, and road building and maintenance. The regulations also provide for the establishment of a watershed management committee.

2.4 Governance

The mechanisms that govern the protection of the Lake Major watershed include provincial policies and regulations, a management committee and municipal land use planning policies and by-laws.

2.4.1 Provincial Policies and Regulations

While all lands within the *PWA* are governed by the *PWA Regulations* (see *Appendix 1* on page 167), additional provincial land use designations provide further regulatory protection with respect to land-use practices within the entire watershed area as outlined below and described further under the respective subheadings.

Provincially managed land areas cover 2845.6ha (~41%) of the *PWA*. Most of this area, 2448.2ha (~86%), is designated as the *Waverley-Salmon River Long Lake (WSRLL) Wilderness Area* (defined on page on page 38). Added protection for this land area is provided through the *Wilderness Areas Protection Act* 1998, c. 27, s. 1 (*WAPA*) which is managed by Nova Scotia Environment (NSE)'s Protected Areas and Ecosystems Branch.

The Waverley Game Sanctuary (WGS) covers approximately two thirds (2529.67ha) of the watershed area and provides another level of protection with respect to hunting game, which is prohibited in the WGS. The Department of Natural Resources (DNR) has jurisdiction to enforce WGS legislation (described on page 38) through the *Wildlife Act* 1989, c. 504, s. 113.

A significant portion of the WSRLL Wilderness Area and WGS within the watershed area (2081.48ha) overlap. Another portion of provincially owned land within the watershed area (634 ha) is Crown land, which is managed by DNR (described on page 39).

Remaining provincially-managed lands in the watershed area (58.41ha) are owned by other provincial government departments and do not provide significant additional protective watershed legislation. Where there is a conflict or inconsistency between Acts or regulations and any other enactment, the most stringent policy typically prevails. For certainty, however, contact the applicable governing agency.

Waverley-Salmon River Long Lake (WSRLL) Wilderness Area

The WSRLL Wilderness Area is one of approximately 40 provincially-significant protected areas designated under *WAPA*. The WSRLL Wilderness Area covers a total of 8662.64ha, of which 28% (2448.2ha) is contained within the watershed area (see *Map G: Landownership* on page 35). The whole WSRLL Wilderness Area is governed by the *WAPA* under the authority of NSE, as previously described.

Wilderness Areas protect representative examples of Nova Scotia's 80 natural landscapes, native biological diversity, and outstanding natural features. The intended use of Wilderness Areas is for scientific research, education and a variety of recreation and nature-tourism related activities such as hiking, canoeing, sea-kayaking, sport fishing and hunting.

The 2448.2ha portion of the WSRLL Wilderness Area within the watershed area, which has been given *WAPA* designation, adds protection to the watershed area from the following activities that may be prohibited:

- acquiring mineral or petroleum rights, constructing infrastructure associated with energy, hydro and water resource development;
- carrying out agricultural activities, creating a transportation route, using a vehicle, including bicycles, camping, tenting or occupying the land;
- disturbing flora and fauna, or articles of scientific or historical significance;
- introducing a substance that may destroy or damage the ecosystem;
- having a fire (except at designated sites); and
- dumping litter.

Certain recreational activities are permitted per the terms and conditions set out by the Minister. Hunting and fishing are permitted in accordance with applicable laws.

Waverley Game Sanctuary

The Waverley Game Sanctuary (WGS) amounts to 5232.34ha of which 2530ha falls within the watershed area (see *Map G: Landownership* on page 35). All of the WGS area

is managed under DNR's jurisdiction through the *Wildlife Act*, which regulates activity within the WGS, including the prohibition of hunting and trapping.

Nova Scotia Wetland Conservation Policy

The Nova Scotia Wetland Conservation Policy provides direction and framework for the conservation and management of wetlands in Nova Scotia. The policy highlights the important roles wetlands play in Nova Scotia's landscapes and their value to society. It represents a commitment to managing Nova Scotia's wetlands in a consistent manner and to maintaining a high level of wetland integrity for future generations, while allowing for sustainable economic development in our communities. The policy recognizes wetlands in designated watersheds as Wetlands of Special Significance (WSS). This policy is significant for the Lake Major watershed considering there are 671.13ha (9.66%) of wetland or lacustrine areas in the PWA (see section 2.1.3: *Lacustrine (Wetlands)* on page 14 and *Map D: Hydrology and Elevation* on page 25).

Crown Lands

The Crown owns ~634ha of watershed area land that is predominantly located on the west side of Lake Major – see on *Map G: Landownership* on page 35. These areas are governed by the PWA and other applicable regulations such as the Forest Sustainability Regulations and by management guidelines such as Halifax Water's Best Management Practices (BMPs) – see www.halifax.ca/hrwc/documents/2010ApprovedBMPs.pdf.

Management of Crown land such as those parcels around the northwest side of the watershed area between Soldier's Lake and the WSRLR Wilderness Area will be addressed through the Department of Natural Resources' Integrated Resource Management (IRM) process and/or through management planning processes for individual wilderness areas through NSE Protected Area's Branch.

Halifax Water, DNR and NSE Protected Areas Branch are discussing potential land swap opportunities which include lands within the Lake Major watershed.

2.4.2 Management Committee

Under section 105 (4) of the *Environment Act 1994-95, c. 1, s. 1.*,

“the Minister may identify any qualified persons, including water or watershed advisory boards, committees or authorities, and request those persons to promote informed public participation, provide advice to the Minister respecting watershed management and undertake such aspects of watershed management as may be assigned to those persons by the Minister 1994-95, c. 1, s. 105; 2006, c. 30, s. 34.”

⁸ Province of Nova Scotia: Nova Scotia Wetland Conservation Policy Website. 2014-Mar-31. Accessed: May 3, 2016 at: <https://www.novascotia.ca/nse/wetland/conservation.policy.asp>.

The Lake Major Watershed Advisory Board (LMWAB) at the time, established in 1989, was tasked to develop the regulations of activities in the PWA. *Lake Major Watershed Protected Water Area Regulations* define the Board's responsibility as: "... to provide advice to the Minister and the Water Utility with respect to the management of the Lake Major Watershed."

The regulations recommended by the LMWAB became the Lake Major Water Supply Protected Water Area Regulations (see section *Appendix 1: Lake Major Watershed Protected Water Area Designation and Regulations* on page 167). With the added responsibility afforded the LMWAB under section 105 (4) of the Environment Act, the LMWAB developed its Terms of Reference to reflect its added responsibility.

Terms of Reference

The initial LMWAB Terms of Reference (ToR) was approved in June 1998. As part of Halifax Water's commitment to continued improvement, a review of the ToR was initiated in October 2009 and completed in October 2011. See *Appendix 2: LMWAB Terms of Reference* on page 168 for the most recent version.

The Board meets at least twice a year; additional meetings are held according to the needs associated with activities within the watershed area.

Board membership consists of:

- One voting identifiable group, organization or individual representative from each of the communities of
 - North Preston,
 - Lake Major,
 - East Preston,
 - Lake Loon/Cherry Brook; and
- One technical representative from
 - Halifax Water,
 - Halifax Regional Municipality Planning and Development Services,
 - Nova Scotia Environment, and
 - Nova Scotia Department of Natural Resources.

2.4.3 Municipal Land-use Planning Policies and By-laws

Municipal governance of the land use conducted within the watershed area is managed through the Halifax Regional Municipal Planning Strategy (RMPS) (2014)⁹ and municipal planning strategy (MPS) policies and land-use by-laws (LUBs). The following sections explain the complexities of the various municipal regulatory documents relative to the Lake Major watershed by:

- identifying the RMPS (2014) policies specific to the watershed area described in section 2.4.3: *HRM and Halifax County By-laws* on page 64 and outlined in *Table 9: HRM Regional and Halifax County By-laws* on page 64;
- defining Municipal Planning Strategy (MPS) Districts and the associated Land-use By-law (LUB) areas specific to the watershed area (see *Table 6: HRM LUB Plan Areas in Watershed and Applicable By-law Zones and Descriptions* on page 45; and
- highlighting any planning district policies and/or land-use by-laws that are relevant to the watershed area (see *Table 7: Lake Major - North Preston MPS Watershed-Specific Policy Outline* on page 53 and *Table 8: Shubenacadie Lakes MPS Policies Respecting the Lake Major Watershed* on page 57).

Regional Municipal Planning Strategy Policies

The updated version of the Halifax Regional Municipal Planning Strategy (RMPS (2014)) introduced new policies affecting HRM zoning regulations within the Lake Major watershed. Policies E-7, E-8 and E-9 specifically acknowledge the underlying landownership and designations associated with sensitive natural areas, not just within the watershed area, but throughout the Halifax Municipality. Further, policies E-13 and E-14 were adjusted and added, respectively, to enhance the protection of potable water supplies and to trigger awareness of the sensitivity of the areas among potential developers and development officers. These policies are provided under the subheadings below.

Natural Area Protection Policies

“[Policy] E-7

HRM shall, through the applicable land use by-law, establish a Protected Area Zone. This Zone shall be applied to wilderness areas which have been designated under the Wilderness Areas Protection Act, nature reserves

⁹ While the Lake Major SWPP was being developed, the HRM RMPS (2006) was undergoing the RP+5 review process. Through the development of the Lake Major SWPP, gaps which affected the ability to protect HRM's water supply areas were observed in the RMPS (2006). Halifax Water used much of the information gathered through this SWPP development process to recommend changes to the RMPS (2006), particularly regarding the Potable Water policy and associated mapping. The recommendations were subsequently considered and reflected in the latest version of the RP (2014) and incorporated into this SWPP.

designated under the Special Places Protection Act, and conservation-related properties owned by government or private conservation organizations. The Zone shall only permit scientific study and education, trails and similar public, conservation and recreational uses.

[Policy] E-8

Further to Policy E-7, HRM shall encourage the Province of Nova Scotia to evaluate the potential for the designation of additional lands for protection under the Wilderness Areas Protection Act.

[Policy] E-9

Where HRM is considering approval of new secondary planning strategies or amendments to existing secondary planning strategies to allow new developments, natural corridors shall first be delineated, consistent with the Greenbelting and Public Open Space Priorities Plan approach, to identify areas to be retained for natural areas and natural corridors.

Potable Water Supply Protection Policies

“[Policy] E-13:

HRM shall, through the applicable land use by-law, establish a Protected Water Supply Zone which shall be applied to all publicly owned lands which serve as a water supply watershed, including emergency water supply watersheds and well head protection areas. This Zone may also be applied to private lands within these watersheds deemed necessary to protect the public water supply. The Zone shall permit water distribution and purification facilities, passive parks and trails, conservation related uses, and other uses as provided by the existing secondary planning strategies for these areas. The zone shall establish a minimum 30.5 metre riparian buffer around water supply sources.

Policy E-14

For any lands within a watershed or ground water supply area where a public water supply system has been established or is proposed, Council shall consider amendments to land use by-laws deemed necessary to:

- (a) protect the water supply;*
- (b) ensure that a consistent regulatory approach within each watershed; or*
- (c) conform with any Statement of Provincial Interest Regarding Drinking Water.”*

A new map (Map 12 of the Regional Plan (2014)¹⁰) illustrating the water supplies that are owned and operated by Halifax Water was also incorporated into the RMPS (2014).

Wind Energy Policy

The most relevant RMPS (2014) policy respecting zoning for wind energy facilities in the watershed area is stated below; note that the policy states that wind turbines “shall be prohibited” in protected areas.

“[Policy] E-30:

Within all Regional Plan Designations, HRM shall establish three overlay zones including an Urban Wind (UW-1) Zone, a Rural Wind (RW-2) Zone and a Restricted (R) Zone within the Land-use By-law to regulate wind energy facilities. These regulations will be implemented through the community land-use by-laws. The Urban Wind (UW-1) Zone and the Rural Wind (RW-2) Zone shall be applied to those areas where various categories of wind energy facilities shall be permitted in urban and rural areas. The Restricted (R) Wind Zone shall be applied to the those areas where wind energy faculties shall be prohibited including Regional Parks, Conservation Areas, Protected Areas and the Western Commons and areas within Urban HRM not suitable for wind energy facilities.”

Municipal Planning Strategies and Land-use By-laws

Within the watershed area are four different Halifax Regional Municipality (HRM) Municipal Planning Strategy (MPS) and Land-use By-law (LUB) Districts or Plan Areas:

- Cole Harbour/Westphal;
- North Preston/Lake Major/Lake Loon/Cherry Brook and East Preston (North Preston – Lake Major);
- Planning Districts 8 & 9 (Porter’s Lake); and
- Planning District 14/17 (Shubenacadie Lakes).

Each Plan Area (MPS) (illustrated on *Map I: Plan Area and Zoning* on page 66) has its own set of Land-use By-laws (LUBs) in addition to Halifax Regional Municipal Planning Strategy (RMPS (2014)) By-laws and provincial or federal regulations.

All the LUB Planning Districts, within the watershed area, together have 13 By-law Zones including MR - Mixed Resource, P-1 (Recreation Open Space), P-2 (Community Facility), P-3 (Park Zone), P-4 (Protected Area), PA (Protected Area), PWS (Public Water Supply), R-1 (Single Unit Dwelling), R-1b (Suburban Residential), R-3 (Mobile

¹⁰ Halifax Regional Municipal Planning Strategy: Map 12 – Water Supply Areas. October 2014. Website accessed April 5, 2016 at <http://www.halifax.ca/regionalplanning/documents/Map12HRMWaterSupplesRP5.pdf>.

Dwelling), R-7 (Rural Estate), RA (Residential) and RS (Rural Settlement). *Table 6: HRM LUB Plan Areas in Watershed and Applicable By-law Zones and Descriptions* on page 45 describes the By-law Zones; and *Map I: Plan Area and Zoning* on page 66 illustrates the locations.

In addition to the regulatory provisions of the HRM By-laws, HRM Planning and Development staff sits on the LMWAB to advise the Board of LUB regulations and acts as a liaison between the Board and HRM for development applications as they arise.

Table 6: HRM LUB Plan Areas in Watershed and Applicable By-law Zones and Descriptions		
Cole Harbour/Westphal (3)		1230.71* ha
By-law Zone	Zone Area* (ha) in PWA	Permitted Uses
P-1 (Recreation Open Space)	0.75	Open Space Uses; Public and private parks and playgrounds; Cemeteries; Historic sites and monuments.
PWS** (Protected Water Supply) + P-4 (Conservation Zone) changed to PWS in MPS when Regional Plan Adopted)	1147	Municipal Water Distribution or Purification Facilities; Public Parks w/ no Buildings; Conservation Uses; Uses Accessory to Foregoing Uses; Single Unit Dwellings
R-1 (Single Unit Dwelling)	11.29	Single Unit Dwellings, Home Businesses, Daycare ≤14 children
R-3 (Mobile Dwelling)	0.17	Mobile Dwelling w/ perm foundation; Single Unit Dwellings; Home Businesses; Daycare ≤14 children
R-7 (Rural Estate Zone)	71.46	Single Unit Dwellings; Home Businesses; Daycare ≤14 children
Planning Districts 8 and 9 (Porter's Lake) (12)		454.85* ha
By-law Zone	Zone Area* (ha) in PWA	Permitted Uses
PA (Protected Area) (RC-Jun 27/06;E-Aug 26/06)	66.58	Scientific study and education, involving no buildings; Trails, boardwalks or walkways; Conservation Uses; Uses accessory to the foregoing uses;
PWS** (Protected Water Supply); Formerly P-4 (Conservation Zone) changed to PWS when Regional Plan was adopted; Aug. 06)	388.27	Municipal water distribution or purification facilities; Public parks involving no buildings; Conservation uses; Uses accessory to the foregoing uses

Table 6: HRM LUB Plan Areas in Watershed and Applicable By-law Zones and Descriptions		
N. Preston, Lake Major, Lake Loon/Cherry Brook, East Preston (N. Preston–Lake Major) (15) 837.3* ha		
By-law Zone	Zone Area* (ha) in PWA	Permitted Uses
MR (Mixed Resource)	497.97	Resource Uses: except Intensive Agricultural Uses within the Lake Major Watershed; Composting operations that are 328ft (100m) from a watercourse; Community Uses; Residential Uses
P-1 (Recreation - Open Space)	13.96	Commercial Recreation; Private/Public Parks and Open Space
P-2 (Community Facility)	3.24	(a) Institutional Uses: Community centres and halls; Day care facilities, including single unit dwellings in conjunction with day cares; Denominational institutions and uses; Educational institutions and uses; Fire and police stations; Government offices and public works; Hospitals and medical clinics; Nursing homes; Public libraries, museums and galleries; Residential care facilities (b) Open Space Uses Cemeteries; Historic sites and monuments; Public and private parks and playgrounds
PA (Protected Area)	4.55	Scientific study and education, involving no buildings; Trails, board-walks or walkways; Conservation uses Uses accessory to the foregoing uses Other Requirements: Within any PA zone, no infilling, excavation, alteration of grade or removal of vegetation shall be permitted. The construction of board walks, walkways or trails shall be permitted provided that no infilling or alteration of grade occurs other than the placement of piles or the placement of trails on top of the existing grade.
PWS** (Protected Water Supply) (formerly P-4 (Conservation Zone); changed to PWS Zone in RMPS (2006) when Regional Plan Adopted)	35.31	13.1 PWS USES PERMITTED Municipal Water Distribution or Purification Facilities; Public/Private Parks w/ no Buildings; Conservation Uses; Crop Farming; Grazing, and pasturage if in existence at the time of by-law effect; Uses Accessory to Foregoing Uses 13.3 SPECIAL PROVISIONS: EXISTING RESIDENTIAL USES Notwithstanding Section 13.1, existing residential uses in a PWS Zone shall be permitted to be expanded, altered, repaired and rebuilt and, in addition, certain properties within a PWS Zone shall be permitted to be used for residential use, such existing uses and certain properties identified by Appendix "D" [<i>Found in Appendix 3 on page 169</i>]
RA Residential	59.5	Residential Uses; Community Uses
RS (Rural Settlement)	222.68	Residential Uses; Community Uses; Commercial Uses except , automotive repair outlets and service stations within the Lake Major Watershed; and Resource Uses except Intensive Agricultural Uses within the Lake Major Watershed

Table 6: HRM LUB Plan Areas in Watershed and Applicable By-law Zones and Descriptions		
Planning Districts 14 & 17 (Shubenacadie Lakes) (19)		3576.22* ha
By-law Zone	Zone Area* (ha) in PWA	Permitted Uses
P-3 (Park Zone)	9.73	<p><u>Park Uses:</u> Conservation uses; Recreation Uses Public and private parks and playgrounds; Campgrounds</p> <p><u>Commercial Uses:</u> Restaurants; Guest homes; Inns; Retail outlets; Lodges; Craft shops (MC-Jul 26/93;SCC-Aug 10/93;E-Sep 4/93).</p> <p><u>Resource Uses:</u> Agricultural uses; Forestry uses.</p> <p><u>Commercial Uses:</u> In any P-3 Zone where commercial uses are permitted, no open storage or outdoor display of goods shall be permitted.</p>
PA (Protected Area)	35.31	<p>Scientific study and education, involving no buildings; Trails, board-walks or walkways; Conservation uses</p> <p>Uses accessory to the foregoing uses</p> <p>Within any PA zone, no infilling, excavation, alteration of grade or removal of vegetation shall be permitted. The construction of board walks, walkways or trails shall be permitted provided that no infilling or alteration of grade occurs other than the placement of piles or the placement of trails on top of the existing grade.</p>
PWS** (Protected Water Supply)	3405.87	Municipal Water Distribution or Purification Facilities; Public Parks; Conservation Uses; Uses Accessory to Foregoing Uses; Single Unit Dwellings
R-1B (Suburban Residential)	75.88	Residential Uses; Community Uses
R-7 (Rural Estate)	49.43	<p><u>Residential Uses:</u> Single unit dwellings; Two unit dwellings; CSA approved mobile dwellings; Day care facilities for not more than fourteen (14) children in conjunction with a dwelling; Business uses in conjunction with permitted dwellings; Pet care facilities in conjunction with a permitted dwelling (HE/MDVCCC-Aug 6/09;E-Aug 22/09)</p> <p><u>Community Uses:</u> Open space uses; Institutional uses; Fraternal halls; Nursing homes; Residential care facilities; Resource Uses; Forestry uses; Agricultural uses; Intensive agricultural uses (MC-Mar 28/94;SCC-Apr 12/94;E-May 7/94); Indoor riding barn, private (MDVCCC-Jan 25/12;E-Feb 11/12)</p> <p><u>Other Requirements:</u> are described in extensive detail in the District 14 & 17 Plan</p>
<p>* Note: Lake and waterway area amounts are not included in the By-law Zone areas.</p> <p>** Note: The acronym PWS is sometimes referenced as “Public” Water Supply and sometimes “Protected” Water Supply, even within the same LUB. For the sake of consistency PWS will always mean “Protected” Water Supply in this document.</p>		

Cole Harbour / Westphal

The Cole Harbour/Westphal (CH/W) Plan Area applies to the watershed area within Municipal Electoral Districts 1, 2 and 4. This area includes the communities of Cole Harbour and Westphal and intervening lands which cover approximately 1230.71ha of the southwest section of the watershed area, not including surface water areas, as illustrated on *Map J: Polling Districts and Plan Area* on page 67.

CH/W Municipal Planning Strategy

The CH/W MPS provides the background and basis upon which the Plan Area LUBs are created as per the *Municipal Government Act*. The official study of the Lake Major watershed¹¹, and the planning process for the Lake Major-Preston area stress that “*the watershed area should be zoned in a manner which is consistent with watershed protection and that support should be given to the acquisition of watershed lands by the City of Dartmouth.*”¹² The CH/W MPS sets up the configuration of the LUBs relevant to the PWA through specific policies.

The MPS applies a Watershed Designation (WS), as shown on the Generalized Future Land Use Map (GFLUM)¹³, to the Lake Major watershed land area that falls approximately between Montague Road and Lake Major, recognizing the potable water supply area. The CH/W MPS policies associated with this WS include support for low-density housing, conservation and watershed management uses that are compatible with the water quality objectives for the watershed area, establishing a conservation zone and applying the appropriate zoning to existing uses. The most significant MPS policy with respect to the watershed area includes Policy W-4 which states:

W-4 *It shall be the intention of Council to support the work of the Lake Major Watershed Advisory Board, in particular the preparation of guidelines and regulations controlling activities within the watershed and to solicit the Board's comments on development proposals located within the watershed.*

CH/W Land-use By-Laws

The CH/W Land-use By-Law (LUB) regulates land-use according to the provisions and policies set in the CH/W MPS. *Map I: Plan Area and Zoning* on page 66 illustrates the CH/W Plan Area LUB zones applicable to the watershed area. Under the HRM RMPS (2006) Policy E-8, the CH/W LUB P-4 (Conservation Zone) became a PWS (Protected Water Supply) Zone.

In addition to the protection provided by the PWS By-law, the CH/W Plan Area is regulated by By-law Zones P-1, R-1, R-3, and R-7 (see *Table 6: HRM LUB Plan Areas in Watershed and*

¹¹ Lake Major Watershed Management Study, Volume One -Executive Summary, Montreal Engineering Company Ltd., February 1980, pp.3-6.

¹² Halifax Regional Municipality Municipal Planning Strategy for Cole Harbour/Westphal. March 1993; p. 96. Website accessed April 5, 2016 at http://www.halifax.ca/planning/documents/ColeHarbourWestphal_MPS.pdf.

¹³ Cole Harbour Westphal Plan Area Municipal Planning Strategy: Map 1 – Generalized Future Land Use. Website Accessed April 5, 2016 at www.halifax.ca/planning/documents/ColeHarbourWestphal_MPS_Map1Gflum.pdf

Applicable By-law Zones and Descriptions on page 45) which apply regulations on 83ha in the CH/W Plan Area as described below:

- Recreation Open Space (P-1) Zone covers only 0.75ha of land located on the southwestern edge of the PWA in Montague Gold Mines.

Allowable land-uses in this Zone are described in *Table 6* on page 45 and include open space uses, public and private parks and playgrounds, cemeteries, and historic sites and monuments.

- Protected Water Supply (PWS) Zone (including the P-4 Conservation Zone) amounts to 1146.53ha (~93%) of the CH/W Plan Area covering most of the southwestern portion of the watershed including over half of the western shoreline of Lake Major and all of the central eastern region of Lake Major.

Allowable land-uses in this area are outlined in *Table 6* on page 45 and include municipal water distribution or purification facilities, public/private parks with no buildings, conservation uses, crop farming, grazing, and pasturage (if in existence at the time that the by-law came into effect), and uses accessory to the foregoing uses.

- Single Unit Dwelling (R-1) Zone covers 11.27ha (~1%) of the CH/W Plan Area and is located in Montague Gold Mines.

Allowable land-uses are described in *Table 6* on page 45 and include single unit dwellings, and home businesses including daycares with up to 14 children.

- Mobile Dwelling (R-3) Zone covers a very small section (0.17ha) of the watershed area, in the CH/W Plan Area.

The permitted land-uses for this By-law Zone in the CH/W Plan Area is described in *Table 6* on page 45 and includes mobile dwellings with a permanent foundation, single unit dwellings, home businesses, and daycares with up to 14 children.

- Rural Estate (R-7) Zone covers 71.46ha (~5.8%) of land in the CH/W Plan Area of the watershed area. This Zone is predominately located north of Lake Loon Road and northeast and southwest along Montague Road.

The land-use activities permitted in this By-law Zone are described in *Table 6* on page 45 and include single unit dwellings, home businesses, and daycares with up to 14 children.

- Within the CH/W LUB are special provisions that further restrict activities within the watershed area:

- “4.17: WATERCOURSE SETBACKS AND BUFFERS (RC-Jun 25/14; E-Oct 18/14)

...(e) Notwithstanding clause (a), the required buffer shall not be less than 15.2m of the Little Salmon River, 76.2m from Lake Major, or 30.5m from any tributary within the Lake Major Watershed as designated by the Minister of the Environment on April 8, 1996....

...(h) Activity within the required buffer pursuant to clause (e), shall be limited to the placement of board walks, walkways and trails, conservation uses, parks on public lands, historic sites and monuments, public roads and wastewater, storm and water infrastructure, and water control structures.”

- **“24A.3 OTHER REQUIREMENTS: C&D MATERIALS TRANSFER STATIONS**

No development permit shall be issued for a C&D Materials Transfer Station except in compliance with the following provisions:

(a) any building or structure shall meet the following separation distances: ...

(iii) from a watercourse 30 metres (98.4 feet)

(b) notwithstanding Section 24A.3(a), where a building or structure is not to be located within 250 metres of a residential or institutional use or building, the building setback from any property line may be reduced to 10 metres (32.8 feet).

(c) notwithstanding Section 24A.3(a), any C&D Materials Transfer Station which is to be totally enclosed within a building (no outdoor storage of material, product, or equipment) setback from any property line may be reduced to 10 metres (32.8 feet).

- **24A.4 GENERAL REQUIREMENTS: C&D MATERIALS OPERATIONS**

No development permit shall be issued for a C&D Materials Operation except in compliance with the following provisions:

(a) no operation shall be permitted, result in, causes or produces any of the following effects discernible outside any building or structure or affecting any adjacent property: ...

(iii) discharge of any waste material whatsoever into a watercourse or water resource except in accordance with the applicable government requirements.”

Lake Echo / Porter’s Lake (Planning Districts 8 & 9)

The Lake Echo/ Porter’s Lake (LE/PL) MPS District, overlying the smallest section of the watershed area, is approximately 455ha, not including surface water areas, and situated in the northeast section of the watershed area. This area is uninhabited and virtually all within the WSRLR Wilderness Protection Area, which is owned by the Province under the jurisdiction of NSE. Halifax Water owns approximately 5ha of land within the LE/PL Plan area.

Lake Echo / Porters Lake MPS

The LE/PL MPS acknowledges the need to protect the watershed area, a portion of which is located in the northwest corner of the Plan Area, as recommended by the Lake Major Watershed Working Committee, which stresses that the watershed area should be zoned with respect to watershed protection. Furthermore, the MPS supports acquisition of watershed lands by the City of Dartmouth (now HRM).

The MPS also states that [t]he land within the Watershed Designation is Nova Scotia non-granted land and it is the intention of the provincial government to preserve these lands in their natural state (see *Map G: Landownership* on page 35 and *Map H: Landownership - Montague Mines & N. Preston* on page 36 for non-granted lands areas).

Further:

P-74 *“In recognition of the importance of protecting the Lake Major potable water supply, it shall be the intention of Council to establish the Watershed Designation as shown on the Generalized Future Land-use Map (Map 1). Within this Designation, Council shall create a Conservation Zone, which permits only water distribution and management uses and open space uses compatible with watershed management.”*

This policy has been fulfilled, as indicated on various GIS maps¹⁴, such that all of the land that falls under the LE/PL Plan Area is designated PA (Protected Area) and owned by NSE.

LE/PL Land-use By-Laws

The By-laws relevant to the watershed area are outlined in *Table 6: HRM LUB Plan Areas in Watershed and Applicable By-law Zones and Descriptions* on page 45. The By-laws and their associated Zones are derived from the LE/PL MPS outlined in the previous section, illustrated on *Map I: Plan Area and Zoning* on page 66 and described below. With regard to the PWA, the only applicable LE/PL LUB zone is – Protected Area Zone which amounts to 455ha of the PWA (see *Map I: Plan Area and Zoning* on page 66).

Additionally, there are special provisions with regard to grade alteration and vegetation removal within the PA Zone which further restricts land-use activities within the watershed area section of the LE/PL Plan Area as described:

- Other Requirements: Grade Alteration and Vegetation Removal

“22E.3 Within any PA zone, no infilling, excavation, alteration of grade or removal of vegetation shall be permitted. The construction of board walks, walkways or trails shall be permitted provided that no infilling or alteration of grade occurs other than the placement of piles or the placement of trails on top of the existing grade.”

Further, there are by-law provisions to consider for specific types of potential facilities within the watershed area, such as those for wind energy:

- Wind Energy Facilities policies in the LE/PL LUB with regard to permit requirements for wind energy facilities are found under section 4.29 Wind Energy Facilities (RC-Jun 25/14; E-Oct 18/14) and are based on the Wind Energy policies of the RMPS (2014). This policy stipulates under Part V: Exceptions and Part VIII: Miscellaneous that Wind Energy

14 a) Halifax Regional Municipality’s Municipal Planning Strategy: Schedule “A”: Porter’s Lake/Lake Echo Zoning Map. Website accessed April 6, 2016 at:

http://www.halifax.ca/planning/documents/PlanningDistricts8and9_LUB_ScheduleAZoning18Oct2014.pdf.

b) HRM GIS Feature Class SDEADM.NAT_restricted_land_use. Accessed: April 6, 2016.

Facilities shall not be permitted in the PA (Protected Area) Zone and that the siting of all accessory buildings is subject to watercourse setbacks under this By-law, respectively, as detailed below.

“4.29 WIND ENERGY FACILITIES (RC-Jun 25/14; E-Oct 18/14)

The use of windmills or wind turbines to produce electricity or for any other purpose shall be regulated in accordance with the provisions of this Section.”

The details of these provisions include the definition of terms (e.g., tower height), wind zones (e.g., Urban Wind Zone UW-1) permit application requirements and well as

“V Exceptions

- a) *Wind Energy Facilities shall not be permitted in the ...PA (Protected Area) Zone”). ...*

VII Miscellaneous

- b) *“The siting of Wind Energy Facilities is subject to the requirements for Watercourse Setbacks and Buffers as set out in the Land-use By-law.”*

North Preston / Lake Major / Lake Loon / Cherry Brook and East Preston

The North Preston – Lake Major (NP-LM) Plan Area applies to an area within Municipal Electoral Districts 2 and 4 which includes the communities of Lake Loon/Cherry Brook, Lake Major, North Preston and East Preston, as well as intervening lands. The NP-LM Plan area covers approximately 837.3ha (not including surface water areas) of the PWA. See *Map I: Plan Area and Zoning* on page 66.

Table 10: Risks Associated with Landownership and Permitted Land-use Activity on page 92 outlines the landownership breakdown per by-law zone, and illustrated on *Map G: Landownership* on page 35.

North Preston-Lake Major Municipal Planning Strategy

The North Preston-Lake Major (NP-LM) Municipal Planning Strategy MPS was initially developed as a means to resolve conflicts between the continued functioning of the Lake Major watershed as a primary source of potable water for residents on the north side of Halifax Harbour, and established communities located partly within the watershed area. In the fall of 1978, the communities of Lake Loon/Cherry Brook, Lake Major, North Preston and East Preston established a Joint Action Committee (JAC) with a mandate to resolve conflicts between watershed management and community development.

Through this process it was determined that the needs and concerns of the communities went beyond watershed-related issues. Consequently, the Plan Area boundaries do not coincide with the watershed area boundaries. However, watershed management recommendations significantly influenced the outcomes of the planning process and are reflected in the policies of this MPS. Legacies of this planning process are the Watershed Association Development Enterprise (WADE) and the LMWAB (see section 2.4.1: *Provincial Policies and Regulations* on page 37)

which was formed to provide a forum for future watershed management policy recommendations and for government/local community discussions of watershed issues.

The policies established for this Plan Area in relationship to the Lake Major watershed are outlined in *Table 7* below.

Table 7: Lake Major - North Preston MPS Watershed-Specific Policy Outline	
Land-use	Lake Major Watershed – Specific NP-LM Policy(ies)
Transportation	TR-9 – “all new roads and highways are constructed in a manner which creates a minimum impact on the Watershed”
Road Construction Practice Specifications	EH-12 – “...the Departments of NSTIR and NSE be requested to enforce compliance with the Province of Nova Scotia Environmental Construction Practice Specifications.”
De-icing	EH-3 - NSTIR ...substitute the use of de-icing agents such as road salts, where it may affect water quality in the Lake Major Watershed where possible.”
On-site Sewage Disposal	EH-5 – “...explore the feasibility of introducing an on-site sewage disposal system maintenance programme.”
Stormwater Management	EH-10 – “ it shall be the intention of Council to consult with ... the Lake Major Watershed Advisory Board prior to adopting any stormwater drainage by-law applying within the Plan Area.”
Erosion and Sedimentation resulting from construction practices	EH-13 – “Construction practices will be encouraged to follow appropriate guidelines and regulations established by the Department of the Environment and the Lake Major Watershed Advisory Board...
	E-14 – “ establish special provisions within the land-use by-law to exempt existing properties from the setback requirements established under Policy EH-13...for residential purposes only....
	E-15 – “ recognize the guidelines and watershed regulations prepared by the Lake Major Watershed Advisory Board in all matters related to the use of land and erection of buildings within this watershed. ...”
Solid Waste Management	“EH-19 – “...seek and provide specific assistance in closing existing dumps and to support annual community clean-up campaigns.”
Construction and Demolition (C&D) Materials	SW-6 – “...consider permitting C&D operations with approved amendments to the By-law areas, only when they are within MU Zones, excludes those areas located within the watershed.”
Recreation	REC-10 – “...encourage the LMWAB to integrate low intensity recreational development within the overall management plan for the Lake Major Watershed ... in consultation with appropriate government agencies and Plan Area residents.”
Land-use Intent: Six land-use designations	Mixed Use “...permits most uses that might occur in residential, commercial, institutional, or resource designations, ...the primary consideration is to retain traditional rural uses ... Development agreements are required for extensive industrial uses and for certain types of resource uses within the Lake Major Watershed.

Table 7: Lake Major - North Preston MPS Watershed-Specific Policy Outline		
Land-use	Lake Major Watershed – Specific NP-LM Policy(ies)	
define intended land-use activities permitted in the NP-LM Plan Area:	Residential	RES-2 and RES-8 "... may be developed for commercial recreation and resource-based activities to accommodate commercial, forestry and agriculture, through ...development agreements ...allow[ing] for a reasonable separation between resource-based activities and existing residential areas, and ensure[ing] that such developments are ...with a minimum of environmental disruption."
	Institutional-Open Space	IO-1 and IO-2 are specific to Institutional Open Space design and does not directly impact the watershed.
	Highway Commercial	HE-1 and HE-2 outline the policies which focus on Hwy 107 and do not recognize Lake Major issues directly.
	Resource	Policies RE-1 to RE-14 describe the resource activities that may be permitted in this Plan Area and under what conditions. They are applied in consideration and in support of these resource-based activities and to reflect water quality objectives for the Lake Major watershed.
	Conservation	This designation is based on the Lake Major Watershed Management Study, and supports a precautionary buffer of 250 feet around Lake Major and Long Lake to reduce the level of contaminants reaching these lakes. Policies CO-1- CO-3 express the intention that lands within this designation remain structurally undeveloped while providing exemptions for the continued residential use of specific properties.
Land Use Implementation	IM-19 "It shall be the intention of Council to recognize the guidelines and watershed regulations prepared by the Lake Major Watershed Advisory Board in matters related to land and water-based activities within the Lake Major Watershed, and to solicit the Board's recommendation for development proposals occurring within the watershed.	

NP-LM Land-use By-Laws

The NP-LM Land-use By-laws (LUBs) that regulate land-use and development activities within the PWA are outlined in *Table 6: HRM LUB Plan Areas in Watershed and Applicable By-law Zones and Descriptions* on page 45. The By-laws are based on the policies that are set out in the NP-LM MPS, and the RMPS (2014). *Map I: Plan Area and Zoning* on page 66 illustrates the LUB Zones within the PWA portion of the NP-LM Plan Area that are described below:

- Community Facility (P-2) Zone has the least coverage at 3.24ha (0.4%) of the NP-LM Plan Area. *Table 6* on page 45 describes the allowable uses that include institutions and open space.
- Mixed Resource (MR) Zone covers the largest portion, 498ha (59.5%) of the NP-LM Plan Area, located on the southeast portion of the watershed area around Long Lake. This By-law Zone allows a wide variety of land-uses as described in *Table 6* on page 45.
- Protected Area (PA) Zone covers 4.6ha (0.54%) of land in the northeast corner of the Plan Area within the watershed area. As outlined in more detail in *Table 6* on page 45,

allowable land-use for this Zone is restricted to scientific study and education, involving no buildings, trails, boardwalks or walkways, and conservation uses.

- **Protected Water Supply (PWS) Zone** covers 35.26ha (4.2%) of the NP-LM Plan Area within the watershed area. Allowable uses in this area (see *Table 6* on page 45) include municipal water distribution or purification facilities and public/private parks with no buildings, conservation uses, crop farming, grazing, and pasturage if in existence at the time of by-law effect.

Through a special provision in the NP-LM LUB, existing residential uses in a PWS Zone are “permitted to be expanded, altered, repaired and rebuilt and, in addition, certain properties within a PWS Zone shall be permitted to be used for residential use, such existing uses and certain properties identified by Appendix “D”.¹⁵ See Appendix 3: *Properties Exempt from Provisions in North Preston - Lake Major LUB* on page 169 for the identified properties.

- **Recreation Open Space (P-1) Zone** covers a very small portion, 14 ha (1.7%) of the NP-LM Plan Area within the watershed area. This Zone allows for commercial recreation, parks and open space. The area is located at the south eastern-most point of the watershed area below Long Lake.
- **Residential (RA) Zone** covers 62.26ha (7.4%) of the NP-LM Plan Area and is situated along the lowest portion of the watershed area around the southern tip of Lake Major. This area includes the dam, the community of Lake Major and Old German Road and an isolated section within the community of Lake Loon/Cherry Brook near the southwest tip of the watershed area. The RA Zone, detailed in *Table 6* on page 45, allows for residential and commercial uses.

Additionally, there are special provisions in the NP-LM LUB directed specifically at the Lake Major watershed including:

“3.6 APPLICATIONS WITHIN THE LAKE MAJOR WATERSHED

Every application for a development permit for lands situated within the Lake Major Watershed as shown in Schedule A [map of the By-law Zone Areas available at HRM Planning Offices] shall be referred to the Lake Major Watershed Advisory Board, and the Development Officer shall consider any reply from the Board to the extent permitted by the Planning Act, or any other provincial statute.”

The adoption of the RMPS in 2006 resulted in further provisions being added to the NP-LM LUB to provide for greater watercourse setbacks, specifically around Lake Major and Long Lake including:

“4.21: WATERCOURSE SETBACKS AND BUFFERS (RC-Jun 27/06; E-Aug 26/06)

¹⁵ Halifax Land Use By-Law for North Preston/Lake Major/Lake Loon/Cherry Brook and East Preston, with amendments to 29 October 2011. p. 56 Website accessed April 6, 2016 at: http://www.halifax.ca/planning/documents/NorthPrestonLakeMajorLakeLoonCherryBrookEastPreston_LUB.pdf.

(1)(a) No development permit shall be issued for any development within 20m of the ordinary highwater mark of any watercourse.

(b) Where the average positive slopes within the 20m buffer are greater than 20%, the buffer shall be increased by 1 metre for each additional 2% of slope, to a maximum of 60m.

(c) Within the required buffer pursuant to clauses (a) and (b), no excavation, infilling, tree, stump and other vegetation removal or any alteration of any kind shall be permitted in relation to a development.

(d) Within the required buffer pursuant to clauses (a) and (b), activity shall be limited to the placement of one accessory structure or one attached deck not exceeding a footprint of 20 m² or a combination of an accessory structure and attached deck not exceeding 20 m², fences, board-walks, walkways and trails not exceeding 3 metres in width, wharfs, boat ramps, marine dependent uses, fisheries uses, conservation uses, parks on public lands, historic sites and monuments, and public road crossings, driveway crossings and wastewater, storm and water infrastructure.

(e) Notwithstanding clause (a), the required buffer shall be 76.2 m of the mean high water mark of Lake Major and Long Lake. [Bold editor's addition]

(f) Notwithstanding clause (a), the required buffer shall be 30.5 m of the mean high water mark of any watercourse located in the Lake Major Watershed. [Bold editor's addition]

(g) Notwithstanding clause (a), the required buffer for construction and demolition operations shall be as specified under the applicable CD Zone.

(h) Within the buffer required pursuant to clauses (e), (f) or (g), no excavation, infilling, tree, stump and other vegetation removal or any alteration of any kind shall be permitted in relation to a development....”

Properties Exempt from the provisions of Sections 4.21(a) and 13.1 are found in *Appendix 3: Properties Exempt from Provisions in North Preston - Lake Major LUB* on page 169;

...and...

“13.3 SPECIAL PROVISIONS: EXISTING RESIDENTIAL USES

Notwithstanding Section 13.1, [PWS permitted uses] existing residential uses in a PWS Zone shall be permitted to be expanded, altered, repaired and rebuilt and, in addition, certain properties within a PWS Zone shall be permitted to be used for residential use, such existing uses and certain properties identified by Appendix “D”[See Appendix 3 on page 169 for the identified properties].

- **Rural Settlement (RS) Zone** covers the second largest portion of the Plan Area, 222.77 ha (26.6%), which surrounds the northern portion of the Plan Area around Long Lake and the community of North Preston. As outlined in *Table 6* on page 45, this Zone allows for residential, community and commercial uses **except** automotive repair outlets and service

stations within the Lake Major Watershed, and resource uses **except** intensive agricultural uses within the Lake Major watershed.

Shubenacadie Lakes (Planning Districts 14/17)

The Planning District 14/17 (Shubenacadie Lakes) Plan Area within the watershed area covers 3576.21ha of land, of which 3405.87ha (95.24%) falls within the PWS LUB Zone. This area excludes surface water areas which include the top 1/3 portion of Lake Major, Spider Lake, East Lake, Three Mile Lake and Long Lake. The Shubenacadie Plan Area is situated within Municipal Electoral Districts 1 and 2. The Shubenacadie Lakes Plan Area essentially takes in the top half of the watershed area, less the LE-PL Plan Area that is situated along the eastern edge of the watershed area which is zoned PA, as shown on *Map I: Plan Area and Zoning* on page 66.

The 2529.67ha portion of the Waverley Game Sanctuary that falls within the watershed area is located in the Shubenacadie Lakes Plan Area, and overlaps 1711ha of the WSRL Protected Wilderness Area that is also contained in the Shubenacadie Lakes Plan area.

Shubenacadie Lake MPS

The Shubenacadie Lakes MPS describes the context of land-use and development activities that have, are currently, or are predicted to occur in the Plan Area. The MPS provides policies adopted by Municipal Council that are prefaced by explanatory text which shall also be considered to be a legal part of the strategy. Overall, the Shubenacadie Lakes MPS recognizes that the PWA falls within the Plan Area and regards the protection of its water quality as “essential”.

The Shubenacadie Lakes Plan (MPS) is organized into four sections, each containing activity-specific land-use designations. The land-use designations are intended to direct the pattern of future development in the Plan Area as implemented through the Shubenacadie Lakes LUBs (described in the next subsection). The land-use designations specific to the Lake Major watershed are outlined in *Table 8: Shubenacadie Lakes MPS Policies Respecting the Lake Major Watershed* below and described in more detail in the bulleted sections following this table:

Table 8: Shubenacadie Lakes MPS Policies Respecting the Lake Major Watershed		
MPS Section Sub-Headings	Land-use Activities and Designations	Policy Numbers
Community Issues and Concerns	Recreation	N/A – Explanatory text also hold legal weight.
Environment	Surface Water Quality	P-46
	Acid Rock Drainage (ARD)	P-47
Land-use Intent	Residential Designation	Policies P-65 – P-84, Policy 68 specific to on-site septic systems
	Special Area Designation	P-122; P-123; P-125
	Waverley Game Sanctuary	P-124, P-125

Table 8: Shubenacadie Lakes MPS Policies Respecting the Lake Major Watershed		
MPS Section Sub-Headings	Land-use Activities and Designations	Policy Numbers
	Resource Designation	P-128 – P-131
	Aggregate and Mineral Extraction	P-138
	Watershed Designation	P-139, P-143, P-154
Implementation	Plan Adherence	P-157, P-161

- Community Issues and Concerns

The MPS encourages serious consideration of the use and development of Crown lands such as the Waverley Game Sanctuary for both tourism and community open space.

- Environment

The MPS acknowledges the importance of protecting surface water quality, and mitigating the potential impact of acid run-off from exposure of pyritic slates which are prevalent in the Plan Area with respect to drinking water supply watershed areas. The policies established for the Shubenacadie Lakes Plan Area, in relationship to environmental protection of the Lake Major watershed, are outlined below:

- Surface Water Quality

“P-46 *In recognition of the need to protect surface water quality, it shall be the intention of Council to consider the application of site grading and drainage controls for development adjacent to watercourses within the Plan Area. Until such time as these controls are effective, it shall be the intention of Council to establish a minimum building setback from lakes and streams of fifty (50) feet except for private boathouses, boat docks, float plane hangars. Furthermore, it shall be Council's intention to establish a lesser setback for existing lots of land which would not otherwise be eligible for development.*”

- Acid Rock Drainage (ARD)

“*Drainage from exposed slate bedrock in the Plan Area can be highly acidic. High levels of acid in surface waters can cause fish kills and can affect drinking water quality. ... development can create sediment loads which could negatively [a]ffect water quality. It is important in both watershed areas and areas underlain by pyritic slates that measures are taken to ensure that surface waters are not contaminated.*

P-47 *In the interests of maintaining water quality it shall be the intention of Council to investigate storm water control measures for both subdivision and development and to consider amendments to the Top Soil Removal By-law in order to provide*

for a review of all development within the environmentally sensitive areas described on the Environmental Features Map (Map 4).”

- LAND-USE INTENT

There are seven land-use development patterns designated in the Shubenacadie Lakes Plan area: Residential, Mixed Residential, Community Centre, Industrial, Special Area, Resource and Watershed, four of which impact the watershed area:

- RESIDENTIAL DESIGNATION

The Residential Designation recognizes current suburban residential development patterns in parts of the Plan Area within the watershed area, a pattern that is expected to continue due to improved accessibility provided by the 100 series highways in communities such as Waverley and Fall River. This designation’s *“development pattern is one of low density single unit dwellings with scattered two unit dwellings and some home business uses.”* Development patterns that are accommodated by this designation include a *“low density residential environment ... [and] ... supports certain home businesses which will not be incompatible with the residential environment.”*

There are 20 policies, from #65 to #84, within the Shubenacadie Lakes MPS that fall under the Residential Designation, which guide decisions on the types of dwellings and their locations with respect to adjacent land types and uses. Almost all of the Shubenacadie Lakes Plan Area permits some form of residential development (see *Table 6: HRM LUB Plan Areas in Watershed and Applicable By-law Zones and Descriptions* on page 45). Only the area (35ha) zoned PA and the WSRL Protected Wilderness Area Regulations prevent residential development from occurring in this area despite its PWS zoning.

Within the Residential Designation are provisions for situations such that previous *“experiences with septic system failures and overall concern with density, community form, and the need to protect surface water quality, suggests that multiple unit housing is not appropriate without full central municipal services. New multiple unit dwellings will not, therefore, be permitted within the Plan Area.”* However, in areas where large septic systems have already been installed, *“it may be appropriate to consider their redevelopment for multiple unit residential uses subject to the provisions of a development agreement.”* Policy 68 directs how development with respect to septic systems may take place in this area.

- SPECIAL AREA DESIGNATION

The Special Area Designation applies to lands within the Shubenacadie Plan Area that have regional, environmental, and/or historical significance, some of which are publicly owned and some privately owned. The Special Area Designation recognizes the distinct characteristics and importance of these lands. According to the Shubenacadie Lakes Plan Area Generalized Future Land-use Map (GFLUM), the Special Area Designation includes the northern and western perimeters of the watershed area. The policies that apply to this designation that are relevant to the PWA are:

P-122 *It shall be the intention of Council to establish the Special Area Designation, as shown on the Generalized Future Land-use Map (Map #1) in recognition of lands*

within the Plan Area which have significant environmental, regional and/or historical importance.

P-123 *Within the Special Area Designation it shall be the intention of Council to establish a park zone, which permits agricultural, forestry and park uses, including campgrounds together with limited commercial uses which do not involve any open storage or outdoor display and which are supportive of the park use.*

- Waverley Game Sanctuary

Within the Waverley Game Sanctuary (see *Map G: Landownership* on page 35) are a number of privately owned properties, not all of which are included within the Special Area Designation; some are included within the Residential Designation because they are in an area suitable for residential development.

Although hunting and firearms use are regulated within the Game Sanctuary, there are no regulations respecting land-use other than those associated with the PWA situated within the Game Sanctuary. Development around the Game Sanctuary has substantially increased over the years. The MPS purports the use of the lands in this area as ideal for development due to its proximity to Highways 118 and 102, which provide relatively quick and easy access to and from the Metro region.

According to the MPS, until the ultimate use of the Sanctuary is determined, *“it is appropriate to permit the utilization of these properties in conformity with the provisions of the Resource Designation. Once the future of Game Sanctuary lands is established it may be appropriate to consider the application of park zoning to these private properties.”* All Game Sanctuary Lands will initially “be zoned in a manner consistent with the remainder of the Game Sanctuary lands.”

P-124 *In recognition of the changing nature of land-use around the Waverley Game Sanctuary and the easily accessible location of these lands at an apex of the metropolitan area's major highway network, it shall be the intention of Council to cooperate with and encourage the Province to consider the development of a provincial park facility on lands located outside of the Lake Major Watershed which is oriented to serving local and metropolitan area residents and tourists.*

As mentioned, the northern and western perimeters of the watershed area are designated as a Special Area. These areas are also deemed suitable for residential development. It is the north western portion of the watershed area perimeter that the following policy applies:

P-125 *Notwithstanding Policy P-123, it shall be the intention of Council to apply the Rural Estate Zone (see Policy P-129) to privately owned lands within the Waverley Game Sanctuary portion of the Special Area Designation.*

- RESOURCE DESIGNATION

The Resource Designation covers approximately 122ha of the watershed area. The original settlement of the Shubenacadie Plan Area was based on the utilization of natural resources, predominantly mining, agriculture and forestry. The following policies recognize the need to support traditional resource-based activities while encouraging residential growth in the area:

“P-128 *In recognition of the tradition of resource use and the need to provide for the future growth, it shall be the intention of Council to establish the Resource Designation as shown on the **Generalized Future Land Use Maps 1A and 1B (RC-Oct 23/12;E-Jan 12/13)**. While lands within the Designation may be used for resource activities they shall be considered a secondary area for residential development.*

P-129 *Within the Resource Designation, Council shall establish a rural estate zone which permits forestry and smaller scale agricultural uses, single and two unit dwellings, mobile homes, the use of residential properties for business uses, and community uses. The minimum lot size permitted for residential and community uses shall be (80,000) square feet. Controls on outdoor storage and display, requirements related to separation from watercourses, and larger lot sizes for some resource activities will also be established.*

P-130 *Notwithstanding Policy P-129, it shall be the intention of Council to apply a Park Zone (Policy P-123) to crown lands located within the Resource Designation.*

P-131 *Notwithstanding Policy P-129, Council may consider permitting residential development on lots which have an area of less than eighty thousand (80,000) square feet, through application of a residential zone (Policies P-66 and P-86), by amendment to the land-use by-law and with regard to...” a list of effects on neighbouring lands.*

- Aggregates and Mineral Extraction

Within the Resource Designation Area is the consideration of aggregate removal and mineral extraction. These operations are of regional and local concern according to the MPS. To accommodate these activities and given its broader context, HRM considers that it would be most appropriate for the province to review and approve permits for such activities. The following policy to this effect is found in the MPS:

P-138 *It shall be the intention of Council to encourage the Province to establish provincial land-use policies and regulations for aggregate and mineral extraction operations within the Plan Area. In the interim period, the Province shall be encouraged to maintain the present requirement for regional development permits for such uses.*

- WATERSHED DESIGNATION

The Watershed Designation encompasses the drainage basins of the Lake Major public water supply area (and Bennery Lake’s, which is also within the Shubenacadie Lakes Plan Area) to recognize the importance and need to protect the water quality of the supply source for public use. The Shubenacadie Lakes MPS acknowledges that the Lake Major/Preston and Cole Harbour/Westphal area planning processes supported the protection of the Lake Major watershed. The Shubenacadie Lakes MPS indicates the appropriateness of imposing development restrictions with the Lake Major Watershed.

Though the natural watershed area is defined on the GFLUM, the PWA is not, and therefore not all of the PWA is covered under the Watershed Designation policies (see Map:

*“P-139 In recognition of the importance of protecting the ... Lake Major water supply areas, it shall be the intention of Council to establish the Watershed Designation as shown on the **Generalized Future Land-use Maps 1A and 1B (RC-Oct 23/12;E-Jan12/13)**, and to restrict development through the establishment of a watershed zone which shall permit conservation and water distribution uses as well as limited residential development on lots which have a minimum area of eighty thousand (80,000) square feet. Further, the land-use by-law shall provide that, except for water distribution uses, no building shall be located within one hundred (100) feet of any watercourse or two hundred and fifty (250) feet of ... Lake Major.*

A very small area of land (0.1 acres) owned by the Brightwood Golf Course follows along the western of the watershed boundary parallel to Spider Lake. The MPS has established policy relative to this area to deal with potential problems with respect to stormwater runoff and the use of fertilizers:

P-143 *Notwithstanding Policy P-139, it shall be the intention of Council to consider permitting a golf course on that portion of the lands of Brightwood Golf and Country Club, lying within the Watershed Designation, LRIS land parcel index number 517045, according to the provisions of Sections 55, 66 and 67 of the Planning Act. In considering such an agreement, Council shall, in addition to the provisions of Policy P-91, have regard to the following:*

- (a) the effects of the use on the natural environment, including the use of chemical fertilizers and herbicides, as contained in a report from the appropriate Provincial or Federal government authority;*
- (b) that no site grading shall be permitted within 100 feet of Spider Lake and that natural vegetation shall be maintained;*
- (c) that no main building shall be located within the Watershed;*
- (d) that the proposed use complies with all regulations and guidelines of the provincial Department of the Environment and the Lake Major Watershed Advisory Board and*
- (e) the provisions of Policy P-155.*

The MPS acknowledges the implications of development within the watershed area such that “[i]n response to the environmental concerns to which development in a watershed gives rise, development permit applications will be forwarded to federal and provincial government

agencies for review.”¹⁶ It is anticipated that appropriate environmental measures will be required and enforced by these agencies.

P-154 *The following uses shall only be considered subject to the entering into of a development agreement according to the Provisions of Section 55, 66 and 67 of the Planning Act:*

...(g) within the Watershed Designation:

(i) a golf course on the lands of Brightwood Golf and Country Club, LRIS #517054, according to Policy P-143;

(ii) commercial recreation uses according to Policy P-145.

- **IMPLEMENTATION DESIGNATION**

The Implementation Designation of the Plan requires policies to ensure the Plan is being adhered to:

“P-157 *It shall be the intention of Council to provide further controls over development within the Plan Area by fully enforcing the... by-laws*”

which are relevant to the watershed area and are described in more detail in section 2.4.3: *Municipal Land-use Planning Policies and By-laws* on page 41 and *Table 6: HRM LUB Plan Areas in Watershed and Applicable By-law Zones and Descriptions* on page 45.

Although the LMWAB is not specifically mentioned with respect to providing an opportunity to comment on development applications or by-law amendments, the Shubenacadie Lakes Advisory Board is, which implies that an Advisory Board “*shall be*” required to review applications such:

P-161 *It shall be the intention of Council, in considering amendments to the land-use by-law or Municipal Planning Strategy, to give notification to the Shubenacadie Lakes Advisory Board, for any proposed amendment adjacent to a watercourse within the Shubenacadie Lake system.*

Shubenacadie Lakes LUBs

The Land-use By-laws (LUBs) for Planning Districts 14/17 (Shubenacadie Lakes) are based on the policies that are set out in the Shubenacadie Lakes Municipal Planning Strategy and the RMPS (2014). The LUBs relevant to the watershed area are illustrated in *Map I: Plan Area and Zoning* on page 66, outlined in *Table 6* on page 45 and described below:

- **P-3 (Park) Zone** covers 9.73ha(0.27%) of the Plan Area situated at the north eastern tip of the Plan Area and the watershed area. Permitted uses include park, commercial and resource uses and are described in more detail in *Table 6* on page 45.

¹⁶ Halifax Municipal Planning Strategy for Planning Districts 14 and 17 (Shubenacadie Lakes) with amendments to October 18, 2014; p. 94. Website accessed April 8, 2016 at http://www.halifax.ca/planning/documents/PlanningDistricts14and17_MPS.pdf

- **PA (Protected Area) Zone** covers 35.31ha(1%) of the northern section of the Shubenacadie Lakes Plan Area and the watershed area. Permitted uses are outlined in *Table 6* on page 45 and include scientific study and education involving no buildings, trails, boardwalks or walkways and conservation uses. In the PA Zone, no infilling, excavation, grade alteration, or removal of vegetation is permitted.
- **PWS (Protected Water Supply) Zone** covers almost all (approximately 95.23% or 3405.87 ha) of the central portion of the Shubenacadie Lakes Plan Area. Permitted uses are outlined in *Table 6* on page 45 and include municipal water distribution or purification facilities, public parks, conservation uses, and single unit dwellings.
- **R-1B (Suburban Residential) Zone** covers approximately 75.88ha(~2.1%) of the Plan Area situated along the western outskirts of the Shubenacadie Lakes Plan Area and watershed area. Permitted uses in this Zone are outlined in *Table 6* on page 45 and include residential and community uses.
- **R-7 (Rural Estate) Zone** covers approximately 49.4ha(~ 1.4 %) of the Plan Area located immediately below the P-3 Zone and to the north eastern and north western edge of the watershed area. Permitted uses in this Zone are outlined in detail in *Table 6* on page 45 and include residential, community and resource uses.

HRM and Halifax County By-laws

In addition to each MPS District LUBs, there are HRM Regional By-laws and Halifax County Municipality By-laws (see *Table 9: HRM Regional and Halifax County By-laws on page 64* below) which apply to the whole region and/or to multiple municipal electoral districts. For more details on Land-use By-laws and their requirements, please visit www.halifax.ca/planning/map.html.

Table 9: HRM Regional and Halifax County By-laws	
HRM Regional By-laws¹⁷	
By-law	Description
A-300	A By-law respecting animals and responsible pet ownership; cited as the "Animal By-law".
By-law L-200	A Buy-Law respecting licensing of construction and demolition materials recycling and disposal operations; cited as the AC&D Materials Recycling and Disposal License By-law"
By-law L-300	A By-law respecting lot grading and drainage; cited as the "Lot Grading By-law".
By-law No. S-600	A By-law respecting solid waste resource collection and disposal; cited as the "Solid Waste Resource Collection and Disposal By-law".

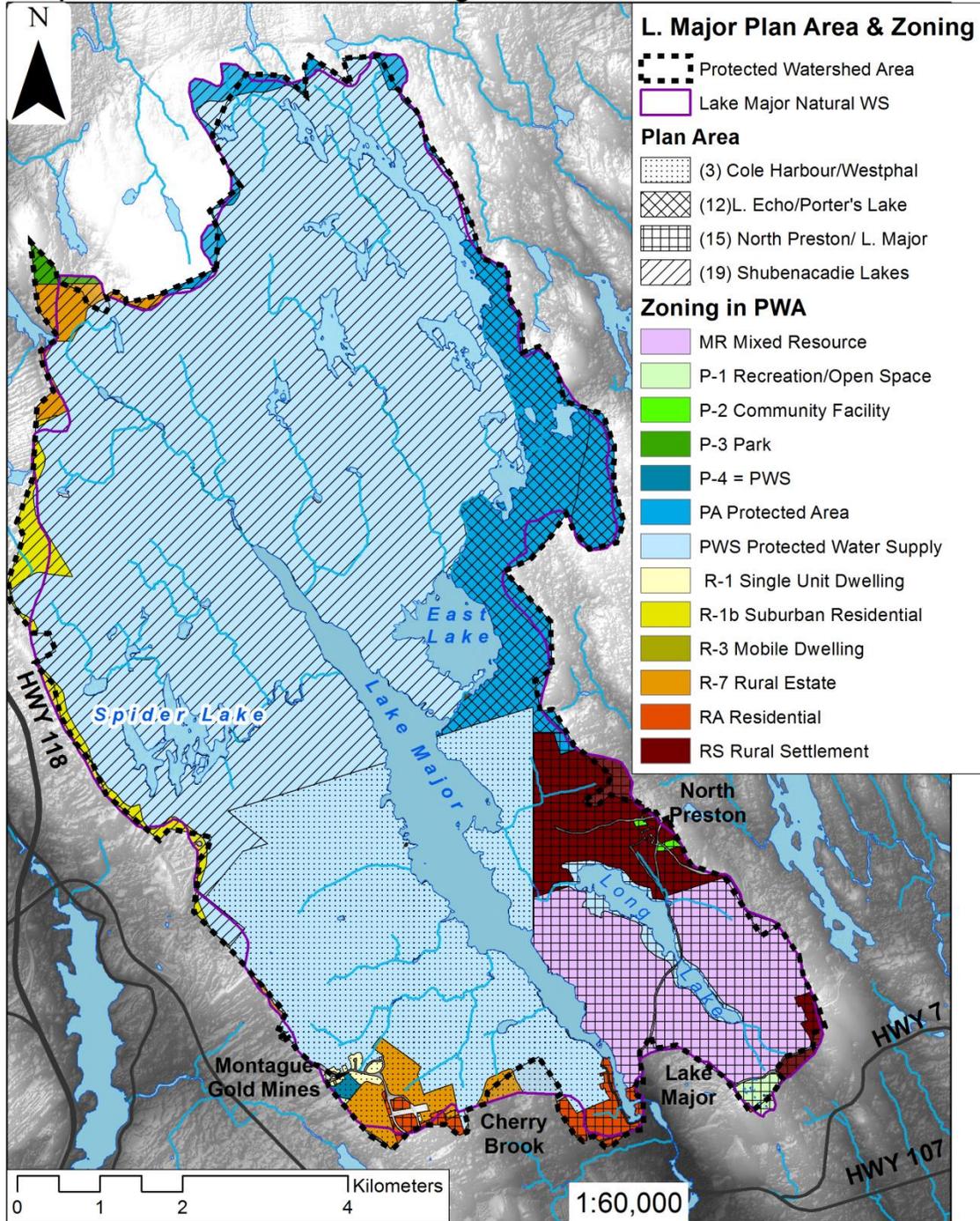
¹⁷ Halifax Legislation: HRM By-Laws. Website accessed April 8, 2016 at: <http://www.halifax.ca/legislation/bylaws/hrm/index.php> .

By-law W-101	A By-law respecting discharge into public sewers and may be cited as the "Wastewater Discharge By-law".
Halifax County Municipality By-laws¹⁸	
Topsoil By-law 40	A By-law respecting the regulations and controls of the removal and movement of topsoil and earth and the alteration of the grade of the land. With respect to the PWS, this By-law applies to the Municipal Polling Districts 1, 2, 4 (See section 2.4.3 : HRM and Halifax County By-laws on page 64 and Map J: Polling Districts and Plan Area on page 67) for a breakdown of these districts in relation to the MPS Planning Districts.
Excavation By-law 41	A By-law respecting gravel pits and excavations.

¹⁸ Halifax Legislation: Halifax County Municipality By-Laws. Website accessed April 8, 2016 at: <http://www.halifax.ca/legislation/bylaws/county/index.php> .

MAP I: PLAN AREA AND ZONING

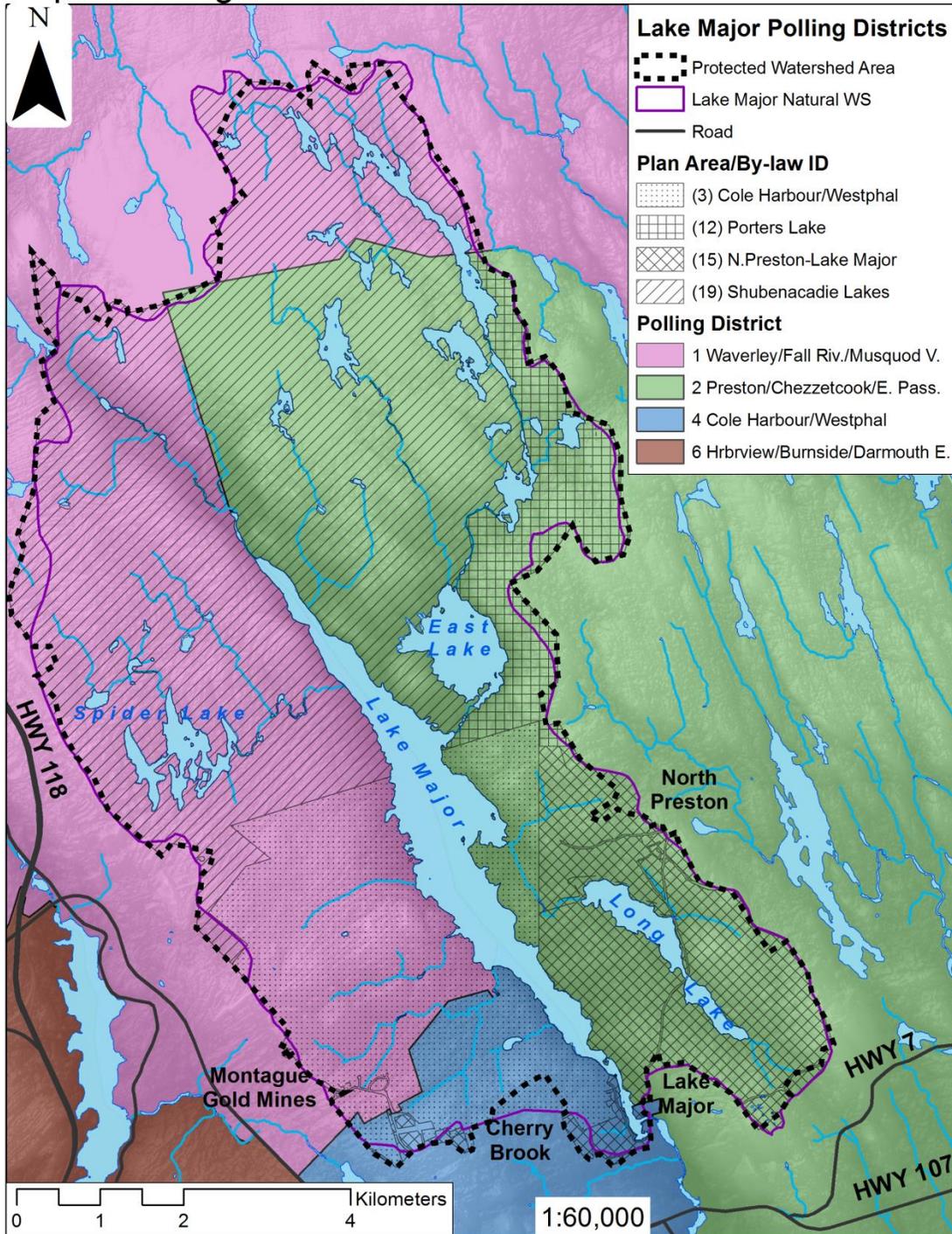
Lake Major Watershed PWA SWPP 2016 Map I: Plan Area and Zoning



* This map is for informational purposes only and should not be used for legal, engineering, or surveying purposes.

MAP J: POLLING DISTRICTS AND PLAN AREA

Lake Major Watershed PWA SWPP 2016 Map J: Polling District and Plan Area



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3. RISK IDENTIFICATION AND ASSESSMENT

This chapter identifies and assesses in two sections the risk factors with the potential to impact the Lake Major watershed:

- Section, 3.1: *Inherent Risk Factors* on page 68 describes the anthropogenic risk factors which are inherent and more predictable due to environmental, political, historic, social or cultural influences; the potential risk factors associated with these activities; and the necessary measures to protect the water supply from these activities.
- Section 3.2: *Critical Infrastructure Threats and Hazards* beginning on page 107 describes the hazards and threats to critical infrastructure that are accidental, natural or intentional or deliberate, which are more difficult to predict. Intentional or deliberate risk factors are more acute, resulting from highly unusual events such as a terrorist attack.

3.1 Inherent Risk Factors

Inherent risks associated with the Lake Major watershed include the operation of Halifax Water facilities, recreation, residential and commercial development and forestry activities. Natural geological factors such as soil thickness and the susceptibility to erosion due to the lack of till over the significant bedrock base in the watershed area, rapid drainage characteristics due to the soil types and thicknesses in the area, and impacts of leaching soil elements and erosion (see section 2.2.2: *Natural Land Cover* on page 26) must also be taken into consideration when assessing risks to water quality.

HRM MPS policies and LUBs applicable to the Lake Major watershed identify a number of requirements that must be met prior to development activity taking place (see section 2.4.3: *Municipal Land-use Planning Policies and By-laws* beginning on page 41 for the descriptions of the LUB policies; and by-laws section 3.1.7: *Municipal Land-use Planning and Development Activities* on page 82 for descriptions of the risks associated with the policies and LUBs).

The PWA Regulations (see *Appendix 1: Lake Major Watershed Protected Water Area Designation and Regulations* on page 167), which take precedence over municipal regulations, set prohibitions and restrictions on activities within the PWA.

Despite the potential risks, there are many safeguards to help manage the risks associated with land-use activities:

- Approximately 96.4% of the PWA, which restricts or prohibits specific land and water use activities in the watershed area, intersects with the Lake Major natural watershed (see *Map G: Landownership* on page 35);
- Approximately 78% of the land area within the watershed area is publicly owned by DNR, NSE or by Halifax Water, which limits the land area available for potential private or municipal development to 22%; and
- HRM Plan Area District LUBs, of which there are four, provide further protection through enforcement of zoning by-laws specific to the Lake Major watershed, particularly the Protected Water Supply (PWS) Zone.

The following sections describe potential risks, associated potential contaminants and measures taken to date to protect the Lake Major watershed.

3.1.1 Forestry

Prior to the Lake Major watershed becoming part of the City of Dartmouth's water supply, it provided an abundance of natural resources, which played an important role in the local economy. In 1977, the City of Dartmouth purchased the last active sawmill and associated watershed lands from a private landowner. The acquisition of these lands ensured that any forestry activities conducted on these lands were consistent with the City of Dartmouth's water quality goals. In 1996 these lands were transferred to Halifax Water during the merger of the water utilities as a result of the amalgamation of the Halifax region's municipal entities (i.e., City of Dartmouth, City of Halifax, Town of Bedford and the Municipality of the County of Halifax). The role of forest management in the watershed area is now an important tool that Halifax Water uses to maintain the health of its watershed lands for the purpose of water quality.

The following section describes the risks associated with forestry related activities within the Lake Major watershed, see *Table 11: Summary of Existing and Potential Risk Activities* on page 112 for further details.

Forest Land Management

Forest cover amounts to 5065ha (~73%) of the watershed area, see *Map F: Land Cover* on page 34. Halifax Water and DNR are partners in the management of forestry activities on Crown lands inside the watershed area. A five-year Forest Management Plan is maintained and implemented on both Halifax Water and Crown lands. In both instances, forest management plans are developed using provincial guidelines, Halifax Water BMP's and environmental regulations that are subject to special conditions to protect water quality. Further, any forest operations taking place on Crown, private or industrial lands must comply with provincial forest policies and regulations.

Anyone wishing to practice forestry on PWA lands must first obtain an approval from Halifax Water in consultation with the Lake Major Watershed Advisory Board (LMWAB) to operate. Failing to do so is subject to penalties under the Lake Major PWA regulations.

The portion of the PWA that falls within the WSRLR Wilderness Area is exempt from the changes. As defined in the *Wilderness Areas Protection Act 1998, c.27,s.1*, commercial activities such as forestry are not permitted within designated provincial Wilderness Areas unless otherwise approved to by the Minister.

Best Management Practices

In addition provincial regulations, Halifax Water developed Best Management Practices (BMPs) to further aid in forest management of the Lake Major and Pockwock watershed areas. The BMPs were developed in partnership with DNR, NSE, the Lake Major Watershed Advisory Board, the Pockwock Watershed Management Committee and the Bennery Lake Watershed Management Committee.

The BMPs are not intended to replace existing legislation but to enhance the way activities were conducted to protect the water supply. For those carrying out activities on company and Crown lands managed by Halifax Water, it is a requirement to be familiar with and follow the applicable BMPs. For all other watershed lands, the BMPs are currently voluntary and intended for educational purposes.

3.1.2 Mining, and Pits and Quarries

Gold was discovered in the Lake Major watershed in the 1860's. As a result, a gold mine was established in the Montague Gold Mines area in 1863. The mine operated for many years until most of the easily accessible deposits were depleted. Mining for gold has long since been discontinued. However, mine shafts and shallow pits can still be found throughout the watershed area on private and Crown lands. Landowners are responsible for posting warning signs around any known mining pits and shafts. Halifax Water has posted signs in known areas and conducts random surveillance to ensure the pits and shafts are well marked and clearly visible on its lands. The Mineral Resources Branch of DNR is responsible for keeping records of old mine sites.

Restrictions to mining, and pits and quarries, and associated activities are stated in sections 14 and 15 of the *Lake Major Protected Water Area Regulations* (see *Appendix 1* on page 167). As outlined in the following sub-sections, these Regulations are not sufficient to adequately protect the Lake Major water supply from the risks associated with such activities.

Mining

Any mining activity that has the potential to impact the Lake Major watershed is subject to regulations, including but not limited to, the *Environment Act*, the *Mineral Resources Act (MRA)*, the *Halifax Charter* and the *Halifax Regional Water Commission Act*.

Mining is regulated through the *Environment Act's Activities Designation Regulations*. All mining subjected to these regulations require an Industrial Approval and an Environmental Assessment. The *MRA* focuses on the minerals, how they are recovered, and how the land is reclaimed; the *Environment Act* through the Environmental Assessment process and associated regulations (e.g., water approvals and erosion and sedimentation control) detail how to carry out activities with respect to the environment and communities. In the “*event of a conflict between the Environment Act and any other enactment, this [Environment] Act prevails*” (Sec. 6(1))¹⁹.

Landowners are key participants in mineral exploration. All prospectors and exploration companies must have landowner consent or agreement to access their land before any excavation can occur, according to section 51(3)(c) of the *Mineral Resources Regulations*, which states that “[a] person submitting an excavation registration must provide a statement confirming the consent or agreement of the owner or tenant of the land.”

¹⁹ Province of Nova Scotia. *Environment Act*. Chapter 1 of the Acts of 1994-95 as amended by 1998, c. 18, s. 557; 1999 (2nd Sess.), c. 12, s. 76; 2001, c. 6, s. 103; 2004, c. 3, ss. 20, 21; 2006, c. 2, s. 3; 2006, c. 30; 2011, c. 61. Document website-accessed April 8, 2016 at <http://nslegislature.ca/legc/statutes/environment.pdf>.

When any exploration is being considered on municipal water supply area lands, in the interest of good relations, companies and prospectors are encouraged to consult with the water utility. Specifically, section 73 of the *Mineral Resources Regulations* pertains to water utility lands. Halifax Water actively monitors potential mining activities or expansions through the Department of Natural Resource Geology Maps and database, NovaROC, a Mineral Rights online registry system as a means of monitoring potential mineral exploration activity. In watershed areas, exploration companies and prospectors must consult with DNR and NSE before conducting any exploration activity “*in addition to any requirements established by the landowner or tenant or under a surface rights permit.*” Mineral exploration and mining companies are expected to take precautions with respect to the environment and affected landowners.

The current *PWA Regulations* does not specifically restrict mining operations from occurring within the Lake Major watershed area. Upon review of the DNR geological map and database website, it is apparent that as of April 2016, the owners of the quarry operation located in the Montague Gold Mines area of the watershed area (see also subsection *Pits and Quarries* on page 71) were issued an exploration license for all minerals on a 445ha area of land partially owned by the quarry operators, the Crown and Halifax Water. In addition to the previously referenced mining regulations, section 25 of *The Halifax Regional Water Commission Act* prohibits the release of deleterious or offensive substances that impair the quality of water for domestic use which could include activities associated with mining.

Halifax Water is investigating amendments to regulations so that the potential for mining activities within the watershed area is limited or removed.

Pits and Quarries

Section 14 of the *Lake Major Watershed Protected Water Area Regulations* (Appendix 1 on page 167) states:

“No person shall commence an operation or use any pit, mine or quarry for the extraction of gravel, rock or minerals unless that person has received the prior written approval from the Administrator following consultation with the Board.”

Among the greater risks to the watershed area associated with pit and quarry activities are due to the physical risks associated with changes in grade and the resulting direction of water flow, chemical use (ammonium nitrate) associated with blasting, and regulatory ambiguities.

There are a number of established pits and quarries throughout the Plan Area and a strong likelihood of there being more. Municipalities have no jurisdiction under the *Municipal Government Act* (nor does HRM have jurisdiction under the *Halifax Charter* if the province is deemed to have jurisdiction) at the extraction site, but operations (e.g., associated buildings) and reclamation (through the Municipal Excavations By-law) may be controlled by the municipality. The province has approved regulations under the *Environment Act* (including the *PWA Regulations*), which are intended to ensure that extraction activities are environmentally safe and that sites are reclaimed once the operation has ceased. HRM also recognizes that municipal and

provincial regulations complement each other such that provincial enforcement is directed towards major developments, while municipal units look after the smaller areas.

Rock Quarry

An active rock quarry located in the central west region of the watershed area near Montague Gold Mines has been in operation since the 1960s (see *Map F: Land Cover* on page 34). Approximately 40ha of the quarry company's land falls inside the PWA boundary. The current PWA boundary designated in 1984 included 20.81ha of the original property on which the rock quarry operated. There is documentation that the PWA boundary was to be changed by the City of Dartmouth in 1989 to allow for the continued operation of the quarry without interference from the PWA Regulations, however, it was never registered with the province nor recognized by NSE. The quarry continued to operate on the original property until the early 1990s at which time the quarry owner commenced operations on a second parcel prior to the approval of the PWA Regulations in 1992 and prior to the permit being issued in 1993. Negotiations continued for the second parcel to be included in the original quarry permit to operate within the PWA.

In 1998 an agreement was reached between Halifax Water and the quarry owner/operator to allow the quarry operator to alter the watershed boundary using a berm system. The new boundary would exclude 17.5ha of land from the watershed area and allow pit operations to occur without risk. The agreement was conditional on a number of terms by Halifax Water and the LMWAB including:

- a. A new watershed boundary would be defined by a berm made of native soil constructed in such a way as to divert pit water away from the watershed area, provided the berm would define the new boundary.
- b. Complete an on-site topographical and sub-surface investigation to determine whether the setback of the quarry operations from the new watershed boundary would be sufficient to ensure that blasting activity would not open cracks in the rock and cause water to drain from the watershed area into the quarry, and vice versa.

Since the agreement was reached the berm was constructed and joint quarry site visits are conducted yearly with quarry staff. Based on up-to-date monitoring, Halifax Water is satisfied with the nature of the quarry activity with respect to its impact on the Lake Major watershed. Halifax Water continues to monitor the rock quarry operations and conducts regular site visits. Close monitoring conducted by Halifax Water staff re-established lines of open communication between the quarry company and the concerns and desires of the LMWAB. Communication and collaboration activities, described in the management section (see section 4.3.4: *Mining, and Pits and Quarries – Pits and Quarries* on page 130), are designed to help minimize the risks associated with quarry operations within the PWA.

3.1.3 Recreation

Recreational activities have the potential to negatively affect the watershed area; however, if managed effectively, some forms of recreational activity can be low-risk and may be permissible

in specific areas of the watershed. These activities may include walking, hiking, biking, fishing, hunting, geocaching and cross-country skiing.

In addition to the above low impact recreational activities listed, there is a golf course located within the Lake Major watershed; however it has a higher order of risks associated with it due to golf course maintenance practices.

The sub-sections below outline the most prevalent recreational activities, the risks they present and specific restrictions as per the *Lake Major Watershed PWA Regulations (Appendix 1* on page 167).

Golf Course

A golf course adjacent to Crane Hill Road and Glasgow Road partially (14.43ha) lies within the Lake Major PWA (see *Map G: Landownership* on page 35).

Management practices associated with maintaining the golf course present a low-medium risk to the watershed.

The golf course operator made a request to Halifax Water to either alter the *PWA* boundary or allow for chemical application for golf course maintenance purposes. Halifax Water has no knowledge of any pesticide application permit within the *PWA*. During communications with the golf course company in 2008 and 2009, Halifax Water requested that the golf course company conduct a ground drainage survey to support their request to alter the *PWA* boundary.

Subsequently, the golf course hired a consulting company to complete a survey²⁰ to determine water flow and runoff direction. In summary, the survey reported that the golf course company was correct in its assumptions that approximately 8.26ha of the golf course area no longer lays inside the watershed area and that only 1.74ha of the 14.3ha area that is inside the *PWA* actually drains into the Lake Major watershed; the remaining area is intercepted by a drainage ditch that directs water into two ponds, which effectively diverts runoff away from the watershed. The 1.74ha of the golf course area that remains in the *PWA* is the driving range upon which the golf course company does not intend to use pest control products.

Pesticide and Fungicide Applications

Generally, Halifax Water does not support the use of chemicals inside the watershed area as it could put water quality at risk due to the potential for runoff or leaching of chemical products from managed areas that have had enhancement applications (fertilizers, herbicides and pesticide applications). Concerns with regard to pesticide runoff within the watershed area were attended to by the golf course company, which submitted a *Golf Course Best Management Practices* policy to Halifax Water. The use of pesticides at the Golf Course – a potential concern when used near watercourses, requires the necessary approvals from NSE and HRM as per section 8 of the *PWA Regulations*. However, at this time, the *PWA Regulations* do not require Halifax Water

²⁰ The consulting company used a plan date November 28, 1983, by Servant, Dunbrack, MacKenzie and MacDonald Ltd., Land Surveyors as their reference for the Watershed boundary.

or the LMWAB be consulted prior to permit approval. To our knowledge, no pesticide permit application was submitted to NSE for use inside the PWA.

In a letter dated February 23, 2009 to Halifax Water, the golf course company indicated that they practice Integrated Pest Management such that pesticides are only applied as required and as a last resort. They indicated in response to Halifax Water's requests that the golf course developed and implemented "*Golf Course Best Management Practices*" inside the watershed area and supplied a copy to Halifax Water.

The level of actual risk from pesticide and herbicide and fungicide application activity is assessed quarterly through the results of the water quality monitoring program (see section 5.4.4: *Target-Based Sampling: Total Phosphorus and Nitrate-Nitrogen* on page 164). Since 2009, no fungicides, herbicides or pesticides of any nature have been detected in the watershed area. Halifax Water will continue to proactively monitor the runoff from the golf course for proactive measures. All detectible levels will be reported to NSE for compliance purposes.

Off Highway Vehicles (OHVs)

Use of recreational vehicles such as all-terrain vehicles (ATV's), trail bikes and snowmobiles can cause environmental damage that may eventually impair raw water quality. Depending on the extent of the damage (e.g., soil erosion leading to the alteration or sedimentation of waterways) or whether the activity directly involves the lake water (e.g., machine going through ice or the use of amphibious machines), such activities could quickly impair the source water supply. The use of these recreational vehicles is therefore considered to be a moderate to severe risk and restricted within the watershed area. Despite the *Lake Major Watershed PWA Regulations* and Halifax Water's best efforts to block key access points, off-highway vehicle use continues inside the watershed area.

Swimming

Swimming is considered to be a low-impact recreational activity and is restricted to within 800m of the Lake Major Dam and shall not take place within 100m of the WSP intake. See locations of these areas illustrated on *Map L: Development Risk Areas in Communities* on page 118. For all other lakes and tributaries within the PWA, swimming is prohibited.

Boating

Boating is restricted inside the PWA with the exception of Long Lake where boating is prohibited. Boating restrictions in the PWA apply to within 100m of the Lake Major WSP intake (see *Map L: Development Risk Areas in Communities* on page 118). Additionally, boat motor size is restricted to 9.9 hp unless it is authorized by Halifax Water for safeguarding the water supply.

Fishing

Fishing is allowed within the watershed area; however, the PWA regulations prohibit fishing within 100m of the Lake Major water supply plant intake (see *Map L: Development Risk Areas in Communities* on page 118).

Waverley – Salmon River Long Lake Protected Wilderness Area

The Waverley–Salmon River Long Lake (WSRLL) Wilderness Area, which covers 2448ha (28 %) of the watershed area (see *Map G: Landownership* on page 35), increases recreational impacts on the watershed area because it is often mistakenly viewed by some users as an ideal open area for a variety of activities that may not be allowed in the Wilderness Area or the watershed area. However, due to the overlapping of regulations in this area, i.e., the *Wilderness Areas Protection Regulations*, in addition to the *Lake Major Watershed Protected Water Area Regulations*, recreation activities are further restricted. For more details on permitted activities in this area see section 2.4.1: *Waverley-Salmon River Long Lake (WSRLL) Wilderness Area* on page 38 and visit www.gov.ns.ca/nse/protectedareas/map.asp.

3.1.4 Roads

The following subsections describe the main risks, the various types and amounts of roadway surfaces, the activities that take place on them and the risks they present to the water supply.

Major Collector Roads

The major collector roads within the watershed area include Lake Major, Montague and North Preston Roads, and Upper Governor Street. These roadways connect the communities within the watershed and act as main trucking routes. A portion of Lake Major Road that runs through the watershed area alongside Long Lake is identified as high risk for petroleum and chemical spills due to the potential for vehicular accidents and its proximity to Long Lake.

Public Roads

Public transportation routes are well established throughout the watershed area. HRM is responsible for managing these routes. Most of these roads are far enough away from the water sources and are therefore considered a low risk to the water supply, except for Lake Major Road, for the reasons described in the previous paragraph.

Road Construction

Sections 16(1) and (2) of the *Lake Major Watershed Protected Water Area Regulations* (see Appendix 1 on page 167) restricts the timeframe of activity and the amount of exposed roadway sub-base and right-of-way clearing. Therefore, any impact due to road construction should be minimal as long as the regulations are adhered to and enforced.

Water Crossings

A yearly monitoring-and-maintenance program was developed and implemented for water crossing structures (culverts and bridges) controlled by Halifax Water. Data gathered included GPS coordinates, as well as structure type, dimensions, condition and effectiveness. This information identifies where and how water is crossing the drivable road system and where unmapped streams are located along roads. Knowing the condition and effectiveness of crossings provides a basis for a yearly monitoring-and-maintenance program to repair or replace existing

drainage structures. In addition, the inventory has pinpointed where culverts need to be installed to maintain natural drainage patterns or to improve the control of runoff and ditch water.

Prior to Hurricane Juan in 2003, road access within the watershed area was limited to provincial and municipal roads. Since then, Halifax Water has constructed new access roads on company and Crown lands within the watershed area in order to clean up wind-damaged areas. All newly constructed water crossings have been identified and are part of the annual monitoring and maintenance program.

Road De-icing

Road de-icing agents applied on public roadways increase surface water chloride concentrations and present a risk to water sources due to the accumulation of chloride entering surface waterways through stormwater runoff events. All levels of government have developed road de-icing application guidelines due to concerns that road salt is a hazard to the environment.

The following subsections provide an overview of the various guidelines which set the framework for managing the risks to water sources associated with road salts.

Environment Canada's Code of Practice

Environment Canada conducted a five-year study in 2001, which determined that in sufficient concentrations, road salts do pose a risk to plants, animals and the aquatic environment. It was subsequently recommended that road salts be added to the Canadian Environmental Protection Agency's List of Toxic Substances²¹.

In response to the 5-year study, rather than banning the use of road salts and risk increased hazards to the public on winter roads, the Federal Government designed a system to help municipalities manage their use of road salts to reduce harm to the environment while maintaining road safety through the *Code of Practice for the Environmental Management of Road Salts* (2004).²² Within this Code of Practice, Annex B, sections 7 and 8 identify the potential for chloride concentrations to present risks to drinking water and groundwater sources respectively²³. Environment Canada also outlines a Road Salt Management Strategy.²⁴ However, Environment Canada makes it clear that nothing in the Code should be construed as a recommendation to take action to the detriment of road safety.

²¹ Environment and Climate Change Canada: Toxic Substances List – Schedule I. Date modified 2015-07-06. Website source: <http://www.ec.gc.ca/lcpe-cepa/default.asp?lang=En&n=0DA2924D-1&wsdoc=4ABEFFC8-5BEC-B57A-F4BF-11069545E434>.

²² Environment Canada and Climate Change: Road Salts – Code of Practice: The Environmental Management of Road Salts. Date modified: 2013-07-02. Website source: <http://www.ec.gc.ca/sels-salts/default.asp?lang=En&n=F37B47CE-1>

²³ Environment Canada and Climate Change: Road Salts – Code of Practice: The Environmental Management of Road Salts – Annex B. Date modified: 2013-07-02. Website source: <https://www.ec.gc.ca/sels-salts/default.asp?lang=En&n=82FAD3D4-1>

²⁴ Environment Canada and Climate Change: Road Salts. Last updated: 2015-01-08. Website source: <http://www.ec.gc.ca/sels-salts/>.

Environment Canada also notes public expressions of concern regarding the use of ferrocyanide salts in formulations of road salts, given that, in solution, they can photolyse to yield free cyanide ions, which are highly toxic to aquatic organisms. Sodium ferrocyanides are used as an anti-caking agent in road salts in the Atlantic Provinces. See also section 4.2.6: *Public Roads and Highways - Road De-icing* on page 123.

Provincial Policy and Regulations

NSTIR has developed road de-icing application standards, which are found in the department's Highway Maintenance Standards. The Standards state: *The use of salt in environmentally sensitive areas will be monitored and alternatives to salt will be used where practical.*"

The current definition of "environmentally sensitive areas" with respect to the Provincial Highway Maintenance Standards does not classify surface water supply areas, although it does classify areas associated with ground water discharge with medium to high solubility soils.²⁵ Further, "[s]and is to be applied to all roads or sections of a road designated as being in environmentally sensitive areas. The use of salt in environmentally sensitive areas will be monitored and alternatives to salt will be used where practical."²⁶ However, there are examples of provincial regulations restricting the use of chloride road salt de-icing agents within water supply areas; e.g., section 7(5) of the *Bennery Lake Watershed PWA Regulations*.

Chloride levels in the watershed area are monitored at locations associated with winter road maintenance activities namely LMG1, LMG6 and LMG7. Samples collected indicate minimal risk because they are below the recommended chloride levels for long and short term toxicity outlined in the CCME guidelines for the Protection of Aquatic Invertebrates.

Further, upon consultation with NSTIR and HRM winter road maintenance staff, it was confirmed that the anti-caking agent sodium ferrocyanide is added by the Canadian Salt Mine to road salt prior to delivery to the various destinations to ensure the salt is free flowing. Transportation and Infrastructure Renewal's specification for road salt states that it must be treated with an anti-caking conditioner (YPS or equivalent) at a minimum rate of 50 ppm. NSTIR advised that Canadian Salt typically adds 100 ppm. The Material Safety Data Sheet (MSDS) for ferrocyanide received from NSTIR indicates that "the reported probable lethal dose in humans is 0.5-5gm/kg. Ferrocyanide salts are rapidly excreted in urine without metabolic alteration." Additionally, according to a Stantec Report:

"In the absence of direct sunlight, ferrocyanide complex is stable and low in toxicity. However, exposure to sunlight results in dissociation and release of free

²⁵ Referenced from Nova Scotia Transportation and Infrastructure Renewal's Salt Management Plan Manual located in-house.

²⁶ Nova Scotia Department of Transportation and Infrastructure Renewal Highway Programs: *Highway Maintenance Standards: Effective 1 July 2009*. Chapter 6: Snow and Ice Control, p. 101, 102 and 103(2x). Website source: <http://gov.ns.ca/tran/publications/Highway%20Maintenance%20Standards%20Manual.pdf>.

cyanide, which can be hydrated to hydrogen cyanide; both compounds are toxic.”²⁷

For more information on the management of this compound with respect to the risks to the water supply see section 4.2.6 *Road De-icing* on page 123.

Halifax Regional Municipality Policy Restrictions

HRM has recognized and expressed in the RMPS (2014) the need for managing the use of road salts in watershed area planning to help prevent lakes, watercourses and coastal waters from further degradation. In response to this need, a water quality monitoring program began in 2006 to identify lake water quality status and trends that included chloride data (chloride is the primary toxic component of road salts from HRM’s perspective). Based on the water quality data collected, and to fulfill Environment Canada’s Code of Practice (see page 76), HRM has created a salt management plan, identified best management practices and applied innovative techniques to winter works operations.

HRM Transportation and Public Works is developing a new Winter Works Management Plan to reflect upgrades in policies and practice. In October of 2011, the HRM Municipal Operations Winter Works Staff initiated and piloted the application of brine (Direct Liquid Brine Application) to HRM roads to achieve enhancements to public safety and a reduction in overall salt usage. A summary of this practice is posted on HRM’s website.²⁸ However, none of the roadways within the PWA is part of this brine application pilot project.

Road De-icing Application Practices and Strategies

HRM is the primary agency responsible for winter road maintenance and applying road de-icing agents on roadways within the PWA. NSTIR maintains the remaining 1.7 km of roadways that consist of sections of the collector roads Upper Governor Street and Crane Hill Drive situated in the watershed area.

The less salt-infused road de-icing agent – brine – is currently not being applied on any watershed area roadways. The current brining program is conducted using HRM equipment; however, winter road maintenance in the watershed area is currently conducted by a subcontractor who applies typical chloride rock salt, due to limitations in their equipment (not equipped to apply brine). The province is just beginning to trial brine applications, however, not in the Lake Major watershed. Therefore, greater amounts of salt per pass are being applied along designated roadways than if brine were applied.

²⁷ Halifax Regional Municipality. Environment and Sustainability Standing Committee, April 16, 2012, Information Report. Attachment 1: Stantec. November 7, 2011. *Draft Report: Road Salt – Review of Best Management Practices* Prepared for Halifax Regional Municipality Sustainable Management Environment Office. Halifax NS; p. 11. Web-site source: <http://www.halifax.ca/boardscom/swrac/documents/RoadSaltImpactsonLakes.pdf>.

²⁸ Halifax: Snow – Salt Management Strategies. Website accessed April 11, 2016 at: <http://halifax.ca/snow/SaltManagementStrategies.php>.

Almost all of the watershed area roadways are categorized under HRM's winter road maintenance program as "priority" salted or "secondary" salted. Small offshoots of road from some of the primary or secondary roadways are sanded. Primary salting occurs on 5.6 km of roadways in the watershed area: of these, 3.5 km are major collector roads (e.g., Lake Major Road) and 2.1 km are local streets. Secondary salting occurs on 2.1 km of watershed area roadways, all of which are local streets (e.g., Old German Road, and Churchill Terr. and Cain Street). Sanding occurs on only 0.21 km of local streets with the watershed area.

As previously stated, the only sections of roadways within the watershed area maintained by NSTIR are Upper Governor Road and Crane Hill Drive. The 1.7 km of collector roadways also continue to have the typical salt concentration applied to them.

Despite the Code of Practice, regulatory requirements and management plans from the various levels of government, designed to restrict the application of road salt as a de-icing agent particularly in "*environmentally sensitive*" areas, typical chloride salt applications are still being applied within the watershed area. Therefore, the risks associated with road salt are still prevalent on all roadway areas of the watershed area.

Due to the distance from waterways and the flat terrain of the roadways maintained by NSTIR, the application of road salts on these roads is considered to be very low risk for any chloride impact to water quality. However, the Lake Major collector road, maintained by HRM, is adjacent to Long Lake and poses a higher risk to water quality. Water quality monitoring sampling is conducted in strategic areas (see *Map K: Lake Major HRWC Services and Development Risk Areas* on page 117) to monitor the impacts due to chloride salt applications.

Halifax Water uses salt on steep sections of the treatment plant road where icy conditions could cause vehicles to slide off the road. The remaining sections are maintained during the winter months using sand. The forest access roads see very little traffic in the winter months and therefore are usually not maintained during these months; however, sanding is recommended by Halifax Water if increased traction is needed.

Controlled Access

Halifax Water maintains gated control of the supply plant, pipeline and forest access roads. The supply plant is further restricted by a second gate with surrounding fence.

In the event of any emergency on these roads, the *Emergency Response Plan for Halifax Water* will be followed, copies of which are found at the Lake Major water treatment plant or the main administrative office located at 450 Cowie Hill Road in Halifax.

3.1.5 Water Supply System Infrastructure

The following subsections briefly describe the risks associated with the Lake Major water supply system infrastructures including the dams; and the water supply plant pumping station, treatment effluent and power transformers.

Dams

In 2012 Halifax Water completed a dam safety review of all of its dams and spillways including the two dam infrastructures operating in the Lake Major watershed; East Lake and Lake Major. Halifax Water is responsible for the operation and maintenance of these dams. The license to operate these dams falls under the AOP registered to Halifax Water issued by Nova Scotia Environment. The assessments and recommendations produced in this report were based on the Canadian Dam Association (CDA) Guidelines: dams were classified based on the consequences of failure in terms of life safety, environment and cultural impacts and infrastructure and economic impacts (see *Table 3* on page 28). There are five consequence categories ranging from Low to Extreme. Descriptions of the dams and spillway, including dam review results, are described under the subheadings below and outlined in section 2.2.3: *Water Supply System Infrastructures* on page 27.

East Lake Dam

The East Lake dam is classified as a Low consequence structure based on the CDA Guidelines 1999 (see *Table 3: Canadian Dam Association Classification System (2007)* on page 28). In the event of a dam break or failure the East Lake dam is considered not to have a significant impact on water levels and flows at Lake Major.

Regarding life safety, there is no anticipated loss of life or property in the event of a fair weather failure of the East Lake dam because there is no sedentary population between the dam and the Lake Major reservoir. A cascade effect on the Lake Major dam is considered unlikely and the current dam safety review assumes it will not occur. The East Lake dam is considered to be low consequence for this factor as well.

Environmental and cultural losses are considered to be minimal as well. The impact of a failure would be on woods and be small-reaching.

Lake Major Road Dam

The Lake Major dam and appurtenant structure are classified as High consequence for various risks of failure as shown in *Table 3: Canadian Dam Association Classification System (2007)* on page 28. Typical causes of failures in timber dams include decay or deterioration of timber members, impact from floating debris and ice, static ice pressures, breakage of timber crib members and loss of ballast rock and buoyancy resulting from high tailwater levels. The conditions that are prevalent at Lake Major that impact the dam are from the wet/dry conditions, which make the timbers vulnerable to decay. Core samples on the timber structures at Lake Major indicate that the timber has deteriorated significantly, and no longer possess their design strength.

Water Supply Plant

In 1999, the Lake Major Water Supply Plant (WSP) (see location illustrated on *Map L: Development Risk Areas in Communities* on page 118) was commissioned. The infrastructures associated with the WSP are the pumping station, WSP treatment effluent discharge process and

the power transformers. The risks associated with these infrastructures, systems and processes are described under the subheadings below.

Pumping Station

The Lake Major water supply pumping station uses four vertical high-capacity turbine raw water pumps that contain 15 litres of lubrication oil to help the bearings work properly. SOP's are in place to minimize the risk to the water supply in the event of an accident or vandalism.

Supply Plant Treatment Effluent

The Lake Major water supply plant treatment discharge, holding tanks and drying beds are located inside the watershed area. The sediment created from the settling process is then mechanically separated from the water and stockpiled in the engineered drying bed. Remaining residual water is wicked away by direct sunlight and wind, or by gravity filtered through the bottom of the drying bed into an underground drainage system that intersects the water supply plant discharge piping system where it eventually makes its way back to the lake. Once the sediment has been dried, it is transported to a government-approved waste facility. The risk associated with the material is considered low because it is inert. The mechanically separated water is de-chlorinated and returned to Lake Major through an underground piping system. The return water is tested daily as it leaves the holding tanks. Drying bed water is not subjected to any treatment process other than the natural elements and gravity filtration. Weighted volume of the final discharge water that drains into Lake Major is mainly made up of water supply plant discharge water rather than drying bed water. In each case the risks associated with the return water include aluminum, chlorine, pH, and suspended solids; water test samples indicate measurement results above NSE guidelines. Halifax Water continues to work diligently with NSE to meet all provincial guidelines.

Power Transformers

Nova Scotia Power (NSP) maintains two transformers on the water supply plant grounds: one is adjacent to the pumping station near Lake Major; and the other is outside of the water supply plant. Neither transformer has double walls. Halifax Water inspects both transformers daily, as identified under its ISO 14001 Environmental Management system, in addition to yearly inspections performed by NSP. The fluid contained in each transformer is mineral oil which is considered a low-medium risk contaminant to the water supply. Environmentally-friendly alternatives to mineral oil exist; however, Halifax Water currently feels the impact of mineral oil has been mitigated through alternative measures that are in place. Specific details for each current transformer are below:

Lake Major Intake Pumping Station

The risks associated with the intake pumping station transformer are considered low because the 1,750 litres of mineral oil contained within it has secondary containment. The secondary containment consists of an external pad mount system with a continuous cement lip in which the transformer is confined allowing rainwater to flow through a drain line into an oil/water

separator. When sensors detect a leak in the transformer, a valve on the drain line closes to contain any leaking fluid.

Lake Major Water Supply Plant

The water supply plant transformer which contains ~1,600 litres of mineral oil sits on top of a small hill away from any roadways; lacks secondary containment and sits on an open concrete slab. A catch basin is near the transformer, however, the risks to the water supply are considered low since the transformer is far removed from the water supply (>320m) and the catch basin drains under the water supply plant roadway into a grassy area between the water supply plant and the fence lining the pump station access road where there is no direct route for fluid to flow through. In the event of a spill the location allows easy access for clean-up, if necessary.

3.1.6 North Preston Wastewater Treatment Plant

North Preston is a fully serviced community with its own wastewater treatment plant located next to Wynder (also spelled Winder) Lake; and five wastewater pumping (lift) stations which are located at Amos Walter Drive, Donald Lane, Amelia Court, Simmonds Road, and North Preston Road (see *Map L: Development Risk Areas in Communities* on page 118). The wastewater treatment plant and the Amos Drive lift station are located outside of the watershed while the remaining four lift stations are located inside the watershed area. The highest risk lift station is located on North Preston Road which lies within 90m of Long Lake. An unnamed tributary to Long Lake runs within eight (8)m of the lift station, increasing the risk to the water supply if a spill or overflow were to occur. In the past, this location has overflowed, mainly during high water periods and flood events. In 2006 the wastewater systems, including the lift stations, were upgraded, which greatly reduced the risk. Since the upgrades, overflows from the Long Lake lift station have been virtually eliminated and are now considered a low risk.

In addition to wastewater infrastructure improvements, the North Preston Water Treatment Plant was also decommissioned in 2009 in favour of extending the Lake Major water main. By connecting to the Lake Major Water Supply Plant, located further down gradient of the overflow pipe, the public health risk has been greatly reduced due to higher dilution factors and improved water treatment procedures at the plant. Communications between the Wastewater and Water utilities have also significantly improved since the merger in May of 2006.

The combined upgrades of the North Preston wastewater and drinking water systems have greatly reduced the risk of contamination to the water supply. The Lake Major Water Supply Plant pumping station is also located further away from the lift station overflow pipes than the Long Lake Water Treatment Plant intake was.

3.1.7 Municipal Land-use Planning and Development Activities

All land-use planning and development activities have the potential for negative or positive impacts on the watershed area. The challenge is to ensure that negative impacts are mitigated or eliminated where possible. Many potentially negative activities may be and are regulated through municipal land-use and zoning by-laws, as well as by federal and provincial legislation.

This subsection explains municipal land-use activities carried out by Halifax Water and others in the Lake Major watershed; the provincial regulations and zoning by-laws that regulate existing and potential land-use activities in the watershed area; the potential contaminants and risks associated with the permissible land-use activities; and the measures taken to protect the water supply.

Residential and commercial activities in densely populated areas carry the greatest potential for risk to the Lake Major water supply. The areas of greatest concern in the watershed area are Montague Gold Mines, North Preston, Lake Loon/Cherry Brook and Lake Major (see *Map K: Lake Major HRWC Services and Development Risk Areas* on page 117 and *Map L: Development Risk Areas in Communities* on page 118) due to the pressures on watershed lands that population density brings. Some of the risks include:

- improper use and disposal of household and commercial products;
- illegal garbage dumping;
- infilling;
- recreational pressures;
- washing of vehicles in close proximity to tributaries;
- the use of fertilizers;
- on-site septic tank failures and poor maintenance;
- failure of furnace oil tanks; and
- improper maintenance of heavy equipment.

Commercial Activities

The Lake Major watershed has a number of commercial concerns including forestry, an open pit rock quarry, the Lake Major WSP, as well as other developments and a number of small salvaging company contractors. Many of the activities carried out on company or Crown watershed lands are tackled through company and government policies, procedures and BMPs, which are described under the relevant headings.

Nova Scotia Power

Nova Scotia Power owns 28ha of land south of Spider Lake in a zoning area that permits development. It is currently unclear what Nova Scotia Power intends to do with this land although adjacent lands have been developed into residential subdivisions within the last 8 years. For this reason Halifax Water considers these lands to be at a low to moderate risk of being lost to development. Halifax Water has expressed to NSP its interest in purchasing these lands; however, NSP has not been interested in selling. Halifax Water will continue to closely monitor these lands. Should an opportunity to purchase the land arise, Halifax Water will make a bid to complete the transaction.

Waste Refuse Sites and Infilling

Infilling is a concern within the watershed. Several sites near key drainage points have been identified and reported to the appropriate government agencies by Halifax Water. Local Councillors, Government inspectors, compliance officers and biologists have visited many of these sites. In most cases the person or company responsible has complied and cleaned up the problem. However, there are a few cases where the offender has not fully complied. Subsequently, Orders have been issued to clean up or address problem cases. Some of these cases are ongoing and remain open. Halifax Water will continue to monitor these areas and immediately contact the government agencies if any changes occur. Halifax Water has targeted these as high priority areas in its raw water-sampling program described in section 5.4.4: *Target-Based Sampling* on page 164.

Residential

Primary residential areas that exist within the watershed area are located in the communities of North Preston, East Preston, Lake Loon/Cherry Brook and Montague Gold Mines. These communities pose the greatest risk to the watershed area due to the potential for and from existing residential land-use activities (see *Map I: Plan Area and Zoning* on page 66). The by-law zones within the PWA that permit residential development are PWS, P-2, P-3, P-4, RA, RS, R-1b, R-3, R-7, and MR. However, land-use activity restrictions apply within these by-law zones where DNR and NSE provincial Regulations (i. e. , WSRLR Wilderness Area (see page 38) and the Waverley Game Sanctuary (see page 38)) take precedence. Further, Halifax Water owns a significant portion of land (2592.8ha) within these by-law zone areas, which further restricts land-use activities. Beyond these restrictions, according to the Land-use By-law (LUB) Zoning (see *Table 6: HRM LUB Plan Areas in Watershed and Applicable By-law Zones and Descriptions* on page 45), residential development is still permitted on 675.8ha (9.73 %) of the PWA.

Within the 675.73ha of developable (or developed) land, the risks associated with residential development remain (see outline of risks in *Table 10: Risks Associated with Landownership and Permitted Land-use Activity* on page 92 and illustrated on *Map L: Development Risk Areas in Communities* on page 118) as the subsections below explain.

On-site Septic Systems

On-site septic systems are permitted in the watershed area as per section 13 of the *Lake Major Watershed Protected Water Area Regulations* (See *Appendix 1* on page 167). Approximately 102.16ha (1.5%) of the total land area within the watershed area is within the sewershed; i.e., the area where there is infrastructure available to connect private landowners to the municipal wastewater system. This leaves approximately 573.64ha (8.3%) of the developable private properties located in the Lake Major watershed (note: not the PWA) that either are or could potentially rely on on-site septic systems for the treatment of domestic wastewater. Microbial contamination risk associated with on-site septic systems is considered to be a contamination risk factor. Wastewater can impact the surface water supply when septic systems are improperly installed or maintained; deleterious materials enter the system; there is surface damage to the

drainage field; or contaminants leach from the septic system to surface water through ground saturation and high stormwater flow periods. For an illustration of real and potential high risk areas due to on-site septic systems see *Map K: Lake Major HRWC Services and Development Risk Areas* on page 117.

Home Heating Fuel

Many homes in this area rely on oil-fired heat. Oil tank spills or failure pose a risk to the water supply due to the potential persistence and movement of petroleum products in a fractured bedrock aquifer. Home heating oil tanks that are exposed to weather, are not installed or maintained properly, or have shifted at their base from frost action have the potential to leak, causing serious environmental problems and property damage.

Household Chemicals

The potential use of household chemicals associated with subdivision residences including persistent, mobile chemicals (e.g., fertilizers, private road and driveway de-icing agents, petroleum products, pesticides, solvents, and other chemicals) could present a risk to surface water quality if repeatedly used in large enough quantities.

Impervious surfaces

Impervious surfaces as in paved roads and driveways, rooftops and concrete pose an impact on surface water through increased water flow and contaminants that are picked up and carried in stormwater runoff and into the stormwater systems and ditches. Approximately 59.5ha (0.85%) is considered impervious surface although not all of this area is due to development; some is due to hard natural surfaces such as rock (not including the barrens). Besides roads not specifically associated with communities, the largest contiguous impervious surfaced areas are the quarry (20.8ha), North Preston community (8.7ha), Montague Gold Mines community (3.5ha) and the Lake Major WSP grounds (2ha) (see *Map F: Land Cover* on page 34).

Agriculture Uses

Permitted agriculture uses and intensive agriculture uses (see outline of these uses in *Table 6: HRM LUB Plan Areas in Watershed and Applicable By-law Zones and Descriptions* on page 45) pose a potential risk to the Lake Major watershed due to leachate from manure piles, or farmland pesticide and fertilizer application runoff flowing into surface waterways within the Lake Major watershed. Halifax Water monitors the watershed area for indications of agriculture practices. The only known agricultural practices apparent within the watershed area are home scale gardens and green houses, which, according to the PWS by-law, may continue to operate until they cease to be active.

Notwithstanding landownership, LUBs permit low level (and 50ha intense) agricultural uses within 815.12ha (11.73 %) of the watershed area. Most of this area is within the NP-LM Plan Area whereby 498ha (7%) is zoned Mixed Resource and 223ha (3.2%) is zoned Rural Settlement. The remaining area is in the Shubenacadie Lakes Plan Area whereby 10ha (0.1%) is zoned Park and 49.4ha (0.7%) is zoned Rural Estate.

Halifax Water and DNR own approximately 480ha (62%) of the 815.12ha in the identified LUB zones, leaving 335.12ha that could be potentially used for agricultural purposes. However, any new development application for new or expansion of existing agricultural development would be permitted only through development agreement.

Additional agricultural use risk factors include potential runoff containing pesticides, herbicides and chemical fertilizers from existing greenhouse operations.

3.1.8 Land-use Plan Zoning

The Lake Major watershed is municipally governed by Regional Municipal Planning Strategy (RMPS (2006)) policies (see section 2.4.3: *Regional Municipal Planning Strategy Policies* on page 41); HRM and Halifax County By-laws (see outline in *Table 9: HRM Regional and Halifax County By-laws* on page 64); and a complex matrix of four sets of municipal Land-use By-laws (LUBs), each defined by their respective Municipal Planning Strategy (MPS) (see *Table 6: HRM LUB Plan Areas in Watershed and Applicable By-law Zones and Descriptions* on page 45) which fall within the Lake Major watershed (see *Map I: Plan Area and Zoning* on page 66).

HRM Plan Areas associated with the Lake Major watershed are:

- Cole Harbour / Westphal (CH/W)
- North Preston / Lake Major / Lake Loon / Cherry Brook and East Preston (NP-LM)
- Lake Echo / Porter's Lake (LE/PL)
- Shubenacadie Lakes

The land-use planning exercises that produced the above-named MPS', dictate which activities may or may not occur within the Lake Major watershed, and are defined by the LUBs. Through these exercises, each of the applicable MPS' acknowledges the need to protect the Lake Major watershed. However, the means to protect the watershed area differs within each MPS policy and associated LUBs as described in detail in section 2.4.3: *Municipal Land-use Planning Policies and By-laws* beginning on page 41.

The levels of risk to the Lake Major watershed associated with each LUB Zone is dependent upon the activities that are permitted within each Zone, and are described later in this section. However, notwithstanding the zoning, there are risks presented simply by the current municipal and provincial Lake Major watershed protection regulatory structure.

The number of MPS' in the Lake Major watershed and differences between their associated LUBs presents confusion and oversight when considering the appropriate by-law through the application review process. For instance, there are varying requirements in the MPS policies and LUBs with respect to the LMWAB reviewing development applications. In 2012 alone, nine known development permits were issued inside the PWA without providing the LMWAB the opportunity for input as per the NP-LM Land-use By-law 3.6. While By-law 3.6 and the corresponding MPS policy require that the LMWAB review development applications, there is no by-law to this effect in the CH/W LUB, where some of the nine development applications

occurred. However, policy W-4 in the CH/W MPS *does* require that the LMWAB review development applications (see page 35 of the MPS).

Within the remaining MPS' (Shubenacadie Lakes and LE/PL) and corresponding LUBs, there is no policy or by-law requiring that the LMWAB review development applications. However, there is reference in the Shubenacadie Lakes MPS that any amendments to the MPS or LUBs be referred to the now defunct Shubenacadie Lakes Advisory Board for comment (see policy P-161 details on page 63 of this SWPP). In the remaining portion of the PWA, i.e., the LE/PL Plan Area, there is no need to refer development applications (DAs) to a Board since all of this area is zoned Wilderness Protected Area, where no development exists or is permitted. If plan area boundaries change, the review process for DAs inside the watershed area will need to be revisited.

The regulatory inconsistencies just described present confusion for all concerned with the planning and development permitting process. Until these inconsistencies are corrected, confusion and oversights will persist, which will increase the risk for inappropriate development and land-use activity inside the Lake Major watershed.

The following sections describe the risks associate with each MPS and their associated LUBs:

Cole Harbour/Westphal Plan Area

The Cole Harbour/Westphal (CH/W) Plan Area covers approximately 1230.71ha (17.72%) of the watershed area, as described in *Table 6: HRM LUB Plan Areas in Watershed and Applicable By-law Zones and Descriptions* on page 45, and illustrated on *Map I: Plan Area and Zoning* on page 66.

The greatest risks to the watershed area are associated with the Mixed Resource (MR), Residential Uses R-1, Suburban Residential (R-1b), Rural Estate (R-7), and Rural Settlement (RS) LUB Zones, due to the land uses permitted in these zones that include residential, commercial and resource uses. The risks associated with the land-use activities with respect to landownership and these by-law Zones are described later in this section and outlined in *Table 10: Risks Associated with Landownership and Permitted Land-use Activity* on page 92).

North Preston/Lake Major/Lake Loon/Cherry Brook and East Preston Plan Area

There are a number of commercial activities that are of particular concern to Halifax Water as well as trail and residential development due to the potential risks they pose to the watershed area. The potential risks are described in more detail below.

Commercial Activities

Commercial activities throughout the NP-LM Plan Area that are of concern to Halifax Water include a golf course, a non-conforming auto repair shop close to Long Lake, and a number of small local contracting businesses as described in the following subsections.

Golf Course

The risks to the watershed area have decreased due to course improvements over the years which have directed water drainage away from the watershed area. As a result, the golf course has requested an alteration to the *PWA* boundary. As well, golf course management has developed golf course best management practices to help protect the remaining areas inside the watershed area. While the risk to water quality is considered low, Halifax Water has developed a water quality monitoring program at a key drainage point of the proposed watershed area boundary alteration to help Halifax Water evaluate whether the *PWA* boundary should be altered through a scientifically-based risk assessment. See section 3.13: *Recreation: Golf Course* on page 73 for further details.

Auto Repair Shop

A non-conforming land use-permit was issued (1992) to an auto repair shop along Johnson Road in North Preston. It presents a high-moderate risk to the watershed area because of past over stock piling of used cars for parts and the proximity to Long Lake. Vehicle fluids could easily make their way into Long Lake potentially impairing water quality throughout the system. However, Halifax Water continues to conduct site visits and has implemented a monthly raw water sampling program to monitor the water run-off in the area (see section 5.4.3: *Activity-Based Sampling* on page 160).

Small Contractors

There are a number of small contractors in residential areas who have conducted unauthorized dumping and infilling activities in the North Preston area. The risks to the watershed area are considered moderate. The proper authorities have been contacted and orders have been issued to clean up any illegal construction debris or other material that could pose a threat to human health. Halifax Water continues to monitor the sites and has included these areas in the monthly raw water sampling program (see section 5.4.3: *Activity-Based Sampling* on page 160).

Trail Development

Halifax Water has partnered with HRM's Active Transportation Program and the Preston and Area Trails Association to build and maintain a non-motorized community multi-use trail which runs along Long Lake and connects North Preston to other Lake Major watershed communities. The trail promotes active living, connectivity and a safe means of travel and recreation along Lake Major Road. Risks to the lake, the Lake Major WSP and other sensitive Halifax Water infrastructure have been minimized through the design process. Trails were located in less sensitive areas with guidance from Halifax Water.

Land Use Designations and Activity

The NP-LM Planning District contains well-established land-use activities areas throughout the Plan area. While there are few opportunities for new land-use activity within the whole watershed area since most of the vacant land is owned by Halifax Water or the Province, there are a few opportunities for new development as described below.

The communities of North Preston and East Preston are situated beyond the urbanized metropolitan area, and exhibit semi-rural land-use characteristics. Although the predominant

form of land-use is the single unit dwelling, many residents of these communities are also engaged in small-scale commercial and resource related activities on their properties. Livestock production, construction contracting, forestry, automotive repair and small-scale service and retail outlets are prevalent throughout these two communities. The NP-LM MPS acknowledges these characteristics by designating the lands in this area Mixed Use (MU) or Rural Settlement (RS). More specifically, 500ha (7.2%) located on the south east portion of the PWA around Long Lake is zoned MU; and 223ha (3.2%) is zoned RS (Rural Settlement) (not including 35ha of the PWS buffer area around Long Lake) (see *Map I: Plan Area and Zoning* on page 66).

The NP-LM MPS also considers that a good portion of the MU designation is located within the Lake Major PWS. So while the MU designation is intended to retain the mixture of residential, community, commercial and resource uses which are traditionally found within rural communities, the MPS permits *most* uses that might occur within residential, commercial, institutional or resource designations. To take into consideration the special nature of the Lake Major watershed as a drinking water supply area, the MPS specifies the requirement to establish limitations relative to the size and nature of each land-use in addition to site specific evaluation of certain development proposals within the watershed area (as defined on Map 1, Generalized Future Land Map referenced in the NP-LM MPS).

In order to provide a degree of flexibility, while allowing discretion to be exercised certain uses such as commercial developments having in excess of 2,000ft² of floor area, multiple unit dwellings and light industrial developments shall be accommodated through the development agreement provisions of the Planning Act. In addition, the development of new livestock production facilities and auto related industries within the Provincially Designated PWA will be subject to more site specific evaluations afforded through the development agreement process.

It is recognized within the NP-LM MPS that, within the MU designation, there may be areas which may desire or benefit from a rezoning to a more restrictive residential zone in order to provide source water protection compatible uses. The MU designation, therefore, provides for rezoning to a more restrictive residential zone in order to reflect a transition from a mixed land-use pattern to a predominantly residential environment.

Land in the watershed area overlaid by the MR Designation, is owned by Halifax Water (442ha) which leaves approximately 56ha that falls within the MR Zoning. However, policy within the MPS acknowledges and accounts for the risks whereby:

“MU-1 It shall be the intention of Council to establish a Mixed Use Designation, as shown on Map 1 – Generalized Future Land-use. Within this designation, those uses which are traditionally found in rural communities and which may be accepted into the Plan Area without adversely affecting the character and attractiveness of this environment will be permitted.

MU-2 Within the Mixed Use Designation, it shall be the intention of Council to establish a rural settlement zone which permits single and two unit dwellings, multiple unit dwellings containing up to four (4) units, mobile homes skirted and on individual lots, senior citizen housing, residential care facilities and institutional uses. The zone shall also permit limited home business activities, as well as general commercial activities of

up to two thousand (2,000) square feet of floor area, except for auto service outlets within the Lake Major Watershed, and shall permit resource related activities except new or expanded facilities associated with existing intensive resource uses. In addition, the zone shall establish controls on open storage, outdoor display, parking and signage in order to address compatibility concerns with surrounding development.”

Section 3.6 of this district’s LUB requires that **every development permit applicant must be referred to the Lake Major Watershed Advisory Board** and the development officer shall consider any reply from the Board.

“3.6. General Provisions for All Zones:

Every application for a development permit for lands situated within the Lake Major Watershed as shown in ‘Schedule A’²⁹ shall be referred to the Lake Major Watershed Advisory Board and the Development Officer shall consider any reply from the Board to the extent permitted by the Planning Act, or any other provincial statute.”

Further;

“4.21 Watercourse Setbacks and Buffers

1(e) – 76.2 m buffer from Lake Major & 30.5 m from tributary within Lake Major Watershed as designated by Minister of Environment.”

Lake Echo / Porter’s Lake Plan Area

The section of the Lake Echo / Porter’s Lake Plan Area that falls within the watershed area is considered to have very low risk-potential for impacting water quality because it is mainly owned (except for 5ha by Halifax Water) by the Province. This area also is contained within the WSRL Wilderness Area, which is governed by NSE through WAPA (which supersedes PWA regulations), further reducing the risk-potential to water quality.

In the event that the province decides to change legislation or alter the boundaries, which could potentially increase the risk to water quality, a public consultation process would be required. This process would give Halifax Water the opportunity to review and provide comment to any proposed changes toward reducing any potential risk to water quality.

However, on the municipal side, currently the district by-law zones do not require the permit applicant to contact DFO, NSE, DNR, the water utility, or the LMWAB for comments.

District 14& 17 Shubenacadie Lakes Plan Area

Much of the watershed area land in this district is either provincially protected within the WSRL Wilderness Area or owned by Halifax Water. For these reasons there is no immediate concern related to potential residential development; however, a large active rock quarry operation located in the central western region of the watershed area is contemplating expansion

²⁹ aA map showing the locations of each by-law zone in this planning district

of its operation further into the watershed area. The *PWA* regulations do not prohibit the pit expansion; however, the pit operator must seek approval from Halifax Water. As outlined in section 3.1.2: *Mining, and Pits and Quarries - Pits and Quarries* on page 71 an agreement was reached in 1998 pending conditions. Halifax Water routinely monitors the site with the quarry manager to ensure no new risks have emerged and that the agreed to conditions are being implemented to reduce the impact on the watershed area and the water supply.

Halifax Water maintains open communications with HRM staff and requests that the Municipality contact Halifax Water with any emergencies that take place in, or proposals that relate to, the watershed area. The LMWAB also has excellent representation from both HRM and the residential areas within the watershed area.

For more information about Halifax Regional Municipality by-laws and zoning restrictions, visit www.halifax.ca.

Table 10: Risks Associated with Landownership and Permitted Land-use Activity				
Cole Harbour/Westphal (3)			1230.71* ha land	
By-law Zone	Zone Area* (ha) in PWA	Allowable Development Activity	Landownership ha in PWA (% of Plan Area)	Risks Associated with Permitted Activity in By-law Zone
P-1 (Recreation Open Space)	0.75	Open Space Uses; Public and private parks and playgrounds; Cemeteries; Historic sites and monuments.	DNR 0.75ha (0.0006%)	<u>Very Low Risk:</u> Low-impact land-use activities permitted; area located on the southwest border of the PWA, which includes a portion that falls outside the natural watershed area. In the event a cemetery was permitted, a risk analysis impact study should be completed prior to any decision in order to properly assess the risk to the water supply
P-4 (Conservation Zone) changed to PWS in MPS when Regional Plan Adopted) PWS (Protected Water Supply)	1146.53 ha (1140.2ha PWS) 93% of the CH/W LUB Area. 17% of the PWA.	Municipal Water Distribution or Purification Facilities; Public Parks w/ no Buildings; Conservation Uses; Uses Accessory to Foregoing Uses; Single Unit Dwellings	Halifax Water 878.23ha (71.36%)	<u>Very Low Risk:</u> Development unlikely unless ownership changes.
			DNR 158.41ha (12.9%)	<u>Low Risk:</u> Development unlikely unless ownership changes.
			Private individual landownership 83.52ha (6.8%)	<u>Low Risk:</u> Approximately 3ha falls outside of unserviced areas and broken into small scattered individual lots considered too small for development; therefore risk considered low, should area become serviced risk potentially could rise due to activities associated with residential development. <u>Medium - High Risk:</u> Approximately 81.4ha single ownership parcel immediately adjacent to Lake Major central eastern shoreline Should owner decide to develop, this would present a high risk of impact to Lake Major water supply and the watershed area.
			HRM 3.2ha (0.0004%)	<u>Low Risk:</u> Development unlikely unless ownership should change.

Table 10: Risks Associated with Landownership and Permitted Land-use Activity

			Industry (Quarry) 22ha (1.8%)	<p><u>Medium Risk:</u></p> <p>Parts of two larger single ownership parcels are currently being worked as an active rock and gravel quarry. The <i>PWA</i> boundary intersects these parcels. The risk to the water supply and watershed area has been greatly reduced through a conditional agreement reached between Halifax Water and the landowner. Conditions include: constructing a berm to effectively create a new watershed boundary - not to be breached or altered in any way; quarry BMP's including no fuelling practices and no contaminated material/debris inside the <i>PWA</i>; and annual joint site visits conducted between Quarry staff and Halifax Water.</p>
R-1 (Single Unit Dwelling)	11.29	Single Unit Dwellings, Home Businesses, Daycare ≤14 children	Private Individual Landownership 9.5ha (0.8%)	<p><u>Low - Medium Risk:</u></p> <p>Most of this By-law Zone area is distributed between 35 landowners who own a mean average of 0.2ha each. The largest lot is 1.5ha. The biggest risk in this area is that they are in an unserviced area and therefore depend on on-site septic systems for wastewater treatment and are in close proximity to brooks and streams that eventually drain into Lake Major.</p>
			DNR 1.77ha (0.14%)	<p><u>Low Risk:</u></p> <p>Development unlikely unless ownership changes.</p>
R-3 (Mobile Dwelling)	0.17	Mobile Dwelling w/ permanent foundation; Single Unit Dwellings; Home Businesses; Daycare ≤14 children	Private Individual Landownership 0.17ha (0.0001%)	<p><u>Very Low Risk:</u></p> <p>Small size lot; On-site septic system.</p>

Table 10: Risks Associated with Landownership and Permitted Land-use Activity

R-7 (Rural Estate Zone)	71.46	Single Unit Dwellings; Home Businesses; Daycare ≤14 children	Private Landownership 45.11ha (3.7%)	<p><u>Medium - High Risk:</u></p> <p>Land area is located in an unserved (sewer) area within the Montague Gold Mines community. Development is sparse and contains 25 individual land parcels. The largest land parcel 11ha is located in close proximity to Flat Barren Brook which flows into Lake Major. Seven more parcels between 1 and 9ha, of which six have structures, are dispersed throughout the watershed area and could be further developed.</p> <p>The greatest risk associated with development of these lots is the potential for malfunctioning on-site septic systems and/or the eventual leaching of nutrients into the watershed area and water supply. To reduce the risk in this area Halifax Water will consider purchasing these properties and/or educate the landowners wishing to develop, about the importance of proper on-site septic system maintenance.</p>
			Crown 11.78ha (1.0%)	<p><u>Low Risk:</u></p> <p>Development unlikely unless ownership changes.</p>
			NSTIR 4.6ha (0.4%)	<p><u>Medium - High Risk:</u></p> <p>NSTIR purchased properties with the intent of building new access high to improving traffic conditions from Forest Hill extension out to Porters Lake.</p> <p>New access highway will have negative impact on water supply. Serious consideration/ mitigation will need to take place between Halifax Water and the province to minimize impact or alter route.</p>
			HRM 4.54ha (0.37%)	<p><u>Low - Medium Risk:</u></p> <p>Development unlikely unless ownership changes.</p>
			Halifax Water 5.7ha (0.5%)	<p><u>Very Low Risk:</u></p> <p>Development unlikely unless ownership changes.</p>
Planning Districts 8 and 9 (Porter's Lake) (12)			454.85* ha land	
By-law Zone	Zone Area* (ha) in PWA	Allowable Developments	Landownership ha in PWA (% of Plan Area)	Risks Associated with Permitted Activity in By-law Zone

Table 10: Risks Associated with Landownership and Permitted Land-use Activity				
PA (Protected Area) (RC-Jun 27/06;E-Aug 26/06)	454.85	Scientific study and education, involving no buildings;	NSE 448.18ha (98.5%)	<u>No - Very Low Risk:</u> Waverley-Salmon River Long Lake (WSRLL) Wilderness Area (see page 38) which provides an extra layer of protection further activities within this area. Low impact recreation would be the only risk to consider.
		Trails, boardwalks or walkways; Conservation Uses; Uses accessory to the foregoing uses;	Halifax Water 6.65ha (0.15%)	<u>Very Low Risk:</u> Development unlikely unless ownership changes.
North Preston, Lake Major, Lake Loon, Cherry Brook, East Preston				
(North Preston – Lake Major) (15)			837.3* ha land	
By-law Zone	Zone Area* (ha) in PWA	Allowable Developments	Landownership ha in PWA (% of Plan Area)	Risks Associated with Permitted Activity in By-law Zone
MR (Mixed Resource)	497.97	Resource Uses: except Intensive Agricultural Uses within the Lake Major Watershed; Composting operations that are 328 feet (100 m) from a watercourse; Community Uses; Residential Uses	Private Individual Landownership 56.1ha (8.7%)	<u>Low - High Risk:</u> Presently low risk due to lack of development. Risk level could change to “high” depending on land-use activities, such as composting facilities, agriculture or residential uses that are permitted here Highest risks are four properties equalling 38.3ha in size located at the southern end of Long Lake; near Crane Hill Road. These properties abut with two brooks running between them and drain into Long Lake which presents an increased risk. These properties are in an unserviced area which requires on-site septic systems, further adding to the risks in this area. Mainly due to their isolated location, the remaining 18ha of privately owned land in this zone pose a low-medium risk depending on the permitted activity.
			Halifax Water 441.87ha (52.8%)	<u>Very Low Risk:</u> Development unlikely unless ownership changes.
			Roadways 0.0034 ha	<u>Medium - High Risk:</u> This area is associated with Lake Major Road which runs along Long Lake. Roads and ditches pose a medium to high risk of contamination to the water supply as potential contaminants could be washed off the roadway and into the ditches which make their way into the water supply.

Table 10: Risks Associated with Landownership and Permitted Land-use Activity

P-1 (Recreation - Open Space)	13.96	Commercial Recreation; Private/Public Parks and Open Space	Golf Course 13.96ha (1.7%)	<u>Low - Medium Risk:</u> The risks associated with the golf course have been addressed. For details on the management of this risk, please refer to the section on 4.3.3: <i>Recreation: Golfing</i> on page 128.
P-2 (Community Facility)	3.24	(a) Institutional Uses: Community centres and halls; Day care facilities, including single unit dwellings in conjunction with day cares;	Private Landownership 0.08ha (0.0009%)	<u>No - Very Low Risk:</u> There is only one lot in this By-law Zone which currently supports a North Preston community church. It is situated within the municipal sewershed and therefore does not pose any wastewater concerns.
		Denominational institutions and uses; Educational institutions and uses; Fire and police stations; Government offices and public works;	HRM 1.58ha (0.2%)	<u>Low Risk:</u> This area poses a low risk to the watershed area and may help to mitigate some of the risks posed by this high-density community. The area supports the North Preston Community Centre and a bus station. The wastewater is handled through the municipal wastewater system.
		Hospitals and medical clinics; Nursing homes Public libraries, museums and galleries; Residential care facilities (b) Open Space Uses Cemeteries; Historic sites and monuments; Public and private parks and playgrounds	Halifax Water 1.58ha (0.2%)	<u>Low Risk:</u> This is land on which the reservoir sits. Halifax Water recognizes the community's desire for open space land-use and will consider community interests in using a portion of the property. Low risk uses will be given preference over higher risk uses.
PA (Protected Area)	4.55	Scientific study and education, involving no buildings; Trails, board-walks or walkways;	NSE 3.12ha (0.37%)	<u>No - Very Low Risk:</u> Waverley-Salmon River Long Lake (WSRLL) Wilderness Area (see page 38) provides an extra layer of protection unless further activities are permitted within this area. Low impact recreation currently is the only risk to consider.

Table 10: Risks Associated with Landownership and Permitted Land-use Activity

		<p>Conservation uses</p> <p>Uses accessory to the foregoing uses</p> <p>Other Requirements:</p> <p>Within any PA zone, no infilling, excavation, alteration of grade or removal of vegetation shall be permitted. The construction of board walks, walkways or trails shall be permitted provided that no infilling or alteration of grade occurs other than the placement of piles or the placement of trails on top of the existing grade.</p>	<p>Halifax Water</p> <p>0.2 ha</p>	<p><u>No Risk:</u></p> <p>This small area abuts properties that are owned by the NSE (WSRLL Wilderness Area) and Halifax Water. Essentially no activity will present a risk here.</p>
			<p>NS Ungranted Lands</p> <p>1.25ha (0.15%)</p>	<p><u>No - Very Low Risk:</u></p> <p>The Waverley-Salmon River Long Lake (WSRLL) Wilderness Area (see page 38) provides an extra layer of protection unless further activities are permitted within this area. Low impact recreation currently is the only risk to consider.</p>
<p>PWS (Protected Water Supply) (formerly P-4 (Conservation Zone); changed to PWS Zone in RMPS (2006) when Regional Plan Adopted)</p>	<p>35.3</p>	<p>13.1 PWS USES PERMITTED</p> <p>Municipal Water Distribution or Purification Facilities; Public/Private Parks w/ no Buildings; Conservation Uses; Crop Farming; Grazing, and pasturage if in existence at the time of by-law effect; Uses Accessory to Foregoing Uses</p> <p>13.3 SPECIAL PROVISIONS: EXISTING RESIDENTIAL USES</p>	<p>Private Landownership</p> <p>11.26ha (1.3%)</p>	<p><u>Low – Medium – High Risk:</u></p> <p>All of the land area in this By-law Zone abuts the north and northeast shoreline of Long Lake, except for two small vegetated buffers along the southern shoreline of the lake. Currently there is one building on one of the lots which is situated closer to the road than to the shoreline. This area currently provides a significant vegetative riparian zone to this section of Long Lake. The land area is also serviced by wastewater and stormwater which would potentially help to mitigate negative impacts from stormwater runoff and on-site septic systems. Since there is only one existing building use, and new uses will not permit residential dwellings, risks presented by residential uses are not present. However, should the landowner decide to use the area for grazing animals or farming, the associated impacts could significantly increase the risk to the water quality in this area depending on the use and the proximity to the Long Lake. Such activity is not restricted in the PWA Regulations and therefore presents a risk.</p>

Table 10: Risks Associated with Landownership and Permitted Land-use Activity

		Notwithstanding Section 13.1, existing residential uses in a PWS Zone shall be permitted to be expanded, altered, repaired and rebuilt and, in addition, certain properties within a PWS Zone shall be permitted to be used for residential use, such existing uses and certain properties identified by Appendix "D" [See Appendix 3 for the identified properties]	Halifax Water 24ha (2.9%)	<u>No Risk:</u> Risks presented by Zoning allowances are unlikely to impact this area unless ownership changes.
RA Residential	59.49	Residential Uses; Community Uses	HRM 1.23 ha (0.15%)	<u>Low - Risk:</u> The largest of the 10 land parcels that make up this area is 0.6ha and situated in the community of Lake Major. The other parcels are dispersed between the communities of Lake Loon/Cherry Brook and Lake Major. One parcel (0.1 ha) is situated on Lake Major. These areas present a low risk due to the disparity of the parcels and the sizes of the lots, which are not large enough to develop unless they are serviced.
			Halifax Water 17.6ha (2.1%)	<u>Low - Medium Risk</u> This land surrounds the lower portion of Lake Major along Old German Road and across the water around the dam. These lots have been slowly acquired by Halifax Water as a first line of defense for watershed area protection. Some of these properties are occupied with tenants while maintained by Halifax Water. The risk of impact on these lots decreases as Halifax Water reverts these properties back to land and riparian-only status.
			NSTIR 2.8ha (0.33%)	<u>Low Risk:</u> Currently, this area consists of two lots that are undeveloped. Any increase in risk in these areas will depend on what land-use activity takes place in the future, especially considering there is no wastewater treatment service. There is a stormwater collection system through ditching.

Table 10: Risks Associated with Landownership and Permitted Land-use Activity

			Golf Course 0.47ha (0.0005%)	<u>Low - Medium Risk:</u> The risks associated with the golf course have been addressed. For details on the management of this risk, please refer to section 4.3.3: <i>Recreation: Golfing</i> on page 128.
			Business 0.26 ha (0.00031%)	<u>Low-Medium Risk</u> The business activity of this landowner is unknown but is presumed to be a developer. This parcel is located on the edge of the PWA in the community of Lake Loon/Cherry Brook and is too small to develop inside the PWA unless the area is services and therefore presents a low risk.
			Private Individual Landownership 37.1ha (4.4%)	<u>Low - Medium Risk:</u> Individual landowners are mainly located in the communities of Lake Major along Old German Road, Lake Loon/Cherry Brook, and Montague Gold Mines. The greatest risks posed by these areas are on-site septic systems associated with residential development. However, since most of the lots inside the PWA in the Lake Loon/Cherry Brook and Montague Gold Mines communities are undeveloped, the risks are currently low. When and if development occurs, the risks will need to be reassessed.
			NSTIR 2.8ha (0.33%)	<u>Low – Medium Risk:</u> This area of land is situated outside the Montague Mines community and is currently undeveloped. The area is bordered by roads and housing development. Until the land use changes to a transportation use, this area currently presents little risk to the PWA.
			DNR Negligible amount	<u>No Risk:</u> There are negligible areas owned by DNR and present no risk to the watershed area.
RS (Rural Settlement)	222.69	Residential Uses; Community Uses; Commercial Uses except,	Halifax Water 16.3ha (2%)	<u>Very Low Risk:</u> Development risks unlikely unless ownership changes.

Table 10: Risks Associated with Landownership and Permitted Land-use Activity

		<p>automotive repair outlets and service stations within the Lake Major Watershed; and Resource Uses except Intensive Agricultural Uses within the Lake Major Watershed</p>	<p>Private individual landowners 164.4ha (19.6%)</p>	<p><u>Medium – High Risk:</u> The land parcels in this area are primarily situated in North Preston community and have a mean value of 0.6ha, and present a “medium – high” rather than “high” risk of impacting the PWA due to the wastewater infrastructure that exists in this area. However, runoff from residential land-use activities such as lawn fertilizer use and salvage yards in the area as well as the proximity to Long Lake and tributaries leading to Lake Major present additional risks, ranking this a higher risk to the PWA.</p>
			<p>CMHC 0.61ha (000.7%)</p>	<p><u>Low Risk:</u> This area is associated with four housing lots that are dispersed throughout the sewershed area of the North Preston Community. Depending on the activity that takes place, this area is a low risk to negatively impact the PWA.</p>
			<p>Community Use (Church) 1.34ha (0.16%)</p>	<p><u>Low Risk:</u> This area is at low risk of negatively impacting the watershed area due to its specific use and location; it is situated within the municipal sewershed.</p>
			<p>Business / Industry 1.17 ha (0.14%)</p>	<p><u>Medium – High Risk:</u> This is a salvage collection service industry that is located in the community of North Preston. The risk of the salvaged material contaminating the watershed area is high enough to warrant periodic inspection to ensure that the materials collected are not posing a negative impact to the watershed area.</p>
			<p>Provincial (Ungranted, NSE and DNR) 32.8ha (0.5%)</p>	<p><u>Low Risk:</u> Immediately south and adjacent to the WSRL Protected Wilderness and is owned by the Province as “Ungranted Lands”. The risk presented by the potential land use of these parcels is low considering they are primarily ungranted lands to remain in a natural state.</p>

Table 10: Risks Associated with Landownership and Permitted Land-use Activity

			Community Housing Services (Provincial and NGO) 4.9ha (0.69%)	<u>Medium Risk:</u> These parcels are situated in a densely populated area of the North Preston community in close proximity to Long Lake. They are considered a medium risk to negatively impact the PWA due to the residential nature of the activities that could take place in these areas, the dense nature of the development and the proximity to Long Lake. However these parcels are situated in the sewershed and therefore do not pose a wastewater contamination risk.
			HRM 1.0ha (0.19%)	<u>Very Low Risk:</u> A negligible area is owned by HRM and appears to be guardrails and land that supports the North Preston Community Centre and the community Fire station.
			Financial Institutions 0.25ha (0.0003%)	<u>Very Low Risk:</u> These financial institutions present little risk to the watershed area due to their small size, location within the sewershed and benign business activity.
Planning Districts 14 & 17 (Shubenacadie Lakes) (19)			3576.2 ha* land	
By-law Zone	Zone Area* (ha) in PWA	Allowable Developments	Landownership ha in PWA (% of Plan Area)	Risks Associated with Permitted Activity in By-law Zone
P-3 (Park Zone)	9.73	Park Uses; Conservation uses; Recreation uses; Public and private parks and playgrounds; Campgrounds; Commercial Uses; Restaurants; Guest homes; Inns; Retail outlets; Lodges; Craft shops (MC-Jul 26/93; SCC-Aug 10/93; E-Sep 4/93); Resource Uses; Agricultural uses; Forestry uses.	DNR (3.0%)	<u>Low Risk:</u> Due to Crown ownership, this area is not considered to be at risk.

Table 10: Risks Associated with Landownership and Permitted Land-use Activity

<p>PA (Protected Area)</p>	<p>35.31</p>	<p>Scientific study and education, involving no buildings; Trails, board-walks or walkways; Conservation uses</p> <p>Uses accessory to the foregoing uses</p> <p>Other Requirements: Within any PA zone, no infilling, excavation, alteration of grade or removal of vegetation shall be permitted. The construction of board walks, walkways or trails shall be permitted provided that no infilling or alteration of grade occurs other than the placement of piles or the placement of trails on top of the existing grade.</p>	<p>NSE (0.5%) (1%)</p>	<p><u>No - Very Low Risk:</u> The Waverley-Salmon River Long Lake (WSRLL) Wilderness Area (see page 38) provides an extra layer of protection depending on future activities that are permitted in this area once the Protected Areas Plan is finalized. Low impact recreation would be the only risk to consider.</p>
<p>PWS (Protected Water Supply)</p>	<p>3405.87</p>	<p>Municipal Water Distribution or Purification Facilities; Public Parks; Conservation Uses; Uses Accessory to Foregoing Uses; Single Unit Dwellings</p>	<p>Halifax Water 1130.4ha (31.6%)</p> <p>DNR 442ha (12.4%)</p> <p>NSE 1675.7ha (46.9%)</p>	<p><u>Very Low Risk:</u> Development and associated risks unlikely unless ownership changes.</p> <p><u>Very Low Risk:</u> Development unlikely unless ownership changes. Potential expansion of the WSRLL Protected Wilderness Area further reduces risk. Low impact recreation currently is the only risk to consider.</p> <p><u>No - Very Low Risk:</u> These parcels are located in the Waverley-Salmon River Long Lake (WSRLL) Wilderness Area (see page 38) which provides an extra layer of protection from potential land use activity. Low impact recreation would be the only risk to consider.</p>

Table 10: Risks Associated with Landownership and Permitted Land-use Activity

			<p>Nova Scotia Power 21.3ha (0.6%)</p>	<p><u>Low - Medium Risk:</u> This land parcel is located close to the Waverley area providing potential for future expansion of new transmission lines. Transmission lines require significant maintenance of the vegetation in the area and the potential for herbicide use. Communications with NS Power is important to ensure such activity is not an impact to the watershed area.</p>
			<p>Private Landownership 120.9ha (3.4%)</p>	<p><u>Low - Medium – High Risk:</u> This area incorporates six parcels of land with a mean of 20ha; the largest parcel being 74ha owned by a private individual and situated at the top of Lake Major. Other landowners in this area include developers, contractors and private landowners. Should these landowners decide to develop, this could pose a significant risk if development activity is not considered with respect to the PWA. Currently, no development permit applications have been submitted to the LMWAB for review for these parcels, so the risk to the watershed area remains low. These parcels are illustrated as high risk if developed on Map K on page 117</p>
			<p>Industry (Quarry) 15.1ha (0.4%)</p>	<p><u>Medium Risk:</u> This parcel is the most active portion of the rock and gravel quarry lands. The watershed boundary borders the western edge of the parcel; the eastern edge is bound by a berm. The risk to the water supply and watershed area has been greatly reduced through a conditional agreement reached between Halifax Water and the landowner. Conditions include: constructing a berm to effectively create a new watershed boundary-not to be breached or altered in any way; quarry BMP's including no fuelling practices and no contaminated material/debris inside the watershed area; and annual joint site visits conducted between Quarry staff and Halifax Water. More details are provided in the rock quarry section on page 72.</p>
R-1B (Suburban Residential)	75.88	Residential Uses; Community Uses	<p>Halifax Water 52ha (01.45%)</p>	<p><u>Very Low Risk:</u> Development unlikely unless ownership changes.</p>
			<p>DNR 5.0ha (0.14%)</p>	<p><u>Low Risk:</u> Due to Crown ownership, this area is not considered to be at risk.</p>

Table 10: Risks Associated with Landownership and Permitted Land-use Activity

			Private Landownership 9.0ha (0.26%)	<p><u>Low Risk:</u></p> <p>This area incorporates six parcels of land with a mean of 1.5 ha; the largest parcel being 8.8 ha, owned by a development company and situated at the far western edge of the PWA, outside of the natural watershed area, near Soldier Lake. The remaining parcels are situated on the border of the watershed area. These areas present a low risk to the watershed area due to their location and size and proximity to watercourses. Other landowners in this area include developers, contractors and private landowners. Currently, no development permit applications have been submitted to the LMWAB for review.</p>
			Nova Scotia Power 6.8ha (0.2%)	<p><u>Low - Medium Risk:</u></p> <p>This land parcel straddles the natural watershed boundary close to the Waverley area. This area may provide potential for future expansion of new transmission lines which require significant maintenance of the vegetation in the area and the potential for herbicide use. Communications with NS Power is important to ensure such activity is not an impact to the watershed area.</p>
R-7 (Rural Estate)	49.43	Residential Uses; Community Uses; Resource Uses	Halifax Water 17ha (0.5%)	<p><u>Very Low Risk:</u></p> <p>Development risk potential unlikely unless ownership changes.</p>
			DNR 5ha (0.14%)	<p><u>Very Low Risk:</u></p> <p>Development unlikely unless ownership changes.</p> <p>Potential expansion of the WSRL Protected Wilderness Area further reduces the risk.</p>
			Private Individual Landownership 27.4ha (0.77%)	<p><u>Low – Medium Risk:</u></p> <p>This parcel is owned by a single landowner and straddles the natural watershed boundary near Soldiers Lake and is in the Waverley Game Sanctuary. If developed, this area could pose at least a medium risk to the watershed area, depending on the density of the development. Currently, no development permit application has been submitted to the LMWAB for review so the risk remains low.</p>

*Note: Lake and waterway area amounts are included in the total LUB area but not in the By-law Zone area.

** Lake and waterway area includes roads and other areas without zone classification.

3.1.9 Chemicals

This section identifies and assesses the potential risks associated with chemical use inside the Lake Major watershed. Halifax Water does not support the use of chemicals inside the watershed

area except with respect to the water treatment process, which is strictly monitored and controlled.

General Use

Under section 10 of the *PWA Regulations*, the use of chemical toxins are not permitted within the *PWA*; however, section 8 allows for an exemption of specific pest control products considered low risk if applied in the appropriate manner. Although there are provincial permitting processes and regulations in place to control and monitor the use of biocides or pest control products, the use of any chemical around source water is still considered a risk to the water supply.

For areas beyond the *PWA* boundary, chemical and/or biocide pest control use may be permitted through provincial and/or municipal permit and regulations. Halifax Water encourages all landowners to protect the watershed area and to contact NSE or their municipal office or Halifax Water for more information regarding chemical or pest control product use or where the watershed area boundary is located. To report the use of any chemicals, residents are encouraged to contact Halifax Water at 902-869-4304 or 902-490-6940.

Commercial Use

As per the *Lake Major Regulations*, the use of some pest control chemical products is permitted within the *PWA* with the approval of the Administrator (NSE).

Golf Course

A golf course located inside the watershed area has contacted Halifax Water with regard to chemical use (as outlined under heading section 3.1.3: *Golf Course* on page 73). Some of the chemicals used for golf course maintenance may fall under the *PWA Regulations* and would therefore require exemption for use. Under Section 8 of the *PWA Regulations*, the golf course is required to apply to NSE for permission to use these products.

To monitor the risks associated with the golf course, presented by runoff directed toward the Lake Major watershed, a source water quality monitoring sampling station has been established. Section 5.4.3: *Activity-Based Sampling - Pesticides* on page 162 describes the water sampling parameters collected at this sampling station near the golf course, and *Map K: Lake Major HRWC Services and Development Risk Areas* on page 117 illustrates the sampling site location (LMG7). To date no evidence of chemicals related to golf course maintenance considered restricted have been detected.

Lake Major Water Supply Plant Use

Approximately 20,000 litres of caustic soda is delivered monthly by tractor-trailer to the Lake Major Water Supply Plant via the gated main access road off of Cherry Brook Road. Other chemicals such as aluminum sulphate and hydrofluosilicic acid are delivered in bulk on a less frequent basis. These chemicals are used in the water treatment process. Diesel fuel for the emergency generators is also delivered as required.

The risk to the watershed area from these products being spilled due to a collision is low considering the road to the water supply plant is isolated and contained within security fencing. There are security cameras at each end of the water supply plant access road to provide a means of visually monitoring the roadways for trespassers, and in an emergency where those involved are unable to call for help.

Nova Scotia Power

Nova Scotia Power has a number of main transmission lines that run through the watershed area. Through consultation with Halifax Water, NSP has elected not to use chemical treatment on these areas. In the event that NSP decides to change this practice, they would have to contact NSE to apply for an exemption and consult the LMWAB to demonstrate the need to use chemicals inside the watershed area and provide a management plan.

Forest Fire Fighting

In the event of a forest fire and as a very last resort, DNR has identified with Halifax Water the type of chemical that would be used; Silv-Ex and/or FIRE-TROL Fire Foam 104. The material safety data sheets (MSDS) indicate that the application of these products poses little risk of environmental impact as they are readily biodegradable and exhibit little to no biotic toxicity when used according to the manufacturer's recommendations. In the event of fire in the watershed area, the benefits outweigh the risks to water quality if fire suppression chemicals are not used. Halifax Water and DNR have established in writing that DNR will be responsible for conducting a follow-up water quality assessment if either of these chemicals is used to fight a fire inside the watershed area.

In the event of a fire emergency, the *Emergency Response Plan for Halifax Water* will be followed, and target-based water quality sampling will be conducted accordingly (see section 5.4.4: *Target-Based Sampling* on page 164). Emergency Plan copies are found at the Lake Major WSP or the main office located at 450 Cowie Hill Road in Halifax.

PWA Potential Use Beyond Halifax Water Control

Approximately 164.9ha (2.4%) of the Lake Major watershed is located outside the PWA where chemical and/or biocide pest control use may be permitted through provincial and/or municipal permit and regulations. Of particular concern is 4-6ha of land located within the Lake Major watershed, and just outside of the PWA, managed by the golf course. Although the area is small in relation to the watershed area, the use of any chemical or biocide pest control within the watershed area still presents a risk to water quality (see section 3.1.3: *Pesticide and Fungicide Applications* on page 73). The drainage point for this area is monitored through the Source Water Quality Monitoring Program at sample point LMG7 for precautionary measures for pesticide use and potential run-off into the watershed area, as outlined in section 5.4.3: *Activity-Based Sampling* on page 160 and illustrated on *Map K: Lake Major HRWC Services and Development Risk Areas* on page 117. To date no evidence of restricted chemicals have been detected.

3.2 Critical Infrastructure Threats and Hazards

This section identifies and assesses the risks to the Lake Major watershed as critical infrastructure. Water is considered to be “critical infrastructure” by Public Safety Canada which is defined as “processes, systems, facilities, technologies, networks, assets and services essential to the health, safety, security or economic well-being of Canadians and the effective functioning of government. . . . Disruptions of critical infrastructure could result in catastrophic loss of life and adverse economic effects.”³⁰

3.2.1 Critical Infrastructure Threats and Hazards

According to Public Safety Canada, the risks to critical infrastructure, which include accidental, natural and intentional hazards (also referred to as threats), are increasingly complex and frequent. Although the list of hazards and threats is never complete, the Public Safety Canada’s Risk Management Guide for Critical Infrastructure Sectors has created a list of common threats and hazards that could affect critical infrastructure (found in that document’s Appendix B: List of Hazards and Threats). There is no single way to assess the risks presented by hazards and threats; the methods and best practices to assess risks continually evolve.

No matter what technique is used to assess the risks, lessons learned and recommendations for improvement need to be captured to keep abreast of the progression of threats to the water supply as they evolve.

The four factors that have been identified as contributing to Canada's vulnerability to a broad spectrum of threats on critical infrastructure such as a municipal water supply utility are:

1. population, built environment, and wealth, which are increasingly concentrated in a small number of highly vulnerable areas so that such communities are at risk from multiple hazards;
2. climate change, which may increase the frequency and severity of extreme weather events;
3. infrastructure that is aging and is more susceptible to damage; and
4. communities that are increasingly more reliant on advanced technologies and are frequently disrupted during disasters.”³¹

The common threats and hazards that have been considered in this document as having the potential to have the greatest impact to the Lake Major source water supply system are listed in

³⁰ National Strategy for Critical Infrastructure, Public Safety Canada Her Majesty the Queen in Right of Canada, 2009. ISBN: 978-1-100-11248-0; p. 2. Website sources: <http://www.publicsafety.gc.ca/cnt/rsrscs/pblctns/srtg-crtcl-nfrstrctr/srtg-crtcl-nfrstrctr-eng.pdf> .

³¹ Public Safety Canada: Risk Management Guide for Critical Infrastructure Sectors. Website source: <http://www.publicsafety.gc.ca/cnt/rsrscs/pblctns/rsk-mngmnt-gd/rsk-mngmnt-gd-eng.pdf> p. 37.

Table 11: Summary of Existing and Potential Risk Activities on page 112 and described in detail in the corresponding following sections.

Accidental Emergencies

Responsibility for emergency measures, including the protection of critical infrastructure (CIP) in Canada is shared among all three levels of government. The federal government provides national leadership and coordinates the overall CIP effort. The federal government lead agencies include the Office of Critical Infrastructure Protection and Emergency Preparedness (OCIPEP) agencies which include but are not limited to Health Canada, Transport Canada, RCMP, Natural Resources Canada, and the Canadian Security Intelligence Service (CSIS). The lead agency in Nova Scotia is the Nova Scotia Emergency Management Office.

In the event of an emergency, the *Emergency Response Plan for Halifax Water* must be followed, which is modelled after the Incident Command System (ICS); a nationally recognized emergency command system that assigns roles and responsibilities for the implementation of a plan following an emergency (see section 4.4.1: *Critical Infrastructure Management of Security Threats and Hazards Management* on page 135) for more details). The following potential emergencies are considered to present the greatest risks to the water quality of the Lake Major watershed, in terms of impact.

Accidental Fire

There is substantial potential for accidental fire from various sources including residences, forests, commercial businesses/industry, salvage yards, stockpiled tires, and other anthropogenic activities such as recreational pursuits that are permitted inside the watershed area. Such activities pose a medium-high risk to the watershed area. In the event of a fire, emergencies are addressed through 911 services, Halifax Water Emergency preparedness documents contained in Halifax Water's *Emergency Response Plan for Halifax Water* and BMPs, Nova Scotia Emergency Measures Organization and, in the event of forest fire, provincial Forest Fire Prevention policy. Specific fire emergencies (e.g. forest) and their risks are described under the applicable sections.

Aircraft Disaster

The Halifax region's airspace is used by multiple users including domestic and international flights arriving to and departing from the Halifax Stanfield International Airport, Canadian Armed Forces who are training at Canadian Forces Base Shearwater, and helicopter, non-scheduled tourism and non-commercial flights. All things considered, having busy air-space in the vicinity of the Lake Major watershed area presents a low-extreme risk.

If an aircraft lands in the watershed area, there is risk for water quality impairment associated with the potential for fire and the chemicals to arrest the fire, fuel leakage, and intrusion of sediments and debris into waterways. Depending on the severity of an aircraft disaster within the Lake Major watershed area, the result could be long term damage to the water supply— an extreme risk. However, the likelihood of such an event is very low, hence the low risk potential consideration.

Chemical and Oil spills

There is substantial potential for chemical and oil contamination through accidental spills from various sources including vehicle road traffic, residences, industrial operations, commercial, salvage yards, and anthropogenic activities such as recreational pursuits that are permitted inside the watershed area. Such activities pose a medium-high risk to the watershed area. In the event of a spill, emergencies are addressed through 911 services, Halifax Water Emergency preparedness documents contained in Halifax Water's *Emergency Response Plan for Halifax Water* and BMPs, and Nova Scotia Emergency Measures Organization.

Natural Events and Disasters

Natural events and disasters are unpredictable and can have long-term negative effects on source water quality. The key natural factors to consider when developing a Source Water Protection Plan for the Lake Major watershed include wind and flooding, fire, drought, natural biological outbreaks and infestations and climate change impacts. Natural events and disasters are hard to predict; however, in order to respond effectively, Halifax Water prepares its staff and facilities through company policy and management plans, and Emergency Response and Preparedness Plans.

Wind and Flooding

Wind and rain storm events resulting from tropical storms, surges and hurricanes are a significant threat in Nova Scotia, and put water quality and public health at risk. Such events cause: flooding, which puts drinking water supplies at risk by way of microbial cross contamination; power outages, which threaten to disrupt water supply plants; and blow down of massive forested areas that lead to short and long-term water quality impacts such as soil erosion and sedimentation, increased colour, suspended solids and organic matter levels.

According to Public Safety Canada, floods are the most frequent natural hazard in Canada. They can occur at any time of the year and are most often caused by heavy rainfall, rapid melting of a thick snow pack, ice jams, or more rarely, the failure of a natural or man-made dam, of which there are two within the Lake Major watershed (see *Map K: Lake Major HRWC Services and Development Risk Areas* on page 117).

In September 2003 Hurricane Juan levelled thousands of acres of forested land including hundreds of acres inside the Lake Major watershed. Since Hurricane Juan, water quality is slow to return to that of pre-Juan conditions. Decaying woody debris and sediment run-off from overturned trees impact raw water quality, particularly colour, total suspended solids and total organic carbon levels which cause unwanted levels of disinfectant by-product to be released back into the water supply through the water treatment process.

Wildland Fire

Generally, wildland fires in Nova Scotia have become less of a risk due to: public awareness and education; a successful Provincial Fire Fighting Program; and Forest Management Practices. However, areas in close proximity to residential or urban development (interface zone) are still considered at high risk.

Evidence of past forest fires can be found throughout the watershed area although none were of significant stature. Prior to the 1970's, before the City of Dartmouth purchased the former Ernst Family sawmill and forest holdings, the watershed area was actively managed as a wood supply for the sawmill and other markets. From the mid 1970's the Lake Major watershed was virtually untouched until Hurricane Juan in 2003; in less than two hours 7% of the forested watershed area was blown down. At the same time, the watershed area was under the Brown Spruce Longhorn Beetle (BSLB) quarantine which prevented the blown down and damaged trees to be cleaned up in a timely and effective manner. The watershed area remained in a blow-down state until 2007 when the quarantine zone was expanded to include processing facilities. In 2004 and 2006 independent fire hazard assessment reports were completed which indicated the blown down areas were a high-extreme fire hazard risk especially near the human-forest interface zone. As a result, in 2007 Halifax Water developed a forest management plan (fuel reduction plan) around cleaning up the most severely damaged areas which included most of the interface areas around the Lake Major Water Supply Plant and residential buildings. Despite Halifax Water's best efforts, a small man-made forest fire occurred in an area where the decaying wood had not been salvaged, located in a residential interface zone near the water supply plant. The fire was quickly extinguished.

Significant wind damaged areas inside the watershed area still remain a forest fire risk; however, due to the small size, scattered nature and remoteness of the damaged areas, which are difficult to access without building roads, they will be left alone rather than risking further damage to the watershed area to gain access to clean up these areas.

Drought

According to Environment Canada, Atlantic Canada may be more susceptible to drought impacts than in areas where drought is more prevalent; where drought occurs less frequent there tends to be a lower adaptive capacity. The risk of drought in the Lake Major watershed area is low now, but as the climate continues to change risks associated with drought could rise.

Natural Biological

Natural biological outbreaks can affect the health of the watershed area and water supply which ultimately put humans, animals, and plants at risk. Natural biological risks which need to be considered for the Lake Major watershed and its water supply include insect infestation and water and air borne diseases.

With respect to watershed health, insect and disease outbreak is a real concern. Much of the forested watershed area that survived Hurricane Juan remains in a weekend state as it is in the mature to over mature age class. These conditions favour insect infestation and disease outbreaks which if not managed properly could lead to widespread deterioration of the remaining watershed area and further degradation of water quality.

Climate Change

Climate change is a global problem that threatens to impact water quality chemistry. The risk is difficult to assess due to the high number of factors to consider; however Halifax Water has recently begun sampling to better understand and monitor some of these risks.

Sulphur Dioxide (SO₂), an emission released into the air through the industrial manufacturing process, is known to chemically react with water and air to form sulphuric acid which then falls in the form of acid rain negatively impacting water quality, namely pH. At the same time through atmospheric deposition SO₂ positively contributes to sulphate level in water bodies, further impacting water quality. Therefore sulphate is typically used as an indicator of the level of acid rain.

In 2016, Halifax Water began sampling sulphate levels, in parallel with other parameters; to better understand the impact industrial emissions are having on its raw water quality, see section: *5.4.1 Total Sulphate* on page 155. This will help Halifax Water predict where its water quality is headed and how to prepare the water treatment plant for those changes.

Intentional / Deliberate Threats

An intentional or deliberate threat involves an attack or a deliberate act for the purpose of doing damage that involves malicious intentional threats on national security such as chemical, physical, cyber or biological attacks; sabotage, crimes, social unrest, strike or labour disruption; or non-malicious intentional actions such as a border closure or regulation change that can affect critical infrastructure.³² The different types of possible intentional/deliberate threats and their risks on the Lake Major source water supply are described under the next two headings.

Malicious Intent

Halifax was founded by the British Government due to its strategic location, initially for trade and later for military purposes as it is today. Consequently, the risk of malicious intent such as chemical, physical, cyber or biological attacks; sabotage, crimes, social unrest, strike or labour disruption, to any of our large water supply systems, therefore Lake Major, is considered high.

Non-malicious Intent

The risk of non-malicious intent to Lake Major watershed is much less than that of a non-protected water supply; however Halifax Water has pursued land purchases within the Lake Major watershed which provides another level of protection beyond the *Lake Major Watershed Protected Water Area Regulations*.

³² Public Safety Canada. Risk Management Guide for Critical Infrastructure Sectors. p. 36. Web-accessed May 14, 2015 at: <http://www.publicsafety.gc.ca/cnt/rsrscs/pblctns/rsk-mngmnt-gd/rsk-mngmnt-gd-eng.pdf>.

3.3 Risk Activities Summary

The following *Table 11: Summary of Existing and Potential Risk Activities* on page 112 provides a summary of the existing and potential risk activities that have been identified as risks in the Lake Major watershed.

Table 11: Summary of Existing and Potential Risk Activities				
INHERENT RISK FACTORS				
Activity	Potential Contaminant	Point Source	Non-Point Source	Potential Impact
Forestry Operations: Harvesting, silviculture, road maintenance and construction.	Petroleum Hydrocarbons and fluids	X		Oil, fuel or hydraulic spill would likely be limited to immediate area because there are usually limited quantities of these fluids, unless there was direct discharge to nearby water course.
	Sedimentation	X		Sedimentation of streams may occur through poor harvesting practices or culvert and bridge failure. BMPs assist in mitigating impacts from harvest practices, and road construction and maintenance.
Mining and rock quarry operations	Petroleum Hydrocarbons and fluids	X		Oil, fuel or hydraulic spill would likely be limited to immediate area because there are usually limited quantities of these fluids, unless there was direct discharge to nearby water course.
	Sedimentation	X		Removal of vegetative cover for quarrying purposes increase risk of sedimentation of water supply
	Heavy metals	X		Increased risk of release of heavy metals into the water supply from exposed bedrock to acid rain and/or processing
Recreation: motorized boating, OHV's, pedestrian activities	Petroleum Hydrocarbons and fluids		X	Fuel in streams and lakes
	Sedimentation		X	Shore line action and bank erosion leads to sedimentation of water supply or tributaries.
	Garbage		X	Pedestrian activity is light impact and sometimes results in garbage being left behind.
Public roads and highways	Petroleum Hydrocarbons and fluids	X		Potential spill into nearby water supply, namely Long Lake which may eventual shutdown of plant.
	Chemical contamination including chemical spills and road salt / de-icing agents.	X		Short and long term effect on water supply depending on concentration and location.
Lake Major Water Supply Plant System	WSP: failure of water treatment system could result in higher levels of chlorine, aluminum, pH and suspended solids being released directly into the water supply.	X		Immediate shutdown of supply plant if there is a direct spill into source water because it is in very close proximity of the intake (<100m).

Table 11: Summary of Existing and Potential Risk Activities				
	Pump station: Petroleum Hydrocarbons and fluids.	X		
Wastewater Treatment Infrastructure	Untreated wastewater overflowing into water supply from pump stations	X		Increase in heterotrophic plate and coliform counts.
HRM Regional Plan guiding policy designating permissible land use planning and development activity compounded by landowner type.	Automotive Fluids and petroleum products; sedimentation due to soil exposure; bedrock - acid (pyritic) slate – exposure promoting ARD; commercial and residential chemicals/fertilizers; nutrients and bacteria from sewage system failures; and petroleum products from fuel spills.		X	Increased sedimentation through stormwater runoff and turbidity; ARD lowering pH of water and causing fish kills; chemical run off from vehicular fluids; eutrophication of water bodies; hydrocarbon contamination from fuel storage and motorized vehicles; fecal bacteria and nutrient contaminants from sewage treatment infrastructure breaks and overflow escaping into water source.
Chemicals	General use of chemicals permitted through provincial and/or municipal legislation.	X		The risk of using any chemical and/or biocide pest control products depends on its properties and reaction with the surrounding environment.
CRITICAL INFRASTRUCTURE RISK FACTORS				
Activity	Potential Contaminant	Point Source	Non-Point Source	Potential Impact
Accidental Emergencies				
Accidental Fire	Contaminated water run-off from burnt materials, potentially containing hazardous chemicals, organic matter and sedimentation	X		Short and long-term impact on water quantity and quality depending on severity.
Aircraft disaster	Aircraft and debris from crash into water supply	X		Total shutdown of WSP and long-term damage to the water supply.
Chemical and Oil Spills	Fuel, Fungicides, insecticides, herbicides, and other biocides; diesel	X		Total shutdown of WSP and long-term damage to the water supply.
		X		Short and long-term impact on water quantity and quality depending on severity;
Natural Events & Disasters				
Wind and floods resulting from tropical storms, surges and hurricanes	Microbial cross contamination from flooding and storm surges; disruption of water treatment from power outages; soil erosion and sedimentation from tree blow down.	X		Short or long-term impact on water quantity and quality depending on severity of event, which could lead to shut-down of BoMont WSP. Such events could lead to increased levels of colour, turbidity, bacteria, suspended solids and organic matter.
Wildland Fire	Water run-off from burnt materials that potentially contain hazardous chemicals; nutrient loading caused by organic matter;	X		Short or long-term impact on water quantity and quality depending on fire severity. Such events may lead to increased levels of colour, turbidity, bacteria, suspended solids, organic matter

Table 11: Summary of Existing and Potential Risk Activities				
	and soil erosion and sedimentation.			nutrients and possible chemical contamination.
Drought	Promotes growth and concentrations of microorganisms; and increased concentrations of non-microorganism contaminants.	X		Short or long-term impact on water quantity and quality depending on extent of drought and demand on water supplies.
Climate Change	Difficult to assess and determine due to varied and multifaceted considerations.	X		Dependent upon rate and severity of extreme weather events, although impacts would be consistent with those already described throughout Chapter 3.
Intentional Events				
Malicious intent: Terrorism, Vandalism, or Sabotage; crimes, social unrest, strike or labour disruption	Difficult to assess and determine due to varied and multifaceted considerations. Priority consideration of contaminants includes chemical, physical, cyber or biological materials.	X		Catastrophic loss of life, adverse economic effects, and significant harm to public confidence creating partial or total shutdown of WSP and long or short-term damage to the water supply.
Non-malicious Intent	Difficult to assess and determine due to varied and multifaceted considerations.	X		Regulation or by-law change initiated by the municipal or provincial government which creates negative impact(s) to the protection of the source water supply due to inability to provide maximum protection to the water supply.

3.4 Risk Activities Prioritized

The scale and ranking of the known and potential activities within the watershed area are described in *Table 12: Scale of and Priority Ranking of Existing and Potential Risk Activities* below. Issues of priority concern are contamination of spills at pumping station, hydrocarbon spills associated with roads, auto salvage yards, residential fuel tanks, forest harvesting activities, motorized boating, off-highway vehicles and other recreational activity, and development of residential and commercial areas. Issues of lesser priority are also ranked in the *Table 12* below:

Table 12: Scale of and Priority Ranking of Existing and Potential Risk Activities			
Activity	Contamination Issue	Scale of problem*	Priority rank**
Forestry Operations: Harvesting, silviculture, road maintenance and construction	Petroleum Hydrocarbons and fluids	5	3
	Sedimentation	5	3
Mining and rock quarry operations	Petroleum Hydrocarbons and fluids	5	3
	Sedimentation	5	3
	Heavy metals	5	3
	Watercourse/ wetland alteration	2	2

Recreation: OHVs, anthropogenic activities, boating	Petroleum Hydrocarbons and fluids	4	2
	Sedimentation	4	2
	Garbage	5	5
Public roads and highways	Petroleum Hydrocarbons and fluids	3	1
	Chemical contamination including chemical spills and road salt / de-icing agents.	4	3
Lake Major Water Supply Plant System	WSP: failure of water treatment system which could result in higher levels of chlorine, aluminum pH and suspended solids washed directly into the water supply. Pump station: Diesel, lube oil, discharge from transformer(s), transformers, untreated back wash water discharge	5	2
Wastewater pump station	Untreated waste entering water supply from pump stations.	3	4
Residential areas	Septic field failure	5	3
	Furnace oil tank failure	4	2
	Exposed mineral soil/ Acid Rock Drainage	3	1
	Chemicals	5	1
	Automotive waste and spills	3	3
Chemicals:	Forestry	5	2
	NSP	5	3
	Golf Course	4	2
	Halifax Water WSP/ Pump station	5	2
	Residential	4	1
Accidental Emergencies			
Accidental Fire	Contaminated water run-off from burnt materials, potentially containing hazardous chemicals, organic matter and sedimentation, change in water chemistry	2	1
Aircraft Disaster	Aircraft fluids and debris	5	3
Chemical and Oil Spills	Fuel, Fungicides, insecticides, herbicides, and other biocides	5	2
Natural events and disasters			
Wind and flood	Microbial cross contamination	4	1
	Soil erosion and sedimentation	3	2
Wildland Fire	Petroleum hydrocarbons/ liquids	3	1
	Hazardous chemicals	3	1
	Nutrient loading	3	1
	Soil erosion and sedimentation	3	1
Drought	Ideal conditions for microbial and pathogen growth	3	1
	Soil erosion and sedimentation	3	1
	Nutrient loading	3	1
	Increased metal concentrations	3	1
	Increased demand on water supply (secondary objective – water quantity)	3	1
Natural biological	Water and airborne biological outbreak	3	1
	Water quality degradation and ecosystem disruption	3	1
Climate Change	Water quality degradation and ecosystem disruption	4	1
Intentional Threats			
Malicious intent	Hazardous materials	4	2

Terrorism,	Hazardous materials	4	2
National Security	Hazardous materials	4	2

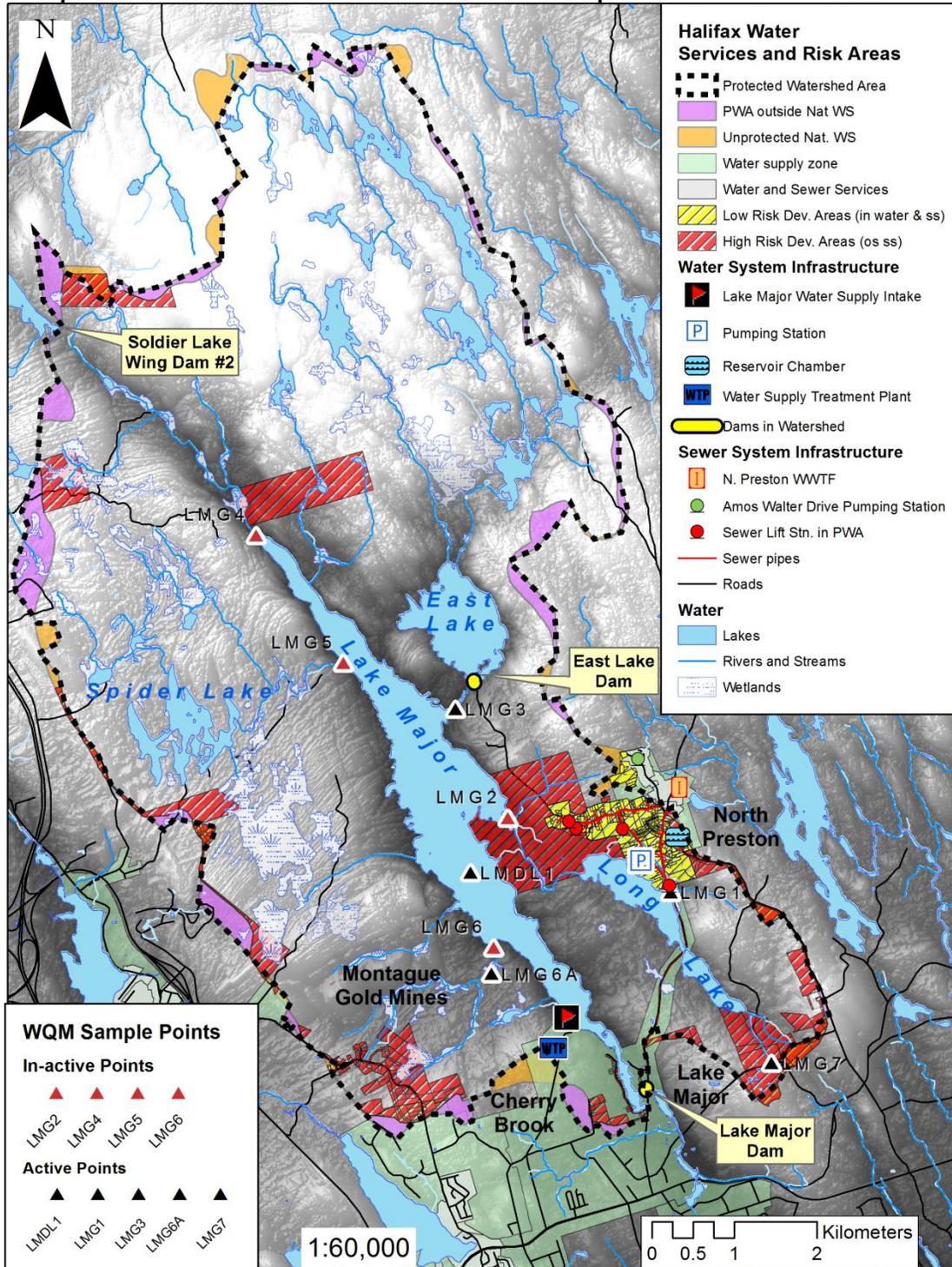
*Scale of Problem rank: 1=severe, 3=moderate, 5=minimal

**Priority rank: 1=high, 3=moderate, 5=low

MAP K: LAKE MAJOR HRWC SERVICES AND DEVELOPMENT RISK AREAS

Lake Major Watershed PWA SWPP 2016

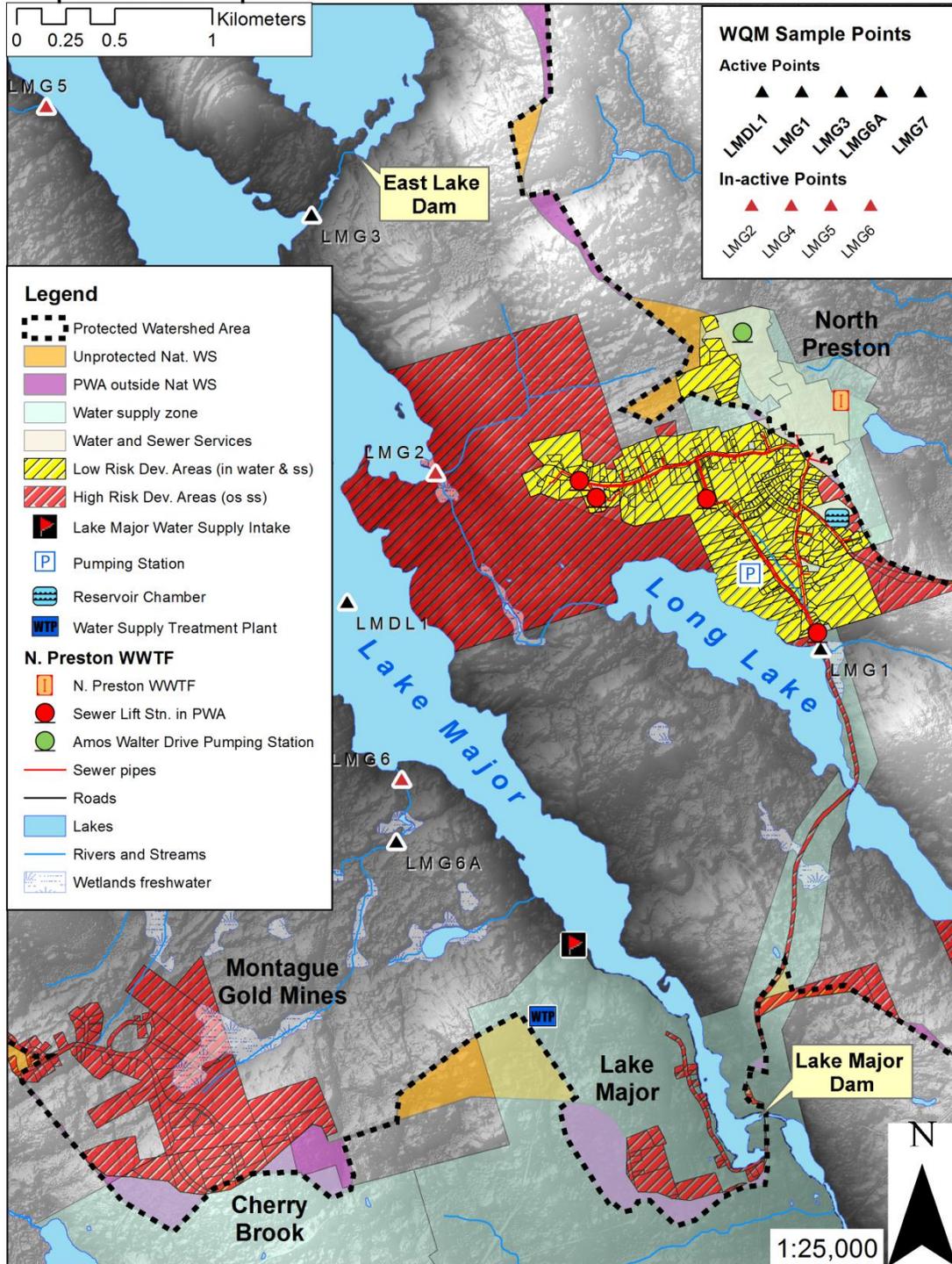
Map K: HRWC Services and Development Risk Areas



* This map is for informational purposes only and should not be used for legal, engineering, or surveying purposes.

MAP L: DEVELOPMENT RISK AREAS IN COMMUNITIES

Lake Major Watershed PWA SWPP 2016 Map L: Development Risk Areas in Communities



* This map is for informational purposes only and should not be used for legal, engineering, or surveying purposes.

4. MANAGEMENT PLAN

This section describes the management aspect of the Source Water Protection Plan (SWPP) which addresses the risks and issues identified in *Chapter 3: Risk Identification and Assessment* on page 68. The primary goal of the management plan is source water protection, implemented through a multi-barrier approach that ensures the source water is clean and safe for consumption, and that the mechanisms are in place to prove it is safe, as directed by the Nova Scotia Department of Environment's Drinking Water Strategy for Nova Scotia. Descriptions of the components of the implementation strategy and the contingency measures in place follow.

4.1 Background

Stakeholder collaboration and cooperation provide the means to evaluate the risks to water quality and help contribute to the development of methods that overcome the obstacles to ensuring clean, safe potable water is provided for Halifax Water clients.

Consistent and sustained communication between those who have a responsibility to ensure clean, safe water is paramount. Meetings between Halifax Water, NSE, and HRM help to achieve this goal.

Progress of the Lake Major SWPP is reported annually to NSE as part of the Annual Drinking Water Quality Report. The report is used to measure the successes of the Lake Major SWPP and make adjustments where necessary. A major review is conducted when a significant change is required or on a 7-year review schedule, whichever comes first.

4.2 Implementation Strategy

To ensure a safe water supply is being delivered to Halifax Water customers, Halifax Water uses the multi-barrier approach that involves a system of checks and balances. Source water protection is the first in a series of source water quality management steps used in the multiple-barrier approach. Designating the watershed as a PWA has laid the groundwork for source water protection planning. Guided by the Lake Major Watershed Advisory Board, Halifax Water has developed programs around set objectives for implementing the SWPP including:

- Land acquisition programs;
- Best Management Practices;
- Public communication, education and awareness programs;
- Fostering water supply area protection through stakeholder collaboration and cooperation on a watershed advisory committee;
- Regulation and land-use by-law adherence;
- Public Roads and Highway maintenance collaboration;
- Controlled access and boundary maintenance;
- Enforcement;
- Adherence to supply plant and pumping station maintenance schedules;

- Chemical use management plans;
- Emergency measures; and
- Source Water Quality Monitoring.

Source water protection implementation timelines have been developed by Halifax Water and are included with this SWPP as an addendum. Halifax Water will inform NSE if changes to those timelines are required.

4.2.1 Land Acquisition Program

Early acquisition of key watershed lands has laid the foundation for effective source water protection planning for the Lake Major watershed. By successfully purchasing watershed lands, Halifax Water has been able to reduce the risk of development within the Lake Major watershed, especially along Lake Major. Halifax Water is closely monitoring a few remaining high priority properties in anticipation of acquiring them (see *Map K: Lake Major HRWC Services and Development Risk Areas* on page 118). **Halifax Water’s strategy is to continue to investigate and purchase watershed lands, as long as necessary, to provide the highest water quality protection possible.**

4.2.2 Best Management Practices

Halifax Water manages activities on Company and Crown lands within the Lake Major watershed with respect to provincial regulations and Best Management Practices (BMPs) focused around water quality. In 2001, Halifax Water developed and implemented separate watershed area BMPs to aid in forest management in the Pockwock and Lake Major Protected Watershed Areas, which proved to positively influence the way forestry activities were conducted on watershed lands. In 2009, Halifax Water identified the need to expand and improve the existing BMPs by developing a single working document to reach beyond forest management. In 2010, Halifax Water developed BMPs to include aggregate removal, recreation, heavy equipment, and various other activities that impact water quality in source water areas.

The latest version of Halifax Water’s BMPs was approved and immediately implemented with support from Forest Industry (Elmsdale Lumber Company), DNR, NSE, the Lake Major Watershed Advisory Board, the Bennery Lake Watershed Management Committee, and the Pockwock Watershed Management Committee. They are available online at www.halifax.ca/hrwc/documents/2010ApprovedBMPs.pdf.

The BMPs are not intended to replace existing legislation; they are to enhance watershed protection practices on watershed lands. Staff and contractors practicing on Halifax Water and Crown-managed lands are required to be aware of and to follow the BMPs, the legislation and the Standard Operating Procedures (SOPs) before work can begin.

On other watershed lands they are to be used as an educational tool and guiding document for activities which may pose a risk to the watershed area. Halifax Water will make available and promote its BMPs via public communication and awareness efforts, which are outlined in the next section.

4.2.3 Public Communication, Education and Awareness

Public communication, education and awareness are key components in Halifax Water's source water protection strategy. Currently, Halifax Water's communication and awareness program includes:

- posting information and regulatory signage;
- conducting and/or supporting educational programming;
- developing source water protection publications (e.g., newsletters, public notifications and reports);
- publishing information on Halifax Water's website; and
- placing advertisements in periodicals.

The objectives of communicating information about the watershed area are:

- to inform users of the location of the watershed area boundaries;
- to outline the potential impacts of detrimental activities on the water supply; and
- to promote what measures are required to avoid such occurrences.

Public outreach will be continuously developed to encourage cooperation between Halifax Water, customers and stakeholders to ensure quality drinking water.

Signs

Currently, signs that define restricted activities and provide contact information are posted along the defined boundary, along frequently used trails and at main entry points to the watershed area. Signs are upgraded on an as-needed basis.

Educational Programming

Halifax Water is supportive of the development of watershed area protection education programming by non-government organizations such as Clean Nova Scotia (CNS) and the Discovery Centre. These agencies deliver water education programs to elementary, junior and senior high school students in accordance with the curriculum. Other educational program development activities involve supporting community groups and associations in their efforts to conduct community clean-ups, open houses, surveys, and to develop publications that serve to educate residents about how to protect the water quality of surface water supplies in the community. Spin-off benefits to supporting such programs come through the leveraging of watershed area education and awareness to other groups and agencies that are exposed to the programs that Halifax Water supports.

Discovery Centre

The Discovery Centre has solicited Halifax Water for program development support of the Water Gallery exhibit in their new science centre project. The new Water Gallery exhibit will explore:

the properties of water; demonstrate the importance of sustainable consumption and returning water to nature as it was taken; encourage conservation through instilling a sense of pride in Nova Scotia's water resources; and will relate to other areas of the centre, i.e.; Energy.

Publications

Publishing newsletters and advertising in local newspapers, outdoor magazines and in the provincial fishing manual are other tools that Halifax Water uses to promote awareness of the water supply area and communicate protection techniques to the broader community.

Lake Major Newsletter

Halifax Water's publishes a *Lake Major Newsletter* aimed at the Lake Major watershed area residents. The newsletter is published twice a year, winter and summer edition, to inform residents of activities within the watershed and to educate them on source water protection. Features of the newsletter also include a profile of a member of the Lake Major Watershed Advisory Board or community member who has made a significant contribution toward water protection and Lake Major community news. The first issue was published in summer 2007. Past issues of the newsletter may be accessed at www.halifax.ca/hrwc/Publications.html.

Website

Halifax Water maintains and regularly updates its website www.halifaxwater.ca to provide public notifications and important information on source water protection.

4.2.4 Watershed Advisory Board

The Lake Major Watershed Advisory Board (LMWAB) meets as per its Terms of Reference (ToR): twice per year, usually in the spring and fall, to provide input to Halifax Water on the management of the watershed area and activities that may impair the source water supply and applicable MPS' and Land-use By-laws. These meetings will continue to occur.

In addition to the regulatory provisions of the HRM By-laws, an HRM Planning Services representative sits on the LMWAB, who can advise the Board of LUB regulations, and will advise HRM staff to consult with Halifax Water when applicable plans are submitted for approval.

As per the ToR, Halifax Water prepares an annual spring report for the Committee for review.

4.2.5 Regulations and Land-use By-laws

To overcome the challenges associated with HRM Planning by-laws and reporting requirements due to inconsistencies between each LUB region and/or the PWA regulations, Halifax Water continually explores opportunities to strengthen or create new provincial legislation and local by-laws to enhance the protection of HRM's drinking water supply areas.

To this end, Halifax Water has presented recommendations in relation to the fourth bullet below through the HRM Regional Municipal Planning Strategy review process and will further make the following recommendations to HRM planning staff:

- ensure developers are aware of the PWA regulations associated with watershed area;
- recognize the Watershed Advisory Board or Halifax Water as an authority to review and provide comment on all development applications within the watershed area;
- ensure all building permits within the watershed area have an attached copy of the *Lake Major Watershed Protected Water Area Regulations*; and
- ensure all building permits are copied to Halifax Water and reviewed by the LMWAB as per the Cole Harbour MPS and NP-LM Land-use By-laws (see section 2.4.3: *CH/W Municipal Planning Strategy* on page 48 and *NP-LM Land-use By-Laws* on page 54).

A number of small areas amounting to approximately 2.4% of the natural watershed area fall outside of the designated PWA. Nevertheless, Halifax Water has requested that those areas also be included in the review process as they potentially have a direct impact on the water supplies. Although some risks may be small due to the type of activity or the size of the land area, any risk to the water supply should be effectively diverted through the involvement of HRM planning staff and good communication between HRM and Halifax Water staff.

Through the LMWAB, Halifax Water continues to work closely with Halifax Water and HRM community development staff to review applicable SOPs, by-laws and possible developments related to any relevant source water areas.

4.2.6 Public Roads and Highways

HRM maintains half (approximately 10 km) of the roadways in the watershed area, while the Nova Scotia Department of Transportation and Infrastructure Renewal (NSTIR) maintains 1.7km of roadway within the watershed area that includes sections of Crane Hill and Upper Governor Roads. The remaining 8.2km are categorized as private roadways, including most of Simmonds Road, about half of the roads in the community of North Preston and a small section of Wynder Road. Most of the private roadways are maintained by HRM in the winter months.

Halifax Water maintains open communication with HRM and NSTIR staff and provides updated contact lists as required. Lake Major Road presents a moderate to high risk level of concern on water sources due to the proximity of Long Lake and given the potential for contamination through road maintenance and in the event of traffic accident spills.

To establish a baseline and monitor the potential effects of these roads on water quality, Halifax Water has established source water sampling locations to monitor road effects as described in section 5.4.3: *Activity-Based Sampling - Total Chloride* on page 163 and in the next subsection below on road de-icing.

In the event of a spill along any of the roadways within the watershed area, the *Emergency Response Plan for Halifax Water* will be followed. A copy of the Plan can be found at the Lake Major Water Supply Plant or the main office located at 450 Cowie Hill Road in Halifax.

Road De-icing

Through the compliance program, Halifax Water monitors raw water total chloride concentrations at the water supply plants twice per year and in its treated water four times per

year. Additionally, Halifax Water collects monthly total chloride samples through its Source Water Quality Monitoring Program from November to April of each year at locations associated with winter road maintenance activities; i.e., LMG1, LMG6 and LMG 7 (see section 5.4.3: *Activity-Based Sampling - Total Chloride* on page 163 and on page 118).

To develop a better understanding of road de-icing practices a meeting was held between NSTIR, HRM and Halifax Water in 2013. At that meeting, Halifax Water shared its Lake Major water quality data with NSTIR and HRM which indicated chloride levels were within the recommended long and short term toxicity levels outlined in the CCME guidelines for the Protection of Aquatic Invertebrates. In turn HRM and NSTIR staff shared the information with its Public Works department to improve winter road maintenance practices in Halifax Water drinking water supply areas in hopes of avoiding increased levels of chloride through winter road maintenance best management practices.

Regarding NSTIR's required use of the road salt anti-caking agent, sodium ferrocyanide, NSTIR provided Halifax Water with the Material Safety Data Sheet (MSDS) for sodium ferrocyanide. Although the potential health effects on humans for handling the product are relatively minor, there is concern about the use of ferrocyanide salts in formulations of road salts, given that, in solution, they can photolyse to yield free cyanide ions, which are highly toxic to aquatic organisms. As a result of the meeting, Halifax Water is considering adding ferrocyanide to its Source Water Quality Monitoring program to establish a baseline and assess whether there is a water quality concern with ferrocyanide to the Lake Major water supply.

4.2.7 Controlled Access and Boundary Maintenance

Halifax Water has established methods to control access to the watershed area which includes physical barriers and signage, a land access strategy and stewardship protection methods, and boundary maintenance options as described in the following subsections.

Land Access

Halifax Water and the Crown control most of the land (78%) and access into the watershed area. For all other private lands within the watershed area, Halifax Water encourages open communication with adjacent landowners and others users (e.g., recreation); and has developed access strategies for specific groups; i.e., Geocaching Policy (see Section 4.3.3: *Recreation - Geocaching* on page 129). These strategies augment the existing regulatory and by-law tools available and limit or establish terms for access to watershed lands in order to ensure a high quality drinking water supply is maintained.

Gates and Fencing

Halifax Water maintains gates, fences, barriers and posts them with signs to limit access to its facilities and protected areas. Halifax Water will continue to monitor these areas and enhance security measures when required.

Boundary Maintenance

Halifax Water hires licensed land surveyors to establish the legal watershed boundaries as outlined in the *PWA* designation. Halifax Water monitors the boundary lines yearly and updates them as required.

4.2.8 Enforcement

Halifax Water works with local authorities to enforce Acts, regulations and by-laws that apply to the watershed area. However, even with the cooperation of local authorities, violations occur.

Changes to the *Environment Act Regulations* in 2012 gave municipal utilities the authority to issue blanket Summary Offense Tickets (SOT) to offenders. This new authority has provided Halifax Water with the ability to respond and enforce, where applicable, regulations that apply inside the *PWA*. A Memorandum of Understanding (MOU) was signed between Halifax Water and NSE providing Halifax Water the authority required to appoint and train staff in order to carry out enforcement activities specific to the watershed area regulations. In May of 2015 Halifax Water staff successfully completed Special Constable training as a result of the MOU.

4.2.9 Lake Major Pumping Station and Water Supply Plant

The Lake Major pumping station and Water Supply Plant are located inside the watershed area. To provide power to the pumping station and supply plant during an electrical failure, Halifax Water maintains a diesel generator and fully-contained 4000-litre fuel tank at the pumping station. Plans and procedures to protect raw water from risks associated with the pumping station are reviewed regularly through Halifax Water Standard Operating Procedures (SOPs). All plant operators and contractors working in and around the pumping station and treatment plant are made aware of surrounding risks and are educated on response plans and procedures which are outlined in Halifax Water's ISO 14001 *Environmental Management System Manual* and *Emergency Response Plan for Halifax Water*, copies of which are found at the Lake Major water supply plant or the main office located at 450 Cowie Hill Road in Halifax.

Supply Plant Treatment Effluent

Effluent from the water supply plant, holding tanks, and drying beds are discharged inside the watershed area. Details on the discharge and holding tanks are described earlier in section 3.1.5: *Water Supply System Infrastructure* on page 79. All discharge water is covered under the Lake Major Operating Permit and monitored through the compliance monitoring program, on which Halifax Water reports to NSE.

Nova Scotia Power Transformers

In addition to Nova Scotia Power (NSP)'s yearly inspection of the supply plant and pumping station power transformers, Halifax Water staff visually inspect the transformers daily and immediately reports leaks to NSP. In the event of a spill, Halifax Water's *Emergency Response Plan for Halifax Water* outlines the steps to be followed. Copies of the manual are at the Lake Major Water Supply Plant or Halifax Water's main office at 450 Cowie Hill Road in Halifax.

4.2.10 Chemical, Biocide and Pest Control Use

In all chemical use situations, described in *section 3.1.9: Chemicals* on page 104, Halifax Water's source water protection management strategy is focussed on ensuring chemicals do not contaminate the water supply. With support from the LMWAB, Halifax Water keeps abreast of the potential for chemical use and contamination by collaborating with the relative agencies that typically use chemicals to conduct business by working with them through applicable regulations to ideally eliminate chemical use in the watershed area.

As per sections 8 and 10 of the *Lake Major Watershed Protected Water Area Regulations* (see *Appendix 1* on page 167), the use of biocides or pest controls are restricted while chemicals are prohibited, respectively, inside the PWA. Furthermore, the use of chemicals other than for water treatment purposes is not permitted on lands managed by Halifax Water. Halifax Water will continue working with the applicable agency including NSP, DNR, NSE and HRM to reduce or eliminate the use of all chemical control products inside the watershed area.

In the event a chemical spill threatens the water supply, the *Emergency Response Plan for Halifax Water* will be followed. A copy of the Plan is at the Lake Major Supply Plant or the main office at 450 Cowie Hill Road in Halifax.

4.2.11 Emergency Measures

In any emergency, the *Emergency Response Plan for Halifax Water* provides: system information; chain of command and lines of authority; facility damage assessments; lists of events that cause emergencies; and the procedures to follow in a variety of emergency situations including who to notify in the event of an emergency, sampling procedures in the event of an emergency, communication strategies, response actions risk assessment of infrastructure, alternative water sources, curtailing water usage, and return to normal operation procedures. The procedures outlined in the Manual must be followed. A copy of the Plan is at the Lake Major Water Supply Plant or the main office at 450 Cowie Hill Road in Halifax. The Plan is reviewed and updated annually.

4.2.12 Source Water Quality Monitoring

In 2011, Halifax Water reached its two-year goal of setting water quality trend baselines for seven source water sample sites, LMG1 through LMG7, identified for the Lake Major watershed (illustrated on *Map K: Lake Major HRWC Services and Development Risk Areas* on page 117). The decision to move to a risk-based monitoring program in the fall of 2011 is supported by the consistent data gathered during the two year baseline collection program established in 2009.

Furthermore, the majority of the watershed land base is maintained through public ownership; 37% Halifax Water and 41% which greatly reduces the risk of development on those lands within the watershed area. For this reason Halifax Water has delayed sample collection in low risk development areas, specifically LMG2, LMG4, and LMG5 until further notice or to monitor an event. In an event occurrence, the water quality data gathered prior to the event will provide a water quality benchmark.

For public reporting, signage with contact information is located throughout the watershed area. For more details on the Source Water Quality Monitoring Program please refer to *Chapter 5*.

4.3 Contingency (Mitigation, Preparedness and Response)

The following describes the contingency plans that Halifax Water has in place to mitigate, prepare and respond to events associated with the land-use activities described in section 4.2, which may put the water supply at risk.

4.3.1 Accidental Fire within Residential Areas

To address wildfire safety concerns when siting and designing houses, applicants are encouraged to review the Nova Scotia Department of Natural Resources brochure: “How to Protect your Home and Property from Wildfire” found at www.gov.ns.ca/natr/forestprotection/wildfire/firecentre/pdf/Wildfirebrochure2.pdf. This type of management method reduces the potential for water-crippling events from taking place within the watershed areas and promotes a vibrant healthy forest.

To further reduce the potential for accidental fire, Halifax Water has developed public communication, education and awareness programs, described in section 4.2.3: *Public Communication, Education and Awareness* on page 121.

4.3.2 Forest Management

Forest Management is a key tool used by Halifax Water to sustainably manage Company and Crown forest lands within the Lake Major watershed area. By identifying at-risk areas early, Halifax Water has been able to create a resilient forest that is less susceptible to wind damage, insect and disease outbreak, forest fire and a forested watershed area that produces high quality water.

Where forest management plans are considered, the province (41% ownership) and Halifax Water (~37% ownership) coordinate efforts to ensure protection of the whole watershed area, including avoiding areas adjacent to private lands that have been recently harvested; allowing time for the land to recover and to sustain high quality water. This management strategy reduces the risk of over harvesting the watershed area. For other privately-owned (~12%) watershed land, Halifax Water continues to monitor and educate landowners about applicable government regulations and BMPs.

All applicable by-laws, provincial regulations and Halifax Water policy, procedures and BMPs will be followed.

Hydrocarbon spill

Those involved with a hydrocarbon spill will follow the applicable portions of Section 6: *Emergency Response and Reporting* of the Halifax Water BMPs. Contractors are directed to attempt to contain the spill with spill kits and to wait for agencies to guide the site clean-up. Halifax Water will continue to evaluate any threat to the raw water supply through the Target-

Based Sampling Program as outlined in section 5.4.4: *Target-Based Sampling - Petroleum Hydrocarbons* on page 164.

4.3.3 Recreation

In recent years recreational activities within the watershed area have increased which has led to new challenges and increased risk to the watershed area and its water supply. To help reduce the impact, Halifax Water closely monitors recreational activities and educates users who wish to conduct their activities inside the watershed area.

Education and awareness information on watershed area signage, Halifax Water's website, the Lake Major Newsletter, the Source Water Protection brochure and publications in local newspapers provide information about how to reduce potentially harmful activities in the watershed area. Halifax Water also developed a Land Access Strategy to help watershed area users organize their approach to accessing watershed lands.

Establishing communication and working relationships with recreational groups helps to build respect and a collaborative approach to watershed area protection and helps to promote cooperation and the eventual development of best management practices guidelines for various recreational pursuits.

If any recreational activity occurring within the watershed area results in an emergency, Halifax Water's *Emergency Response Plan for Halifax Water* outlines the steps that must be followed. A copy of the Plan can be found at the Lake Major Water Supply Plant or Halifax Water's main administrative office located at 450 Cowie Hill Road in Halifax.

Off-highway Vehicles

Gates and barriers are maintained at known watershed access points to restrict vehicle access. To supplement gates and barriers, signs identifying contact information and restrictions are posted throughout the watershed area (including access points). Halifax Water regularly patrols the watershed area regularly by foot, boat, OHV and marked vehicles. Halifax Water also works with the local RCMP and Conservation Officers to deter such activity inside the watershed area.

Golfing

The golf course identified in section 3.1.3: *Golf Course* on page 73 and its associated management activity is currently described as low to medium risk of presenting an impact to water quality due to the cooperative relationship between Halifax Water and the golf course company. However, because 17.9ha of the golf course is situated inside the Lake Major watershed area and golf courses typically apply pesticides, herbicides and fungicides to provide quality playing conditions there remains a need to manage for potential risk to the watershed area.

In 2008, Halifax Water met with golf course management and determined that the golf course company generally practiced Integrated Pest Management such that pesticides are only applied as required and as a last resort. However, herbicides and fungicides, which are deemed to be essential for a competitive golf course company, are applied more frequently.

In response to a request by the golf course to allow the application of chemicals inside the *PWA* for maintenance purposes, the golf course company hired an independent consulting company to conduct a drainage survey to determine whether the areas where chemicals are being applied are inside or outside the watershed area. The survey indicated that runoff from the portion of the golf course where herbicides and pesticides are applied are intercepted by a watercourse which flows into ponds and then drained away from the watershed area through a series of ditches and culverts. The survey also indicated that only 1.74ha of the golf course drains toward the Lake Major watershed “through the west culvert.” This area consists of the driving range, which does not require chemical application. This was reconfirmed in June of 2013 with the golf course superintendent.

As a result of the consultant’s findings (see *3.1.3: Golf Course* on page 73), the company provided a copy of its golf course Best Management Practices and agreed that the area situated inside the watershed area, namely the driving range, would be chemical free. For the remaining area inside the *PWA*, the golf course company proposed to formally request a boundary alteration reflecting drainage flow patterns away from the watershed area. In response to the request and in consultation with the LMWAB, Halifax Water identified a sample location below the west culvert (LMG7) (see the site location on *Map K: Lake Major HRWC Services and Development Risk Areas* on page 117) and monitoring details under section *5.4.3: Pesticides* on page 162 to monitor water quality over a two year period and determine whether golf course maintenance practices were impacting water quality. To date there is little indication of water quality impairment from golf course maintenance activities.

Originally, the LMWAB was in favour of a boundary alteration rather than a regulation exemption to allow chemical use inside the *PWA*. However, representatives of the LMWAB have changed their opinion based on concerns about perceived impacts to private well water supplies outside of the watershed area. The golf course company has been contacted and informed of the Board’s position. Any potential impact from the golf course, affecting areas outside the watershed supply area, is a matter for NSE to address.

Geocaching

There are 17 different types of geocaching: about 90% are “traditional” while the other types are described here: www.geocaching.com/about/cache_types.aspx. Pristine areas are a significant attraction, particularly our watershed areas. There are close to 100 geocaches in Halifax Water watershed areas. Halifax Water developed Guidelines for Geocaching in cooperation with the Atlantic Canada Geocaching Association. These Guidelines facilitate safe and low-impact use of Halifax Water watershed lands by geocachers, while ensuring the protection of the quality of Halifax Water managed resources.

Mountain Biking

Generally, mountain biking does not pose a problem if bikers keep to main access roads and away from critical infrastructure; however, the tendency has been to create new trails and challenges. Since a new subdivision was developed in the Spider Lake area there is renewed interest in mountain biking leading to new trails, illegal tree cutting, unsafe ramps and water

crossings being constructed throughout the area. Halifax Water posts signs and removes structures as they are found, to no avail. Halifax Water has been striving to identify responsible group(s) to propose developing guidelines with/for them which are similar to the Geocaching Policy (see 4.3.3 *Geocaching* above). At this point, no group has been identified; however, Halifax Water has made contact with some who may be interested in collaborating on solutions.

4.3.4 Mining, and Pits and Quarries

The following subsections describe the management techniques being used to mitigate impacts from mining and pits and quarries.

Mining

Halifax Water will consider changes to the *Lake Major Watershed PWA Regulations* with respect to mining to provide maximum protection to the watershed area. Halifax Water will continue to work with DNR and monitor the DNR ArcIMS viewer: Natural Resources – Geology Maps and Databases website <http://gis4.natr.gov.ns.ca/website/nsgeomap/viewer.htm> for updates on the issuance of mineral exploration licenses and permits in the area.

With respect to development, Halifax Water will contact NSE and HRM to propose known mining tailing sites to be left undisturbed.

Halifax Water is investigating amendments to the *PWA Regulations* to bring them more in line with the *Bennery Lake Watershed PWA Regulations* respecting erosion and sedimentation control and toward prohibiting mining inside the watershed area considering that the goals and objectives of the mining community are considerably different from those of Halifax Water.

Pits and Quarries

Currently, there is an active pit and quarry operating near the Montague Gold Mines area of the watershed area which is permitted to operate as per NSE approval.

A permit to construct and/or operate a Rock Quarry was granted by the Province in 1993 subject to the following conditions:

1. General Stipulations:
 - a. Adherence to the regulations associated with the *Environment Act* and the *Dangerous Goods and Hazardous Waste Management Act*; local municipal environmental by-laws and zoning restrictions; and the Pit and Quarry Guidelines.
 - b. Provide a legal property survey outlining the area of the quarry.
 - c. Expose only those areas that are being actively used/ excavated.
 - d. That the permit be on site at all times.
2. Particulate emissions:
 - e. Dust shall not exceed these limits off site property boundaries:
 - i. Annual Geometric Mean $70 \mu\text{g}/\text{m}^3$

- ii. Daily average (24 hour) 120 µg/m³
- f. Generation of fugitive dust from the site will be suppressed by applying water sprays or other suitable suppressant (not waste oil).
- g. Site access roads shall be maintained to minimize dust generation

Note: Monitoring of Particulate Emissions shall be at the request of NSE.

3. Sound levels at property boundaries shall not exceed sound levels Leq:

- h. 65 dBA 0700-1900 hours (Days)
- i. 60 dBA 1900-2300 (Evenings)
- j. 55 dBA 2300-0700 hours (Nights)

Note: Monitoring shall be conducted at the request of NSE.

4. Surface Water:

- k. The site shall be maintained to prevent siltation of the surface water which is discharged from the property boundaries into the nearest watercourse. This includes the installation of soil erosion and sedimentation control designed to meet the specification of NSE.
- l. All erosion and sedimentation control devices shall be installed prior to any excavation of material.
- m. If it becomes necessary to drain the quarry workings, the wastewater shall be drained to settling ponds for appropriate treatment to meet the suspended solids limits.
- n. The proponent shall sample and ensure the following liquid effluent levels are met:

Parameters	Max in a grab sample	Monthly Arithmetic Mean	Monitoring frequency
Total Suspended Solids	70mg/L	35mg/L	weekly
pH	5-9	6-9	weekly

A schedule of communication and reporting activities has been developed with the active quarry company such that yearly quarry site visits are conducted with the Quarry Manager and the Watershed Manager. A presentation was made to the LMWAB in 2012 regarding the quarry’s activities, scale of economy, monitoring programs, and blast information. These communication and mutual cooperative activities help to manage the risks associated with the quarry operations within the watershed area.

It is Halifax Water’s intention to request that NSE to not allow any new pit or quarries or additions of existing ones that may impact the watershed area further.

4.3.5 Transportation Routes

Lake Major Road, in particular, presents a moderate to high risk to the source water supply because there are no mitigation measures in place to limit vehicle fluid contamination from

entering the watercourse through accidents or runoff. Halifax Water's water quality monitoring program measures road effects on watercourses as described in section 5.4.2: *Risk-Based Sampling* on page 159.

In the event of an emergency as a result of a spill along any of the roadways within the watershed area, the *Emergency Response Plan for Halifax Water* outlines the steps that are to be followed. Copies of the manual are at the Lake Major Water Supply Plant or Halifax Water's main office at 450 Cowie Hill Road in Halifax.

4.3.6 Boundary Maintenance

If watershed area boundary lines have become indistinguishable due to an event such as a natural disaster, a licensed land surveyor will be hired to re-establish the line.

4.3.7 Public Communication, Education and Awareness

Halifax Water will continue to make the public aware of the Lake Major watershed through signage, media, newsletters, seminars, education programs and website links.

4.3.8 Commercial

Through consultation with Halifax Water and the LMWAB upon which there is an HRM Development Officer representative and as per the applicable Plan Area By-laws (see section 2.4.3: *Municipal Planning Strategies and Land-use By-laws* on page 43) HRM will consider threats to the Lake Major watershed when applications are being made for commercial development.

Businesses with concerns or an emergency can contact their respective municipal office/first responders, 911 or Halifax Water (902-490-6940) to report the incident so Halifax Water can activate its emergency-response plan.

In the event of an emergency, the *Emergency Response Plan for Halifax Water* outlines the steps that are to be followed. Copies of the manual can be found at the Lake Major Water Supply Plant or Halifax Water's main office located at 450 Cowie Hill Road in Halifax.

4.3.9 Residential

Through consultation with Halifax Water and the LMWAB upon which there is an HRM Development Officer representative, and as per the applicable Plan Area By-laws (see section 2.4.3: *Municipal Planning Strategies and Land-use By-laws* on page 43) HRM will consider threats to the Lake Major watershed when applications are being made for new residential development.

Garbage and illegal dumping

In addition to provisions made under Section 10 of the *PWA Regulations: Discharge Prohibitions*, which are enforceable by Halifax Water, HRM policy, i.e., the *Dangerous and Unsanitary Premises Administrative Order* (Number 30) provides authority to HRM By-law Services for property-related public safety and quality of life issues including enforcing exterior property

legislation on private property such as dangerous or unsightly premises. Furthermore, in 2011, the provincial government enacted the *Dangerous and Unsightly Premises Amendment (2011) Act* to strengthen municipal restrictions on dangerous and unsightly premises. Halifax Water will explore avenues to enforce garbage and illegal dumping issues using these and other enforcement tools.

On-Site Septic Systems

In addition to provisions made under Section 10 of the *PWA Regulations* (see *Appendix 1* on page 167: Discharge Prohibitions), which are enforceable by Halifax Water, NSE is responsible for approving on-site septic systems and ordering landowners who have malfunctioning septic systems to repair them under the *On-site Sewage Disposal Systems Regulations* (March 2016) or face serious penalties. Landowners are responsible for maintaining their own septic systems. Halifax Water will encourage septic system best management practices in the watershed area through its education and communications program.

Furnace Oil Spill

In addition to provisions made under Section 10 of the *PWA Regulations* (see *Appendix 1* on page 167: Discharge Prohibitions), which are enforceable by Halifax Water, NSE is responsible for enforcing the *Environmental Emergency Regulations* (2013) that states:

These regulations apply to a release of a substance or impending release of a substance into the environment, including all of the following:

- (a) an environmental emergency;
- (b) a reportable release;
- (c) an unauthorized release;
- (d) a release of a substance or impending release of a substance into the environment on lands owned or claimed by Her Majesty in the right of Canada.

If the owner(s) does not comply, NSE or the Minister responsible could impose penalties or perform the clean-up for which the owner is responsible for reimbursing the minister or NSE. As part of the education and communications program, Halifax Water will encourage proper maintenance practices of Furnace Oil holding tanks through education and awareness programming.

Residents with concerns or an emergency can contact their respective municipal office/first responders at 911 or Halifax Water (902-490-6940) to report an incident so Halifax Water can activate its Emergency Response Plan.

In the event of an emergency, *Emergency Response Plan for Halifax Water* outlines the steps that are to be followed. Copies of the manual are at the Lake Major Water Supply Plant or Halifax Water's main office at 450 Cowie Hill Road in Halifax.

4.3.10 Halifax Water Operations

The following operations are under Halifax Water's control and responsibility to ensure the water quality is clean and safe to drink. In the event of an emergency associated with any of the systems described below, the *Emergency Response Plan for Halifax Water* outlines the steps that are to be followed. Copies of the manual can be found at the Lake Major Water Treatment Plant or Halifax Water's main office located at 450 Cowie Hill Road in Halifax.

Lake Major Water Supply Plant

Halifax Water has plant staff dedicated to the operations and maintenance of the Lake Major Water Supply Plant 24 hours a day, 7 days a week. There is currently a contingency plan in place in the event of an accident that threatens the source water.

During a power outage, Halifax Water has an automatic switch gear system to detect power failure and determine when to transfer power to the two emergency power generators (gensets). One of the generators is located at and provides diesel power to the lowlift pumping station and the other to the water supply plant:

Lowlift pumping station generator:

The lowlift pumping station backup generator is located next to Lake Major inside the watershed area. The 2000-litre fuel tank supplying the generator sits in its own double-walled concrete containment unit. An oil drip pan is situated under the fuel tank as well.

Main Supply Plant generator

The main Water Supply Plant backup generator which is housed in its own building is situated within the watershed area. The fuel tank supplying the generator is a 4000 litre double walled tank which is housed within the same building as the generator.

Halifax Water has developed and implemented Standard Operating Procedures (SOPs) for the operation and maintenance of the generator, fuel transfer and storage. Included in these standard operating procedures is daily visual inspection of the fuel tanks and generator. Any leaks in the fuel tank are detected through fuel loss indicators. Annual inspections of the generators take place with the manufacturer of the generator engines.

In the event of an emergency the ISO 14001 *Environmental Management System Manual* and *Emergency Response Plan for Halifax Water* procedures will be followed. Copies of the manuals are located at the Lake Major Water Supply Plant or at the main administrative office located at 450 Cowie Hill Road in Halifax.

Chemical Use

If a chemical sourced to the Water Supply Plant enters a watercourse inside the watershed area and threatens the source water supply, the *Emergency Response Plan for Halifax Water* will be used to respond, minimize and clean-up the impact to source water. A copy of the Plan can be found at the Lake Major Water Supply Plant or the main office located at 450 Cowie Hill Road in Halifax.

4.4 Emergency Response Management for Critical Infrastructure

Water is listed as one of the ten critical infrastructure sectors in the National Strategy and Action Plan for Critical Infrastructure³³ and in Public Safety Canada’s Risk Management Guide for Critical Infrastructure Sectors – Appendix B: List of Hazards and Threats³⁴. A key principle of the National Strategy is

“Critical infrastructure roles and activities should be carried out in a responsible manner at all levels of society in Canada...” whereby the responsibilities are shared by “ *federal, provincial and territorial governments, local authorities and critical infrastructure owners and operators – who bear the primary responsibility for protecting their assets and services. Individual Canadians also have a responsibility to be prepared for a disruption and to ensure that they and their families are ready to cope for at least the first 72 hours of an emergency.*”³⁵

Considering Halifax Water is critical infrastructure, the National Security’s principles and statements should be adhered to such that Halifax Water should be prepared for a 72 hour National Security critical infrastructure disruption scenario that could result in “*catastrophic loss of life, adverse economic effects, and significant harm to public confidence.*”

4.4.1 Critical Infrastructure Management of Security Threats and Hazards Management

Halifax Water’s ERP attempts to identify and categorize all emergencies that could affect its operations including stormwater, wastewater and drinking water services. To help sort and identify potential emergency scenarios, this SWPP’s Emergency Response management subsection on management is divided into four sections: accidental, natural event, intentional threats and hazards and backup emergencies.

Emergencies caused by natural disasters, accidents or spills, and malicious intent pose serious threat to water quality because they are often unpredictable and difficult to prepare for. Further, considering, as previously stated, “*disasters most often occur locally, the first response to a disruption is almost always by the owners and operators, the municipality, or the province or territory.*” Also, the smaller the party affected, the fewer resources may be available to effectively and quickly deal with the emergency.

Security against malicious intent is taken very seriously at Halifax Water. However, also as previously stated, “[*i*]mproving the resilience of Canada’s critical infrastructure will always be

33 Public Safety Canada: National Strategy for Critical Infrastructure. Web-accessed April 11, 2016 at: <http://www.publicsafety.gc.ca/cnt/rsrscs/pblctns/srtg-crtcl-nfrstrctr/srtg-crtcl-nfrstrctr-eng.pdf>.

34 Public Safety Canada: Risk Management Guide for Critical Infrastructure Sectors; p. 36. Web-accessed April 11, 2016 at: <http://www.publicsafety.gc.ca/cnt/rsrscs/pblctns/rsk-mngmnt-gd/rsk-mngmnt-gd-eng.pdf>.

35 Public Safety Canada: National Strategy for Critical Infrastructure. p. 2. Web-accessed April 11, 2016 at: <http://www.publicsafety.gc.ca/cnt/rsrscs/pblctns/srtg-crtcl-nfrstrctr/srtg-crtcl-nfrstrctr-eng.pdf>.

a work in progress. It will never be possible to protect against every threat or hazard and mitigate against every consequence.”³⁶

For specific types of emergencies, the following subsections describe Halifax Water’s response and contingency plans according to whether it is an accidental, natural or malicious type of emergency.

Accidental Emergency Response

The following emergencies are considered to be the greatest threat to water quality in the Lake Major watershed.

Accidental Fire

Due to the Wildland-Urban Interface (WUI), a characteristic of the Lake Major watershed, there is substantial potential for accidental fire from various sources including residences, recreational pursuits, highway mishaps, distribution line maintenance activity and other anthropogenic activities (see section 3.2.1: *Accidental Fire* on page 108). In the event of a fire, emergencies are addressed through 911 services and Halifax Water Emergency preparedness documents and its BMPs. While Halifax Water’s Emergency Response protocols must be followed in water supply areas, wildland fire reporting and response protocols follow provincial Forest Fire Protection Regulations.

Aircraft Disaster

NavCanada is the agency responsible for safe and efficient traffic flow in Canadian airspace. Transport Canada is responsible for licensing pilots and other aviation specialists as well as registering and inspecting aircraft. The Transportation Safety Board of Canada is responsible for advancing transportation safety in Canada.

Through meetings with HIAA Security staff and by regularly reviewing its emergency-response plans Halifax Water continues to assess the possibility of an event occurring. More details on the risks of aircraft disasters are found in section 3.2.1: *Aircraft Disaster* on page 108.

- Halifax Water has offered to supply the HIAA with GIS shape files of the watershed areas to use as a reference layer, especially in case of a catastrophic event, to add to their mapping system. The HIAA recognizes the importance of the water supply areas, but places greatest priority on insuring flight safety. Halifax Water will also approach CFB/Shearwater with the same offer.

In an aircraft emergency, Halifax Water will cooperate with the appropriate agency(ies), and follow the outlined procedures documented in the *Emergency Response Plan for Halifax Water* located at 450 Cowie Hill Road, Halifax.

³⁶ Her Majesty the Queen in Right of Canada. Public Safety Canada: Action Plan for Critical Infrastructure (2014 – 2017). 2014. Web-accessed August 21, 2014 at: <http://www.publicsafety.gc.ca/cnt/rsrscs/pblctns/pln-crtcl-nfrstrctr-2014-17/pln-crtcl-nfrstrctr-2014-17-eng.pdf>

Chemical or Oil Spill

In the event of a chemical spill inside the Lake Major watershed, emergencies are addressed through 911 services. Emergency response protocols include Halifax Water's ERP and Halifax Water's ERP and Halifax Water's BMPs, Nova Scotia Environment's *Environmental Emergency Regulations*, the Nova Scotia Emergency Management Office and those in cooperation with Transport Canada, the agency responsible for an accident or spill occurring on roadways..

Natural Event Response

Natural events and disasters that could occur within the Lake Major watershed area include wind and flooding, fire, drought, natural biological outbreaks and infestations and climate change impacts. Management considerations for such events are described in the subsections below.

Wind and Flood

Wind and flood

- put drinking water supplies at risk through microbial cross-contamination;
- cause power outages that threaten to disrupt water pumping stations; and
- cause forest blow down that lead to short and long-term water quality impacts such as soil erosion and sedimentation, increased colour, suspended solids and organic matter levels.

Halifax Water will manage the risks presented by these events by following the ERP and continuously improving response procedures and readiness in preparation for such events. Communication with other first responders will help to ensure Halifax Water is connected to the appropriate agencies to ensure timely response in such events.

Wildland Fire

In 2012, a *Provincial Forest Fire Watershed Protection Policy (FFWPP)* was created as an internal government document regarding how to respond to and fight fires within municipal water supplies. The protocol includes applying water first, only using the "Primary" drinking water supply source as a water source to fight fire as a last resort and using only those chemicals described in section 3.1.9: *Forest Fire Fighting* on page 106. NSDNR staff is aware of these protocols. Another tool available is the *Renewable Resources Municipal Source Water Protection Wildfire Management Manual IV6*, which is available on the provincial government's intranet site. There is also an updated GIS layer available showing watershed area boundaries to help NSDNR staff define fire suppression limits.

During forest management planning, Halifax Water and NSDNR target high-risk forest stands prone to natural disasters such as insect, disease, wind damage and fire, and follow the Fire Policy developed by NSDNR on the advice of NSE. Forest fire reporting protocol and procedures fall under the provincial *Forest Fire Protection Regulations* made under subsection 23(2) and Section 40 of the *Forests Act*. Also, 911 Emergency Response information signs are strategically placed throughout the watershed area.

As per Halifax Water's BMPs, contractors hired by Halifax Water must

- complete a yearly review of the fire regulations before start-up when operating inside the watershed area during fire season;
- conduct daily monitoring of the provincial fire index;
- follow appropriate operating restrictions;
- maintain fire equipment on-site; and
- check equipment daily.

Halifax Water will evaluate any threat to the raw water supply through the Target-Based Sampling Program outlined in 5.4.4: *Target-Based Sampling* on page 164.

Drought

As indicated in section 3.3: *Drought* on page 112, according to Environment Canada, Atlantic Canada may be more susceptible to drought impacts than are areas where drought is more prevalent because it occurs less frequently in Atlantic Canada, resulting in a lower adaptive capacity. Drought also makes forests more susceptible to fire and puts more pressure on water use and more demand on the water supply.

The *Emergency Response Plan for Halifax Water* (ERP) outlines the procedures in a drought or water rationing situation that includes banning of non-essential water use (e.g. lawn watering, car washing etc.) and the procedures to implement in the event of wildfire that may or may not be caused by drought conditions. A copy of the ERP is at 450 Cowie Hill Road, Halifax.

Climate Change

Regarding the impacts associated with climate change events (e.g., precipitation and temperature fluctuations), Halifax Water will continue to collaborate with other agencies to keep abreast of new challenges and techniques that limit the impacts on water infrastructure and impact the ability to adapt to climate change.

Natural Biological

Natural events and disasters are hard to predict; however, in order to respond effectively, Halifax Water prepares its staff and its facilities through company policy and management plans, and Emergency Response and Preparedness Plans. In the event of a natural event occurrence that requires an emergency response, Halifax Water's Emergency Response protocols must be followed (see section 4.4.2: *Backup Emergency Supply* on page 139 for more detailed information).

Intentional Threat Response

In this document an intentional threat is considered to be one that involves an attack or a deliberate act for the purpose of doing damage. Protecting against an intentional or deliberate attack on the water supplies in the event of war or sabotage is perhaps more difficult than protecting against more predictable events such as social unrest and labour disputes.

Maintaining open lines of communication and fostering new opportunities for cooperation with the various agencies that affect or would be affected by the inability to use the Lake Major water supply will help to continuously decrease the risk level of malicious intent and non-malicious intent attacks. The next two subsections describe these two forms of intentional threats; and how Halifax Water may manage them.

Malicious Intent

Halifax Water has completed an industry-developed risk assessment for its facilities. The security measures procedures were designed based on this assessment to reduce the probability, increase the likelihood of detection and lessen the impact of a malicious event. In the event of an emergency resulting from malicious intent, Halifax Water will follow the ERP to continue operations during an emergency. A copy of the ERP is located at 450 Cowie Hill Road in Halifax.

Halifax Water posts signs, maintains fences and gates, installs security cameras at main operating locations, performs patrols, conducts routine intense water sampling to ensure the safety of HRM's drinking water and encourages watershed area users to report any suspicious activities within the watershed areas. Contact information can be found on signage throughout the watershed area as well as listed on Halifax Water's website www.halifaxwater.ca.

Non-malicious intent

An example of non-malicious intent that could occur in the Lake Major watershed is in the event that the municipality develops watershed area lands in a manner that is not consistent with source water protection efforts, which may pose a negative impact to the protection of the source water supply or a change in provincial legislation that reduces protection mechanisms (as described in section 3.2.1: *Non-malicious Intent* on page 111). The most important tool to manage for non-malicious intent is open communications and “*cooperation with Canada's international partners, all levels of government, security intelligence and law enforcement agencies, industry stakeholders and civil society*”³⁷.

4.4.2 Backup Emergency Supply

In case of an emergency (e.g., contamination, security, disaster, etc.) at the Lake Major WSP, senior management will decide whether a shutdown will take place. In such situation, the existing distribution system could function for approximately 24 hours on water stored in reservoirs, depending on usage. The system could then be supplemented for approximately 5-6 days with water from the Pockwock system via the MacDonald Bridge water main connection and in extreme cases the Lake Lemont emergency back-up water supply system can be brought on line to supplement the water supply for an additional 3-4 days prior to reduced usage being implemented.

³⁷ Her Majesty the Queen in Right of Canada. Public Safety Canada: Action Plan for Critical Infrastructure (2014 – 2017). 2014. p. 4. Web-accessed August 21, 2014 at: <http://www.publicsafety.gc.ca/cnt/rsrscs/pblctns/pln-crtcl-nfrstrctr-2014-17/pln-crtcl-nfrstrctr-2014-17-eng.pdf>

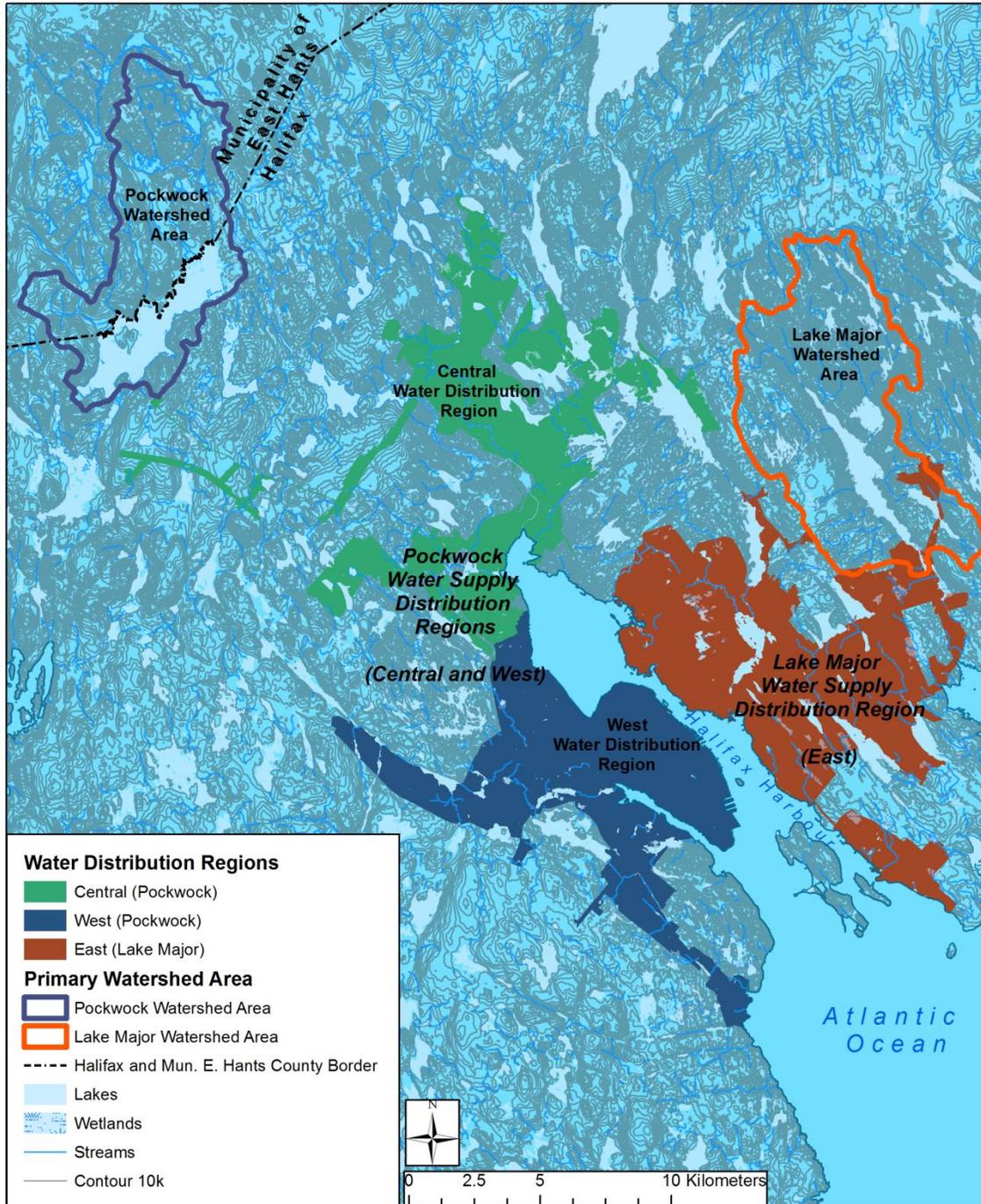
Emergency procedures are in place for shutting down the Lake Major WSP, which involves public notification, customer restrictions, emergency plant start-up, etc., of which all water supply plant operators and engineering staff are fully aware. These procedures are found in the *Emergency Response Plan for Halifax Water*. Copies of the manual can be found at the Lake Major WSP or Halifax Water's main office located at 450 Cowie Hill Road in Halifax.

The Lake Lemont emergency supply plant has not been used since the Lake Major WSP became operational in 1998; however, plans are in place to run the plant on a yearly basis to ensure the ability to respond in a timely manner when necessary.

MAP M: PRIMARY WATER SUPPLY NATURAL WATERSHED AND DISTRIBUTION AREAS

Lake Major Watershed PWA SWPP 2016

Map M: Primary Water Supply Watershed and Distribution Areas



5. MONITORING AND EVALUATION

Halifax Water is responsible for monitoring, reporting and enforcing activities that may impair water quality within the Lake Major watershed area. Monitoring consists of maintaining a presence by way of patrolling, encouraging public reporting of unauthorized or suspicious activities, conducting raw water sampling, and liaising with various governing agencies and stakeholders to ensure a clean and safe drinking water supply.

5.1 Reporting

Monitoring the watershed area involves reciprocal reporting processes: Halifax Water provides annual reports to governing agencies and to the public via the Lake Major Watershed Advisory Board (LMWAB) and via publications found on Halifax Water's website. Halifax Water also relies on and encourages the public to act as a "watch dog" and report activities that could adversely affect source water quality.

5.1.1 Annual Reports

In March of each year, Halifax Water prepares and provides a Source Water Protection Report to the LMWAB for review and comment. The report includes, but is not limited to: the status of present risks; identification of new risks; results of the previous year's monitoring program; activities that occurred within the watershed area; and recommended changes to the SWPP for continuous improvement. Annual review of the Report by the Lake Major Watershed Advisory Board in March, allows Halifax Water time to submit possible changes to the report to meet obligations to NSE for the annual 90-day utility report.

5.1.2 Public Reporting

Halifax Water maintains signage throughout the watershed area for public information purposes. Information includes restricted activities, applicable legislation and contact information. Contact information includes, but not limited to, applicable civic address if available, DNR hotline, emergency spill contact numbers (e.g., 911), and Halifax Water's 24 hr emergency hotline (902) 490-4820.

5.2 Meetings

Consistent and sustained communication between those who have a responsibility to ensure clean, safe water is paramount. Meetings between stakeholders provide a means to evaluate risks to water quality and help contribute to the development of methods that overcome obstacles to ensuring clean, safe potable water is provided for Halifax Water clients. Stakeholders that help to attain this goal include the LMWAB, Halifax Water, NSPI, DNR, HRM and NSTIR.

5.2.1 Scheduled Meetings

Halifax Water meets with HRM on a bi-annual basis, mainly by way of the LMWAB, to exchange information about possible development or scheduled events that could pose a threat to water quality. As a result of these meetings HRM staff has been providing updates including subsequent reports of development permits issued for the Lake Major watershed per request.

5.2.2 Watershed Committee Meetings

The Lake Major Watershed Advisory Board continues to meet as per the Terms of Reference. Currently no new board members are being considered; however if circumstances warrant new members, the LMWAB will consider them as they arise.

5.3 **Patrolling**

Halifax Water continues to conduct regular patrols throughout the Lake Major watershed by foot, ATV, boat, and marked vehicles, to identify activities that may be a concern. In addition, Conservation Officers continue to conduct random patrols, stopping drivers of OHVs who are in the watershed area illegally. Those who are stopped during patrols and enforcement activities are informed of the protected status of the watershed area. As identified in section 5.1.2: *Public Reporting* on page 142 Halifax Water encourages watershed users to report any illegal or suspicious activities using the contact information located on the posted watershed signs.

5.4 **Source Water Quality Monitoring Program**

In September of 2009, Halifax Water updated its raw water sampling program to include a proactive five-part Source Water Quality Monitoring Program (SWQMP) to measure the health of the watershed area with respect to baseline, risks, activities, targets and operations. In 2011, Halifax Water accomplished its two-year goal of establishing a water quality trend baseline for seven source water sample sites identified for the Lake Major watershed – LMG1 through LMG7 (illustrated on *Map K: Lake Major HRWC Services and Development Risk Areas* on page 117).

The decision to move to a risk-based monitoring program in the fall of 2011 is supported by the results of the consistent data gathered during the two year program. Further, considering the majority of the land base is maintained through public ownership; i.e., 37% Halifax Water and 41% provincial ownership, the risk of development or other risky activity occurring in these areas are greatly reduced. For these reasons Halifax Water has delayed sample collection in low risk areas, specifically LMG2, LMG4, and LMG5 until further notice or unless an event arises. In an event, water quality data gathered prior to the event will provide a baseline upon which future events may be measured against.

The remaining sample locations, LMG1, LMG6, LMG7, are sites where human impact plays a significant role on water quality, therefore, sampling at these sites will continue to be collected on a monthly basis. Water samples at LMG3 also will continue to be collected to provide a water quality control point and for East Lake Dam monitoring purposes. In each instance, the data gathered will help Halifax Water work towards maintaining the highest water quality possible.

In 2016 Halifax Water added total sulphate to the SWQMP in order to better understand how industrial emissions are impacting, positive or negative, water quality. See Sulphate for further details.

Water Quality samples are collected pending weather and safety conditions and analyzed to help determine the effectiveness of the Source Water Protection Program. The sampling parameters are measured and assessed, where possible, against the standards set out by the Canadian Council of the Ministers of Environment Water Quality Guidelines for the Protection of Aquatic Life

(WQGPAL). Halifax Water considers these to be the highest standards available to assess the health of its watershed areas. In some cases, no aquatic life parameters exist; in such cases, Halifax Water will use Health Canada's Guidelines for Canadian Drinking Water Quality (GCDWQ) standards.

Sampling procedures are included in the current *Water Quality Sampling and Permit Compliance Manual* which can be found by contacting the Water Quality Manager. The manual is revised on an as needed basis. Lake Major source water sampling locations and dominant tributaries are illustrated on see *Map K: Lake Major HRWC Services and Development Risk Areas* on page 117, listed in *Appendix 4: Tributary and Lake Water Sampling Locations, Frequency and Parameters* on page 170.

5.4.1 Baseline Sampling

Baseline sampling is used to set water quality parameter baselines within the watershed area. Each baseline parameter is measured monthly, except for the metals scan which is measured twice per year. Subsequent water quality parameter data results are compared with the baseline data to determine if an investigation is required and whether parameter changes are associated with land use activities.

In this section, the general baseline SWQMP is divided into four sections: field tested (in-situ), lab tested (both tested monthly); metals scan (tested twice a year); and deep lake sampling (collected typically three times per year). The first set of parameters, i.e., dissolved oxygen, pH, temperature, and specific conductivity parameters are measured in the field (in-situ) using a specialized handheld unit while turbidity is measured in the field using a portable turbidity meter. The second set of parameters consists of total suspended solids (TSS), *E. coli*, Nitrate / Nitrite, Total Phosphorus (TP), and Total Organic Carbon, which are tested by a third party accredited laboratory. Both sets of parameters are collected in the same location and at the same approximate time. The difference is that the second set is taken to an independent lab for analysis. The following subsections describe the parameters and purpose for the four types of monitoring program methodologies.

Field Tested

The following describes the significance of sampling for each set of in-situ-tested parameters (as listed in the previous paragraph):

Dissolved Oxygen

Dissolved Oxygen (DO) is essential to the metabolism of aerobic aquatic organisms. Concentrations of DO are indicative of a stream or lake system's overall health. Minimum levels are required to support fish and other aquatic life. Dissolved Oxygen also plays a key role in the chemical form and solubility of many inorganic nutrients (i.e., measuring shifts between aerobic and anaerobic aquatic conditions that influence the biological availability of nutrients and metals). Therefore, long-term changes in DO conditions can drastically alter the productivity and function of an entire lake or stream.

Of the seven sample locations, only LMG7 experiences DO concentrations below the CCME WQGPAL: minimum DO concentrations are 5.5mg/L for warm water and 6.5mg/L for cold water (See *Table 13: Lake Major DO Results* (Avg. by Year 2009 – 2016 mg/l)* below.

Table 13: Lake Major DO Results* (Avg. by Year 2009 – 2016 mg/l)								
Year Sample Site Name	2009	2010	2011	2012	2013	2014	2015	2016
LMG1	10.95	9.45	9.27	10.5	10.00	8.07	11.03	10.35
LMG2	10.08	7.31	11.19	-	-	-	-	-
LMG3	12.6	10.61	9.89	11.06	10.42	9.95	11.64	11.25
LMG4	12.85	10.89	14.00	-	-	-	-	-
LMG5	13.49	10.22	14.68	-	-	-	-	-
LMG6	13.25	11.52	10.28	10.2	9.5	9.77	9.87	9.96
LMG7	9.28	4.77	4.65	8.43	7.02	5.03	2.72	5.74
DLS	-	9.75	11.97	12.77	-	10.36	8.04	10.81

* All results are Baseline Conditions unless otherwise indicated

pH

Within an aquatic environment, pH is a measurement of hydrogen ions in water and an indicator of acidity or alkalinity. A reading between 0 and 7 is considered acidic and contains more hydrogen. A reading between 7 and 14 is considered basic or alkaline and contains more hydroxyl groups. Acidification from land use activities, soil conditions and precipitation can negatively impact aquatic biota, contribute to the mobilization of toxic metals and affect drinking water aesthetics. Halifax Water’s SWQMP is intended to establish baseline conditions and track changes in pH to determine which, if any, watershed activities are affecting pH levels.

CCME guidelines suggest pH levels for the Protection of Aquatic Life should fall within the range of 6.5 to 9.0 of which none of the Lake Major watershed sample sites consistently meet this standard. Samples collected to date suggest where little to no human activity occurs, pH baseline conditions are the lowest, i.e., LMG2, LMG3, LMG4 and LMG5, while sites influenced to some degree by human activities, LMG1, LMG6, and LMG7 experience higher pH levels, see *Table 14: Lake Major pH Results* (Avg. by Year 2009 – 2016)* below.

Table 14: Lake Major pH Results* (Avg. by Year 2009 – 2016)								
Year Sample Site Name	2009	2010	2011	2012	2013	2014	2015	2016
LMG1	6.09	6.47	6.42	5.93	6.10	6.38	6.54	6.19
LMG2	4.76	4.97	4.93	-	-	-	-	-
LMG3	4.31	4.41	4.40	4.28	4.26	4.39	4.50	4.27
LMG4	4.38	5.00	4.30	-	-	-	-	-
LMG5	4.28	4.41	4.33	-	-	-	-	-
LMG6	4.57	5.04	5.52	5.21	5.70	5.63	5.44	5.30

LMG7	5.87	6.06	6.21	5.62	5.88	6.14	6.06	5.76
DLS	-	4.78	4.87	4.41	-	4.69	4.85	4.40
* All results are Baseline Conditions unless otherwise indicated								

Surficial geology has considerable impact on the water quality within the Lake Major watershed in sections 2.1.3: *Surficial Geology* beginning on page 12, and illustrated on *Map B: Surficial Geology* on page 23. Sample sites LMG2 through LMG5 lie in the northern section of the watershed area where the advancement of glaciers from north to south scraped off the northern section of the watershed area and deposited them in the southern section. This process left shallow acid bearing soils with poor water buffering capacity and poor vegetative cover in the north, while deeper, richer soils with excellent vegetative cover and buffering capacity were left in the south. The water quality data therefore indicates that it is imperative that the northern section of the watershed area be managed in a way that promotes a healthy vegetative cover that holds and protects what remaining buffering capacity exists. This could perhaps be achieved by limiting the types of activities and implementing best management practices such as limiting the size and time of year of any soil disturbance, for example. To the south, where sample sites LMG1, LMG6, and LMG7 are located, these areas could withstand some degree of human impact. However, one must keep in mind that the pH levels are still below the CCME guidelines. Therefore, any land-use practices employed within any section of the watershed area should be done so with water quality and conservation in mind.

Furthermore industrialization of North America from the mid-west to the east has resulted in industrial gases being released into the atmosphere that falls in the form of acid rain over the Atlantic Region further expediting the acidification of the region’s water ways including the Lake Major water supply.

Halifax Water continues to monitor LMG1, LMG6, and LMG7 which continue to be highest risk from human activities; and LMG3 which is used as a control point for comparison purposes.

Temperature

Temperature affects many biological (e.g., biotic growth and decay, uptake of toxins, organism behaviour) and chemical (e.g., solubility’s, rates of reactions) processes. Monitoring the source water temperature allows Halifax Water to establish a normal conditions baseline, add context to some of the water quality parameters, and track changes due to anthropogenic activities.

Water temperature characteristics were quite uniform across the watershed area regardless of whether it was an impacted section or not. Temperatures range from 0.02 degrees Celsius on the coldest day of the year to 23.25 degrees Celsius on the warmest day of the year. At this point nothing would suggest a great cause for concern, however, sample points LMG1, LMG6, and LMG7 will continue to be monitored for temperature changes due to current and potential human impacts including future development and possible changes due to climate change.

Specific conductivity

Specific conductivity is a measurement of the ability of water to conduct electricity and is very dependent on the concentration of dissolved solids such as salt. Monitoring specific conductivity is useful for detecting the effects of road de-icings, as well as other pollution inputs. Specific conductivity deviations from normal baseline conditions are used to assess the effects of cold-weather treatment of roads and highways within the watershed area, and provide an indication of events causing potential source water contamination.

CCME CWQG for specific conductivity has yet to be specified. However, the impact that human activities have on specific conductivity levels may be formulated through measurement, i.e., sites LMG2, LM3, LMG4, and LMG5, which have no known human inputs, all have a specific conductivity $\sim 30\mu\text{s}/\text{cm}^2$; while sites LMG1, LMG6, and LMG7 are impacted to some degree by anthropogenic activities (see *Table 15: Lake Major Specific Conductivity Results* (Avg. by Year 2009 – 2016 $\mu\text{s}/\text{cm}^2$)* below). Specific conductivity for LMG1 and LMG7 are $271\mu\text{s}/\text{cm}^2$ and $270\mu\text{s}/\text{cm}^2$ respectively, where both sites are directly downstream of developed areas; LMG1 is below a major drainage point of North Preston and runs along and under Lake Major Road; and LMG7 is a major drainage point of a golf course which runs under Crane Hill Road. LMG6 levels are only slightly elevated at $56\mu\text{s}/\text{cm}^2$, where the tributary originates from Montague Mines area, a less developed area when compared to LMG1 and LMG7.

Table 15: Lake Major Specific Conductivity Results* (Avg. by Year 2009 – 2016 $\mu\text{s}/\text{cm}^2$)

Year \ Sample Site Name	2009	2010	2011	2012	2013	2014	2015	2016
LMG1	239	369	279	191	217	212	212	277
LMG2	32	33	37	-	-	-	-	-
LMG3	27	25	30	27	27	24	22	23
LMG4	34	30	30	-	-	-	-	-
LMG5	33	30	32	-	-	-	-	-
LMG6	43	57	58	60	69	67	64	72
LMG7	218	292	324	215	213	270	487	337
DLS	-	33	34	33	-	31	30	30

* All results are Baseline Conditions unless otherwise indicated

Halifax Water, HRM public works and NSTIR met in May 2013 to discuss winter road maintenance practices and to share water quality information. HRM and NSTIR acknowledged the water quality data collected by Halifax Water and the need to improve the water quality based on that data. HRM suggested that operator awareness and road de-icing best management practices would help to reduce the impact of cold weather road practices on water quality. NSTIR and HRM indicated they would share the information with operations staff and search for possible solutions that would not compromise traffic safety. Follow-up letters have been received confirming NSTIR and HRM have spoken with operations and are working on solutions.

Halifax Water has also contacted the manager of the golf course which partially falls inside the Lake Major watershed, who has indicated they are also using best management practices aimed

at reducing their impact on the landscape. Halifax Water continues to collect samples from LMG1, LMG6, and LMG7 to monitor trends and work with the relative stakeholders to further reduce the impact on water quality.

Turbidity

Turbidity is a visual property of water, a measurement of light scattered and absorbed due to the presence of suspended material (i.e., organic or inorganic particles originating from the erosion of soil or re-suspension of bottom sediments).

Freshwater CCME standards for turbidity is set at 8 NTU's above background conditions. Sample site LMG7 exceeded the standard in 2015 and met it in 2016, however this location is a drainage water course from a nearby golf course which dissipates into the forest with no clearly defined path to a watercourse or waterbody (see *Table 16: Lake Major Turbidity Results* (Avg. by Year 2009 – 2016 NTU)* below).

Year Sample Site Name	2009	2010	2011	2012	2013	2014	2015	2016
LMG1	0.71	2.04	1.57	1.17	1.34	1.68	1.14	1.11
LMG2	0.39	0.57	0.38	-	-	-	-	-
LMG3	0.62	0.58	0.81	0.72	0.76	0.73	0.56	0.56
LMG4	0.58	0.72	0.77	-	-	-	-	-
LMG5	0.65	0.53	1.23	-	-	-	-	-
LMG6	0.32	0.64	0.94	0.94	0.62	0.75	0.93	1.38
LMG7	3.29	5.08	5.55	6.35	4.39	5.25	10.38	7.99
DLS	-	0.42	0.67	0.37	-	0.75	0.37	0.54

* All results are Baseline Conditions unless otherwise indicated

At sample points where human activity is limited, i.e., LMG2, LMG3, LMG4, and LMG5 the turbidity levels remains very low while areas where human activity is more prevalent, mainly due to development, turbidity levels of the raw water reach higher concentrations, see *Table 16* above. Overall, turbidity levels remain acceptable; however Halifax Water continues to monitor LMG1, LMG3, LMG6, and LMG7 for changes should they occur.

Colour

Colour is an aesthetic parameter that is normally present in surface water. Colour is not a concern to human health however a change in colour may be the first indication of a water quality problem. Further testing is required to tell the type of contaminant and to identify the source.

Colour was added to the Halifax Water SWQMP in 2013 to tract changes over time and to improve source water protection planning and the management of water treatment plants. See *Table 17* below for Colour samples collect in the Lake Major watershed.

Historic water quality colour prior to Hurricane Juan was around the 29 TCU range; however continued to rise for about a 10 year period after. It has only been in the last 2-3 years that colour is showing signs of recovery; however still has a way to go before it returns to baseline conditions prior to Hurricane Juan in 2003, (see *Table 17: Lake Major Colour Results* (Avg. by Year 2009 – 2016 TCU)* below.

Year	99	00	01	02	03 ^z	04	05	06	07	08	09	10	11	12	13	14	15	16
Sample Site Name																		
LMG1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	27	20	14
LMG2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LMG3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	52	65	48
LMG4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LMG5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LMG6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	60	70	44
LMG7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	47	22	25
DLS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	34	44	42
Raw Water Intake	28	29	29	24	37	29	25	35	36	40	47	39	52	51	52	37	39	35

* All results are Baseline Conditions unless otherwise indicated
03^z Denotes the year Hurricane Juan happened

The initial bump in colour is believed to be a result of the humus layer and sediment being washed into the water supply from the uprooted trees. The legacy of decaying trees left by Hurricane Juan, which could not be harvested due to slope, and location within protected wilderness and old growth areas, are the major contributors of colour, and total organic carbon (see *Table 22* on page 154) to the water supply.

Lab Tested

These lab tested parameters described in the subsections below are also used to set baselines to measure against during changes in activities within the watershed area. These source water samples are collected and contained in the appropriate bottles at the same sample points as the general field tested parameters and delivered to an independent laboratory for analysis. Results of samples may guide the investigation of whether changes are associated with land management activities.

The following describes the significance of sampling for total suspended solids (TSS), *E. coli*, Nitrate / Nitrite, Total Phosphorus (TP), and Total Organic Carbon parameters that are sent to an independent lab for analysis (as described in the previous paragraph):

Total suspended sediments (TSS)

Total Suspended Solids (TSS) are solids found in water that can be trapped in a filter. Increased suspended solids change a stream's ecological integrity by filling in interstitial spaces between rocks, altering the stream bottom and affecting light penetration in the water column. These effects have a cascading effect (i.e., there is a decrease in dissolved oxygen, causing stress on aquatic biota and an increase in TSS-associated substances). Changes in TSS can be indicative of erosion and run-off. For example, land-use activities such as forestry, agriculture or community development can increase the amount of sediment released into a stream or lake. CCME WQGPAL for TSS is based on clear flow or high flow conditions as described on the following page.

Clear flow conditions

Maximum increase of 25 mg/L from background levels for any short-term exposure (i.e., 24 hour period). Maximum average increase of 5 mg/L from background levels for longer term exposures (i.e., inputs lasting between 24 hours and 30 days); and/or

High flow conditions

Maximum increase of 25 mg/L from background levels at any time when background levels are between 25 and 250 mg/L and should not increase more than 10% of background levels when background is ≥ 250 mg/L.

Background conditions indicate that TSS levels for the Lake Major system fall within CCME WQGPAL for clear and high flow conditions (see *Table 18: Lake Major TSS Results** (Avg. by Year 2009 – 2016 mg/L) below), exceptions include:

- A spike of 110mg/L in the month of June for LMG2. No known activities were taking place in the vicinity at that time. Since the TSS levels have returned to background conditions; and
- Water quality baseline data for LMG7 suggests normal background conditions for TSS to be ~9 mg/L. Mainly during summer months TSS levels for LMG7 have reached 30 plus mg/L; August 2010 180mg/L. These observations support the reasoning behind choosing this sample site; to monitor the impact of golf course practices on water quality as it leaves the property. At this time, Halifax Water has no immediate concerns that the water supply will be impacted as the area affected is not in close proximity to a water body or a defined watercourse. Halifax Water will continue to monitor LMG7 for any abnormalities above what has been monitored to date. Should those abnormalities be observed and water quality impact to the water supply is imminent, Halifax Water will have the information necessary to facilitate discussions with the golf course to remedy the situation.

Year Sample Site Name	2009	2010	2011	2012	2013	2014	2015	2016
LMG1	ND	3.04	1.68	1.53	3.00	4.2	1.96	ND
LMG2	ND	20.75	ND	-	-	-	-	-
LMG3	ND	ND	ND	ND	ND	ND	ND	ND
LMG4	ND	ND	ND	-	-	-	-	-
LMG5	ND	ND	1	-	-	-	-	-
LMG6	ND	ND	ND	ND	ND	ND	ND	ND
LMG7	8.33	23.92	14.75	14.63	4.85	28.33	33.07	19.05
DLS	-	ND	ND	ND	-	ND	ND	ND

* All results are Baseline Conditions unless otherwise indicated

E. coli

E. coli is an indicator of how much fecal contamination is entering a water system through human or animal waste. However, research suggests *E. coli* may not be the best indicator as it mutates over time, making it difficult to identify where the contamination originated. CCME WQGPAL for *E. coli* is not specified. Until an alternative cost-effective and qualitative scientific method is identified, Halifax Water will continue to gather *E. coli* samples and report results.

E. coli data collected from 2009 to 2016 suggests sites LMG2, LMG3, LMG4, LMG5, LMG6, and LMG7, for the most part, are within acceptable limits, see Table 19: Lake Major *E. coli* Results* (Avg. by Year 2009 – 2016 mg/L) below. These sites experienced small increases over the summer months due mainly to warmer water temperatures and lower water levels or after a rainfall event causing natural fecal bacteria to be washed in to the system. LMG1 is directly downstream from a major drainage point greatly influenced by run off from the community of North Preston and an overflow pipe from a Halifax Water wastewater pumping station (see section 3.1.6: North Preston Wastewater Treatment Plant on page 82).

Sample Site Name \ Year	2009	2010	2011	2012	2013	2014	2015	2016
LMG1	11.5	44.9	33	5.5	8.4	12.1	28.9	16
LMG2	ND	1.8	1.0	-	-	-	-	-
LMG3	ND	1.2	2.2	ND	ND	ND	ND	ND
LMG4	ND	2.1	ND	-	-	-	-	-
LMG5	ND	ND	3.0	-	-	-	-	-
LMG6	1.3	ND	3.3	6.9	1.8	6.2	27.1	14
LMG7	ND	3.0	2.2	3.7	7.0	1.7	ND	18
DLS	-	ND	ND	ND	-	ND	ND	ND

* All results are Baseline Conditions unless otherwise indicated

Total Phosphorus and Nitrate-Nitrogen

Total phosphorus and nitrate-nitrogen concentrations are used to monitor nutrient loading in a freshwater system. Excess nutrient loading is harmful to an aquatic ecosystem and promotes an increase in trophic status, which can result in algal and plant growth. These conditions are a concern for drinking water quality due to the difficulty in removing nitrate-nitrogen through the water treatment process, and loss of aquatic habitat biodiversity. Excessive growth places oxygen demands on aquatic systems during organic breakdown of material, and can promote the secretion of algal toxins.

Total Phosphorus (TP)

Phosphorus is not considered to be toxic by itself. However, phosphorus is the key limiting nutrient that determines the trophic status of aquatic ecosystems. The CCME WQGPAL TP trigger range is 20µg/L. Recorded ranges for TP that indicate trophic status levels are:

- ultra-oligotrophic <4
- oligotrophic 4-10
- mesotrophic 10-20
- meso-eutrophic 20-35
- eutrophic 35-100
- hyper-eutrophic >100

The water quality levels observed in the Lake Major watershed area system are well within the TP 20µg/L trigger range as outlined in *Table 20: Lake Major Total Phosphorus Results** (Avg. by Year 2009 – 2016 µg/L) below, except for LMG7, the latter being associated with a drainage ditch of a local gold course driving range. The risk of LMG7 phosphorus loading affecting the water supply is very low because there is no direct path to the water supply and most of the phosphorus should be taken up by the surrounding vegetation.

Sample Site Name \ Year	2009	2010	2011	2012	2013	2014	2015	2016
LMG1	ND	11	15	8	6	14	14	12
LMG2	ND	13	5	-	-	-	-	-
LMG3	ND	5	10	6	6	3	9	6
LMG4	ND	9	14	-	-	-	-	-
LMG5	ND	6	14	-	-	-	-	-
LMG6	ND	11	19	12	10	12	16	9
LMG7	ND	17	24	18	11	13	19	43
DLS	-	ND	5	5	-	ND	4	ND

* All results are Baseline Conditions unless otherwise indicated

Nitrate-Nitrogen

Nitrogen is the second limiting nutrient in influencing trophic status of freshwater systems. Nitrogen occurs in freshwater in numerous forms; the major form of inorganic nitrogen is likely found in the nitrate form.

GCDWQ standards for nitrate concentrations are 10µg/L which is a higher standard than CCME's WQGPAL, at 13µg/L; therefore, Halifax Water uses the GCDWQ for nitrogen as the minimum acceptable baseline standard (10µg/L). All nitrate/nitrite samples collected since 2009 from the Lake Major water quality sampling locations are well below the detection limit (see *Table 21: Lake Major Nitrate Results** (Avg. by Year 2009 – 2016 µg/L) on page 154).

Studies suggest there is a link between nitrate and nitrite and health issues such as Blue Baby Syndrome as well as possible links to cancer if consumed. Nitrate is difficult and expensive to remove from untreated water; therefore, it is best to avoid increases in nitrogen levels in the water supply. Halifax Water will continue to monitor phosphorus and nitrate-nitrogen

concentrations. If water quality becomes impacted, water quality background information will assist Halifax Water in developing effective solutions.

Table 21: Lake Major Nitrate Results* (Avg. by Year 2009 – 2016 µg/L)

Sample Site Name \ Year	2009	2010	2011	2012	2013	2014	2015	2016
LMG1	0.62	0.48	0.40	0.28	0.32	0.16	0.15	0.14
LMG2	ND	ND	ND	-	-	-	-	-
LMG3	ND	ND	ND	ND	ND	ND	ND	ND
LMG4	ND	ND	ND	-	-	-	-	-
LMG5	ND	ND	ND	-	-	-	-	-
LMG6	ND	0.063	0.006	0.062	0.047	0.082	0.058	0.064
LMG7	0.12	0.12	0.046	0.050	0.045	0.061	0.025	0.062
DLS	-	ND	ND	ND	-	ND	ND	ND

* All results are Baseline Conditions unless otherwise indicated

Total Organic Carbon (TOC)

Total organic carbon concentration is indicative of organic matter loading into source water supplies. Elevated organic matter concentrations can result in taste and odour issues and lead to the formation of disinfection by-products. Dissolved organics can also play a role in the transport and availability of metals (i.e., methyl mercury). There is no maximum allowable concentration (MAC) for TOC for either the WQGPAL or GCDWQ because there is no known health concern directly related to elevated TOC concentrations. Detection limits are at 0.5 mg/L.

Lake Major watershed TOC concentrations are highest in areas where natural processes prevail, with little human interference; specifically, at LMG3, LMG4, LMG5, and LMG6. Areas where human impact is prevalent, LMG1 and LMG7, deforestation and development limit TOC concentrations. See *Table 22: Lake Major TOC Results* (Avg. by Year 2009 – 2016 mg/L)* below.

Table 22: Lake Major TOC Results* (Avg. by Year 2009 – 2016 mg/L)

Sample Site Name \ Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
LMG1	-	-	-	-	-	3.1	3.2	3.6	3.0	3.0	3.8	3.0	3.3
LMG2	-	-	-	-	-	3.5	5.8	4.2	-	-	-	-	-
LMG3	-	-	-	-	-	6.4	5.5	5.9	6.0	6.1	4.9	5.8	5.5
LMG4	-	-	-	-	-	10.1	7.5	9.7	-	-	-	-	-
LMG5	-	-	-	-	-	10.8	8.8	11.0	-	-	-	-	-
LMG6	-	-	-	-	-	8.0	7.1	8.5	7.7	7.6	6.9	8.3	6.0
LMG7	-	-	-	-	-	2.6	4.0	5.1	3.9	3.5	5.8	5.3	4.7
DLS	-	-	-	-	-	-	4.3	5.7	5.3	-	4.3	4.5	4.7

Raw Water Intake	2.3	4.1	-	-	5.1	-	4.0	3.9	4.6	4.7	4.4	4.7	4.7
* All results are Baseline Conditions unless otherwise indicated													

Lake Major’s water treatment process removes adequate TOC concentrations to ensure that disinfection by-products such as trihalomethanes are reduced to below acceptable levels when they leave the plant.

Halifax Water will continue to measure TOC to properly assess the health of the water supply. If CCME WQGPAL or GCDWQ change, Halifax Water will have adequate water quality information available to aid in water quality management decision-making.

Total Chloride

Chlorides are measured across the watershed to better understand natural conditions and monitor for anthropogenic activities. CCME WQGPAL chloride levels considered toxic to aquatic life are; short term concentration is 640mg/L and long term concentration is 120mg/L.

All data from the seven sample points indicate that the water quality is well below the total chloride concentration limit. Water quality collected from undeveloped areas, namely LMG3, LMG4, and LMG5, have very low chloride levels, while sites LMG1, LMG6, and LMG7 which are all impacted to some degree by anthropogenic activities portray the highest chloride levels, see *Table 23: Lake Major Chlorides Results* (Avg. by Year 2009 – 2016 mg/L)* below..

Table 23: Lake Major Chlorides Results* (Avg. by Year 2009 – 2016 mg/L)								
Sample Site Name \ Year	2009	2010	2011	2012	2013	2014	2015	2016
LMG1	69	56	38	39	40	39	30	35
LMG2	-	-	-	-	-	-	-	-
LMG3	-	3.7	5.2	-	4.3	-	3.8	-
LMG4	-	4	3	-	-	-	-	-
LMG5	-	4.5	4	-	-	-	-	-
LMG6	-	15	12	-	18	11	13	13
LMG7	56	68	53	-	63	59	53	74
DLS	-	5.5	6	5.5	-	5.5	4.7	5.5
* All results are Baseline Conditions unless otherwise indicated								

Total Sulphate

Although naturally occurring, sulphate levels are measured throughout the watershed to better understand the potential risk industrial emissions, which are linked to climate change, have on water quality, see section 3.2.1 *Climate Change* on page 111.

As more information is collected water quality baselines will become more apparent. *Table 24: Lake Major Total Sulphate Results* (Avg. by Year 2009 – 2016 mg/L)* below illustrates the level of sulphates collected since 2016 in the water supplies.

Year Sample Site Name	2009	2010	2011	2012	2013	2014	2015	2016
LMG1	-	-	-	-	-	-	-	7.0
LMG2	-	-	-	-	-	-	-	-
LMG3	-	-	-	-	-	-	-	<2.0
LMG4	-	-	-	-	-	-	-	-
LMG5	-	-	-	-	-	-	-	-
LMG6	-	-	-	-	-	-	-	3.1
LMG7	-	-	-	-	-	-	-	9.0
DLS	-	-	-	-	-	-	-	2.4
Raw Water Intake	-	3	3	2.5	2.5	2.1	<2.0	2.7

* All results are Baseline Conditions unless otherwise indicated

Metals Scan

Metals occur naturally within soils and bedrock and can present a negative impact to drinking water quality. Therefore, it is important to determine which metals are detectable within the Lake Major water supply and whether they are within the recommended GCDWQ and CCME WQGPAL, and/or are present as a result of watershed area activities.

Water chemistry of surface waterways is highly influenced by the kind of soil and rock through or over which the water flows. The main physical, chemical and biological parameters that influence water composition are temperature, pH, redox potential, adsorption and desorption processes from inorganic or organic suspended matter or bottom sediments, cation exchange, dilution, evaporation, and presence of organisms. These conditions are the product of natural background conditions and/or anthropogenic activities that cause heavy metals to accumulate to critical levels in the food web and damage to organisms on a higher trophic level.

Metal samples are collected twice a year; once during low-flow conditions (typically in July) and once during high-flow conditions (typically in September) at each of Halifax Water’s six sample point locations.

The following are the most prevalent metal concentrations found in the Lake Major watershed.

Arsenic

Arsenic levels at LMG6 were consistently higher than both the CCME guidelines for the Protection of Aquatic Life - 5µg/L and Health Canada’s GCDWQ standard - 10µg/L, see *Table 25: Lake Major Arsenic Results* (Avg. by Year 2009 – 2016 µg/L)* on page 158. The tributary monitored at LMG6 originates from the Montague Gold Mines area where gold was mined in the 1860’s. Arsenic is associated with gold deposits and is considered a health risk in drinking water. No other tributary shares the same level of concentrations; most are below the detection limit of 1µg/L. Arsenic levels taken in the Lake Major Deep Lake Sampling Program are also below the 1µg/L detection limit. There is no immediate cause for concern to the water supply; however a

close watch on human activities such as further residential build-up in the area or the possibility of a gold mine reopening are concerns.

Table 25: Lake Major Arsenic Results* (Avg. by Year 2009 – 2016 µg/L)

Sample Site Name \ Year	2009	2010	2011	2012	2013	2014	2015	2016
LMG1	-	ND	ND	ND	ND	8.25	ND	ND
LMG2	-	ND	-	-	-	-	-	-
LMG3	-	ND	ND	ND	ND	ND	ND	ND
LMG4	-	ND	-	-	-	-	-	-
LMG5	-	ND	-	-	-	-	-	-
LMG6	-	39.5	24.8	25.05	22.25	21	35	23.5
LMG7	-	2.35	2.56	2.06	1.58	2.8	2.51	1.6
DLS	-	ND	ND	ND	ND	ND	ND	ND

* All results are Baseline Conditions unless otherwise indicated

Aluminum

Aluminum is the most abundant element on earth, making up about 8% of the earth’s crust and is found naturally in foods such as spinach, potatoes and tea. It is widely used throughout the world in manufacturing processes, agriculture industries and as a coagulant in the treatment of drinking water to reduce the organic matter, colour, turbidity and microorganisms contained in raw water.

Aluminum concentrations in natural waters “*can vary significantly depending on various physicochemical and mineralogical factors*”. Also, “*acid environments caused by ... acid rain [accumulated in the soils] can cause an increase in the dissolved aluminium content of the surrounding waters (ATSDR, 1992; WHO, 1997).*” PH influences the solubility of aluminum such that “[i]n pure water, aluminium has a minimum solubility in the pH range 5.5–6.0; and concentrations of total dissolved aluminium increase at higher and lower pH values (CCME, 1988; ISO, 1994).” The main sources of aluminum in the environment are from fertilizers, sewage sludge, mining and smelting.

The CCME WQGPAL recommends maximum aluminum concentration levels at: 5µg/L where pH is <6.5 and 100µg/L where pH is >6.5. Studies associating the link of human health effects due to the consumption of high levels of aluminum found in drinking water (<2000µg/L) are inconclusive, therefore, presently there is no recommended Maximum Acceptable Concentration (MAC) for Aluminum. With reference to *Table 14: Lake Major pH Results* (Avg. by Year 2009 – 2016)* on page 145, Lake Major’s source water pH levels, for the most part are hovering near or below a pH of 5, therefore aluminum levels should not exceed 5µg/L for the CCME WQGPAL. However, as *Table 26: Lake Major Aluminum Results* (Avg. by Year 2009 – 2016 µg/L)* on page 159 illustrates, Lake Major aluminum hovers around the 200-250µg/L. This demonstrates the impact natural background conditions already have on water quality. This is why it is very important to understand baseline conditions prior to any proposed activities.

Year Sample Site Name	2009	2010	2011	2012	2013	2014	2015	2016
LMG1	-	69.55	87.7	85.15	108	140	35	107.5
LMG2	-	309	-	-	-	-	-	-
LMG3	-	269	313.5	312.5	305	265	270	265
LMG4	-	207	-	-	-	-	-	-
LMG5	-	314	-	-	-	-	-	-
LMG6	-	233	196.5	329.5	272.5	190	215	102
LMG7	-	55.95	120	91.96	51.85	114.3	126.86	153.4
DLS	-	211	245	237	-	203	210	207

* All results are Baseline Conditions unless otherwise indicated

Deep Lake Sampling

The Bathymetry of Lake Major at its deepest point is 65.0 (see *Appendix 5: Bathymetry Maps and Data of Three (3) of Four (4) Largest Lake Major Watershed Lakes (Major, East and Spider)* on page 171).

Weather permitting, Deep Lake Sampling (DLS) is carried out in Lake Major (see sample site location indicated on *Map K: Lake Major HRWC Services and Development Risk Areas* on page 117) quarterly. Deep-lake sampling is collected to better understand baseline conditions of the water supply characterize the water supply source and monitor for any changes in baseline water-quality conditions. The method used to conduct deep lake sampling involves collecting several discrete water samples at various depths using a single volume-weighted sampling unit.

Deep lake water quality information collected to date is outlined in *Table 13 – Table 26* beginning on page 145. Based on the information gathered, Lake Major displays oligotrophic characteristics capable of supporting a wide range of aquatic life despite natural elevated aluminum levels characteristic of the watershed geology.

5.4.2 Risk-Based Sampling

Risk-based sampling is scheduled and linked to probable risk(s). Results of the sampling may lead to changes in management, protection efforts, regulations and/or restriction of certain activities.

Petroleum Hydrocarbons

Petroleum-hydrocarbon is monitored at three (3) locations, LMG1, LMG6, and LMG7 for potential spills associated with vehicle traffic and home heating in the communities of North Preston, East Preston, and Lake Major. Samples are collected twice a year, March and September during high water-flow periods. To date, samples collected show no indication of Petroleum-hydrocarbon contamination. Halifax Water will continue to monitor these locations as precautionary measures and to raise the alert should one arise.

5.4.3 Activity-Based Sampling

Activity-based sampling is scheduled during known or planned events such as WSP backwash, forestry land-management or other known activities. Activity-based sampling helps determine cause-and-effect relationships and short- and long-term effects of impacts on the watershed area that help determine how best to manage land-use activities and the frequency with which physical patrols and water quality monitoring are conducted. The parameters tested for are determined by the activity and the impact it may present to the water supply source, as described in the subheadings below.

Water Supply Plant Discharge:

After the water treatment process, filtered backwash water is discharged to Lake Major after it has met the required Approval to Operate (AOP) performance standards and limits set by NSE. Samples are collected at a location half way between the WSP and Lake Major, below where the drying bed pipes connect with the outfall pipe. The mouth of the outfall-pipe is approximately 15m offshore in approximately 15m of water. Lake Major's AOP discharge limits are as follows:

Suspended Solids

Maximum concentrations of suspended solids 20mg/L leaving the backwash water have not been an issue for Halifax Water except at times when the centrifuge has experienced maintenance issues. The centrifuge has only been down 3 times since 2005. During these times, concentrations have ranged from 300-400mg/L during major issues and 25-50mg/L during minor maintenance problems. To reduce the impact to the receiving waters, hydro vacuum trucks provide temporary relief until the centrifuge is up and running again.

Aluminum Concentrations

Maximum aluminum concentrations in the discharge water shall not exceed background concentrations (< 0.25mg/L or 250µg/L) in Lake Major. Recently an issue has been discovered with aluminum concentrations in the discharge water. Through laboratory tests carried out at the WSP lab, it was believed that aluminum concentrations were below natural lake background conditions (See *Table 26* row DLS on page 159) and AOP limits. However, it has come to Halifax Water's attention recently that this is not so.

Third-party laboratory services results show that the concentrations are much higher than originally thought. The third-party laboratory analysis is much more complex; acid is added to the sample to dissolve aluminum particulates that may exist. This allows the true concentration of the outgoing back wash water to be measured. Halifax Water's method does not use an acid to dissolve the particulates; therefore, concentration levels are missing the larger particulate concentrations. For instance, in 2012, Halifax Water's testing method captured an average of 72.44µg/L of concentrate being discharged into Lake Major, well below both the AOP guideline and the CCME guidelines for the Protection of Aquatic Life at 100µg/L. The third-party laboratory services, however, measured an average of 490µg/L in 2012, well above the AOP limit and CCME guidelines for the Protection of Aquatic Life. Halifax Water is working towards a solution to correct the problem.

Chlorine Residual

Chlorine residual in discharge shall not exceed 0.002mg/L (2µg/L). Vita-D-Chlor neutral, an environmentally friendly chemical is added as a de-chlorination agent to the discharge water prior to leaving the plant. A sample is collected half way to Lake Major as outfall location as it is in 15m of water. The AOP residual Chlorine limit is set by NSE is 0.002mg/L (2µg/L), which is the threshold for most aquatic organisms. Samples collected to date show a residual yearly average of 0.021mg/L (21µg/L). At the moment Halifax Water is looking at ways to correct the situation by optimizing the outfall treatment process.

pH

Backwash water pH levels are just meeting the minimum AOP limits (6.5 to 9.0) set by NSE. The AOP pH limits are the same as CCME Protection of Aquatic Life limits. Average pH levels taken by Halifax Water are approximately 6.45, while pH measurements taken to a third party lab are approximately 6.80. Discrepancies could be due to temperature differences during time of measurement. Natural pH conditions observed through the Lake Major SWQMP and the DLS program are below CCME guidelines for the Protection of Aquatic life; the average pH is 4.75 for top to bottom measurements taken every meter, while surface pH levels average around 5.2. Currently, Halifax Water and NSE are assessing options to meet compliance.

Discharge summary

Discharge from the WSP must be non-toxic to aquatic life. For the most part, backwash water returning to Lake Major meets the CCME guidelines for the Protection of Aquatic Life and in most cases re-enters Lake Major at a higher quality than when it was withdrawn. The parameters that are of concern are addressed in the previous sub-sections that describe the acceptable discharge limits.

E. coli

Activity-based *E. coli* sampling is a result of activities such as removing beaver dams, or wastewater replacement programs within the watershed. When there is a clear and direct pathway to the lake during an activity, *E. coli* sampling will be performed daily and continue for one week after the event is over.

Total Phosphorus and Nitrate-Nitrogen

Phosphorus and nitrate testing may occur following scheduled activities such as forestry related herbicide applications, and/or development activities. Water samples will be taken daily for two weeks prior to activities commencing and continue daily for a minimum of two weeks after the activity has stopped or concentrations drop below findings prior to application. Samples will be taken at any lake, stream or tributary running within 200m of the operation within the watershed area. If concentrations increase above acceptable limits due to the operations, the operations are to stop immediately and be reported to NSE.

Pesticides

Pesticide sampling may occur following scheduled activities such as forestry related pesticide application and/or golf course maintenance. Sampling will be conducted daily for two weeks prior to activities commencing and continue daily for two weeks after the activity has stopped and/or concentrations drop below findings prior to application. Samples will be taken at any lake, stream or running tributary within 200m of the operation within the watershed area.

For precautionary measures, LMG7, a drainage ditch of a golf course is monitored for pesticide use and potential run off into the watershed area. Samples are collected during the months of April, June, August and October of each year. To date, there is no indication of pesticide use. In addition to the SWQMP, pesticide testing samples are collected yearly at the intake through the compliance monitoring program. To date this program has also turned up negative results.

Total Suspended Sediments

Total suspended sediments typically increase in-stream during and immediately following activities such as forestry activities, road construction and maintenance, WSP discharge water or any other activity that requires crossing a stream. Increased suspended sediments change a stream's ecological integrity by filling in interstitial spaces between rocks, altering the stream bottom and affecting light penetration in the water column. These effects have a cascading effect (i.e., there is a decrease in dissolved oxygen, causing stress on aquatic biota and an increase in TSS-associated substances). With the exception of the Lake Major Water Treatment Plant, sampling will be conducted daily, directly below and during stream-crossing activities where there is a clear and direct pathway to the lake. If concentrations exceed 25mg/L or natural background conditions, operations are to stop immediately and be reported to NSE.

Petroleum Hydrocarbons

Activity based petroleum sampling is in response to events or spills occurring within the watershed area. In response to such an event, sampling will be conducted daily and continue for one week after operations have been completed. Samples will be collected from watercourses within 200m of the event site, as well as from affected dominant feeder streams downstream from the spill where it flows into Lake Major.

Metals Scan

Activity-based metal scan samples are collected at LMG1, LMG6, and LMG7 to measure any impacts from human-related cold-weather road activities along Montague Gold Mines Road, Lake Major Road, and Glasgow Road, as well as the potential for golf course green maintenance practices near LMG7.

Metal parameters worth noting are calcium, magnesium, potassium and sodium as they are associated with cold-weather road operations. Calcium and sodium concentrations at these three locations are in the 10,000's µg/L, while potassium and magnesium are in the 1000's µg/L. At the same time, where no known human inputs exist, LMG2-LMG5 calcium and sodium concentrations are in the 100's µg/L to low 1000's µg/L, while potassium and magnesium are in the 100's µg/L. The good news is since the SWQMP stepped up its monitoring operations in

2010, HRM has adopted best management practices (BMP) for its cold-weather road operations aimed at reducing the impact to water quality. Since then, all three locations have seen concentrations cut by more than half. For example, in 2010 LMG1 calcium concentrations were at an average of 21,500µg/L; while in the following years, 2011 to 2016 concentrations ranged from 3600 to 13,000µg/L.

Iron concentrations at LMG7 are 29 times greater than the average of the other six area sample sites; and manganese is 6 times greater than the next heaviest impacted location, LMG1, and 40 times higher than the non-impacted sites. Iron concentrations for LMG7 averaged 11,468µg/L, which exceeds the 300µg/L CCME guideline for the Protection of Aquatic Life. Background conditions in the area hovered around 33µg/L for manganese, well below the 1,323µg/L reading at LMG7. Presently, there are no suggested manganese guidelines for the Protection of Aquatic Life. After discussions with the golf course operator, golf course maintenance practices have been ruled out as the company does not fertilize the area within the watershed area. The golf course operator indicated they conduct soil samples yearly in order to properly treat the remaining grounds. The soil samples collected suggest iron and manganese levels are naturally high; therefore the only possible explanation is water quality is being negatively impacted by natural surrounding conditions.

Halifax Water will continue to gather information at sites LMG1, LMG6, and LMG7 to aid in mitigating issues in the areas that could negatively impact water quality and in working towards remediation of any other issues that have already been identified. LMG3 will continue to be sampled as a control point, as well as any for East Lake Dam issues that should arise.

Total Chloride

Activity based chloride sampling occurs following activities such as cold-weather road maintenance along major roadways within the watershed area such as the Lake Major Road, and Montague Gold Mines Road or any other human related chloride activity.

Road de-icing is not restricted within the Lake Major watershed; therefore, samples are collected monthly at LMG1, LMG6 and LMG7 from November to April of each year to specifically target the effects of cold-weather road maintenance activities on the watershed area. As was found in the metals scan for calcium, potassium, magnesium, and sodium described in the previous activity-based metals scan section, elevated chloride levels were also observed during the months that road salt was applied. Natural chloride background concentrations at approximately 4.5mg/L were observed, at LMG2, LMG3, LMG4, and LMG5; however, the sites affected by urbanization – LMG1, LMG6, and LMG7 – ranged from ~13mg/L to ~70mg/L. Even though CCME chloride guidelines for the Protection of Aquatic Life were exceeded, according to Halifax Water's numbers, HRM's adoption of cold-weather maintenance BMPs has further reduced the concentrations since 2010; LMG1, being the heaviest impacted site, averaged chloride concentrations of 56mg/L in 2010; while from 2011 to 2016 the levels were reduced to a range of 35-40mg/L, see *Table 23: Lake Major Chlorides Results* (Avg. by Year 2009 – 2016 mg/L)* on page 155. Halifax Water will continue to monitor LMG1, LMG6 and LMG7 as a precautionary measure and to improve base-line statistics.

In the event that any of the above activity-based parameters and their associated activities show a high risk to the water supply plant, consideration will be given to shut down the plant until the situation has passed or deemed to have no impact. The *Emergency Response Plan for Halifax Water* outlines the steps that are to be followed in regards to plant shut-down procedures and customer notification. Copies of the manual can be found at the Lake Major Water Supply Plant or Halifax Water's main office located at 450 Cowie Hill Road in Halifax.

5.4.4 Target-Based Sampling

Target-based sampling is done as a response to incidents or unplanned events such as fuel or environmental spills, significant weather events, or vandalism. Such sampling protects customers by providing a warning system through monitoring events that have the potential to shut down the supply plant.

Target-based sampling will be conducted at watercourses within at least 200m of the scene and in all dominant feeder streams downstream of the event at minimum 500m intervals daily until it reaches Lake Major, then daily at minimum 500m intervals along the lake(s) to track its progress. Sampling intensity could be increased and or reduced depending on whether detection limits persist and the contaminant progresses along the travel path. The pumping station will be shut down, if in operation, when an event occurs and high-levels of a contaminant persist within 500m of the pumping station. Sampling will continue until it has been determined there is no longer a threat to water quality and the plant can be restarted.

The following parameters are considered to present the highest probable threat to water quality in the event of an accident or unplanned event within the Lake Major watershed area and are monitored as described under the following headings.

Petroleum Hydrocarbons

Petroleum-hydrocarbon sampling may be conducted in response to incidents or unplanned events that could include, but are not limited to, forestry activities, traffic accidents, boating, and construction within the watershed area.

E. coli

E. coli sampling may be conducted in response to unplanned events such as an on-site septic-tank failure or overflows from the Long Lake lift station. From the sampling results it will be determined if there is a threat to the WSP and if a potential shutdown should be ordered.

Total Phosphorus and Nitrate-Nitrogen

Total phosphorus and nitrate-nitrogen sampling may be conducted in response to unplanned events such as, but not limited to, chemical spills, accidents, vandalism, deforestation, and golf course maintenance.

Turbidity

Turbidity samples will be collected in response to unplanned events such as a storm or fire and wastewater failure.

Chemical Spill

Chemical samples will be collected in response to incidents or unplanned events along Lake Major Road or within the communities of North Preston, East Preston, Lake Major, Lake Loon and Cherrybrook.

5.4.5 Operational/Compliance Raw Water Sampling

Operational raw water samples, requirement of the AOP, are collected daily at the WSP and is the responsibility of the WSP operator. Raw water compliance monitoring is also conducted at the intake and reported back to NSE. Water quality data gathered for both programs may be used as supplemental water quality data if necessary for the SWQMP.

5.4.6 Source Water Quality Monitoring Program Summary

The SWQMP indicates, under normal (baseline) conditions, that the Lake Major water supply, with minimal treatment, will meet GCDWQ and thereby provides an acceptable long-term water supply to Halifax Water customers served by the Lake Major system. It is strongly recommended that Halifax Water continue to monitor Lake Major watershed sample sites to continue to provide data that will guide watershed and/or water treatment plant decision-making; and continually assess and evaluate the program to ensure water quality needs are being met.

6. ACKNOWLEDGEMENTS

Halifax Water would like to acknowledge the following agencies for their professional support in creating this Source Water Protection Plan: Nova Scotia Environment, Nova Scotia Department of Natural Resources, and Nova Scotia Power.

Halifax Water also thanks its diverse staff for its professional support in the Source Water Protection Program: particularly Carl Yates, Reid Campbell, Garry Oxner, Barry Geddes and Anna McCarron; the Lake Major Watershed Advisory Board for its contribution to the SWPP.

**APPENDIX 1: LAKE MAJOR WATERSHED PROTECTED WATER AREA
DESIGNATION AND REGULATIONS**

APPENDIX 2: LMWAB TERMS OF REFERENCE

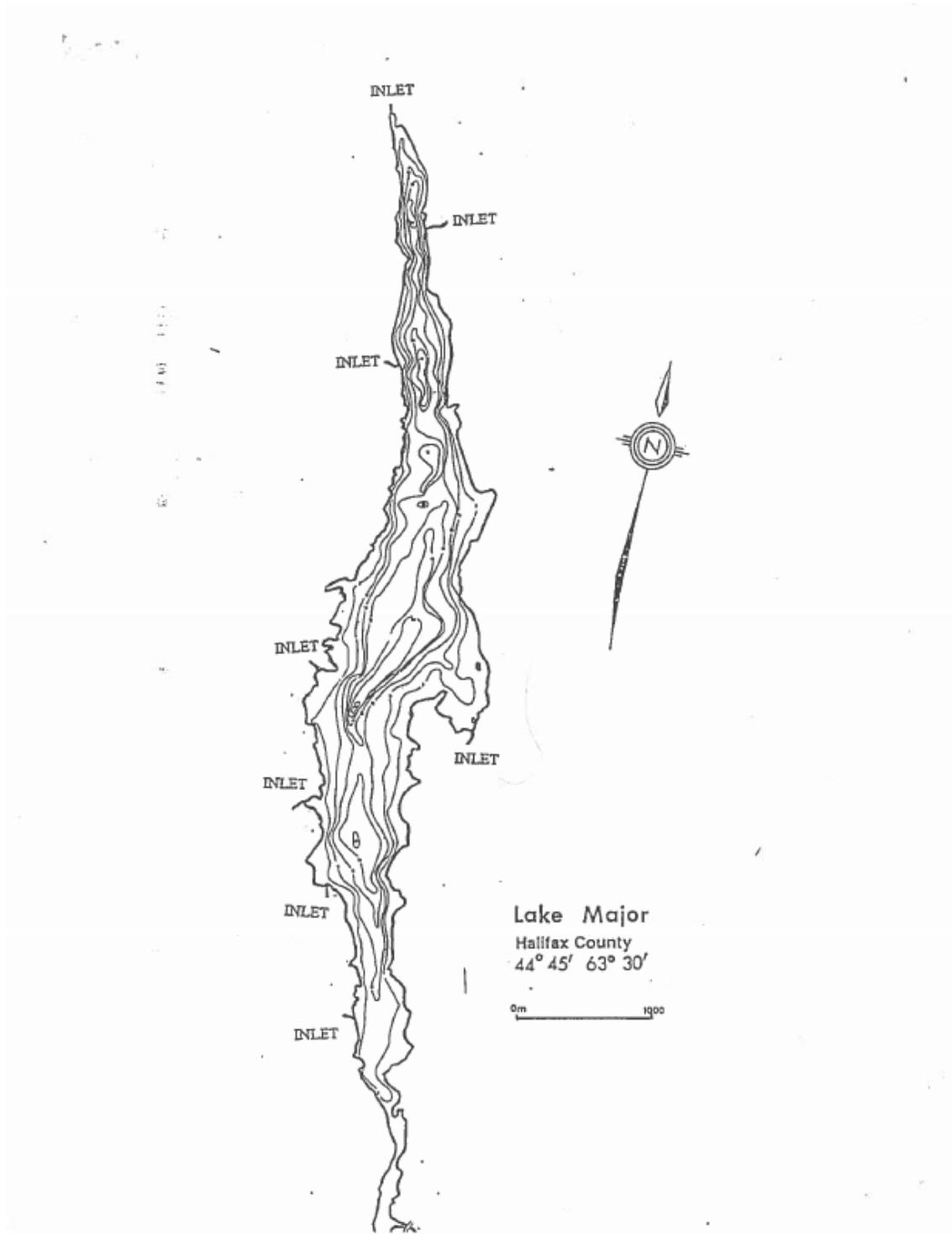
APPENDIX 3: PROPERTIES EXEMPT FROM PROVISIONS IN NORTH PRESTON - LAKE MAJOR LUB

APPENDIX "D" (of the North Preston – Lake Major LUB): PROPERTIES EXEMPT FROM THE PROVISIONS OF SECTIONS 3.6 and 4.21

APPENDIX 4: TRIBUTARY AND LAKE WATER SAMPLING LOCATIONS, FREQUENCY AND PARAMETERS

See *Map K: Lake Major HRWC Services and Development Risk Areas* on page 117 for illustration of sample sites.

**APPENDIX 5: BATHYMETRY MAPS AND DATA OF THREE (3) OF FOUR (4)
LARGEST LAKE MAJOR WATERSHED LAKES (MAJOR, EAST AND SPIDER)**

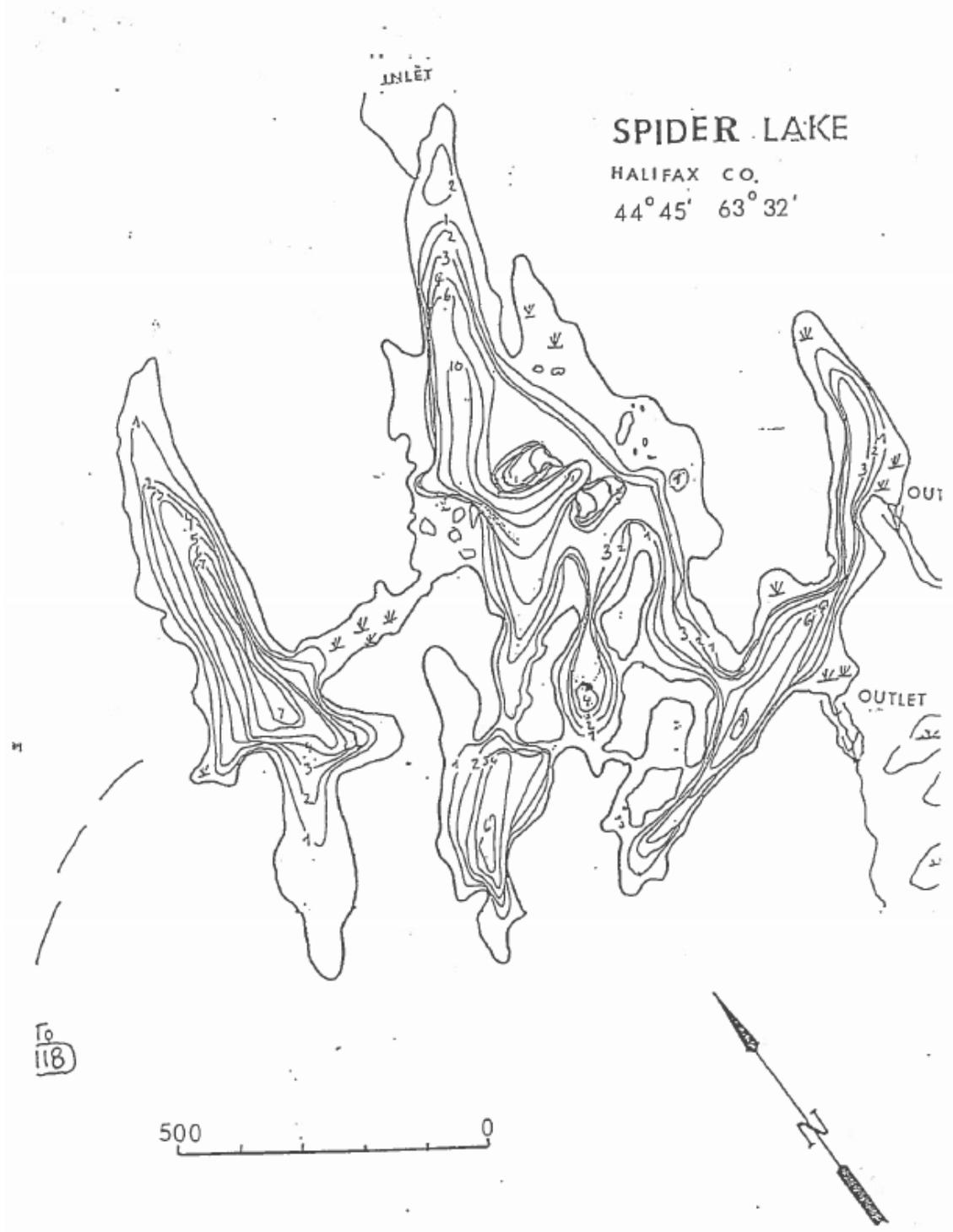


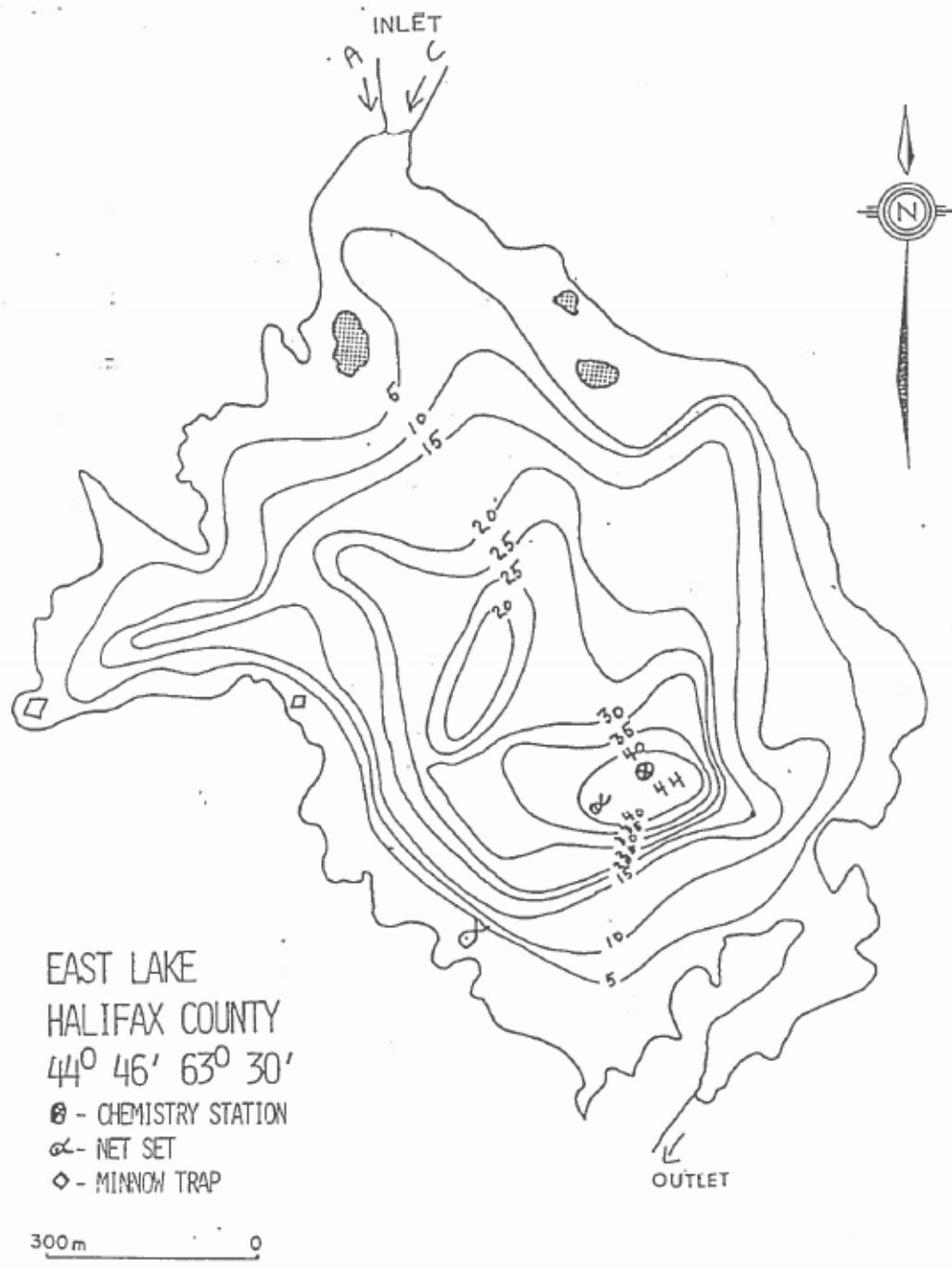
LAKE NAME: MAJOR
NS MAP REFERENCE: 24A4
CO-ORDINATES: 44456330
AREA (HA): 343.0
MAX. DEPTH (M): 65.0
ACCESS: DIRT ROAD
PROJECTED USE: LIGHT
SPAWNING HABITAT: EXCELLENT
SPECIES SAMPLED:
BROOK TROUT, AMERICAN EEL,

COUNTY: HALIFAX
LAKE CODE: 08909
SURVEY DATE: 15/08/84
PH: 4.8
TEMP.(C): BOTTOM 28.0
SURFACE 25.3
DO2(MG/L): BOTTOM 8.0
SURFACE 7.0
WATER CLASS: C
FISHERY RESOURCE
CLASS:

LAKE NAME: SPIDER
NS MAP REFERENCE: 24A4
CO-ORDINATES: 44456332
AREA (HA): 64.7
MAX. DEPTH (M): 10.0
ACCESS: LOGGING RD
PROJECTED USE: LIGHT
SPAWNING HABITAT:
SPECIES SAMPLED:
BROOK TROUT,

COUNTY: HALIFAX
LAKE CODE: 08193
SURVEY DATE: 22/08/89
PH: 5.2
TEMP.(C): BOTTOM 2.0
SURFACE 15.0
DO2(MG/L): BOTTOM 3.2
SURFACE 4.2
WATER CLASS: C
FISHERY RESOURCE
CLASS:





LAKE NAME: EAST	COUNTY: HALIFAX
NS MAP REFERENCE: 24B4	LAKE CODE: 08959
CO-ORDINATES: 44466330	SURVEY DATE: 08/08/84
AREA (HA): 74.1	PH: 4.6
MAX. DEPTH (M): 44.0	TEMP. (C): BOTTOM 6.4 SURFACE 25.1
ACCESS: DIRT ROAD	DO2 (MG/L): BOTTOM 10.0 SURFACE 8.0
PROJECTED USE: LIGHT	WATER CLASS: C
SPAWNING HABITAT: ADEQUATE	FISHERY RESOURCE CLASS:
SPECIES SAMPLED: BROOK TROUT,	
