Chapter 2
Table of Contents

List of Tables in Text

No tables are included in Chapter 2 text.

List of Figures in Text

No figures are included in Chapter 2 text.

*Other Figures and Tables may be found in Part II, *Tables, Figures, and Appendices*

2 Mississippi-Rideau Source Protection Region

Introduction

The physical and human features of a watershed play an important role in defining groundwater and surface water availability, vulnerability, and other characteristics. This chapter describes the two watersheds, the Mississippi Valley and the Rideau Valley watersheds, in the Mississippi-Rideau Source Protection Region (MRSPR) in terms of non-living (abiotic) features such as topography and geology and living (biotic) terrestrial and aquatic communities. It includes information on monitoring programs within the watershed and defines human settlement patterns within the region, discussing how these patterns can affect quality and quantity of our water resources.

Information in this chapter is provided both for the MRSPR as a whole, and for its two source protection areas, the Mississippi Valley Source Protection Area (MVSPA) and the Rideau Valley Source Protection Area (RVSPA).

Summary of Key Findings

The MRSPR consists of two subwatersheds in the Ottawa River Basin, the Mississippi and Rideau watersheds, and has been divided into 20 natural subwatersheds and 22 subwatersheds for the purpose of developing the Water Budget found in Chapter 3. The region covers an area of 8,585 square kilometres (km^2).

Regional geological features have been greatly influenced by glacial activity, especially by the most recent Wisconsin glaciation. Surface water in the region is comprised of hundreds of lakes, wetlands, and rivers.

Groundwater consists of two key aquifers, the Oxford – March dolostone aquifer and the Nepean Sandstone aquifer. Portions of the region have other unconfined and confined overburden aquifers. Water quality in the region reflects the influences of natural factors such as soil or rock types which come in contact with the water.

The most prominent types of land cover are:

- Forest, covering 41%;
- Agricultural crops and rural land uses, covering 18% and 17%; and
- Wetland and water bodies, covering 13% and 7% of the region.

Approximately five percent of the MRSPR is settled. Settlement in the region consists of the City of Ottawa as well as numerous towns, villages and scattered rural hamlets. Population density varies widely, from the very dense urban areas found in the City of Ottawa to very sparse populations in the western portion of the watershed. The total population for the MRSPR in 2006 is estimated at approximately 865,000.

Surface water quality in the region is generally good to excellent, with some indications of impairment related to human activity primarily in the vicinity of settlement areas.

Regional groundwater quality within the MRSPR is generally good. In some local instances mineral composition of aquifer material may adversely affect the quality of a groundwater supply aquifer. Similar to surface water quality, human activities may have local impacts on the groundwater quality and/or quantity.

Technical Studies

The Mississippi-Rideau Source Protection Region Watershed Characterization Report (2008) is the key source of information for this chapter. Further details on physical and human geography in the MRSPR are found in that report. Information on data gaps may be found in Chapter 8. A summary of all supporting reports for the MRSPR Assessment Report may be found in Appendix A-1.

2.1 Watersheds in the Source Protection Region

The MRSPR is located in eastern Ontario, with an area of 8,585 km^2. The region includes watersheds and subwatersheds that discharge to the Mississippi River, Rideau River or Ottawa River. Figure 2-1 shows the map of the MRSPR.

The Mississippi-Rideau Source Protection Region is one of 19 watershed regions identified in Ontario's Clean Water Act. The MRSPR consists of all jurisdictional areas of the Mississippi Valley Conservation Authority (MVC) and the Rideau Valley Conservation Authority (RVCA). The Mississippi Valley Source Protection Area and the Rideau Valley Source Protection Area encompass the same lands as the respective Conservation Authorities.

2.1.1 Watershed Boundaries

The boundaries of the MRSPR are defined by the boundaries of the Rideau watershed to the east and Mississippi watershed to the west. The Carp River and smaller water courses within the City of Ottawa drain into the Ottawa River and are included in the MRSPR even though, strictly speaking, they are not part of either watershed. As well, the Ontario portion of the Ottawa River adjacent to the

City of Ottawa is included. As illustrated in Figure 2-1, the two major watersheds are of roughly the same size.

Mississippi River Watershed

The Mississippi River watershed is 3,765 km^2 in size. Headwaters in Mazinaw Lake have an elevation of 325 metres above sea level (masl). The river flows 212 km to a downstream elevation of 73 masl, for a total drop of 252 metres (m) and an average slope of 0.1%. These characteristics are summarized in Table 2-1.

Rideau River Watershed

The Rideau River watershed is 3,849 km^2 in size. It extends from Burridge Lake, at an upstream elevation of 163 masl, for 160 km to a downstream elevation of 40 masl, for a total drop of 123 m and an average slope of 0.08%. These characteristics are summarized in Table 2-2.

Carp River Watershed

The Carp River watershed falls within the MVSPA and covers an area of 300 km^2. It flows northwest from Stittsville to Kinburn then bends to the north, emptying into the Ottawa River downstream of Chats Lake at Fitzroy Harbour. The Carp River drops 48.8 m over 45.8 km for an average slope of 0.1%.

Ottawa River Tributaries

Within the boundaries of the City of Ottawa, several smaller streams drain directly into the Ottawa River. The smaller streams include Constance Creek, Still Water Creek, Pinecrest Creek, Shirley's Brook, Watts Creek in the MVSPA, and Green Creek and Bilberry Creek in the RVSPA. The total drainage area of these streams is 672 km^2.

2.1.2 Subwatershed Areas

In total, 20 natural subwatersheds have been identified within the MRSPR. The subwatersheds are identified in Table 2-3 and their locations are shown in Figure 2-1. Table 2-3 identifies the source protection area (MVSPA or RVSPA) where each of the subwatersheds are located.

NOTE: Discussions on the Tier I water budget in Chapter 3 refers to 22 subwatersheds. These subwatersheds were determined by streamflow gauge locations (where available) for the purpose of determining water budget calculations and should not be confused with natural subwatersheds.

Figure 3-1 shows the subwatersheds which are delineated in the water budget. Table 2-4 lists the size of the major drainage areas of the 20 natural subwatersheds.

Neighbouring Source Protection Areas/Regions

Source Protection areas and regions found adjacent to the MRSPR are the Raisin-South Nation Source Protection Region to the east, Cataraqui Source Protection Area to the south and Quinte Source Protection Region to the south and west. Areas to the north-west of the region include the northern area of Lanark, Frontenac, and Lennox & Addington Counties. Figure 2-2 shows the Eastern Ontario Source Protection Areas and Regions.

2.2 Physical Geography

Physical geography includes water, bedrock and soil features which have formed in the ancient and recent past and continue to shape our waterways. It also includes biotic communities which have developed in the region. These features all play a role in determining intrinsic water quality and water quantity in the region.

2.2.1 Geology

The MRSPR is part of a larger physiographic region known as the Ottawa-St. Lawrence Lowland basin. This is a low lying area bounded to the north by the Laurentian Highlands of the Canadian Shield and to the south by the Adirondack Mountains in New York State. The western boundary of this basin is the Frontenac Axis (or Arch), an extension of the Precambrian Shield that runs northwest to southeast and connects the Canadian Shield to the Adirondack Mountains.

The Frontenac Axis separates the sedimentary rocks of south-central Ontario from the sedimentary rocks of the Ottawa-St. Lawrence Lowlands. To the east, the Ottawa-St. Lawrence Lowland basin is bounded by the “Beauharnois anticline”, a broad geologic structure consisting of gently folded Paleozoic bedrock. The anticline can be seen near the confluence of the Ottawa and St. Lawrence Rivers, and extends north to south from the Canadian Shield to the Adirondack Mountains. Figure 2-3 shows the Ottawa St. Lawrence Lowland Basin and the location of the Frontenac Arch.

The Precambrian Era includes approximately 80% of the Earth’s history and ended about 570 million years ago. Following the Precambrian Era, the Precambrian Shield within Eastern Ontario became flooded by an ancient ocean from the east. This occurred over 400 million years ago. During the following

Paleozoic Era, erosion of the Precambrian landmass, and later the deposition of conglomerates and sandstone along the shallow water shorelines resulted in the Covey Hill and Nepean Formations. As the ocean level increased, carbonate-rich fine-grained sediments were deposited, resulting in the March and Oxford sandstone formations. The ocean then retreated and re-flooded many times, creating the limestone, dolostone, and sandstone sequences that currently overlie the Nepean Sandstone Formation.

After the Paleozoic era, a period of extensive faulting occurred followed by another long period of erosion and deposition. During the Quaternary Era, (1.6 million years ago to 8,000 years ago) a period of glaciation covered much of North America in massive sheets of ice. The most recent glaciation in North America, known as the Wisconsin glaciation, retreated from the Ottawa-St. Lawrence lowlands approximately 12,000 years ago. As the ice retreated, the Atlantic Ocean invaded from the east forming a large water body known as the Champlain Sea, which covered the Ottawa-St. Lawrence Lowlands and deposited clays, silts and sands in low lying areas. These deposits provided the foundation for the soils that we see in the region today.

Bedrock Geology

Precambrian igneous and metamorphic rocks, overlain by Paleozoic sedimentary rocks make up most of the bedrock in the MRSPR. The Precambrian Shield exists throughout the entire MRSPR: in the western portion of the region it appears prominently at surface, and east of Perth and Almonte it is covered with Paleozoic sedimentary rocks (the Nepean, March, and Oxford Formations). Groundwater in the MRSPR consists of two key aquifers, the Oxford – March dolostone aquifer and the Nepean Sandstone aquifer. Portions of the region have other unconfined and confined overburden aquifers.

Figure 2-4 shows the bedrock geology throughout the MRSPR.

The outcropping of the Precambrian Shield in the western portion of the region is a prominent feature of the MRSPR. In the RVSPA, the shield appears at the surface in the Upper Rideau region, west of Westport. In the MVSPA, the shield appears just southwest of Almonte, and dominates the landscape upstream from that point. Glaciation of the shield means that the western portion of the two watersheds contains numerous lakes of various shapes and sizes.

Bedrock Faults

Although Eastern Ontario is located well within a stable part of the large North American Tectonic Plate, seismic activity (faulting) still occurs in regions of crustal weakness. The MRSPR is situated in a historically-active fault zone called the Western Quebec Seismic Zone. It extends from the St. Lawrence River near Montreal to Temiscaming, Quebec. The tectonic history within this area has resulted in many faults and fault zones, evident in both the Precambrian and Palaeozoic bedrock formations.

Most faults in the MRSPR run from the southeast to northwest. Figure 2-4 shows the locations of faults in MRSPR. Figure 2-5 shows simplified regional cross-sections which includes major faults in the region. These faults are characterized by a vertical displacement exceeding 200 m. They include the Pakenham, Hazeldean, Gloucester, and Rigaud faults, and the Ottawa River fault series.

The three regional cross-sections in Figure 2-5 illustrate geologic formations in the MRSPR. The locations of each of the cross-sections are shown in the top right corner of the Figure.

The cross-sections are:

- Regional Cross Section A-A’ - Southwest to Northeast through the MRSPR;
- Regional Cross Section B-B’ – North to South through Richmond Area;
- Regional Cross Section C-C’ – West to East through Perth Area.

When a bedrock layer that acts as an aquifer is displaced by faulting, the horizontal groundwater flow patterns can be disrupted. Examples of this displacement can be seen along most of the fault lines in the cross-sections. Sometimes, vertical hydraulic conductivity (how easily water travels vertically up from the aquifer) increases by providing a short-cut through the bedrock units to the surface. Rates of downward flow may also be affected. Little specific information is available on how faulting affects local aquifers.

Surficial Geology

Above the bedrock lies a layer of broken rock, gravel, sand and soil, collectively called “overburden”. It is the result of abrasion, deposition and erosion that have occurred since the end of the Wisconsin glaciation approximately 12,000 years ago. Overburden deposits can be categorized as till, glaciofluvial, glaciomarine and glaciolacustrine deposits depending on how they are deposited. As the Laurentian glacier advanced from the north, eroded materials were transported and deposited as till sheets and drumlins in low lying areas in the bedrock surface. As portions of the glacier melted, material was transported by melt water and deposited on top of the till sheets at the edge of the glacier as glaciofluvial deposits (eskers and glacial outwash fans). Sediment carried by glacial melt waters and subsequently deposited in low-lying lakes are known as glaciomarine deposits.

The weight of the Wisconsin ice sheet resulted in a depression of the earth's crust throughout the area. As a result, after the glacier's retreat, the Atlantic Ocean flowed westward and flooded most of southern Ontario. This flooding covered the entire Ottawa-St. Lawrence Lowland. This body of salt water was called the Champlain Sea. It deposited massive amounts of silt and clay, known as glaciomarine deposits, over the underlying tills and esker deposits. Table 2-5 lists soil texture types.

As the earth's crust rebounded, the Champlain Sea drained gradually to the east, exposing drumlin and esker deposits. The North Gower Drumlin Field in the southern portion of the region covers approximately 250 km^2. A large sand plain, covering approximately 270 km^2 within the eastern portion of the MRSPR, is known as the Edwardsburg Sand Plain.

Figure 2-6 shows the interpreted thickness of overburden materials based on information provided in the MOE water well records. Generally, the overburden thickness within the MRSPR is thin to non existent (less than one m). The exception is where bedrock valleys near the Ottawa and Rideau Rivers allowed the accumulation of 10 to 30 m of clays and sands. Overburden thicknesses are much greater east of the MRSPR (in the South Nation and Raisin watersheds), where the Palaeozoic bedrock elevation drops and where the deepest parts of the Champlain Sea were located.

2.2.2 Physiography

Bedrock and soil characteristics partially define the types of river systems in the region. Terrain within the MRSPR is highly variable, but generally slopes from southwest to northeast with a drop of approximately 430 m in relief. Figure 2-7 shows the surface elevations throughout the MRSPR.

The region can be divided into two general areas. The western half covers about 70% of the MVSPA and the upper 30% of the RVSPA. It features Precambrian bedrock outcrops and ground surface elevations greater than 175 masl. The eastern half has Paleozoic bedrock on top of Precambrian bedrock and ground surface elevations less than 175 masl.

The highest ground surface elevation in the MRSPR occurs at the Mississippi watershed's most western edge, south of Denbigh, where ground surface is at approximately 470 masl. The lowest ground surface elevation occurs along the shores of the Ottawa River, where ground surface is at approximately 40 masl.

The MRSPR features a complex network of lakes, rivers, wetlands and streams. The western portions of the Region, underlain by Canadian Shield, are speckled with glacially-formed lake systems. The eastern portion is dominated by large riverine systems. Many of these systems are controlled by hydraulic structures, both natural and man-made.

Chapman and Putnam (1984) categorize the physiography of Southern Ontario, which encompasses the area south of Lake Nipissing and the northern shore of Georgian Bay, into 55 separate and distinct regions. The MRSPR contains seven of these physiographic regions. Of these seven, Algonquin Highlands, Smiths Falls Limestone Plain, and Ottawa Valley Clay Plains are most prevalent, covering 40, 26, and 17 percent of the region, respectively.

The Algonquin Highlands region is characterized by the presence of Precambrian bedrock at or near surface, covered by little or no soil. This physiographic region covers the south-western portion of the MRSPR, where the topography of the Canadian Shield is apparent.

The Smiths Falls Limestone Plain cuts through the centre of the RVSPA, extending from the southern end of the City of Ottawa through to the northern edge of the Cataraqui watershed. It is relatively flat, characterized by shallow, poorly drained soils over limestone or dolostone bedrock.

The Ottawa Valley Clay Flats are apparent at the northernmost edge of the MRSPR, along the shores of the Ottawa River. This region is characterized by thick deposits of clay and ridges of gravel or sand and is considered highly productive agricultural land.

All seven physiographic regions are described in Table 2-6. Figure 2-8 shows the distribution of these physiographic regions within the MRSPR.

2.2.3 Natural Vegetative Cover

Naturally vegetated areas are ecological features that perform various beneficial functions on the landscape and contribute to the quality and quantity of water in the region. In the MRSPR, these areas include woodlands, wetlands, and riparian areas.

The most prominent land cover in the MRSPR is wooded area, covering 3,482 km^2, or 41%, of the region. Next are agriculture and a variety of rural land uses, covering 18% and 17% of the region, respectively. These occur primarily in the eastern portion of the MRSPR. Wetlands and waterbodies are also significant in the MRSPR, covering approximately 13% and 7%, respectively. Detailed land use percentages for this section can be found in the Mississippi-Rideau Source Protection Region Watershed Characterization Report (2008) Table 1.2-6.

Of special interest in the MRSPR is the presence of rare habitats known as alvars (Figure 2-9). Alvars are naturally open habitats with either a thin covering of soil or no soil over a base of limestone or dolostone. The unique geological, post-glacial historic and physical stress characteristics that define an alvar create conditions for species-rich communities which simply cannot exist elsewhere.

Woodlands

Woodlands provide a number of beneficial ecological functions, including protecting water quality. Tree canopies reduce the impact of rain on soils and their roots bind the soil, resulting in less soil erosion. This can result in reduced sedimentation of creeks, streams and rivers flowing adjacent to wooded areas. Woodland shading is a factor in reducing water temperatures of adjacent aquatic habitats.

Using the provincial land cover dataset, approximately 41% of the MRSPR is covered by wooded areas. However, the distribution of that coverage is uneven across the region. As shown in Figure 2-9, the majority of wooded area in the MRSPR is found in the western portion of the region. Much of the lower Rideau and eastern Mississippi areas are devoid of woodland. Much of the middle Rideau area and most of the upper Rideau, as well as the western and central Mississippi areas, are covered with trees and shrubs.

The MRSPR is located within the Upper St. Lawrence Forest District (L.2) of the Great Lakes - St. Lawrence Forest Region according to Rowe (1972). This forest region is characterized by woodlands of a predominantly deciduous nature. Poorly-drained depressions frequently carry a hardwood swamp type in which Black Ash is prominent. Wet sites are often characterized by Black Spruce or Eastern White Cedar. Eastern White Cedar is also found on dry, rocky or stony sites.

Wetlands

Wetlands and their surrounding area are known to be important for the control and storage of surface water and the recharge and discharge of groundwater. Vegetation in wetlands reduces water flow which aids in reducing shoreline erosion and trapping sediment that would otherwise enter watercourses. Some wetland plants are known for reducing contaminant release into waterways through absorption and reduction of chemicals and metals.

Wetland plants provide shelter and food for a diverse array of aquatic species. They also serve as a nursery for amphibious species which spend a portion of their lives in an aquatic environment. Overall, wetland vegetation contributes to the maintenance of water quality and aids in flood control.

A total of 623.4 km^2 of provincially significant wetland and 51.4 km^2 of locally significant wetland is found within the MRSPR (Ontario Natural Resources Values Information System (NRVIS)). This means that evaluated wetlands cover 8% of the geographic area of the MRSPR, while unevaluated wetlands cover an additional 5% of the MRSPR.

The distribution of wetlands in the region is uneven, with few wetland features of any note remaining in the lower Rideau or eastern Mississippi regions. However, the limited wetland features remaining in these areas are extremely valuable to the landscape. The most extensive wetland coverage for the MRSPR is found in the middle and upper Rideau and western and central Mississippi regions, most of which has never been evaluated using the Ontario Wetland Evaluation System (OWES).

The MVSPA contains thousands of wetlands, with 52 having been assessed using the OWES (MNR, 1993, 1994, 2002). Of these, 16 have been assessed as locally significant and 36 as provincially significant. In the MVSPA there are 14,931 unevaluated wetlands.

The RVSPA also contains thousands of wetlands, of which 89 have been assessed using the OWES (MNR, 1993, 1994, 2002). Of these, 19 have been assessed as locally significant and 70 as provincially significant. In the RVSPA there are 13,810 unevaluated wetlands.

Wetland coverage in the MRSPR is shown in Figure 2-10 and detailed in Table 2-7. The wetlands figures include a number of types of wetlands including bog, fen, marsh, swamp, and open water. In addition, the evaluated status of wetlands (provincial or local) can be found in Figure 2-10.

Riparian Areas

The shorelines of individual properties on the Rideau River from Smiths Falls to Ottawa have been classified by RVCA for ecological integrity using a standard protocol. Three reports based on field work and analysis conducted between 2002 and 2004 categorize Rideau River shoreline conditions into four predominant groups: natural, regenerating, ornamental and degraded. For more information on these reports please see the MRSPR Watershed Characterization Report.

Knowing the extent of each these riparian conditions is important due to the essential role that naturalized shorelines can play in water quality protection. Healthy buffers of riparian and littoral zone vegetation provide diverse terrestrial and aquatic habitat and perform many hydrologic functions. They significantly contribute to the overall health of a water body or watercourse.

No comprehensive mapping and assessment of riparian habitat across the MRSPR has been completed to date. Ecologists at the RVCA and MVC are working to establish set criteria for riparian assessment.

2.2.4 Aquatic Habitats

The work of the MVC and the RVCA, and their role in fisheries management, has mainly dealt with examining aspects of water quality, monitoring overall health of various water bodies, and protecting aquatic habitat from harmful impacts. This data, and specifically information on the status of fish populations and habitat, have been collected via the Ontario Stream Assessment Protocol (OSAP), City Stream Watch, Macro Stream Assessment, Beaver Dam Monitoring, and Municipal Drain Classification monitoring programs. These studies also give information on the existing conditions of the watershed, identify opportunities for water quality and habitat improvement, and help monitor any environmental changes that may be occurring.

Macroinvertebrate Communities

The composition of benthic invertebrate communities (bottom-dwelling insects) can be used as indicators of water quality. The main index used in comparisons of water quality is known as the Family Biotic Index (FBI), where each family of invertebrate is given a tolerance value related to water pollution. When an abundance of pollution-intolerant organisms are found, then it may be said that the water quality is good. When the proportion of pollution-tolerant organisms is greater, it can be an indication that water quality is poor.

Benthic populations can be affected by several factors that may have a direct influence on water quality. Substrate composition, flow characteristics, riparian land use and buffer condition, and basic chemical parameters (dissolved oxygen, pH, and temperature) are evaluated when analyzing water quality in relation to benthics.

Both the RVCA and MVC carry out monitoring of macroinvertebrate communities. RVCA has been partnered with the Ontario Benthos Biomonitoring Network (OBBN) since 2003. The scope of the sampling program has grown to 15 lake sites and 33 stream sites sampled twice a year since 2003. MVC has been involved with the OBBN since 2005 and a total of 9 sites have been sampled. The locations of the OBBN sampling sites are on Figure 2-11.

In addition to the OBBN monitoring program, the City of Ottawa has sampled for benthic macroinvertebrates since 2000 at many of the urban streams and tributaries in the MRSPR. A total of 131 invertebrate sampling locations within the MRSPR have been used by the City of Ottawa and are listed in Figure 2-11.

The sampling locations coincide with the stream water quality sampling stations that the City of Ottawa operates.

RVCA monitoring under this program indicates that the condition of the Rideau River is generally good. The Tay River, Jock River and Kemptville Creek all have benthic communities which are considered to be indicative of good water quality. Sites within the Lower Rideau region have a lower quality of water. Areas such as Cranberry Creek and Sawmill Creek have low benthic populations and the composition of the benthic communities indicate fairly poor to very poor conditions. This decrease may be due to location (Sawmill Creek is an urban watercourse) or may indicate poor habitat quality (Cranberry has fairly stagnant water with poor substrate conditions). However, the limited history of data collection (since 2003) makes conclusions about water quality based solely on the presence of benthic species inconclusive.

Conditions within the MVC have not yet been assessed. The amount of monitoring information is insufficient due to the short period that the program has been in place.

Locations and Types of Aquatic Communities

The composition of aquatic communities is directly affected by water temperature. Fish such as Northern Pike and Muskellunge are cool water fish which thrive in waters in the range of 18 to 25 degrees Celsius (^{o}C). Cold water species such as a number of trout species prefer 10 to 18 ^{o}C.

Although water temperatures have not been monitored under any type of established protocols, anecdotal evidence indicates that there are a number of cool and cold water streams within the MVSPA and RVSPA. The Mississippi River and some lakes in the Mississippi watershed are well known fishing destinations for cold and cool water species and in the past some lakes and rivers in the watershed have been stocked with these species by MNR. Warm water is considered to be above 25 ^{o}C.

While some preliminary work has been done to initiate water temperature data collection, staff at RVCA and MVC are currently developing more comprehensive programs.

2.2.5 Species and Habitats at Risk

Ontario has traditionally had a rich diversity of wild plants and animals. More recently, the populations of more than 190 species of plants, fish, mammals, reptiles, amphibians, and birds in Ontario have been identified to be in decline.

Species may be at risk due to a number of reasons. Some common reasons include habitat loss or degradation, incompatible land use and resource management activities, and changes in habitat such as the spread of invasive species or those related to climate change. When there is concern that a species may be "at risk" in the province, the species is reviewed by the Committee on the Status of Species at Risk in Ontario (COSSARO). If a species is classified "at risk" they are added to the Species at Risk in Ontario (SARO) list under one of four categories, depending on the degree of risk:

- Extirpated if it lives somewhere in the world, and it at one time lived in the wild in Ontario, but no longer lives in the wild in Ontario
- Endangered if it lives in the wild in Ontario but is facing imminent extinction or extirpation
- Threatened if it lives in the wild in Ontario, is not endangered, but is likely to become endangered if steps are not taken to address factors threatening it
- Special Concern if it lives in the wild in Ontario, is not endangered or threatened, but may become threatened or endangered due to a combination of biological characteristics and identified threats.

Thirty-five species of plants, animals, reptiles, and fish on the 2005 SARO list are found in the Mississippi-Rideau Source Protection Region. The Ministry of Natural Resources' Kemptville District office has identified 30 Species at Risk within the RVSPA, and 25 within the MVSPA. In the RVSPA, 10 are *endangered*, 8 are *threatened,* and 12 are listed as *special concern*. In the MVSPA, 6 are *endangered*, 9 are *threatened,* and 10 are listed as *special concern*. Table 2-8 and Table 2-9 list the Species at Risk in the Rideau and Mississippi watersheds, respectively.

Projects to address habitat degradation, protection, or other concerns related to the species in question have been done in the region or are currently in progress. Table 2-10 lists a number of aquatic and terrestrial SARO projects in the MRSPR.

2.2.6 Surface Water Quality

Surface water originates from a variety of sources. It is a combination of water from precipitation (rain and snowfall, including runoff), and groundwater discharge to the surface (baseflow).

The ratio of precipitation to baseflow in surface water affects the water's chemical composition. Typically the chemical composition of precipitation depends on the balance of natural gases within the atmosphere. The chemical composition of groundwater depends on the soil or rock formation that the groundwater emerges from, the length of time that the water is in the ground, and groundwater temperatures. As a result, there are often higher percentages of dissolved solids in water which originated as groundwater than as precipitation.

The chemical composition of surface water can also be altered by natural and anthropogenic (man-made) factors. Increased streamflows during precipitation events can potentially increase erosion and surface water can react with any mineral solids in the riverbed or in suspension. The presence of organic matter may have an effect. Human activities such as spreading nutrients on adjacent lands or improper placement or inadequate maintenance of septic systems can also have a significant impact on surface water quality. Surface water can also be receiving waters for sewage treatment facilities.

Surface Water Quality Monitoring Programs

A number of surface water quality monitoring programs currently operate within the MRSPR. A list of all physical, chemical and biological parameters monitored is provided in Table 2-11. A list of all active surface water quality stations, as of 2006, is presented in Appendix 2-1. The locations of all active surface water monitoring stations are shown in Figure 2-12.

In 2006, there were 70 surface water quality stations within the MRSPR being monitored by the City of Ottawa. Each monitoring location is sampled monthly (when possible) for 45 physical, chemical, and biological parameters. A list of these parameters at unique locations is provided in Table 2-11 and a list of the OBSWQ monitoring stations is provided in Appendix 2-1. A detailed summary of the program and results are presented in the Technical Report, Five-Year Analysis 1998 through 2002 by the Water Environment Protection Program of the City of Ottawa.

MVC Watershed Watch Lake Monitoring Program

The MVC Watershed Watch program was started in 1998 and samples 42 lakes for a number of chemical and physical parameters. Approximately eight lakes are sampled each year, and all 42 lakes are sampled every five years. Chemical parameters include Total Phosphates (TP) and chlorophyll. Physical parameters include water clarity (Secchi Disk), pH, temperature, and dissolved oxygen. A list of the MVC Watershed Watch surface water monitoring stations is provided in Appendix 2-1. Annual reports are compiled for each lake.

RVCA Watershed Watch Lake Monitoring Program

The RVCA Watershed Watch program was started in 2002 and, since 2005, involves the sampling of 41 lake sites. Approximately 15 lake sites are sampled each year. Monthly monitoring occurs at varying depths and locations at each lake from late spring to early fall. The bacteriological and chemical parameters monitored include *E. coli*, Dissolved Organic Carbon (DOC), Total Kjeldahl Nitrogen (TKN) and TP. Physical parameters such as water clarity (Secchi Disk), temperature, and dissolved oxygen are also monitored. Annual reports are compiled for each lake. A list of the RVCA Watershed Watch surface water monitoring stations is provided in Appendix 2-1.

Provincial Water Quality Monitoring Network (PWQMN)

There are 21 active PWQMN stations within the MVC boundaries as of 2006. Each monitoring location is sampled monthly (when possible) for 36 physical, chemical, and biological parameters. A list of these parameters is provided in Table 2-11 and a list of the PWQMN monitoring stations appears in Appendix 2-1.

In 2005, the RVCA maintained and sampled 54 surface water quality monitoring stations. Each monitoring location is sampled monthly, when possible, for 41 physical, chemical, and biological parameters. A list of these parameters is provided in Table 2-11 and a list of the RVCA surface water monitoring stations is provided in Appendix 2-1.

Surface Water Quality Results

The following are results of surface water quality monitoring programs in the MRSPR on a subwatershed basis. Data presented is from 2000 to 2005 with the exception of the MVC Watershed Watch program (1998-2005) and the OBSWQ monitoring program (2000-2006). A detailed listing of the surface water quality monitoring sites is presented in Appendix 2-1. The Canadian Council of Ministers of the Environment (CCME) has developed a scoring system to evaluate the level of impairment of surface water. Evaluation is based on the percentage of samples that show no evidence of impairment and are in compliance with any relevant objectives. The categories are as follows:

- Excellent water quality – 95-100%
- Good water quality – 80-94%
- Fair water quality – 65-79%
- Marginal water quality – 45-64%
- Poor water quality – 0-44%

Appendix 2-2 lists the CCME scoring for each individual water quality station for indicator parameters and presents the CCME scoring for the various subwatersheds.

Surface water quality within the MRSPR is good to excellent according to this system. Generally, water quality within the larger rivers is better than in smaller tributaries. In some instances, local conditions such as the composition of soils and rock and/or human activities may impact the quality of the surface water. Data availability varies across the region with data being widely available within the City of Ottawa, but relatively sparse in the western portions of the MRSPR.

Figure 2-13 (chloride), Figure 2-14 (TKN), and Figure 2-15 (TP) show elevated concentrations of parameters that are commonly associated with human activities, such as nitrogen compounds and chloride (associated with human waste / water softeners), and sodium chloride (common road salt). Concentrations are highest in areas of higher population density.

Great Lakes Water Quality Agreements

Watersheds in the MRSPR drain in the Ottawa River and not directly into any of the Great Lakes or St. Lawrence River. The Great Lakes Water Quality Agreements were considered in the preparation of the Assessment Report but did not warrant any actions.

2.2.7 Groundwater Quality

Groundwater obtains its natural geochemical signature based on the time it spends below the surface and the types of surrounding rock. Groundwater that has been underground for a short period of time, for example, will show chemical characteristics similar to its source (e.g. rainfall or surface water). Conversely, groundwater that resides underground for a long period of time will have chemical characteristics of the dissolved minerals along its flow path. It is also important to note that generally, groundwater found furthest below the surface is oldest. The natural composition of shallow groundwater, therefore, is typically low in Total Dissolved Solids (TDS). TDS concentrations increase with depth, with the highest concentrations found in the deepest (and oldest) groundwater.

Groundwater Quality Data Sources and Monitoring Programs

For the Watershed Characterization technical report, a wide variety of groundwater quality data sources were reviewed and are listed below.

- Renfrew County - Mississippi - Rideau Regional Groundwater Study (Golder et al., 2003), which included:

- Groundwater chemistry from selected bedrock wells (Belanger, 2001) [41 locations]
- Groundwater chemistry from selected overburden wells (Belanger, 2001) [13 locations]
- Review of paper copy reports from MOE Regional office in Kingston [115 locations]
- Leeds and Grenville Regional Groundwater Study (Dillon, 2001) [129 locations]
- 2002 groundwater sampling program (Golder et al., 2003) [35 locations]
- Subdivision and quarry reports filed with RVCA - current to 2000 [176 locations]
- Provincial Groundwater Monitoring Network (PGMN) - current to 2003 [18 locations]
- 2005 groundwater sampling program as part of Carp Road Groundwater Study (Dillon, 2006) [58 locations]
- 2005 groundwater sampling program as part of North Gower Groundwater Study (Dillon, 2006) [63 locations]
- 2005 groundwater sampling program as part of Constance Bay Groundwater Study (Dillon, 2006) [74 locations]
- City of Ottawa Municipal Well Data - 2001 through 2005 [7 locations]
- MVC 2007 groundwater sampling program near Crotch Lake [15 locations]

Groundwater Quality Results

Regional groundwater quality within the MRSPR is generally good. In some local instances mineral composition of aquifer material may adversely affect the quality of a groundwater supply aquifer. Similar to surface water quality, human activities may also have local impacts on the groundwater quality and/or quantity.

Groundwater quality data is widely available within the City of Ottawa and especially for larger rural population communities serviced by domestic wells and septic (Carp Road Corridor, Constance Bay, North Gower). However, groundwater quality data is relatively sparse in the western and southern rural portions of the MRSPR.

Table 2-12 lists parameters with aesthetic objectives or operational guidelines (ODWSOG), or health related criteria in the ODWQS. It also lists the percentage and locations of samples within the MRSPR that exceed these standards. Figure 2-16 (Ammonia), Figure 2-17 (Chloride), and Figure 2-18 (Nitrate), show the distribution levels of compounds generally associated with human activities. Appendix 2-4 is a summary of groundwater quality results.

There may be elevated concentrations of some or all of these compounds in sections of higher density rural developments. Examples include nitrogen compounds and chloride (associated with human waste). Sodium chloride (salt) may also be present in shallow groundwater systems due to human activity though in deeper wells it occurs naturally due to the presence of the Champlain Sea during post-glacial melting and flooding. Since domestic wells often draw from shallow, overburden aquifers, these elevated concentrations may indicate that groundwater is being impacted by human activities. Groundwater obtained from bedrock aquifers throughout the entire region is generally considered to be 'hard', and therefore susceptible to scaling and poor taste.

2.3 Human Geography

2.3.1 Settlement Areas

The MRSPR and adjacent lands show evidence of occupation from as early as 5,000 B.C. The area was originally occupied and travelled by various First Nations groups, with Europeans beginning to settle in the region during the late 18th century. Organized military settlements in the early 19th century evolved into the villages of Perth and Lanark. The European settlers cleared the existing dense virgin forests for lumber and developed the fertile clay plains into agricultural areas.

During the 19th century much of the region was used for timber production, mineral extraction, and agriculture. Manufacturing industries such as grist and saw mills, cheese factories and woollen mills were also present. Within the MRSPR agriculture and timber production still represent significant primary land uses.

Today, settlement areas represent approximately 5% of the MRSPR, being divided between built-up areas and transportation routes. These areas are primarily in the northern portion of the MRSPR. The most significant areas of settlement fall within the amalgamated boundary of the City of Ottawa, as the former cities of Ottawa, Nepean, Gloucester, Vanier, Kanata, and Cumberland. Significant suburban development exists outside the City's greenbelt, in areas once primarily used as agricultural land.

Other principal settlement areas include the towns of Almonte, Carleton Place in the MVSPA and Kemptville, Perth and Smiths Falls in the RVSPA. In total there are 20 settlement areas with populations over 500. Land use within these settlement areas is a mixture of residential, commercial, industrial and other land uses. Figure 2-19 shows settlement areas in the MRSPR.

Industrial development typically occurs within larger urban developments, in specifically designated areas. Some industrial land use occurs in the general rural area, typically requiring specific zoning amendments. Heavy industrial land use is generally not permitted within rural hamlet and village development areas.

With the hundreds of lakes and rivers within the MRSPR, many significant regions of waterfront development exist. Closer to settled areas, waterfront development typically consists of permanent homes. In more remote areas, significant seasonal cottage development exists. There is an ongoing shift, however, to redevelop and convert seasonal cottages into permanent year round homes as developed areas and transportation corridors spread outward from the main urban core.

2.3.2 Municipal Boundaries

Within the MRSPR there are 23 lower tier, two single tier and seven upper tier municipalities. A list of the municipalities within the MRSPR is presented in Table 2-13. The municipalities within the MRSPR can be found in Figure 2-1.

Several municipalities have very small portions of the MRSPR within their boundaries (less than 3% of the area of each respective municipality). This is the case for Township of Athens, City of Clarence-Rockland, Township of Edwardsburg - Cardinal, Township of North Dundas, and Township of Greater Madawaska) and upper tier municipalities United Counties of Prescott and Russell, United Counties of Stormont, Dundas & Glengarry, and Renfrew County. The majority of Athens Township is within the Cataraqui watershed region. The majority of the City of Clarence-Rockland, Township of Edwardsburg - Cardinal, North Dundas Township, United Counties of Prescott and Russell, and the United Counties of Stormont, Dundas & Glengarry are within the Raisin-South Nation watershed region.

2.3.3 Population

The total population of the MRSPR in 2006 was approximately 865,000. Table 2-14 presents a detailed breakdown of estimated population by lower/single tier municipality, as per 2006 census dissemination areas. Where a dissemination area boundary crosses the MRSPR boundary, the estimated population is based on the percentage of the dissemination area falling within the MRSPR.

Figure 2-20 maps the population distribution in urban areas. Figure 2-21 shows population density by dissemination area. The urban areas within the City of Ottawa (Barrhaven/Riverside South, Kanata/Stittsville, Orleans, Ottawa), several villages within the amalgamated City of Ottawa (Constance Bay, Manotick, Munster, Osgoode, Richmond), and other urban areas outside of the City of Ottawa (Almonte – Mississippi Mills, Carleton Place, Kemptville – North Grenville, Perth, Smiths Falls) have population densities greater than 1,000 people per square kilometre. Most of the western portion of the MRSPR has a population density of less than 10 people per square km; for example North Frontenac had a population density of 1.7 people per km^2 in the 2006 census.

The MRSPR has significant seasonal population increases associated with cottage and camp development. Although census data does not record seasonal resident populations, municipalities with significant cottage and camp development can experience two to three fold increases in population during the summer months.

Population Projections

Projected population data was collected from the Ministry of Finance for 2011, 2021, and 2031. The population data is presented on an upper tier or county basis. The projected population for the MRSPR is presented in Table 2-15. Population growth for the MRSPR, referenced to 2001 as the baseline population, is expected to range from 6 – 17% by 2011, 12 – 31% by 2021, and 16 – 44% by 2031. The area projected to have the lowest growth rate is Renfrew County; the area projected to have the largest growth rate is the City of Ottawa.

2.3.4 Municipal Drinking Water Systems

Twelve municipal drinking water facilities exist within the MRSPR. Seven are supplied by groundwater and five by surface water. Groundwater systems service the municipalities of Almonte and Carp in the MVSPA and Kemptville, Merrickville, Munster, Richmond (Kings Park) and Westport in the RVSPA. Surface water systems service Carleton Place in the MVSPA, and the City of Ottawa (two plants, Lemieux Island and Britannia), Perth, and Smiths Falls, all in the RVSPA. Figure 2-22 shows these systems and their associated intakes and wells.

The Township of Lanark Highlands, located in the MVSPA, is currently seeking construction funding and working on the design of a new municipal groundwater-based drinking water system for the Village of Lanark in Lanark County. The approximate location of the planned Village of Lanark municipal drinking water system is provided in Figure 2-22. This planned system has been studied in accordance with the environmental assessment process and is included in the Approved Terms of Reference for the Mississippi Valley Source Protection Area.

Table 2-16 lists The Population of Municipal and Non-Municipal Serviced Areas in the MRSPR. The locations of these municipal water systems (including the locations of their associated wells and intakes) and the extent of their service areas are presented in Figure 2-23 and Figure 2-24.

Table 2-17 provides details of the 12 municipal systems, including their maximum permitted and average daily water takings. Maximum pumping rates are regulated by the Ontario Ministry of the Environment's Permit to Take Water (PTTW) program.

2.3.5 Other Regulated Drinking Water Systems

Other types of regulated drinking water systems include:

- small municipal residential systems;
- small and large municipal non-residential systems;
- non-municipal year-round and seasonal residential systems; and
- small and large non-municipal non-residential systems.

Table 2-18 presents a summary of the different types of communal wells and designated facilities within the MRSPR, based on Ministry of the Environment records. These systems are regulated by the Province of Ontario, under O. Reg 170/03 or O. Reg 252.

O. Reg 170/03 regulates municipal and private water systems that provide water to year-round residential developments or designated facilities that serve vulnerable populations such as children and the elderly. Designated facilities include children's camps, child and youth care facilities, health care and social care facilities, and schools.

O. Reg 319/08 regulates small and large municipal and non-municipal non-residential drinking water, and non-municipal seasonal residential systems. These include motels, churches, restaurants, community halls, arenas, campgrounds, and trailer parks.

The locations of communal wells and designated facilities (nursing homes, schools, day care facilities) that supply drinking water to the public within the MRSPR are presented on Figure 2-25. All non-municipal water supply wells from the MOE PTTW database are also shown.

It should be noted that the locations of many communal wells within the MRSPR could not be mapped on Figure 2-25 due to incomplete addresses. Table 2-18 presents a summary of all communal wells and designated facilities within the MRSPR, including those that could not be mapped on Figure 2-25.

Within the MRSPR there are 47 communal water supplies that supply residential water on a seasonal basis. These are referred to as non-municipal seasonal residential supplies (NMSRS). These NMSRS are typically trailer parks, campgrounds or other water supplies.

Additionally, within the MRSPR there are 39 communal water systems that supply residential water on a year round basis. These are referred to as non-municipal year-round residential supplies (NMYRRS). These NMYRRS are typically permanent mobile home parks, condominiums or other communal water supplies.

Table 2-18 also lists several other types of non-residential water supply. The non-municipal non-residential water supply facilities include churches, motels, and resorts. The municipal non-residential water supply facilities include community halls, township offices, and sports complexes. Within the MRSPR there are 371 non-municipal and 135 municipal non-residential water supplies.

2.3.6 Federal Lands

Federal lands within the MRSPR fall into several categories. In the City of Ottawa, the federal government owns lands used by a large variety of federal agencies and offices. In addition, the National Capital Commission (NCC), a federal agency, owns and manages official residences, many parks and open spaces, as well as the ‘greenbelt’ lands (these are agricultural lands and natural areas that were designed to ring the metropolitan area). Flowing through the City of Ottawa and to the south and west of the city is the Rideau Canal, with numerous locks and adjacent federal lands. Though there is general public information readily available on areas such as the NCC greenbelt and the Rideau Canal system there is not a consolidated set of information available for all federal lands within the MRSPR.

There are no reserve lands within the MRSPR as defined under the *Indian Act* (Canada).

2.3.7 Impervious Surfaces

Areas with buildings, pavement and other built features don’t allow fluids to soak into the ground. Precipitation runs off these impervious surfaces rather than penetrating the ground surface. This can have a number of impacts on both groundwater and surface water. Impermeable surfaces do not allow groundwater recharge and rainwater or snowmelt which cannot soak into the ground will likely enter surface water systems as runoff, often carrying contaminants such as road salt with it.

The provincial Technical rules require that the percent of impervious surface is mapped for each vulnerable area with the intent of identifying areas where road salt may enter source water. Percentages of impervious surfaces within vulnerable areas of the MRSPR are discussed in Chapters 5 and 6.

2.3.8 Interactions between Physical and Human Geography

Settlement patterns have been directly linked to the loss of natural ecosystem functions. In time, as understanding of ecosystems and their values increase, the potential for reducing the degradation through smart design also increases. Protecting natural ecosystem functionality makes simple economic sense. By allowing natural systems to do things such as moderate water flows and provide contaminant filtering for free, the public saves the cost of development and maintenance of facilities to provide these functions. When these natural functions are retained it becomes easier to provide safe drinking water as the “raw” water entering water treatment often carries fewer contaminants.

Woodlands and wetlands within settlement areas in the MRSPR have been reduced, in some areas quite dramatically, compared to natural coverage prior to settlement. Riparian areas have been modified in many areas. Rather than diverse natural communities we see groomed lawns which may result in reduced water quality and aquatic habitat in settlement areas.

Protection of source water may be at least partially achieved through protection, rehabilitation, and retention of the functionality of natural features such as wetlands, which serve to moderate water levels and filter surface water before it enters lakes and rivers. The naturalization of shorelines and riparian areas also restores filtering characteristics, thereby reducing the volumes of human-based contaminants and sediment from entering waterways.

2.4 Ottawa River

Ninety-four percent of the Ottawa River Basin is found outside the MRSPR. The Mississippi and Rideau watersheds are tertiary subwatersheds in the larger Ottawa River watershed which is a secondary subwatershed in the larger Great Lakes-St. Lawrence watershed. The MRSPR is found in the Lower Ottawa Basin.

The headwaters are found northwest of Ottawa, east of the Dozois Reservoir in Quebec. The river is 1,130 km long with a watershed drainage area of 146,300 km^2 found both in the provinces of Ontario (35%) and Quebec (65%). The river eventually flows into the St. Lawrence River at Montreal. Figure 2-26 shows the Ottawa River watershed and the MRSPR within.

Thirty storage reservoirs can be found on the river, with the potential to store 14 billion m^3 of water. There are a total of 43 hydroelectric generating stations in the watershed and numerous control structures, including approximately 25 dams in the Mississippi River, 24 dams in the Rideau River, and 19 locks in the Rideau Canal. Integrated operation of the principal reservoirs within the watershed helps to alleviate flood flows in most years (ORRPD 2009).

Surface water quality in the Ottawa River within the MRSPR is influenced by factors in upstream portions of the Ottawa River watershed. The Ottawa River is the primary source of drinking water for City of Ottawa residents, with two water intakes within City boundaries.

2.5 References

Mississippi-Rideau Source Protection Region. 2008. Watershed Characterization Report Preliminary Draft.