Greater Sudbury Source Protection Area

Assessment Report

Approved on September 2, 2014

The Greater Sudbury Source Protection Area
Assessment Report

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Limitations of this Report

This report has been prepared according to the provincial requirements laid out under the *Clean Water Act, 2006*. It should not be used for other purposes without consulting the Nickel District Conservation Authority (NDCA).

The information contained within is current as of the date of issuance and this report is based upon the best information available at the time. The information, data and conclusions contained in the report were prepared for the specific purposes laid out in the *Clean Water Act, 2006*.

The assessment report has been prepared and reviewed by the Greater Sudbury Source Protection Area Source Protection Committee, the Greater Sudbury Source Protection Authority and members of the Nickel District Conservation Authority technical team.

All information contained herein is produced solely for the purposes to fulfill the obligations under the *Clean Water Act* and is not to be used for any other intention. For confidentiality purposes, any personal information related to the assessment has been removed.

Executive Summary

The assessment report is written in compliance with the *Clean Water Act*. The Greater Sudbury Source Protection Committee, a local multi–stakeholder committee, was formed to oversee the production of this report and the drinking water source protection plan which contains policies to address the findings of this report. The Nickel District Conservation Authority is coordinating the production of this report and the source protection plan. With the passage of the *Clean Water Act*, the Nickel District Conservation Authority became the Greater Sudbury Source Protection Authority for the purposes of meeting conservation authority responsibilities under the *Clean Water Act*.

There are three major watersheds in the planning area: the Wanapitei, the Vermilion and the Whitefish River watersheds, covering approximately 9,150 km^2. There is one municipality, the City of Greater Sudbury, which has municipal residential drinking water systems in the area. Two First Nations, Atikamksheng Anishnawbek (Whitefish Lake) and Wahnapitae First Nation are located within the city boundaries and both participate on the source protection committee.

The purpose of the assessment report is to delineate areas around municipal drinking water sources that are the most vulnerable to contamination and overuse. Within these vulnerable areas, land use activities were identified that could pose a threat to municipal water sources.

The population of the City of Greater Sudbury is 160,274, approximately 90% of which obtain drinking water from the municipality. There are eight municipal systems servicing the area.

Municipal drinking water systems in the Greater Sudbury Source Protection Area

Drinking Water System	Description
Valley	13 wells, serving approximately 35,000 residents
Dowling	2 wells serving approximately 1,850 residents
Falconbridge	3 wells serving approximately 750 residents
Garson	3 wells serving approximately 4,890 residents
Onaping	3 wells serving approximately 2,150 residents
Vermilion River	Serving approximately 13,000 residents in the communities of Copper Cliff, Lively, Naughton and Whitefish
Ramsey Lake	Ramsey Lake David Street Water Treatment Plant and Wanapitei River Water Treatment Plant combined, serving approximately 90,000 residents
Wanapitei River	

To date, 95 significant drinking water threats, as defined by the *Clean Water Act*, have been identified in the Greater Sudbury Source Protection Area. In addition, Microcystin LR (blue green algae) and sodium have been identified as issues in the Ramsey Lake system. As a result, all properties in the Ramsey Lake vulnerable areas have been identified for their potential to contribute to these issues. Elevated levels of sodium have also been measured in the Dowling, Valley and Garson systems. No significant threats have been identified in the Falconbridge or Vermilion River vulnerable areas.

Significant Drinking water quality threats for each municipal system

Drinking Water System	Drinking Water Threat	Number of Occurrences
Ramsey Lake Intake	Operation or maintenance of a waste disposal site.	2
	Storm sewers	2
	Application of road salt.	1
	Transportation of hazardous substances along transportation corridors.	3
	The application of commercial fertilizer to land.	3
Wanapitei River Intake	Handling and storage of fuel.	1
	The application of road salt.	1
	Transportation of hazardous substances along transportation corridors.	2
Valley	Operation or maintenance of a waste disposal site.	1
	Septic systems.	34
	The application of agricultural source material to land.	1
	The storage of agricultural source material.	6
	The application of commercial fertilizer to land.	1
	Handling and storage of commercial fertilizer.	1
	Handling and storage of pesticide.	1
	Storage of snow.	2
	Handling and storage of fuel.	2
	Handling and storage of a dense non-aqueous phase liquid.	4
	Use of land as livestock grazing, pasturing land, or farm-animal yard.	6
	Transportation of hazardous substances along transportation corridors.	2
	Water Quantity (water takings)	10
	Water Quantity (recharge reduction)	1
Garson	Handling and storage of fuel.	1
	Transportation of hazardous substances along transportation corridors.	2
Onaping	Septic systems.	2
	Transportation of hazardous substances along transportation corridors.	2
Dowling	Transportation of hazardous substances along transportation corridors.	1

Drinking water quality issues and associated threats for the Ramsey Lake system

Drinking Water System	Drinking Water Issue	Associated Threat	Number of properties in Ramsey Lake Watershed
Ramsey Lake Intake	Microcystin LR (blue green algae)	Septic systems	210
		The application of commercial fertilizer to land	4,550
		Discharge of untreated stormwater from a stormwater retention pond	2
		Lift stations	8
	Sodium	The application of road salt	4,550
		The handling and storage of road salt	205
		Septic systems	210
		Storage of Snow	19

Public consultation is an integral part of developing both the assessment report and the source protection plan. The public has identified a number of other potential threats not listed in the *Clean Water Act* Technical Rules that are of concern in the Greater Sudbury Source Protection Area. These include abandoned and improperly constructed wells; removal of top soil; and concerns specific to Ramsey Lake such as motorized boats, vehicles and planes, and pet waste and bird waste near the Ramsey Lake intake.

A water quantity analysis was done for each major watershed and for each individual drinking water system. There was low stress for all watersheds and for all municipal systems, except for the Valley groundwater system where a significant water quantity risk was identified.

The source protection committee wrote a source protection plan to address threats and issues that were identified in the 2011 approved assessment report. The plan was submitted to the Minister of the Environment in August 2012. The assessment report and the source protection plan are being updated concurrently to add water quantity threats and policies for the Valley groundwater system. The municipality and landowners affected by the source protection plan were involved in developing the policies. The Nickel District Conservation Authority is responsible for preparing annual reports on the implementation of the source protection plan and coordinating the updating of assessment reports and source protection plans.

Sommaire

Le Rapport d'évaluation est rédigé en conformité avec la Loi de 2006 sur l'eau saine. Le Comité de protection des sources du Grand Sudbury, un comité local multipartite, a été crée pour surveiller la production du présent rapport et du Plan de protection des sources d'eau potable qui contient des politiques visant à traiter les constatations du présent rapport. L'Office de protection de la nature du District du Nickel coordonne la production de ce rapport et du Plan de protection des sources d'eau potable. Par l'adoption de la Loi de 2006 sur l'eau saine, l'Office de protection de la nature du District du Nickel est devenu l'Office de protection des sources du Grand Sudbury afin de remplir ses responsabilités en tant qu'office de protection de la nature, conformément à la Loi de 2006 sur l'eau saine.

La zone de planification comprend trois grands bassins hydrographiques : Les bassins hydrographiques des rivières Wanapitei, Vermilion et Whitefish couvrent une surface d'environ 9 150 km^2. La Ville du Grand Sudbury est une municipalité qui compte des systèmes résidentiels d'eau potable municipale dans la zone. Deux Premières nations, soit celles d'Atikamksheng Anishnawbek (lac Whitefish) et de Wahnapitae, se situent dans limites de la ville et font partie du Comité de protection des sources.

Le Rapport d'évaluation a pour objet de délimiter les zones entourant les sources d'eau potable municipale qui sont les plus vulnérables à la contamination et à la surutilisation. Dans ces zones vulnérables, on a déterminé les activités d'utilisation des terres qui pourraient représenter une menace pour les sources d'eau municipale.

La Ville du Grand Sudbury compte une population de 160,274, dont environ 90 % obtient son eau potable de la municipalité. Huit systèmes d'eau potable municipale desservent la zone.

Systèmes résidentiels d'eau potable municipale dans la zone de protection des sources du Grand Sudbury

Système d'eau potable	Description
Valley	13 puits qui desservent environ 35 000 résidents
Dowling	2 puits qui desservent environ 1 850 résidents
Falconbridge	3 puits qui desservent environ 750 résidents
Garson	3 puits qui desservent environ 4 890 résidents
Onaping	3 puits qui desservent environ 2 150 résident
Rivière Vermilion	Desservant environ 13 000 résidents dans les communautés de Copper Cliff, Lively, Naughton et Whitefish
Lac Ramsey	L'usine de traitement de l'eau de la rue David approvisionnée par le lac Ramsey et l'usine de traitement de l'eau de la rivière Wanapitei desservent un total d'environ 90 000 résidents.
Rivière Wanapitei	

À ce jour, 95 menaces importantes pour l'eau potable, aux termes de la Loi de 2006 sur l'eau saine, ont été identifiées dans la zone de protection des sources. En plus, la microcystine LR (algues bleu-vertes) et le sodium ont été identifiés comme questions liées à l'eau potable dans le système du lac Ramsey. En conséquence, toutes les propriétés dans les zones vulnéables du lac Ramsey ont été identifiées pour leur potentiel à contribuer à ces questions. En plus, des taux élevés de sodium ont été mesuré dans les systèmes de Dowling, Valley et Garson. Aucune menace importantes n'a été décelée dans les zones vulnérables à Falconbridge et la rivière Vermilion.

Menaces importantes pour l''eau potable (qualité et quantité) pour chaque systèmes résidentiels d'eau potable municipale

Système d'eau potable	Menace pour l'eau potable	# d'occurrences
Prise d'eau du Lac Ramsey	Exploitation ou entretien d'un site d'élimination des déchets.	2
	Égouts pluviaux.	2
	Application de sel de voirie.	1
	Transportation des produits dangereux par voie de transportation.	3
	L'application d'engrais commercial aux terres.	3
Prise d'eau de la Rivière Wanapitei	Manipulation et entreposage de carburant.	1
	Application de sel de voirie.	1
	Transportation des produits dangereux par voie de transportation.	2
Système d'eau potable de la Vallée	Exploitation ou entretien d'un site d'élimination des déchets.	1
	Fosses Septiques.	34
	L'application de matière fertile agricole aux terres.	1
	L'entreposage de matière fertile agricole.	6
	L'application d'engrais commercial aux terres.	1
	Manipulation et entreposage d'engrais commercial.	1
	Manipulation et entreposage de pesticides.	1
	Entreposage de neige.	2
	Manipulation et entreposage de carburant.	2
	Manipulation et entreposage de liquides en phases dru et non aqueux .	4
	Utilisation des terres pour l'exploitation de pâturages, les terres de pâturage ou la cours d'animaux agricoles.	6
	Transportation des produits dangereux par voie de transportation.	2
	Quantité d'eau (prises d'eau).	10
	Quantité d'eau (reduction de recharge)	1
Garson	Manipulation et entreposage de carburant.	1
	Transportation des produits dangereux par voie de transportation.	2
Onaping	Fosses Septiques	2
	Transportation des produits dangereux par voie de transportation.	2
Dowling	Transportation des produits dangereux par voie de transportation.	1

Questions liées à l'eau potable et menaces associées pour le système du lac Ramsey

Système d'eau potable	Question liée à l'eau potable	Menaces associées	Nombre d'occurrences dans le Lac Ramsey
Prise d'eau du Lac Ramsey	Microcystine LR (algues bleu-vertes)	Fosses septiques	210
		L'application d'engrais commercial aux terres	4,550
		Égouts pluviaux.	2
		Poste de relevage des eaux usées	8
	Sodium	Application de sel de voirie	4,550
		Manipulation et entreposage de sel de voirie	205
		Fosses septiques	210
		Entreposage de neige.	19

La consultation publique constitue une partie intégrante de l'élaboration du Rapport d'évaluation et du Plan de protection des sources. Le public a décelé de nombreuses autres menaces éventuelles qui ne figurent pas dans les règles techniques de la Loi de 2006 sur l'eau saine, mais qui sont préoccupantes pour la Zone de protection des sources du Grand Sudbury. Elles comprennent les puits mal construits et abandonnés, l'excavation de la couche végétale et les préoccupations liées au lac Ramsey comme les bateaux motorisés, les véhicules et les avions, ainsi que les déchets d'animaux et d'oiseaux à proximité de la prise d'eau du lac Ramsey.

Une analyse de la quantité d'eau a été effectuée pour chaque grand bassin hydrographique et pour chaque système d'eau potable. Le niveau de stress était faible pour tous les bassins hydrographiques et pour tous les systèmes municipaux, à l'exception du système de puits de la Vallée où un risqué important pour la quantité d'eau a été identifiée.

Le Comité de protection des sources a élaboré un Plan de protection des sources visant à traiter les menaces et les questions identifiées dans le Rapport d'évaluation de 2011. Le plan a été presenté au minister de l"Environnment en août 2012. Le plan de protection des sources et le Rapport d'évaluation sont mis à jour concurremment enfin d'ajouter les menaces et les politique de la quantité d'eau pour le système de puits de la Vallée. La municipality et les personnes touchées pas le plan de protection des sources ont été impliqués dans l'élaboration des politiques. L'Office de protection de la nature du District du Nickel est responsable d'élaborer des rapports annuels sur la mise en oeuvre du Plan de protection des sources ainsi que de coordonner le renouvellement des rapports d'évaluation et des plans de protection des sources.

Acknowledgements

The Greater Sudbury Source Protection Committee would like to thank all the people who helped prepare this report. We sincerely thank members of the public for coming to our meetings and open houses to let us know what is important to them for protecting our drinking water sources. We thank Stephen Kaufman, Blythe Reiha, Roch Duval, Karen Besemann and other staff from Golder Associates for doing the water budget and water quantity work, and for surface water modeling to delineate intake protection zones; Rich Schmidt, Tom Killingbeck and Jean-François Dionne from WESA Inc for conducting the groundwater vulnerability analysis; Tim McBride and Ron DeGagne from AMEC for doing the initial surface water vulnerability assessment according to draft guidance material; Peter Richards of Waters Environmental Geosciences Ltd. for serving as the groundwater peer reviewer of the water quantity analysis and the water quality vulnerability analysis; Eric Smith for the surface water peer review of the water quantity analysis and the water quality vulnerability analysis; Anne Watelet of Laurentian University for peer reviewing the Tier 1 water budget analysis; Laura Landriault, Scott Bates and Mike Garraway from the Ministry of Natural Resources for guidance on the water budget analysis; Conservation Ontario for program guidance; Ministry of the Environment Liaison Officers John Westlake and Neil Gervais for working to resolve issues expediently, and other Source Protection Programs Branch staff for keeping us apprised of changes as they occurred throughout the process; Richard Auld, Mark Rondina, Ed Gardner and Burgess Hawkins from the Sudbury and District Health Unit for attending committee meetings regularly and for advising the committee on health related concerns; the Greater Sudbury Source Protection Authority for support and guidance throughout the process; and Nickel District Conservation Authority staff who contributed to the research, writing and editing of the report, namely Sharon Bennett, Jessica Brunelle, Brianne Carter, Jamie Dumoulin, Linda Lachance, Katherine Mackenzie, Anoop Naik, Paul Sajatovic, Judy Sewell and Melanie Venne.

Foreword

Implementing the Greater Sudbury Source Protection Plan – The Assessment Report Phase

The *Clean Water Act* not only introduces a new level of protection for Ontario's municipal drinking water, it represents a significant step toward a more integrated watershed based approach to water management. Based on the central principles of creating watershed scale and scientific-based, multi-stakeholder solutions, the *Clean Water Act* focuses on protecting water before it enters the drinking water system. Following the outcome of the Walkerton Inquiry, the province commenced an ambitious program to ensure that municipal drinking water was protected at the source and that high quality source water would become the first barrier to preventing unacceptable drinking water quality. Further, the plans were to be driven locally by source protection committees in each of the 19 defined Source Protection Areas (Conservation Ontario, undated).

The Sudbury Source Protection Area includes eight municipal drinking water systems in three major watersheds. It is a complex integrated system of wells, lake surface water intakes and river intakes. Most systems are owned and operated by the City of Greater Sudbury. One system is owned and operated by Vale.

The planning process is carried out under the direction of the Greater Sudbury Source Protection Committee (see Table 1.1), with representation from the local municipal, industrial and commercial business sectors, the public at large, the environmental NGO sector and the two local First Nations. The committee has been strongly supported by the Greater Sudbury Source Protection Authority, led by Chair Lin Gibson, and staff of the Nickel District Conservation Authority, led by General Manager Paul Sajatovic and Program Manager Judy Sewell, and the team of dedicated, talented staff. This leadership has allowed the committee to draft sound terms of reference that were approved by government in 2009 and, subsequently, to assess the threats to Sudbury's municipal source water. The assessment report was submitted in May 2010, updated in 2011 and is now being amended to reflect the completion of technical studies on water quantity.

The residents of the Sudbury Region are very proud of the recent environmental accomplishments of the area and the City has proudly been dubbed the "City of Lakes." On many of the City lakes, local volunteer stewardship committees measure water quality and help formulate lake-wide plans. Stewardship committees are supported by City staff.

From City Council to local residents, people have been very responsive to the source protection planning process and have facilitated the job of the committee. As well as the strong staff support, the committee has been supported by dedicated representation from the Ministry of the Environment and the Sudbury & District Health Unit.

The committee has identified a number of unique threats to source water, as well as threats prescribed in the rules laid out by the province. The report highlights issues that have been identified in the drinking water areas during public open houses and from local knowledge of the sources. In some areas, the committee has identified data gaps. Filling the gaps will require resources dedicated to ensuring that the gaps are narrowed to allow scientifically sound plans to be implemented.

Nels Conroy
Greater Sudbury Source Protection Committee Chair

Preface

In May 2000, an outbreak of *E. coli* occurred in the drinking water supply in the small rural town of Walkerton, Ontario. The outbreak caused approximately 2,500 people to become ill and resulted in the deaths of seven people. The tragedy was felt throughout both the community and the province, and was one of the more publicized in a series of incidents across Canada resulting in a wave of concern throughout the country that greater attention needed to be given to the protection of drinking water supplies.

In response to the Walkerton tragedy, the provincial government initiated the Walkerton Inquiry to investigate the circumstances surrounding the event. Justice Dennis O'Connor of the Supreme Court of Ontario led the inquiry, the findings of which were released in 2002. The completed investigation determined that a number of the safety barriers designed to ensure a safe drinking water supply had been compromised.

In his report, Justice O'Connor outlined recommendations for the province of Ontario to ensure the safety of drinking water for the residents of Ontario and prevent another tragedy from occurring. He recommended that a multi-barrier approach be used to protect drinking water supplies. The first step in this approach is Source Protection.

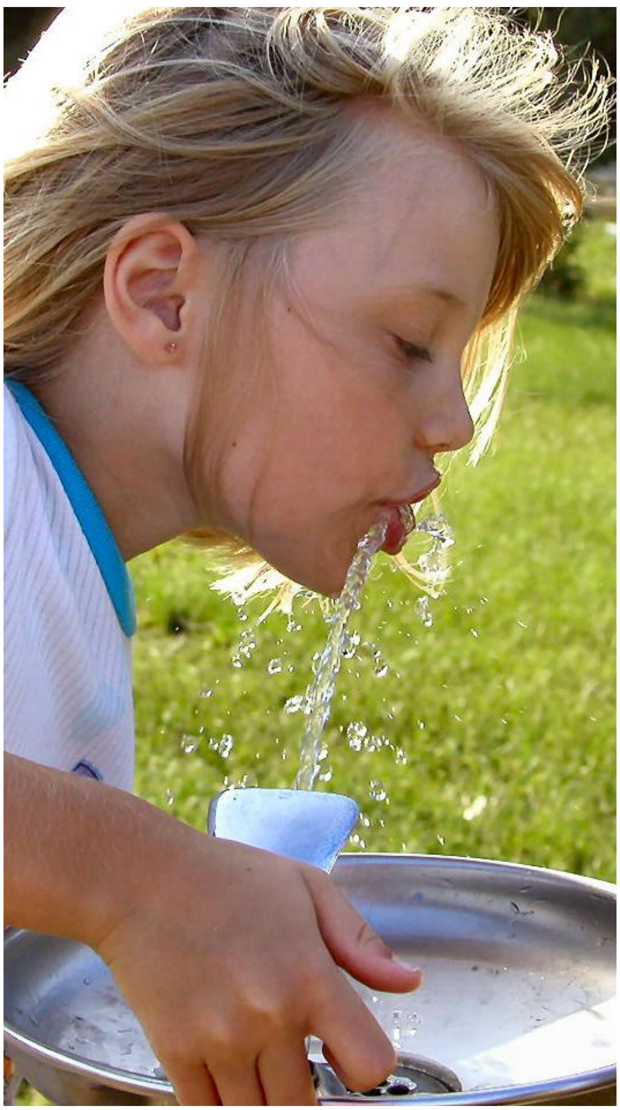
The province of Ontario responded by passing the *Clean Water Act* in 2006. Under the Act, each source protection region is required to develop plans to protect both the quality and quantity of their municipal drinking water sources. The province was divided into 19 Source Protection Regions (SPRs) based on watersheds, with each SPR responsible for forming a source protection committee based on local stakeholder representation. The source protection committees have been tasked with preparing the assessment report and the source protection plans.

The Nickel District Conservation Authority and the Greater Sudbury Source Protection Authority are overseeing the Drinking Water Source Protection Program for Greater Sudbury. These partners will work with the committee to develop and implement the source protection plan.

This assessment report comprises a number of different technical background studies to assess the risk to water quality and quantity for source waters. This information is used for preparing the source protection plan for the Greater Sudbury Source Protection Area.

Part One

Report Overview and Methodology



This Assessment Report provides the technical material upon which the Source Protection Plan is based. It has been prepared according to current requirements under the *Clean Water Act,* and according to current technical direction and data availability.

Approved on September 2, 2014

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Chapter 1 - Overview of the Assessment Report

1.1 Report Components

The assessment report consists of 10 parts and a total of 55 chapters. Part One describes the methodology for completing the water quality risk assessment and the water quantity risk assessment, which comprise the material presented in this report. Part Two provides an overview of the Greater Sudbury Source Protection Area. It describes the drinking water systems in the area, the physical and human geography, the geology and the climate of the planning area. The three major watersheds that make up the source protection area are described, including the main surface water flows, groundwater flows and surface water and groundwater interactions. Conceptual water budget and Tier 1 water budget information for each of the three major watersheds is presented in Part Two, as well as a description of water quality sampling programs and results to date. A brief description of aquatic ecology is also provided.

The remaining eight parts of the assessment report describe each of the municipal residential drinking water systems in the source protection area. Each part has a chapter describing the drinking water system, an assessment of the vulnerability of the source water, an assessment of the threats to the source water, a water quantity assessment or a water budget, and an evaluation of the uncertainty and data gaps associated with the assessment of each system.

The appendices include the glossary, the technical reports that were completed to help meet the requirements of this report, references, public consultation information and the tables of circumstances under which certain activities are or would be low, moderate or significant threats.

1.2 Source Protection Committee

The Greater Sudbury Source Protection Committee consists of nine members plus the chair. The chair was appointed by the Minister of the Environment and members were appointed by the Greater Sudbury Source Protection Authority in 2007. The Province of Ontario regulates the size of the committee, and stipulates that it must consist of one third municipal members, one third local economic sector members and one third other members, such as environmental, academic, public, or other local representation.

The Greater Sudbury Source Protection Committee has three staff members from the City of Greater Sudbury, a local mining representative, a Chamber of Commerce representative, a local land developer, an environmental representative and two public members at large. Both local First Nations and liaison members from the Greater Sudbury Source Protection Authority, Sudbury & District Health Unit and Ministry of the Environment also participate on the committee. Table 1.1 shows source protection Committee membership and First Nations representation.

The committee met approximately once a month from its inception in 2007 until 2011 when most of the technical work for the assessment report was completed and the related policy base for the first source protection plan was completed. Since then it the committee has met as required. All meetings are open to the public. The committee's role is to oversee the development of the source protection plan, which started with preparing the terms of reference, and then this assessment report. Committee members represent their sectors and their role is to develop practical policies that can be implemented to protect drinking water sources in this area. The source protection plan was prepared and submitted to the Ministry of the Environment on August 20, 2012 and is currently being amended in conjunction with this assessment report update to include water quantity policies.

Table 1.1 Members of the Greater Sudbury Source Protection Committee and First Nation representation

Name	Sector	Expertise/Background
Nels Conroy	Chair	Water Resources and Facilitation
Nick Benkovich	Municipal	Director, Municipal Water/Wastewater Services
Stephen Monet	Municipal	Manager of Environmental Planning Initiatives
Paul Baskcomb	Municipal	Director of Planning Services
Wendy Wisniewski	Economic/Mining	Vale, Environmental Analyst
Luc Bock	Economic/Land Development	Sudbury & District Home Builder's Association, L&S Bock Development
Greg Haddad	Economic/Small Business/Commercial	Greater Sudbury Chamber of Commerce, Uptown Cleaners and Sudbury Steam Dry Cleaners Ltd, Owner
Lilly Noble	Other/Environmental NGO	Coalition for a Liveable Sudbury
Richard Bois	Other/Public Member	Retired Chief Administrative Officer/Clerk, Town of Walden
Tim Worton	Other/Public Member	Retired from the Sudbury & District Health Unit
Cheryl Recollet	First Nations	Wahnapitae First Nation, Environmental Coordinator
Heather Swandon	First Nations	Atikameksheng Anishnawbek (Whitefish Lake First Nation), Natural Resources Coordinator

1.3 Source Protection Authority

With the passage of the *Clean Water Act* in 2006, the board of the Nickel District Conservation Authority became the Greater Sudbury Source Protection Authority for the purposes of meeting conservation authority obligations under the *Clean Water Act*. In some parts of the province, several conservation authorities joined to form one source protection region governed by one source protection authority. The Greater Sudbury Source Protection Authority has five public members and four elected municipal councillors, who provide a strong and necessary link to the Greater Sudbury City Council.

1.4 Public Consultation

Public consultation is an integral part of the development of the assessment report. Public comments received by mail, email, telephone and at two public meetings that were held during the development of the terms of reference, highlighted many local concerns about threats to local drinking water sources. These local concerns are reflected in the addition of a local threat (the transportation of hazardous substances along transportation corridors), in the identification of sodium and Microcystin LR (blue green algae) as issues for the Ramsey Lake system, and also as other local concerns described in Chapter 14.5.

The source protection authority and source protection committee are committed to reflecting local public concerns about protecting drinking water sources in both the assessment report and the source protection plan. Public consultation requirements for the assessment report are being met by hosting five public meetings during the consultation periods, by publishing the draft, proposed, amended and final assessment report on the Conservation Authority website, by making copies available in local libraries and the Conservation Authority office, by publishing notices in English and French language newspapers, by providing notice to the two local First Nations and to each municipality listed in the terms of reference, and by considering public comments in the preparation of the report. Appendix 4 provides a summary of public consultation on the assessment report.

1.5 Technical Team and Peer Review Process

This assessment report was prepared according to a set of Technical Rules developed by the Ontario Ministry of the Environment specifically for the assessment reports. The work presented in this report was done by a number of different technical experts. The province mandated that all water budget work be peer reviewed and also provided for the delineation and scoring of vulnerable areas to be peer reviewed. Work commenced in 2005, when some components of draft technical guidance first became available from the province and proceeded as more guidance subsequently became available. This report complies with the November 20, 2008, Drinking Water Source Protection Assessment Report Technical Rules and Regulations, as amended November 16, 2009, and with all Ministry of the Environment source protection technical bulletins issued up to February 25, 2010. This amendment complies with the MOE Technical Bulleting, Water Budget and Water Quantity Risk Assessment Tier 2 Subwatershed Stress Assessment and Tier 3 Local Area Risk Assessment, April 2010.

A water budget peer review team was established in 2005 to prepare the conceptual water budget. This team stayed on to prepare the Tier 1, Tier 2 and Tier 3 water budgets. The first peer review meeting was in January 2006. This group met approximately every six weeks until the Tier 3 water budget work was completed. A record of peer review was completed after the conceptual water budget was completed, as well as after Tier 1, Tier 2 and Tier 3 work was completed.

Work for water quality assessment proceeded as guidance for the required products became available. The vulnerability assessment work started in June 2006, and peer review started as soon as funding became available from the province in January 2008.

1.6 Continuous Improvement for the Assessment Report

This assessment report provides the technical material upon which the source protection plan is based. It has been prepared according to current requirements under the *Clean Water Act*, according to current technical direction and data availability. It will be updated as determined by the Greater Sudbury Source Protection Authority, the Greater Sudbury Source Protection Committee and the Ontario Ministry of the Environment.

As new information arises, either from increased or continuous monitoring, improved models, or a change in methodology, the results from this report will need to be updated to reflect new information. In addition to data gaps that have been identified for certain drinking water systems in those relevant sections of this report, there are also some types of future work that could improve the analyses for subsequent assessment reports. For the groundwater systems, the following work would be beneficial:

- Modeling of the wellhead protection areas was based on actual pumping rates between the years 2002 through 2007. These rates will have to be revisited on a regular basis to reflect any changes in usage in order for the protection zones to accurately reflect the current system;
- Updated and additional water level data throughout the contributing area would improve the calibration of the groundwater models developed for this assessment;
- The installation of monitoring wells within the municipal well field would improve water quality and quantity assessments; and
- Improved monitoring of sodium levels to determine if sodium is a drinking water quality issue.

For the Wanapitei surface water system, it would be useful to study the flow dynamics in the vicinity of the intake and the influence of wind to ascertain the potential for contamination from an accidental spill on the rail line or highway. For the Ramsey Lake surface water system, the following work would be useful:

- Circulation modeling for Ramsey Lake to update and further refine IPZ-1, 2 and 3 delineations;

- Continued water quality monitoring to determine any long term impacts of increased sodium and chloride;
- Continued monitoring of the presence of cyanobacterial blooms and the potential local conditions to trigger a bloom;
- Continued monitoring of inflows and outflows to refine water balance calculations;
- Increased monitoring of quality and quantity of inflows with respect to storm events;
- Improved mapping and monitoring of storm drainage in the watershed; and
- Improved information management of local climate stations within the Ramsey Lake watershed.

Chapter 2 - Water Quality Risk Assessment

A water quality risk assessment is conducted for each surface and groundwater municipal system. This consists of delineating vulnerable areas, assigning a vulnerability score to those areas and identifying and assessing potential water quality threats to the drinking water supply. The following sections will describe the surface water and groundwater methodology to determine vulnerable areas and water quality threats.

2.1 Surface Water Vulnerable Area Delineation and Scoring

Vulnerability for surface water intakes was originally assessed by AMEC for the three surface water intakes in the Greater Sudbury Source Protection Area. The study was completed in early 2008 and subsequently the Technical Rules were not finalized until December 2009. Consequently, many of the results needed to be re-evaluated and changed to reflect the final rules. The full studies conducted by AMEC are referenced in Appendix 2.

Intake protection zones (IPZ) are delineated for all surface water municipal intakes. The type of intake it is (A, B, C or D) determines how the IPZs are delineated.

In the Greater Sudbury Source Protection Area there are three surface water intakes. Two intakes, the Vermilion and Wanapitei, are classified as a Type C. The David Street intake is classified as a Type D (See Rule 55).

Type C Intake Protection Zone Delineation

Table 1.2 describes the methodology for each IPZ for Type C intakes.

Table 1.2 – Description of intake protection zones for a Type C (river) intake

Intake Protection Zone	Description
Intake Protection Zone 1*	A semi-circle that has a radius of 200 m extending upstream from the centre point of every intake that serves as the source or entry point of raw water supply for the system and a rectangle with a length of 400 m and a width of 10 m extending downstream from the centre point.
Intake Protection Zone 2	Extends from the IPZ-1 to include areas within each surface water body and storm sewershed that reflect the response time for a water treatment plant operator to respond to adverse conditions (minimum 2 hour travel time). Where IPZ-2 abuts land, a maximum 120 m setback from the high water mark and the area of the regulation limit. IPZ-2 may be extended to include an area that contributes water through a transport pathway.
Intake Protection Zone 3	Includes the area within each surface water body that may contribute water to the intake. Where it abuts land, a 120 m setback from the high water mark and the area of the Regulation Limit will be included. IPZ-3 may extend to include a transport pathway.

*An IPZ-1 can be modified to reflect local hydrodynamic conditions affecting stream flow (Rule 64).

The IPZ-1 in the Vermilion River intake was modified to reflect the local hydrodynamic conditions of the river. The modification was based on the results of drogue studies conducted in 2006 by AMEC. A full description of the modification is in Chapter 29. The delineation of the IPZ-1 for the Wanapitei River remained consistent with the Technical Rules.

Intake protection zone 2 for the Vermilion and Wanapitei Rivers was delineated based on models developed in HEC-River Analysis System (HEC-RAS) by Golder Associates (Golder 2011). The model used surveyed cross sections from river reaches and hydraulic properties such as slope and elevation to simulate water levels for various discharge scenarios.

The river reaches were previously modeled by the Nickel District Conservation Authority for flood mapping purposes using HEC-2, an early version of modeling software. Previously estimated IPZ-2 distances were based on earlier flood plain analysis, and it was recognized that the modeled reaches and river profiles were not necessarily reflective of the actual conditions. Also the uncertainty reflected in the IPZ-2 delineations was very high. Following the initial IPZ-2 analysis additional field work was carried out on the Wanapitei and Vermilion Rivers in order to reduce uncertainty. The river bed cross sections and velocity profiles were collected to improve the local understanding of river geometry upstream of the WTP intakes. The surveyed reach extended upstream of the WTP intake until rapids were encountered.

Discrete manual cross sections and velocity profiles were completed at three locations on the Vermilion River and four locations on the Wanapitei River. Manual cross section measurements were conducted with a graduated tagline strung across the river, and river depth was measured at 5 m intervals using a weighted sounding line which was compared to the sonar reading at that location. Velocity was measured at each 5 m interval with a Valeport (BFM001) impeller-type flow meter and suspension kit. The collected field data was used to construct a Digital Terrain Model (DTM) as well as a 2-Dimensional model in the hydraulic simulation program HEC-River Analysis System v. 4.0.

Several scenarios were simulated in the model to estimate the velocity required to determine the 2 hour time of travel to delineate the IPZ-2. The 1 in 2 year flood was considered an appropriate scenario to estimate the travel time. The results of the HEC-RAS analysis provide an estimate of travel time through the modeled river reach without the effect of contaminant mixing. IPZ-2 for the Wanapitei intake was extended to include transport pathways.

The IPZ-3 for the Vermilion and Wanapitei River intakes were delineated based on the Technical Rules.

Type D Intake Protection Zone Delineation

The David Street intake is the only Type D intake in Greater Sudbury and is located in Ramsey Lake. Table 1.3 describes the methodology for delineating intake protection zones in a Type D intake.

The IPZ-1 for the David Street intake was delineated based on the Technical Rules. In order to determine the IPZ-2, current and drogue studies were conducted in 2006 by AMEC as part of the surface water technical studies. The delineation of IPZ-2 was based these studies, which also considered transport pathways such as storm sewers. Chapter 19 describes the results of the AMEC study and the complete study is located in Appendix 2. The IPZ-3 was delineated based on the Technical Rules and included transport pathways such as storm sewers.

Table 1.3 – Description of intake protection zones for a Type D (inland lake) intake

Intake Protection Zone	Description
Intake Protection Zone 1*	Area within a surface water body with a circle of a 1 km radius centered on the intake. Where it abuts land, the IPZ-1 will be a 120 m setback from the high water mark and the area of the Regulation Limit along the abutted land.
Intake Protection Zone 2	Extends from the IPZ-1 to include areas within each surface water body and storm sewershed that reflect the response time for a water treatment plant operator to respond to adverse conditions (minimum 2 hour travel time). Where IPZ-2 abuts land, a maximum 120 m setback from the high water mark and the area of the regulation limit. IPZ-2 may be extended to include an area that contributes water through a transport pathway.
Intake Protection Zone 3	Includes the area within each surface water body that may contribute water to the intake. Where it abuts land, a 120 m setback from the high water mark and the area of the Regulation Limit will be included. IPZ-3 may extend to include a transport pathway.

*An IPZ-1 can be modified to reflect local hydrodynamic conditions affecting stream flow (Rule 64).

Intake Protection Zone Vulnerability Scoring

Each vulnerable area is scored by multiplying two factors: the Source Vulnerability Factor and the Area Vulnerability Factor.

Source Vulnerability Factor x **Area** Vulnerability Factor = **Vulnerability Score**

The **source** vulnerability factor refers to the specific vulnerability of the intake. This is based on the depth of the intake, the distance of the intake from shore and if there have been any drinking water issues present.

The **area** vulnerability factor refers to the degree of vulnerability to contamination in the protection zone. This factor is based on land characteristics (i.e. slope, soil type, and land cover), distance to the intake, the presence of transport pathways and the percentage of land within the protection zone. The area vulnerability factor for an IPZ-3 cannot be greater than the factor assigned to IPZ-2 (Rule 91).

Table 1.4 summarizes the vulnerability scoring for Type C and D intakes (See Rules 86 - 96). The technical team took a qualitative approach to assess the vulnerability factors based on local knowledge and professional judgment for each intake.

2.2 Groundwater Vulnerable Area Delineation and Scoring

There are two types of vulnerable areas to be delineated in accordance with the Technical Rules for groundwater quality vulnerability: wellhead protection areas and highly vulnerable aquifers. Wellhead protection areas relate to municipal wells and highly vulnerable aquifers apply to the entire Greater Sudbury Source Protection Area.
Groundwater vulnerable areas were first delineated for the City of Greater Sudbury as part of the provincially directed municipal groundwater studies completed in 2005. Golder Associates performed the research and analysis for the report based on the MOE Terms of Reference for the municipal groundwater studies (MOE, 2001). The study is described further in the section below.

The drinking water source protection Technical Rules, finalized in December 2009, included some changes to the original study parameters and therefore necessitated an update to the vulnerable areas to integrate with the requirements of the *Clean Water Act*. Golder Associates and WESA Inc. collaborated in providing the updated groundwater vulnerable areas for the Greater Sudbury Source Protection Area. The results are described later in this section.

Table 1.4 – Summary of intake protection zone vulnerability scoring

Type	Source Vulnerability Factor	Area Vulnerability Factor		
		IPZ-1	IPZ-2	IPZ-3
Type C	0.9 or 1.0	10	7 – 9	1 – 9
Type D	0.8 – 1.0	10	7 – 9	1 – 9

Municipal Groundwater Studies

As part of the MOE Municipal Groundwater studies, groundwater flow models for all municipal water supply wells within the City of Greater Sudbury were created in accordance with the Technical Terms of Reference for

Municipal Groundwater Studies (MOE, 2001). The three-dimensional numerical groundwater flow modeling code MODFLOW/MODPATH was selected to estimate time-related capture zones for the wells within the city. Conceptual geologic models were developed for each area and were based on the MOE Water Well Information System and other available geologic and hydrogeologic data.

In accordance with the terms of reference, the pumping rates used in the models were the maximum permitted pumping rates defined in the relevant permits to take water. The capture zones delineated included the 50-day, 2-yr, 10-yr and 25-yr time of travel zones.

The previous municipal groundwater study did not delineate a 5 year time of travel (WHPA-C) and did not include a 100 m buffer around the well (WHPA-A). Golder Associates updated each model to include these new vulnerable areas to be consistent with the Technical Rules. WHPA-E and Fs were also not delineated for wells designated as GUDI (Groundwater Under the Direct Influence of Surface Water). WESA Inc. delineated WHPA-Es based on HEC-RAS modeling and professional judgment as described in the surface water vulnerability process for the delineation of intake protection zone 2. It was not necessary to delineate any WHPA-Fs because no drinking water issues were identified for the GUDI wells. Further details are provided in Part 6 and Part 10 where GUDI wells are assessed.
Additionally, the municipal groundwater studies were modeled based on the maximum permitted pumping rates for each well as required by the terms of reference. This requirement was not part of the new Technical Rules and professional judgment can be applied to determine appropriate pumping rates to use in the groundwater models for the municipal wells. After considerable discussion, the technical team considered these pumping rates to be overly conservative because they are generally significantly higher than the observed recent pumping rates. Conversely, the average monthly pumping rate was considered inappropriate because it does not allow for any growth in the pumping rate or any uncertainty in the protection areas.

Wellhead Protection Area Delineation

The Technical Rules, finalized in December 2009 as part of the *Clean Water Act*, defined the wellhead protection areas based on different criteria than the original municipal groundwater studies. Rules 47 – 50 define how the wellhead protection areas to be delineated. Table 1.5 summarizes the delineation of each wellhead protection area.

The team decided to assess the protection areas based on the 95th percentile of the observed historic monthly pumping rates, or a pumping rate that was not exceeded 95% of the time. Use of these rates eliminates outlying data points without omitting a significant portion of the data. The resulting wellhead protection areas are conservative estimates based on actual pumping rates. Appendix 2 provides the details of the selection of appropriate pumping rates.

Subsequent to completion of the municipal groundwater study, WESA Inc. completed field investigations for the Vale Garson Mine Groundwater Characterization Study. Groundwater elevation data collected during the field investigations indicated that dewatering of the Garson mine affects groundwater flow directions in the vicinity of the municipal water supply wells. The original model created for the Garson municipal water supply wells did not incorporate this information and therefore, the resulting wellhead protection areas required updating. WESA Inc. updated the modeling for the Garson wells to include the additional information.

Table 1.5 – Description of wellhead protection areas for a Type I system. (See Rules 47 - 50)

Wellhead Protection Area	Description
WHPA-A	100 m radius centered on the well
WHPA-B	The time of travel is less than or equal to 2 years and excludes WHPA- A.
WHPA-C	The time of travel is less than or equal to 5 years, but greater than 2 years.
WHPA-D	The time of travel is less than or equal to 25 years but greater than 5 years.
WHPA-E	Applies only to GUDI* wells. An IPZ-2 is delineated as if an intake for the system were located: a) At the point of interaction between the groundwater supply and surface water directly influencing the supply; or b) At the point in the surface water body that is closest in proximity to the well if is not known.
WHPA-F	Applies only to GUDI* wells. An IPZ-3 is delineated as if an intake for the system were located in the surface water body in closest proximity to the well.

*GUDI refers to Groundwater Under the Direct Influence of Surface Water

Groundwater Vulnerability Assessment

To assess groundwater vulnerability, the Intrinsic Susceptibility Index (or ISI) was used. The index is based on the MOE Water Well Information System (WWIS) database to produce a numerical score for each well in the database. The score is derived from the overburden soil type, thickness above the aquifer and the static water level in the well. The scores are then interpolated between the well locations to produce a spatial assessment of intrinsic vulnerability of groundwater.

Groundwater vulnerability in the Source Protection Area was assessed based on the WWIS where the density of wells provided some confidence in the results and surficial geology maps were used in areas that had sparse well records. Well density within most of the residential and agricultural areas of the City of Greater Sudbury was sufficient to allow the use of the well database. Well density outside of the residential and agricultural areas of the City of Greater Sudbury was sparse or zero and, therefore, aquifer vulnerability was assessed based on surficial geology. The resulting aquifer vulnerability for all areas was reviewed using professional judgment and local knowledge to ensure consistency with the intent of the Technical Rules. Aquifer vulnerability was assigned as low, medium or high based on available surficial geology maps, soil descriptions and local knowledge of the depositional environments.

The Technical Rules categorize aquifers into high, medium or low vulnerability (Rule 38). Using the ISI scores:

- Areas with **high** vulnerability are those with ISI scores that are **less than 30**,
- Areas with **medium** vulnerability are those with ISI scores that are **greater than or equal to 30 and less than or equal to 80**, and
- Areas with **low** vulnerability are those areas with ISI scores that are **greater than 80**.

For a full report regarding the specifics of the vulnerability assessment, please refer to Appendix 2.
According to Rule 84, the vulnerability score within a WHPA- E must be defined following the rules for an IPZ-2. It is calculated as the product of the area vulnerability factor, which is defined based on the vulnerability area within the WHPA- E and the source vulnerability factor, which is defined based on the vulnerability of the intake.

Significant Groundwater Recharge Area Vulnerability Scores

Significant groundwater recharge areas are delineated as part of the Tier 1, Tier 2 and Tier 3 water budget process and vulnerability scores are assigned as part of the water quality risk assessment process. The methodology and results of the delineation and vulnerability assessment are in Chapter 12 for the Tier 1 results for the entire source protection area, and in Chapter 18 for Ramsey Lake Tier 1/2 and Tier 3 results and Chapter 33 for Valley East Tier 2 and Tier 3 results.

A summary of the data sources used for the groundwater vulnerability studies in provided in Appendix 6.

Highly Vulnerable Aquifer Delineation and Vulnerability Score

A highly vulnerable aquifer as defined in the Technical Rules is an area that has been identified with high vulnerability (Rule 43). A vulnerability score of 6 is given to this area (Rule 79). The highly vulnerable aquifers are delineated across the entire Greater Sudbury Source Protection Area.

Wellhead Protection Area Vulnerability Scores

Vulnerability for the wellhead protection areas is assessed based on Rules 82 to 84 of the Technical Rules. The results of the intrinsic susceptibility index method are used to give a numerical score to the wellhead protection area. Table 1.6 illustrates the scoring system used in this report.

Table 1.6 – Wellhead protection area vulnerability scores using the ISI method

Groundwater Vulnerability Category for the Area	WHPA-A	WHPA-B	WHPA-C	WHPA-D
High	10	10	8	6
Medium	10	8	6	4
Low	10	6	4	2

2.3 Water Quality Threats Assessment

The final step in determining the risk to water quality is a threats assessment. In the Technical Rules, there are three approaches to determining a threat to water quality. They are:

1. Drinking Water Quality Issues
2. Drinking Water Threat Activities
3. Drinking Water Condition

The methodologies for these approaches are described on the next page.

Drinking Water Quality Issues Approach

Rule 114 in the Technical Rules states that the presence of a parameter in water at a surface water intake or in a well is said to be a drinking water issue if the parameter is listed in schedule 1, 2 or 3 of the Ontario Drinking

Water Standards or Table 4 of the Technical Support Document for the Ontario Drinking Water Standards and Guidelines and:

a) The parameter is present at a concentration that may result in the deterioration of the water quality of the water for use as a source of drinking water; or
b) There is a trend of increasing concentrations of the parameter at the surface water intake, well or monitoring well and a continuation of that trend would result in the deterioration of the quality.

To determine the existence of drinking water quality issues in the municipal wells and surface water intakes, raw water quality data collected from the drinking water supplies through the MOE Drinking Water Surveillance Program (DWSP) was assessed. Data for the period 1991 to 2007 was subjected to trend analysis and compared to the Ontario Drinking Water Standards. Recorded confirmation of toxic cyanobacterial blooms (blue green algae) were also used to identify issues.

If an issue is identified, an issues contributing area is defined. The issues contributing area is the area where an activity or condition can contribute to the issue. Any activities listed in Table 1.7 or conditions that could contribute to the issue are identified as significant threats.

Drinking Water Threats Activities Approach

A drinking water threat is considered an activity or past activity that has the potential to impact drinking water quality.

There are four steps in identifying a drinking water threat through the threats activities approach. They are:

1. Listing of prescribed activities that are or would be drinking water threats
2. List circumstances for all is or would be significant, moderate or low drinking water threats for all vulnerable areas
3. Identify areas for significant, moderate and low drinking water threats
4. Enumeration of significant, moderate and low drinking water threats

List of Prescribed Drinking Water Threats

The list of prescribed drinking water threats is referenced in O.Reg. 287/07 s.1.1 paragraphs 1 through 18 and paragraph 21. Table 1.7 presents the prescribed drinking water threats.

List of Circumstances of Significant, Moderate and Low Threats

As required under Rule 111 and 112, a list of circumstances for all is or would be significant, moderate or low threats is to be generated for every vulnerable area. The threats tables list all prescribed threats with their associated circumstances that determine if a threat is significant, moderate or low. A hazard rating is given to each circumstance that is based on toxicity, environmental fate, method of release, quantity of chemical of concern and type of vulnerable area. The hazard score is then multiplied by the vulnerability score to determine the level of risk.

Hazard Score x **Vulnerability Score** = **Risk Score**

If the risk score is 80 or greater, the threat is significant. If the score is 60 but less than 80, the threat is moderate. If the risk score is 40 but less than 60, the threat is low.

As the list of associated circumstances for each vulnerable area is quite large, the MOE has developed a list of reference tables for each combination of vulnerability score. These reference tables are cited in the relevant sections.

Table 1.7 – List of prescribed drinking water quality threats under O.Reg. 287/07 s.1.1

1	The establishment, operation, or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act.*
2	The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.
3	The application of agricultural source material to land.
4	The storage of agricultural source material.
5	The management of agricultural source material.
6	The application of non-agricultural source material to land.
7	The handling and storage of non-agricultural source material.
8	The application of commercial fertilizer to land.
9	The handling and storage of commercial fertilizer.
10	The application of pesticide to land.
11	The handling and storage of pesticide.
12	The application of road salt.
13	The handling and storage of road salt.
14	The storage of snow.
15	The handling and storage of fuel.
16	The handling and storage of a dense non-aqueous phase liquid.
17	The handling and storage of an organic solvent.
18	The management of runoff that contains chemicals used in the de-icing of aircraft.
21	The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard. O. Reg. 385/08, s.3.

Identification of areas where significant, moderate or low threats can occur

- Areas with a vulnerability score of 8 or greater can have the potential for a significant, moderate or low threat.
- Areas with a vulnerability score of 6 or greater can have the potential for a moderate or low threat to occur.*
- Areas with a vulnerability score of 4 or greater can have the potential for a low threat to occur.*
- Areas with a vulnerability score of less than 4 cannot contain a drinking water threat.*

*DNAPLs are an exception because they are always a significant threat in WHPA-A, B, C/C1 regardless of the vulnerability score.

Enumeration of Significant, Moderate and Low Threats

The enumeration of threats takes into consideration the number of locations at which a person is engaging in an activity that is or would be a drinking water threat.

According to Rule 9 of the Technical Rules, an inventory of drinking water threats is required to be conducted for the vulnerable areas where a significant threat could occur. Initially, a prescreening was conducted to determine the circumstances and the areas where a significant threat could occur. A short list of properties where a significant threat could occur was generated based on orthophotos, municipal property information and vulnerability mapping. The short listed properties received notification via mail noting that a Nickel District Conservation Authority staff person may conduct a site visit to identify potential drinking water threats on their property. Site visits were conducted in the summer and fall of 2009.

Moderate and low threats were enumerated using a similar methodology. Prescreening using orthophotos, GIS layers, municipal property information and existing databases was used to identify properties were a threat may be occurring. Drive-by surveys were used to verify the threats in all WHPAs and IPZs. The exceptions were the SGRA and HVA where threats were not verified by field surveys due to the high quantity of threats and the time required to drive to these very large vulnerable areas.

Drinking Water Conditions Approach

A drinking water condition is a result from a past activity where any of the following situations occur:

1. The presence of a non-aqueous phase liquid in groundwater in a highly vulnerable aquifer, significant groundwater recharge area, or wellhead protection area.

2. The presence of a single mass of more than 100 litres of one or more dense non-aqueous phase liquids in surface water in a surface water intake protection zone.

3. The presence of a contaminant in groundwater in a highly vulnerable aquifer, significant groundwater recharge area or a wellhead protection area, if the contaminant is listed in Table 2 of the Soil, Ground Water and Sediment Standards and is present at a concentration that exceeds the potable groundwater standard set out for the contaminant in that Table.

4. The presence of a contaminant in surface soil in a surface water intake protection zone if, the contaminant is listed in Table 4 of the Soil, Ground Water and Sediment Standards is present at a concentration that exceeds the surface soil standard for industrial/commercial/community property use set out for the contaminant in that Table.

5. The presence of a contaminant in sediment, if the contaminant is listed in Table 1 of the Soil, Ground Water and Sediment Standards and is present at a concentration that exceeds the sediment standard set out for the contaminant in that Table.

If there is evidence of off-site contamination, the condition is given a hazard score of 10. If there is no evidence, the condition is given a hazard score of 6.

Conditions may occur throughout the Greater Sudbury Source Protection Area, however, at the time of report production no information existed regarding evidence of off-site contamination and therefore were not included in this report.

Managed Lands

The percentage of managed lands was calculated for all vulnerable areas in order to evaluate this type of non-point source threat, as per Technical Rule 16. Percent of managed land was calculated using guidance from the Technical Bulletin entitled "Proposed Methodology for Calculating Percentage of Managed Lands and Livestock Density for Land Application of Agricultural Source of Material, Non-Agricultural Source of Material and Commercial Fertilizers" issued by the Ontario Ministry of the Environment in December 2009. A separate percentage of managed land was calculated for each vulnerable area with a score of 6 or above.

The following steps were used to calculate the percentage of managed lands:

1. Managed lands were categorized into two groups: agricultural managed land and non-agricultural managed land. Agricultural managed land includes areas of cropland, and fallow and improved pasture that may receive nutrients. Non-agricultural managed land includes golf courses, sports fields, lawns in residential areas and other built-up grassed areas that may receive nutrients, primarily commercial fertilizer (MOE Technical Bulletin, 2009).

   A Ministry of Natural Resources land cover database was used to calculate the amount of agricultural land. Visual inspection using 2007 orthophotography was used to define non-agricultural lands that could receive nutrients. For residential areas it was estimated that grassed areas comprised 60% of the property.

2. The amount of agricultural land and non-agricultural land that could receive nutrients was calculated for each vulnerable area. It was divided by the size of the vulnerable area to obtain the percentage of managed land.

3. Each vulnerable area fell into one of three risk categories:
   - Low potential risk – managed lands < 40% of vulnerable area;
   - Moderate potential risk – managed lands between 40% to 80% of vulnerable area; and
   - High potential risk – managed lands > 80% of vulnerable area.

Livestock Density

Nutrient units per acre were calculated for all vulnerable areas in order to evaluate this type of non-point source threat, as per Technical Rule 16. The method for calculating livestock density follows the Technical Bulletin entitled "Proposed Methodology for Calculating Percentage of Managed Lands and Livestock Density for Land Application of Agricultural Source of Material, Non-Agricultural Source of Material and Commercial Fertilizers" issued by the Ontario Ministry of the Environment in December 2009. A separate percentage of managed land was calculated for each vulnerable area with a score of 6 or above.

The calculation of livestock density involved three steps (MOE Technical Bulletin, 2009) and was estimated as follows:

1. Estimate the number of each category of animals present within the specified area. In the absence of existing information about number of livestock, a Municipal Property Assessment Corporation (MPAC) database was used to identify agricultural properties. Barn size on the property was used as an indicator of livestock density. An estimate of barn size was calculated.

2. Convert the number of each category present into nutrient units in order to compare all livestock on an equivalent unit of measure in terms of nutrients produced.

   This was done using conversion factors from the MOE Technical Bulletin.

3. Sum the total nutrient units of all categories and divide the resulting nutrient unit's value by the area of agricultural managed land within the same area. A nutrient unit per acre value was calculated for all vulnerable areas. Results can fall into one of three categories: < 0.5 NU/acre, 0.5 to <1 NU/acre, and >1NU/acre.

Impervious Surfaces

The percentage of impervious surface areas was calculated for all vulnerable areas in order to evaluate road salt as a non-point source threat, as per Technical Rule 16. A map was created for each vulnerable area showing the percentage of impervious surface area per square kilometre where road salt can be applied.

The percentage of impervious area was calculated using a one kilometre grid overlay. Residential roads were given a width of 8 meters and major roads were given a width of 10 meters. Information on parking lots, pedestrian walkways and other related surfaces that may also receive road salt were not considered as data was not available for these features within the study area. The exception is within the Ramsey Lake watershed where information of these features was available from the City of Greater Sudbury.

The percentage of impervious surface for each grid square was calculated and fell into one of four categories: < 1% impervious; 1% to < 8% impervious; 8% to < 80% impervious and ≥ 80% impervious.

Addition of a Local Threat – Transportation Corridors

In addition to the 21 water quality and water quantity threats identified in the MOE table of drinking water threats, source protection committees have the ability to request that local threats be added to their assessment report.

Under Technical Rule 119, a source protection committee can request that the Director allow an activity to be listed as a threat if:

1. The activity has been identified by the source protection committee as an activity that may be a drinking water threat; and

2. The Director indicates that the chemical hazard or pathogen hazard rating of the activity is greater than 4.

The Greater Sudbury Source Protection Committee had concerns regarding major transportation corridors which run through many of the municipal drinking water vulnerable areas within the Greater Sudbury Source Protection Area. These include railway corridors within IPZs 1, 2 and 3 of the Ramsey Lake watershed, IPZs 1 and 2 for the Wanapitei River intake, WHPA C of the Capreol wellhead areas and WHPA-B of the Onaping wellhead area. A number of major roadways also cross through vulnerable areas in the Ramsey Lake watershed, the Wanapitei River watershed, the Valley well fields, and the Garson and Dowling well areas. Dangerous and/or hazardous goods are transported on both the railway corridors and the roadways, and the potential exists for a spill.

Due to the potential for a spill to occur, the Greater Sudbury Source Protection Committee requested that the transportation of hazardous substances along transportation corridors be included in the Greater Sudbury Source Protection Area Assessment Report as a non-prescribed threat. The Committee felt it was important that the transportation of hazardous substances in areas of close proximity to municipal drinking water sources be considered a significant threat to enable the inclusion of appropriate mandatory policies in the source protection plan.

The Director of the Source Protection Programs Branch agreed to allow the local threat of transportation of hazardous substances along transportation corridors to be considered a drinking water threat in the Greater Sudbury Source Protection Area. Transportation of hazardous materials as a threat considers the following circumstances:

- Transportation of sulphuric acid by freight tank
- Transportation of liquid fuel by tanker truck
- Transportation of liquid fuel by freight tank
- Transportation of septage

A copy of the request letter and rationale from the Greater Sudbury Source Protection Committee and the response letter from the Director are in Appendix 7. The documentation in Appendix 7 also includes the circumstances and hazard rating of included activities.

Chapter 3 - Water Quantity Risk Assessment

A water balance in its simplest term is an evaluation of the inputs and outputs of a system. In theory, the inputs and outputs should balance over a period of time. If the inputs are less than the outputs, the water supply is depleted and can become limited. The Water Quantity Risk Assessment is a process to evaluate if the supply system is under threat of not having sufficient water to adequately meet capacity demands.

A water budget can be described as:

$$\Delta S = P + Q_{SIN} + Q_{GIN} + Anth_{IN} - ET - Q_{SOUT} - Q_{GOUT} - Anth_{OUT}$$

where ΔS is change in storage, P is precipitation, Q_{SIN} is surface water input, Q_{GIN} is groundwater input, $Anth_{IN}$ is anthropogenic input, Q_{SOUT} is surface water output, Q_{GOUT} is groundwater output and $Anth_{OUT}$ is anthropogenic output. Evapotranspiration (ET) occurs at its potential rate (PET) when water is freely available and the evaporating air mass is stable. aSoil moisture conditions can restrict evapotranspiration to an actual rate (AET). Over the course of a month or a day, these terms vary in their contributions to change in storage (ΔS).

Water quantity stress assessments for this report were calculated using the formula:

$$WaterQuantityStress(\%) = \frac{Q_{DEMAND}}{Q_{SUPPLY} - Q_{RESERVE}} x100$$

where Q_{DEMAND} is the consumptive demand, Q_{SUPPLY} is the water supply, and $Q_{RESERVE}$ is the water reserve.

3.1 Overview of Water Budget and Stress Assessment Framework

The water budget and stress assessment followed a tiered approach. Figure 1.1 outlines the process. A conceptual water budget outlines the basic movement of water throughout the Greater Sudbury Source Protection Area. Next, a Tier 1 water budget and stress assessment was completed for the three main watersheds: the Vermilion, Wanapitei and Whitefish River watersheds. In addition, due to the isolated nature of the municipal water supplies, a Tier 1 assessment was completed for each drinking water system. The Tier 1 used a simple water budget to calculate stress within each watershed based on a series of scenarios as listed in Table 1.8. If the system was deemed to be a significant or moderate stress, it progressed to a Tier 2 water budget and stress assessment.

A Tier 2 water budget and stress assessment was completed for the David Street and the Valley East drinking water systems. The Tier 2 refined the water budget and assessed the level of stress based on scenarios A to I as listed in the following table. Both of these systems progressed to a Tier 3 level based on the evaluated level of stress.
The Tier 3 or Local Area Risk Assessment delineates water quantity vulnerable areas. An intake protection zone – Q (IPZ-Q) is delineated for surface intakes and a wellhead protection area – Q (WHPA-Q) is delineated for municipal wells. Exposure and tolerance of the intake or well based on certain scenarios are assessed to determine level of risk. If a significant water quantity risk is assessed, water quantity threats are evaluated.

Significant groundwater recharge areas are delineated as part of the Tier 1, Tier 2 and Tier 3 water budget process and vulnerability scores are assigned as part of the water quality risk assessment process.

Full details for the methodology and results for the Tier 1, Tier 2 and Tier 3 work are in Appendix 2. The methodology and results of the delineation and vulnerability assessment are in Chapter 12 for the Tier 1 results for the entire source protection area, and in Chapter 18 for Ramsey Lake Tier 1/2 and Tier 3 results and Chapter 33 for Valley East Tier 2 and the Valley Tier 3 results.

A summary of data sources used for the water budget studies is provided in Appendix 6.

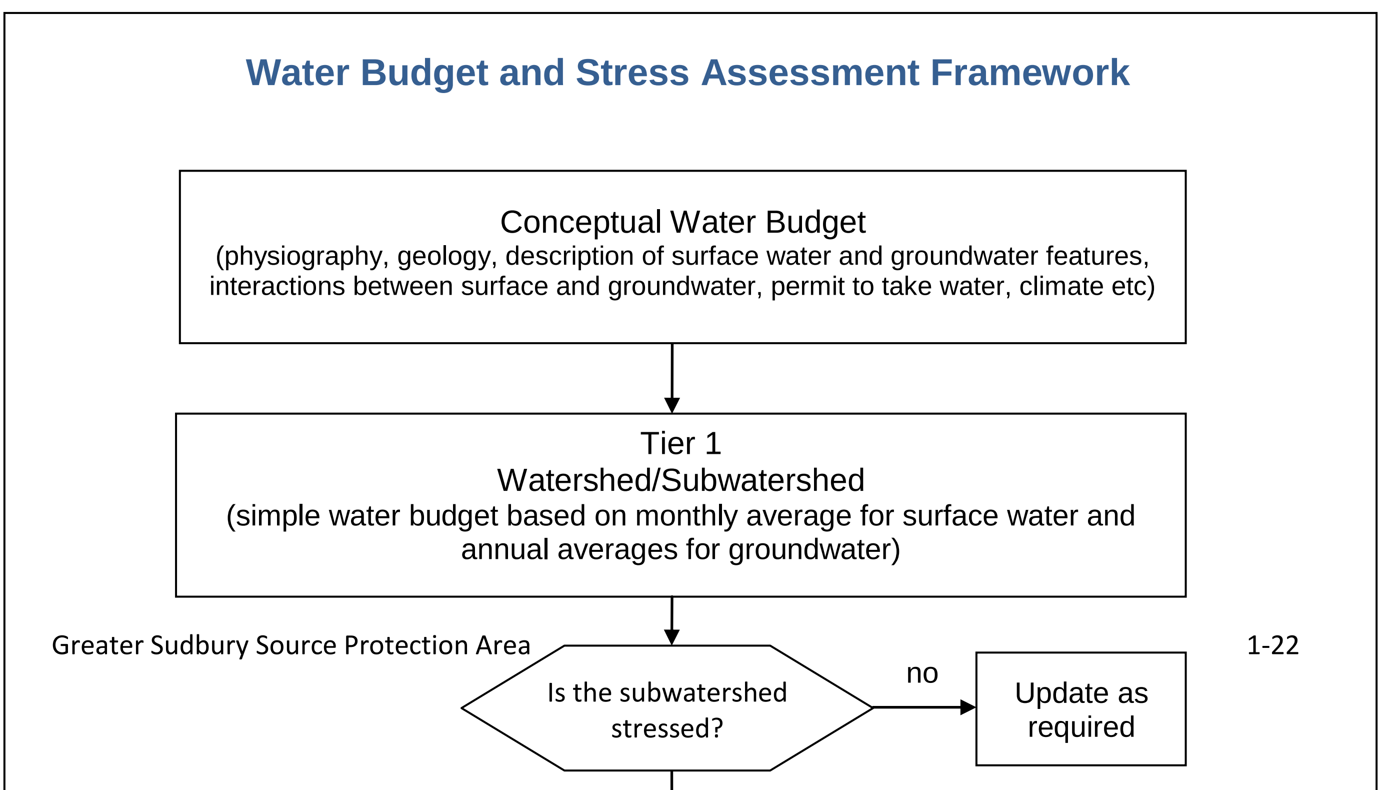


Figure 1.1 – Summary of water budget and stress assessment framework

Table 1.8 – Summary of water budget and stress scenarios used for Tier 1 and Tier 2

Scenario	Description of the Scenario	Data Restrictions - Demand	Data Restrictions - Supply and Reserve
A	Existing system-average		Data related to climate and stream flow shall be the historical data set for climate and stream flow.
B	Existing system-future demand	Data related to demand, associated with an existing type I, II or III system within the subwatershed shall be reflective of the demand that would exist in the year that the planned system will be operational.	Data related to climate and stream flow shall be historical data set for climate and stream flow. Data related to land cover shall be reflective of the future development in the subwatershed.
C	Planned system demand – operational year	Data related to demand associated with an existing type I, II or III system within the subwatershed shall be reflective of the demand that would exist in the year that the planned system will be operational.	Data set related to climate and stream flow shall be the historical data set for climate and stream flow. Data related land cover shall be reflective of the year that the planned system will be operational.
D	Existing system – two year drought		Data related to climate and stream flow shall be reflective of the two year drought

			period.
E	Existing system – future two year drought	Data related to demand associated with an existing type I, II or III system within the subwatershed shall be reflective of the future development in the subwatershed.	Data related to climate and stream flow shall be reflective of the two year drought period. Data related to land cover shall be reflective of the future development in the subwatershed.
F	Planned system – operational year – two year drought	Data related to demand associated with an existing type I, II or III system within the subwatershed shall be reflective of the demand that would exist in the year that the planned system will be operational.	Data related to climate and stream flow shall be reflective of the two year drought period. Data related to land cover shall be reflective of the future development that would exist in the subwatershed in the year that the planned system will be operational.
G	Existing system – ten year drought		Data related to climate and stream flow shall be reflective of the ten year drought period.
H	Existing system – future ten year drought	Data related to demand associated with an existing type I, II, or III system within the subwatershed shall be reflective of the future development in the subwatershed.	Data related to climate and stream flow shall be reflective of the ten year drought period. Data related to land cover shall be reflective of the future development in the subwatershed.
I	Planned system – operational year – ten year drought	Data related to demand associated with an existing type I, II, or III system within the subwatershed shall be reflective of the demand that would exist in the year that the planned system will be operational.	Data related to climate and stream flow shall be reflective of the ten year drought period. Data related to land cover shall be reflective of the future development that would exist in the subwatershed in the year that the planned system will be operational.

Conceptual Water Budget

The conceptual water budget for the Greater Sudbury Source Protection Area was completed in 2006. It contains general information about the flow, volume and bodies of water within the Vermilion, Wanapitei and Whitefish River watersheds. Appendix 2 contains the full report.

Components of the conceptual water budget report can be found in Part 2 of this document. In particular, the geology, hydrology, hydrogeology and water use chapters describe the findings of the conceptual water budget.

Tier 1 Water Budget and Stress Assessment

The Tier 1 Water Budget and Stress Assessment were calculated for the Vermilion, Wanapitei and Whitefish River watersheds by Golder Associates. The results are found in Part 2, Chapter 13 of this report. Tier 1 water budgets and stress assessments were also calculated for each drinking water system due to the isolated nature of each system. For the full report, please refer to Appendix 2.

Separate stress assessments were performed for surface water and groundwater systems in each study subwatershed. The Tier 1 stress assessment is a screening level calculation to define subwatersheds that may be at risk of failing to provide a sustainable supply of water. Stress at each study subwatershed was calculated under two scenarios: 1) current water supply and demand; and 2) future water supply and demand.

Water Budget Model Structure

All terms for the Tier 1 water budget calculations were integrated over a catchment area and reported as equivalent water depths (mm), volumes (m3) or water fluxes (m3/s).

A spreadsheet model was constructed and monthly and annual water budgets were prepared using a soil moisture balance (Holmes and Robertson 1959; Strahler and Strahler 1997). The soil moisture balance was used because it requires data readily available for the Sudbury area (e.g. temperature, precipitation, streamflow). This spreadsheet-type model presents an average measure of the conditions over a watershed and does not account for spatial heterogeneity within the study area.

The model was run for a 35-year period (1970-2005) and utilized a monthly water budget to estimate recharge, evapotranspiration, and surface soil storage capacity. Subsequent sections in this assessment report describe the model structure and specific data requirements for Tier 1 model inputs.

The general model procedure was as follows:

1. Soil water holding capacity was estimated by weighting surficial geology type over the study watershed.

2. Precipitation (P) was applied to the watershed; either as rainfall or snowmelt on a monthly basis.

3. Potential Evapotranspiration (PET) was determined by the Thornthwaite temperature index model as described in (Thornthwaite and Mather 1957). If P>PET, the water surplus was calculated as P-PET. If P<PET, water is removed from soil at actual evapotranspiration (AET), where AET<PET. The water deficit was calculated as P-AET.

4. Streamflow (QS) was separated into baseflow (QB) and surface runoff (RO).

If a water surplus was predicted when P-AET-RO>0, water was first used to fill soil water storage. If soil water holding capacity was at its maximum, the remaining water was assigned to groundwater recharge (QR). Recharge did not occur during December, January or February when soils were assumed frozen.

Water Stress Assessment

At the Tier 1 level, it was assumed that the current water supply was equivalent to the future water supply. It was also assumed that only municipal demand could be forecast based on 20-year population scenarios. Other water demands, such as industrial or agricultural, were not forecast due to the associated high uncertainty.

Stress levels were assigned based on the percent water demand as listed in Table 1.9.

Table 1.9 – Water stress level assignments for surface water and groundwater for scenarios A and B

	Surface Water	Groundwater	
	Maximum Monthly % Water Demand	Annual % Water Demand	Maximum Monthly % Water Demand
Significant	≥50%	≥25%	≥50%
Moderate	>20% to <50%	>10% to <25%	>25% to <50%
Low	≤20%	≤10%	≤25%

Tier 2 Water Budget and Stress Assessment

Within the Greater Sudbury Source Protection Area, two drinking water systems, the Valley East wells and the David Street intake in Ramsey Lake proceeded to the Tier 2 water budget and stress assessment process.

In general, the Tier 2 Water Budget and Stress Assessment aimed to refine the water budget analysis and include Scenarios A to I to assess stress to the water supply.

As the methodology for these two systems differed greatly, the process is described in greater detail in Part 3 – David Street Drinking Water System and Part 6 – Valley Drinking Water System.

Tier 3 Water Budget and Local Area Risk Assessment

After completion of the Tier 2 analysis, both the Valley system and the David Street intake proceeded to the Tier 3 water budget and stress assessment process.

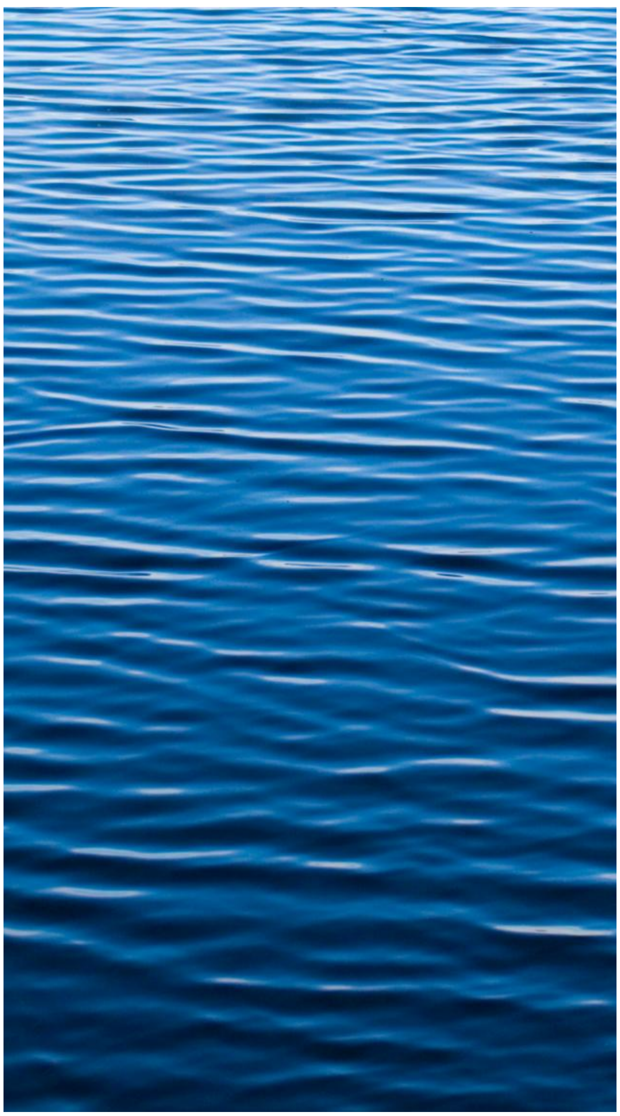
The Tier 3 Water Budget and Risk Assessment broadly aimed at providing simulated water levels and water removals for the Valley system and David Street intake. These analyses, including the scenarios used, and the results are described in Part 3 – David Street Drinking Water System and Part 6 – Valley Drinking Water System.

A significant water quantity risk was assessed for the Valley drinking water system, so water quantity threats were evaluated. Table 1.10 shows the two water quantity threats (prescribed threats # 19 and # 20) under the *Clean Water Act*.

Table 1.10 – Prescribed drinking water quantity threats under O.Reg. 287/07 s.1.1

19	An activity that takes water from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body.
20	An activity that reduces recharge to an aquifer.

Part X, Table 5 of the Technical Rules lists the circumstances for the water quantity threats.



Part Two

The Greater Sudbury Source Protection Area

Meandering through one of Canada's largest mining centres and covering 9,150 km^2 are three large river systems: the Vermilion, the Wanapitei and the Whitefish.

Approved on September 2, 2014

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Chapter 4 - The Greater Sudbury Source Protection Area: A Tale of Three Rivers

Meandering through one of Canada's largest mining centres and covering 9,150 km^2 are three large river systems: the Vermilion, the Wanapitei and the Whitefish. Beginning at the Arctic Divide, the Vermilion and Wanapitei Rivers wind their way through the vast expanse of the Canadian Shield, boreal forest, and numerous wetlands and lakes before reaching the boundary of the City of Greater Sudbury. The City itself spans more than 3,600 km^2 and contains more than 330 lakes, earning it the nickname the "City of Lakes." Map 2.1 illustrates the boundaries of these watersheds.

The Wanapitei River begins as two main branches in the upper reaches of the watershed. The western limb begins by flowing to the northeast before turning south and joining with the East Wanapitei River. An unending number of lakes that were once part of historical canoe routes for First Nation peoples and fur traders scatter this heavily forested terrain. After travelling 117 km, the Wanapitei reaches the sandy shores of Lake Wanapitei, the largest and most notable lake within the Source Protection Area. Covering an area of 132.5 km^2, Lake Wanapitei is thought to be a relic from a meteor impact approximately 37 million years ago. Few people live on the shores, with the exception of the Wahnapitae First Nation on the western shore and the community of Skead on the southern shore. The Lake Wanapitei Dam regulates the water and marks the beginning of the Wanapitei River as it continues its way south. The Wanapitei River travels through three more dams before becoming the water source for approximately 90,000 residents of the City of Sudbury and passing through the town of Wahnapitae. The Wanapitei continues until it meets the French River and finally makes its way into Georgian Bay.

Like the Wanapitei, the Vermilion River begins almost 70 km north of the City boundary. In an odd strike in the topography, the Vermilion system straddles the Wanapitei River on either side with two subwatersheds: The Onaping River and the Upper Vermilion. The Onaping River strings together a number of long lakes beginning at Onaping Lake. As it enters Lower Onaping Lake, a large portion of the river is diverted through the Bannerman Dam to join the Spanish River watershed. The other portion is allowed to continue moving towards the towns of Levack and Onaping and, ultimately, through large tracts of mining territory before reaching the Vermilion River. The Upper Vermilion, bordering the eastern side of the Wanapitei, also flows through large expanses of relatively uninhabited land before reaching the town of Capreol. Here, the Vermilion River passes through the flattest part of the region and offers precious wetland habitat identified as a Provincially Significant Wetland.

The pace changes as the Vermilion joins with the Onaping and journeys through Vermilion Lake. The Whitson River, which passes through the only available agricultural land in the area, meets the Vermilion and continues the journey south. The Vermilion once again enters relatively undisturbed land and passes over Cascade Falls where it becomes the drinking water source for many of the smaller communities in the western part of the City of Greater Sudbury. The last major subwatershed to join forces with the Vermilion drains most of the City itself and the historical footprint of Sudbury's mining legacy. The Junction Creek subwatershed drains the town of Garson and the City of Sudbury including countless mine and tailings sites, sewage lagoons and outfalls, urban drainage and other industrial land uses. It also includes a third drinking water source for the City, Ramsey Lake. The Vermilion River then dumps into the Spanish River system where it continues to the North Channel of Lake Huron.

The Whitefish River watershed has more humble beginnings in the southern section of the City, flowing through more populated terrain. The long string of lakes joining the watershed is home to a number of cottagers and lake residents and includes the Atikamksheng Anishnawbek (Whitefish Lake) First Nation. It flows through Lake Panache, the largest recreational lake in the area, before entering the North Channel.

Chapter 5 - Drinking Water Systems

Drinking Water Systems are covered under a number of different regulations in the Province of Ontario. This chapter lists the drinking water systems that fall within O. Reg. 170/03.

5.1 Large Municipal Residential Drinking Water Systems

The City of Greater Sudbury municipal water supplies include three surface water intakes and 24 municipal wells under O. Reg. 170/03 and are classified as Large Municipal Residential.

Table 2.1- Municipal groundwater wells within the City of Greater Sudbury

Name	Owner	Community Serviced	Name of Wells	Number of Users	Watershed
Garson wells	City of Greater Sudbury	Garson	Garson 1, 2 and 3	4,890	Vermilion
Falconbridge wells	City of Greater Sudbury	Falconbridge	Well 5, 6 and 7	750	Wanapitei
Onaping wells	City of Greater Sudbury	Onaping and Levack	Hardy Wells 3, 4 and 5	2,150	Vermilion
Valley wells	City of Greater Sudbury	Capreol, Valley East, Azilda, Chelmsford	Wells M, J and I Linden Notre Dame Pharand Frost Michelle Deschene Kenneth Phillipe Well Q Well R	35,000	Vermilion
Dowling wells	City of Greater Sudbury	Dowling	Riverside Lionel	1,850	Vermilion

Table 2.2 - Municipal surface water intakes within the City of Greater Sudbury

Name of Water Treatment Plant	Owner	Source of Water	Community Serviced	Number of Users	Watershed
Wanapitei WTP	City of Greater Sudbury	Wanapitei River	Sudbury, Garson, Coniston, Wanapitei, Markstay	These systems are combined by the Ellis Reservoir and serve approximately 90,000 residents.	Wanapitei
David Street WTP	City of Greater Sudbury	Ramsey Lake	Sudbury		Vermilion
Vermilion River WTP	Vale	Vermilion River	Lively, Naughton, Whitefish, and Copper Cliff	13,000	Vermilion

5.2 Small Non-municipal, Non-residential

Table 2.3 – Registered small non-municipal, non-residential systems

Name of System	Owner	Source of Water	Community Served
Long Lake Public School Well Supply	Rainbow District School Board	Groundwater	Long Lake Public School
Wanup Public School Well Supply	Rainbow District School Board	Groundwater	Wanup Public School
Hannah Lake Bible Centre Well Supply	Canadian Finnish Evangelization Society Inc.	Groundwater	Hannah Lake Bible Centre
Camp Solelim Water Treatment Plant	Camp Solelim	Surface Water	Camp Solelim
YMCA Camp Falcona Water Treatment Plant	YMCA Sudbury	Surface Water	Camp Falcona
Goodfellow Home Well Supply	---	Groundwater	Unknown

5.3 Non-municipal, Year Round Residential

Table 2.4 – Registered non-municipal, year round residential systems

Name of system	Owner	Source of Water	Community Serviced
Eagle Valley Investment Limited Well Supply	Kona Management	Groundwater	Pine Grove Mobile Home Park
Skead Well Supply	Skead Heritage Homes Inc.	Groundwater	Skead
Southlane Trailer Park Well Supply	---	Groundwater	Southlane Trailer Park
Mobile Homes Court Hwy 69 Ltd. Well Supply	---	Groundwater	Mobile Homes Court Hwy 69 Ltd.
Humarcin Residents Organization Well Supply	Humarcin Residents Organization	Groundwater	Humarcin Residents
Hamersveld Trailer Park Well Supply	---	Groundwater	Hamersveld Trailer Park
Chuck's Mobile Home Village Well Supply	Chuck's Mobile Home Village	Groundwater	Chuck's Mobile Home Village
Rintala Mobile Home Park Well Supply	Rintala Construction Company	Groundwater	Rintala Mobile Home Park
Peace Valley Trailer Haven Well Supply	Peace Valley Trailer Haven	Groundwater	Peace Valley Trailer Haven
Kingwell Trailer Park Well Supply	Kingwell Trailer Park	Groundwater	Kingwell Trailer Park

Chapter 6 - Physical Geography

The Greater Sudbury Source Protection Planning Area comprises part of the Abitibi Uplands to the north and west, the Cobalt Plain to the east, and the Laurentian Highlands and Penokean Hills to the southeast and southwest, respectively (Bostock, 1970; Chapman and Putnam, 1984).

The dominant feature in the Sudbury area is the Sudbury Igneous Complex (SIC) and the Sudbury Basin known as the "Valley." The formation of these geographical landmarks and the theories behind their existence are described in Chapter 8. Chapter 7 explains the strong relationship between Sudbury's geography, patterns of settlement and economic development.

6.1 Topography

The topography of this region is rugged, with elevations above mean sea level (AMSL) ranging from a maximum of 579 m in Leask Township in the north to a minimum of 174 m in Curtain Township to the south. The maximum topographic relief within the planning area is between 410 to 427 m AMSL.

Within the southern reaches of the planning area the topography is generally lower and undulating. Elevations increase abruptly towards the north rim of the Sudbury Basin, reaching 460 m AMSL and then dropping off slightly in a northward direction.

Bedrock ridges along the east rim generally have elevations between 335 and 385 m AMSL. Elevations along the south rim are generally in the order of 305 m to 335 m AMSL (Bajc and Barnett, 1999). Elevations within the valley are generally in the order of 290 m AMSL.

6.2 Soil Characteristics

Soil characteristics are greatly influenced by parent material composition and weathering and erosion processes. Soils in the Sudbury area belong to five orders of the Canadian Soil Classification System including Luvisolic, Gleysolic, Podzolic, Brunisolic and Organic.

Luvisols develop on glaciolacustrine sediments in well to imperfectly drained sites on sandy loam to clay parent material. Luvisols of the Sudbury area belong to the Gray Luvisol Great Group, due primarily to the effect of climate and parent material on soil development.

Gleysols are characterized by poorly drained sites and long periods of water saturation and reducing conditions. Gleysols in the Sudbury area belong to two groups, Humic Gleysols and the Gleysol Great Group. These soils develop most commonly on glaciolacustrine, glaciofluvial or fluvial sediments.

Podzols develop in coarse to medium textured parent materials or strongly leached calcareous materials under forest or heath vegetation in cool to very cold humid to prehumid climates.

Brunisols in the Sudbury area include Melanic and Sombric Brunisols. These soils develop on coarser textured morainal and outwash parent materials and exhibit a lack of horizon development.

Three groups of organics soils are located in the Sudbury area and include Fibrisols, Mesisols, and Humisols. Organic soils are commonly found in enclosed basins, or on margins of lake basins.

6.3 Land Cover

Land cover is one of the main factors which determines the amount of evapotranspiration, infiltration and surface runoff. Land development through urbanization plays a significant role in changing the hydrologic balance in a watershed. The land cover change not only affects the water quantity but adversely affects the water quality in terms of sediment and the nutrients attached to the sediment particles. According to the province of Ontario's Provincial Land Cover 2000 database, the planning area is 77% forest and 12% water as tabulated below. The remaining 11% of the area consists of wetlands, bedrock, urban and rural areas and aggregate areas and mine tailings. Map 2.2 and Table 2.5 illustrate the land cover of the planning area.

Table 2.5- Land Cover within the Greater Sudbury Source Protection Planning Area

Land cover	Hectares	GSSPA	Wanapitei	Vermilion	Whitefish
Agriculture	9,646	1.1%	0.0%	2.2%	0.0%
Settlement	20,585	2.3%	1.0%	3.6%	0.7%
Forest	706,744	77.2%	80.3%	76.8%	66.9%
Wetland	21,612	2.4%	3.2%	1.5%	3.1%
Bedrock	38,792	4.2%	4.7%	3.5%	6.0%
Sand / Gravel / Mine Tailings	9,688	1.1%	0.4%	1.8%	0.0%
Water	108,033	11.8%	10.4%	10.6%	23.3%
Total Area (ha)	915,100	100%	377,960	442,937	94,204

6.4 Forest Cover

The Greater Sudbury Source Protection Area spans the transition forest from the Great Lakes-St. Lawrence Forest in the south to the Boreal Forest in the north. The Great Lakes-St. Lawrence forest type dominates the central and southern parts of the planning area with even-aged mixed stands of white pine, red pine, white spruce, poplar and white birch. Concentrations of tolerant hardwoods, particularly hard maple and yellow birch, occur in these areas. The distribution of jack pine stands exhibits a somewhat scattered pattern along with lowland pockets of black spruce.

Boreal forest types dominate in the northern parts of the planning area. Pure to mixed stands of jack pine, poplar, white birch and black spruce predominate but these stands are also interspersed with sections of white pine and red pine. Tolerant hardwood stands of hard maple and yellow birch have a scattered occurrence. Black spruce predominates on the lowland peat bogs.

Statistics from the 2005 to 2010 Sudbury Forest Management Plan show that white birch, jack pine and poplar are the most common tree species in the area. White pine is also found throughout the area and black spruce is common in wetter areas. Other tree species include balsam fir, red pine, soft maple, white spruce, red oak, hard maple, cedar, hemlock, yellow birch, ash and larch.

Mining and smelting activities from the early to mid-1900's caused severe damage to forest vegetation in the Sudbury area. Logging and repeated fires were also significant factors in deforestation. About 80,000 hectares were disturbed or damaged by smelting (VFM Co, 2005). A land reclamation program sponsored by municipal, provincial and federal governments, industry and academia began in the mid-1960's. The program began with research trials, proceeded to liming and grassing and, eventually, to tree planting by the mid-1970's. Over 10 million trees have been planted since 1979 (VFM Co, 2005). The planting focus has been on conifer species - jack pine, red pine, white spruce, white pine, cedar and larch but some deciduous species have been planted as well; these include red oak, silver maple and ash. Natural regeneration of poplar and white birch is also occurring as a result of the liming process and artificial regeneration efforts. Poplar, birch and the tree species planted by the program are believed to be the major components of the original forests in the Sudbury area (VETAC, 2006).

The woodland cover is illustrated in Map 2.3.

6.5 Wetlands

Wetlands in the boreal landscape are numerous and scattered, tucked between bedrock outcroppings and hugging the edges of a number of lakes and streams. According to the Ministry of Natural Resources' Forest Resource Inventory (FRI), 5% of the Sudbury source protection planning area is classified as wetland. Wetlands are also mapped as part of the Provincial Land Cover program. Many of the wetlands on this part of the Canadian Shield are small and only 2.4% of the planning area shows as wetland at this coarser resolution. Map 2.4 illustrates wetlands in the planning area.

The Ministry of Natural Resources' Values Information System (NRVIS) lists one provincially significant wetland in the planning area, the Vermilion River Delta Wetlands. This wetland complex is also a Canada Life Science Area of Natural and Scientific Interest. The Vermilion River Delta Wetlands are a series of abandoned channels and remnant levees located where the Vermilion River empties into Vermilion Lake, approximately 16 km upstream of the water intake. Marsh and, in a few instances, fen types, occupy the wettest areas and willow and alder thicket swamps serve as transitional communities between the wettest areas and the silver maple deciduous swamps on the periphery. Both permanently and seasonally wet moisture conditions are associated with these silver maple forests. These latter forests are "spring" swamps in the sense that they are inundated by flooding during the spring season. Silver maple also dominates the levee ridges but as an upland forest type. The levee ridges, which are dry during the summer, also support some bur oak (OMNR, 2005).

6.6 Water Features

The Sudbury area is not only characterized for its mining footprint and legacy. As its nickname, "the City of Lakes" suggests, lakes, rivers and streams, along with associated riparian areas are abundant throughout the planning area. Approximately 12% of the area is covered by water bodies. There are approximately 3,000 lakes that are greater than 2 hectares[1] and 997 lakes that are 10 hectares or greater. These lakes are predominantly deep, nutrient poor lakes. There are more than 1,200 km of rivers, tributaries and subtributaries, and more than 10,000 km (10,383 km) when streams and intermittent streams are counted. Riparian areas are typically defined as an area of wet soils and distinctive vegetation immediately adjacent to streams, rivers and lakes, and are a transition zone between a water body and upland vegetation communities.

The amount of area classified as riparian was calculated using the same buffer widths as specified in the Conservation Authority Generic Regulations. A 30 metre buffer was placed on lakes and wetlands less than 2 hectares and on streams that are less than 20 metres wide. A 120 metre buffer was placed on lakes and wetlands greater than 2 hectares and on rivers that are consistently wider than 20 metres. Riparian areas are illustrated on Map 2.3.

[1] There are 3,430 water bodies which are greater than 2 ha in the Greater Sudbury Source Protection area. However, out of the 3,430 water bodies, some of them may be segments of rivers that are not labeled as such. Therefore, it is estimated that there are approximately 3,000 lakes that are greater than 2 ha in the planning area.

Water bodies and associated riparian areas comprise 64% of the planning area or 518,669 hectares. There are 331,207 hectares of riparian areas in the planning area; this represents 36% of the total planning area.

Chapter 10 describes the hydrologic features of the main watersheds in the Source Protection Area in greater detail.

Consideration of Great Lakes Agreements

The *Clean Water Act, 2006,* requires Source Protection Areas that drain directly into the Great Lakes or the St. Lawrence River to consider the following documents:

- Canada-United States Great Lakes Water Quality Agreement
- Canada Ontario Agreement Respecting the Great Lakes Basin Ecosystem
- Great Lakes Charter
- Great Lakes St. Lawrence River Basin Sustainable Water Resources Agreement
- Any other Agreement to which the Government of Ontario or Canada is a party

These documents deal with water quality and quantity concerns and principles for joint water management of the Great Lakes Basin. The Great Lakes do not provide drinking water for any municipal systems in the Greater Sudbury Source Protection Area. The Whitefish River watershed does flow into the North Channel of Lake Huron at Whitefish Falls, but there are no municipal drinking water systems in this watershed.

Water from the Vermilion River watershed enters the Great Lakes via the Spanish River, which is outside of the Greater Sudbury Source Protection Area. The Spanish River flows into the North Channel in the community of Spanish, west of Sudbury. The Wanapitei River flows into the French River, which is also outside of the source protection area. The French River flows into Georgian Bay south of the town of Killarney. Since neither of the watersheds with municipal drinking water systems flow directly into the Great Lakes or the St. Lawrence River, the Great Lakes Agreements were not considered in the assessment report.

Chapter 7 - Human Geography

In the late 1800s, the town of Sudbury was in its infancy and was beginning to make a name for itself in the forestry business. A major fire in Chicago became the impetus for increased logging and the creation of transportation corridors. Then, in 1895, the discovery of large deposits of nickel ore changed the course of history for Sudbury. The region quickly became one of the world's largest producers of nickel, copper and other metals.

The population distribution in the Sudbury area has been largely influenced by its geography and mining history. During World War I, mining camps and company towns dispersed along the Sudbury Igneous Complex and the flat, fertile land of the Valley was developed into agricultural lands and rural villages. Houses in company towns were often scattered due to solid rock outcrops preventing organized development. The development of Sudbury from a village to a town, and later a city, was moulded by physical constraints that had few parallels elsewhere in Canada.

During the 1950s and '60s the pattern of dispersed urban sprawl continued to flat glacial deposits in the Valley and along highways. Company towns scattered along the Sudbury Igneous Complex contributed to the low density population distribution. Today, this pattern of development has continued and has resulted in the sprawling nature of the City of Greater Sudbury. The broad pattern of development of the City has been determined by the location of ore bodies, the history of human settlement, the technology of transportation and the geography of the land. The dispersed pattern of growth poses challenges for the efficient provision of services and infrastructure. Map 2.5 and Table 2.6 illustrate the pattern of dispersal throughout the planning area.

The source protection planning area consists of virtually all of the City of Greater Sudbury and the entirety of the three major watersheds from which residents obtain their drinking water. Greater Sudbury with a population of approximately 160,274 (Stats Can, 2011) consists of a large central urban area surrounded by more than 20 smaller communities. Over half of the total population of the city lives in the former City of Sudbury. The communities of Whitefish Falls and Estaire are outside of the City of Greater Sudbury border, but within the planning area and make up less than 1% of the total population in the Source Protection Area.

Table 2.6 – Major population centres within the Greater Sudbury Source Protection Area

Area	Population (2011)
Capreol	3,286
Garson, Coniston, Wahnapitae, Falconbridge, Skead	13,232
Onaping Falls (Dowling, Onaping, Levack)	4,874
Rayside Balfour (Azilda, Chelmsford)	14,557
Sudbury	88,503
Valley East (Val Thérèse, Blezard Valley, Hanmer, Val Caron)	23,978
Walden (Lively, Naughton, Whitefish)	10,564
City of Greater Sudbury	160,274
Wahnapitei First Nation	320 members
Atikamksheng Anishnawbek (Whitefish Lake) First Nation	1,092 members

7.1 Population and Settlement Areas

Historically a resource-based settlement, Sudbury has evolved from a railway village to a frontier mining town and a regional capitol. Since the 1970s, the City has strengthened its role as a regional center. As the primary industrial activity, mining still plays an important role in the community, but the economy has diversified to include education, health care, government, retail and tourism services. The shift to a service-based economy is reflected by the City's changing work profile, as more than 80% of Greater Sudbury's labour force now work in the service-producing sector (CGS 2008b).

The Greater Sudbury population has fluctuated over the years due to the large influence of the typical boom and bust cycle of resource based industries. Population scenarios were developed as part of the Infrastructure Background Study to the 2006 Official Plan in order to assess the long-term viability of the water and wastewater infrastructure systems and their ability to service future growth. The population projections were developed by City of Greater Sudbury staff. The base population for the projections and basis for the Background Study was 155,225 people, taken from the 2001 Statistics Canada Census data.

7.2 Industry

As described in the previous sections, the Sudbury area is a major mining centre for nickel and other metals. Mining and associated mineral processing activities in Sudbury are primarily concentrated in Copper Cliff in the south-central area, Onaping Falls/Levack in the northwest, the Creighton Mine Complex in the west, and Falconbridge in the east. Additional mines are also located in Garson, Fairbanks (in the southwestern portion), and north of Valley East.

Numerous abandoned and closed mine sites are also present throughout the planning area. Closed mines are owned by Vale, Xstrata Limited or junior companies such as KGHM International (formerly Quadra FNX) or other companies and are not considered to be abandoned. Some of the abandoned sites may simply consist of small abandoned adits from which no ore was ever removed, to larger sites where some production has occurred. Currently, the Ministry of Northern Development and Mines is undertaking a study to assess the environmental hazards of these abandoned mines.

The Official Plan, Section 4.6.1 and Schedule 1a, has designated a large section of the Sudbury Igneous Complex as Mining/Mineral Reserve. The reserve is approximately 40% of the City of Greater Sudbury and 1,450 km^2. The reserve may be used for a variety of purposes related to the extraction of minerals and include mining and mining related uses, mineral aggregate uses, smelting and refining uses, pits and quarries and related uses, and accessory uses and structures associated with mining. Other development may occur within the reserve; however, it must not interfere with possible mining related activity. Mining activity is legislated under the *Mining Act* and administered by the Ministry of Northern Development and Mines.

The Official Plan also designates an Aggregate Reserve to be protected for pits and quarry operations. Other uses that do not preclude the possibility of future extraction may also be permitted. Lands designated as Aggregate Reserve are to be protected from uses and/or activities that may hinder the extraction of aggregates in the future. Aggregate Reserve is located in patches across the City of Greater Sudbury area and represents approximately 5% of the City of Greater Sudbury or 178 km^2.

Forestry is done on a small scale in the planning area and is conducted mainly by the Vermilion Forest Management Company Ltd. In addition to the Sudbury Forest, small parts of the planning area in the west are located in the Northshore Forest and the Spanish Forest and, in the northeast, the Timiskaming Forest. The Ontario Ministry of Natural Resources oversees legislation and compliance for forest management activities on Crown land.

7.3 Agriculture

The majority of farms in the planning area are located in the Valley, which is located in the Vermilion River watershed. Agriculture has played a central role in the historical development of the Valley and continues to be an important part of the local economy. During the development of the mining industry, the Valley attracted people from the French speaking community to develop family farms. In recent times, agriculture activity has decreased, though it still plays an important part in the Valley community and the local economy.

According to the 2011 Census, there were 141 reported farms in the District of Sudbury. Approximately 60% of the farms are between 10 and 129 hectares. The majority of these farms are animal production, including beef and diary cattle, poultry and egg production or crop farming. Field crops produced in the area include mainly hay and clover with some oat and barley production.

A variety of other agriculture activities in the area include floriculture, nurseries, and fruits and vegetables. A number of farms produce berries, potatoes and other vegetables, but they do not represent a significant portion of agricultural activities in the area.

The Agricultural Background Study for the Official Plan investigated the state of agricultural lands within the City of Greater Sudbury and provided an overview of trends in the community. Using aerial photographs, it was clear that large areas under cultivation in the mid-50's are no longer used for agriculture today. Some farms may not have been viable and were abandoned; however, some lands are highly productive and no longer in use. Many farms were abandoned in the 1960's when the mines attracted farmers looking for better wages and better hours. Today, the agricultural lands in the region are faced with two significant pressures: lot creation and topsoil removal. Lot creation in agricultural areas is increasing rapidly due to high demand for rural residential housing. These developments are typically located in areas with prime agriculture potential. Topsoil removal will downgrade the agricultural productivity of the land and hinder the ability to grow crops. Removal of topsoil has a short term financial benefit to land owners but will adversely affect the ability to grow food in the long term. Subsequently, land where top soil has been removed may be converted into non-agricultural use where it may not have been permitted before.

Section 6.0 of the Official Plan describes overall agricultural objectives and an Agriculture Reserve to be preserved for growing crops, raising livestock for food, fur or fibre, aquaculture, apiaries, agroforestry and maple syrup production (See Schedule 1a of the Official Plan). The reserve is less than 1% of the City of Greater Sudbury total area and is approximately 29 km^2. The objective of the reserve is to retain prime agricultural land and minimize the non-farm use of productive agricultural land.

7.4 Recreation

The City of Greater Sudbury and the surrounding area offer a wide variety of opportunity for recreational pursuits and activities. The surrounding area provides an abundance of outdoor recreational activities including cottaging, snowmobiling, skiing, golfing, canoeing, hiking and fishing. Within the City, there are a number of community centres, arenas, swimming pools and athletic fields available for the community to use.

7.5 Protected Areas

Protected areas are generally kept from developmental changes that could alter their natural character. Protection can be designated by the federal government (National Parks), the provincial government (Provincial Parks, Crown land), and local initiatives such as Conservation Areas.

There are four provincial parks, seven Conservation Reserves and six Forest Reserves in the planning area. There are no national parks, nor any other federal lands in the source protection area other than the two First Nation communities described in the next section.

In addition to the provincial protected lands described above, the Nickel District Conservation Authority has control over one Conservation Area, which is in the vicinity of the urban area of Sudbury.

Within the City of Greater Sudbury, publicly-owned lands designated as parks and open space include a variety of lands used for active and passive recreational uses. According to the Official Plan, the City provides a ratio of approximately 4.18 hectares of developed parkland per 1,000 population, or 3.83 hectares when parks are included and facilities are excluded.

7.6 First Nation Perspectives

The First Nation communities within close proximity to the City of Greater Sudbury include the Wahnapitae First Nation and the Whitefish Lake First Nation. Wahnapitae First Nation and Whitefish Lake First Nation are progressive communities proactively participating within the drinking water source protection planning process for the City of Greater Sudbury. There are many other First Nation communities which have close connection with the Sudbury area. First Nation communities located on Manitoulin Island, the North Shore of Lake Huron and Georgian Bay consistently visit the Sudbury area. First Nation communities within this area are considered Anishinaabe people.

Historically, the First Nations in the area utilized the territory for traditional activities such as hunting, fishing, trapping and harvesting. The area was particularly significant for trade routes utilizing the Wahnapitae and Vermillion River to gain access to the Great Lakes and other major waterways. The route included the establishment of the Hudson's Bay Trading Post located at the North River on Lake Wahnapitae in 1821 and in the mid-1870s on Post Creek.

It is commonly recognized that Indigenous people around the world have a close spiritual connection with Mother Earth and are often viewed as the stewards of the earth. In the Anishinaabe culture, women are considered to be the guardians of water, it is their responsibility to ensure the health of Shkagamik-kwe (Mother Earth) and keep the water clean for future generations as water is the life blood of Mother Earth. Grandmother Josephine Mandamin has pledged her life to the environment and love for water and has walked around the five great lakes in hopes of raising awareness for the protection of water sources. Josephine Mandamin said "water is precious and sacred; it is one of the basic elements needed for life to exist."

In Sudbury, the Anishnaabe-Kweg Water Journey was initiated in order to raise awareness of the sacredness of water and the need to respect, protect and rehabilitate it. The water journey is a relay walk of Anishinaabe women who carry a bucket of water around Ramsey Lake to raise awareness of the sacredness of water and the importance of keeping the water clean. The Anishinaabe-Kweg Water Journey is held annually in September.

Wahnapitae First Nation

The Wahnapitae First Nation (WFN) is a signatory to the Robinson-Huron Treaty of 1850. It is listed as #11 on the Schedule of Reserves. The First Nation is an Ojibway Band and is part of the Anishinabek Nation. The First Nation Reserve is located approximately 50 km north of Sudbury and is accessible by all season gravel roads from the town of Capreol. The reserve land base is 3.2 km by 3.2 km on the north shore of Lake Wanapitei and covers approximately 1,036 hectares of land. A pending land claim settlement may increase this land base. The Wahnapitae First Nation elects its Chief and Council under Band Custom. There is one chief and 4 councillors.

The WFN is a developing community with a growing population and expanding land base. There are approximately 320 members with approximately 60 living on reserve. There are several tourism related businesses owned by individual members. These include a licensed restaurant and four camp/ trailer/cottage grounds. Band members residing on reserve are employed in Band administration, public works and in other areas of the reserve. Limited development has occurred on reserve, primarily along the north shore of Lake Wanapitei. There are more than 70 surveyed residential lots. The community is surrounded by mining (nickel exploration/mining, and gold exploration activity), forestry (pine and spruce harvesting) and tourist operators. The Band participates in some of these activities, and the community has developed a Community Development Plan. This Plan is based on the priority needs of the community as follows: Economic Development, Watershed Management and Infrastructure.

Atikameksheng Anishnawbek (Whitefish Lake) First Nation

Atikameksheng Anishnawbek are descendants of the Ojibway, Algonquin and Odawa Nations. In 1850, Chief Shawenekezhik, on behalf of the Whitefish Lake First Nation, signed the Robinson-Huron Treaty granting the Canadian Government much of the First Nation's land. The First Nation is located approximately 19 km west of the City of Greater Sudbury. The current land base is 43,747 acres, much of it being deciduous and coniferous forests, surrounded by eight lakes, with eighteen lakes within its boundaries. As of January 2013, the total population is 1,092 members. The community has grown significantly throughout the years. Currently, there are 120 houses located in the community and 30 cottages owned by residents on various lakes throughout the First Nation. Along the northern shores of Lake Penage, 43.5 acres of land was surrendered for cottage leasing purposes. Currently, there are 97 lots that have road access to the cottages. Not only is it road accessible, but electricity and telephone services are available for the cottagers.

Band Government falls under section 74 of the Indian Act. Elections are held every two years. The number of councillors is based on the amount of registered Band members; for every 100 people, one councillor is elected. Band meetings are held bi-weekly. Each council member holds a portfolio based upon the organizational structure of the First Nation. The First Nation Government belongs to a variety of political organizations such as the Assembly of First Nations, Chiefs of Ontario, Anishinabek Nation and North Shore Tribal Council.

Chapter 8 – Geology

The geology of the area is directly responsible for hydrological characteristics such as gradients, flow rates, and the direction and type of drainage network. The bedrock deposits within the planning area record a complex geologic history spanning approximately 3 billion years of Earth history. Bedrock in the northern portions of the Vermilion and Wanapitei watersheds include some of the oldest crustal rocks in Ontario. Rocks in the southern portions of the City record the opening and closing of an ancient ocean basin, and a subsequent billion-year-old continent-continent collision resulting in the creation and erosion of a mountain range comparable to the present-day Himalaya of Indo-China.

8.1 Bedrock Geology

The primary geological feature in the planning area is referred to as the Sudbury Structure. The Sudbury Structure comprises: the Sudbury Igneous Complex (SIC), the surrounding brecciated footwall rocks and the Sudbury Basin, which is located within the SIC. In plan view, the SIC is elliptical in shape with its long axis oriented SW-NE, and is approximately 60 km long by 27 km wide.

There are several theories about how the Sudbury Basin was formed, but no single one is totally accepted. The opinion is that this feature was either formed by Meteor Impact (Deitz, 1960) or the Volcanic Collapse Theory (McDonald, 1987). The basin has an oval shape, with high relief bedrock ridges along the north, east and south rims. The central portion of the basin is commonly referred to as the "Valley," an area of regionally low topographic relief (Bajc and Barnett, 1999). Within the central valley, the bedrock is overlain by Quaternary sediments. Much of the terrain within the planning area consists of either exposed bedrock or shallow overburden deposits that were deposited during the past 25,000 years (Barnett and Bajc, 2002).

The Sudbury Basin comprises an extremely thick package of metasedimentary and exhalative rocks of Paleoproterozoic age, called the Whitewater Group. The more commonly known formational terms for this succession, from base to top, include: the Onaping, Onwatin and Chelmsford formations. These rocks both overlie the SIC and appear to be confined to its interior.

The rocks that make up the Archean assemblage to the north of the SIC include mainly granitic plutonic rocks (2.6 Ga – billion years) and gneissic rocks (at least 2.7 to more than 3 billion years old). A small greenstone belt has also been mapped to the northwest of the Sudbury Basin.

The Proterozoic-age rocks of the Southern Geologic Province, which outcrop predominantly to the south of the SIC, include gabbro-peridotite intrusive complexes such as the East Bull Lake complex (situated to the west of the SIC; Peck et al., 1993), Shakespeare-Dunlop complex in the Archean rocks (see Vogel et al., 1998) and the metavolocanic-metasedimentary rocks that make up part of the Huronian Supergroup of the Southern Geologic Province (more specifically the Elliot Lake and Hough Lake Groups). The Huronian Supergroup comprises an extremely thick succession of volcanic and metasedimentary rocks that formed between approximately 2.5 to 2.2 billion years ago (2490 Ma to 2200 Ma). These rocks have been subsequently intruded by porphyritic granitic rock bodies known as the Creighton Granite dated at 2333 Ma (Frarey *et al.*, 1982) and Murray Granite dated at approximately 2388 Ma, and slightly later by Nipissing diabase sills or dykes that have been dated at 2150 and 2220 Ma (Golder, 2005). Map 2.6 illustrates the bedrock geology for the City of Greater Sudbury, however, data at this scale is not available for the entire watershed area.

8.2 Surficial Geology

The Quaternary geology of significant portions of the planning area has been described in detail by Bajc and Barnett (1999). The following summary is based in large part upon this field guide. Several Quaternary geology maps have also been prepared by Bajc (1997) and include Ontario Geological Survey Maps 2519, 2520, 2521 and 2522. Map 2.7 illustrates the surficial geology of the area based primarily upon these maps. In areas not covered by these maps, information from the Ontario Geological Survey Northern Ontario Engineering Geology Terrain Study (NOEGTS) Data Base Maps was used.

Overburden deposits in the area are generally located along bedrock depressions or former erosional features (Richards, 2002). Much of this ancient bedrock is largely impermeable, making it a very poor source of any significant quantities of potable groundwater for the scattered communities located within the planning area. Therefore, most of the drinking water resources are derived from either surface waters and/or shallow groundwaters within glacially-derived, Quaternary sands and gravels.

In general, the Quaternary deposits in the Sudbury region are of Wisconsinan age and are a result of glaciation and deglaciation associated with the Laurentide ice sheet which covered all of Ontario and some of the northern US states approximately 20,000 years ago (Bajc and Barnett, 1999). Various types of glacial deposits have been mapped in the planning area and include two distinct till facies, ice-contact deposits, outwash deposits, glaciolacustrine deposits of clays, silts and sands, and fluvial deposits. From a groundwater perspective, the ice-contact deposits, outwash deposits and fluvial deposits have the highest groundwater supply potential.

The glaciofluvial ice-contact stratified deposits have been subdivided into four units by Bajc and Barnett (1999) and include lee-side cavity fills, isolated esker ridges and/or esker systems consisting of glaciofluvial complexes, spatially associated with ice-marginal positions and large areas of ice stagnation, and ice marginal subaquatic fans and deltas. The sediments in these deposits are highly variable and can include various mixtures of boulder gravel to very fine sand and silt.

One of the largest of these deposits is located in the eastern section of the planning area and extends from the southern tip of Lake Wanapitei, past the Sudbury Airport and through the former Town of Garson towards the former City of Sudbury. This esker deposit also extends upwards of 22 km along a north-south axis on the northern side of Lake Wanapitei. These linear features on both the north and south sides of Lake Wanapitei are locally referred to as the Wanapitei Esker, but the feature actually comprises a complex mixture of glaciofluvial, deltaic and glaciolacustrine deposits.

Another significant ice-contact deposit is located in the northwestern portion of Valley East, and consists of esker and kame deposits (Bajc and Barnett, 1999).

Terraced glaciofluvial outwash deposits have been mapped within all of the significant structurally-controlled river valleys that enter the Sudbury Basin from the north and east rims (Bajc and Barnett, 1999), including the Vermilion River, the Rapid River, the Nelson River, Sandcherry Creek and Onaping River valleys.

A large delta deposit associated with the Wanapitei Esker is also present to the south of Lake Wanapitei, in the Sudbury Airport area. This delta is associated with a re-entrant that formed along the ice margin at a structural zone of weakness. It should be noted that thickness of overburden deposits along this stretch of deltaic outwash deposits in the Sudbury Airport area are in excess of 100 m. Other deltaic / outwash deposits are present in the northern portion of the Valley and in Dowling. The outwash deposits in the planning area generally consist of gravel and sand, with some boulder gravel zones. These coarse grained deposits generally have high groundwater supply potential.

Glaciolacustrine deposits in the Sudbury area are associated with Glacial Lake Algonquin and consist largely of massive to laminated deposits of pebbly sand to silt with minor clay. These deposits are generally only found in low-lying areas of the Valley (Bajc and Barnett, 1999) and have generally been observed to fine laterally away from the sediment input sources along the north and east rims. Most of the glaciolacustrine deposits in the planning area are sandy facies, whereas finer textured sediments, such as silts and clays, are generally limited to the southeastern parts of the Valley region. These deposits generally have poor groundwater supply potential.

Across the entire planning area, overburden comprises approximately 24.6% of the land area. This 24.6% can be further subdivided into approximately 7% eolian deposits, 8.6% glaciofluvial, 1.2% glaciolacustrine, 3.3% morainal, 3.4% organic and less than 1% alluvial. Over the entire planning area, approximately 0.37% of the land mass is covered by manmade features, including mine tailings and waste rock piles.

Chapter 9 - Climate and Climatic Trends

The planning area is located in two climatic regions with some minor variations: the southern part is associated with the Laurentian Plateau while the northern area is located in the Boreal climatic zone (NDCA, 1980). The area is traversed alternately by:

- Cool, dry polar air from the north;
- Pacific air that has become warmed and somewhat moister over the western portion of the continent;
- Continental polar air, returning from the south; and
- Sub-tropical air, carrying by far the most water vapour and generally warm temperatures.

Changes to the above mentioned air masses generally occur approximately every three days throughout the area, with precipitation occurring at the margins of the moving air masses (NDCA, 1980).

9.1 Climate Stations

The network of climatic gauges in the Sudbury area to record temperature and precipitation data has varied throughout time. Most of the gauges are concentrated in the southern part of the watershed while the north has had a few gauge stations in the past, which have since been abandoned (i.e. data is no longer being collected). The Biscotasing, Turbine, Sudbury Airport, Massey and Monetville gauges contain the most continuous data records. The Biscotasing gauge station has data from 1914 to 2000. The Turbine gauge has data from 1914 to 1990. The Sudbury Airport location is the only currently operating gauge and has data from 1954. Unfortunately, there are currently no active gauges in the northern part of the watershed and the historical records have many missing values.

9.2 Temperature

The planning area is subjected to temperate summers and moderately severe winters. In the southern part of the area, mean monthly minimum temperature taken at the Sudbury Airport between 1963 and 1990 for January and February ranges from -19°C to -17°C. Colder temperatures were observed in the north at Biscotasing during the same time period and ranged from -23°C to -21°C. Drastic variations in temperature are observed during summer months. Occasional extreme hot days can be expected during June, July and August with mean monthly maximum temperature ranging from 22°C to 25°C at the Sudbury Airport in the south and 22°C to 23°C in the north at Biscotasing.

9.3 Precipitation

The average annual precipitation from 1963 – 1990 ranged from 817 mm in the north at Biscotasing to 940 mm in Monetville in the south and varied from location to location.

For gauges where complete records are available, the northern part of the watershed showed less precipitation compared to the southern part of the watershed, and a general trend of increased precipitation from southwest to southeast.

9.4 Climatic Trends and Climate Change

Variations in average temperature and average precipitation for the Sudbury Airport from one decade to another during the data duration of 1955-2004 are indicative of the minor climatic fluctuations for the region. Although the specific climatic values in the northern and southern portions of the planning area would be expected to vary, the overall climatic trends should generally be the same. As such, only the decadal temperature, precipitation and potential evapotranspiration (PET) data from the Sudbury Airport have been used for trend analyses. The resultant trend graph is shown in Figure 2.1, which indicates overall increases in temperature and precipitation since 1955. The trend lines were added using linear regression with Microsoft Excel. However, as can be seen in the graphical depictions, trends can change from decade to decade, and are not necessarily good predictors of future decades. Figure 2.2 shows the overall upward trend in precipitation, temperature and evapotranspiration from 1955-2004 at the Sudbury Airport. Figures 2.3 and 2.4 further depict the departure of temperature and precipitation from 1971-2000 climatic normals at the Sudbury Airport.

9.5 Local Initiatives for Climate Change Adaptation

Climate change is being experienced in Greater Sudbury watersheds. Adapting to the changed climate is of utmost importance and it is a collective responsibility for the community to act. In order to move forward in the community, the Nickel District Conservation Authority spearheaded the formation of the Greater Sudbury Climate Change Consortium. The consortium is a collaboration of many partners from the community, including the municipality, health sector, education sector, business/industry and NGO/ENGO sectors, among others. The vision of the consortium is to:

- Facilitate and coordinate the work of community agencies and organizations to develop sound climate change adaptation strategies for the community and for residents.
- Engage the community in dialogue on climate change adaptation.
- Champion locally, provincially and nationally, the work being done in Greater Sudbury in terms of developing climate change adaptation strategies.
- Seek opportunities for joint projects and partnership collaborations.
- Support and encourage local research, projects and activities.
- Feed into regional, provincial and national processes as appropriate.
- Report back to the partners and the community on a regular basis.

The Greater Sudbury Climate Change Consortium is an example of a community based initiative that will work proactively to deal with our changing climate and the future impacts of climate change.

As part of a climate change adaptation project led by the Ministry of the Environment, eight climate change monitoring stations were installed across the province. One of the locations is on the Whitson River in the Vermilion watershed. These climate change stations measure water level, rainfall, soil moisture, groundwater levels and wind speed. All of this information is being uploaded to a central database for interpretation and analysis.

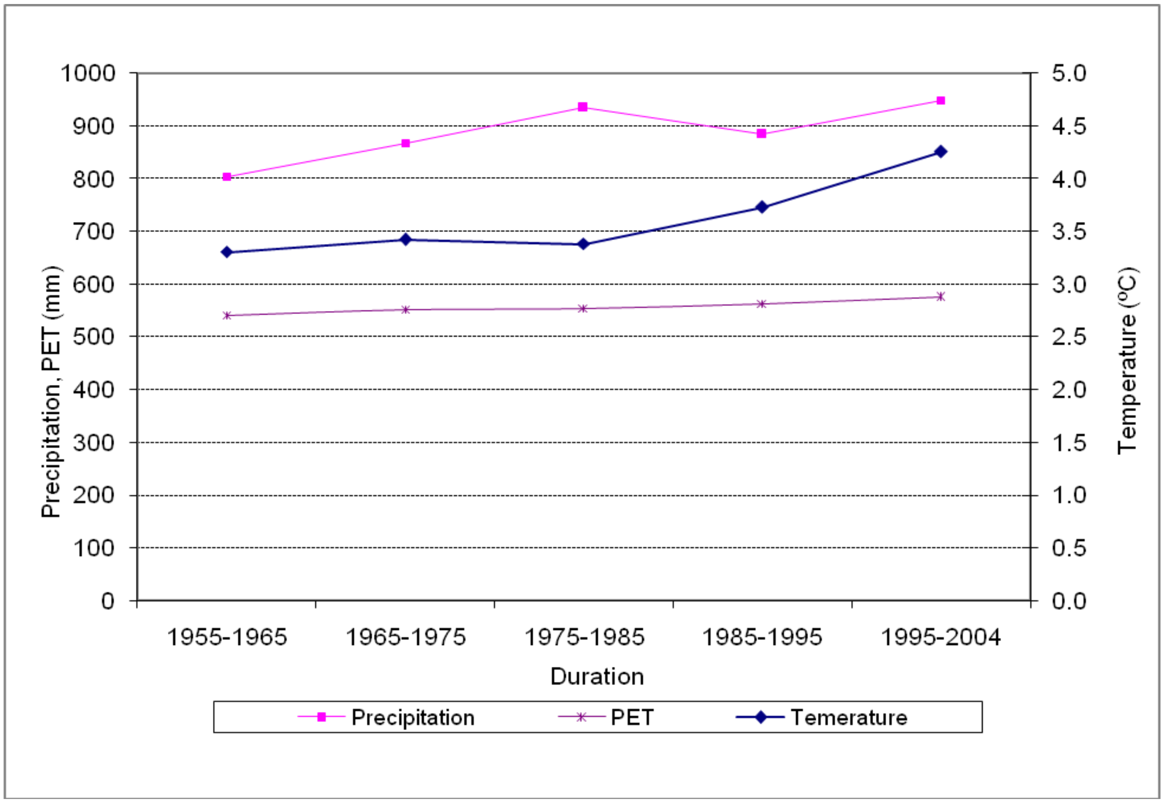


Figure 2.1– Decadal climatic trends at Sudbury Airport (EC, 2002)

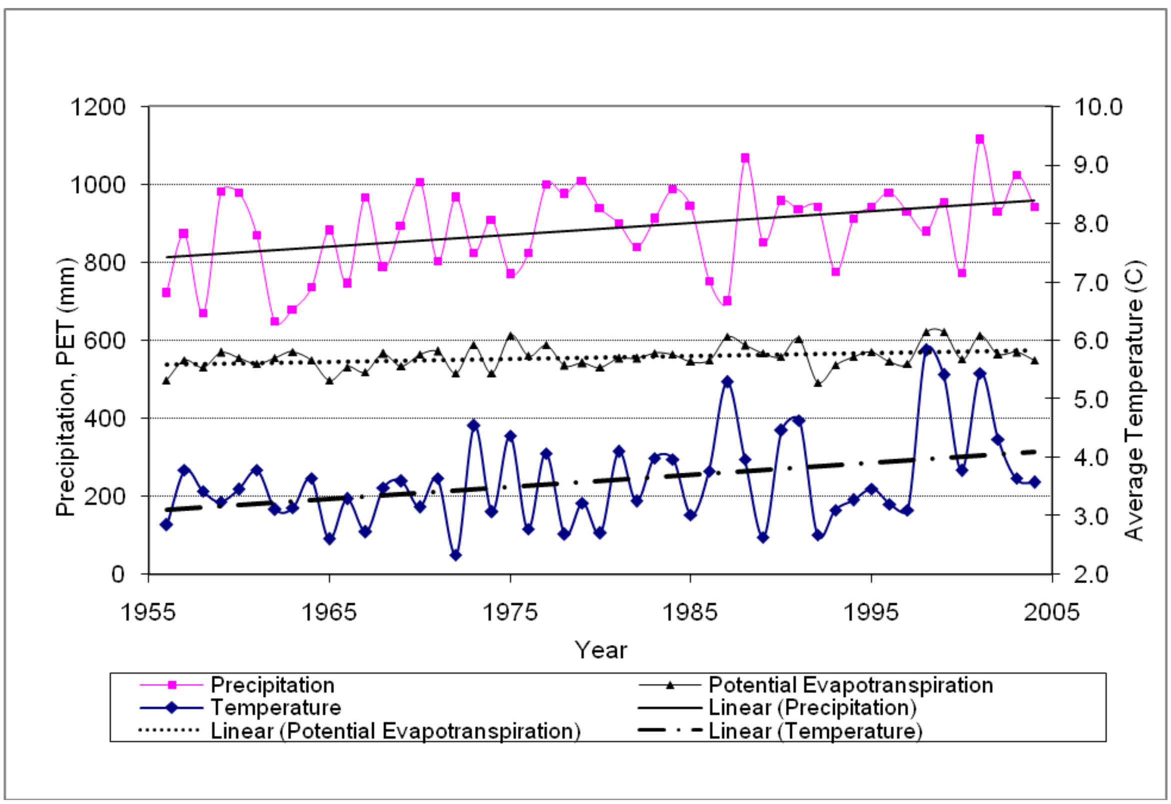


Figure 2.2 – Long term climatic trends at Sudbury Airport (EC, 2002)

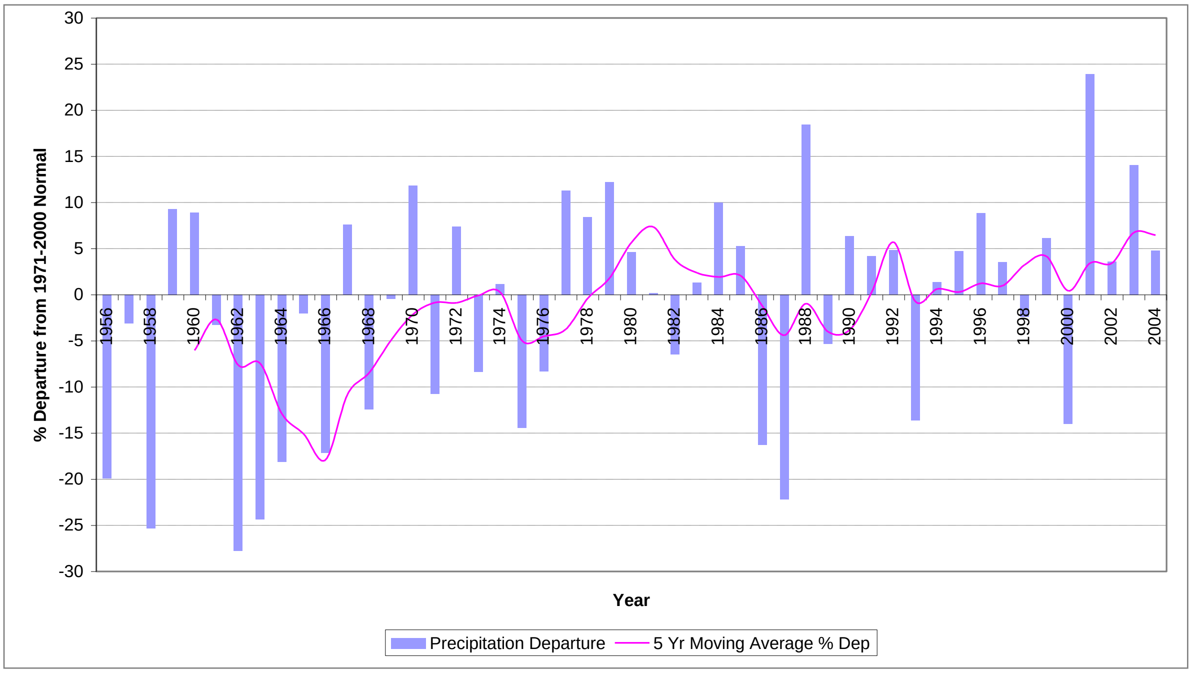


Figure 2.3 – Annual precipitation departure from 1971-2000 normal at Sudbury Airport (EC, 2002)

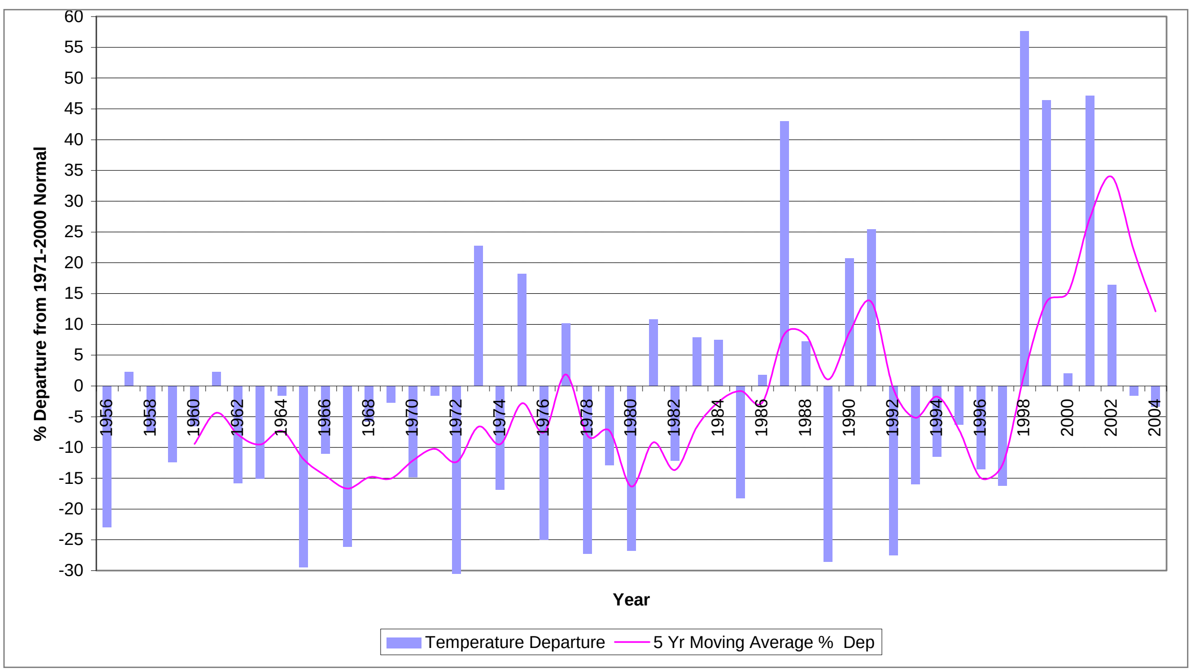


Figure 2.4 – Annual temperature departure from 1971-2000 normal at Sudbury Airport (EC, 2002)

Chapter 10 – Hydrology

10.1 Wanapitei River Watershed

The Wanapitei River, a main tributary of the French River, drains an area of approximately 3,780 km^2, starting from the north at Scotia Lake and flowing towards the south. The watershed area is mostly forested and consists of approximately 268 km^2 of lakes. Lake Wanapitei, the largest inner-city lake in the world, has an area of 132 km^2 and is the main feature of the watershed.

The river is approximately 257 km long with an approximate elevation change of 230 m. The operating level of the lake is shown in Table 2.16. The river is fed by various tributaries and sub-tributaries along the flow as tabulated in Table 2.7. The river above Lake Wanapitei has two main tributaries, the west and the east. The eastern tributary drains an area of 193 km^2 (OMNR, 2005) while the western tributary, which is the main river, drains an area of 1,794 km^2. The western branch drains a number of large tributaries including Scotia Lake, and Meteor, Raven, Rosie, Silvester, Unwin, Barnet and Demott Creeks in the northernmost reaches of the watershed.

The river downstream of Lake Wanapitei is regulated by the Lake Wanapitei Dam and several other hydropower generating stations. Main dams on the river include Lake Wanapitei Dam, Moose Rapids, Stinson Dam, Coniston Dam and McVittie Dam. Four generating stations are installed at Moose Rapids, Stinson, Coniston and McVittie Dams.

A network of streamflow gauges exists on the system and historical flow records are available from the Water Survey of Canada and Ontario Power Generation. The flow records from 1955-2003 show a mean annual flow of 29.8 m^3/s at Lake Wanapitei Dam, 32.4 m^3/s at Stinson GS, 32.6 m^3/s at Coniston GS, 36.6 m^3/s at Wanup GS and 38.3 m^3/s at McVittie GS. The mean annual flow (1955-2003) at the outlet of the watershed is 44.6 m^3/s, which was pro-rated on the basis of flow recorded at McVittie generating station.

The watershed hydrology is illustrated on Map 2.8.

Table 2.7 - Wanapitei River watershed tributaries and sub-tributaries

River	Length (km)	Drainage area (km^2)	Drop (m)	Average gradient (m/km)
Barnet Creek	18	128.94	50	2.78
Meteor Creek	44	287.82	42	0.95
Silvester Creek	32	161.04	33	1.03
Burwash Creek	31	184.01	121	3.90
East Wanapitei River	25	193.61	48	1.92
Parkin Creek	27	192.74	121	4.48

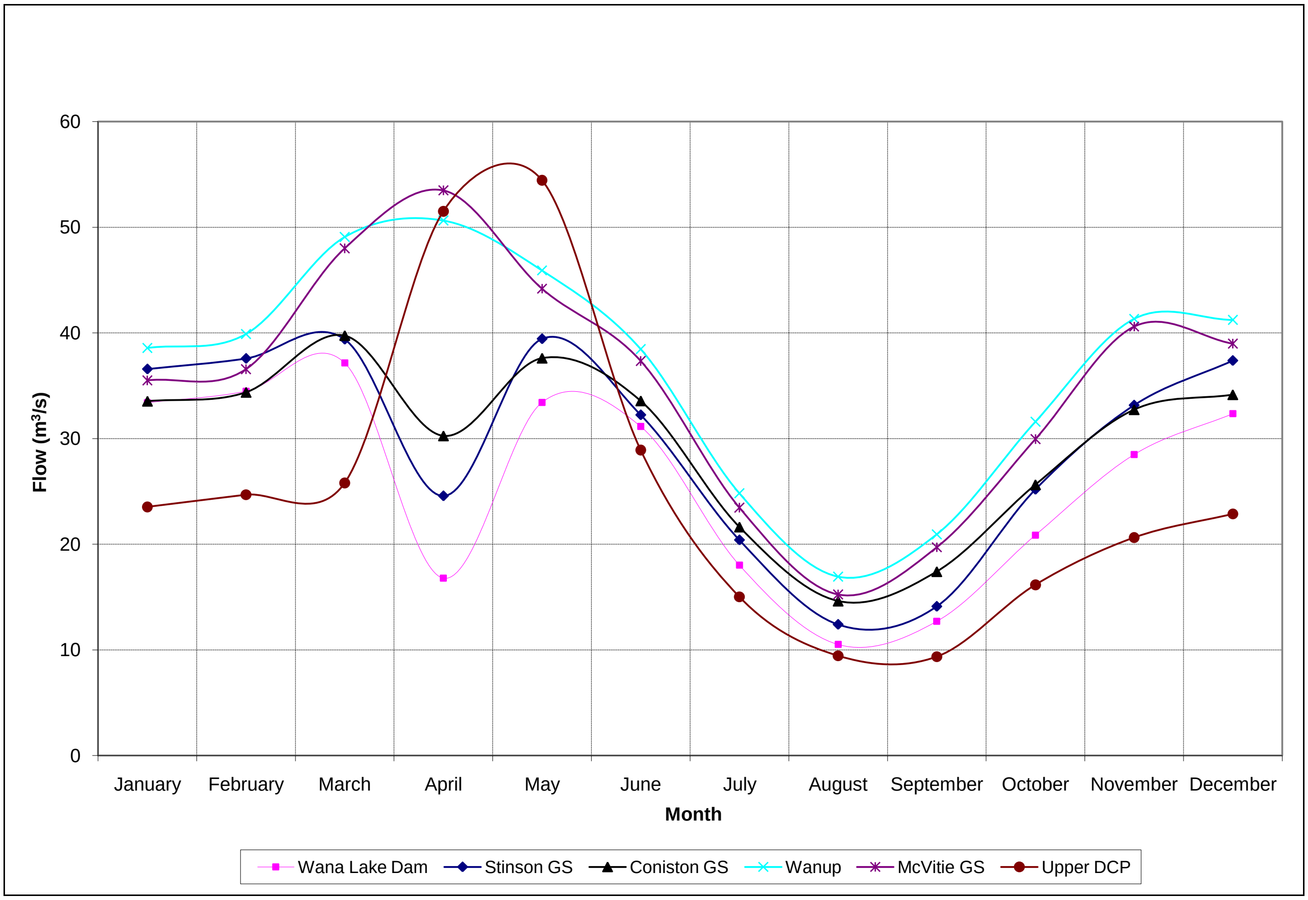
Table 2.8 - Stream flow gauge data gaps

Stream Gauge	Status	Data Record
Wanapitei-Wanup	Active	1955-2013

Coniston-Coniston	Active	1980-2013
Upper DCP Gauge	Active	1986-2013
Wanapitei Lake Dam	Active	1955-2013
Stinson	Active	1955-1961 & 1975-2013
Coniston	Active	1955-2013
McVittie	Active	1955-2013

Table 2.9 - Wanapitei River watershed dams and diversion structures

Dam Structure	Owner/Operator	Purpose	Description of Operational Plan
Wanapitei Lake Dam	Ontario Power Generation	Impound lake water for power generation and attenuate peak flows.	Dam has 15 sluiceways, capable of passing 100 year return flood. Stores water during spring freshet and flow is released for power generation.
Moose Rapids Dam	Canadian Hydro Developers	Power generation	Consists of diversion weir and a dam. Plant operates year around through computer control system that automatically starts and stops turbines to keep the water level at the diversion weir at 261.4 m.
Stinson Dam	Ontario Power Generation	Power generation	The dam receives water from various streams and a controlled runoff from Wanapitei Lake Dam. The flow is regulated through the operation of stop logs and gates.
Coniston Dam	Ontario Power Generation	Power generation	The flow is regulated through the operation of sluice gates and stop logs. A minimum flow of $3m^3$/sec is maintained for environmental reasons at the request of MNR.
McVittie Dam	Ontario Power Generation	Power generation	The facility is composed of a side dam, main dam and head works. Flow is regulated through sluice gates. A minimum flow of 10 m^3/sec is maintained during the pickerel spawn as per directions of MNR.
Burnt Lake Weir Dam	Ministry of Natural Resources	Facilitate the landing of float planes. Also acts as an access for cottagers on Horseshoe Lake.	



Wanapitei Figure 2.5 – Mean monthly flows for the River 1955-2003

10.2 Vermilion River Watershed

The Vermilion River is the main tributary of the Spanish River and its head waters originate in Frechette Township in the rugged northern Precambrian ridges of the watershed. It flows in a southerly direction and follows a winding path. The watershed area is mostly forested, with approximately 302 km^2 of lakes. The watershed hydrology is illustrated on Map 2.8. The operating level of several lakes in the watershed is shown in Table 2.16.

The Vermilion River has an approximate length of 248 km with an approximate elevation drop of 251 m and drains an area of 4,429 km^2. The flow in the Vermilion River comes from a number of tributaries and sub-tributaries as tabulated in Table 2.10.

Onaping Lake, which is a head water reservoir for the Onaping River, eventually discharges in three directions: southerly to the Vermilion River, westerly to the Spanish River and northerly to the Mattagami River. The northern flow has been blocked and the water is mainly diverted towards the Spanish River through regulation of the Bannerman Dam. The Onaping River is the main outlet of the lake and a main tributary of the Vermilion River. It drains an area of 1,378 km^2 which includes Onaping Lake with a surface area of 66 km^2.

The Whitson River, another main tributary of the watershed, flows in a south-westerly direction and enters the Vermilion River in Creighton Township in the City of Greater Sudbury. The Whitson River drains an approximate area of 313 km^2. This river passes through the urban towns of Val Caron and Chelmsford and has been a source of a number of flooding events in the past.

Junction Creek, another urbanized watershed, includes significant mining activity. It drains an area of 324 km^2 passing through the City of Greater Sudbury and eventually joins the Vermilion River at McCharles Lake. Nolin Creek and Copper Cliff Creek are the sub-watersheds which join Junction Creek in downtown Sudbury.

The water level and flow is measured at various locations by the Water Survey of Canada, NDCA, Domtar and Vale. The river has a mean annual flow of 45.7 m^3/s at Lorne Falls and 46.6 m^3/s (pro-rated on the basis of recorded flows at Lorne Falls) at the outlet to the Spanish River.

Table 2.10 - Vermilion River watershed tributaries and sub-tributaries

River	Length (km)	Drainage area (km^2)	Drop (m)	Average gradient (m/km)
Michaud River	19	145.86	38	2.00
Rapid Creek	34	82.66	146	4.29
Roberts River	28	187.67	108	3.86
Onaping River	71	1377.56	141	1.99
Sancherry Creek	24	139.82	148	6.17
Windy Creek	19	90.64	102	5.37
Junction Creek	49	324.19	55	1.12
Levey Creek	17	148.14	13	0.76
Whitson River	44	312.88	43	0.98
Cameron Creek	34		103	3.03
Fairbank Creek	23	72.47	68	2.96
Nelson River	16	193.35	74	4.63

Table 2.11 - Stream flow gauge data gaps

Stream Gauge	Status	Data Record
Bannerman Dam		N/A
Onaping Lake Dam		N/A
Stobie Dam		N/A
Windy Lake Dam		N/A
Moose Creek	Active	1981-2013
Onaping-Levack	Active	1976-1997 / 2002-2013
Vermilion-Capreol/Milnet	Active	1970-1977 / 2006-2013
Vermilion-Val Caron	Active	1970-1994 / 2006- 2013
Whitson-Val Caron	Active	1962-2013
Whitson-Chelmsford	Active	1960-2013
Nolin Creek-Sudbury	Discontinued	1959-1994
Junction-Sudbury	Active	1958-1996 / 2006-2013
Junction-Kelley Lake	Active	1977-2013
Vermilion-Lorne Falls	Discontinued	1955-1993

Table 2.12 - Vermilion River dams and diversion structures

Dam Structure	Owner/Operator	Purpose	Description of Operational Plan
Bannerman Dam	Domtar	Onaping Lake serves as a reservoir.	The reinforced concrete dam has a single log sluiceway, which contains stop logs. The dam also has east and west weir.
Onaping Lake Dam	Domtar	In conjunction with the Bannerman Dam, regulates the lake level.	The reinforced concrete dam has three log sluiceways, which contain many stop logs.
Strathcona Creek Dam	Xstrata	Is a final effluent polishing pond dam. The purpose of the control station is to control water quantity and quality.	A 61 cm diameter pipe is installed in the roadway beside the existing 1.83 m diameter culverts (culverts remain for contingency purposes). A separate 31 cm pipe is installed to provide extra discharge. The 61 cm pipe flow is measured by an ultrasonic flow meter which is controlled by a butterfly valve.
Stobie Dam	Domtar	Water management	The reinforced concrete dam has five log sluiceways, four of which have double stop logs. The dam also has an east and west weir.
Windy Lake Dam	Ministry of Natural Resources	The dam is used to regulate the water level.	The dam discharges in to the Windy Creek, which finally discharges in to the Onaping River near Dowling. The dam consists of a log sluiceway and an Ogee Spillway.
Whitewater Lake Dam	Ministry of Natural Resources	Regulate water level for recreational purposes. Dam controls the level of Whitewater Lake.	The reinforced concrete dam has two log sluiceways which contain stop logs. The sluiceways are 8.5 m in width, the height of the dam is 3.96 m with maximum head of 2.7 m and a total dam length of 24.4 m.
Maley Dam	NDCA	Flood control	Dam discharges through sluiceway and steel gates.
Nickeldale Dam	NDCA	Flood control	Controls a discharge area of 9 km^2. The dam is 381 m long and 9 m high with a core of impervious clay covered with earth fill and protected by a layer of rock fill.
Lake Laurentian Dam	NDCA	Controls lake level	The structure is a concrete box culvert with six 4 inch logs installed. Controls a drainage area of approximately 8 km^2.
Nepawhin Dam	NDCA	Water level control	The dam has three bays, each approximately 0.9 m wide, with a 10 cm log in each bay.
Kelly Lake Dam	NDCA	Manage water level in Kelly Lake	The concrete weir is about 18.3 m wide and 1.22 m high.
Robinson Lake Dam	City of Greater Sudbury	Used for recreation and to prevent a back flow from Kelley lake.	The concrete weir has one stop log and covers a drainage area of 25.4 km^2.
Ramsey Lake Dam	City of Greater Sudbury	Used for flood control, recreation and water level control for the municipal water supply intake.	The reinforced concrete dam has two sluiceways and contains up to seven stop logs in each sluiceway. The dam covers a drainage area of 12.7 km^2.
Wabageshik Dam	Vale	Power generation	The run on the river facility consists of a concrete gravity type dam structure. The dam is 221 m in length. The spillway consists of a single motorized gate, which is 12.2 m in length and 7.3 m in height.

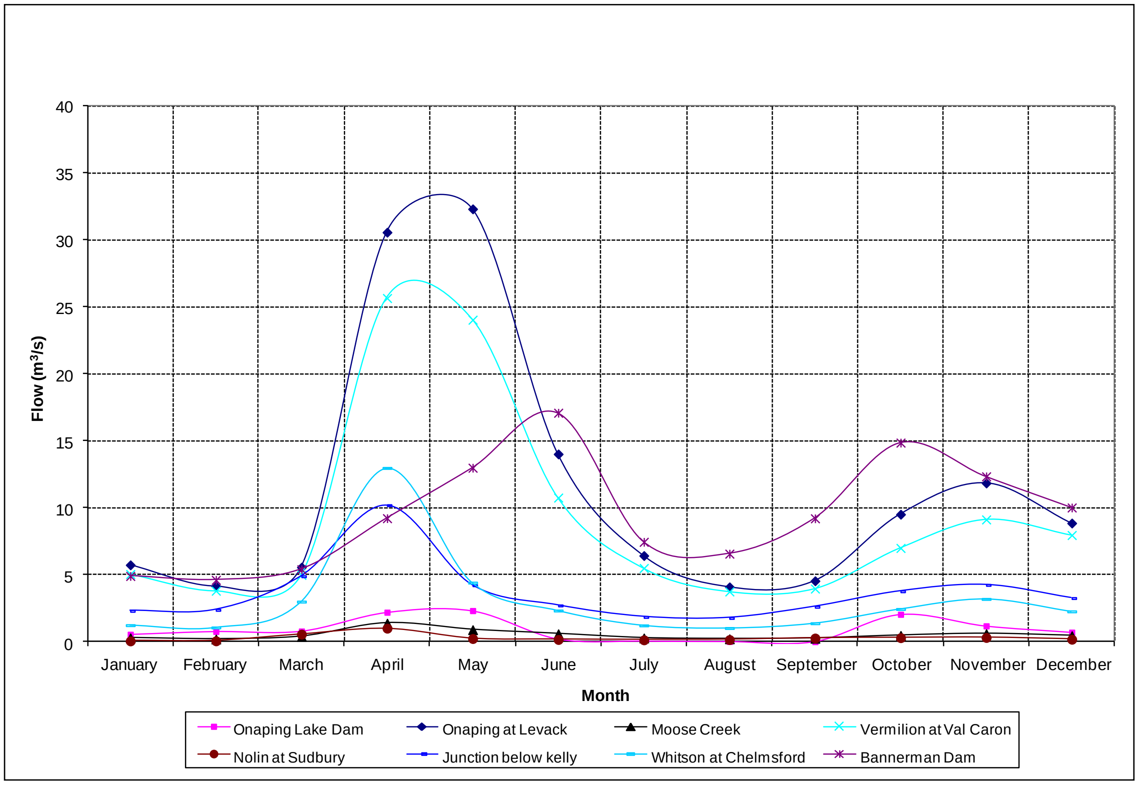


Figure 2.6 – Mean monthly flows for the Vermilion River 1955-2003

10.3 Whitefish River Watershed

The Whitefish River, which ultimately drains into the Lake Huron system, is bounded to the north by the Vermilion River system, to the south by the South La Cloche Range drainage basins and to the southeast by the Wanapitei River system. The watershed hydrology is illustrated on Map 2.8.

The river flow originates at Daisy Lake and flows southwest through Richard, McFarlane, Long, Round, La Vase, Panache, Walker, Little Bear, Lang, Cross, Charlton and Frood Lakes before discharging into the Bay of Islands in the North Channel of Lake Huron at Whitefish Falls.

Blackwater Creek, which flows into Round Lake, is also connected to the Vermilion River, which enters the Whitefish System through Round Lake during high flows. Observation indicates that Blackwater Lake is the headwaters of the watercourses leading to the Vermilion River and Round Lake. Blackwater Lake has been reported to be higher in elevation than Round Lake and the Vermilion River (EGA Consultants, 2000). The degree to which inter-basin transfer is occurring during high flows has not been quantified by studies undertaken to date.

The Whitefish River has a length of 90 km, an elevation drop of 58 m and drains an area of 942 km^2. The area is mostly forested and approximately 20% of the surface area consists of lakes. Three dams are constructed on the river to regulate water levels and flow, and are located on Lake Panache, Lang Lake, and Frood Lake. MNR operates and records the water levels at Lake Panache Dam, Lang Lake Dam and Frood Lake Dam. Mean annual flow at the Frood Lake Dam is 11.0 m^3/s. The operating level for Lake Panache is shown in Table 2.16.

The main contributing tributaries are West River, Howry Creek and Bevin Creek as tabulated in Table 2.13.

Table 2.13 – Whitefish River watershed tributaries and sub-tributaries

River	Length (km)	Drainage area (km^2)	Drop (m)	Average gradient (m/km)
West River	25	80.64	13	0.52
Howry Creek	28	112.06	32	1.12
Bevin Creek	14	62.22	62	4.55
Wavy Creek	6	25.67	45	7.59

Table 2.14 - Stream flow gauge data gaps

Stream Gauge	Status	Data Record
Panache Dam	Active	1999-2013
Lang Lake Dam	Active	1999-2013
Frood Lake-Whitefish Falls	Active	1999-2013
Frood Lake - Automatic	Active	2005-present
Panache Lake @ Jackson's Point	Active	2005-2013

Table 2.15 – Whitefish River watershed dams and diversion structures

Dam Structure	Owner/Operator	Purpose	Description of Operational Plan
Panache Lake Dam	Ministry of Natural Resources	Maintain lake water level within regulated ranges	The concrete gravity dam consists of three stop log control bays and an overflow Ogee weir. The stop log bays have a sill elevation of 220.1 m and a bay width of 4.27 m. The crest of the overflow ogee weir is 8 m long and 1.95 m high.
Lang Lake Dam	Ministry of Natural Resources	Water level	The concrete dam consists of four stop log control bays and overflow weir. The west two stop log bays have a width of 4.2 m. The two stop logs bays have a bay width of 4.3 m. The overflow weir is 9.96 m long and 1.7 m high.
Frood Lake Dam	Ministry of Natural Resources	Control Frood and Charlton Lake water levels	The concrete dam consists of two adjoining control sections and overflow weir. The north control section has three stop log control bays and the south section of the dam consists of two stop log bays and an overflow weir.

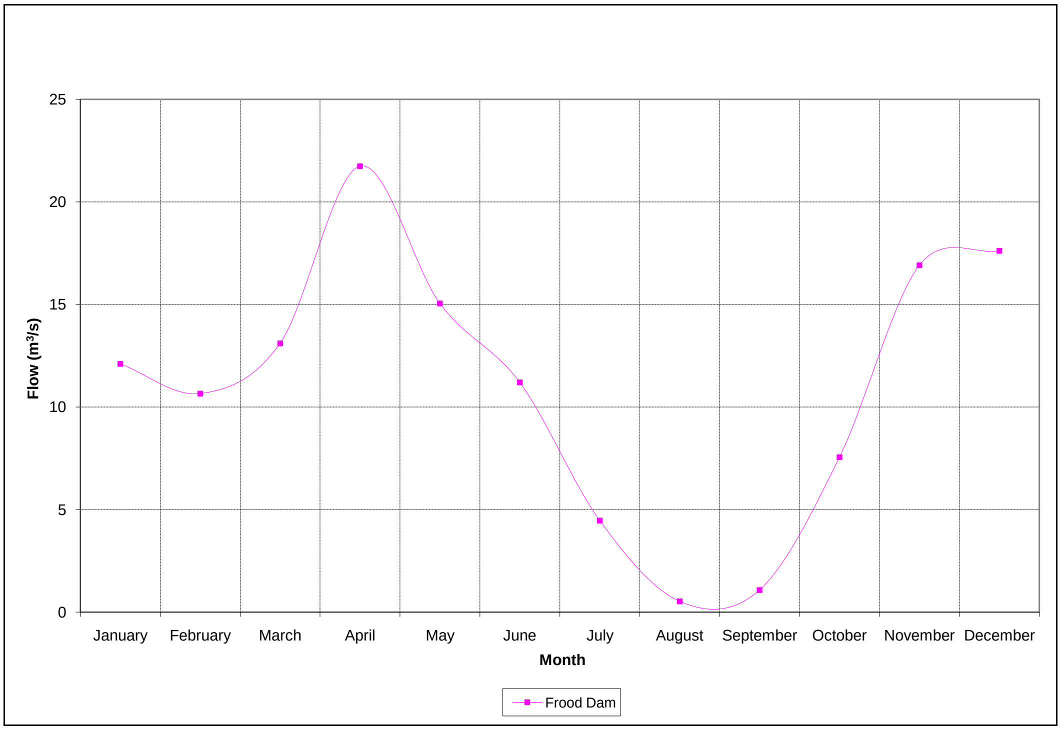


Figure 2.7 – Mean monthly flows for the Whitefish River 1955-2003

Table 2.16 – Operating levels of the lakes

Surface Water Bodies	Operating Ranges/Target Elevation (m)
Ramsey Lake	249.35 – 249.48
Robinson Lake	246.92
Vermilion Lake	256.49
Whitewater Lake	265.17 – 265.48
Whitson Lake	290.56
Windy Lake	0.5 drawdown
Onaping Lake (Onaping Dam)	2.74 above sill
Ella Lake Outlet (Wabageshik Dam)	225.4 – 225.73
Wanapitei Lake	265.05 – 267.95
Panache Lake	221.45

Chapter 11 – Hydrogeology

Groundwater is defined as subsurface water that occurs beneath the water table in soils and geological formations, such as aquifers and aquitards that are fully saturated. Hydrogeology is the study of the movement and interactions of groundwater in geological materials. This chapter will characterize the aquifers within the watershed in the planning area.

The MOE Water Well Information System (WWIS) contains information on the subsurface geology, aquifer properties and groundwater use in the province. This database provided the majority of the information to produce the recharge/discharge, depth to water table, sediment thickness and bedrock topography maps. In addition, this database is used to determine the specific capacity values of the wells in order to have an estimate of the physical hydrogeologic properties of the aquifer in the vicinity of that particular well.

There are 4,108 wells listed in the MOE WWIS for the planning area with most wells concentrated along the major roads and in the most heavily settled areas. Approximately 73% of the wells in the planning area are located within the Vermilion watershed. Very few wells are located to the north and northwest of Lake Wanapitei; therefore, very little information is available for the northern portions of the Wanapitei and Vermilion watersheds.

11.1 Overview of Aquifers

The hydrogeology of the planning area can be separated into two distinct groundwater systems, namely:

- The bedrock groundwater system: flow within this system occurs in relatively small, localized fractures. This system is considered to have limited groundwater supply potential and is generally considered to be a regional aquitard; and
- A series of overburden aquifer systems whose distribution and three-dimensional geometry is complex. Overburden aquifers are generally surrounded by bedrock outcrop and vary from small restricted aquifers in local bedrock valleys, to the extensive aquifers beneath the Valley and within the prominent, north-south trending Wanapitei Esker.

The planning area can be divided on the basis of geology into areas of exposed bedrock or thin overburden cover, and areas of thick overburden deposits. The bedrock areas are considered to be a limited groundwater resource, sufficient only for domestic private water supply. Transmissivity values of the bedrock in the planning area have been found to be generally less than 5 m^2/day (Richards, 2002). As a comparison, transmissivity values less than 12 m^2/day are generally considered to be only sufficient for domestic wells or low yield uses.

The more extensive aquifers are found in areas of thick overburden, including former glacial meltwater channels (Levack and Onaping areas), large glaciofluvial and deltaic deposits around the margin of a former glacial lake that occupied the Sudbury Valley (Dowling, Valley East and Capreol) and the Wanapitei Esker, a major subglacial tunnel and delta feature extending from Lake Wanapitei to the downtown Sudbury area (through Falconbridge and Garson). This esker also extends along the north side of Lake Wanapitei. Several morainal features are located in the northern portions of the Wanapitei and Vermilion watersheds as well as along the eastern limit of the Wanapitei watershed. In many cases, these thick overburden deposits fill deep valleys eroded into the bedrock surface.

A more extensive discussion of the hydrostratigraphy of each groundwater system can be found in the Groundwater Vulnerability Assessment Report, dated January 2010 in Appendix 2.

11.2 Groundwater Flow

The regional groundwater flow in the planning area generally appears to be a result of topographic features, and parallels the surface drainage patterns, with discharge generally being towards the Vermilion, Wanapitei and Whitefish Rivers (Richards, 2002).

In the areas around Levack, Onaping and the Valley, groundwater is found relatively close to the surface and the direction of groundwater flow generally follows surface water flow and overall topography. Within the Valley, groundwater generally flows towards the southwest, exiting the Valley as surface water flow in the Vermillion River.

Groundwater flow directions are more complex within the Wanapitei Esker. North of Falconbridge, groundwater flows towards the north, discharging into Lake Wanapitei, and the water table is up to 40 m below ground surface. Between Falconbridge and Garson, groundwater flow directions are complex and not well mapped. Southwest of Garson, where the esker is confined on both sides by higher bedrock topography, groundwater flow is generally towards the southwest, with some discharge supporting flow in Junction Creek.

11.3 Highly Vulnerable Aquifers

The interaction of surface water and groundwater not only replenishes the quantity of water but can also transport contaminants. The type and thickness of the overlying substrate can determine the vulnerability of the aquifer to contamination from surface activities. To assess groundwater vulnerability in the Greater Sudbury Source Protection Area, an intrinsic susceptibility index (or ISI method) was used. This method generates an overall vulnerability score on the scale of 1 to 100. For more information regarding the ISI method, please refer to Chapter 2 or Appendix 2. The results of this assessment demonstrate the groundwater vulnerability as high, medium or low for the entire source protection area and can be seen on Map 2.9.

To calculate ISI scores, well records were used where the density of wells provided some confidence in the results and surficial geology maps were used in areas that had sparse well records.

The Technical Rules categorize aquifers into high, medium or low vulnerability (Rule 38). Using the ISI scores:

- Areas with **high** vulnerability are those with ISI scores that are **less than 30,**
- Areas with **medium** vulnerability are those with ISI scores that are **greater than or equal to 30 and less than or equal to 80,** and
- Areas with **low** vulnerability are those areas with ISI scores that are **greater than 80.**

A highly vulnerable aquifer as defined in the Technical Rules is an area that has been identified with high vulnerability (Rule 43). A vulnerability score of 6 is given to this area (Rule 79). Map 2.10 shows the extent of the highly vulnerable aquifer and its vulnerability score.

11.4 Drinking Water Quality Threats Activities

The assessment of potential threats to drinking water quality followed the methodology outlined in Chapter 2. The list of prescribed drinking water threats is located in Table 1.7 in Part 1 of this report.

List of circumstances of all is or would be threats

As required under O.Reg. 287/07 subsection 13, a list of references for all is or would be moderate or low threats in each vulnerable area is listed in Table 2.17. Tables listing is or would be threats can be found in Appendix 5.

Identification of areas where threats can occur

The areas where a potential threat is or would be moderate or low are illustrated on Map 2.10. The highly vulnerable aquifer areas have a vulnerability score of 6, which means that they have the potential for a moderate or low threat to occur. The types of activities that could be threats in these areas are listed in the tables referred to in Table 2.17.

Table 2.17 – Table references for all is or would be threats and associated circumstances in highly vulnerable aquifers

Score	Significant	Moderate	Low
6	N/A	CSGRAHVA6M - Chemicals in an SGRA or HVA with a vulnerability score of 6 where threats are moderate	CSGRAHVA6L - Chemicals in an SGRA or HVA with a vulnerability score of 6 where threats are low

Managed Lands, Impervious Surfaces and Nutrient Units

Areas within the highly vulnerable aquifer which had a vulnerability score of 4 and above were assessed for percentage of managed lands, impervious surfaces and nutrient units. These results were used to evaluate non-point source threats. The methodology used to calculate these is described in Chapter 2.

The storage, handling and application of agricultural source material, non-agricultural source material, pesticides and fertilizers can result in potential contamination of municipal water supplies. The percentage of managed lands in the area was assessed to be under 40% (low) and is illustrated on Map 2.11. The exception is the Whitson River Sub-watershed which had between 40 and 80% managed land (moderate).

Impervious surfaces are measured as an indicator of the amount of area where road salt can be applied. The percentage of surface area within a vulnerable area which will not allow surface water or precipitation to be absorbed into the soil is measured. According to these calculations, most of the highly vulnerable aquifers are in the <1% range, but the 1-<8% range dominates in the Sudbury Basin, and the 8-<80% range occurs in built-up areas and along some of the major road corridors. The percentage of impervious area is illustrated on Map 2.12. The outcome of the impervious surface calculations resulted in the application of road salt being designated as a low threat.

The calculation of livestock density is based on the calculation of nutrient units per acre of agricultural managed lands. Overall, there is very little agricultural land in the highly vulnerable aquifers resulting in a score of under 0.5 nutrient units per acre, as illustrated on Map 2.13. The result of the managed land and livestock density calculations lead to the application of commercial fertilizer to land and the application of agricultural source material to land both being designated as a low threat for the highly vulnerable aquifer area.

Enumeration of Threats

Table 2.18 lists an estimate of the current number of moderate and low drinking water quality threats in the highly vulnerable aquifer in accordance with the Drinking Water Threats Tables.

Table 2.18 - Drinking water quality threats for the highly vulnerable aquifers

Drinking Water Threat Category	Number of Occurrences with Threat Classification		
	Significant	Moderate	Low
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act.		5	21
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.			48
The application of agricultural source material to land			1
The storage of agricultural source material.			325
The application of commercial fertilizer to land.			1
The application of pesticide to land.			12
The handling and storage of commercial fertilizer.			7
The handling and storage of pesticide.			3
The application of road salt.			1
The handling and storage of road salt.			6
The storage of snow.			12
The handling and storage of fuel.			45
The handling and storage of a dense non-aqueous phase liquid.			13
The handling and storage of an organic solvent.			14
The management of runoff that contains chemicals used in the de-icing of aircraft.			1
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard. O. Reg. 385/08, s. 3.			325

Chapter 12 - Surface Water and Groundwater Interactions

The identification of areas of groundwater recharge and discharge is important from the perspective of surface water and groundwater management and protection. Groundwater recharge areas act to replenish the aquifer and are susceptible to impacts from near surface contaminants, which can migrate with groundwater flow into the sub-surface and affect potable aquifers. Contamination in recharge areas can also affect surface water quality where impacted groundwater discharges into receiving streams and wetlands. Groundwater discharge areas also provide cold water habitat for aquatic life and can maintain stream flow in times of drought conditions.

Unconfined groundwater aquifers are a principle source of drinking water and also typically network with surface water streams. These streams receive their baseflow from the aquifer. Surface water feeds groundwater through precipitation, which infiltrates into the ground and percolates into the aquifer.

As previously indicated, the bedrock in the planning area is generally considered to be a regional aquitard, with low infiltration potential and high runoff potential. As such, in areas where bedrock outcrops are at surface or at shallow depth, most of the precipitation runs off the bedrock and often flows directly into nearby surface water bodies.

With the exception of the glaciolacustrine deposits, the overburden deposits in the planning area are considered to be local unconfined aquifers, often of limited extent and bounded by bedrock outcropping. The overburden is considered to have low runoff potential and, in turn, high infiltration potential. Significant groundwater and surface water interaction is likely limited to overburden aquifer areas, which consists of approximately 24% of the planning area.

The overburden and shallow bedrock systems interact to some extent, with recharge to the bedrock being supplied primarily from the overburden in areas of downward vertical gradients. Groundwater also likely flows from the shallow bedrock into the overburden in areas of upward hydraulic gradients. However, the quantity of groundwater contribution from the underlying bedrock into overburden is likely minimal in most parts of the planning area.

12.1 Significant Groundwater Recharge Areas

Groundwater recharge is the process in which precipitation or surface water replenishes an aquifer. A *significant* groundwater recharge area is defined in the Technical Rules as an area that (Rule 44):

a) annually recharges water to the underlying aquifer at a rate that is greater than the rate of recharge across the whole of the related groundwater recharge area by a factor of 1.15 or more; or,

b) annually recharges a volume of water to the underlying aquifer that is 55% or more of the volume determined by subtracting the annual evapotranspiration for the whole of the related groundwater recharge area from the annual precipitation for the whole of the groundwater recharge area.

Additionally, the significant groundwater recharge area must be hydrologically connected to a surface water body or aquifer that is a source of drinking water for a drinking water system (Rule 45).

The average annual water surplus for the source protection area was estimated to be 400 mm. The estimation was based on a series of calculations involving surficial geology, precipitation, potential evapotranspiration, actual evapotranspiration, streamflow, baseflow and surface runoff.

Using criteria b) as described above, 55% of the average annual water surplus (i.e. 55% of 400 mm) is 220 mm. Therefore, a significant groundwater recharge area for the Greater Sudbury Source Protection Area is an area that can achieve a water surplus of greater than 220 mm. Soils that fall into this category include coarse till, silt, silty sand and sand (Golder, 2009).

In the planning area, the dominant surficial geology includes bedrock, wetlands, glaciofluvial and glaciolacustrine deposits (See Map 2.7 and refer to Chapter 8). The principal groundwater recharge areas occur in the glaciofluvial and glaciolacustrine deposits which consist of silt and sand. The MOE Water Well Records were used to determine the location of drinking water systems in the GSSPA. The resulting significant groundwater recharge areas are located in the Valley East area, Dowling, Onaping and the length of the Wanapitei Esker. An isolated recharge area is also located in the northern reach of the Wanapitei River watershed.

Map 2.14 shows the vulnerability scores for the SGRAs in the Source Protection Area. The SGRAs were overlaid on the ISI map and scoring applied in accordance to Technical Rule VII.2(81). Areas with high groundwater vulnerability were scored 6; areas with medium groundwater vulnerability were scored 4. There were no areas within the Source Protection Area SGRAs with low groundwater vulnerability, which would be scored 2. Areas within wellhead protection areas (WHPA-A, WHPA-B, WHPA-C, WHPA-D and WHPA-E) were excluded from the scoring because these areas were scored in accordance with Technical Rules VII.3(83-84).

The aquifer vulnerability mapping is based on calculated ISI values where the density of wells is sufficient to provide confidence in the results. In these areas, the uncertainty in the SGRA vulnerability scores is low. Outside of the residential and agricultural areas of the City of Greater Sudbury, the density of well data was insufficient to allow extrapolation of ISI values across the Source Protection Area. In those areas, assessment of surficial geological maps was used to define aquifer vulnerability, and therefore, the uncertainty in the SGRA vulnerability scores is high.

12.2 Drinking Water Quality Threats Activities

The assessment of potential threats to drinking water quality followed the methodology outlined in Chapter 2. The list of prescribed drinking water threats is located in Table 1.7 in Part 1 of this report.

List of circumstances of all is or would be threats

As required under O.Reg. 287/07 subsection 13, a list of references for all is or would be moderate or low threats in each vulnerable area is listed in Table 2.19. Tables listing is or would be threats can be found in Appendix 5.

Table 2.19 – Table references for all is or would be threats and associated circumstances in significant groundwater recharge areas

Score	Significant	Moderate	Low
6	N/A	CSGRAHVA6M - Chemicals in an SGRA or HVA with a vulnerability score of 6 where threats are moderate	CSGRAHVA6L - Chemicals in an SGRA or HVA with a vulnerability score of 6 where threats are low

Identification of areas where threats can occur

The significant groundwater recharge areas have a vulnerability score of 6 or 4. Areas with a score of 6 have the potential for a moderate or low threat to occur. Areas with a score of greater than 4 and less than 6 have the potential for a low drinking water threat to occur. The types of activities that could be threats in these areas are listed in the tables referred to in Table 2.19.

Managed Lands, Impervious Surfaces and Nutrient Units

Areas within the significant groundwater recharge area which had a vulnerability score of 4 and above were assessed for percentage of managed lands, impervious surfaces and nutrient units. These results were used to evaluate non-point source threats. The methodology used to calculate these is described in Chapter 2.

The storage, handling and application of agricultural source material, non-agricultural source material, pesticides and fertilizers can result in potential contamination of municipal water supplies. The percentage of managed lands in the significant groundwater recharge areas was assessed to be under 40% (low) and is illustrated on Map 2.15. The exception is the Whitson River Sub-watershed which had between 40 and 80% managed land (moderate).

Impervious surfaces are measured as an indicator of the amount of area where road salt can be applied. The percentage of surface area within a vulnerable area which will not allow surface water or precipitation to be absorbed into the soil is measured. According to these calculations, most of the significant groundwater recharge area is in the <1% range and 1-<8% range, with a fairly even amount in each range. Impervious areas in the 8-<80% range occur in built-up areas and along some of the major road corridors. The percentage of impervious area is illustrated on Map 2.16. The outcome of the impervious surface calculations resulted in the application of road salt being designated as a low threat.

The calculation of livestock density is based on the calculation of nutrient units per acre of agricultural managed lands. The amount of agricultural land in the significant groundwater recharge areas is very limited, therefore there is a score of under 0.5 nutrient units per acre. The results are illustrated on Map 2.17. The outcome of the managed land and livestock density calculation resulted in the application of commercial fertilizer to land and the application of agricultural source material to land both being designated as a low threat for the significant groundwater recharge areas.

Enumeration of Threats

Table 2.20 lists an estimate of the current number of moderate and low drinking water quality threats in the significant groundwater recharge areas in accordance with the Drinking Water Threats Tables.

Table 2.20 - Drinking water quality threats for the significant groundwater recharge areas

Drinking Water Threat Category	Number of Occurrences with Threat Classification		
	Significant	Moderate	Low
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act.		4	13
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.			47
The application of agricultural source material to land			1
The storage of agricultural source material.			304
The application of commercial fertilizer to land.			1
The application of pesticide to land.			12
The handling and storage of commercial fertilizer.			6
The handling and storage of pesticide.			3
The application of road salt.			1
The handling and storage of road salt.			6
The storage of snow.			10
The handling and storage of fuel.			47
The handling and storage of a dense non-aqueous phase liquid.			13
The handling and storage of an organic solvent.			14
The management of runoff that contains chemicals used in the de-icing of aircraft.			1
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard. O. Reg. 385/08, s. 3.			304

12.3 Groundwater Discharge Areas

To identify areas of potential groundwater discharge, the vertical hydraulic gradients were calculated by comparing the shallow water table elevation with the potentiometric surface. Where the potentiometric surface is greater than 2 m below the water table surface, vertical gradients are downwards and the deeper aquifer systems are likely receiving groundwater from the shallow system. Likewise, when the potentiometric surface is more than 2 m above the shallow water table, vertical gradients are upwards and the deeper aquifer systems are potentially discharging to the shallow system.

In the Sudbury Basin, areas of upward hydraulic gradient and potential groundwater discharge are seen along the southern margin of the basin and north of Vermilion Lake and east of Dowling. These areas have also been identified as groundwater discharge areas through the groundwater modelling efforts undertaken as part of the Municipal Groundwater Study for the City of Greater Sudbury.

Along the Wanapitei Esker, groundwater discharge patterns are more complex. North of Garson, groundwater discharges northwards to Lake Wanapitei. South of Garson, groundwater discharge is primarily along Junction Creek and associated tributaries. Water bodies that likely receive a significant portion of groundwater discharge within the planning area include the Vermilion, Whitson and Onaping Rivers, Lake Wanapitei and Junction Creek.

Baseflow is the contribution to streamflow that originates from delayed sources, such as groundwater or surface depression storage (Smakhtin, 2001). During dry periods, these delayed releases help to maintain streamflow and, therefore, baseflow is an important contributor to water quantity and quality. A number of manual and automatic methods have been developed to separate baseflow from streamflow records (see Tallaksen, 1995 for review).

In southern Ontario, deep glacial deposits allow for the calculation of baseflow to be an estimate of groundwater discharge to streams (Piggott et al., 2005). However, conventional baseflow separation techniques in the lake-dominated, shallow soil and relatively impermeable bedrock areas of northern Ontario predict >50% annual contribution from baseflow to streamflow (Conceptual Water Budget Report). This predicted baseflow is too high to represent groundwater inputs to streams, but may realistically reflect slow inputs from the numerous wetlands, lakes and reservoirs in the region. Wang and Chin (1978) suggested that for northern Ontario, the 95% flow exceedance value on a flow-duration curve appropriately estimated groundwater contributions to streamflow (i.e. the groundwater component of baseflow), while government reports (MNR, 1984; Singer and Chang, 2002) calculated approximately 20% - 30% of annual streamflow in Northern Ontario was contributed by groundwater.

A recent USGS report (Neff *et al.*, 2005) investigated baseflow in the Great Lakes Basin, including parts of the Canadian Shield near Sudbury. Their model incorporated functions for surface water attenuation and soil classification. Using this method, annual groundwater contributions to streamflow in the source protection planning area were calculated to be 35%. It should be noted that groundwater contributions may be higher in areas of thicker/deeper overburden and considerably less in areas dominated by bedrock.

Chapter 13 - Water Quantity

13.1 Wanapitei River Watershed

In the Wanapitei Watershed there are 38 Permits to Take Water: 21 are for surface water, 13 are for groundwater and 4 are for both groundwater and surface water. The actual water use estimates for each sector is detailed in Table 2.24 and Figure 2.8 represents water use by sector in the watershed. The groundwater withdrawal is estimated to be 10% while 90% usage is surface water. The City of Greater Sudbury takes surface water from the Wanapitei River for the Wanapitei Water Treatment Plant which provides 60% of the water for the former City of Sudbury (CGS, 2004). The treated water from this plant is delivered to New Sudbury, Coniston, Wahnapitae, Markstay, and parts of downtown. The water diverted to New Sudbury and parts of downtown constitutes an inter-basin transfer to the Junction Creek (sub-watershed of the Vermilion River) because the sewage system of the area is discharged into Junction Creek at Kelly Lake. The City of Greater Sudbury's groundwater wells in Falconbridge are also located in the Wanapitei River watershed.

As noted in Chapter 3, a Tier 1 water budget was done for this watershed, and the results showed a low stress level, so Tier 2 and Tier 3 analyses were not required. A summary of the results of the Tier 1 analysis are provided in this section and the complete report is provided in Appendix 2. Monthly and annual water budget analyses were carried out to evaluate water quantity stress within the Wanapitei Watershed. The water budget results are detailed in Table 2.21. Stress assessments were performed for surface water and ground water systems in the watershed separately. Tables 2.22 and 2.23 summarize the stress assessment results for surface water and groundwater systems. Maps 2.18 and 2.19 illustrate the stress level of surface water and groundwater systems for the Wanapitei River watershed.

A Tier 1 water budget was also done for each of the drinking water systems within this watershed. The results of these analyses are in Part Four, Wanapitei River Drinking Water System and Part Eight, Falconbridge Drinking Water System.

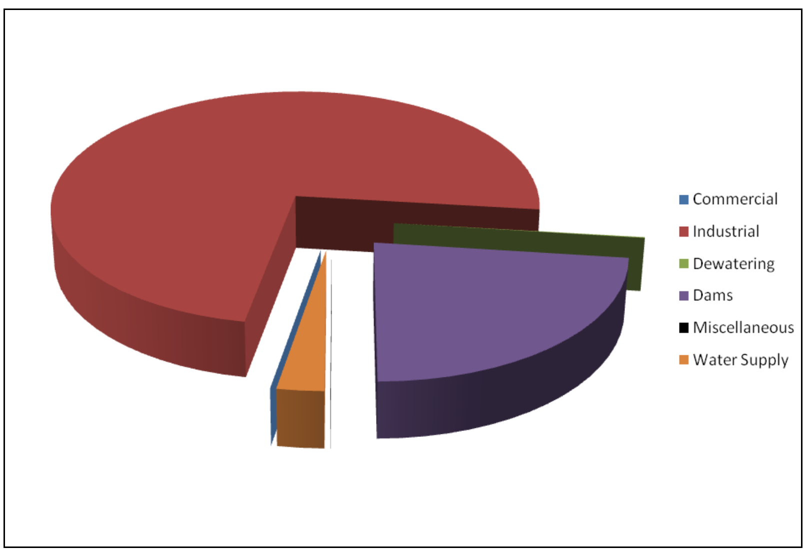


Figure 2.8 –Summary of Wanapitei River watershed water use by sector

Table 2.21- Wanapitei River watershed water budget

Water Balance Element (mm)											
Month	Rainfall	Snowfall	Snow-melt	Total Input	PET*	AET*	Stream-flow	Base-flow	Runoff	Water Surplus	Water Deficit
January	2.3	61.2	5.8	8.1	0	0	32.4	8.0	24.4	0	-24.3
February	2.9	48.5	13.5	16.4	0	0	33.5	7.0	26.5	0	-12.2
March	20	46.7	67.2	87.2	0	0	40.9	12.0	28.9	46.3	0
April	52	13.4	129.2	181.2	19.2	19.2	42.5	20.0	22.5	119.5	0
May	80.8	1	8.8	89.6	74.5	74.5	41.3	25.0	16.3	0	-26.2
June	77.1	0	0	77.1	110.5	107.4	34.0	18.0	16.0	0	-64.3
July	78	0	0	78	130.3	114.7	19.3	14.0	5.3	0	-56
August	84.9	0	0	84.9	112.7	100.2	12.8	8.0	4.8	0	-28.1
September	106.4	0	0	106.4	69	69.0	14.8	6.0	8.8	22.6	0
October	82.3	2.5	2.5	84.8	30.2	30.2	24.8	12.0	12.8	29.8	0
November	45.4	33.3	19	64.4	0.7	0.7	34.0	14.0	20.0	29.7	0
December	9.3	55.5	15.2	24.5	0	0	34.9	25.0	9.9	0	-5.3
Annual Total	**641.4**	**262.1**	**261.2**	**902.6**	**547.1**	**515.8**	**365.3**	**169.0**	**196.3**	**247.9**	**-216.4**
Annual Recharge											31.5

*PET – Potential Evapotranspiration
**AET – Actual Evapotranspiration

Table 2.22 – Wanapitei River watershed surface water stress assessment

Month	Supply (m^3/s)		Demand (m^3/s)				Stress (%)	
	Median	Reserve	Municipal	PTTW	Total	Forecast	Present	Forecast
January	47.31	36.57	0.29	0.44	0.73	0.75	6.79	7.03
February	48.9	35.53	0.28	0.43	0.71	0.74	5.31	5.5
March	59.61	47.47	0.29	0.43	0.72	0.75	5.95	6.017
April	62.0	32.23	0.29	0.43	0.72	0.75	2.42	2.51
May	60.25	16.23	0.29	0.43	0.72	0.75	1.64	1.7
June	49.64	13.66	0.32	0.46	0.78	0.81	2.16	2.24
July	28.13	13.28	0.32	0.46	0.77	0.80	5.22	5.41
August	18.68	9.49	0.31	0.45	0.76	0.79	8.3	8.61
September	21.59	8.97	0.30	0.45	0.75	0.78	5.93	6.15
October	36.2	12.41	0.29	0.43	0.71	0.74	3.0	3.1
November	49.55	24.29	0.29	0.43	0.71	0.74	2.84	2.94
December	50.88	33.09	0.30	0.44	0.73	0.76	4.13	4.28

Table 2.23 – Wanapitei River watershed groundwater stress assessment

Month	Supply (m^3/s)		Demand (m^3/s)					Stress (%)	
	Median	Reserve	Municipal	PTTW	Agriculture	Total	Forecast	Present	Forecast
January	3.78	0.38	0.003	0.05	0	0.05	0.02	1.53	0.94
February	3.78	0.38	0.003	0.04	0	0.05	0.02	1.50	0.94
March	3.78	0.38	0.003	0.04	0	0.05	0.02	1.47	0.94
April	3.78	0.38	0.003	0.05	0	0.05	0.02	1.63	0.94
May	3.78	0.38	0.004	0.04	0	0.05	0.03	1.42	0.97
June	3.78	0.38	0.005	0.05	0.01	0.07	0.03	2.07	1.28
July	3.78	0.38	0.006	0.05	0.02	0.07	0.04	2.25	1.61
August	3.78	0.38	0.004	0.05	0.02	0.07	0.04	2.28	1.50
September	3.78	0.38	0.003	0.05	0.01	0.06	0.03	2.0	1.23
October	3.78	0.38	0.003	0.05	0	0.05	0.02	1.62	0.94
November	3.78	0.38	0.003	0.05	0	0.05	0.02	1.53	0.94
December	3.78	0.38	0.003	0.05	0	0.06	0.02	1.78	0.94
Annual	3.78	0.38	0.004	0.05	0	0.06	0.03	1.76	1.10

Table 2.24 – Summary of Permits to Take Water by Sector in the Wanapitei Watershed

Type	Surface Water	Groundwater	Both	Total	Percentage
	(Thousands of cubic meters)				
Commercial	49			49	0.004
Industrial	812,578	2,782	995	816,355	74
Water Supply	22,201	7,412	332	29,936	2.715
Dewatering		1,195		1,195	0.108
Dams	254,880			254,880	23
Miscellaneous	42			42	0.004
Total				1,102,456	

13.2 Vermilion River Watershed

In the Vermilion River watershed there are 80 Permits to Take Water: 39 are for surface water, 36 are for groundwater and 5 for both groundwater and surface water together. The actual water use estimates for each sector is detailed in Table 2.25 and Figure 2.9 represents water use by sector in the watershed. The groundwater withdrawal is estimated to be 13% while 77% usage is surface water. Surface water-groundwater combined contributes about 10%. Municipal supply removals from this watershed include the Vale owned surface water removal from the Vermilion River, the City of Greater Sudbury's surface water removal from Ramsey Lake, and groundwater removals in the Valley, Capreol, Dowling, Onaping and Garson.

A summary of the results of the Tier 1 analysis for this watershed are provided in this section and the complete report is provided in Appendix 2. Monthly and annual water budget analyses were carried out for the period 1970-2005, to evaluate water quantity stress within the Vermilion River watershed. The water budget results are shown in Table 2.26. Stress assessments were performed for surface water and ground water systems in the watershed separately. Tables 2.27 and 2.28 summarize the stress assessment results for surface water and groundwater systems.

Maps 2.18 and 2.19 illustrate the Tier 1 stress level for the Vermilion River watershed and for the Ramsey Lake and Valley subwatersheds, and Maps 2.20 and 2.21 show the Tier 2 stress levels.

Tier 1 water budgets and stress assessments were also completed for each municipal drinking water system within this watershed. The results of these analyses are in Part Five (the Vermilion system upstream of the intake), Part Six (Valley), Part Seven (Garson), Part Eight (Falconbridge), Part Nine (Onaping), and Part Ten (Dowling). Further analyses were required for the Ramsey Lake system where a combined Tier 1/2 was completed as well as a Tier 3 (Part Three), and for the Valley system where Tier 2 and Tier 3 analyses were completed (Part Six).

Table 2.25 – Summary of Permits to Take Water by Sector in the Vermilion Watershed

Type	Surface Water	Groundwater	Both	Total	Percentage
	(Thousands of cubic meters)				
Commercial	605			605	0.04
Industrial	118,215	1,386		119,601	7.15
Water Supply	18,579	8,892		27,471	1.64
Dewatering	1,207	13,638	16,883	31,727	1.90
Dams	1,492,067			1,492,067	89.25
Miscellaneous	7	316		322	0.02
Total				1,671,794	

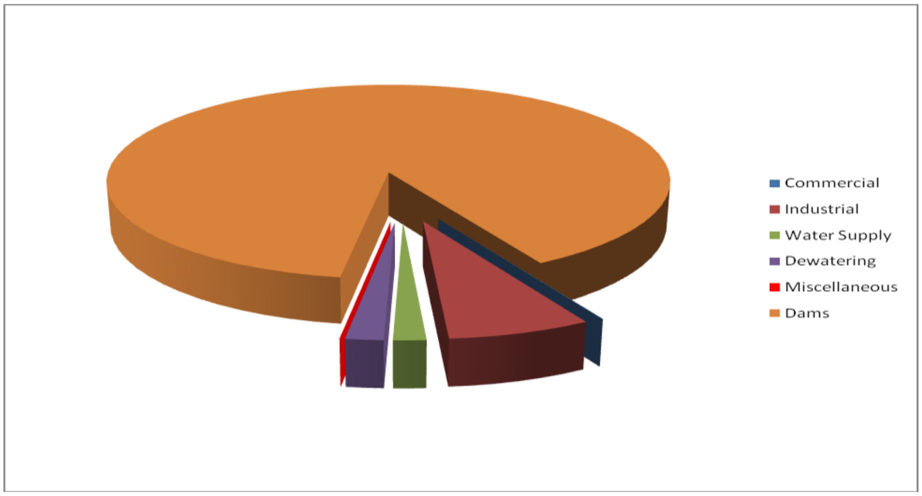


Figure 2.9 – Vermilion River watershed water use by sector

Table 2.26 – Vermilion River watershed water budget

Water Balance Element (mm)											
Month	Rainfall	Snowfall	Snow-melt	Total Input	PET*	AET*	Stream-flow	Base-flow	Runoff	Water Surplus	Water Deficit
January	2.3	61.2	5.8	8.1	0	0	13.4	8.0	5.4	0	-5.3
February	2.9	48.5	13.5	16.4	0	0	11	7.0	4.0	5.4	0
March	20	46.7	67.2	87.2	0	0	20.3	12.0	8.3	66.9	0
April	52	13.4	129.2	181.2	19.2	19.2	87.2	50.0	37.2	74.8	0
May	80.8	1	8.8	89.6	74.5	74.5	64.9	30.0	34.9	0	-49.8
June	77.1	0	0	77.1	110.5	108.2	30.7	20.0	10.7	0	-61.8
July	78	0	0	78	130.3	118.7	16.3	15.0	1.3	0	-56.9
August	84.9	0	0	84.9	112.7	103.1	9.3	8.0	1.3	0	-27.5
September	106.4	0	0	106.4	69	69	9.9	8.0	1.9	27.5	0
October	82.3	2.5	2.5	84.8	30.2	30.2	17.7	18.0	2.7	36.9	0
November	45.4	33.3	19	64.4	0.7	0.7	27.3	14.0	13.3	36.4	0
December	9.3	55.5	15.2	24.5	0	0	21.7	2.0	19.7	2.8	0
Annual Total	**641.4**	**262.1**	**262.1**	**902.6**	**547.1**	**523.6**	**329.6**	**189.0**	**140.6**	**250.7**	**-201.4**
Annual Recharge											49.3

*PET – Potential Evapotranspiration
**AET – Actual Evapotranspiration

Table 2.27 – Vermilion River watershed surface water stress assessment

	Supply (m^3/s)		Demand (m^3/s)				Stress (%)	
Month	Median	Reserve	Municipal	PTTW	Total	Forecast	Present	Forecast
January	21.89	11.71	0.02	0.19	0.22	0.22	2.14	2.16
February	18.67	11.03	0.02	0.19	0.22	0.22	2.87	2.90
March	25.9	16.02	0.02	0.19	0.22	0.22	2.19	2.21
April	147.14	90.47	0.02	0.19	0.22	0.22	0.38	0.38
May	103.94	48.81	0.02	0.19	0.22	0.22	0.4	0.40
June	41.16	24.79	0.02	0.23	0.25	0.25	1.54	1.55
July	22.24	10.19	0.02	0.23	0.25	0.25	2.10	2.12
August	14.53	7.38	0.02	0.23	0.25	0.26	3.57	3.60
September	13.62	6.74	0.02	0.23	0.25	0.26	3.70	3.73
October	22.05	6.67	0.02	0.19	0.22	0.22	1.41	1.42
November	37.41	13.38	0.02	0.19	0.22	0.22	0.90	0.91
December	34.94	14.94	0.02	0.19	0.22	0.22	1.08	1.09

Table 2.28 – Vermilion River watershed groundwater stress assessment

	Supply (m^3/s)		Demand (m^3/s)					Stress (%)	
Month	Median	Reserve	Municipal	PTTW	Agriculture	Total	Forecast	Present	Forecast
January	24.44	2.44	0.14	0.26	0	0.39	0.4	1.79	1.84
February	24.44	2.44	0.13	0.26	0	0.38	0.39	1.74	1.79
March	24.44	2.44	0.13	0.26	0	0.38	0.4	1.75	1.80
April	24.44	2.44	0.13	0.26	0	0.38	0.4	1.76	1.80
May	24.44	2.44	0.13	0.26	0	0.39	0.4	2.36	1.81
June	24.44	2.44	0.14	0.37	0.01	0.52	0.4	2.36	2.42
July	24.44	2.44	0.13	0.37	0.03	0.52	0.53	2.38	2.43
August	24.44	2.44	0.13	0.37	0.03	0.52	0.53	2.37	2.43
September	24.44	2.44	0.14	0.37	0.01	0.52	0.53	2.36	2.42
October	24.44	2.44	0.13	0.26	0	0.38	0.39	1.74	1.79
November	24.44	2.44	0.12	0.26	0	0.38	0.39	1.72	1.77
December	24.44	2.44	0.12	0.26	0	0.38	0.39	1.72	1.77
Annual	24.44	2.44	0.13	0.29	0.01	0.43	0.44	1.95	2.01

13.3 Whitefish River Watershed

The Whitefish River drains an area of approximately 940 km^2, and is bounded to the north by the Vermilion River system, to the south by the La Cloche Range drainage basins and to the southeast by the Wanapitei River system. According to the most recent Permit to Take Water database, there are no current permits in the Whitefish River watershed. There remains the possibility of older removals that precede Permit to Take Water regulation. There are no municipal removals from this watershed. Where municipal water is provided, it is transported from the Vermilion River water treatment plant, which is owned and operated by Vale. According to the MOE Water Well Information System (WWIS), there are 683 recorded wells in the watershed. The majority of these wells (83%) were designated as domestic use.

As noted in Chapter 3, a Tier 1 water budget was done for this watershed, and the results showed a low stress level, so Tier 2 and Tier 3 analyses were not required. A summary of the results of the Tier 1 analysis are provided in this section and the complete report is provided in Appendix 2. Monthly and annual water budget analyses were carried out to evaluate water quantity stress within the watershed. The water budget results are detailed in Table 2.29. Stress assessments were performed for surface water and ground water systems in the watershed separately. Maps 2.18 and 2.19 illustrate the stress level of surface water and groundwater systems for the Whitefish River watershed.

Table 2.29 – Whitefish River watershed water budget

Water Balance Element (mm)											
Month	Rainfall	Snowfall	Snow-melt	Total Input	PET*	AET*	Stream-flow	Base-flow	Runoff	Water Surplus	Water Deficit
January	2.3	61.2	5.8	8.1	0	0	32.8	8.3	24.5	0	-24.7
February	2.9	48.5	13.5	16.4	0	0	26.0	5.5	20.4	0	-9.6
March	20.0	46.7	67.2	87.2	0	0	35.5	9.06	25.9	51.7	0
April	52.0	13.4	129.2	181.2	19.2	19.2	59.3	13.8	45.5	102.7	0
May	80.8	1.0	8.8	89.6	74.5	74.5	40.9	12.4	28.5	0	-25.8
June	77.1	0	0	77.1	110.5	107.6	30.3	9.6	20.6	0	-60.7
July	78.0	0	0	78.0	130.3	115.6	11.7	4.1	7.6	0	-49.4
August	84.9	0	0	84.9	112.7	100.9	0.9	0.6	0.3	0	-16.8
September	106.4	0	0	106.4	69.0	69.0	2.4	1.4	1.0	35.0	0
October	82.3	2.5	2.5	84.8	30.2	30.2	20.2	5.5	14.7	34.4	0
November	45.4	33.3	19	64.4	0.7	0.7	46.0	6.9	39.1	17.7	0
December	9.3	55.5	15.2	24.5	0	0	47.9	8.3	39.7	0	-23.4
Annual Total	641.4	262.1	261.2	902.6	547.1	517.7	353.8	85.8	268.0	241.5	-210.3
Annual Recharge											**31.1**

*PET – Potential Evapotranspiration
**AET – Actual Evapotranspiration

Chapter 14 - Water Quality

The quality of water has become one of the most important political and environmental topics of our time. As water makes its way through the water cycle, it picks up minerals and compounds from the natural and human environment which inevitably impacts its chemical makeup. Generally, the quality of water can determine the safety and palatability of drinking water as well as impact the habitat of aquatic organisms.

This chapter provides a general overview of surface water and groundwater quality in the planning area. Sudbury's history of mining and smelting has created great interest from scientists and academics who study the recovery and reclamation of mining impacted environments. Since reclamation efforts began in the 1970s, there has been a wide range of water quality data collected in the area. The Provincial Water Quality Monitoring Network (PWQMN), the Lake Water Quality Group with the City of Greater Sudbury and the Freshwater Ecology Unit at Laurentian University have collected and stored a large amount of surface water quality data. Preliminary trends in water quality can be determined from their work.

14.1 Sampling Programs

The Provincial Water Quality Monitoring Network (PWQMN) collects surface water quality information from streams at locations across Ontario. The purpose of the PWQMN network is to assess water quality, determine the location and causes of water quality problems and measure the effectiveness of pollution control and water management programs. Information is used by the Ministry of the Environment to evaluate applications for certificates of approval, permits to take water and to develop water quality standards.

The standard set of water quality indicators monitored at each PWQMN station includes chloride, nutrients, suspended solids, trace metals and other general chemistry parameters. Other substances such as pesticides and other contaminants are monitored in detailed water quality surveys in priority watersheds.

A total of 84 stations have historically been monitored within the planning area. Of these 84 stations, two stations are currently monitored. These stations are located along Junction Creek and the Wanapitei River. The data from these two locations were used for both water quality trends over time as well as current water quality of the watershed. The other 82 stations were sampled anywhere from 1 to 31 years, from 1968 to 1999.

Groundwater quality sampling in the Sudbury area has been irregular and there is limited available data for long term trend analysis. Historical groundwater data collection was conducted in the late 70's by the MOE as part of a water resources assessment program. Various wells in the Sudbury area were monitored for parameters relating to drinking water at one point in time.

More recently, the Provincial Groundwater Monitoring Network (PGMN) has been established by the MOE to build a comprehensive groundwater database for Ontario. The NDCA has been operating the PGMN program since 2003 and sampling occurs in the late summer/fall season. Physical, chemical and biological parameters and water levels are measured in each sampling period and results are compiled in a database administered by the MOE. Any exceedances in the Ontario Drinking Water Standard (ODWS) for health related parameters are reported to the Conservation Authorities and designated authorities. As part of this program, five new monitoring wells have been installed in the planning area.

In 2012, the City of Greater Sudbury initiated a groundwater monitoring program for the Valley drinking water system. Twelve wells that had been drilled for various purposes were re-commissioned and two new wells were drilled in 2013. Samples were collected in the 2012 field season and the program is on-going for 2013. The NDCA designed the sampling program with input from various local and provincial groundwater experts and the City of Greater Sudbury. The NDCA is currently managing and delivering this sampling program for the City.

14.2 Indicator Parameters

The planning area intakes and wells are subject to a variety of activities that may have an impact on water quality. Preliminary findings indicate that road salting, urban runoff and mining are the major contributors to changes in local water quality. Three categories of potential contaminants were identified as indicator parameters for the area. These include: 1) sodium and chloride; 2) nutrients and microbial abundance; and 3) metals related to the mining industry and natural deposits.

Sodium and chloride concentrations have been selected to evaluate the impact of road salting to surface water and groundwater quality. Sodium is a common component of road salt and therefore is useful to indicate impacts from road salting. Although the ODWS for sodium is 200 mg/L, the regulations also require that the local Medical Officer of Health be notified when sodium in drinking water exceeds 20 mg/L due to concerns for people on sodium-restricted diets. Chloride is also often used as an indicator parameter for road salt impact as well as municipal landfill leachate impact, as it is a common constituent of municipal landfill leachate and road de-icing agents. In the Canadian Shield region, natural chloride levels are relatively low and therefore elevated chloride levels signal impacts from human activity. High chloride levels in freshwater can also severely impact natural lake cycles and ecosystem dynamics.

Phosphate, nitrate and nitrites are used as indicator parameters to evaluate nutrient loadings from sources such as lawn fertilizers, detergents, domestic sewage or treated wastewater contamination, and decay of plant or animal material. Nitrogen and phosphorus are essential nutrients required for the growth of plants, however in excess can be deleterious to ecosystem health. For example, excess phosphorus in freshwater lakes can cause algae blooms which can lead to poor water clarity and low dissolved oxygen levels.

Several metals have been selected as indicator parameters due to the prevalence of mining activity and natural mineral features in the Sudbury area. The presence of trace metals in the aquatic system is necessary for plant and organism growth, however in excess, some metals have an associated aesthetic or health related concern. Arsenic, nickel, cobalt, copper, and zinc have been selected as indicators for contamination and all have ODWS with the exception of nickel. Because there is no ODWS for nickel, municipal water supplies are not routinely analyzed for nickel. The World Health Organization (WHO) Guidelines for Drinking-water Quality is 0.07 mg/L. The Provincial Drinking Water Quality Objectives (PWQO) for nickel is 0.025mg/L.

The analytical methods used to determine water quality have improved significantly over the past several decades, consequently reducing method detection limits. As such, during the evaluation of water quality trends over time, in particular for the PWQMN stations, this information must be considered. It is possible that some of the apparent decreases in water quality over time may be attributed to improvements in analytical method detection limits.

14.3 Surface Water Quality

Nitrate and nitrite concentrations at both stations were generally low, and below their respective ODWS. Total phosphorus concentrations were often measured at concentrations in excess of the PWQO for the Junction Creek station. Total phosphorus concentrations ranged between 0.002 and 0.098 mg/L at both surface water monitoring stations. Data for the Junction Creek station from 2003 to 2012 ranged from 0.007 to 0.243 mg/L. Sodium and chloride concentrations at the Junction Creek monitoring station ranged from 70 to 119 mg/L and 9.1 to 165 mg/L respectively.

Metals

Metal concentrations have generally been decreasing at most surface water monitoring stations since the 1970s, following the reduction in smelter emissions. Many of the metal parameter concentrations, including nickel, copper and zinc exceeded their respective PWQOs at several of the historical sampling locations. Many of these parameter concentrations were decreasing, and were often measured at concentrations below or approaching their respective PWQO when sampling was discontinued in the 1990's.

Copper concentrations at four of the surface water stations (Ramsey Lake, 2 stations along the Wanapitei River and Junction Creek) generally exceeded their respective PWQO of 0.005 mg/L. Copper concentrations in the Wanapitei River are measured above the PWQO. The highest copper concentrations were measured along Junction Creek, at Kelly Lake. Junction Creek receives runoff from several mine sites as well as urban runoff.

Nickel from the two active PWQMN stations has generally been measured at concentrations above the PWQO, but below the WHO drinking water standard. Concentrations at the Wanapitei station have been in the order of 0.006 mg/L to 0.06 mg/L from 2003 to 2012.

Concentrations of iron exceeding the PWQO occur frequently at many PWQMN sites. Very high concentrations of iron is observed in Emery Creek between 2007 and 2012, concentrations ranging from 331 mg/L to 4270 mg/L were reported. Iron is extremely prevalent in rock forming minerals and elevated iron concentrations are typically associated with elevated suspended solids.

Even though some of the water quality parameters at many sites have exceeded the guidelines, with the limited data available it is very difficult to access the issues and identify their source of contamination. At present there are ten active PWQMN stations within the Vermilion and the Wanapitei River watersheds. In 2007 seven new stations were introduced two old stations on Junction Creek and Wanapitei River were reinstated. A new station on Whitson River was established in 2012. Summary statistics for the nine PWQMN stations are given in Table 2.30.

The Freshwater Ecology Unit has prepared a summary report, entitled the Recovery of Acid and Metal Damaged Lakes near Sudbury, Ontario: Trends and Status (Keller *et al*, 2004). This summary report was prepared for the Sudbury Area Risk Assessment (SARA) Group, as a supporting report for the Ecological Risk Assessment, Sudbury Soils Study that was undertaken in the Sudbury area. This report examines recent trends in the chemistry of Sudbury lakes, providing considerable evidence of continuing chemical and biological recovery as a result of smelter emission reductions. The following is based in large part on this summary report.

Over 7,000 lakes within a 17,000 km^2 area surrounding the Sudbury area have been acidified to pH 6.0 or lower and have elevated concentrations of potentially toxic trace metals as a result of over one hundred years of metal mining and smelting in the Sudbury area. Some lakes within 20 to 30 km of the smelters have been reported as among the most atmospherically-contaminated lakes in the world. However, since emissions of SO_2 and metals were dramatically reduced in the 1970's, and further reduced in the 1990's due to the implementation of the Countdown Acid Rain Program, large improvements in lake water quality have been observed in the Sudbury area.

Dominant trends in the data from annual monitoring of 44 lakes within about 100 km of Sudbury conducted from 1990 to 2002 included increased pH (66% of the lakes), and decreased concentrations of sulphate, calcium and magnesium (98, 95, and 89% of the lakes, respectively). Reductions in metal concentrations were also observed during the 1990's. Copper and nickel concentrations exceeding Ontario's Provincial Water Quality Objectives (PWQOs) are restricted to lakes within about 20 km of Sudbury. Recent lake sediment data showed continuing relationships between metal concentrations in surface sediments and distance from the smelters. Surface sediments were contaminated with copper and nickel in lakes up to 50 km from Sudbury, with concentrations in lakes closest to the smelters far exceeding Ontario sediment quality guidelines of 110 µg/g for copper and 75 µg/g for nickel. Lead concentrations in lake sediments often approached, and in one case exceeded, provincial guidelines. Cobalt and arsenic concentrations exceeded provincial guidelines in several lakes within 20 km of Sudbury.

There have been some remarkable pH recoveries in many of Sudbury's historically acidified lakes, particularly in some lakes closest to the smelters. Although the reasons for these declines in acidity are not clear, it has been suggested that the natural buffering capacity of many Sudbury lakes was relatively high, and was simply overcome by the magnitude of the historical acid load rather than totally exhausted. If this were the case, a rapid rebound might be expected under reduced acid loads. Another possible contributor to the dramatic pH recovery is the stimulation of internal alkalinity-generating processes by abundant nutrient inputs from changing watershed conditions. For example, land liming and tree planting programs have had noticeable effects on the water quality of some lakes.

Overall, there is considerable evidence of chemical recovery in Sudbury's aquatic ecosystems. However, in order to fully understand the direct effects of the most recent emission reductions and develop a more complete understanding of the recovery process, continued monitoring will be essential.

Nutrients

The Lake Water Quality Group with the City of Greater Sudbury has been active in measuring phosphorus concentrations in several area lakes for a number of years. A Lake Water Quality report is released annually, which details the results from the sampling season in select lakes (approximately 45 lakes per year. Annual reports for 2001 through to 2012 show that Bethel, Minnow, Mud and Simon Lakes had phosphorous concentrations in excess of the PWQO of 20 μg/L each year they were sampled. Little Beaver Lake exceeded 20 μg/L seven out of the eight years it was sampled; McCharles seven out of 11 years sampled and Robinson Lake eight out of 11 years sampled.

Phosphorous concentrations in Ramsey Lake were measured at 15.2 μg/L in 2005. Since 1978, a total of 14 water samples have been analyzed for phosphorous in Ramsey Lake. Concentrations have ranged from 7.5 μg/L in 1982 and 1985 to 16.8 μg/L in 2002. Phosphorous concentrations appear to be increasing slightly in Ramsey Lake.

Phosphorous concentrations in Lake Wanapitei have been sampled on 4 occasions from 1981 to 2002. Concentrations have ranged from 3.0 μg/L (1981) to 5.8 μg/L (2002). Although only limited data is available for Lake Wanapitei, total phosphorous concentrations appear to be increasing in Lake Wanapitei, but are below the PWQO of 20 μg/L.

14.4 Groundwater Quality

The PGMN wells were brought online in 2003, however the water quality sampling did not begin until 2006. Water quality samples from these wells are sampled once a year in late summer or early fall. Data trends could not be analyzed due to the lack of long term data. However, the results to date indicate elevated sodium levels in two of the PGMN wells. One well is located in the vicinity of Ramsey Lake, while the other is in the south-west end of the City near Municipal Rd 55. Elevated levels of iron and manganese are also present in these wells, though do not pose a health risk.

Though statistical analysis cannot be performed on this data, some general observations can be made. In several of the wells sampled, elevated sodium levels were observed and ranged from 3-105 mg/L. As well, select wells indicated elevated iron and manganese levels which would not be unusual due to the geology of the region.

Table 2.30 - Summary of Provincial Water Quality Monitoring Network Sampling, page 1 of 2

Para-meter	Statistic	Onaping River	Whitson River	Levey Creek	Vermilion River	Junction Creek	Lily Creek	Wanapitei River	Emery Creek	East Wanapitei	PWQO	ODWS
Chloride (mg/L)	Number	40	40	40	40	60	39	59	35	39	250	250
	Minimum	0.5	0.5	14.7	5	9.1	77.3	1.6	0.6	0.2		
	Maximum	39.6	60.6	379.	122	165	233	17.7	3	1.7		
	25^{th} Percentile	0.9	35.2	17.4	8.5	100	85.6	2	1.1	0.4		
	Median	1.2	41.4	18.2	9.5	118.5	87.9	3	1.6	0.5		
	75^{th} Percentile	1.5	52.7	19.3	11.1	130	92	4.6	2.6	0.8		
	Std. Deviation	6.1	11.6	3.5	17.9	25.8	28.4	2.8	0.8	0.3		
TKN (mg/L)	Number	40	40	40	40	60	39	59	35	39	N/A	N/A
	Minimum	0.17	0.22	0.18	0.24	0.18	0.24	0.21	0.34	0.21		
	Maximum	1.38	2.95	0.73	1.38	5.32	0.97	0.43	1.01	0.56		
	25^{th} Percentile	0.23	0.46	0.34	0.29	0.84	0.29	0.24	0.51	0.3		
	Median	0.27	0.54	0.37	0.32	1.59	0.30	0.26	0.67	0.33		
	75^{th} Percentile	0.29	0.6	0.40	0.34	2.82	0.37	0.30	0.88	0.41		
	Std. Deviation	0.19	0.4	0.10	0.18	1.22	0.16	0.05	0.21	0.08		
Total Phosphorus (mg/L)	Number	40	40	40	40	61	40	59	35	39	0.03	N/A
	Minimum	0.003	0.002	0.005	0.005	0.007	0.002	0.002	0.006	0.002		
	Maximum	0.29	0.8	0.033	0.069	0.243	0.098	0.031	0.056	0.013		
	25^{th} Percentile	0.005	0.016	0.011	0.008	0.03	0.010	0.007	0.016	0.006		
	Median	0.006	0.019	0.014	0.010	0.042	0.012	0.008	0.025	0.008		
	75^{th} Percentile	0.011	0.025	0.018	0.012	0.059	0.023	0.01	0.036	0.011		
	Std. Deviation	0.045	0.124	0.007	0.01	0.038	0.019	0.005	0.012	0.003		

Table 2.30 - Summary of Provincial Water Quality Monitoring Network Sampling, page 2 of 2

Para-meter	Statistic	Onaping River	Whitson River	Levey Creek	Vermilion River	Junction Creek	Lily Creek	Wanapitei River	Emery Creek	East Wanapitei	PWQO	ODWS
Iron (mg/L)	Number	39	40	40	40	60	40	57	35	38	300	0.3
	Minimum	140	76.2	31.7	34.3	54.7	13.6	96	331	82.1		
	Maximum	788	1010	327	399	3160	1420	455	4270	526		
	25^{th} Percentile	245	246	58	95	107	32	127	1010	204		
	Median	348	181	123	165	130	138	199	433	250		
	75^{th} Percentile	424	687	153	245	206	249	187	2380	347		
	Std. Deviation	138	258	69	86	407	287	58	1023	109		
Copper (ug/L)	Number	40	40	40	40	60	40	57	35	39	5	1,000
	Minimum	-4.76	-0.597	3.11	-3.53	3.59	1.51	0.43	-1.61	-2.7		
	Maximum	9.55	13.3	15.4	10.9	80.7	32.3	13.8	28	3.65		
	25^{th} Percentile	0.81	3.29	6.37	2.91	13.8	9.4	3.66	10.36	0.56		
	Median	1.21	4.40	7.57	3.28	19.40	11	4.06	14	1.05		
	75^{th} Percentile	1.57	6.69	9.24	3.67	27.85	11.98	5.33	16.85	1.30		
	Std. Deviation	1.85	2.77	2.52	1.87	13.72	4.92	2.52	6.54	0.96		
Nickel (ug/L)	Number	39	39	39	39	59	39	56	34	38	25	N/A
	Minimum	-3.6	0.86	35.9	3.83	11.2	19.2	6.38	22	-3.53		
	Maximum	21.3	34.1	197	412	477	60.2	59.7	140	2.15		
	25^{th} Percentile	1.1	8.05	49.15	8.29	246	38.70	12.65	50.08	0.26		
	Median	3.94	35.0	36.55	231.5	229	26.10	25.20	1.92	0.92		
	75^{th} Percentile	2.33	20.95	99.40	12.8	338	48.85	24.95	81.08	1.32		
	Std. Deviation	3.48	8.0	40.89	64.38	78.73	8.39	12.07	26.03	1.29		

14.5 Potential Threat Considerations

A number of potential threats to water quality exist that are not listed in the prescribed threats tables developed by MOE and are of concern in the Greater Sudbury Source Protection Area. The Greater Sudbury Source Protection Committee acknowledges the concern that the public may have regarding the following activities.

Motorized Boats, Vehicles and Planes on Ramsey Lake

Ramsey Lake is used for a number of motorized recreational pursuits including boating, fishing and ice-fishing, and supports several private float plane users. For many years, there has been debate over the potential banning of these vehicles on the lake. Today, concern regarding potential spills and waste generation from these activities and how they may impact drinking water quality still exists.

Pet Waste

The shores of Ramsey Lake offer a number of walking trails and beaches where residents can enjoy access to the lake and bring their pets for exercise. People also walk, skate and snowshoe on the lake in the winter with their dogs. Although not listed as a prescribed drinking water threat, pet waste was brought to the attention of the source protection committee by local residents during the completion of this report. Concerns were raised regarding the addition of nutrients and bacteria to the lake as a possible drinking water threat. At this time, there is no information to determine the magnitude of this threat and, therefore, it cannot be properly assessed.

Bird Waste

Ramsey Lake's shores and islands are residence to a variety of geese and gull populations. Droppings from large numbers of birds, potentially causing nutrient enrichment and addition of bacteria to the lake, has been noted as a concern in the community, however it is not included in the prescribed list of threats. Currently, there is no information to suggest that the bird populations in the Ramsey Lake watershed are causing any water quality issues that would threaten the drinking water source.

Mining Related Activities

The Greater Sudbury Source Protection Area has been shaped and transformed by the mining industry over the last century. Mining related activities affect all the drinking water systems in the Greater Sudbury Source Protection Area; however, primarily influence the Ramsey Lake watershed, the Wanapitei River watershed and the Vermilion River watershed. The Ramsey Lake watershed does not contain any direct mining activities within its boundaries; however, the area has historically been impacted by the deposition of air pollutants. The Wanapitei River watershed contains numerous mining related activities throughout the watershed. The Vermilion River watershed has a number of mining related activities within its boundaries, however they are not deemed to be a significant threat under the Technical Rules. Although air emissions and related pollutant releases from the mining industry have improved in recent years, long term effects remain a concern within the community.

Urban/Residential Drainage

Many drinking water systems and associated vulnerable areas are located in urban or residential neighbourhoods. While not identified as a prescribed threat, there are cumulative and various non-point sources of contaminants that could impact the quality of the drinking water at the wells and intakes.

Abandoned Wells, Improperly Constructed Wells and Boreholes

An abandoned well, an improperly constructed well or boreholes can increase the vulnerability of the groundwater resource to contamination. As the Valley drinking water system already has a high vulnerability ranking, a higher ranking cannot be given to reflect the presence of these wells and boreholes. It is known that a number of abandoned, improperly constructed wells and boreholes are present in the Valley, which increases the vulnerability of the groundwater resource to contamination. The presence of abandoned and improperly constructed wells and boreholes pose a concern in the Greater Sudbury Source Protection Area.

Removal of Top Soil

The Valley area consists of relatively deep deposits of soil compared to other areas within the Greater Sudbury Source Protection Area. This deposit of soil provides one of the few potential opportunities for agricultural activity in the region. Top soil removal has become a relatively common practice in the Valley to provide surrounding urban landscapes with adequate soil for lawns and gardens. The removal of soil is not considered a threat in the prescribed list of threats; however, it does increase the vulnerability of groundwater resources to contamination.

Transportation Corridors

A number of transportation corridors, including rail lines and major road arteries, exist within close proximity to many drinking water sources. These corridors do not fall within the MOE prescribed list of drinking water threats. However, the Greater Sudbury Source Protection Committee had concerns with these transportation corridors and requested, under technical rule 114, to have the transportation of specific hazardous substances (sulfuric acid, diesel fuel, and hauled sewage) added as a local threat. More details about the addition of this local threat to the Greater Sudbury Source Protection Area Assessment Report can be found in section 2.3 and within each relevant drinking water section in the tables of drinking water threats.

Contaminants of Emerging Concern

Public interest and concern is increasing regarding the environmental and health-related effects of substances which, historically, have not been monitored or assessed. These contaminants of emerging concern include pharmaceuticals, personal care products, endocrine disruptors, antibiotics and antibacterial agents. The public has expressed concern regarding the implications of these trace contaminants in finished drinking water and the issue has been highlighted in many publications. Justice O'Connor's recommendations in Part Two of the Walkerton Report (2002) include a statement that "water providers must keep up with scientific research on endocrine disrupting substances and disseminate the information."

Pharmaceuticals and personal care products are found where people or animals are treated with medications and where people use personal care products. These contaminants are often found in rivers, streams, lakes and groundwater influenced by wastewater treatment plants.

The Ministry of the Environment completed a survey of emerging contaminants in source water and drinking water directly from treatment systems across Ontario. The samples were collected in 2005 and 2006 from six lake-based water systems and were analyzed for 25 antibiotics, nine hormones, 11 pharmaceuticals and one emerging contaminant. The survey results showed that 15 antibiotics, seven pharmaceuticals and the one emerging contaminant (Bisphenol A) were detected in at least one sample of source water at trace levels (Ministry of the Environment, 2010).

The concentrations measured were below therapeutic level and the estimated, maximum acceptable daily intake for drinking water. The report suggests that an individual would have to drink thousands of glasses of water in a day to reach the maximum daily level for any of the compounds detected. The Ministry of the Environment also showed that five of the compounds were removed with the existing treatment processes.

Chapter 15 - Aquatic Ecology

15.1 Aquatic Habitat

Aquatic ecosystems in the Sudbury region are especially significant given the vast number of lakes, rivers and wetlands that are present in the area. The ecology of lakes, rivers and wetlands determine the biological and chemical dynamics within the watershed and will, in turn, impact the water quality and storage capacity for drinking water sources.

A significant portion of lakes in the planning area have been impacted by mining and smelting activities. Many lakes have been acidified to pH < 6.0, which is the apparent threshold for significant biological damage. Smelter emissions were greatly reduced in the 1970s and dramatic water quality improvements have occurred, but some lakes are still acidic and continue to retain elevated levels of metals ultimately impacting the ecology of aquatic resources (Keller *et al*, 2004).

There has not been a complete inventory of all water bodies in the source protection planning area yet, but within the boundaries of the NDCA jurisdictional area, there are 1,206 identified cold water lakes, 745 warm water lakes, and 71 lakes designated as cool water bodies (GIS database, NDCA). Map 2.22 illustrates the location of cold and warm water habitat with critical spawning areas for brook trout, lake trout and walleye.

15.2 Fish Species

The planning area supports a diverse range of fish communities. At least 38 species have been characterized within the area, although the focus of these studies has been primarily on lake environments. The most recent broad survey of fish was conducted during the summers of 2000 to 2006 when the Co-operative Freshwater Ecology Unit of Laurentian University assessed 35 lakes within the City of Greater Sudbury (CGS, 2006a). A listing of the species commonly encountered during this study that are expected to be found within the wider area is provided in Table 2.31.

Table 2.31 - List of fish species

Blacknose dace (Rhinichthys atralus)	Lake whitefish (Coregonus culpeaformis)
Blacknose shiner (Notropis heterolepis)	Largemouth bass (Micropterus salmoides)
Bluegill (Lepomis macrochirus)	Log perch (Percina caprodes)
Brook stickleback (*Inculea inconstans*)	Mottled sculpin (*Cottus bairdi*)
Bluntnose minnow (*Pimephales notatus*)	Ninespine stickleback (*Pungitius pungitius*)
Brown bullhead (Ameiurus nebulosus)	Northern pike (*Esox lucius*)
Burbot (Lota lota)	Pearl dace (Margariscus margarita)
Central mudminnow (*Umbra limi*)	Pumpkinseed (Lepomis gibbosus)
Lake herring (Coregonus artedi)	Rainbow smelt (*Osmerus mordax*)
Common shiner (*Luxilus cornutus*)	Rock bass (Ambloplites rupestris)
Creek chub (Semotilus atromaculatus)	Slimy sculpin (*Cottus cognatus*)
Emerald shiner (Notropis athernoides)	Smallmouth bass (Micropterus dolomieui)
Fathead minnow (Pimephales promelas)	Splake (brook trout/lake trout hybrid cross)
Finescale dace (Chrosomus neogaeus)	Spoonhead sculpin (*Cottus ricei*)
Golden shiner (Notemigonus ctysoleucas)	Spottail shiner (Notropis hudsonicus)
Iowa darter (Etheostoma exile)	Trout-perch (Percopsis omiscomaycus)
Johnny darter (Etheostoma nigrum)	Walleye (Sander vitreus)
Lake chub (Couesius plumbeus)	White sucker (Catostomus commersoni)
Lake trout (Salvelinus namycush)	Yellow perch (Perca flavescens)

15.3 Macroinvertebrates

Aquatic macroinvertebrates are used as bio-indicators in the scientific community to aid in the assessment of water quality. As a result of their narrow tolerance range for specific environmental characteristics, the prevalence and type of macroinvertebrate indicator species is indicative of certain water quality conditions.

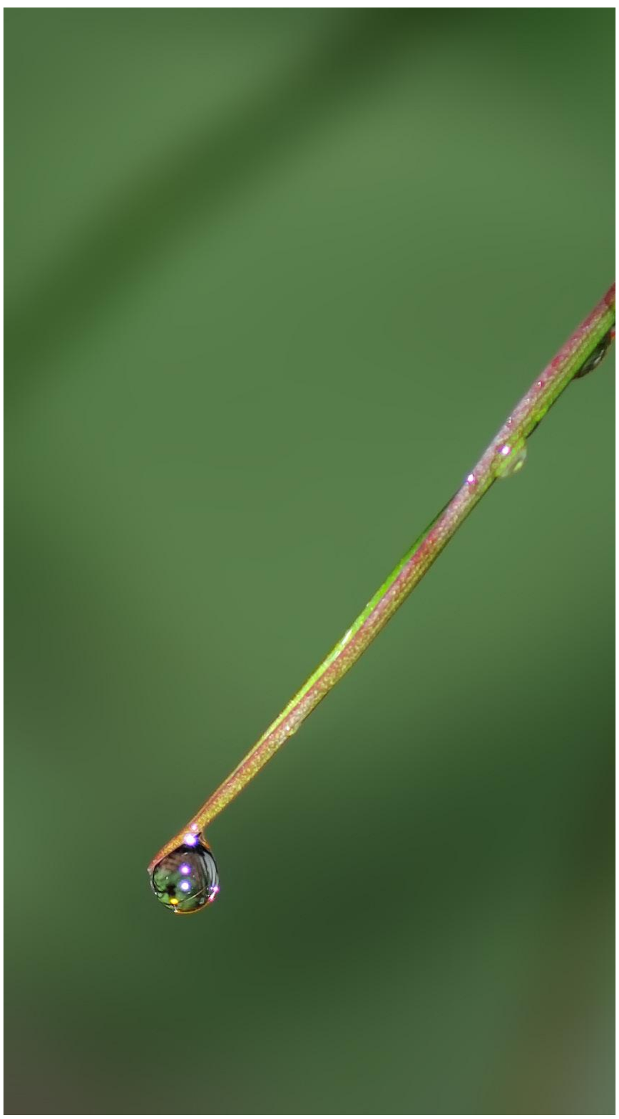
The Ontario Benthos Biomonitoring Network (OBBN), of which the NDCA is not currently a member, has been established to build partnerships and provide information on aquatic ecosystem conditions and evaluate management performance for local decision makers. The OBBN uses a reference-condition approach (RCA) to bioassessment in which samples from reference or minimally impacted sites are used to define the normal range of variation for a variety of indices that summarize biological community composition. Sites where biological health is in question or where there is particular need to address environmental conditions (*i.e.* water quality) can be evaluated by determining whether test site indices fall within the normal range established for minimally impacted sites.

Recent RCA work by the Co-operative Freshwater Ecology Unit at Laurentian University in Sudbury has been initiated within two of the three watersheds (Vermilion River and Wanapitei River). Available data is restricted to a limited number of sites, primarily on Broder Lake (Wanapitei River watershed) and the upper Vermilion River, but is insufficient to draw conclusions from in terms of overall water quality within the planning area.

In general, there are encouraging signs of biological recovery in Sudbury lakes affected by the smelter emissions. A number of acid and/or metal sensitive invertebrate species have recolonized some Sudbury lakes, which appears to be correlated to decreasing metal concentrations. However, despite these signs of recovery, low species richness appears to still be a general characteristic of many Sudbury area lakes, which suggests greater sensitivity of certain species to metals. Even at near-neutral pH, some lakes are lacking several ubiquitous organisms, such as molluscs, amphipods, mayflies and crayfish, that would be expected to thrive in such lakes. Their absence or scarcity may greatly affect the nutrient cycling in Sudbury lakes, which in turn may affect many other indigenous species and lake water quality. The two general factors that appear to be causing the continuing absence of key aquatic organisms from some Sudbury lakes are: inability of these species to reach uninhabited lakes to permit colonization and unsuccessful colonization due to continuing inhospitable conditions (Pearson *et al*, 2002).

Part Three

The David Street Drinking Water System



Situated in the heart of Sudbury, Ramsey Lake is the raw water source for the David Street drinking water system located in the downtown core.

Approved on September 2, 2014

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Chapter 16 - David Street Drinking Water System

Ramsey Lake is the raw water source for the David Street drinking water system located in the downtown core of the City of Sudbury. The intake is considered a Type D intake[1]. Constructed in the late 1800s, the intake was the City's first municipal water supply. The original building still stands and is a historical landmark in the City.

Raw water is drawn from a 1.5 m diameter concrete and stainless steel pipe approximately 300 m from shore. The structure lies 10.5 m below the surface of the lake and 6 m from the lake bottom. A 50 m chlorine solution line, 50 mm raw water sample line and a chlorine diffuser are included inside the pipe.

Ramsey Lake supplies approximately 40% of the City of Sudbury's drinking water. The Wanapitei River supplies the remaining amount and is connected to the Ramsey Lake supply via the Ellis Reservoir. Although the two systems are connected, Ramsey Lake typically services the south, west and downtown areas of Sudbury. Map 3.1 illustrates the distribution system.

Over the years, the treatment system at the David Street Treatment Plant (WTP) has been upgraded many times. In 2002, the system was updated with membrane ultrafiltration. Chlorine, UV irradiation, fluoridation, pH adjustment and polyphosphate are also used.

Pumping rates based on the period between 2000 and 2008 are listed in Table 3.1.

Table 3.1 – Summary of pumping rates for the David Street intake for 2000-2008

	Pumping Rate
Annual Permitted Rate	14,600,000 m^3/year
Maximum annual	9,459,565 m^3 (in 2001)
Average annual	6,345,951 m^3/year
Average monthly	528,829 m^3/month

[1] A Type D intake is described as an intake that does not fit into the description of a Type A, B or C intake. See Rule 55.

Chapter 17 - Ramsey Lake Watershed

Spanning 43 km^2, the Ramsey Lake watershed is situated in the heart of the former City of Sudbury. Within the boundaries of the larger watershed, there are 13 subwatersheds that feed the lake (See Map 3.2). The subwatersheds are small and most do not contain defined tributaries, but rather contribute water through overland flow. Ramsey Lake itself covers 8 km^2 and wetlands cover 1.73 km^2.

The Ramsey Lake watershed, like most areas in the Sudbury region, has been heavily impacted by the proximity of mining activity since the early 1900s. Vegetation and soil cover is sparse, leaving many exposed bedrock areas throughout the watershed. The lake itself managed to escape acidification. This is thought to be attributed to the unique geology of the watershed comprised mainly of gabbro rocks.

The development of the watershed began primarily through the construction of the Canadian Pacific Rail (CPR) line, which traverses across the northern shore of the lake and is evidence of Sudbury's beginnings. The watershed hosts a number of institutions, namely Laurentian University, Science North and Health Science's North Sudbury Algoma Hospital. Ramsey Lake is a central focus for the City, offering a number of recreational and leisure opportunities, including Bell Park, swimming beaches, boating, fishing, skating and snowmobiling.

The lake level is maintained by two main water control structures. The Lake Laurentian dam, located at the outlet of Lake Laurentian, is operated by the Nickel District Conservation. The outlet of Ramsey Lake is controlled by the Ramsey Lake dam, operated by the City of Greater Sudbury. Lake levels are maintained for recreational and water supply purposes.

Chapter 18 - Water Budget and Quantity Risk Assessment

During the initial stages of the water budget assessment, it was determined that little information existed with regards to the overall flow of water within the watershed. Additional field work and measurements were taken in the field seasons of 2006-2009 to begin to develop an improved water budget for the Ramsey Lake watershed. As the development of the water budget progressed, it became evident that a combined Tier 1 and Tier 2 approach was the most appropriate given the amount and type of data available. Following the completion of the Tier 1/2 assessment, it was determined that a Tier 3 assessment was required. The following sections will briefly describe the outcome of these assessments. For a full report on methodology, assumptions and relevant calculations please refer to Appendix 2.

18.1 Tier 1/2 Water Budget

Ramsey Lake Monthly Water Budget

General methodology for the Tier 1 and 2 water budget process is outlined in Chapter 3 and Part III of the Technical Rules. The monthly water budget incorporates a large amount of uncertainty, as a result of a continued lack of detailed knowledge of the outflow volumes from Ramsey Lake or the groundwater contributions. These uncertainties will be discussed in greater detail in the following sections; however the monthly water budget does present the following results:

- The largest losses from the lake are during the spring, when the average lake elevation is greater than the elevation of the top stop log;
- The removals at the David Street Water Treatment Plant are relatively constant throughout the year, and are at the same order of magnitude as estimated lake evaporation; and
- The average surface water supply (precipitation directly on the lake, plus catchment runoff) is exceeded by the removals at the Water Treatment Plant in the winter months (Dec., Jan. and Feb.) when snowpack is building.

The water budget is presented in Table 3.2, and the individual components are discussed in the following sections.

Precipitation and Snowmelt

It was assumed that for this study, the Sudbury Airport climate station was a reasonable long term climate record to represent the Ramsey Lake watershed. Based on the total record length used in this study, (1954-2007), the average annual total precipitation in the Ramsey Lake watershed was calculated to be 902 mm, of which 39% fell as snow. September produced the greatest monthly average rainfall (105 mm), while December and January both provided the maximum average monthly snowfall (57 cm). Approximately 75% of the total snowmelt was estimated to occur during March and April, with the remainder of snowpack losses occurring on warmer winter days along with a minor loss as sublimation.

Lake Evaporation and Sublimation

Lake evaporation was calculated using different methods and the results were compared for consistency. The comparison indicated that using the Thornthwaite heat index method, along with data from the Sudbury Airport, was reliable in estimating the open water evaporation over Ramsey Lake. Evaporation from Ramsey Lake was largest during the summer months (June, July and August), and was minimal during November, a month with low average temperature and little snowpack, leading to low evaporation and sublimation estimates.

Sublimation estimates were below 10 mm per month, with an average annual total of 31 mm. This loss represents 12% of the total average annual snowpack, or approximately 3% of the total available water to the basin. The method adopted does not account for daily radiation, and as such sublimation may be underestimated in late winter, and overestimated in early winter. However, this estimate is considered to be a reasonable estimate of total sublimation, and indicates that it is a minor contributor when compared to other water budget terms.

Streamflow, Lake Level and Runoff

The simulated catchment inflow was dominated by spring snowmelt runoff, and total catchment runoff was estimated to be 505 mm (AMEC 2008). This represents an annual runoff ratio of 56%. In 1988, the MOE estimated total water inflow (as runoff) to the lake as 15 x 106 m^3/year (MOE 1988). This compares well with the AMEC annual surface runoff estimate of 18 x 106 m^3/year.

Actual discharge was calculated by flow meters in the culverts during the months of May through November in 2006, 2007 and 2008, which accounted primarily for the period of time while all stoplogs are in place. Lake discharge as estimated using daily lake level and a sharp-crested weir equation, along with general log operation rules, only allowed for discharge to occur when water level exceeded the stop log elevation. The regional estimate, while temporally representative of a lake outlet, is influenced by inflows from municipal and industrial waste water inputs upstream of Kelly Lake.

As shown in Table 3.2, the modelled and regional discharge estimates were an order of magnitude larger than the other two outflow estimates. For the purposes of this report, all methods of discharge estimation were averaged monthly. These values should be used with the understanding that they represent the best available knowledge at present of the actual lake outflow. Streamflow estimates have a direct affect on the magnitude of the groundwater flux, as the groundwater terms were calculated as a residual from the surface water balance.

Table 3.2 – Discharge estimates for Ramsey Lake outflow

Month	Outflow (m^3)				
	AMEC[1]	Monitored[2]	Estimated[3]	Regional[4]	Present Study[5]
January	191,000	N/A	653,000	2,453,000	1,099,000
February	604,000	N/A	43,000	1,865,000	834,300
March	1,154,000	N/A	45,000	2,486,000	1,228,300
April	6,656,000	N/A	1,151,000	4,722,000	4,176,300
May	2,053,000	162,000	9,000	2,112,000	1,084,000
June	1,399,000	82,000	68,000	1,497,000	761,500
July	742,000	128,000	38,000	1,350,000	564,500
August	206,000	990,000	0	1,371,000	641,800
September	481,000	188,000	0	1,385,000	513,500
October	2,247,000	223,000	0	1,559,000	1,007,300
November	3,312,000	189,000	525,000	1,921,000	1,486,800
December	1,148,000	185,000	440,000	2,385,000	1,039,500
Total	20,193,000	>2,147,000	2,972,000	25,097,000	14,437,000

Notes:

1 AMEC (2008) based on 1974 Hydrograph at Junction Creek at Sudbury gauge station and no stoplogs in outlet

2 Monitored based on monitored discharge July to December 2006, May to July 2007 (by AMEC) and September to October 2008 (by NDCA)

3 Estimated using weir equation, lake level and stoplog operation, 2006 and 2007, no leakage

4 Pro-rated discharge to Ramsey Lake basin from Junction Creek below Kelly Lake streamflow gauge (provisional flows)

5 Average of all methods

Groundwater

During the Tier 1/Tier 2 process, although additional information was collected, it did not provide a definitive method to calculate groundwater flux between Ramsey Lake and the surrounding bedrock and surficial deposits. The NDCA has recently instrumented two groundwater wells in the Ramsey Lake catchment to better understand gradients between the catchment water table and the lake elevation. Generally, gradients exist such that the groundwater table is higher in elevation than the lake water surface (Golder 2005); however, estimates of groundwater inputs to Ramsey Lake are challenged by a limited knowledge of the extent of the surficial deposit at the northeastern shore, and the role of wetlands in providing a source of baseflow to the lake.

For the purposes of this report, groundwater contributions were estimated as the residual in the water budget equation. Using this method, groundwater was estimated to be a net gain to Ramsey Lake of approximately 840,000 m^3/year (Table 3.3).

Anthropogenic Removals

Anthropogenic removals from Ramsey Lake are primarily the water takings for municipal use at the David Street Water Treatment Plant and averaged 6.5 x 10^6 m^3/year over the period 2000-2007, and were assumed to be 100% consumed through cross-catchment transfer. Removals by the additional permits to take water in the catchment or non-municipal water were assumed to be returned to the watershed through septic beds or grounds-keeping infiltration and runoff.

Table 3.3 – Water budget for the Ramsey Lake watershed

	Inputs					Outputs			Residual	Storage		
Month	Rainfall (mm)	Snow-fall (cm)	Snow-melt (mm)	Rain/Snowmelt on Ramsey Lake(m^3)	Runoff from catchment to lake [1](m^3)	Lake Evaporation[2]	Water TreatmentPlant[3](m^3)	Lake Discharge[4] (m^3)	Groundwater [5](m^3)	Lake Elevation (m)	Change in Lake Storage (m^3)	Change in Lake Storage (m^3)
January	9	57	6	113,480	227,000	57,030	544,780	1,099,000	1,332,120	249.31	-28,210	-28,210
February	7	47	11	137,760	64,000	50,900	492,140	834,333	522,950	249.22	-652,660	-652,660
March	25	37	57	614,110	818,000	46,850	552,200	1,228,333	981,710	249.30	586,440	586,440
April	47	16	108	1,168,620	8,088,000	154,970	520,320	4,176,333	-3,297,500	249.45	1,107,500	1,107,500
May	74	2	3	578,460	712,000	564,030	525,270	1,084,000	599,040	249.40	-283,800	-283,800
June	82	0	0	616,060	1,076,000	834,720	570,440	761,500	244,120	249.38	-230,480	-230,480
July	79	0	0	594,500	877,000	977,600	620,270	564,500	76,440	249.30	-614,430	-614,430
August	83	0	0	622,580	476,000	849,760	607,150	641,750	193,590	249.18	-806,490	-806,490
Sept.	105	0	0	790,310	1,773,000	518,880	568,560	513,500	-1,457,850	249.12	-495,480	-495,480
October	76	6	5	612,530	1,780,000	226,290	501,740	1,007,250	-476,190	249.14	181,060	181,060
Nov.	49	31	17	494,110	2,011,000	7,520	491,430	1,486,750	-188,270	249.19	331,140	331,140
Dec.	14	57	13	199,850	7,000	47,820	525,710	1,039,500	2,311,590	249.31	905,410	905,410
Annual	649	253	221	6,542,370	17,909,000	4,336,370	6,520,010	14,436,750	841,750	249.28	0	0

Notes:
[1] Runoff estimated by AMEC (2008)
[2] Evaporation includes sublimation
[3] 2000 - 2007 average removals; more recent removals (2006, 2007) are less than half of 2000 removals
[4] Lake Discharge was estimated as average of all methods used in this study
[5]

Municipal Use

The David Street Water Treatment Plant provides water supply for approximately 40% of Sudbury, mainly in the south, west and downtown areas of Sudbury (CGS 2007). The Water Treatment Plant currently removes approximately 5,000,000 m^3/year, however, there has been a trend towards lower removal volumes as a result of upgrades at the Water Treatment Plant, the construction of the Ellis Street reservoir, and the use of the Wanapitei River Water Treatment Plant. Future municipal demand on the Water Treatment Plant was estimated using the forecasted growth for the City of Greater Sudbury (CGS 2005). Population growth in Greater Sudbury is estimated to be 9% by 2021, and as such a 9% increase in municipal water removal was applied to future water demand scenarios.

Non-Permitted and Rural Use

Residents in the Ramsey Lake watershed not on municipal water are most likely limited to areas of the south and eastern shores of Ramsey Lake, and south of Bethel Lake. These locations are relatively distant from the sewer/water distribution lines, and are areas where corresponding high density of Water Well Information System records were also found. Other residents with waterfront property on Ramsey Lake may utilize private lake intakes. For the purposes of this report, it was assumed that those not on municipal supply were also not on municipal sewers, and as such water removed from the ground or lake would eventually be returned to the lake or groundwater system by septic beds, resulting in negligible net water consumption.

Permit to Take Water

There are two active Permits to Take Water in the Ramsey Lake watershed, both of which are for surface water removals. One permit is for the David Street Water Treatment Plant and another is issued to Science North for aesthetic purposes, which is for a maximum of 50 days per year (Table 3.4). An additional Permit to Take Water will likely be required for the planned upgrade to the Ramsey Lake outlet structure.

Table 3.4 – Permit to take water summary, Ramsey Lake watershed

Source	Purpose	Max Pumping per day (L)	Max Days Pumping per year	Max Hours Pumping per day	Max Pumping per year (m^3)
Surface Water	Aesthetic	130,925	50	2	6,546
Surface Water	Water Supply	40,000,000	365	24	14,600,000

18.2 Tier 1/2 Water Quantity Stress Assessment

General methodology for the Tier 1 and 2 water quantity stress assessment process is outlined in Chapter 3 and Part III of the Technical Rules.

Scenarios A and B – Subwatershed Stress Level Assignment

The water supply term was estimated from the water budget inputs, while the water demand was estimated as the average monthly removals from the David Street Water Treatment Plant. The water reserve was taken as 10% of the inflow to the lake basin.

Monthly stress level assignments for current and future water demand scenarios (Scenarios A and B) are displayed in Table 3.5. The estimated removals approach the calculated inflow to Ramsey Lake in winter, which increases water demand values close to 100%. This is reflected in the lowering of the lake level over those months. However, the lowering of the lake is expected during these months and in fact is part of the operational management of the lake to increase storage for the spring freshet. The watershed was calculated to have a water demand of >50% in February, August and September and, therefore, the Ramsey Lake watershed was assigned a significant stress assessment for the current demand scenario. For the future demand scenario, subwatershed stress level remained as significant, and a maximum monthly stress >50% was calculated for February, August and September.

Table 3.5 – Tier 2 Scenario A and B, monthly water quantity stress level calculations

Month	Water Supply	Current Water Demand	Future Water Demand	Water Reserve	Current Water Demand (%)	Future Water Demand (%)
January	1,672,600	544,780	593,810	167,260	36	39
February	724,710	492,140	536,433	72,471	**75**	**82**
March	2,413,820	552,200	601,898	241,382	25	28
April	5,959,120	520,320	567,149	595,912	10	11
May	1,889,500	525,270	572,544	188,950	31	34
June	1,936,180	570,440	621,780	193,618	33	36
July	1,547,940	620,270	676,094	154,794	45	49
August	1,292,170	607,150	661,794	129,217	**52**	**57**
September	1,105,460	568,560	619,730	110,546	**57**	**62**
October	1,916,340	501,740	546,897	191,634	29	32
November	2,316,840	491,430	535,659	231,684	24	26
December	2,518,440	525,710	573,024	251,844	23	25

Note: Bold numbers indicate significant stress.

Scenarios D to H – Drought Conditions

For a screening-level drought analysis on Ramsey Lake, a two-year time period with the lowest mean annual precipitation was used to estimate lake level. From available data, the time period of 1962–1963 (mean annual precipitation 640 mm) met this criterion. The following assumptions were made as part of this analysis:

- Lake elevation was at 249.37 m (top of stop log) at the onset of the drought;
- Groundwater gains/losses were considered to be negligible over the course of a year;
- Catchment runoff was estimated at 56% of total precipitation, reflective of the long term average in the watershed. This is the average annual runoff percentage as calculated by AMEC (2008); and
- Surface water loss from the outflow structure was estimated as the total long-term discharge from the water budget. This introduced uncertainty that is addressed in the Tier 3 analysis.

The drought scenario was performed under current average pumping conditions and estimated future pumping conditions (a 9% increase in demand). The results of this drought analysis are shown in Table 3.6 and Table 3.7. A maximum lake level decrease of 2.1 m was estimated as possible under the outlined assumptions. The large lake volume is able to minimize the effect of the simulated drought conditions without exposing the intake pipe, which is located approximately 10.5 m below the water surface. This lake level would likely affect recreational activities and public perception of the health of Ramsey Lake, as was the case in the 1987-1988 low water period (see Appendix 2 for details). As there was not an estimated exposure of the intake under the two-year drought scenario, the related ten-year drought scenarios (Scenarios G and H) were not performed. Similarly, drought scenarios involving a planned system (Scenarios F and I) were not performed, as there is no planned system in the watershed.

Table 3.6 – Tier 2 Scenario D, current pumping rates, drought analysis results

Year	Current Average WTP Removal	Annual Input to Lake (Rainfall + Snowmelt + Runoff, m^3)	Total Water Volume Lost from Lake (WTP + evaporation + streamflow, m^3)	Lake volume at end of year (m^3)	Estimated water level at end of year (m)
One	6,520,010	17,912,400	25,293,130	59,619,270	248.5
Two	6,520,010	18,740,400	25,293,130	53,066,540	247.6
Total	13,040,020	36,652,800	50,586,260	53,066,541	247.6

Table 3.7 – Tier 2 Scenario E, future pumping rates, drought analysis results

Year	Future WTP Removal	Annual Input to Lake (Rainfall + Snowmelt + Runoff, m^3)	Total Water Volume Lost from Lake (WTP + evaporation + streamflow, m^3)	Lake volume at end of year (m^3)	Estimated water level at end of year (m)
One	7,106,811	17,912,400	25,879,931	59,032,469	248.4
Two	7,106,811	18,740,400	25,879,931	51,892,938	247.3
Total	14,213,622	36,652,800	51,759,862	51,892,938	247.3

Table 3.8 provides a summary of the stress levels for the Tier 2 water quantity scenarios.

Table 3.8 – Tier 2 Subwatershed stress level scenario summary

Scenario	Description of Scenario	Results and Comments
A	Existing system – average	Maximum monthly water demand > 50%; significant stress level assigned
B	Existing system – Future demand	Maximum monthly water demand >50%; significant stress level assigned
C	Planned system demand – operational year	N/A; no planned system in subwatershed
D	Existing system – two year drought	Maximum estimated lake level drawdown 1.8 m; no intake exposure
E	Existing system – future two year drought	Maximum estimated lake level drawdown 2.1 m; no intake exposure
F	Planned system – operational year – two year drought	N/A; no planned system in subwatershed
G	Existing system – 10 year drought	N/A; exposure of intake not estimated under 2 year scenario
H	Existing system – future 10 year drought	N/A; exposure of intake not estimated under 2 year scenario
I	Planned system – operational year – ten year drought	N/A; no planned system in subwatershed

Water Budget and Stress Assessment Uncertainty

There remains high uncertainty in many components of the Ramsey Lake water budget. The atmospheric exchanges (precipitation, snowmelt, sublimation and evaporation) have been calculated with a more robust methodology and increased accuracy for this study than that done for the initial Tier 1 analysis. Although the surface water inflows were based on mapping of catchment physiography, the results agreed favourably with previous MOE estimates. Surface water outflows, along with groundwater contribution, remain highly uncertain.

Given the very limited amount of data available for the Tier 1/2 analysis, the stress assignment remained high, and it was necessary to proceed to a Tier 3 analysis. The following variables were manipulated to explore the degree of uncertainty and the affect of these on the stress assessment:

- Catchment runoff was decreased by 50% and increased by 50% affecting the water supply;

- The removals at David Street were lowered to the volume removed in 2007 and raised to the volume removed in 2000, affecting the water demand; and
- The additional water calculated as groundwater input was eliminated from the water supply to the lake.

These bulk changes to the water supply and demand altered the number of months that supply was exceeded by demand, but did not change the month that the maximum occurred in, or the maximum stress level assignment to below significant. Therefore, the uncertainty assigned to the stress designation was considered as low.

Significant Groundwater Recharge Areas

Rule 46 of the Technical Rules state that a significant groundwater recharge area shall be delineated based on the models developed for the water budget assessment. The significant groundwater recharge area delineation was refined to reflect the updated information generated from the Tier 2 process. See Chapter 12 for more information about calculating significant groundwater recharge areas.

In the Ramsey Lake subwatershed, the average annual water surplus was estimated at 391 mm. A value of 215 mm (or 55% of 391 mm) was then calculated as the amount of surplus water and available for recharge on an annual basis to aquifers within the subwatershed. The glaciofluvial and glaciolacustrine sediments were designated as significant groundwater recharge areas in the Ramsey Lake watershed. Recharge values greater than 215 mm occur in these areas, and the entire area has a vulnerability score of 6 (high). See Map 3.3.

Tier 1/2 Conclusions

The average annual watershed water budget showed that the total precipitation over the lake area is approximately equal to the average water removals at the David Street Water Treatment Plant, and lake evaporation was also the same order of magnitude as these terms. All estimated water budget terms should be regarded in context of the operational water level data for Ramsey Lake, which shows minimal storage changes in the years studied.

The watershed was assigned a ‘significant’ subwatershed stress level assignment for existing and future water demand scenarios. Therefore, in accordance with provincial guidance, a Tier 3 Water Quantity Risk Assessment for the Ramsey Lake surface water intake was undertaken.

18.3 Tier 3 Water Budget and Local Area Risk Assessment

The Tier Three Water Budget and Local Area Risk Level Assignment was completed using a 2-Dimensional surface water model as outlined in the Technical Bulletin: Part IX Local Area Risk Level, for both existing and future pumping rates. A 2-Dimensional model of the Ramsey Lake watershed was constructed using the Hydrologic Engineering Center Hydrological Modelling System (HEC-HMS v3.3), made available by the United States Army Corps of Engineers (USACE 2009). The scenarios illustrated in the technical bulletin were modeled using hourly climate data over the period 1954-2005.

An enhanced field monitoring program was designed and initiated in March, 2009. Stream water level stations were installed at the inflows to Ramsey Lake and outfitted with automatically logging pressure transducers. These key monitoring locations were located at:

- Lake Laurentian outflow;
- Minnow Lake outflow;
- drainage channel at Greenwood Avenue; and
- drainage channel at Second Avenue and Bancroft Drive.

In addition, at the Ramsey Lake outflow, discharge monitors were placed in each downstream culvert and supplemented with a pressure transducer in Lily Creek immediately downstream of the culverts. Stream water levels at each location were converted to discharge through rating curves created by periodic manual streamflow measurements using a Marsh-McBirney velocity meter and stream cross-section measurements.

The surface water model was fed by the data collected in the field along with the data related to water use and groundwater levels. Details on model inputs are provided in a report found in Appendix 2. The required modelled scenarios produced water levels that did not fall below the elevations that would limit municipal water supply quantities or cause unacceptable impacts to other uses. The uncertainty analysis yielded a 'low' designation, and therefore, the risk level for the Ramsey Lake Local Area was designated as 'low'. Results from the modeling for different scenarios are illustrated below.

Local Area and IPZ-Q Delineation

Additional reports and drawings were obtained from the CGS with regard to construction activity along roadways to the northeast of the Ramsey Lake catchment, in the area of potential connection between the Wanapitei Esker with the Ramsey Lake watershed. Geotechnical investigations and construction details for the Kingsway/Falconbridge Road/Second Avenue intersection describe a generally silty-sand overburden with a shallow water table that appears to slope northward from the topographic high. These boreholes were generally shallow (<5 m) and most did not encounter bedrock. Therefore the thickness of the aquifer remains uncertain in some locations.

This limited information suggests that groundwater from this area is directed northwards. Modelling results did not suggest the presence of a major unaccounted groundwater source. As conclusive evidence was not found of a groundwater connection via the Wanapitei Esker across the topographic boundary of the Ramsey Lake watershed, and following discussions with the Technical Review Committee, the Local Area and IPZ-Q was defined as the watershed boundary (Map 3.4). A focused study would be required to further determine the potential of groundwater influence from outside the catchment boundary.

Preliminary Field Results

Daily average water level recorded at the monitored inflows and at Lily Creek (outflow) are displayed on Figure 3.1. The steep rising and falling limbs on these water level plots are an indication of the fast response in the watershed to precipitation and melt events, as well as responses to operations (stop log procedures) at the Lake Laurentian and Ramsey Lake outfall structures. Of interest is the sharp increases in water level at the northern inflows to Ramsey on July 26, 2009, when approximately 90 mm of rainfall occurred within 1.5 hours (Sajatovic, pers. comm). As shown in Figure 3.1, Lake Laurentian outflow and Ramsey Lake outflow at Lily Creek water level do not display these sharp increases, indicating the isolated nature of the storm as well as the buffering capacity in Ramsey Lake.

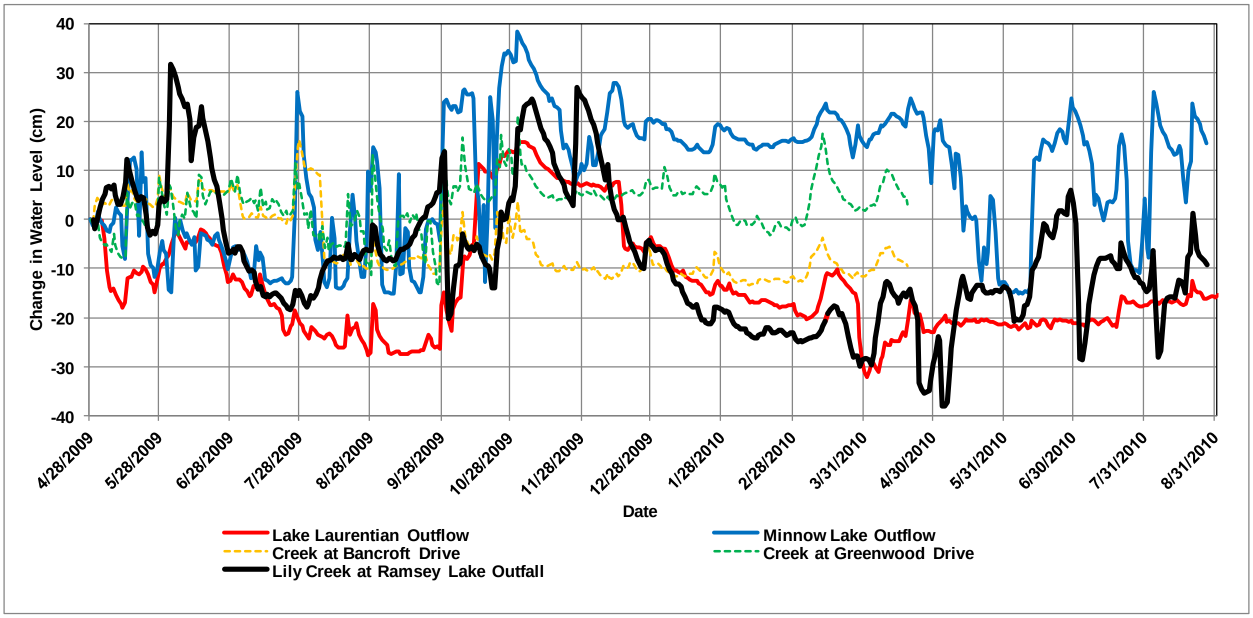
Discharge through the Ramsey Lake outfall to Lily Creek was summarized for a generally 'wet' year (2009) and a 'dry' year (2010). Data collected from the flow meters over the ice-free season of each year displays different flow regimes that reflect the wet and dry conditions, however each year discharge trends towards very low flow or stagnant (zero flow) conditions within the culverts (Figure 3.2). This occurs despite a relatively small range (±40 cm) of water level within the culvert (Figure 3.2). Therefore, the following observations can be made:

1) Discharge over the stoplogs can generate substantial flow through the outfall to Lily Creek.

2) Discharge is quickly reduced with lowering lake levels (presumably once the stoplogs are no longer overtopped and discharge is primarily through stoplog leakage). Total leakage was estimated to average approximately 50L/s.

3) The presence of recorded (and field observed) stagnant water conditions at the culvert outflow suggest that below a certain elevation leakage is negligible. Field observations suggest that negligible leakage can occur during dry periods.

4) Water level in Lily Creek is sustained by either this negligible leakage rate or a backwatering effect from Nephawin Creek (or a combination of both).



Note: Water level change calculated from daily average water level

Figure 3.1 – Recorded water level changes, Ramsey Lake Watershed 2009-2010

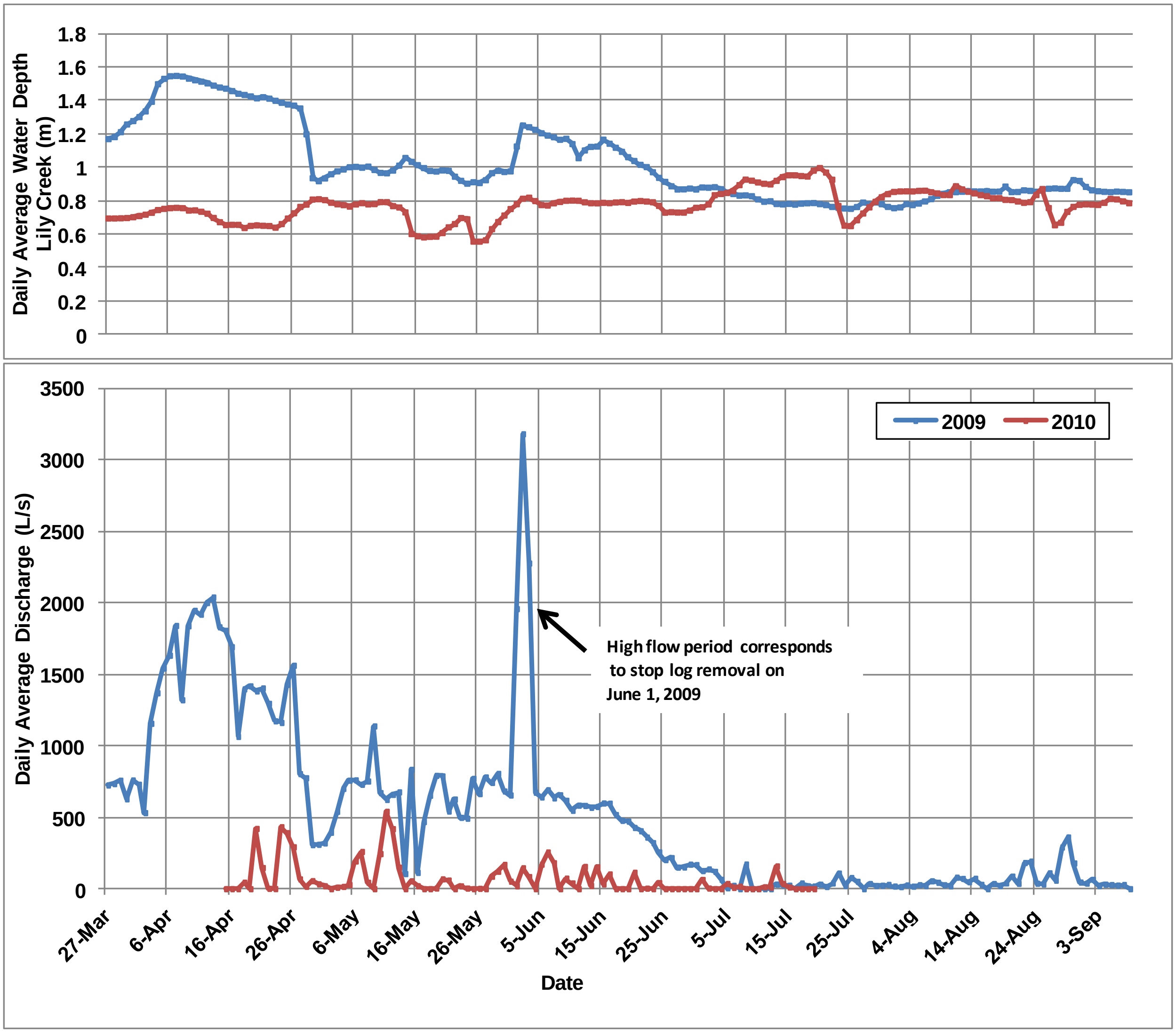


Figure 3.2 – Monitored water level and discharge, Lily Creek 2009-2012

Water Budget

The daily fluxes of water predicted with HEC-HMS and Scenario A were summarized on an annual basis and are presented for the period of 1955 to 2008 in the Tier 3 Water Budget Report, which can be found in Appendix 2. The water budget was dominated by surface flows, and did not require significant groundwater input in order to maintain water levels in the lake over the simulated period of time. This finding was consistent with the Tier One/Tier Two assessment of the watershed. However, the addition of a groundwater component to Ramsey Lake may improve correlation with observed water levels as described in a report found in Appendix 2. The analysis also indicated that the evaporative losses from Ramsey Lake are approximately equal to the municipal water withdrawals, on a monthly average basis.

Modelled Scenarios

Water budget elements for each subwatershed in Ramsey Lake were simulated for each hour within the available long term climate record or drought period. For long-term scenarios, these analyses produced approximately 450,000 data points for each hydrological parameter (including Ramsey Lake water level). As the primary objective of the Tier Three study is to determine the tolerance of the drinking water system, water level data was reduced to a minimum daily water level for display within this report. The daily minimum water level was taken as a conservative daily value that would represent the greatest simulated lake drawdown (i.e. this level would likely be closest to the specified trigger water level elevations).

Scenario A – Long Term Climate, Existing Pumping, Existing Land Cover

Water level was maintained well above the intake for the David St. WTP and did not exhibit periods where the defined exposure level of 248.7 masl was reached. Generally, low water levels occur during winter months, when snowpack is building. This is consistent with findings at the Tier One/Two level where the highest stress occurred under winter conditions with pumping from the lake.

These simulated water levels suggest that the quantity of water removed from the Local Area would be sufficient to meet the existing water demand and peak demand at the intake.

Scenario B – Drought Period, Existing Pumping, Existing Land Cover

For the ten-year drought period (1955 to 1964) and the two-year drought period (1962 to 1963) lake water level was maintained above the intake for the David St. WTP. As with the long-term Scenario A, the lowest simulated water levels occurred during winter months, when snowpack was building.

Scenario B resulted in a predicted minimum lake elevation of 249.02 masl, or approximately 10 m above the WTP intake level of 239 masl.

These simulated water levels suggest that the quantity of water removed from the Local Area would be sufficient to meet the existing water demand and peak demand at the intake.

Scenario E(1) – Long-Term Climate, Existing plus Committed Pumping, Future Land Cover

Similar to Scenario A, simulated minimum daily water level was maintained above the intake for the David St. WTP. Minimum water levels were simulated during winter months, when snowpack is building.

Lake water level did not reach the low water trigger of 248.7 masl, indicating that the lake level would not impact other uses as defined by Rule 99 of the Technical Rules.

These simulated water levels suggest that the quantity of water removed from the Local Area would be sufficient to meet the existing plus committed water demand at the intake, and that the low water levels would not unacceptably affect other uses on Ramsey Lake.

Scenario E(2) – Long-Term Climate, Existing plus Committed Pumping, Existing Land Cover

Simulated water level resultant from existing plus committed pumping rates was above the WTP intake elevation of 239 masl. Additionally, long term simulated minimum water level was on average approximately 50 cm greater than the low water trigger elevation of 248.7 masl, although winter water level occasionally approached 20 cm above this level.

These simulated water levels suggest that the quantity of water removed from the Local Area would be sufficient to meet the existing plus committed water demand at the intake, and that the low water levels would not unacceptably affect other uses on Ramsey Lake.

Scenario E(3) – Long-Term Climate, Existing Pumping Rates, Future Land Cover

Long-term simulated minimum water levels were maintained above the WTP intake elevation and the low water trigger elevation for the modelled time period (1954 to 2005). Simulated water level for Scenario E(3) was similar to Scenario A despite the land cover change, indicating low sensitivity in the basin to planned development in the watershed in terms of water quantity reaching Ramsey Lake.

These simulated water levels suggest that the quantity of water removed from the Local Area would be sufficient to meet the existing water demand at the intake with future planned development changes to watershed characteristics.

Scenario F(1) – Drought Period, Existing plus Committed Pumping, Future Land Cover

Simulated water levels in Ramsey Lake were below 249.0 masl in the 10-year drought and in the 2-year drought scenarios. However, this water level maintains nearly 10 m of freeboard above the WTP intake and as such these results suggest that the Local Area could provide the allocated quantity of water to the intake.

Scenario F(2) – Drought Period, Existing plus Committed Pumping, Existing Land Cover

Simulated Ramsey Lake water levels were maintained above the intake for scenario F(2) for both the 10-year drought and the 2-year drought. As with the corresponding long-term Scenario E(2), the lowest simulated water levels occurred during winter months, when snowpack was building. These results suggest that the Local Area could provide the allocated quantity of water to the intake.

Scenario F(3) – Drought Period, Existing Pumping, Future Land Cover

Scenario F(3) simulated water level was similar to the prior drought condition results. For both the 10-year drought and the 2-year drought, approximately 10 m of freeboard remained between the winter drawdown lake level and the WTP intake elevation. This suggests that under these conditions the Local Area could provide the allocated quantity of water to the intake.

Scenario X(1) – Drought Period, Rated Capacity Pumping, Existing Land Cover

Scenario X(1) was completed as a ‘worst case’ combination of drought climate and increased pumping at the David St. WTP. The results of this simulation show water level that falls to the low water trigger during the winter months in both the 10-year drought and in the 2-year drought. However, the WTP intake elevation remains approximately 10 m below the lowest lake drawdown elevation.

Scenario X(2) – Drought Period, Rated Capacity Pumping, Future Land Cover

Scenario X(2) was completed to investigate the combination of drought climate and increased pumping from Scenario X(1)while incorporating land cover changes within the watershed at the David St. WTP. The results of this simulation indicated little to no difference in simulated water level from the X(1) Scenario under the 10-year drought and in the 2-year drought. For this Scenario, the WTP intake elevation remains approximately 10 m below the lowest lake drawdown elevation.

Results Summary, Tolerance and Preliminary Risk Assignment

Simulated Ramsey Lake water levels were consistently above the defined trigger elevations for the required Scenarios. Changes to land cover, municipal demand and climate affected the absolute magnitude of water level, however the lake dynamics remained similar and the largest drawdowns were noted during winter months, a time period where municipal demand exceeded watershed runoff. Lake drawdown during winter months remains an operational target for the CGS as well; this assists in creating storage for anticipated spring freshet without unacceptable high water levels on the populated lake or large spring discharge downstream through Lily Creek which may create unwanted high water levels for residents.

Along with these simulated water levels, operational evidence suggests that Ramsey Lake is able to meet peak demand. Recent pumping records (2006 to 2008) indicated that the David St WTP has pumped at less than 35% of its permitted rate, and the interconnected Wanapitei River WTP has pumped at up to 62% of its permitted rate over the same period. Although the rated capacity of these WTPs is less than the permitted rates, the additional pumping available at these treatment plants as well as the storage availability at the Ellis Reservoir are indications of the ability of the system to deliver during peak demand periods, which are typically on time scales of one week or less.

Increasing pumping rates to the rated capacity for a period of ten years resulted in regular lowering of the lake level to the defined low water trigger elevation, again during the winter months. This provides an indication that additional pumping may be possible to meet additional municipal water demands on the system.

Table 3.9 provides a summary of Scenarios and designated preliminary risk assignments.

Table 3.9 – Tier 3 risk level summary

Scenario	Municipal Demand	Land Cover	Triggers	Tolerance	Risk
A (long-term)	Existing	Existing	WTP Intake	High	Low
B (drought)	Existing	Existing	WTP Intake	High	Low
E(1) (long-term)	Existing + Committed	Future	WTP Intake; Low Water for other uses	NA	Low
E (2) (long-term)	Existing + Committed	Existing	WTP Intake; Low Water for other uses	NA	Low
E(3) (long-term)	Existing	Future	WTP Intake	NA	Low
F(1) (drought)	Existing + Committed	Future	WTP Intake	NA	Low
F(2) (drought)	Existing + Committed	Existing	WTP Intake	NA	Low
F(3) (drought)	Existing	Future	WTP Intake	NA	Low

Based on these results, a preliminary risk level assignment of 'low' was assigned to the Local Area, subject to the Uncertainty Analysis.

Uncertainty and Sensitivity Analysis

Uncertainty and Sensitivity Analysis was addressed through the following procedures during the course of this project.

1) Hourly Climate Data: Data provided by Environment Canada and the MNR were checked for data gaps. Where possible, data were summarized and extrapolated to better fit the required time period (Section 3.2.3). The use of Ottawa radiation data is a known limitation in the dataset, but provided an adequate comparison to available sunlight data from Sudbury.

2) Water Level and Discharge Simulations: Calibration was limited to available Ramsey Lake level data and downstream regional discharge for the period 2000 to 2005. Although the statistical correlations for simulated vs. observed data were <0.7, the temporal trends in rising and falling limbs on the hydrographs and lake level plots were similar and provided confidence in the long-term ability of the model to reproduce Ramsey Lake dynamics.

3) Scenario Results: Where possible, Ramsey Lake water levels produced in the simulations were checked against recorded observations. For example, consideration was given to the known low lake Ramsey Lake water level that occurred during the mid to late 1980s. During 1986 through 1988, the elevation of Ramsey Lake fell to below 248.0 masl (Golder 2009a), and this period of low water level was not replicated by the model. This result was not unexpected for the following reasons:

    a) As per the Technical Rules, long-term modelled pumping rates were reflective of existing (2007) or existing plus committed pumping rates for that period (Golder 2009a).

    b) Operational strategies (i.e. stop log insertion and removal dates) for the Ramsey Lake outfall were not available for the interval in question, and could not be explicitly incorporated in the model set-up.

A more period-specific study would be required to simulate this 1980s period, however, it is worth recognizing that extended periods of water levels below the optimal operating levels have occurred in the past on Ramsey Lake.

The sensitivity of the model was inherent in the Scenarios and the results produced. Specifically, the changes predicted through increasing development (and decreasing permeability) had a minimal effect on the simulated lake level. This is likely due to the dominance of bedrock and runoff dominated surfaces that are currently present in the watershed.

Increasing pumping rates had a greater effect on the drawdown of the lake, and the X(1) and X(2) Scenarios display this most effectively; sustained increases in pumping rates to the rated WTP capacity caused drawdown to the low water trigger elevation during the winter months. The rated capacity pumping is approximately 30% greater than the currently estimated existing plus committed demand for the watershed.

Although model performance could be improved through increased data collection, these uncertainty and sensitivity analyses show that confidence can be placed in the assessments of tolerance and risk. As such, the uncertainty for the current study can be considered 'low'.

Risk Level Assignment

The results as summarized in Table 3.9 indicated that simulated water levels produced a tolerance of 'high' for Scenarios A and B and a risk level of 'low' for each of the other required modelled Scenarios. Additionally, the Uncertainty and Sensitivity Analysis provided justification for a 'low' level of uncertainty in the modelling exercise. Therefore, the risk level assigned to the Ramsey Lake Local Area was 'low'.

Significant Groundwater Recharge Areas

For the Tier Three analysis, Significant Groundwater Recharge Areas (SGRA) were reviewed from the Tier One/Two delineations. The Local Area and IPZ-Q were defined as the Ramsey Lake watershed in the Tier Three project. As such, the methods, delineations, and vulnerability scoring provided in section 18.2 and shown on Map 3.3 remain valid.

Tier 3 Conclusion

The additional field data collected for the Tier 3 analysis was fed to the 2-Dimensional surface water model. The model simulated water level for different scenarios using the approach set out in the Technical Bulletin: Part IX Local Area Risk Level, for both existing and future pumping rates. The required modelled scenarios produced water levels that did not fall below the elevations that would limit municipal water supply quantities or cause unacceptable impacts to other uses. The uncertainty analysis yielded a 'low' designation, and therefore, the risk level for the Ramsey Lake Local Area was designated as 'low'.

Chapter 19 - Ramsey Lake Water Quality Risk Assessment

19.1 Ramsey Lake Intake Protection Zones

Chapter 2 and Part VI of the Technical Rules explain the delineation methodology for the intake protection zones.

Intake Protection Zone 1

For Type D intakes, the intake protection zone 1 (IPZ-1) is prescribed to be a circle with a 1 km radius centred on the intake. The centre point of the circle is the point of entry of the raw water. Where the circle abuts land, a 120 m setback from the high water mark is applied (Rule 61).

Map 3.5 illustrates the IPZ-1 for the David Street intake. The resultant IPZ-1 for Ramsey Lake covers most of the western bay of the lake and part of the Bethel Peninsula. There was considerable discussion amongst the technical team regarding the applicability of using a 1 km radius to determine the IPZ-1 in Ramsey Lake. The IPZ-1 boundary is drawn within metres of one section of the south shore, but does not capture the entire south shoreline. The technical team considered expanding the IPZ-1 to include the south shore, however, little information was available to support the extension of this zone. A synopsis of the points of discussion is described in the next section under intake protection zone 2. It was determined that until further supporting information is gathered, the delineation of IPZ-1 should remain as a 1 km radius.

Intake Protection Zone 2

Intake protection zone 2 (IPZ-2) is based on the time that is sufficient for a water treatment plant operator to respond to an adverse water quality condition (Rule 65). The time of travel is required to be a minimum time of two hours to the intake (Rule 66).

In order to determine the distance traveled related to time of travel in a lake, knowledge of the dynamics of the movement of water through the lake is required. Measurement of currents is complex as they are based on lake bathymetry, stratification, wind speed and direction, chemistry, temperature, shape, orientation, and inflows and outflows of the lake. Currents will vary widely between different lakes and will often be determined by the time of year and wind conditions.

Ramsey Lake is a relatively complicated lake to model current velocities. The lake is oriented east to west, is populated by a number of islands and has numerous small bays carved into the shoreline. The lake has a natural division between the eastern and western portions of the lake where the lake narrows from the Bethel Peninsula jutting out into its waters. The western bay, where the intake is located, is characterized by deeper waters, while the eastern portion of the lake consists of relatively shallow, warmer waters.

There have been two studies that have attempted to characterize the currents in Ramsey Lake. The first, a master's thesis completed at Laurentian University by Francois Prevost, used a fluid dynamics software, Fluent, to model the circulation in the lake and was completed in 2005 (Prevost, 2005). The second was conducted by AMEC and ASI as part of the source protection technical studies completed in 2006. The study installed current meters at two locations in the lake during the ice free months of 2006 and deployed drogues at three locations during two sampling events throughout the year. See Appendix 2 for both reports (Multi-Dimensional System Modelling in the Anthropogenically Impacted Watershed of Ramsey Lake; Francois Prevost, 2005; and the Intake Characterization, Determination of Intake Protection Zones, and Assigned Vulnerability Scores for Ramsey Lake Intake within The City of Greater Sudbury; AMEC 2008).

Both studies offer some information and insight into the velocity of water movement in the lake; however neither of them was specific to determining if the IPZ-1 and 2 were appropriate delineations of the lake. After much deliberation amongst the technical team, it was agreed that the drogue studies completed in 2006 provided the best information available to determine a 2 hour time of travel. Based on these studies, the maximum observed current velocity of 0.06 m/s would result in a distance of 432 m in 2 hours. More details on this methodology can be found in the 2008 AMEC Report on Ramsey Lake in Appendix 2.

A 2 hour time of travel with a distance of 432 m is smaller than the limit of IPZ-1. Therefore, following Technical Rules 65 and 66, there is no IPZ-2 in Ramsey Lake, but there is an IPZ-2 delineated on land adjacent to the lake because of transport pathways. IPZ-2 includes all the stormwater drains and the area within the storm sewershed adjacent to IPZ-1, as shown on Map 3.6. There is a high degree of uncertainty with this delineation which is discussed further in the vulnerable area delineation uncertainty section below. It is strongly recommended that this be studied in greater detail in order to delineate an appropriate protection zone for Ramsey Lake.

Intake Protection Zone 3

The delineation of the intake protection zone 3 includes the area within each surface water body that may contribute water to the intake and a 120 m setback from the high water mark. Transport pathways may also be included as stated in Rule 70.

The IPZ-3 for Ramsey Lake is illustrated on Map 3.7. It covers all contributing tributaries and storm sewers in the watershed. A 120 m setback was applied to all water bodies and storm sewers. Storm drains in the eastern portion of the watershed are primarily in the form of ditches along road ways and therefore the protection zone included a 120 m setback from the road network.

Vulnerable Area Delineation Uncertainty

As required by Rule 108, an uncertainty analysis of the delineation of intake protection zones and vulnerability scoring are presented in Table 3.10.

Table 3.10 – Summary of intake protection zone delineation uncertainty

IPZ	Level of Uncertainty	Comments
IPZ-1	High	As commented in the Technical Experts Committee Report to the Minister of Environment[1], Recommendation #39 states that the 1 km delineation should be replaced in subsequent planning cycles with a science based approach. Therefore, there is a high degree of uncertainty at this time regarding the applicability of a 1 km zone within Ramsey Lake.
IPZ-2	High	Urban development and bedrock are the dominant land use and land cover within IPZ-2. This storm sewershed has a small drainage area and has little attenuation capacity. The storm water from the entire sewershed drains directly into IPZ-1. The very high uncertainty associated with the storm sewer flow data makes the delineation of IPZ-2 highly uncertain.
IPZ-3	High	IPZ-3 begins at the end of IPZ-1 and 2 (delineations of IPZ-1, 2 and 3 are interdependent) and therefore also has a high uncertainty due to the uncertainty in those protection zones. Storm drains are also poorly mapped in the eastern part of the watershed and therefore a high degree of uncertainty exists in the delineation of the IPZ-3 in this area.

1 Technical Experts Committee Report to the Minister of Environment (Science-based Decision-making for protecting Ontario's Drinking Water Resources, November 2004)

19.2 Vulnerable Area Scoring

For surface water intakes, source and area vulnerability factors are given to determine an overall vulnerability score. The factors for Ramsey Lake are described below.

Source Vulnerability Factor

The Source Vulnerability Factor options for a Type D intake are 0.8, 0.9 or 1.0. A source vulnerability factor of 1.0 was given for Ramsey Lake due to the following reasons:

- The intake is only 300 m from shore;
- The Water Treatment Plant has experienced past water quality issues related to iron and manganese from bottom sediments; and
- The intake was raised by 3 m due to high magnesium levels in the thermocline

Area Vulnerability Factor

The area vulnerability factor is based on the percentage of the protection area covered by land, land cover, soil type, permeability of the land and the slope of any setbacks, the hydrological and hydrogeological conditions of any transport pathway, and the proximity to the intake (Rule 92).

An area vulnerability factor for Ramsey Lake was given to each subwatershed as each subwatershed is relatively small and mainly consists of overland flow to the lake. The factor was primarily based on land cover and permeability of the land. Proximity to the intake was not weighted as heavily as the land cover and permeability of the land, due to the relatively long retention time in the lake. The majority of the Ramsey Lake watershed is covered in bedrock and therefore has little infiltration capacity to attenuate contaminant runoff. Many of the tributaries into the lake are intermittent in nature and respond quickly to storm events. A summary of the vulnerability scores given are described in the next section.

Summary of Vulnerability Scores

Table 3.11 summarizes the vulnerability scoring and rationale given to each subwatershed for the Ramsey Lake vulnerable areas.

Table 3.11 – Summary of Ramsey Lake intake protection zones and vulnerability scores

Intake Protection Zone	Source Vulnerability Factor	Area Vulnerability Factor	Vulnerability Score	Comments
IPZ-1	1.0	10	10	This score is fixed (Rule 88).
IPZ-2	1.0	9	9	Urban development and bedrock are the dominant land use and land cover in these subwatersheds. All subwatersheds have small drainage areas and have little attenuation capacity.
IPZ-3 Minnow Lake	1.0	9	9	
IPZ-3 Moonlight Beach	1.0	9	9	
IPZ-3 North Shore	1.0	9	9	
IPZ-3 Frobisher	1.0	9	9	

IPZ-3 South Shore	1.0	9	9	
IPZ-3 Frenchman's Bay	1.0	9	9	
IPZ-3 Bethel Lake Peninsula	1.0	9	9	
IPZ-3 West South Bay	1.0	9	9	
IPZ-3 Bethel Lake	1.0	9	9	
IPZ-3 Lake Laurentian	1.0	6	6	These subwatersheds are mostly covered by wetlands and lakes and therefore have a high capacity for attenuation of contaminants.
IPZ-3 Laurentian Wetland	1.0	6	6	

Vulnerable Area Scoring Uncertainty

Uncertainty surrounding the vulnerable area scoring assignment is based on the ability for the vulnerability factors to effectively assess the relative vulnerability of the hydrological features. The vulnerability scores for the Ramsey Lake intake protection zones were primarily based on land cover within the watershed and the use of professional judgment. They are shown in Table 3.12.

Table 3.12 – Uncertainty analysis for the vulnerable area scoring

	Uncertainty	Comments
Source Vulnerability Factor	Low	As the source vulnerability factor has been scored conservatively, there is high confidence that the factor will address any concerns to the intake.
Area Vulnerability Factor – Score of 9	Low	IPZ-2 and IPZ-3 have been scored conservatively in the urban areas and therefore there is a high degree of confidence that the value given will protect the intake.
Area Vulnerability Factor – Score of 6	High	The IPZ-3 in the wetland areas has been given a moderate score. A high degree of uncertainty exists as it is unknown if a moderate score is sufficient to protect the intake from contamination.

19.3 Ramsey Lake Drinking Water Quality Threats Activities

The assessment of potential threats to drinking water quality followed Technical Rules 118 to 125 and the methodology as outlined in Chapter 2. The list of prescribed drinking water threats is located in Table 1.7 in Part 1 of this report.

List of circumstances of all is or would be threats

As required under O.Reg. 287/07 subsection 13, a list of references for all is or would be significant, moderate or low threats in each vulnerable area is listed in Table 3.13. Tables listing is or would be threats can be found in Appendix 5.

Table 3.13 – Table references for all is or would be threats and associated circumstances in the Ramsey Lake intake protection zones

Score	Significant	Moderate	Low
10	CIPZ10S- Chemicals in an IPZ with a vulnerability of 10 where threats are significant PIPZ10S- Pathogens in an IPZ with a vulnerability of 10 where threats are significant	CIPZ10M - Chemicals in an IPZ with a vulnerability of 10 where threats are moderate PIPZ10M - Pathogens in an IPZ with a vulnerability of 10 where threats are moderate	CIPZWE10L - Chemicals in an IPZ with a vulnerability of 10 where threats are low PIPZ10L- Pathogens in an IPZ with a vulnerability of 10 where threats are low
9	CIPZWE9S- Chemicals in an IPZ or WHPA E where the vulnerability score is 9 where threats are significant PIPZWE9S - Pathogens in an IPZ or WHPA E with a vulnerability of 9 where threats are significant	CIPZWE9M - Chemicals in an IPZ or WHPA E where the vulnerability score is 9 where threats are moderate PIPZWE9M - Pathogens in an IPZ or WHPA E with a vulnerability of 9 where threats are moderate	CIPZWE9L - Chemicals in an IPZ or WHPA E where the vulnerability score is 9 where threats are low PIPZWE9L - Pathogens in an IPZ or WHPA E with a vulnerability of 9 where threats are low
6	N/A	CIPZWE6M - Chemicals in an IPZ or WHPA E where the vulnerability score is 6 where threats are moderate PIPZ6M - Pathogens in an IPZ with a vulnerability of 6 where threats are moderate	CIPZWE6L - Chemicals in an IPZ or WHPA E where the vulnerability score is 6 where threats are low PIPZ6L - Pathogens in an IPZ with a vulnerability of 6 where threats are low

Identification of areas where threats can occur

The areas where a potential threat is or would be significant, moderate or low are illustrated on Maps 3.5 to 3.7. According to the Technical Rules:

- Areas with a vulnerability score of 8 or greater can have the potential for a significant, moderate or low threat.
- Areas with a vulnerability score of 6 or greater can have the potential for a moderate or low threat to occur.
- Areas with a vulnerability score of 4 or greater can have the potential for a low threat to occur.
- Areas with a vulnerability score of less than 4 cannot contain a drinking water threat.

Managed Lands

The storage, handling and application of agricultural source material, non-agricultural source material, pesticides and fertilizers can result in potential contamination of municipal water supplies. The methodology used to calculate percentage of managed lands in the vulnerable areas is described in Chapter 2. The percentage of managed lands in the area was assessed to be between 40 and 80% (moderate) and is illustrated on Map 3.8.

Impervious Surfaces

Impervious surfaces are measured as an indicator of the amount of area where road salt can be applied. The percentage of surface area within a vulnerable area which will not allow surface water or precipitation to be absorbed into the soil is measured. As a small urban watershed, most of the land area within the watershed is impervious, with the large majority of this area being in the range of 8-<80%, followed by the next greatest amount of area in the 1-<8% range, and a little less area in the <1% range. The percentage of impervious area is illustrated on Map 3.9. The calculation of impervious surface led to the vulnerable area being designated as a significant threat or a moderate threat for the application of road salt depending on the vulnerability score.

The methodology used to calculate percentage of impervious surfaces in the vulnerable areas is described in Chapter 2.

Livestock Density

The calculation of livestock density is based on the calculation of nutrient units per acre of agricultural managed lands. The methodology used to calculate the livestock density in the vulnerable areas is described in Chapter 2.

In the Ramsey Lake intake protection zones, there are no agricultural lands and the area has a score of under 0.5 nutrient units per acre. The results are illustrated on Map 3.10.

Enumeration of Significant Drinking Water Threats

Table 3.14 lists the current number of significant drinking water threat activities in the Ramsey Lake vulnerable areas in accordance with Rule 9 and the Drinking Water Threats Tables.

Table 3.14 – Drinking water quality threat activities for the Ramsey Lake intake

Drinking Water Threat Category	Number of Occurrences with Threat Classification		
	Significant	Moderate	Low
IPZ-1 – Vulnerability score of 10			
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.*	1		
The application of commercial fertilizer to land.*	1		
The handling and storage of fuel.		1	
The application of road salt.*	1		
Local threat: Transportation of hazardous substances along transportation corridors.	1	1	
IPZ-2 – Vulnerability score of 9			
The application of commercial fertilizer to land.*	1		
The application of road salt.*		1	
Local threat: Transportation of hazardous substances along transportation corridors.	1	3	
IPZ-3 - Subwatersheds with a vulnerability score of 9			
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act.	2		
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.*	1		8
The application of commercial fertilizer to land.*	1		
The application of road salt.*		1	
The storage of snow.		1	
The handling and storage of fuel.		7	
The handling and storage of a dense non-aqueous phase liquid.		16	
The handling and storage of an organic solvent.		19	1
Local threat: Transportation of hazardous substances along transportation corridors.	1	2	
IPZ-3 - Subwatersheds with a vulnerability score of 6			
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.*			
The application of commercial fertilizer to land.*		1	
The application of road salt.*			1
Local threat: Transportation of hazardous substances along transportation corridors.		2	1

* Note that there are additional threats in certain categories that have been identified as significant threats using the issues method. These are listed in Table 3.17 – Drinking water quality issues and associated threats for the Ramsey Lake intake.

19.4 Ramsey Lake Drinking Water Quality Threats Conditions

A drinking water condition is a situation that results from a past activity and meets the criteria laid out in Chapter 2 and Rule 126. For a more detailed review of methodology for identifying drinking water conditions, please refer to Part 1, Chapter 2. The areas where a significant, moderate or low condition could exist are the same for the locations where a potential threat could occur. For an illustration, please see Map 3.5 to 3.7.

Currently, there are no known conditions within the Ramsey Lake vulnerable areas.

19.5 Ramsey Lake Drinking Water Quality Issues

Sodium

Raw (or pre-treated) water quality from 1991 to 2007 was studied to determine if any water quality issues exist. Data retrieved from the Drinking Water Surveillance Program conducted by the Ministry of the Environment (MOE) was used in the analysis. Trend analyses were updated to February 2013 for the 2013 amendment of the assessment report.

An elevated and rising level of sodium is of concern in Ramsey Lake and is considered to be a drinking water quality issue for this intake. The Ontario Drinking Water Standard for sodium is 200 mg/L, however if sodium exceeds 20 mg/L the local medical officer of health must be notified so that it may be passed on to local physicians. Chloride levels in Ramsey Lake have been consistently above 50 mg/L in recent years and they appear to be increasing. Figure 3.3 depicts the increasing trend from 1991 to 2013.

Elevated levels of sodium are primarily attributed to the application of road salt. The Ramsey Lake watershed is highly urbanized and consists of a number of major roadways where road salt is applied during winter months. The watershed also includes a public works yard with road salting facilities that store road salt and sand-salt mixtures throughout the year. Road salt can be considered a non-point source pollutant and, therefore, the entire vulnerable area for Ramsey Lake is considered the issue contributing area. Note that in the future, when the assessment report is updated, new developments will become part of the vulnerable area and the issue contributing area. In the meantime, the source protection committee is aware that the discharge point of a pipe from a new stormwater management system into an existing intake protection zone / issue contributing area is a significant drinking water threat, therefore the stormwater discharge points from these new developments are subject to policies for stormwater and sodium.
The issues contributing area is delineated on Map 3.11.

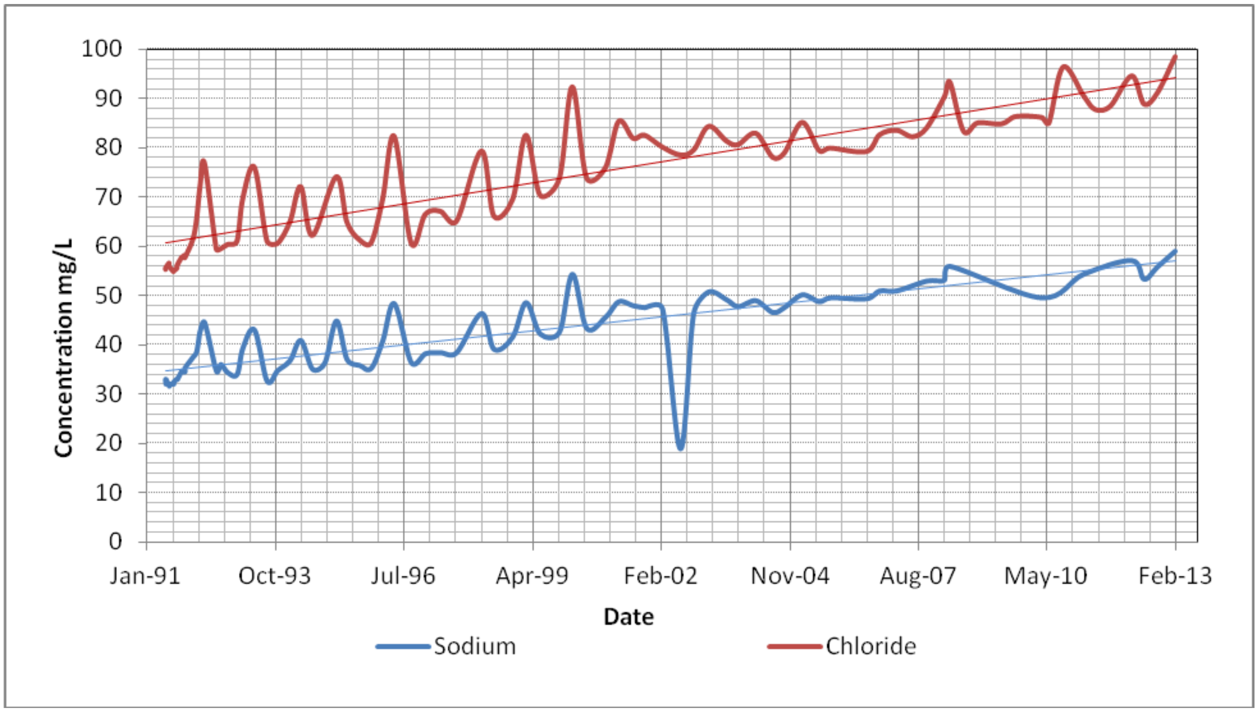


Figure 3.3 – Sodium and chloride levels in Ramsey Lake from 1991 to 2013

Microcystin LR

Cyanobacteria, more commonly known as blue green algae, are ubiquitous bacteria that live in fresh and saline water environments. Some species of cyanobacteria produce a toxin within their cells, which is released after the cell dies. The information surrounding the environmental conditions contributing to the presence of toxins and algae blooms is building in scientific literature, however much is still unknown.

Ramsey Lake has been subject to cyanobacterial blooms historically and relatively recently. In the mid-1960s, algae covered the lake and taste and odour issues were identified in the drinking water supply. Copper sulphate was used to mitigate the blooms and keep the algal growth to a minimum. More recently, a small localized bloom was confirmed in a small bay near South Bay in the fall of 2008, and in the summer of 2010, a bloom was confirmed near the Sudbury Canoe Club. Two blooms were also confirmed in late July 2011, that were located in the South Bay area and the Bell Park area. In 2012 blooms were observed in area surrounding the Sudbury Canoe Club and tested positive for Microcystin LR.

In response to the 2008 bloom, an ad hoc committee was formed with members of the City of Greater Sudbury, Sudbury & District Health Unit, the Ministry of the Environment and the Nickel District Conservation Authority. This group was spearheaded by the City's Water/Wastewater Services department to help ensure that the drinking water quality of Ramsey Lake would be protected from a possible future bloom occurrence. As a result, the Greater Sudbury Source Protection Committee decided to enumerate Microcystin LR as a drinking water issue and an issues contributing area was delineated in accordance with Technical Rule 114. The issue contributing area is delineated on Map 3.11.

Issues Approach to Threat Identification

Technical rule 115 requires that threats be listed for those drinking water issues listed under rule 114. Prescribed drinking water activities contributing to drinking water issues are considered significant threats if located within the issues contributing area, regardless of the vulnerability score.

Phosphorus contributes to the production of cyanobacteria and Microcystin LR. Therefore, any activity contributing phosphorus that occurs within the issues contributing area (Map 3.11) would be considered a significant threat. Likewise, any activity that contributes to the sodium issue would be considered a significant threat.

Tables 3.15 and 3.16 identify the threat activities that can contribute to the drinking water issues identified for this intake.

Table 3.15 – Prescribed threat activities that could contribute to phosphorous

The application of agricultural source material to land.
The application of commercial fertilizer to land.
The application of non-agricultural source material to land.
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.
The establishment, operation or maintenance of a waste disposal site.
The handling and storage of commercial fertilizer.
The handling and storage of non-agricultural source material.
The handling and storage of agricultural source material.
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard.

Table 3.16 –Prescribed threat activities that could contribute to sodium

The application of road salt.
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.
The handling and storage of road salt.
The storage of snow.

There are presently occurrences of five activities out of the 12 listed in Tables 3.15 and 3.16 that are prescribed drinking water threats related to phosphorus or sodium in the issues contributing area. These are listed in Table 3.17 and are considered significant drinking water threats.

Table 3.17 - Drinking water quality issues and associated threats for the Ramsey Lake intake

Drinking Water System	Drinking Water Issue	Associated Threat	Number of properties in Ramsey Lake Watershed
Ramsey Lake Intake	Microcystin LR (blue green algae)	Septic systems	210
		The application of commercial fertilizer to land	4,550
		Discharge of untreated stormwater from a Stormwater retention pond	2
		Lift stations	8
	Sodium	The application of road salt	4,550
		The handling and storage of road salt	205
		Septic systems	210
		Storage of Snow	19

Table 3.18 shows the list of circumstances for threats that have been identified through the issues process.

Table 3.18 – Table references for significant drinking water threats and associated circumstances related to phosphorus and contributing to the issue of Microcystin and prescribed activities contributing to the issue of sodium

Drinking Water Threat	Circumstances	Ref. No.	No. of Occurr-ences
Septic Systems	1. The system is an earth pit privy, privy vault, greywater system cesspool, or a leaching bed system and its associated treatment unit. 2. The system is subject to the *Ontario Building Code Act 1992.* 3. The discharge from the system may result in the presence of Phosphorus (total) in groundwater or surface water.	699	210
	1. The system is an earth pit privy, privy vault, greywater system cesspool, or a leaching bed system and its associated treatment unit. 2. The system is subject to the *Ontario Building Code Act 1992.* 3. The discharge from the system may result in the presence of Sodium in groundwater or surface water.	700	
	1. The system is an earth pit privy, privy vault, greywater system cesspool, or a leaching bed system and its associated treatment unit. 2. The system is a sewage system works within the meaning of the *Ontario Water Resources Act.* 3. The discharge from the system may result in the presence of Phosphorus (total) in groundwater or surface water.	705	
	1. The system is an earth pit privy, privy vault, greywater system cesspool, or a leaching bed system and its associated treatment unit. 2. The system is a sewage system works within the meaning of the *Ontario Water Resources Act.* 3. The discharge from the system may result in the presence of Sodium in groundwater or surface water.	706	
The application of commercial fertilizer to land	1. The commercial fertilizer is applied to land located in a vulnerable area, where the managed land map shows a managed land percentage for the applicable area that is less than 40% and the livestock density map shows a livestock density for the applicable area that is sufficient to annually apply agricultural source material at a rate that is less than 0.5 nutrient units per acre. 2. The application may result in the presence of Phosphorus (total) in groundwater or surface water.	20	4,550
	1. The commercial fertilizer is applied to land located in a vulnerable area, where the managed land map shows a managed land percentage for the applicable area that is at least 40%, but not more than 80% and the livestock density map shows a livestock density for the applicable area that is sufficient to annually apply agricultural source material at a rate that is less than 0.5 nutrient units per acre. 2. The application may result in the presence of Phosphorus (total) in groundwater or surface water.	26	
The application of road salt	1. The road salt is applied in an area where the percentage of total impervious surface area, as set out on a total impervious surface area map, is not more than 1 percent. 2. The application may result in the presence of Sodium in groundwater or surface water.	89	4,550
	1. The road salt is applied in an area where the percentage of total impervious surface area, as set out on a total impervious surface area map, is more than 1, but not more than 8 percent. 2. The application may result in the presence of sodium in groundwater or surface water.	91	

Drinking Water Threat	Circumstances	Ref. No.	No. of Occurr-ences
	1. The road salt is applied to an area where the percentage of total impervious surface area, as set out on a total impervious surface area map, is more than 8, but less than 80 percent. 2. The application may result in the presence of sodium in groundwater or surface water.	93	
The handling and storage of road salt	1. The storage of road salt in a manner that may result in its exposure to precipitation or runoff from precipitation or snow melt. 2. The quantity stored is less than 500 tonnes. 3. Runoff from the area in which the salt is stored may result in the presence of Sodium in groundwater or surface water. 1. The storage of road salt in a salt dome or similar facility designed to protect the salt from exposure to precipitation or runoff from precipitation or snow melt. 2. The quantity stored is more than 5,000 tonnes. 3. Runoff from the area in which the salt is stored may result in the presence of Sodium in groundwater or surface water.	1,434 1,444	205
Discharge Of Untreated Stormwater From A Stormwater Retention Pond	1. The system is a storm water management facility designed to discharge storm water to land or surface water 2. The drainage area associated with the storm water management facility is not more than 1 hectare and the predominant high density residential land use 3. The discharge may result in the presence of Phosphorus (total) in groundwater or surface water. 1. The system is a storm water management facility designed to discharge storm water to land or surface water 2. The drainage area associated with the storm water management facility is more than 1 but not more than 1 hectares and the predominant high density residential land use 3. The discharge may result in the presence of Phosphorus (total) in groundwater or surface water. 1. The system is a storm water management facility designed to discharge storm water to land or surface water 2. The drainage area associated with the storm water management facility is more than 10 but not more than 100 hectares and the predominant high density residential land use 3. The discharge may result in the presence of Phosphorus (total) in groundwater or surface water. 1. The system is a storm water management facility designed to discharge storm water to land or surface water 2. The drainage area associated with the storm water management facility is more than 100 hectares and the predominant high density residential land use 3. The discharge may result in the presence of Phosphorus (total) in groundwater or surface water.	370 389 408 427	2
The storage of snow	1.The snow is stored at or above grade 2. The area upon which snow is storage is at least 0.01, but not more than 0.5 hectares. 3. Runoff from the area in which the snow is stored may result in the presence of Sodium in groundwater or surface water 1.The snow is stored below grade 2. The area upon which snow is storage is at least 0.01, but not more than 0.5 hectares.	1454 1465	19

Drinking Water Threat	Circumstances	Ref. No.	No. of Occurr-ences
	3. Runoff from the area in which the snow is stored may result in the presence of Sodium in groundwater or surface water		
	1.The snow is stored at or above grade 2. The area upon which snow is storage is at least 0.5, but not more than 1 hectares. 3. Runoff from the area in which the snow is stored may result in the presence of Sodium in groundwater or surface water	1476	
	1.The snow is stored below grade 2. The area upon which snow is storage is at least 0.5, but not more than 1 hectares. 3. Runoff from the area in which the snow is stored may result in the presence of Sodium in groundwater or surface water	1487	
	1.The snow is stored at or above grade 2. The area upon which snow is storage is at least 1, but not more than 5 hectares. 3. Runoff from the area in which the snow is stored may result in the presence of Sodium in groundwater or surface water	1498	
	1.The snow is stored below grade 2. The area upon which snow is storage is at least 1, but not more than 5 hectares. 3. Runoff from the area in which the snow is stored may result in the presence of Sodium in groundwater or surface water	1509	
	1.The snow is stored at or above grade 2. The area upon which snow is storage is more than 5 hectares. 3. Runoff from the area in which the snow is stored may result in the presence of Sodium in groundwater or surface water	1520	
	1.The snow is stored below grade 2. The area upon which snow is storage is more than 5 hectares. 3. Runoff from the area in which the snow is stored may result in the presence of Sodium in groundwater or surface water	1531	
Lift Stations	1. The system is part of a wastewater collection facility that collects or transmits sewage containing human waste, but does not include a sewage storage tank or a designed bypass. 2. The system is designed to convey more than 250, but not more than 1,000 cubic metres of sewage per day. 3. The discharge from the system may result in the presence of Phosphorus (total) in groundwater or surface water	654	8
	1. The system is part of a wastewater collection facility that collects or transmits sewage containing human waste, but does not include a sewage storage tank or a designed bypass. 2. The system is designed to convey more than 1,000, but not more than 10,000 cubic metres of sewage per day. 3. The discharge from the system may result in the presence of Phosphorus (total) in groundwater or surface water	667	
	1. The system is part of a wastewater collection facility that collects or transmits sewage containing human waste, but does not include a sewage storage tank or a designed bypass. 2. The system is designed to convey more than 10,000, but not more than 100,000 cubic metres of sewage per day.	680	

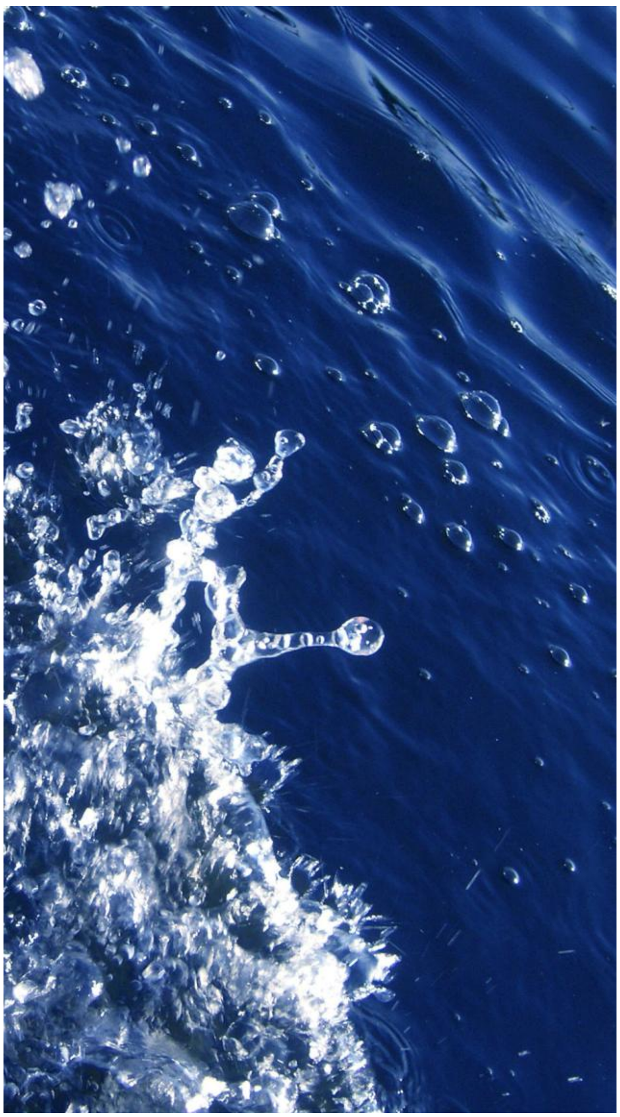
Drinking Water Threat	Circumstances	Ref. No.	No. of Occurr-ences
	3. The discharge from the system may result in the presence of Phosphorus (total) in groundwater or surface water		
	1. The system is part of a wastewater collection facility that collects or transmits sewage containing human waste, but does not include a sewage storage tank or a designed bypass. 2. The system is designed to convey more than 100,000 cubic metres of sewage per day. 3. The discharge from the system may result in the presence of Phosphorus (total) in groundwater or surface water	693	

Chapter 20 - Data Gaps

The analyses for this drinking water system were carried out using the best data available to meet the assessment report requirements. Completing scientific assessments on the quality and quantity of water undoubtedly raises a number of questions and uncertainties regarding the methodologies used, availability of data, reliability of data and overall outcome. As new information arises, either from increased or continuous monitoring, improved models, or a change in methodology, the results from this report will have to be updated to reflect the additional information.

The assessment report is a constantly evolving document as new information becomes available and refinements in approaches are made. Changes in land use will also impact the identification of potential threats to water quality and quantity. Data gaps to be filled include:

- Definite streamflow discharge from Ramsey Lake to Lily Creek is vital for more precise water budgeting;
- Information regarding groundwater gradients will improve the understanding of groundwater contribution to Ramsey Lake; and
- Discharge measurements of inflow streams during dry periods will give an indication of the baseflow contribution to Ramsey Lake.



Part Four

The Wanapitei River Drinking Water System

The City of Greater Sudbury's major water producer is located on the Wanapitei River, just upstream of the Trans-Canada Highway in the community of Wahnapitae.

Approved on September 2, 2014

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Chapter 21 - Wanapitei River Drinking Water System

The City of Greater Sudbury's major water producer is located on the Wanapitei River, just upstream of the Trans-Canada Highway in the town of Wahnapitae. The intake is a Type C[1] intake according to the Technical Rules. Approximately 60% of the City's water supply is produced by the intake, which services the communities of Coniston, Wahnapitae, New Sudbury and parts of downtown Sudbury and Garson. The community of Markstay is also serviced by this intake; however it is located outside of the watershed and is not considered part of the Source Protection Area. The Wanapitei drinking water system is connected with the David Street drinking water system by the Ellis reservoir located in the heart of the City of Sudbury. See Chapter 16 and Map 3.1 for a description of the David Street distribution system.

The intake is located on the western bank of the river and is constructed of two concrete wet wells situated at the bottom of the river. It is 50 m upstream from the Canadian Pacific Railway (CPR) line and a number of residences are located nearby.

The water is pumped through coarse and fine mesh screens and pre-chlorinated before being transferred 2 km west to the Wanapitei Water Treatment Plant. Coagulants are added before clarification and sent through four filters of sand and anthracite coal. The water is post-chlorinated and given additions of fluoride, polyphosphate and lime before distribution. Table 4.1 provides a summary of pumping rates for the Wanapitei River intake for the period 2000-2008.

Table 4.1– Summary of pumping rates for the Wanapitei River intake for 2000-2008.

	Pumping Rate
Permitted Rate	22,201,344 m^3/year
Maximum Annual	12,695,047 m^3
Average Annual	11,817,789 m^3
Average Monthly	984,816 m^3

Chapter 22 - Wanapitei River Intake Watershed Description

[1] A Type C intake is located in a river and neither the direction nor velocity of flow of the water at the intake is affected by a water impoundment structure.

The Wanapitei River intake watershed covers approximately 2,782 km^2. This watershed extends north to the headwaters of the Greater Sudbury Source Protection Area, reaching to the Arctic Divide. The main feature of the watershed is Lake Wanapitei, which is the largest lake in the Source Protection Area, covering 132 km^2. The watershed is mostly forested and consists of approximately 268 km^2 of lakes.

Surficial geology in the Wanapitei River watershed is dominated by bedrock and thin till. Overburden of greater than 1 m in depth is generally the glaciofluvial deposits associated with the Wanapitei Esker south of Lake Wanapitei and sand dunes in the headwaters of the catchment.

The river is approximately 257 km long with an approximate elevation change of 230 m. The river north of Lake Wanapitei has two main tributaries, the west and the east. The western branch drains a number of large tributaries including Scotia Lake plus Meteor, Raven, Rosie, Silvester, Unwin, Barnet and Demott Creeks in the northernmost reaches of the watershed. The river downstream of Lake Wanapitei is regulated by the Lake Wanapitei Dam, Moose Rapids Dam and the Stinson Dam. Map 4.1 illustrates the subwatersheds and the locations of the dams in the Wanapitei River intake watershed.

Chapter 23 - Wanapitei River Watershed Water Budget and Stress Assessment

The Wanapitei River drinking water system lies within the Wanapitei watershed. As previously described in Chapter 13, the Wanapitei River watershed was given a water quantity stress level of low and therefore did not need to progress to the next level of water quantity assessment. Nonetheless, a Tier 1 water budget was created for the watershed contributing to the Wanapitei River intake and it is presented below. The methodology applied is described in greater detail in Chapter 3. A brief summary of the water budget and stress assessment are presented below. For a detailed account of all methodology, assumptions and associated calculations, refer to Appendix 2.

23.1 Wanapitei River Intake Water Budget

A summary of the Wanapitei River intake water budget is presented in Table 4.2. For the period of 1970-2005, the Wanapitei River intake watershed had an average annual moisture surplus of 368 mm. Surface runoff, stream discharge and groundwater recharge all display the largest peak during spring melt and again when soils are saturated in the fall months. The spring freshet did not produce a large discharge peak in April, which is attributed to the large storage volume behind control dams as well as in Lake Wanapitei.

Average annual recharge was calculated to be 225 mm/yr. However, most of this was calculated to have occurred in April (148 mm) and is likely overestimated. This is primarily because the soil moisture budgeting technique moved water into groundwater storage although it is more probable that this water was stored in surface water reservoirs. On an annual basis, baseflow comprised 29% of total streamflow.

Table 4.2 – Water budget for the Wanapitei River intake watershed

	Water Balance Element (mm)									
Month	Rainfall	Snowfall	Snowmelt	Total Input	PET*	AET**	Streamflow	Baseflow	Runoff	Recharge
January	1.9	61.8	3.8	5.7	0	0	33.5	10.1	23.5	0
February	1.6	48.3	8.2	9.9	0	0	31.6	9.5	22.1	0
March	14.0	48.3	55.0	69.0	0	0	42.2	10.6	31.7	41.5
April	41.2	17.3	156.9	198.2	18.6	18.6	42.5	10.6	31.9	147.7
May	75.9	1.8	14.7	90.5	73.7	72.6	42.7	10.7	32.0	9.9
June	75.4	0.2	0.2	75.6	109.0	101.6	34.0	8.5	25.5	0.6
July	80.1	0	0	80.1	127.1	109.2	19.9	8.0	12.0	0
August	83.8	0	0	83.8	109.8	92.6	13.2	6.6	6.6	0.9
September	94.2	0.3	0.3	94.5	67.8	65.7	14.8	5.9	8.9	1.9
October	73.6	4.6	4.1	77.8	29.2	29.2	25.7	7.7	18.0	5.6
November	36.0	35.2	20.2	56.2	0.6	0.6	34.0	9.2	24.8	16.6
December	6.5	57.4	10.2	16.6	0	0	35.7	10.7	25.0	0

Annual Total	584.2	275.2	273.6	857.7	535.7	490.1	369.9	108.0	261.9	224.6

*PET – Potential Evapotranspiration
**AET – Actual Evapotranspiration

23.2 Wanapitei River Intake Stress Assessment

The results from the Wanapitei River intake stress assessment are summarized in Table 4.3. Surface water demand for the Wanapitei River watershed is highest during winter and late summer. Most of the surface water demand was a result of the consumption of water that is transferred from the Wanapitei Basin to the Vermilion Basin (NDCA 2006a). In August, calculated surface water stress for present and forecasted use was 14.9% and 15.6% respectively, therefore the watershed was given a classification of "low" stress.

Municipal Use

Municipal supply removals from this watershed include the surface water intake at the Wanapitei River and groundwater removals in Falconbridge. Separate, smaller groundwater systems also supply the community of Skead Heritage Homes and the Sudbury Airport. Some of the water removed at the Wanapitei Water Treatment Plant is transferred to the Vermilion watershed (through the connection with the David Street distribution system) to the west, as well as the Sturgeon River watershed to the east (through the water supply to Markstay).

Water removed from the Wanapitei River has averaged $1x10^7$ m^3/yr and removals have remained relatively stable for the period of 2000-2005. Agreements between the City of Greater Sudbury and Ontario Power Generation limit the amount of water that can be removed from the Wanapitei River to ensure adequate flow towards the downstream generating stations.

Permit to Take Water

As of February 2008, excluding the municipal supplies, there are 13 available permit to take water records in the Wanapitei River intake watershed. Seven of these permits are for surface water removals, three are for groundwater removals and three are for both groundwater and surface water. Permits that fell under the 'both' category were assumed as groundwater removals. Excluding the municipal water supplies the total permitted amount of these removals was estimated as $7.2x10^7$ m^3/yr for surface water and $2.4x10^6$ m^3/yr for groundwater takings. The consumed amounts were estimated to be $4.4x10^6$ m^3/yr for surface water and $7.8x10^5$ m^3/yr for the groundwater removals.

Agricultural Use

De Loe (2002) estimated 29 farms and an annual water removal of 137,579 m^3/yr in the Wanapitei River watershed. It was assumed that all water for agriculture was from groundwater, occurred only during summer months and was 80% consumptive (Aqua Resource 2005). Therefore, the total water consumed for agriculture in the Wanapitei River watershed was estimated at 110,063 m^3/yr.

Non-permitted and Rural Use

Approximately 1,500 people in the Wanapitei River watershed within the City of Greater Sudbury are without municipal water service (CGS, 2003). There are 168 available well records in the basin, all of which were considered non-consumptive. The majority of these well records are located along the Wanapitei Esker between Lake Wanapitei and the intake.

Water Budget and Stress Assessment Uncertainty

Uncertainty in the Tier 1 process takes into account the quality of the available data. Municipal water removals and water use trends were obtained from the City of Greater Sudbury and from industry, and large volume permits to take water were checked for actual use and active status. For each Tier 1 water budget, the water surplus was in the range of that reported in the literature (e.g. Richards 2002). For the Wanapitei water source, the estimated uncertainty is low.

Table 4.3 – Water quantity stress assessment for the Wanapitei River intake watershed

	Supply (m^3/s)		Demand (m^3/s)				Stress (%)	
Month	Median	Reserve	Municipal	PTTW	Total	Forecast	Present	Forecast
January	33.94	26.92	0.29	0.43	0.72	0.75	10.25	10.71
February	35.77	26.15	0.28	0.43	0.72	0.75	7.46	7.8
March	43.43	34.94	0.29	0.43	0.72	0.76	8.52	8.91
April	43.91	23.72	0.29	0.43	0.72	0.76	3.58	3.74
May	36.36	11.95	0.29	0.43	0.72	0.76	2.96	3.1
June	35.0	10.06	0.32	0.43	0.75	0.79	3.02	3.16
July	19.0	9.78	0.32	0.43	0.75	0.79	8.14	8.52
August	11.99	6.98	0.31	0.43	0.75	0.78	14.9	15.6
September	12.45	6.6	0.3	0.43	0.74	0.77	12.64	13.23
October	25.5	9.14	0.29	0.43	0.72	0.75	4.39	4.59
November	38.52	18.03	0.29	0.43	0.72	0.75	3.5	3.66
December	36.75	24.35	0.3	0.43	0.73	0.76	5.88	6.15

Chapter 24 - Wanapitei River Water Quality Risk Assessment

The following sections provide the results for the water quality risk assessment process for the Wanapitei River drinking water system.

24.1 Wanapitei River Intake Protection Zones

There are three intake protection zones (or IPZs) delineated for each surface water intake. Rules 58 to 71 and Chapter 2 describe the methodology to be applied for each type of intake.

Intake Protection Zone 1

The minimum protection zone for a Type C intake is semi-circle with a radius of 200 m situated over top of the intake with a 10 m extension downstream of the intake (Rule 70). The centre point of the semi-circle is the point of entry of the raw water. Where the zone abuts land, a 120 m setback is applied.

The IPZ-1 for the Wanapitei River intake is illustrated in Map 4.2.

Intake Protection Zone 2

The delineation of IPZ-2 is based on a 2 hour time of travel to reflect the response time of an operator to shut down the water treatment plant in the event of an adverse water quality condition (Rule 65). Bankfull flow[2] conditions were encouraged by the MOE to be used to determine a 2 hour time of travel delineation for an IPZ–2.

The Wanapitei River changes frequently through its reaches from steep sided slopes to low lying wetland areas. This kind of topography makes it difficult to determine what a bankfull condition is as it varies widely throughout the river. Instead, return period flood discharges were estimated to determine the appropriate flow conditions to calculate the IPZ-2 delineation. A two year return period was assumed to be a suitable flow condition to apply to the IPZ-2 delineation. The land portion of IPZ-2 was extended to capture the drainage ditch transport pathway along Highway 17.

In the Wanapitei River, the intake is located near the downstream end of the modeled reach. Field work was carried out on the river in order to improve the local understanding of river geometry upstream of the WTP intake and to reduce uncertainty. The surveyed reach extended approximately 5.5 km upstream of the WTP intake until a set of rapids was encountered.

The 2 hour time of travel based on the above methodology was estimated to be approximately 3,200 m. Map 4.3 shows the extent of the IPZ-2. For a more detailed review of the methodology, assumptions and calculations please refer to the report on the IPZ-2 Update for the Vermilion and Wanapitei River Intakes in Appendix 2.

Intake Protection Zone 3

[2] Bankfull flow is considered the maximum amount of flow a stream channel can contain without spilling over the banks. Typically, bank full flow conditions are observed once every two years.

Intake protection zone 3 (IPZ-3) is the area within each surface water body that may contribute water to the intake with a 120 m set back from the high water mark (Rule 70). The IPZ-3 for the Wanapitei River intake extends to the Arctic Divide, includes Lake Wanapitei, the east and west branches of the Wanapitei River, and stretches approximately 120 km from the intake. See Map 4.4 for an illustration.

Intake Protection Zone Delineation Uncertainty

As required by Rule 108, an uncertainty analysis of the delineation of intake protection zones and vulnerability scoring are presented in Table 4.4.

Table 4.4 – Summary of uncertainty analysis for the Wanapitei River intake protection zones

IPZ	Level of Uncertainty	Comments
IPZ-1	High	This zone was delineated as a fixed radius surrounding the intake according to Rule 61. There has been some anecdotal evidence suggesting that due to wind direction and intensity, the surface of the river appears to flow upstream. With the close proximity of the highway and the rail line, it is uncertain if the prescribed delineation of the IPZ-1 is sufficient to protect the intake from a possible accident in these transportation corridors.
IPZ-2	Low	Field data provided insight into the characteristics of the river profiles upstream of the WTP intake. As a result, IPZ-2 delineation has a higher degree of confidence associated with it.
IPZ-3	High	The delineation for the IPZ-3 was prescribed under Rule 70. The resulting IPZ-3 includes the entire watershed to the Arctic Divide. As this represents a vast area with little detailed mapping information, there is little certainty regarding exact locations of the high water mark with which to delineate a 120 m setback from.

24.2 Vulnerable Areas Scoring

Vulnerability scoring for intake protection zones followed Rules 86 to 95 which require a source vulnerability factor and area vulnerability factor to be determined. Chapter 2 explains the methodology in detail. Due to the sheer size of the Wanapitei River intake protection zones, the area vulnerability factor was determined based on subwatershed. Each subwatershed was characterized and given one overall score as explained in the subsequent pages.

Source Vulnerability Factor

The Source Vulnerability Factor was scored a 1.0 out of a possible 0.9 or 1.0 for the following reasons:

- the intake is situated on the bank of the river
- the intake is very shallow
- periodic taste and odour issues reported by the treatment plant operators and the intake is very exposed to potential contaminants.

Area Vulnerability Factor

The area vulnerability factor for IPZ-1 is fixed at 10.

IPZ-2 is characterized by bedrock with sparse vegetation and relatively steep terrain. A score of 8 was given to this zone as it is within close proximity to the intake and has little attenuation capacity with the land cover present.

IPZ-3 was divided into a number of sections and subwatersheds. The area upstream of and including Lake Wanapitei was classified as having a very low vulnerability and a score of 1. The residence time of the lake is estimated to be approximately 2-4 years and is controlled by the Lake Wanapitei Dam at the outlet. Land cover in this region is heavily forested and the area is sparsely populated.

Downstream of Lake Wanapitei, the distance and travel time to the intake is much less and therefore the vulnerability increases. The closest subwatersheds, the Lower Wanapitei below Stinson Dam, the Emery Creek subwatershed and a small unnamed subwatershed, are given a score of 8. The subwatersheds are similar in land cover as IPZ-1 and 2 and have little attenuation capacity. The subwatersheds are also in close proximity to the intake.

Between the Stinson Dam and the Moose Rapids Dam, a score of 7 was given. The vulnerability of the landscape is moderate as the terrain is dominated by bedrock and is in close proximity to the intake. Above the Moose Rapids Dam, a score of 6 was given as the reach is farther from the intake than the previous reach and has similar land cover.

Summary of Vulnerable Area Scoring

Table 4.5 shows the source vulnerability and area vulnerability factors for the Wanapitei drinking water system intake protection zones.

Table 4.5 – Wanapitei River vulnerable area scoring

Intake Protection Zone	Source Vulnerability Factor	Area Vulnerability Factor	Vulnerability Score	Comments
IPZ-1	1.0	10	10	Fixed score
IPZ-2	1.0	8	8	Steep slopes Mostly bedrock Little attenuation capacity
IPZ -3 – Lower Wanapitei River (below Stinson Dam)	1.0	8	8	Varied topography Mostly bedrock with little vegetative cover
IPZ-3 – Emery Creek	1.0	8	8	
IPZ-3 - Unnamed	1.0	8	8	
IPZ-3 – Lower Wanapitei River (between Stinson and Moose Rapids Dam)	1.0	7	7	Mostly bedrock Varied topography
IPZ-3 – Lower Wanapitei (between Moose Rapids and Lake Wanapitei Dam)	1.0	6	6	Mostly bedrock
IPZ-3 Lake Wanapitei	1.0	1	1	Long residence time in Lake Wanapitei (2-4 yrs) Mostly undeveloped Forested land cover Some mine exploration and forestry activity in the upper reaches of the watershed
IPZ-3 – Parkin Creek	1.0	1	1	
IPZ-3 East Wanapitei	1.0	1	1	
IPZ -3 – Upper Wanapitei	1.0	1	1	
IPZ-3 Burwash Creek	1.0	1	1	
IPZ-3 – Silvestor Creek	1.0	1	1	
IPZ-3 – Rosie Creek	1.0	1	1	
IPZ-3 Meteor Creek	1.0	1	1	

Intake Protection Zone Vulnerability Scoring Uncertainty

Uncertainty surrounding the vulnerable area scoring assignment is based on the ability for the vulnerability factors to effectively assess the relative vulnerability of the hydrological features. The vulnerability scores for the Wanapitei River intake protection zones were primarily based on land cover.

Table 4.6– Uncertainty analysis for the vulnerable area scoring

	Uncertainty	Comments
Source Vulnerability Factor	Low	The intake is situated on the banks of the Wanapitei River with high vulnerability to contamination from surrounding land uses.
Area Vulnerability Factor – Score of 6 to 8	Low	IPZs 2 and 3 have been scored relatively conservatively. There is sufficient information to assign scoring and high confidence that the factor will address any concerns to the intake.
Area Vulnerability Factor – Score of less than 6	High	It was assumed that the time of travel and the dilution were high enough. However, there is no data to confirm this assumption. In addition, there is no detailed mapping for the entire watershed.

24.3 Wanapitei Drinking Water Quality Threats Activities

The assessment of potential threats to drinking water quality followed the methodology outlined in Chapter 2. The list of prescribed drinking water threats is located in Table 1.7 in Part 1 of this report.

List of circumstances of all is or would be threats

As required under O.Reg. 287/07 subsection 13, a list of references for all is or would be significant, moderate or low threats in each vulnerable area is provided in Table 4.7. Tables listing is or would be threats can be found in Appendix 5.

Table 4.7 – Table references for all is or would be threats and associated circumstances in the Wanapitei intake protection zones

Score	Significant	Moderate	Low
10	CIPZ10S- Chemicals in an IPZ with a vulnerability of 10 where threats are significant PIPZ10S- Pathogens in an IPZ with a vulnerability of 10 where threats are significant	CIPZ10M - Chemicals in an IPZ with a vulnerability of 10 where threats are moderate PIPZ10M - Pathogens in an IPZ with a vulnerability of 10 where threats are moderate	CIPZWE10L - Chemicals in an IPZ with a vulnerability of 10 where threats are low PIPZ10L- Pathogens in an IPZ with a vulnerability of 10 where threats are low
8	CIPZWE8S- Chemicals in an IPZ or WHPA E where the vulnerability score is 8 where threats are significant PIPZWE8S - Pathogens in an IPZ or WHPA E with a vulnerability of 8 where threats are significant	CIPZWE8M - Chemicals in an IPZ or WHPA E where the vulnerability score is 8 where threats are moderate PIPZWE8M - Pathogens in an IPZ or WHPA E with a vulnerability of 8 where threats are moderate	CIPZWE8L - Chemicals in an IPZ or WHPA E where the vulnerability score is 8 where threats are low PIPZWE8L - Pathogens in an IPZ or WHPA E with a vulnerability of 8 where threats are low
7	N/A	CIPZWE7M - Chemicals in an IPZ or WHPA E where the vulnerability score is 7 where threats are moderate PIPZWE7M - Pathogens in an IPZ or WHPA E with a vulnerability of 7 where threats are moderate	CIPZWE7L- Chemicals in an IPZ or WHPA E where the vulnerability score is 7 where threats are low PIPZWE7L - Pathogens in an IPZ or WHPA E with a vulnerability of 7 where threats are low
6	N/A	CIPZWE6M - Chemicals in an IPZ or WHPA E where the vulnerability score is 6 where threats are moderate PIPZ6M - Pathogens in an IPZ with a vulnerability of 6 where threats are moderate	CIPZWE6L - Chemicals in an IPZ or WHPA E where the vulnerability score is 6 where threats are low PIPZ6L - Pathogens in an IPZ with a vulnerability of 6 where threats are low

Identification of areas where threats can occur

The areas where a potential threat is or would be significant, moderate or low are illustrated on Maps 4.2 to 4.4. According to the Technical Rules:

- Areas with a vulnerability score of 8 or greater has the potential for a significant, moderate or low threat.
- Areas with a vulnerability score of 6 or greater has the potential for a moderate or low threat to occur.
- Areas with a vulnerability score of 4 or greater has the potential for a low threat to occur.
- Areas with a vulnerability score of less than 4 cannot contain a drinking water threat.

Managed Lands

The storage, handling and application of agricultural source material, non-agricultural source material, pesticides and fertilizers can result in potential contamination of municipal water supplies. The methodology used to calculate percentage of managed lands in the vulnerable areas is described in Chapter 2.

The percentage of managed lands in the area was assessed to be under 40% (low) and is illustrated on Map 4.5.

Impervious Surfaces

Impervious surfaces are measured as an indicator of the amount of area where road salt can be applied. The percentage of surface area within a vulnerable area which will not allow surface water or precipitation to be absorbed into the soil is calculated. The percentage of impervious area in the Highway 17 corridor immediately upstream of the Wanapitei River intake is in the 8-80% range. Most of the impervious area in the rest of intake protection zones 1 and 2 is in the 1-8% range, with a small amount in the <1% range. The opposite is true for the rest of the watershed, where most of the impervious area is in the less than 1% range, with small amounts in the 1-8% range. The percentage of impervious area is illustrated in Map 4.6. The methodology used to calculate percentage of impervious surfaces in the vulnerable areas is described in Chapter 2. The calculation of impervious surfaces led to the vulnerable area being designated as a significant threat or a moderate threat for the application of road salt depending on the vulnerability score.

Livestock Density

The calculation of livestock density is based on the calculation of nutrient units per acre of agricultural managed lands. The methodology used to calculate the livestock density in the vulnerable areas is described in Chapter 2. There are no agricultural lands in the vulnerable areas in the Wanapitei River intake watershed; therefore the area has a score of under 0.5 nutrient units per acre. The results are illustrated in Map 4.7.

The combination of livestock density and managed land calculations assigns a threat rating for the application of commercial fertilizer. Table 4.8 shows the number of occurrences of this threat in different vulnerability areas.

Enumeration of Threats

Table 4.8 lists an estimate of the current number of drinking water threats in the Wanapitei River intake vulnerable areas in accordance with Rule 9 and the Drinking Water Threats Tables.

Table 4.8 – Drinking water quality threats for the Wanapitei River intake

Drinking Water Threat Category	Number of Occurrences with Threat Classification		
	Significant	Moderate	Low
IPZ-1			
The application of commercial fertilizer to land.		1	
The handling and storage of fuel.	1		
The application of road salt.	1		

Local threat: Transportation of hazardous substances along transportation corridors.	1	1	
IPZ-2			
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.			19
The application of commercial fertilizer to land.		1	
The application of road salt.		1	
Local threat: Transportation of hazardous substances along transportation corridors.	1	2	1
IPZ-3			
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act.		1	
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.			86
The application of commercial fertilizer to land.		1	
The application of road salt.		1	
Local threat: Transportation of hazardous substances along transportation corridors.		2	4

24.4 Wanapitei Drinking Water Threats Conditions

A drinking water condition is a situation that results from a past activity and meets the criteria laid out in Rule 126. For a more detailed review of methodology for identifying drinking water conditions, please refer to Part 1, Chapter 2.

The areas where a significant, moderate or low threat condition could exist are the same as the areas where a potential threat could occur. For an illustration, please see Maps 4.2 to 4.4.

At the time of report production, there are no known conditions present within the vulnerable areas for this drinking water system.

24.5 Wanapitei Drinking Water Quality Issues

Drinking water quality issues were assessed based on the methodology outlined in Chapter 2 and Rules 114 and 115.

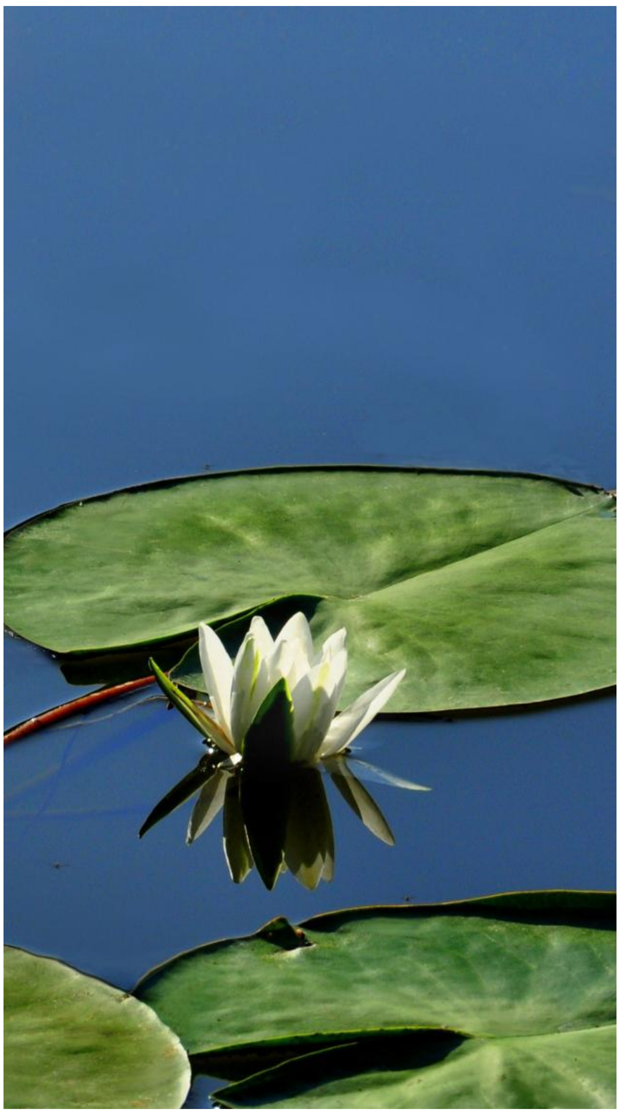
There are no known drinking water quality issues at this time.

Chapter 25 - Data Gaps

The analyses for this drinking water system were carried out using the best data available to meet the assessment report requirements. Completing scientific assessments on the quality and quantity of water undoubtedly raises a number of questions and uncertainties regarding the methodologies used, availability of data, reliability of data and overall outcome. As new information arises, either from increased or continuous monitoring, improved models, or a change in methodology, the results from this report will have to be updated to reflect the additional information.

The assessment report is a constantly evolving document as new information becomes available and refinements in approaches are made. Changes in land use will also impact the identification of potential threats to water quality and quantity. Therefore, there will be a need to continue filling in identified data gaps and to carry out studies in the future. Data gaps for the Wanapitei River intake include:

- River bed cross sections and velocity profiles during higher discharge rates; and
- Detailed contaminant mixing effects at higher discharge rates.



Part Five

The Vermilion River Drinking Water System

The Vermilion River watershed, which contributes to the surface water intake on the Vermilion River, covers approximately 3,764 km^2 and extends to the northern limit of the Greater Sudbury Source Protection Area.

Approved on September 2, 2014

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Chapter 26 - The Vermilion River Drinking Water System

The Vermilion River intake lies just below Cascade Falls located in the lower portion of the Vermilion River watershed. Owned and operated by Vale, the intake pumps raw water from the river to Creighton to be treated at the Vermilion Water Treatment Plant. The intake is considered to be a Type C[1] intake according to the Technical Rules.

Raw water is collected through a concrete structure located on the bottom of the river, protruding 6 metres from shore and is pumped through five coarse bar screens and two fine mesh screens. The raw water is then pumped 8.9 km from the pumphouse to the Vermilion Water Treatment Plant.

At the plant, the water is treated with liquid alum as a coagulant and prechlorinated before directed to the flash mixing chamber. A liquid polymer is added to aid coagulation and then the water is directed to the clarification and filtration process. Clarified water is directed to five single media sand filters and then discharged to a clearwell. Polyphosphate is added for iron and manganese sequestering, caustic soda is added for pH adjustment and chlorine is added for post disinfection.

Treated water is sent to the Creighton Mine and the City of Greater Sudbury distribution system. The distribution of the municipal water supply is owned and operated by the City of Greater Sudbury. The communities of Lively, Naughton, Whitefish and Copper Cliff are serviced by this intake. See Map 5.1 for the location of the intake and the distribution system. Table 5.1 summarizes water usage at the intake.

Table 5.1 – Summary of pumping rates for the Vermilion River intake for 2004-2008

	Pumping Rate
Maximum annual	20,771,331 m^3 (2004)
Average annual	16,510,374 m^3
Average monthly	1,375,864 m^3

[1] A Type C intake is located in a river and neither the direction nor velocity of flow of the water at the intake is affected by a water impoundment structure.

Chapter 27 - Vermilion River Watershed Description

The Vermilion River watershed that contributes to the surface water intake on the Vermilion River covers approximately 3,764 km^2 and extends to the northern limit of the Greater Sudbury Source Protection Area. It includes the Whitewater, Whitson, Cameron, Sandcherry, Nelson, Rapid, Upper Vermilion, and Upper Onaping River watersheds. Map 5.2 illustrates the extent of the watershed. The watershed area is mostly forested, with approximately 302 km^2 of lakes. The geology in the Vermilion River watershed is dominated by bedrock and thin till. Overburden of greater than 1 m depth is generally the glaciolacustrine and glaciofluvial deposits in the Valley East area, and in some areas covered by sand dunes in the headwaters of the catchment.

Some of the water produced in the headwaters of this watershed is diverted towards the Spanish River at Onaping Lake (NDCA 2006a). Onaping Lake, which is a headwater reservoir for the Onaping River, eventually discharges in three directions: south to the Vermilion River, west to the Spanish River and north to the Mattagami River. The northern flow has been blocked and the water is mainly diverted towards the Spanish River through regulation of the Bannerman Dam. The Onaping River is the main outlet of the lake and a main tributary of the Vermilion River.

The Whitson River, another main tributary in the watershed, flows in a southwest direction and enters the Vermilion River in Creighton Township in the City of Greater Sudbury. The Whitson River drains an approximate area of 313 km^2. This river passes through the communities of Val Caron and Chelmsford and has been a source of a number of flooding events in the past.

Chapter 28 - Vermilion River Intake Water Budget and Stress Assessment

The Vermilion River drinking water system lies within the Vermilion River watershed. As previously described in Chapter 13, the Vermilion River watershed was given a water quantity stress level of low and therefore did not need to progress to the next level of a water quantity assessment. Nonetheless, a Tier 1 water budget and stress assessment was completed for the watershed contributing to the Vermilion River intake and is presented below. The methodology applied is described in greater detail in Chapter 3 and in Appendix 2.

28.1 Vermilion River Intake Water Budget

Table 5.2 displays the results of the water budget for the Vermilion River intake. For the period 1970-2005, the Vermilion River intake watershed had an estimated average annual moisture surplus of 354 mm. Runoff, stream discharge and recharge all displayed peaks during spring melt and again when soils were saturated in the fall months. Average annual groundwater recharge was calculated to be 191 mm/yr. On an annual basis, baseflow was estimated to have comprised 32% of total streamflow.

Table 5.2 – Water budget for the Vermilion River intake watershed

	Water Balance Element (mm)									
Month	Rainfall	Snowfall	Snowmelt	Total Input	PET*	AET**	Streamflow	Baseflow	Runoff	Recharge
January	0.6	62.6	3.4	4.0	0	0	15.2	4.5	10.6	0
February	1.6	48.2	8.4	10.1	0	0	10.5	3.2	7.4	0
March	15.0	49.0	56.0	71.0	0	0	20.5	4.1	16.4	53.5
April	39.8	16.2	160.6	200.4	19.7	19.7	87.6	17.5	70.1	110.5
May	75.3	1.9	10.5	85.8	74.2	73.3	63.1	15.8	47.3	1.6
June	7537	0.2	0.2	75.9	108.3	102.8	28.7	11.5	17.2	1.5
July	77.4	0	0	77.4	127.2	112.8	13.5	6.7	6.7	0
August	83.0	0	0	83.0	109.9	96.0	8.5	4.3	4.3	0.8
September	94.8	0.3	0.3	95.1	67.9	66.1	8.9	3.5	5.3	2.2
October	73.5	4.8	4.3	77.8	28.7	28.7	20.8	6.2	14.6	5.0
November	36.1	34.0	20.9	57.0	0.6	0.6	27.7	5.5	22.1	16.1
December	6.8	58.5	10.0	16.9	0	0	25.0	7.5	17.5	0
Annual Total	579.7	275.7	274.6	854.3	536.5	500.2	329.7	90.4	239.4	191.2

*PET – Potential Evapotranspiration
**AET – Actual Evapotranspiration

28.2 Vermilion River Intake Water Quantity Stress Assessment

Table 5.3 summarizes the results of the water quantity stress assessment for the Vermilion River intake. Surface water demand for the Vermilion River watershed was highest in winter and late summer. Most of the surface water demand was a result of industrial permit to take water removals. Water reserve was highest in April (40 m^3/s) and the least volume of surface water was available in August. Calculated stress levels did not exceed 10% for any month, and February was estimated to have maximum monthly surface water stress at 9.2%. Therefore, the Vermilion River watershed contributing area to the surface water intake was classified as a 'low' surface water stress watershed. Forecasted increase in municipal demand did not significantly increase stress in the basin, as maximum monthly surface water stress was increased slightly above 9.2%.

Xeneca Power Development Inc. has a proposed hydro project just above Cascade Falls. The impact of this proposed project on water quantity will be assessed through the provincial review process for hydro projects.

Table 5.3 – Water quantity stress assessment for the Vermilion River intake watershed

	Supply (m^3/s)		Demand (m^3/s)				Stress (%)	
Month	Median	Reserve	Municipal	PTTW	Total	Forecast	Present	Forecast
January	20.05	10.61	0.02	0.55	0.58	0.58	6.11	6.14
February	15.97	9.62	0.02	0.56	0.58	0.59	9.20	9.23
March	18.69	10.8	0.02	0.54	0.56	0.56	7.09	7.12
April	109.09	39.96	0.02	0.53	0.55	0.56	0.80	0.80
May	76.68	28.05	0.02	0.55	0.58	0.58	1.19	1.19
June	31.39	16.11	0.02	0.52	0.54	0.55	3.56	3.57
July	15.10	7.68	0.02	0.53	0.55	0.55	7.38	7.40
August	10.25	3.95	0.02	0.54	0.57	0.57	8.99	9.03
September	10.07	3.08	0.02	0.54	0.56	0.56	8.05	8.08
October	22.77	5.32	0.02	0.54	0.57	0.57	3.25	3.26
November	31.40	12.34	0.02	0.54	0.57	0.57	2.97	2.98
December	31.12	14.88	0.02	0.54	0.56	0.56	3.43	3.45

Permit To Take Water Use

Excluding municipal removals, there were 32 recorded permits to take water in the Vermilion watershed that contribute to the intake at the time of report production. Seventeen of these permits were for surface water removals, while 15 permits were for groundwater removals. The consumed amounts were estimated to be $2.3 x 10^6$ m^3/yr for surface water and $2.3 x 10^6$ m^3/yr for the groundwater removals.

Agricultural Use

De Loe (2002) estimated an annual water removal of 269,501 m^3/yr in the Vermilion River watershed. It was assumed that all water for agriculture was from groundwater during summer months only and was 80% consumptive (Aqua Resource, 2005). Therefore, the total water consumed for agriculture in the Vermilion River watershed was estimated at 215,601 m^3/yr.

Municipal Use

Municipal removals in the Vermilion River Watershed are a combination of facilities owned by the City of Greater Sudbury and water purchased by the City from facilities owned by industry (Vale). Demand on these resources has remained relatively stable for the period of 2000-2005, with the exception of the Valley wells, which have increased in demand. A recent report on water works infrastructure in Greater Sudbury noted a 33% loss in the Valley distribution system and an 8% loss in the Dowling distribution system (CGS 2005b). These losses were assumed as a return to the groundwater system.

Non-permitted or rural use

Approximately 4,514 of the population of the Vermilion River watershed within the City are without municipal water service (CGS 2003). There are 1,828 available well records in the basin, all of which were considered non-consumptive for the calculations. Most of these well records are located in the southern third of the watershed.

Water Budget and Stress Assessment Uncertainty

Uncertainty in the Tier 1 process takes into account the quality of the available data. Municipal water removals and water use trends were obtained from the City of Greater Sudbury and from industry, and large volume permits to take water were checked for actual use and active status. For each Tier 1 water budget, the water surplus was in the range of that reported in the literature (e.g. Richards 2002). For the Vermilion water source, the estimated uncertainty is low.

Chapter 29 - Vermilion River Water Quality Risk Assessment

The following sections provide the results for the water quality risk assessment process for the Vermilion River drinking water system.

29.1 Vermilion River Intake Protection Zones

There are three intake protection zones (IPZs) delineated for each surface water intake. Rules 58 to 71 and Chapter 2 describe the methodology to be applied for each type of intake.

Intake Protection Zone 1

The intake is located in a basin below Cascade Falls. Here, the river widens and circulates within the basin before exiting downstream. Drogue studies were conducted in 2006 to map the direction of flow within the basin. Appendix 2 provides the details of the study (Intake Characterization, Determination of Intake Protection Zones, and Assigned Vulnerability Scores, for Inland River Intakes within the City of Greater Sudbury, January 2008). Based on the river flow conditions at the time of testing, the results of the dye tracer study indicated a relatively rapid initial response, which may be due to preferential current flows. Also a potential contaminant retention time of more than 24 hours was observed, possibly due to the geometry of the basin structure.

Rule 64 allows the modification of IPZ-1 to reflect local hydrodynamic conditions if necessary. IPZ-1 was delineated to reflect the current pattern present in the basin near the intake. A 400 m radius zone, centered over the intake to encompass the entire basin area was used instead of the semi-circle with a radius of 200 m prescribed in the Ministry of the Environment (MOE) Technical Rules. Where this semi-circle abutted land, a 120 m setback from the high water mark was applied. The entire Cascade Basin is incorporated in the IPZ-1. See Map 5.3.

Intake Protection Zone 2

The delineation of IPZ-2 is based on a 2 hour time of travel to reflect the response time of an operator to shut down the water treatment plant in the event of an adverse water quality condition (Rule 65). Bankfull flow[2] conditions were encouraged by the MOE to be used to determine a 2 hour time of travel delineation for an IPZ-2.

The Vermilion River changes frequently through its reaches from steep sided slopes to low lying wetland areas. This kind of topography makes it difficult to determine what a bankfull condition is as it varies widely throughout the river. Instead, return period flood discharges were estimated to determine the appropriate flow conditions to calculate the IPZ-2 delineation. A two year return period was assumed to be a suitable flow condition to apply to the IPZ-2 delineation.

The 2 hour time of travel was estimated to be approximately 3,700 m upstream of the lower end of the model domain plus Cascade Falls and the total length of the intake pool adjacent to the WTP intake. The total distance of IPZ-2 from the WTP intake was estimated at 4,500 m. No information exists with regards to travel time within the basin. Therefore, the IPZ-2 is considered to be conservative and the travel time through the basin is

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[2] Bankfull flow is considered the maximum amount of flow a stream channel can contain without spilling over the banks. Typically, bank full flow conditions are observed once every two years.

considered a data gap. The hydraulic backwater model HEC-River Analysis System (HEC-RAS) was used to simulate water levels through the reaches of the river. More details regarding the modeling are located in the report on the IPZ-2 Update for the Vermilion and Wanapitei River Intakes in Appendix 2. Being that this intake is located in an unsettled, forested area, there are no storm sewers to affect the delineation of IPZ-2. IPZ-2 is illustrated in Map 5.4.

Intake Protection Zone 3

The delineation of IPZ-3 follows the entire contributing area upstream of the intake and includes a 120 m setback from the high water mark (Rule 70). The Vermilion River IPZ-3 reaches to the Arctic Divide and is approximately 105 km long. It encompasses the Lower Vermilion, Mid-Vermilion, Cameron, Whitson, Whitewater, Lower Onaping, Upper Onaping, Sandcherry Creek, Nelson River, Rapid River and the Upper Vermilion watersheds. See Map 5.5 for the illustration of IPZ-3.

Intake Protection Zone Delineation Uncertainty

As required by Rule 108, an uncertainty analysis of the delineation of intake protection zones and vulnerability scoring is presented in Table 5.4.

Table 5.4 - Summary of uncertainty analysis for the Vermilion River intake protection zones

IPZ	Level of Uncertainty	Comments
IPZ-1	High	The drogue studies completed in 2006 provided some information regarding current patterns within the basin where the intake is located, however there still remains a lack of data regarding velocity of flow within the basin.
IPZ-2	High	The field data was limited by the upstream rapids which resulted in the 2 hour ToT reaching beyond the model domain. Along with this, the travel time through Cascade Falls and the pool at the WTP intake remains a data gap.
IPZ-3	High	The delineation for the IPZ-3 was prescribed under Rule 70. The resulting IPZ-3 includes the entire watershed to the Arctic Divide. Detailed mapping is not available for the upper reaches of the watershed; therefore there is little confidence in the 120 m setback delineation.

29.2 Intake Protection Zone Vulnerability Assessment

Vulnerability scoring for intake protection zones followed Rules 86 to 95 which require a source vulnerability factor and area vulnerability factor to be determined (see Chapter 2). Due to the sheer size of the Vermilion River intake protection zones, the area vulnerability factor was determined based on subwatersheds. Each subwatershed was characterized and given one overall score as explained in the subsequent pages.

Source Vulnerability Factor

The source vulnerability factor was given a score of 1.0 due to the close proximity of the intake to shore and the exposure of the intake.

Area Vulnerability Factor

The area vulnerability factor for IPZ-1 is fixed at 10. The remaining IPZ area vulnerability factors were given scores based on land cover, proximity to the intake, topography and geology.

The sheer size of the vulnerable areas for the Vermilion River made it necessary to divide the area into sections. IPZ-3 was divided into sub-watersheds and evaluated as a whole. Proximity was determined based on the outlet of each sub-watershed to the main stem of the Vermilion River.

IPZ-2 was given a moderate score of 7. The area within IPZ-2 is undeveloped, forested and primarily bedrock with pockets of wetland. This zone remains moderately vulnerable given the close proximity to the intake.

The Mid-Vermilion watershed, below the Stobie Dam, is much like the area within IPZ-2. Given the proximity is relatively close to the intake, this zone was given a score of 7. Vermilion Lake sits just upstream of the Stobie Dam, which filters much of the upper reaches of the watersheds. Because of the longer residence time within the lake coupled with the relatively undeveloped area, these watersheds were given a score of 1 to reflect the low vulnerability to contamination.

Both the Whitson and Whitewater watersheds drain most of the Valley area. This area consists of relatively flat agricultural areas with increasing urban development. The geology of the region is different than the bedrock areas typically found in the Sudbury region. There is a greater amount of overburden present and therefore more infiltration capacity than in other areas of the Vermilion watershed. Increased urban development in these watersheds reduces infiltration and increases surface runoff and therefore increases its vulnerability to contamination. These watersheds were given a score of 6 to reflect the moderate vulnerability of these watersheds to contamination.

Summary of Vulnerable Area Scoring

Table 5.5 shows the source vulnerability and area vulnerability factors for the Vermillion drinking water system intake protection zones.

Table 5.5– Vermilion River vulnerable area scoring

Intake Protection Zone	Source Vulnerability Factor	Area Vulnerability Factor	Vulnerability Score	Comments
IPZ-1	1.0	10	10	Fixed score
IPZ-2	1.0	7	7	Undeveloped Forested Bedrock Closest to intake
IPZ-3 Mid Vermilion below Stobie Dam	1.0	7	7	Undeveloped Forested Bedrock Closest to intake
IPZ-3 Whitewater	1.0	6	6	Low lying Agricultural Urban development
IPZ-3 Whitson River	1.0	6	6	
IPZ-3 Mid Vermilion above Stobie Dam	1.0	1	1	Undeveloped Forested

IPZ-3 Cameron	1.0	1	1	Bedrock geology Pockets of wetlands Many lakes From 15 to 105 km from the intake
IPZ-3 Lower Onaping River	1.0	1	1	
IPZ-3 Sandcherry Creek	1.0	1	1	
IPZ-3 Nelson River	1.0	1	1	
IPZ-3 Rapid River	1.0	1	1	
IPZ-3 Upper Vermilion	1.0	1	1	
IPZ-3 Upper Onaping River	1.0	1	1	

Intake Protection Zone Vulnerability Scoring Uncertainty

Uncertainty surrounding the vulnerable area scoring assignment is based on the ability of the vulnerability factors to effectively assess the relative vulnerability of the hydrological features. The vulnerability scores for the Vermilion River intake protection zones were primarily based on land cover within the watershed and are shown in Table 5.6.

Table 5.6– Uncertainty analysis for the vulnerable area scoring

	Uncertainty	Comment
Source Vulnerability Factor	Low	As the source vulnerability factor has been scored conservatively, there is high confidence that this factor will address any concerns up to the intake.
Area Vulnerability Factor – Score of 6 and 7	Low	These areas are heavily vegetated. The time of travel and moderate score should be sufficient to protect the intake from contamination.
Area Vulnerability Factor – Score of less than 6	Low	These contributing subwatersheds become progressively less vulnerable as the proximity to the intake decreases and the land cover becomes less vulnerable to contamination. There is high confidence that the score is sufficient.

29.3 Vermilion River Drinking Water Quality Threats Activities

The assessment of potential threats to drinking water quality followed Technical Rules 118 to 125 and the methodology as outlined in Chapter 2. The list of prescribed drinking water threats is located in Table 1.7 in Part 1 of this report.

List of circumstances of all is or would be threats

As required under O.Reg. 287/07 subsection 13, a list of references for all is or would be significant, moderate or low threats in each vulnerable area is provided in Table 5.7. Tables listing is or would be threats can be found in Appendix 5.

Table 5.7 – Table references for all is or would be threats and associated circumstances in the Vermilion River intake protection zones

Score	Significant	Moderate	Low
10	CIPZ10S- Chemicals in an IPZ with a vulnerability of 10 where threats are significant PIPZ10S- Pathogens in an IPZ with a vulnerability of 10 where threats are significant	CIPZ10M - Chemicals in an IPZ with a vulnerability of 10 where threats are moderate PIPZWE10M - Pathogens in an IPZ with a vulnerability of 10 where threats are moderate	CIPZWE10L - Chemicals in an IPZ with a vulnerability of 10 where threats are low PIPZ10L- Pathogens in an IPZ with a vulnerability of 10 where threats are low
7	N/A	CIPZWE7M - Chemicals in an IPZ or WHPA E where the vulnerability score is 7 where threats are moderate PIPZWE7M - Pathogens in an IPZ or WHPA E with a vulnerability of 7 where threats are moderate	CIPZWE7L- Chemicals in an IPZ or WHPA E where the vulnerability score is 7 where threats are low PIPZWE7L - Pathogens in an IPZ or WHPA E with a vulnerability of 7 where threats are low
6	N/A	CIPZWE6M - Chemicals in an IPZ or WHPA E where the vulnerability score is 6 where threats are moderate PIPZ6M - Pathogens in an IPZ with a vulnerability of 6 where threats are moderate	CIPZWE6L - Chemicals in an IPZ or WHPA E where the vulnerability score is 6 where threats are low PIPZ6L - Pathogens in an IPZ with a vulnerability of 6 where threats are low

Identification of areas where threats can occur

The areas where a potential threat is or would be significant, moderate or low are illustrated on Maps 5.3 to 5.5. According to the Technical Rules:

- Areas with a vulnerability score of 8 or greater has the potential for a significant, moderate or low threat.
- Areas with a vulnerability score of 6 or greater has the potential for a moderate or low threat to occur.
- Areas with a vulnerability score of 4 or greater has the potential for a low threat to occur.
- Areas with a vulnerability score of less than 4 cannot contain a drinking water threat.

Managed Lands

The storage, handling and application of agricultural source material, non-agricultural source material, pesticides and fertilizers can result in potential contamination of municipal water supplies. The methodology used to calculate percentage of managed lands in the vulnerable areas is described in Chapter 2.

The percentage of managed lands in the area was assessed to be under 40% (low) and is illustrated on Map 5.6.

Impervious Surfaces

Impervious surfaces are measured as an indicator of the amount of area where road salt can be applied. The percentage of surface area within a vulnerable area which will not allow surface water or precipitation to be absorbed into the soil is calculated. Most of the vulnerable areas in the Vermilion River intake watershed, including the area immediately around the municipal drinking water intake, have less than 1% impervious area. However, there are some built up areas in the Vermilion River intake watershed where impervious area is in the 8-80% range. The Valley municipal residential drinking water supply in one of these areas; see Chapter 33 for an assessment of the impervious area in the Valley area. Map 5.7 shows the percentage of impervious area in the Vermilion River intake watershed. The calculation of impervious surfaces led to the vulnerable area being designated as a moderate threat or a low threat for the application of road salt depending on the vulnerability score.

The methodology used to calculate percentage of impervious surfaces in the vulnerable areas is described in Chapter 2.

Livestock Density

The calculation of livestock density is based on the calculation of nutrient units per acre of agricultural managed lands. The methodology used to calculate the livestock density in the vulnerable areas is described in Chapter 2. Most of the Vermilion River watershed is forested, however, there are some pockets of agricultural activity, primarily in the Whitson River subwatershed. Overall, there was a score of under 0.5 nutrient units per acre. The results are illustrated on Map 5.8.

The combination of livestock density and managed land calculations assigns a threat rating for the application of commercial fertilizer. Table 5.8 illustrates this threat in different vulnerability areas.

Enumeration of Significant Threats

Table 5.8 lists an estimate of the current number of moderate and low drinking water quality threats in the Vermilion River drinking water system in accordance with the Drinking Water Threats Tables.

Table 5.8 – Drinking water quality threats for the Vermilion River drinking water system

Drinking Water Threat Category	Number of Occurrences with Threat Classification		
	Significant	Moderate	Low
IPZ-1			
The application of commercial fertilizer to land.		1	
The handling and storage of fuel.		1	
The application of road salt.		1	
Local threat: Transportation of hazardous substances along transportation corridors.			
IPZ-2			
The application of commercial fertilizer to land.			1
The application of road salt.			1
Local threat: Transportation of hazardous substances along transportation corridors.			
IPZ-3			
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act.		2	
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.			450
The application of commercial fertilizer to land.			1
The application of road salt.			1
Local threat: Transportation of hazardous substances along transportation corridors.		1	6

29.4 Vermilion River Drinking Water Threats Conditions

A drinking water condition is a situation that results from a past activity and meets the criteria laid out in Chapter 2. For a more detailed review of the methodology for identifying drinking water conditions, please refer to Part 1, Chapter 2.

The areas where a significant, moderate or low threat condition could exist are the same as the areas where a potential threat could occur. For an illustration, please see Map 5.3 to 5.5.

Currently, there are no identified significant conditions within the Vermilion River intake vulnerable areas.

29.5 Vermilion River Drinking Water Quality Issues

Drinking water quality issues were assessed based on the methodology outlined in Chapter 2 and Rules 114 and 115.

Currently, there are no known water quality issues in the raw water at the Vermilion River intake.

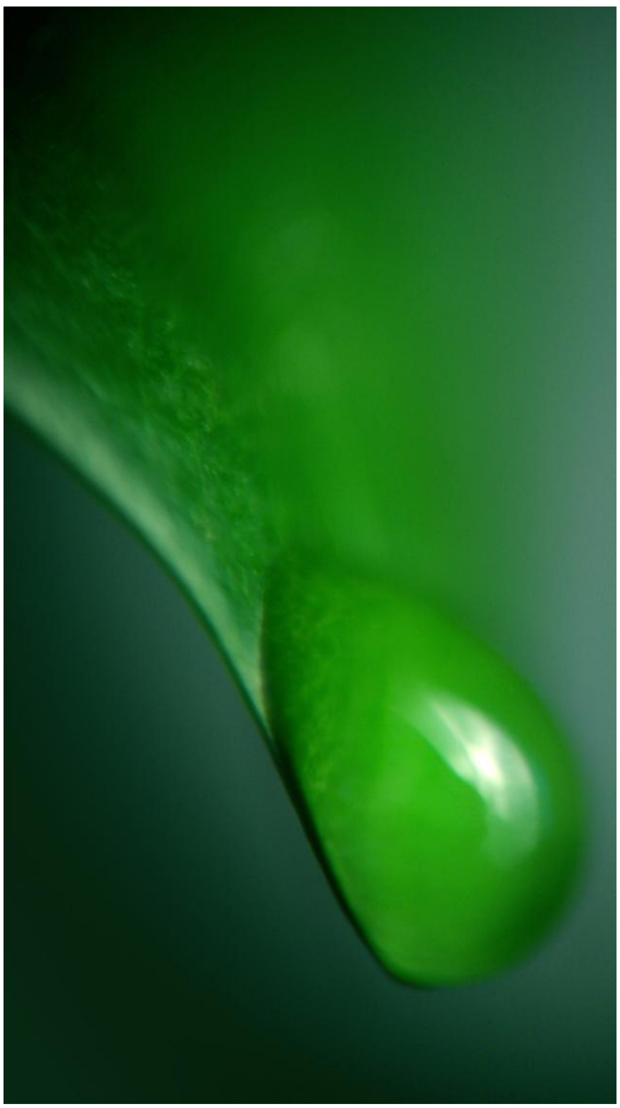
Xeneca Power Development Inc. has a proposed hydro project just above Cascade Falls. The impact of this proposed project on water quality will be assessed through the local and provincial review process for proposed projects.

Chapter 30 - Data Gaps

The analyses for this drinking water system were carried out using the best data available to meet the assessment report requirements. Completing scientific assessments on the quality and quantity of water undoubtedly raises a number of questions and uncertainties regarding the methodologies used, availability of data, reliability of data and overall outcome. As new information arises, either from increased or continuous monitoring, improved models or a change in methodology, the results from this report will have to be updated.

The assessment report is a constantly evolving document as new information becomes available and refinements in approaches are made. Changes in land use will also impact the identification of potential threats to water quality and quantity. Therefore, there will be a need to continue filling in identified data gaps and to carry out studies in the future. Data gaps for the Vermilion River intake include:

- travel time through Cascade Falls and the pool at the WTP intake; and
- detailed contaminant mixing effects at higher discharge rates.



Part Six

The Valley Drinking Water System

The Valley Drinking Water System consists of 13 wells and is the most extensive groundwater system within the City of Greater Sudbury, supplying approximately 35,000 residents with drinking water.

Approved on September 2, 2014

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Chapter 31 - The Valley Drinking Water System

The Valley drinking water system consists of 13 wells and is the most extensive groundwater system within the City of Greater Sudbury. Two new wells were added to the Valley distribution system in 2013, which brought the number of wells in this system from 11 to 13. The Valley drinking water system is a combination of two former systems: the Blezard Valley and the Capreol drinking water systems. The combined system supplies approximately 36,000 residents in the communities of Chelmsford, Azilda, McCrea Heights, Val Therese, Val Caron, Hanmer and Capreol with drinking water.

The wells in the former Blezard Valley system are locally referred to as the Valley East wells. Of the 13 municipal wells, 10 are located within the Whitson River watershed (Kenneth, Deschene, Philippe, Michelle, Frost, Linden, Notre Dame, Pharand, and the two recently drilled wells, Q and R) and three are located in the Vermilion River watershed (Wells M, J and I). See Map 6.1 for the location of the wells and the distribution system.

There are three storage reservoirs which are located in Azilda, Chelmsford and Val Caron, and one pressure booster station at Centennial Drive in the distribution system. Wells are pumped as required based on the level of the Chelmsford Reservoir. UV systems provide primary treatment followed by injection with chlorine gas and fluoridation. All wells are monitored continuously and can be manually controlled from the Wanapitei Water Treatment Plant.

A summary of water usage rates for each of the wells is presented in Table 6.1.

Table 6.1– Permitted and actual pumping rates in the Valley drinking water system

	Deschene Well A	Kenneth Well B	Philippe Well C	Frost Well D	Notre-Dame Well E	Linden	Pharand	Michelle	Well I	Well M & J

Permitted Amount (m^3/day)	1,798	2,288	2,288	2,288	3,105	3,269	2,290	2,290	1,973	7,200
Average Monthly Permitted Amount (m^3)	54,689	69,593	69,593	69,593	94,444	99,432	69,654	69,654	60,012	219,000
Average Actual Monthly Volume (m^3)	21,705	26,955	30,547	41,045	40,299	49,566	25,272	35,655	27,985	65,151
Percentage of Monthly Permitted Volume	40%	39%	44%	59%	43%	50%	36%	51%	47%	30%
Maximum Actual Monthly Volume (m^3)	50,572	44,060	42,805	75,135	42,805	69,993	41,698	55,372	48,259	130,001
Percentage of Monthly Permitted Volume	92%	63%	62%	108%	45%	70%	60%	79%	80%	59%
95^{th} Percentile (m^3)	32,424	37,470	38,902	56,417	73,319	61,643	37,427	47,770	40,821	93,743
Percentage of Monthly Permitted Volume (95^{th} Percentile)	59%	54%	56%	81%	78%	62%	54%	69%	68%	43%

Chapter 32 - The Valley Contributing Areas

Valley East is located in a low lying 'valley' containing glaciofluvial and glaciolacustrine deposits in the Whitson River watershed, a subwatershed of the Vermilion River watershed. Valley East includes the communities of Val Caron, Val Therese, Hanmer and Blezard Valley. The Valley East area is characterized by low topography and some of the deepest overburden deposits in the City of Greater Sudbury. Drainage in the area is generally towards the Whitson River, which, in turn, discharges to the Vermilion River to the southwest of the community of Chelmsford.

From the City of Greater Sudbury groundwater study (Golder 2005), capture zones were developed based on the maximum pumping rates. Based on groundwater elevation data, it was interpreted that groundwater flow to these wells is from the northeast. For the Tier 1 budgeting, the area of watershed that contributes to these wells was estimated as the area surrounding the modeled capture zones plus a 500 m buffer down gradient of the capture zone limit. To the north of the well field, the groundwater divide was used as a flow boundary and to the east the large discharge wetland acted as a flow boundary. The catchment includes runoff from the bedrock knob in the south of the well field. The estimated catchment area around these wells was 34 km^2. See Maps 6.2 and 6.3 for an illustration of the contributing areas.

Chapter 33 - Water Budget and Quantity Assessment

The Valley drinking water system lies within the Vermilion River watershed. As previously described in Chapter 28, the Vermilion watershed was given a water quantity stress level of low and therefore did not need to progress to the next level of a water quantity assessment. Given the isolated nature of the municipal wells, it was decided by the Greater Sudbury Source Protection Area technical team that a Tier 1 water budget should be completed for each drinking water system. The Tier 1 and Tier 2 analyzes were done when the Blezard Valley and Capreol systems were separate systems and before the two new wells (Q and R) came on line. Therefore, the Tier 1 and Tier 2 work was done separately for these two systems and did not include wells Q and R. No further analysis beyond Tier 1 was required for the Capreol system, but the results of the analysis for the Blezard Valley system led to a Tier 2 analysis. The results of the Tier 2 analysis led to a Tier 3 analysis, which was done for the new, combined Valley system and also included the new Q and R wells. The methodology used for Tier 1, Tier 2 and Tier 3 is described in greater detail in Chapter 3 and Appendix 2.

33.1 Tier 1 Water Budget and Stress Assessment

Tier 1 Water Budget

There are no major stream inputs or outflows in this catchment area, so the model for this catchment was a simple vertical soil moisture budget completed for the time period 1970-2005. In the Valley East Well Aquifer, the average annual recharge was calculated to be the average annual water surplus (428 mm). The water removed by all groundwater wells was estimated at approximately 90 mm, or 43% of the permitted pumping rate.

The demand on the Valley East groundwater system has increased over the period 2000-2005. The NDCA has recently started monitoring groundwater elevation in Hanmer, within the Valley East catchment area. Available data shows the transient nature of groundwater recharge that agrees with the monthly soil moisture budget. Other than municipal removals, two other groundwater permits to take water are within the contributing area. In addition, there is a small amount of agricultural water use estimated in this well catchment area. Tables 6.2 and 6.3 summarize the water budget for Valley East (Blezard Valley) and Capreol wells contributing areas respectively.

Table 6.2 – Water budget for the Valley East (Blezard Valley) contributing area

Month	Water Balance Element (mm)							
	Rainfall	Snowfall	Snowmelt	Total Input	PET*	AET**	Water Surplus	Water Deficit
January	2.8	61.8	6.1	8.9	0.0	0.0	8.9	0.0
February	3.1	48.4	13.8	16.9	0.0	0.0	16.9	0.0
March	19.5	45.6	68.2	87.7	0.0	0.0	87.7	0.0
April	51.2	13.0	126.3	177.5	19.5	19.5	158.0	0.0
May	80.8	1.0	8.6	89.3	75.0	73.1	16.2	0.0
June	78.4	0.0	0.0	78.4	110.7	98.5	0.0	-20.1
July	78.8	0.0	0.0	78.8	130.5	101.1	0.0	-22.3
August	85.3	0.0	0.0	85.3	112.5	86.6	0.0	-1.3
September	107.1	0.0	0.0	107.1	69.3	66.6	40.5	0.0
October	81.9	2.4	2.4	84.4	30.1	30.1	54.3	0.0
November	45.1	33.3	19.4	64.4	0.8	0.8	63.6	0.0
December	9.8	55.8	15.0	24.8	0.0	0.0	24.8	0.0
Annual Total	643.7	261.3	259.9	903.5	548.3	476.2	471-0	-43.7
Annual Recharge							**427.3**	

*PET – Potential Evapotranspiration
**AET – Actual Evapotranspiration

Table 6.3 – Water budget for the Capreol wells contributing area

Month	Water Balance Element (mm)										
	Rainfall	Snow -fall	Snow-melt	Total Input	PET*	AET**	Stream-flow	Base -flow	Run-off	Water Surplus	Water Deficit
January	2.8	61.8	6.1	8.9	0.0	0.0	16.8	9.6	9.6	0.0	-7.9
February	3.1	48.8	13.8	16.9	0.0	0.0	12.7	6.6	6.6	4.2	0.0
March	19.5	45.6	68.2	87.7	0.0	0.0	16.6	5.7	13.3	71.1	0.0
April	51.2	13.0	126.3	177.5	19.5	19.5	85.3	18.9	75.6	72.7	0.0
May	80.8	1.0	8.6	89.3	75.0	73.7	80.0	13.7	77.8	0.0	-64.4
June	78.4	0.0	0.0	78.4	110.7	101.9	35.9	7.9	31.7	0.0	-59.4
July	78.8	0.0	0.0	78.8	130.5	108.0	18.3	9.4	11.5	0.0	-47.5
August	85.3	0.0	0.0	85.3	112.5	91.5	12.5	6.4	7.9	0.0	-18.7
September	107.1	0.0	0.0	107.1	69.3	67.2	12.9	5.7	8.6	0.0	0.0
October	81.9	2.4	2.4	84.4	30.1	30.1	22.5	9.0	16.8	27.0	0.0
November	45.1	33.3	19.4	64.4	0.8	0.8	30.1	11.7	21.6	336.6	0.0
December	9.8	55.8	15.0	24.8	0.0	0.0	26.7	12.2	18.3	0.0	-1.9
Annual Total	643.7	261.3	259.9	903.5	548.3	492.6	370.4	117.0	299.5	240.3	-199.8
Annual Recharge										**40.5**	

*PET – Potential Evapotranspiration
**AET – Actual Evapotranspiration

Tier 1 Water Quantity Stress Assessment

For the Valley East (Blezard Valley) wells, calculated present monthly groundwater stress was consistently between 22 and 26% throughout the year with a maximum estimated in June at 25.5%. With future municipal demand forecasted, the June monthly groundwater stress level increased to 27.5%. On an annual basis, groundwater stress level was calculated as 23.4 and 25.2% for present and future scenarios, respectively. The monthly maximum stress was greater than 25% under present and future conditions, and therefore this contributing area was designated as a 'moderate' stress level. Since there was not substantial monthly variation in supply or demand, annual average stress levels were calculated to be close to 25% for current conditions and above 25% for future scenarios. Therefore, the contributing area was designated as 'moderate' (current) and 'significant' (future) groundwater stress level on an annual basis. Calculated 'moderate' and 'significant' annual water quantity stress levels require a Tier 2 local area assessment. Stress levels for the Capreol system were low. Water quantity stress assessment for the Valley East (Blezard Valley) and Capreol wells contributing areas are summarized in Tables 6.4 and 6.5.

Table 6.4 – Water quantity stress assessment for the Valley East (Blezard Valley) contributing area

Month	Supply (m^3/s)	Demand (m^3/s)	Stress (%)

	Recharge	Reserve	Municipal	Other	Total	Forecast	Present	Forecast
January	0.46	0.05	0.09	0.001	0.09	0.10	22.36	24.07
February	0.46	0.05	0.09	0.001	0.09	0.10	22.78	24.55
March	0.46	0.05	0.09	0.001	0.09	0.10	22.76	24.50
April	0.46	0.05	0.09	0.001	0.10	0.10	23.10	24.89
May	0.46	0.05	0.10	0.001	0.10	0.11	23.74	25.58
June	0.46	0.05	0.10	0.001	0.11	0.11	25.52	27.52
July	0.46	0.05	0.10	0.001	0.10	0.11	23.77	25.61
August	0.46	0.05	0.10	0.001	0.10	0.11	24.23	26.11
September	0.46	0.05	0.10	0.001	0.10	0.11	24.29	26.18
October	0.46	0.05	0.10	0.001	0.10	0.11	23.93	25.78
November	0.46	0.05	0.09	0.001	0.09	0.10	22.26	23.97
December	0.46	0.05	0.09	0.001	0.09	0.10	21.89	23.55
Annual	**0.46**	**0.05**	**0.10**	**0.001**	**0.10**	**0.10**	**23.39**	**25.19**

Table 6.5 – Water quantity stress assessment for the Capreol wells contributing area

Month	Supply (m^3/s)		Demand (m^3/s)				Stress (%)	
	Recharge	Reserve	Municipal	Other	Total	Forecast	Present	Forecast
January	0.86	0.09	0.05	0.0	0.05	0.06	6.97	7.60
February	0.86	0.09	0.05	0.0	0.05	0.05	6.12	6.67
March	0.86	0.09	0.05	0.0	0.05	0.06	6.99	7.62
April	0.86	0.09	0.05	0.0	0.05	0.05	6.10	6.65
May	0.86	0.09	0.05	0.0	0.05	0.06	6.9	7.52
June	0.86	0.09	0.05	0.0	0.05	0.05	6.27	6.83
July	0.86	0.09	0.05	0.0	0.05	0.05	6.38	6.95
August	0.86	0.09	0.05	0.0	0.05	0.05	5.93	6.47
September	0.86	0.09	0.05	0.0	0.05	0.05	6.13	6.68
October	0.86	0.09	0.04	0.0	0.04	0.05	5.78	6.31
November	0.86	0.09	0.05	0.0	0.05	0.05	5.84	6.36
December	0.86	0.09	0.04	0.0	0.04	0.05	5.53	6.02
Annual	**0.86**	**0.09**	**0.05**	**0.0**	**0.05**	**0.05**	**6.25**	**6.81**

Tier 1 Water Budget and Stress Assessment Uncertainty

Uncertainty in the Tier 1 process takes into account the quality of the available data. Municipal water removals and water use trends were obtained from the City of Greater Sudbury and from industry, and large volume permits to take water were checked for actual use and active status. For each Tier 1 water budget, the water surplus was in the range of that reported in the literature (e.g. Richards 2002). For all groundwater sources the estimated uncertainty is low.

33.2 Tier 2 Water Budget and Stress Assessment

Tier 2 Water Budget

The Tier 2 water budget analysis was done for the eight wells in the Valley East (Blezard Valley) system. The annual water budget for the delineated subwatershed as shown in Table 6.6 was compiled using regional climate data and recharge as calculated by the calibrated MODFLOW model under steady-state conditions. Annual recharge as estimated by the 3-D model MODFLOW was 298 mm, or approximately 9,300,000 m^3 when weighted by recharge area across the delineated subwatershed. The remainder, runoff, was available for drainage to the ditches and municipal drains that fall within the subwatershed. Sublimation accounted for approximately 3% of the total precipitation input on an annual basis and represented a small loss in the amount of water available for recharge and runoff.

Groundwater recharge as estimated through the MODFLOW model calibration process was approximately 70% of the annual recharge previously estimated under the Tier 1 soil moisture accounting methodology. Realistically, recharge is more temporally dynamic and depends upon daily and monthly precipitation, antecedent moisture conditions and soil temperature conditions. The total current annual pumping amount from the municipal wells within the subwatershed was approximately 35% of the calibrated MODFLOW recharge value on an annual basis.

Table 6.6 – Valley East (Blezard Valley) Tier 2 annual water budget

	Water Budget Element (m^3)				
	Rainfall	Snowmelt	Evapotranspiration	Recharge	Runoff
Annual Average	20,262,000	6,900,000	15,704,000	9,300,000	2,158,000

Tier 2 Water Quantity Stress Assessment

The general methodology for the Tier 1 and 2 water quantity stress assessment process is outlined in Chapter 3 and Part III of the Technical Rules.

Scenarios A and B – Subwatershed Stress Assignment

Monthly stress level assignments are displayed in Table 6.7. Monthly water demand (as a percentage of water supply) ranged from 38 to 42% under current pumping rates and from 39 to 43% under forecasted pumping rates. The consistency in stress calculation results are a reflection of the equal partitioning of annual recharge, and relatively stable monthly water demand requirements throughout the year.

Discussions with Greater Sudbury staff and the Peer Review Team have identified that water table decrease (and therefore, potential distribution concerns) in Valley East are most relevant during the summer months, when precipitation is less than evaporation resulting in less water reaching the groundwater table. Regardless, the monthly maximum water demand was >25% and <50% of supply for Scenarios A and B, and therefore were designated a Stress Level Assignment of 'moderate'.

On an average annual basis, water demand (as a percentage of water supply) was 41% under current pumping rates and 43% under forecasted pumping rates. These demand scenarios (A and B) were both >25%, and were designated a Stress Level Assignment of 'significant'. As defined in the Technical Rules, subwatersheds assigned a moderate or significant stress level will proceed to a Tier 3 water budget.

As noted above, water supply concerns are considered to be most prevalent during the drier summer months in Valley East. During these months, groundwater recharge is decreased, and water is removed from aquifer storage. The current calculations for stress level assignment do not account for these short term changes in the water budget.

Scenario D and E – Two Year Drought with Current and Future Pumping Rates

The two-year drought, defined in the Technical Rules as a 'worst-case' period where no recharge is available to the groundwater table for two years, simulated drawdown of at least 1 m in each well under the current and future pumping rates. With current pumping rates (Scenario D) the Philippe, Notre Dame, Linden, and Michelle wells were simulated to fall below the top of the well screen, while under forecasted pumping rates (Scenario E) these well screens, along with the Kenneth well screen, were exposed. In general, drawing the water level below the top of a well screen can lead to decreased well efficiency and increased maintenance costs associated with mineral precipitation on the screen. Operators will commonly terminate pumping at a well that approaches the screen height in order to allow the water table to recover. The simulated well screen exposure and resulting (likely) interruption of service at a number of the wells in Valley East indicated a 'moderate' stress level assignment under Scenarios D and E.

Scenarios G and H – Ten Year Drought with Current and Future Rates

Ten-year transient drought scenarios were completed as a follow-up to the finding of several well screen exposures simulated under the two-year drought scenario. The ten-year drought conditions were simulated with both current and future daily pumping rates. Annual precipitation at the Sudbury airport has displayed an increasing trend for the period 1954 to 2008. Using a running average, the lowest 10-year average recorded precipitation was 790 mm/year, which occurred during the period 1955 to 1964. This value represents an annual precipitation approximately 13% lower than the long-term average for the area (900 mm/year).

The results of this analysis indicated that under the simulated ten-year drought conditions, the water level in the Michelle well fell below the top of screen elevation during current pumping scenarios (Scenario G), while the Linden well also reached the well screen under the future pumping scenarios (Scenario H). In these cases, the stress assignment level was designated as 'moderate'.

Table 6.7 – Tier 2 monthly and annual groundwater stress assessments for the Valley East (Blezard Valley) wells

Month	Supply (m^3)	Demand (m^3)					Reserve (m^3)	Stress (%)	
	Recharge	Municipal Wells (Current)	Municipal Wells (Future)	PTTW	Agriculture	Rural	10% of Groundwater Recharge	Water Demand (Current)	Water Demand (Future)
January	775,000	279,000	292,000	0	5,000	6,000	77,000	42	43
February	775,000	252,000	263,000	0	5,000	6,000	77,000	38	39
March	775,000	279,000	282,000	0	5,000	6,000	77,000	42	42
April	775,000	279,000	282,000	0	5,000	6,000	77,000	40	42
May	775,000	279,000	292,000	0	5,000	6,000	77,000	42	43
June	775,000	279,000	282,000	0	5,000	6,000	77,000	40	42
July	775,000	279,000	292,000	0	5,000	6,000	77,000	42	43
August	775,000	279,000	292,000	0	5,000	6,000	77,000	42	43
September	775,000	279,000	282,000	0	5,000	6,000	77,000	40	42
October	775,000	279,000	292,000	0	5,000	6,000	77,000	42	43
November	775,000	279,000	282,000	0	5,000	6,000	77,000	40	42
December	775,000	279,000	292,000	0	5,000	6,000	77,000	42	43
Annual	**9,299,000**	**3,284,000**	**3,425,000**	**0**	**65,000**	**76,000**	**930,000**	**41**	**43**

Scenarios F and I – Two Year and Ten Year Drought Scenarios with Planned System

Under the Planned System droughts (Scenario F and I), all water is supplied to the communities through a distribution line from Wanapitei Lake. As such, exposing the screen at any of the municipal wells does not have an operational, or water demand, effect on the local serviced population. Simulation of the two-year drought and ten-year drought with no municipal pumping resulted in a maximum water table drawdown of 2 m and no simulated screen exposure. Therefore the stress level assignment for Scenario F and Scenario I was 'low'.

The results of the steady-state and transient simulations for the Valley East subwatershed show that stress assignments range from 'significant' under the future pumping rate annual average condition to 'low' under scenarios where the Wanapitei Lake future source is operational. All scenarios are summarized in Table 6.8.

Table 6.8 – Tier 2 subwatershed stress level scenario summary

Scenario	Description of Scenario	Results and Comments
A	Existing system – average	Maximum monthly = 42% Moderate stress level Average Annual = 41% Significant stress level
B	Existing system – future demand	Maximum monthly = 43% Moderate stress level Average Annual = 43% Significant stress level
C	Planned system demand – operational year	Monthly Demand% = 0 Low stress level
D	Existing system – two year drought	Screen exposure at 4 wells Moderate stress level
E	Existing system – future two year drought	Screen exposure at 5 wells Moderate stress level
F	Planned system demand – operational year – two year drought	No municipal well operation No screen exposure Low stress level
G	Existing system – future ten year drought	Screen exposure at 1 well Moderate stress level
H	Existing system – ten year drought	Screen exposure at 4 wells Moderate stress level
I	Planned system demand – operational year – ten year drought	No municipal well operation No screen exposure Low stress level

Tier 2 Significant Groundwater Recharge Areas

The model for the Valley East (Blezard Valley) subwatershed was significantly refined for the purposes of the Tier 2 water budget. Rule 46 of the Technical Rules state that a significant groundwater recharge area (SGRA) shall be delineated based on the models developed for the water budget assessment. Therefore, the SGRA delineation was further refined to reflect the updated information generated from the Tier 2 process. See Chapter 12 for more information about calculating significant groundwater recharge areas.

In the Valley East (Blezard Valley) subwatershed, the average annual water surplus was estimated at 367 mm. A value of 202 mm (or 55% of 367 mm) was then calculated as the amount of surplus water and available for recharge on an annual basis to aquifers within the subwatershed. Recharge areas were mapped using the calibrated groundwater model developed for the Tier 2 water budget. The SGRA was delineated in areas where the coarse overburden exists and where the recharge value is greater than 202 mm. Vulnerability for most of this area scored a 6 (high), but there are two small pockets with a vulnerability score of 4 (medium). See Map 6.4 for the delineation and vulnerability assessment of the significant groundwater recharge area.

Tier 2 Water Budget and Stress Assessment Uncertainty

The 3-D MODFLOW model of the Valley East (Blezard Valley) municipal well system was calibrated to steady-state conditions such that the simulated water table elevations provide a reasonable representation of the observed groundwater elevations from the MOE Well Water Information System (WWIS) and available groundwater monitoring wells.

Areas of uncertainty in the calibration process and the resulting parameterization of the Valley East MODFLOW model are presented in Appendix 2. With respect to the predictive simulations completed to support the drought simulations in the Tier 2 process, uncertainty in the groundwater supply (water level in each well) was considered to be a function of the soil properties. In transient simulation mode, the MODFLOW program requires additional aquifer parameters to be estimated. The parameters, specific yield and specific storage were therefore adjusted in a series of sensitivity simulations with the model set to current pumping rates during drought scenarios.

Overall, although the lowest simulated groundwater elevations were changed, screen exposure occurred in at least one well under each modeled scenario and did not change the 'moderate' designation for Scenarios G and H.

33.3 Tier 3 Water Budget and Local Area Risk Assessment

The Tier 3 water budget and local area risk assessment for the Valley system incorporates all 13 wells in the area: the wells in Capreol and the Valley East well field, including the two new wells, Q and R. The local area risk assessment for the Valley system was completed using a 3-Dimensional groundwater model as set out in the Technical Bulletin: Part IX Local Area Risk Level, for both existing and future pumping rates. The existing actual water demand calculations were based on the 2007 study year using pumping rates included in the City of Greater Sudbury Water Works Reports. The methodology for the potential water quantity risks from land use changes was developed with the help of the water budget peer review committee. The Tier 3 local area risk assessment for the Valley system also included updated available information with respect to the pumping well infrastructure.

WHPA-Q1, WHPA-Q2 and Local Area Delineations

Following the methodology provided in Appendix 2, three distinct WHPA-Q1, WHPA-Q2 and Local Areas were delineated. In each case, the surface area that provided sufficient recharge to provide the total annual water removal from the aquifer corresponded closely to a 1 m drawdown area of influence. These areas were designated as WHPA-Q1-A, WHPA-Q1-B and WHPA-Q1-C (Map 6.5). The WHPA-Q1-B incorporated only the 'I' Well, WHPA-Q1-C incorporated the J Well and M Wells, while the remaining wells fell within the WHPA-Q1-A. The drawdown created by J Well and M Well was limited in extent, and as such as per MNR direction a 100 m buffer was placed around these wells to delineate a WHPA-Q1.

The WHPA-Q2 was delineated through the reduction of recharge from planned development areas outside each of the delineated WHPA-Q1, which affected only the WHPA-Q1-A (Map 6.5). Repeating the simulation under these reduced recharge conditions resulted in no substantial change in area required to supply the municipal wells with sufficient water on an annual basis. As such, the WHPA-Q2 was equivalent to the WHPA-Q1 in each case.

Three Local Areas were subsequently defined as the area delineated by each of the WHPA-Q2 areas, and were designated as Local Area A (with ten municipal wells), Local Area B (with one municipal well) and Local Area C (with two municipal wells) (Map 6.5). In the case of the Local Area A, the delineated surface area (38.2 km^2) is greater than the subwatershed area calculated in earlier GSSPA Valley East Water Budget reports (34 km^2). The change in area can be attributed to the inclusion of the two additional wells and that the basis for the subwatershed area was the use of groundwater capture zone areas.

Water Budget

The annual water budget for Local Area A as shown in Table 6.9 was compiled using regional climate data and recharge as calculated by the calibrated MODFLOW model under steady-state conditions.

Table 6.9 – Tier 3 Local Area A annual water budget

Water Budget Element (m^3)[1]					
	Rainfall	Snowmelt	Evapotranspiration [2]	Recharge[3]	Runoff
Annual Average	24,808,000	8,448,100	19,227,300	10,831,600	3,197,200

Note:
[1] All water budget elements distributed over subwatershed area (38.2 km^2)
[2] Evaporation presented is AET and includes sublimation
[3] Recharge estimated using MODFLOW calibration and weighted to recharge area in subwatershed

Annual recharge as estimated by the 3-D model MODFLOW was 283.6 mm, or approximately 10,831,600 m^3 when weighted by recharge area across the delineated Local Area A (Map 6.5). The remainder, runoff, was available for drainage to the ditches and municipal drains that fall within the Local Area A. Sublimation accounted for approximately 3% of the total precipitation input on an annual basis and represented a small loss in the amount of water available for recharge and runoff.

The total current annual pumping amount from the municipal wells ($Anth_{OUT}$) within Local Area A was approximately 41% of the calibrated MODFLOW recharge value on an annual basis.

Groundwater Risk Assessment

Details on the groundwater risk assessment are provided in Appendix 2. The assessment considers the Formation Loss component of the total drawdown as well as additional in-well losses that may occur during actual operations. The in-well losses component are further described later in this section.

For all scenarios, the low simulated head at Linden well, when compared to the other wells in close proximity (Notre-Dame, when applicable Chenier (Q) and well R) was noted at peer review meetings and was the focus of sensitivity analysis performed on the model. This sensitivity analysis is explained later in this section (see Tables 6.10, 6.11 and 6.13) and the water level plots of the simulated water levels in Linden well compared to the other nearby wells can be found in Appendix 2.

Other uses (aquatic habitat) were investigated in the absence of certainty of the presence of cold water streams within Local Area A. Modelled scenarios produced baseflow (groundwater discharge) changes compared against Scenario (C). The other uses analysis was applicable to Scenarios G(1) and G(2), however, risk assignments based on other uses was applied only to Scenario G(2).

Scenario C – Long Term Climate, Existing Pumping, Existing Land Cover

Simulated steady state drawdown for each existing municipal well is summarized in Table 6.10. For this Scenario, water level remained above the trigger elevation (pump intake). This is consistent with the current understanding of the system, that it is able to provide water to satisfy the existing municipal demand.

Table 6.10 – Tier 3 Scenario C groundwater model output

Well Name	Steady-State Simulated Groundwater Elevation (masl)	Bottom of Pump intake (masl)	Top of Screen (masl)
A - Deschene	293.0	287.7	286.9
B - Kenneth	290.7	283.6	282.9
C - Philippe	291.8	285.6	284.7

D - Frost	291.4	284.1	281.9
E - Notre Dame	290.1	284.1	283.7
F - Linden	285.7	278.6	277.2
G - Pharand	288.1	285.0	285.0
H - Michelle	292.0	285.5	285.8
I Well	290.2	282.4	280.3
J Well	294.0	275.3	274.2
M Well	293.4	277.0	274.8

Scenario D – Drought Period, Existing Pumping, Existing Land Cover

Simulated transient water level plots for aquifer level outside of each existing municipal well are displayed in Appendix 2. For the ten-year drought period (1955 to 1964), drawdown ranges from <1 m (Well J) to approximately 4 m (at the Michelle and Phillipe Wells). However, groundwater table elevation was maintained above the intake trigger elevation for each of the municipal wells.

Scenario G(1) – Long Term Climate, Existing plus Committed plus Planned Pumping, Future Land Cover

Simulated steady state drawdown for each existing and planned municipal well is summarized in Table 6.11.

Table 6.11 – Tier 3 Scenario G(1) groundwater model output

Well Name	Steady-State Simulated Groundwater Elevation (masl)	Bottom of Pump intake (masl)	Top of Screen (masl)
A - Deschene	291.3	287.7	286.9
B - Kenneth	289.2	283.6	282.9
C - Philippe	289.8	285.6	284.7
D - Frost	290.0	284.1	281.9
E - Notre Dame	287.6	284.1	283.7
F - Linden	282.4	278.6	277.2
G - Pharand	287.3	285.0	285.0
H - Michelle	289.8	285.5	285.8
I Well	287.7	282.4	280.3
J Well	293.8	275.3	274.2
M Well	293.1	277.0	274.8
Q - Chenier	288.5	-	285.5
R Well	287.3	-	284.9

With respect to other uses, changes to aquatic habitat were assessed using simulated changes to baseflow to the tributaries to the Whitson River (within Local Area A). Two of these tributaries or municipal drains were simulated to show baseflow reductions of greater than 20% (Table 13). Although many of these tributaries are likely intermittent and relatively shallow, they cannot be excluded from providing potential for transient habitat for trout species. These simulations suggest minimal (<5%) baseflow reduction to the Whitson River, and provide context for potential future land use change impacts, but were not applied to the risk assignment for Scenario G(1).

Table 6.12 - Predicted baseflow reductions, Tier 3 Scenario G(1)

Tributary	Scenario C Baseflow (m^3/day)	Scenario G(1) Baseflow (m^3/day)	Percent Change (%)
Rivest Drain	11	8	27
Trib.5	550	524	5
Trib.6	1,007	991	2
Trib.6D	136	136	0
Trib.8	501	437	13
Trib.8A	879	799	9
Trib.10	444	410	8
Trib.11	12,260	8,910	27
Trib.12	13,910	13,767	1
Whitson	6,961	6,938	0.3
WSC Station	15,338	15,122	1

Note: Subwatersheds as delineated in Appendix 2.

For Scenario G(1) the simulated groundwater levels suggest the quantity of water removed from each Local Area would be sufficient to meet the municipal water demand.

Scenario G(2) – Long Term Climate, Existing plus Committed plus Planned Pumping, Existing Land Cover

Simulated steady state drawdown for each existing and planned municipal well is summarized in Table 6.13. For this Scenario, water level remained above the trigger elevation (pump intake). Water levels simulated during G(2) were approximately 1 m higher than those produced under Scenario G(1), indicating the effect of land cover change on the aquifer level.

Table 6.13 – Tier 3 Scenario G(2) groundwater model output

Well Name	Steady-State Simulated Groundwater Elevation (masl)	Bottom of Pump intake (masl)	Top of Screen (masl)
A - Deschene	291.5	287.7	286.9
B - Kenneth	289.4	283.6	282.9
C - Philippe	290.1	285.6	284.7
D - Frost	290.2	284.1	281.9
E - Notre Dame	288.0	284.1	283.7
F - Linden	282.8	278.6	277.2
G - Pharand	287.5	285.0	285.0
H - Michelle	290.1	285.5	285.8
I Well	287.8	282.4	280.3
J Well	293.8	275.3	274.2
M Well	293.1	277.0	274.8
Q - Chenier	288.9	-	285.5
R Well	287.8	-	284.9

With respect to other uses, changes to aquatic habitat were assessed using simulated changes to baseflow to the tributaries to the Whitson River (within Local Area A). The recently constructed Rivest Drain displayed a reduction of 18% and Tributary 11 a reduction of >20% (Table 6.14). The Rivest Drain was designed as a shallow drain that would be constructed with an invert near or above the groundwater table (K. Smart Associates 2009), and therefore can be expected to be dry for much of the year. It was therefore considered a poor representation of the baseflow changes expected in the area. Although many of these tributaries are likely intermittent and relatively shallow, they cannot be excluded from providing potential for transient habitat for trout species. As such, these reductions in baseflow must be considered when assigning risk level to Scenario G(2). Similar to Scenario G(1), the simulation results for Scenario G(2) suggest minimal (1 - 2%) baseflow reduction to the Whitson River.

Table 6.14 - Predicted baseflow reductions, Tier 3 Scenario G(2)

Tributary	Scenario C Baseflow (m^3/day)	Scenario G(2) Baseflow (m^3/day)	Percent Change (%)
Rivest Drain	11	9	18
Trib.5	550	538	2
Trib.6	1,007	1,001	1
Trib.6D	136	136	0
Trib.8	501	473	6
Trib.8A	879	845	4
Trib.10	444	424	5
Trib.11	12,260	9,655	21
Trib.12	13,910	13,808	1
Whitson	6,961	6,953	0.1
WSCStation	15,338	15,253	1

Note: Subwatersheds as delineated in Appendix 2.

For Scenario G(2), the simulated groundwater levels suggest the allocation quantity of water removed from each Local Area would be sufficient to meet the existing plus committed plus planned water demand. However, the other uses of the system may be affected by the increased pumping and land cover change.

Scenario G(3) – Long Term Climate, Existing Pumping, Future Land Cover

Simulated steady state drawdown for each existing municipal well is summarized in Table 6.15. For this Scenario, water level remained above the trigger elevation (pump intake).

The water levels produced from Scenario G(3) were generally 2 m higher in elevation than those simulated in Scenario G(2) (increased pumping) and were 0.1 m or less lower than those simulated for Scenario C (existing land cover), suggesting that pumping rate changes have greater influence on the aquifer water level than land use change in Valley East and Capreol.

Table 6.15 – Tier 3 Scenario G(3) groundwater model results

Well Name	Steady-State Simulated Groundwater Elevation (masl)	Bottom of Pump intake (masl)	Top of Screen (masl)
A - Deschene	291.8	287.7	286.9
B - Kenneth	289.5	283.6	282.9
C - Philippe	290.3	285.6	284.7
D - Frost	290.4	284.1	281.9
E - Notre Dame	289.2	284.1	283.7
F - Linden	284.6	278.6	277.2
G - Pharand	287.8	285.0	285.0
H - Michelle	290.7	285.5	285.8
I Well	288.0	282.4	280.3
J Well	293.9	275.3	274.2
M Well	293.3	277.0	274.8

Scenario H(1) – Drought Period, Existing plus Committed plus Planned Pumping, Future Land Cover

Simulated transient drawdown for each existing and planned municipal well for Scenario H(1) is displayed in Appendix 2. Under these pumping and land use conditions, Linden Well (located within Local Area A) reaches the pump intake elevation (278.6 masl). As such, the model suggests that Linden well would not be able to provide sufficient water to meet its allocated demand under these conditions in simulation year five. Although these drawdown plots also indicate that some of this demand could be transferred to other wells, it has been noted that pumping increases are limited at many wells and any such action would require operator knowledge of the well system at that particular time. Well field optimization was not completed within this work scope.

These simulated groundwater elevations suggest that the quantity of water removed from Local Area A would not be sufficient to meet the existing plus committed plus planned demand at the Linden Well during periods of drought.

Scenario H(2) – Drought Period, Existing plus Committed plus Planned Pumping, Existing Land Cover

As with Scenario H(1), the Linden well (within Local Area A) reaches the pump intake at approximately the third drought summer period. Although some additional capacity to offset the loss of Linden well with increased pumping at other wells appears possible, a well optimization study was not completed within this scope of work.

Scenario H(3) – Drought Period, Existing Pumping, Future Land Cover

As displayed in the transient water level plots in Appendix 2, groundwater elevations remain above the pump intake trigger elevation for each of the existing municipal wells. With the exception of the Linden Well, water level declines from 1 – 2 m, while at Linden water levels fluctuate within a range of approximately 8 m outside of the well casing (i.e. the well shows a strong response to pumping and recharge).

The modelled discrepancy in head at the Linden well when compared with the Notre Dame Well was noted in Peer Review meetings and was the focus of the model sensitivity analysis.

For Scenario H(3), the simulated groundwater elevations suggest that the quantity of water removed from each Local Area would be sufficient to meet the existing demand.

Modelled Scenarios – Summary Note

These steady state and transient results presented herein represent updated estimates of the well screen elevations and pump intakes as surveyed by CGS staff for above ground infrastructure, and interpreted from well rehabilitation reports provided by CGS. As such, simulated groundwater elevations that resulted in wells designated as under 'significant' stress in the Tier Two Study (2009), such as Michelle Well, have much increased freeboard in the Tier Three study. This emphasizes the importance of accurate baseline information during the data collection phases and has greatly improved simulated water level estimates and interpretation of the Valley East aquifer.

Uncertainty and Sensitivity Analysis

Uncertainty and Sensitivity in the 3-Dimensional groundwater model was assessed primarily during calibration of the model, and additional sensitivity of transient parameters were investigated during the Tier Two process (Golder 2009).

For the Tier Three exercise, uncertainty and sensitivity was primarily addressed through

1) Re-investigation of the Linden and Notre Dame Wells. During peer review meetings, it was noted that these wells behaved differently during transient scenarios, and ultimate drawdown was greater in the Linden Well than the Notre Dame Well, despite these wells being located within approximately 1 km of one another.

2) Estimation of In-Well Losses.

Sensitivity Analysis – Linden and Notre Dame Wells

The significance of this discrepancy was magnified once it was identified that the Linden Well would provide a trigger for assignment of a significant risk to the Valley East Local Area A. As such, further investigation of these two wells was undertaken, with a number of discussions among technical team members following.

Initially, a review of the conceptual model of each well's placement in the model was completed, which included review of as-built construction logs, MOE Water Well Information System data, and well rehabilitation reports. The following results were taken from this review:

- The Linden Well was completed to a depth of approximately 28.0 metres below ground surface (mbgs), while Notre Dame Well was completed to 18.1 mbgs.

- The Linden Well was screened over a 9.1 m interval in 'medium to fine sand' (over a range of 19.5 mbgs to 28.0 mbgs), while the Notre Dame Well was screened over approximately 6.4 m in 'sand with some gravel' (over a range of 11.8 mbgs to 18.1 mbgs).

This information was consistent with the placement of the wells within the groundwater model, where the Linden Well was placed in a layer deeper than the Notre Dame Well (see Appendix 2 for layer descriptions). Based on the soil description and the calibration exercise, hydraulic conductivity was set at 15 m/day within the layer at the Linden Well, and at 45 m/day at the Notre Dame Well.

In order to assess the significance of this estimated difference in hydraulic conductivity, the hydraulic conductivity was altered initially at Notre Dame Well to be consistent with the Linden Well (i.e. 15 m/day). Subsequently the estimated hydraulic conductivity at the Linden Well was set to the Notre Dame Well hydraulic conductivity (i.e. 45 m/day). Results of this sensitivity test, completed under Scenario D conditions are shown in Appendix 2.

The drawdown plots display that the drawdown at Linden and Notre Dame Wells are sensitive to changes in hydraulic conductivity. With these plots in mind, it is important to recognize that the calibration of the model has considered local changes in hydraulic conductivity in best matching observed water levels throughout the aquifer. Additional aquifer testing at the Linden and Notre Dame locations would provide a better understanding of the aquifer material properties at each well.

Actual transient water level elevations from inside the municipal wells (or from monitoring wells outside the municipal wells) will ultimately provide the best validation against the assumptions made during model calibration and simulation. The lack of actual water level or groundwater table elevation remains the greatest uncertainty in the Valley East Local Areas.

Given the rigorous sensitivity analyses carried out throughout the Valley East groundwater modeling program, the uncertainty for the current study can be considered 'low'. However, there are steps that can be taken to improve the current state of the aquifer resource, and these are expanded upon later in this chapter.

Sensitivity Analysis – In-Well Losses

In-well losses were considered important additional data that could influence groundwater level interpretations, as they incorporate changes in water level that occur across a well screen. As a result, water level inside a well casing may be lower than the water level in the surrounding aquifer formation; however the magnitude of this difference depends upon well construction, pumping rate and current well condition (e.g. mineral build up on well screens).

A detailed methodology for calculating formation loss and in-well loss was provided by the MNR through S.S. Papadopulos and Associates, Inc. and is included in Appendix 2. For the current Tier Three study, formation loss was estimated through the groundwater modelling exercise, but was recalculated here as well. In-well losses were calculated using post-rehabilitation pumping test information available from CGS well rehabilitation reports and pumping rates reflective of Scenario G(1) (i.e. existing plus committed plus planned pumping rates). Results of this analysis are presented in Table 6.16.

Table 6.16 - In-well loss analysis

Well	Pumping Rate (L/s)	Formation Loss (m)[1]	In-Well Loss (m)[1]	Total Drawdown (m)
Deschene (Well A)	11.2	1.3	0.2	1.5
Kenneth (Well B)	11.7	1.8	0.1	1.9
Phillipe (Well C)	13.4	1.5	0.001	1.5
Frost (Well D)	13.4	1.6	0.04	1.6
Notre Dame (Well E)	21.5	2.9	0.1	3.0

Linden (Well F)	19.7	2.6	0.3	2.9
Pharand (Well G)	7.16	0.9	0.01	0.9
Michelle (Well H)	15.6	2.1	0.01	2.1
I Well	12.1	3.6	1.2	4.9
Well J	2.3	0.5	0.01	0.5
Well M	15.3	3.0	0.2	3.3
Chenier (Well Q)	24.0	4.0	0.1	4.1
R Well	34.1	4.16	0.07	4.2

Note: [1] Additional decimal places shown as required

In most cases, in-well losses are at least an order of magnitude less than the formation losses for the utilized pumping rates, with the exception of 'I' Well. This was interpreted as an indication that the aquifer drawdown provides a comparatively more important role in the total drawdown and that the Valley East Wells are considered efficient, or fall within the 'properly designed and developed' condition suggested by S.S. Papadopulos and Associates Ltd. The exception is the 'I' Well, which shows in-well loss equal to nearly one half of the formation loss. This is consistent with the operators' suggestions that 'I' Well has persistent drawdown problems and is not an efficient pumping well.

In general these in-well losses would not likely further lower groundwater elevation to the pump intake given the results of the modelling Scenarios. Therefore, these results suggest that the key preliminary risk assessment designations would not be altered.

Results Summary, Tolerance and Risk Assignment

In the majority of cases, each of the delineated Local Areas was able to provide sufficient water to meet the allocated demand of each existing and planned municipal well. For ten-year drought conditions and increased pumping rate (i.e. the existing plus committed plus planned rate), the Linden Well (located in Local Area A) was predicted to draw down to the pump intake and would not be able to supply its allocated demand.

At the time of doing the risk assessment in 2010 and 2011, CGS well operators provided insight into earlier droughts where wells had difficulty in meeting demand for a period of several days. This provided an indication of the actual tolerance of the system despite the indication from the results of Scenarios C and D that peak demand periods were being met. As well, the model predictions are a reflection of the water level outside of the well casing (i.e. without in-well losses), and are therefore independent of physical well condition. As actual well condition and operations influence the capacity of each well to meet a short term peak demand period, and as operations staff had noted problems in supplying peak demand, the tolerance level for Scenarios C and D was designated as 'low' for Local Area A and Local Area B. No such concerns had been expressed for Well J and Well M, so the tolerance level was designated as 'high' for Local Area C. As part of this discussion, CGS staff had noted that the tolerance designation would change with the addition of the two new wells scheduled to be added to the system and with the construction of a new water storage tower. The two new wells have since come on-line in February 2013 and staff has indicated that this has changed the designation to high.

Other uses for the Valley East Local Area A were investigated for Scenarios G(1) and G(2) through baseflow reduction analysis. A contributing tributary to the Whitson River (Tributary 11) was estimated to result in a baseflow decrease of greater than 20%, though this was not carried through to the Whitson River. Currently the data related to the characterization of the aquatic habitat, thermal regime and seasonal streamflow variation within Tributary 11 is unavailable. Due to the lack of data a risk level cannot be assigned.

A risk level of 'significant' was presented for Local Area A for Scenario H(1) and Scenario H(2). Although the uncertainty analysis provided justification for a 'low' level of uncertainty, the greatest risk level assigned to a scenario must be assigned to each Local Area. Therefore, the water quantity risk level assignment for Local Area A is 'significant'. The Local Area B and Local Area C water quantity risk level assignment is 'low'. Table 6.17 provides a summary of scenarios and designated risk assignments.

Table 6.17 – Tier 3 water quantity risk assignment

Scenario	Municipal Demand	Land Cover	Triggers	Tolerance	Risk Assignment
C (Long-Term)	Existing	Existing	Pump Intake	Local Area A, B, C High	Local Area A,B,C Low
D (Drought)	Existing	Existing	Pump Intake	Local Area A,B,C High	Local Area A,B,C Low
G(1) (Long-Term)	Existing + Committed + Planned	Future	Pump Intake; Baseflow Reduction	NA	Local Area A,B,C Low
G(2) (Long-Term)	Existing + Committed + Planned	Existing	Pump Intake; Baseflow Reduction	NA	Local Area A Not assigned Local Area B,C, Low
G(3) Long-Term	Existing	Future	Pump Intake	NA	Local Area A,B,C Low
H(1) (Drought)	Existing + Committed + Planned	Future	Pump Intake	NA	Local Area A, Significant, based on Linden Well drawdown Local Area B,C Low
H(2) (Drought)	Existing + Committed + Planned	Existing	Pump Intake	NA	Local Area A, Significant, based on Linden Well drawdown Local Area B,C Low
H(3) (Drought)	Existing	Future	Pump Intake	NA	Local Area A,B,C Low

Significant Groundwater Recharge Areas

For the Tier Three analysis, Significant Groundwater Recharge Areas (SGRA) were reviewed in the context of earlier delineations (Golder 2009) and the area encompassed within each Local Area.

In the delineated Local Areas, the average annual water surplus (total precipitation – evaporation and sublimation) was estimated to be 367 mm (see Table 6.9). A value of 202 mm (0.55 x 367 mm) was then calculated as the amount of water to be recharged on an annual basis to aquifers within the watershed based on previous analysis (Golder 2009).

From the calibrated groundwater model, recharge zones were developed and mapped in the area of the municipal wells. The threshold value of 202 mm was exceeded in the coarser overburden that dominates the western portion of the Local Area. Therefore, these sediments were designated as SGRAs in the delineated Local Areas (Map 6.6).

Water Quantity Drinking Water Threats

As per Part X.2 of the Technical Rules, where a significant or moderate water quantity risk assessment is designated, a listing of activities that may be drinking water threats within the vulnerable area must be compiled. Table 5 of the Technical Rules outlines the activities and circumstances relevant to drinking water quantity threats, and the section of the table relevant to the current Tier Three study is reproduced in Table 6.18. Map 6.5 shows Local Area A where water takings (WHPA-Q1 A) and recharge reduction (WHPA-Q2 A) are significant drinking water threats. There are no areas where moderate drinking water quantity threats occur because Local Area B (WHPA-Q1 B and WHPA-Q2 B) and Local Area C (WHPA-Q1 C and WHPA-Q2 C) were assigned low risks, so no water quantity threats would occur in these areas (Map 6.5).

6.18 - Water quantity threats listing matrix

Activity (Drinking Water Threat)	Reference Number	Circumstances	Area where Activity is a Significant Drinking Water Threat	Area where Activity is a Moderate Drinking Water Threat
An activity that takes from an aquifer or a surface water body without returning the water taken to the same aquifer or surface water body	2	1. An existing taking, an increase to an existing taking or a new taking. 2. The water is or would be taken from within a WHPA-Q1	The local area from which the water is or would be taken if the area relates to one or more wells and it was assessed to have a risk level of significant in accordance with Part IX	The local area from which the water is or would be taken if the area relates to one or more wells and it was assessed to have a risk level of moderate in accordance with Part IX
An activity that reduces recharge to an aquifer.	6	1. An existing activity, a modified activity or a new activity. 2. The activity is or would be wholly or partly located within a WHPA-Q2	The local area from which the water is or would be taken if the area relates to one or more wells and it was assessed to have a risk level of significant in accordance with Part IX.	The local area from which the water is or would be taken if the area relates to one or more wells and it was assessed to have a risk level of moderate in accordance with Part IX.

Note: modified from Table 5, Technical Rules March 2011

Within the delineated Local Area A, the majority of water removal from the aquifer comes from the municipal wells. Therefore the wells themselves present the greatest threat, in terms of water quantity, to the Local Area.

In addition to the municipal wells, there are a number of groundwater wells identified in the MOE WWIS records (Golder 2005) and the CGS recognizes that residents in Valley East and Capreol may have private sandpoint wells that supplement the municipal supply. It is assumed that water from these wells is used on site and returns to the aquifer, and is therefore not a threat.

Recharge reduction within the Valley East Local Area A comes from development. Neither current nor planned development triggered a significant risk in the Tier 3 analyses, but because a significant risk was assigned to Local Area A for water takings, then any development in the local area that reduces recharge is automatically considered as a significant threat. Run off from developed properties in Local Area A is transported mainly through ditches that discharge within the Local Area; therefore they do not reduce aquifer recharge, and are not significant threats. There is some stormwater infrastructure in the Local Area, but most of it discharges within the Local Area and recharges the aquifer. However, there is one municipal stormwater system that discharges outside of Local Area A and it has been enumerated as a recharge reduction threat. There are approximately twenty identified future developments (as delineated by polygon) within Local Area A; if they materialize, they may or may not become significant threats depending on how stormwater is managed with respect to whether or not aquifer recharge is reduced. No future development is currently indicated for Local Area B or Local Area C.

In summary, the identified threats to drinking water quantity in the Valley Local Areas are limited to Local Area A and are as follows:

1) Municipal Wells in Local Area A (ten).

2) A municipal stormwater system that discharges outside of Local Area A (one).

These threats are summarized in Table 6.19.

Table 6.19 - Significant drinking water quantity threats for the Valley drinking water system[1]

Description	Local Area A	Source Protection Area	Municipality
Municipal Water Takings	10	10	10
Non-Municipal Permitted[2] Water Takings	0	0	0
Non-Municipal Non-Permitted Water Takings	0	0	0
Recharge Reduction	1	1	1
Total	11	11	11

[1] Local Areas B and C were excluded from this summary because they were assigned low risks, and therefore they do not have any significant threats

[2] There were no identified non-municipal permitted water takings in the Local Areas at the time of the assessment

Future Water Quantity Work

Through the ongoing source protection program and the previous Municipal Groundwater Study, improvements in understanding of groundwater transport and potential threats to groundwater quality have been made. Continued co-operation among stakeholders in the safety of the quantity and quality of the Valley East municipal water supply is encouraged beyond the scope of these projects.

Additional data that would improve future studies include:

1) Updates of water level data throughout the watershed. The NDCA Provincial Groundwater Quality Network Well in Hanmer is an excellent starting point that could be supplemented with quarterly or monthly monitoring of previously installed boreholes (for example, Waters 2002; 2004).

2) Water level records for within the municipal wells, which would help to track changes in well performance and in-well losses.

3) Monitoring wells installed in the vicinity of each municipal well. Wells placed relatively close (10 m) from each well would indicate water level in the aquifer away from the influence of head loss in the pumping well. In addition, these wells could indicate the necessity for well rehabilitation by providing a reference for aquifer water level against water level within the pumping well.

4) Confirmation/investigation of the low-level lockout alarm elevations at each municipal well.

5) Screening of aquatic habitat in the tributaries and municipal drains that resulted in substantial baseflow decreases.

6) Additional investigation to reconcile hydraulic conductivity at the Linden and Notre Dame municipal wells.

Chapter 34 - Valley Water Quality Risk Assessment

The following sections provide the results for the water quality risk assessment process for the Valley drinking water system.

34.1 Wellhead Protection Areas and Vulnerability Scoring

The wellhead protection areas were delineated according to Rules 47 to 50 and followed the methodology outlined in Chapter 2. The resulting vulnerable areas are illustrated in Maps 6.7 through 6.15 for each well in the Valley drinking water system.

Wells M and J are considered Groundwater Under the Direct Influence of surface water (GUDI) wells which requires the delineation of a WHPA-E (Rule 49). A WHPA-F was not delineated as no water quality issues are present at the well. To determine the 2 hour time of travel (WHPA-E) professional judgment was used. Use of the HEC-RAS model was deemed inappropriate for modeling flow in Greens Lake.

The vulnerability scoring for the WHPA-E follows the same methodology for an IPZ-2 for a Type C intake. The source vulnerability factor was given a score of 0.8 (the score must range from 0.8 to 1.0) due to the travel distance required within the subsurface. The area vulnerability factor was given a score of 7 (out of a range of 7-9) as land cover in the area is mostly forested and the distance and time water must travel to enter the well. The overall vulnerability score for WHPA-E is 5.6, or moderate.

Vulnerability scoring for the wellhead protection areas followed Rules 82 through 85 and the methodology outlined in Chapter 2. Maps 6.16 to 6.24 illustrate the vulnerability scoring for the Valley drinking water system.

Vulnerable Area Delineation Uncertainty

Modeling groundwater flow is complex and requires good information and adequate data to be certain of the model results. Therefore, a degree of uncertainty is always present when using a model to interpret real world situations. In general, geological, hydrogeological and methodological factors contribute to the level of uncertainty within a model. Table 6.20 summarizes the uncertainty in these factors for the Valley drinking water system. For a detailed description of each factor, refer to Appendix 2, Technical Reports.

The models for all of the municipal water supply wells are representations of the real world conditions using the best available information and best available appropriate model codes. The models are limited based on the quality and quantity of data used to construct and calibrate the models, the assumptions inherent in the modeling process, and the assumptions required for each specific model. The structure of the hydrostratigraphic units in the models are interpolated from available surficial and borehole geologic data. The accuracy and reliability of these data vary. Aquifer properties (hydraulic conductivity and porosity) are estimated from a limited number of hydraulic tests. Single values are extrapolated to represent entire hydrostratigraphic units. Real hydrostratigraphic units are inherently heterogeneous and may vary locally or have spatial trends that are not accounted for with the modeled values. As a result, there is not a unique solution to the model construction and calibration process. The resulting wellhead protection areas must be viewed recognizing these limitations.

A number of components of the modeling process have a moderate to high degree of uncertainty. The uncertainty in the WHPA-A and WHPA-B delineations is low. Generally, the uncertainty in delineating the WHPAs decreases closer to the wellhead as there is less compounding of errors. The overall uncertainty for the WHPA-C and WHPA-D was assessed to be high.

Table 6.20 – Summary of wellhead protection area delineation uncertainty for the Valley system

Geological Factors	Depth to aquifer, thickness of overburden	Sufficient data from MOE, MNDM, Vale and City of Greater Sudbury databases
	Soil and Rock characteristics	Data entry estimations, reporting inconsistencies, averaging by assigning Geologic Survey of Canada codes, very few grain size analyses
Hydrogeological Factors	Hydraulic Parameters	Big difference between calculated hydraulic conductivity and value assigned in the model, low density of data, no porosity data
	Hydraulic Head Measurements	Questionable accuracy of values in WWIS, no data from some areas
	Recharge	Recharge assigned according to top layer
	Boundary Conditions	Rivers assigned constant head; no sensitivity analyses
Methodological Factors	Model Used for WHPA Delineation	MODFLOW-SURFACT/MODPATH are industry standards. Only saturated zone flow considered. Natural attenuation not considered.
	Model Calibration and Sensitivity Analysis	Calibrated hydraulic conductivity and recharge only; no sensitivity analyses
	Pump Rate Used for Model	95th percentile of monthly pumping rate is considered a conservative estimate; shape of WHPA's vary depending on pumping rates
	Capture Zone Delineation	High uncertainty due to uncertainty in hydraulic conductivity, boundary conditions and pumping rates.

Uncertainty Level

High Uncertainty | Moderate Uncertainty | Low Uncertainty

Vulnerability Assessment Uncertainty

The vulnerability scores are based on the Intrinsic Susceptibility Index (ISI) and the wellhead protection area (as explained in Chapter 2). Therefore, the uncertainty associated with each score is a function of these two variables. The uncertainty of the delineation of the wellhead protection areas has been described above.

The ISI score is in part based on the presence or absence of an aquitard or confining layer above the aquifer. In the Valley contributing areas, there is no, or a very thin, aquitard and, therefore, the ISI score is highly vulnerable. There is a great amount of reliability in this information; therefore the uncertainty of this score is low.

34.2 Valley Drinking Water Quality Threats Activities

The assessment of potential threats to drinking water quality followed Technical Rules 118 to 125 and the methodology as outlined in Chapter 2. The list of prescribed drinking water threats is located in Table 1.7 in Part 1 of this report.

List of circumstances of all is or would be threats

As required under O.Reg. 287/07 subsection 13, a list of all is or would be significant, moderate or low threats in each vulnerable area is listed in Table 6.21. Tables listing is or would be threats can be found in Appendix 5.

Table 6.21 – Table references for all is or would be threats and associated circumstances in the Valley drinking water system

Score	Significant	Moderate	Low
10	**CW10S** - Chemicals in a WHPA with a vulnerability score of 10 where threats are significant **PW10S** - Pathogens in WHPA A, B with a vulnerability of 10 where threats are significant **DWAS** - DNAPLS in WHPA A, B, C, C1, with any vulnerability where threats are significant	**CW10M** - Chemicals in a WHPA with a vulnerability score of 10 where threats are moderate **PW10M** - Pathogens in WHPA A, B with a vulnerability of 10 where threats are moderate	**CW10L** - Chemicals in a WHPA with a vulnerability score of 10 where threats are low
8	**CW8S**- Chemicals in a WHPA with a vulnerability score of 8 where threats are significant **DWAS**- DNAPLS in WHPA A, B, C, C1, with any vulnerability where threats are significant	**CW8M** - Chemicals in a WHPA with a vulnerability score of 8 where threats are moderate **PW8M** - Pathogens in WHPA A, B with a vulnerability of 8 where threats are moderate	**CW8L** - Chemicals in a WHPA with a vulnerability score of 8 where threats are low **PW8L** - Pathogens in WHPA A, B with a vulnerability of 8 where threats are low
6	**DWAS**- DNAPLS in WHPA A, B, C, C1, with any vulnerability where threats are significant	**CW6M** - Chemicals in a WHPA with a vulnerability score of 6 where threats are moderate	**CW6L** - Chemicals in a WHPA with a vulnerability score of 6 where threats are low
5.6	N/A	N/A	**CIPZWE5.6L** - Chemicals in an IPZ or WHPA E where the vulnerability score is 5.6 where threats are low **PIPZWE5.6L** - Pathogens in an IPZ or WHPA E with a vulnerability of 5.6 where threats are low
2	N/A	N/A	N/A

Identification of areas where threats can occur

The areas where a potential threat is or would be significant, moderate or low are illustrated on Maps 6.16 to 6.24. According to the Technical Rules:

- Areas with a vulnerability score of 8 or greater have the potential for a significant, moderate or low threat.
- Areas with a vulnerability score of 6 or greater have the potential for a moderate or low threat to occur.
- Areas with a vulnerability score of 4 or greater have the potential for a low threat to occur.
- Areas with a vulnerability score of less than 4 cannot contain a drinking water threat.

Managed Lands

The storage, handling and application of agricultural source material, non-agricultural source material, pesticides and fertilizers can result in potential contamination of municipal water supplies. The methodology used to calculate percentage of managed lands in vulnerable areas is described in Chapter 2.

The percentage of managed lands in the Valley wellhead protection areas was calculated as generally being less than 40%. There are small pockets of vulnerable areas where the managed land percentage is between 40 and 80%, and one WHPA-A where managed lands are greater than 80%. The results are illustrated on Map 6.25.

Impervious Surfaces

Impervious surfaces are measured as an indicator of the amount of area where road salt can be applied. The percentage of surface area within a vulnerable area which will not allow surface water or precipitation to be absorbed into the soil is measured. For wells M and J, approximately half of the wellhead protection area has impervious surface areas in the <1% range, and approximately half is in the 1-<8% range. The vulnerable areas surrounding the remaining Valley wells is a fairly even mix of the <1%; 1-<8%; and 8-<80%, however, the 1-<8% dominates, followed by 8-<80%, and lastly by the <1% range. The percentage of impervious area is illustrated on 6.26. The calculation of impervious surface led to the vulnerable area being designated as a moderate or low threat for the application of road salt depending on the vulnerability score. The results are illustrated on Map 6.26.

The methodology used to calculate percentage of impervious surfaces in vulnerable areas is described in Chapter 2.

Livestock Density

The calculation of livestock density is based on the calculation of nutrient units per acre of agricultural managed lands. The methodology used to calculate the livestock density in the vulnerable areas is described in Chapter 2. In spite of the Valley having the most agricultural land in the source protection area, the nutrients units per acre was less than 0.5 (low). The results are illustrated on Map 6.27.

The combination of livestock density and managed land calculations assigns a threat rating for the application of commercial fertilizer to land and the application of agricultural source material to land. Table 6.23 illustrates that threat in the different wellhead protection areas.

Enumeration of Threats

Table 6.22 lists an estimate of the current number of significant drinking water threats in the Valley system in accordance with Rule 9 and the Drinking Water Threats Tables. Table 6.23 lists an estimate of the significant, moderate and low threats for the Valley system in accordance with the Drinking Water Threats Tables.

Table 6.22 – Significant drinking water quality threats in the Valley drinking water system

Drinking Water Threat	# of Occurrences
Kenneth Well	
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	10
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the *Environmental Protection Act.*	1
The handling and storage of fuel.	1
Deschene Well	
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	15
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard.	3
The storage of agricultural source material.	3
The application of agricultural source material to land.	1
The application of commercial fertilizer to land.	1
Philippe Well	
The storage of snow.	1
The handling and storage of fuel.	1
The handling and storage of pesticide.	1
The handling and storage of commercial fertilizer.	1
The handling and storage of a dense non-aqueous phase liquid.	3
Local threat: Transportation of hazardous substances along transportation corridors.	1
Michelle Well	
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	1
Local threat: Transportation of hazardous substances along transportation corridors.	1
Pharand Well	
The handling and storage of a dense non-aqueous phase liquid.	1
Notre Dame Well	
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	4
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard.	1
The storage of agricultural source material.	1
Linden Well	
The storage of snow.	1
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	4
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard.	1
The storage of agricultural source material.	1
“R” Well	
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard.	1
The storage of agricultural source material.	1

Table 6.23 - Drinking water quality threats for the Valley drinking water system

Drinking Water Threat Category	Number of Occurrences with Threat Classification		
	Significant	Moderate	Low
WHPA A & B - Areas with a vulnerability score of 10			
The establishment, operation or maintenance of a waste disposal site within the meaning of Part V of the Environmental Protection Act.	1		
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.	34		2
The application of agricultural source material to land.	1	5	
The storage of agricultural source material.	6		
The application of commercial fertilizer to land.	1	11	
The handling and storage of commercial fertilizer.	1		
The handling and storage of pesticide.	1		
The application of road salt.		12	
The storage of snow.	2		
The handling and storage of fuel.	2	10	
The handling and storage of a dense non-aqueous phase liquid.	1		
The handling and storage of an organic solvent.		1	
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard. O. Reg. 385/08, s. 3.	6		
Local threat: Transportation of hazardous substances along transportation corridors.	2	1	
WHPA-C - Areas with a vulnerability score of 8			
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.		22	2
The application of agricultural source material to land.			3
The storage of agricultural source material.		3	
The application of commercial fertilizer to land.			9
The handling and storage of commercial fertilizer.			2
The handling and storage of pesticide.			2
The application of road salt.		5	4
The handling and storage of fuel.		4	
The handling and storage of a dense non-aqueous phase liquid.	3		
The handling and storage of an organic solvent.			3

The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard. O. Reg. 385/08, s. 3.		3	
Local threat: Transportation of hazardous substances along transportation corridors.		4	
WHPA-D – Areas with a vulnerability score of 6			
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.			62
The storage of agricultural source material.			3
The application of agricultural source material to land.			1
The application of commercial fertilizer to land.			1
The application of road salt.			2
The handling and storage of road salt.			1
The handling and storage of fuel.			2
The handling and storage of a dense non-aqueous phase liquid.			1
The handling and storage of an organic solvent.			1
The use of land as livestock grazing or pasturing land, an outdoor confinement area or a farm-animal yard. O. Reg. 385/08, s. 3.			3

34.3 Valley Drinking Water Threats Conditions

A drinking water condition is a situation that results from a past activity and meets the criteria laid out in Chapter 2. For a more detailed review of the methodology for identifying drinking water conditions, please refer to Part 1, Chapter 2.

The areas where a significant, moderate or low condition could exist are the same areas where a potential threat could occur. For an illustration, please see Map 6.16 through 6.24.

Currently, there are no known conditions located within the Valley vulnerable areas.

34.4 Valley Drinking Water Quality Issues

Drinking water quality issues were assessed based on the methodology outlined in Chapter 2 and Rules 114 and 115.

Elevated levels of sodium are present in a number of wells throughout the period of record. Currently, there is insufficient data to determine if there is a significant increasing trend.

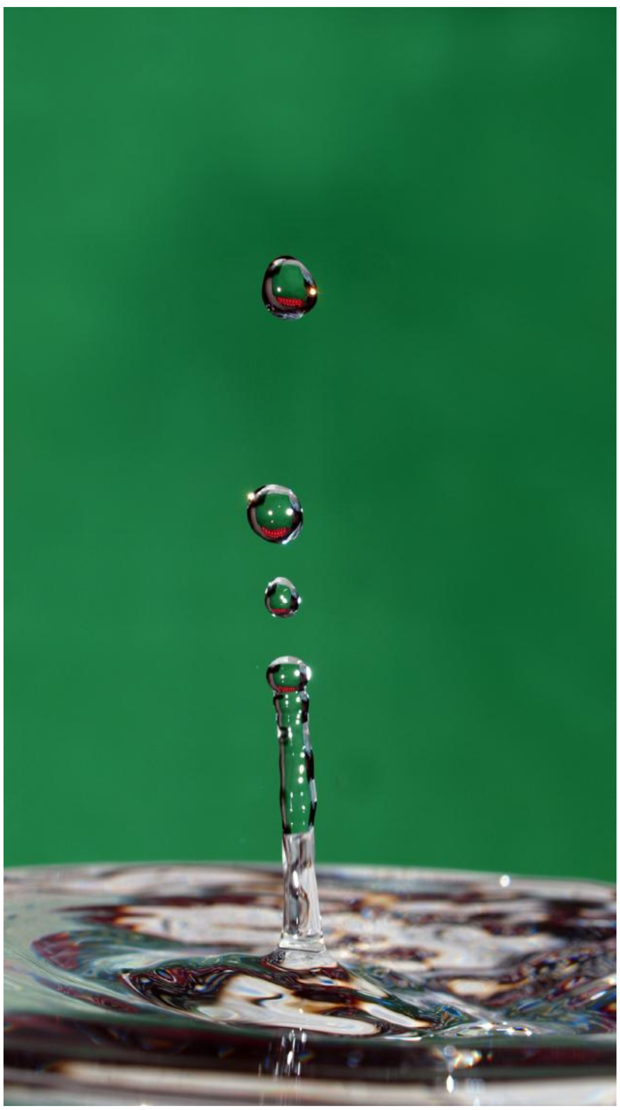
Chapter 35 - Data Gaps

The analyses for this drinking water system were carried out using the best data available to meet the assessment report requirements. Completing scientific assessments on the quality and quantity of water undoubtedly raises a number of questions and uncertainties regarding the methodologies used, availability of data, reliability of data, and overall outcome. As new information arises, either from increased or continuous monitoring, improved models, or a change in methodology, the results from this report will have to be updated to reflect the additional information.

The assessment report is a constantly evolving document as new information becomes available and refinements in approaches are made. Changes in land use will also impact the identification of potential threats to water quality and quantity. Data gaps to be filled include data to determine significant water quality issues and increasing trends.

Part Seven

Garson Drinking Water System



The Garson drinking water system consists of three wells: Garson Wells 1 and 3 are located on Falconbridge Road and Garson Well 2 is located on Vale property near Falconbridge Road.

Approved on September 2, 2014

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Chapter 36 - Garson Drinking Water System

The Garson drinking water system consists of three wells: Garson Wells 1 and 3[1] are located on Falconbridge Road and Garson Well 2[2] is located on Vale property near Falconbridge Road. Combined, these wells service the community of Garson and a population of approximately 4,800.

The Garson system is connected to the David Street and Wanapitei distribution system by a pressure sustaining valve. If pressure drops below acceptable levels in the Garson system, water is automatically directed from the Sudbury system to maintain pressure. This normally only occurs in the event of an emergency. Map 7.1 illustrates the distribution system. Treatment at the wells consists of disinfection using sodium hypochlorite, and fluoridation using hydrofluosilicic acid. Table 7.1 summarizes water usage within the Garson drinking water system between 2002 and 2007.

Table 7.1 – Summary of water usage in the Garson drinking water system for 2002-2007

	Garson 1 and 3	Garson 2
Daily Permitted Amount (m^3/day)	4,847	2,981
Monthly Permitted Amount (m^3/month)	147,430	90,672
Average Actual Monthly Volume (m^3/month)	18,773	32,647
Percentage of Monthly Permitted Volume	13%	36%
Maximum Actual Monthly Volume (m^3)	29,867	40,408
Percentage of Monthly Permitted Volume	20%	45%
95th Percentile (m^3)	25,827	38,781
Percentage of Monthly Permitted Volume	18%	43%

[1] Formerly known as Orell Wells 1 and 3
[2] Formerly known as Inco Well 1

Chapter 37 - Garson Wells Contributing Area

The contributing area for the Garson wells was delineated based on the City of Greater Sudbury Municipal Groundwater Study and on modeling updates done by WESA to reflect new data collected in the area. The contributing area to these wells was estimated as the area encompassing the modeled capture zones plus a 500 m buffer down-gradient of the southwestern capture zone limit. The surrounding bedrock topography is above the elevation of the groundwater wells and it can be expected that these uplands contribute to the recharge of the well aquifer. Therefore, the catchment area was expanded to include bedrock to the height of land in the northwest and southeast of the catchment. In the northeast of the well field, the groundwater divide was used as a flow boundary. The estimated catchment area around these wells was 55 km^2. See Map 7.2 for an illustration of the contributing area.

Chapter 38 - Water Budget and Quantity Assessment

The Garson drinking water system lies within the Vermilion watershed. As previously described in Chapter 28, the Vermilion watershed was given a water quantity stress level of low and, therefore, did not need to progress to the next level of a water quantity assessment. Given the isolated nature of the municipal wells, it was decided by the Greater Sudbury Source Protection Area technical team that a Tier 1 water budget should be completed for each drinking water system. The methodology applied is described in greater detail in Chapter 3 and in Appendix 2.

38.1 Garson Water Budget

A summary for the water budget elements for the Garson watershed is presented in Table 7.2. There are no major stream inputs or outflows in this catchment area, so the model for this catchment was a simple vertical soil moisture budget. In the Garson well contributing area, the average annual water surplus of 398 mm was considered as groundwater recharge for the stress assessment.

Table 7.2 – Water budget for the Garson contributing area

	Water Balance Element (mm)							
Month	Rainfall	Snowfall	Snowmelt	Total Input	PET*	AET**	Water Surplus	Water Deficit
January	2.8	61.8	6.1	8.9	0.0	0.0	8.9	0.0
February	3.1	48.4	13.8	16.9	0.0	0.0	16.9	0.0
March	19.5	45.6	68.2	87.7	0.0	0.0	87.7	0.0
April	51.2	13.0	126.3	177.5	19.5	19.5	158.0	0.0
May	80.8	1.0	8.6	89.3	75.0	74.0	15.3	0.0
June	78.4	0.0	0.0	78.4	110.7	104.3	0.0	-25.9
July	78.8	0.0	0.0	78.8	130.5	113.3	0.0	-34.5
August	85.3	0.0	0.0	85.3	112.5	95.8	0.0	-10.6
September	107.1	0.0	0.0	107.1	69.3	67.7	39.4	0.0
October	81.9	2.4	2.4	84.4	30.1	30.1	54.3	0.0
November	45.1	33.3	19.4	64.4	0.8	0.8	63.6	0.0
December	9.8	55.8	15.0	24.8	0.0	0.0	24.8	0.0
Annual Total	643.7	261.3	259.9	903.5	548.3	505.5	469.0	-70.9
Annual Recharge							**398.1**	

*PET – Potential Evapotranspiration
**AET – Actual Evapotranspiration

38.2 Garson Water Quantity Stress Assessment

Table 7.3 presents the summary of the water quantity stress assessment for the Garson watershed. For the period of 2000-2006, the water removed by the municipal groundwater wells averaged approximately 12 mm, or 22% of the permitted pumping rate. Municipal demand was assumed to be 100% consumed and relatively constant throughout the year.

Municipal demand and industrial mining operations represented the largest groundwater users. The watershed was calculated to have a groundwater stress level of between 5.5% and 9.0% for present conditions, with a monthly maximum occurring in April (8.6%). The forecast municipal demand did not greatly increase monthly stress level calculations, where May increased to 8.9%. Annual average present and forecast stress levels were 6.6% and 6.9%, respectively. These calculations indicated that the watershed was classified as having a 'low' groundwater stress level.

Table 7.3 – Water quantity stress assessment for the Garson watershed

	Supply (m^3/s)		Demand (m^3/s)				Stress (%)	
Month	Recharge	Reserve	Municipal	Other	Total	Forecast	Present	Forecast
January	0.69	0.07	0.02	0.01	0.02	0.02	5.68	5.97
February	0.69	0.07	0.02	0.02	0.02	0.02	5.83	6.13
March	0.69	0.07	0.03	0.02	0.03	0.03	6.68	7.04
April	0.69	0.07	0.02	0.03	0.02	0.03	8.56	8.87
May	0.69	0.07	0.02	0.03	0.02	0.02	7.48	7.78
June	0.69	0.07	0.02	0.02	0.02	0.03	6.86	7.19
July	0.69	0.07	0.02	0.02	0.02	0.03	6.36	6.71
August	0.69	0.07	0.02	0.02	0.02	0.02	6.36	6.66
September	0.69	0.07	0.02	0.02	0.02	0.03	7.03	7.36
October	0.69	0.07	0.02	0.01	0.02	0.03	5.84	6.17
November	0.69	0.07	0.02	0.02	0.02	0.02	6.17	6.48
December	0.69	0.07	0.02	0.02	0.02	0.03	6.76	7.09
Annual	0.69	0.07	0.02	0.02	0.02	0.03	6.63	6.95

38.3 Water Budget and Stress Assessment Uncertainty

Uncertainty in the Tier 1 process takes into account the quality of the available data. Municipal water removals and water use trends were obtained from the City of Greater Sudbury and from industry, and large volume permits to take water were checked for actual use and active status. For each Tier 1 water budget, the water surplus was in the range of that reported in the literature (e.g. Richards 2002). For all groundwater sources the estimated uncertainty is low.

Chapter 39 - Garson Water Quality Risk Assessment

The following sections provide the results for the water quality risk assessment process for the Garson drinking water system.

39.1 Wellhead Protection Areas and Vulnerability Scoring

The wellhead protection areas were delineated according to Rules 47 through 50, and followed the methodology outlined in Chapter 2. The resulting vulnerable areas are illustrated on Maps 7.3 through 7.5 for each well in the Garson drinking water system.

Vulnerability scoring for the wellhead protection areas followed Rules 82 through 85 and the methodology outlined in Chapter 2. Maps 7.6 through 7.8 illustrate the vulnerability scoring for the Garson drinking water system.

The variability in vulnerability scores in the top east of the Garson 2 WHPA, as illustrated on Map 7.8, is lower due to the lower scoring of the groundwater intrinsic susceptibility index for this area.

The geometric appearance of the medium vulnerability zones within the Garson 2 WHPA is caused by a combination of factors, such as the data density in the Garson area, intrinsic susceptibility index values at several wells being close to 30, and the grid size used to krige the intrinsic susceptibility index values.

Across most of the Source Protection Area, the ISI calculation relied primarily on data in the Water Well Information System and the data density is relatively sparse. In the Garson area, Vale granted permission for WESA to use data obtained during a groundwater characterization study for Vale's Garson Mine. As part of that study, a series of monitoring well nests were installed across the community of Garson including near Garson Well No. 1. As a result, the data density in this area is significantly higher than elsewhere in the area. WESA also conducted a detailed well-by-well review of the data used to generate the ISI for the Garson area. The ISI for a number of the wells near Inco Well No. 1 was either slightly less than or slightly greater than 30, which separates high and medium vulnerability areas. The data used to calculate the ISI at these wells were reviewed to ensure that the calculation was based on the most representative data available. As a result of this review, the ISI values for some locations changed. Finally, the original ISI map was generated using a 100 m grid for the kriging calculation. This grid size is appropriate for the data density across this regional area. However, the data density available in the Garson area requires that a finer grid be used to obtain smooth boundaries between medium and high vulnerability areas. So WESA re-kriged this area using a 25 m grid. The resulting ISI grid was smoothly inserted into the larger 100m grid for the rest of the area.

More detail on the intrinsic susceptibility index is available in Chapter 2 and on Map 2.9.

Vulnerable Area Delineation Uncertainty

Modeling groundwater flow is complex and requires good information and adequate data to be certain of the model results. The groundwater model represents a first step in providing a general understanding of groundwater flow conditions. A degree of uncertainty is always present when using a model to interpret real world situations. In general, geological, hydrogeological and methodological factors contribute to the level of uncertainty within a model. Table 7.4 summarizes the uncertainty in these factors for the Garson drinking water system. For a detailed description of each factor, refer to Appendix 2.

There is generally a moderate level of uncertainty related to the groundwater model. The delineation of the wellhead protection areas used a conservative approach and thereby overestimates the size of the protection area. The uncertainty in the WHPA-A, WHPA-B and WHPA-C delineations is low. Generally, the uncertainty in delineating the WHPAs decreases closer to the wellhead as there is less compounding of errors. The overall uncertainty for the WHPA-D was assessed to be high.

Table 7.4 – Summary of wellhead protection delineation uncertainty for the Garson drinking water system

Geological Factors	Depth to aquifer, thickness of overburden	Sufficient data from MOE and WESA databases
	Soil and Rock Characteristics	Data entry estimations, reporting inconsistencies, averaging by assigning Geologic Survey of Canada codes, no grain size analyses
Hydrogeological Factors	Hydraulic Parameters	Difference between calculated hydraulic conductivity and value assigned in the model, no porosity data
	Hydraulic Head Measurements	Low uncertainty for WESA data, but distribution limited. Questionable accuracy of values in WWIS, no data from some areas.
	Recharge	Recharge assigned according to top layer
	Boundary Conditions	Streams assigned as River boundaries. Boundary parameters adjusted during calibration; no sensitivity analyses
Methodological Factors	Model Used for WHPA Delineation	MODFLOW /MODPATH are industry standards. Only saturated zone flow considered. Natural attenuation not considered.
	Model Calibration and Sensitivity Analysis	Calibrated hydraulic conductivity, recharge and river boundary parameters; sensitivity analyses found high sensitivity to bedrock hydraulic conductivity
	Pump Rate Used for Model	95^{th} percentile of monthly pumping rate is considered a conservative estimate
	Capture Zones Delineation	Low uncertainty within WHPA's B and C. High uncertainty in the WHPA-D.

Uncertainty Level

High Uncertainty — Moderate Uncertainty — Low Uncertainty

Vulnerability Assessment Uncertainty

The vulnerability scores are based on the Intrinsic Susceptibility Index (ISI) and the wellhead protection area (as explained in Chapter 2). Therefore, the uncertainty associated with each score is a function of these two variables. The uncertainty of the wellhead protection areas has been described above.

The ISI score is based in part on the presence or absence of an aquitard or confining layer above the aquifer. In the Garson contributing area, there is no, or a very thin, aquitard, resulting in a highly vulnerable ISI score. There is great reliability in this information; therefore, the uncertainty of this score is low.

39.2 Garson Drinking Water Quality Threats Activities

The assessment of potential threats to drinking water quality followed the Technical Rules 118 to 125 and the methodology is outlined in Chapter 2. The list of prescribed drinking water threats is located in Table 1.7 in Part 1 of this report.

List of circumstances of all is or would be threats

As required under O.Reg. 287/07 subsection 13, a list of references for all is or would be significant, moderate or low threats in each vulnerable area is provided in Table 7.5. Tables listing is or would be threats can be found in Appendix 5.

Table 7.5 – Table references for all is or would be threats and associated circumstances in the Garson drinking water system

Score	Significant	Moderate	Low
10	**CW10S** - Chemicals in a WHPA with a vulnerability score of 10 where threats are significant **PW10S** - Pathogens in WHPA A, B with a vulnerability of 10 where threats are significant **DWAS** - DNAPLS in WHPA A, B, C, C1, with any vulnerability where threats are significant	**CW10M** - Chemicals in a WHPA with a vulnerability score of 10 where threats are moderate **PW10M** - Pathogens in WHPA A, B with a vulnerability of 10 where threats are moderate	**CW10L** - Chemicals in a WHPA with a vulnerability score of 10 where threats are low
8	**CW8S**- Chemicals in a WHPA with a vulnerability score of 8 where threats are significant **DWAS**- DNAPLS in WHPA A, B, C, C1, with any vulnerability where threats are significant	**CW8M** - Chemicals in a WHPA with a vulnerability score of 8 where threats are moderate **PW8M** - Pathogens in WHPA A, B with a vulnerability of 8 where threats are moderate	**CW8L** - Chemicals in a WHPA with a vulnerability score of 8 where threats are low **PW8L** - Pathogens in WHPA A, B with a vulnerability of 8 where threats are low
6	**DWAS** - DNAPLS in WHPA A, B, C, C1, with any vulnerability where threats are significant	**CW6M** - Chemicals in a WHPA with a vulnerability score of 6 where threats are moderate	**CW6L** - Chemicals in a WHPA with a vulnerability score of 6 where threats are low

Identification of areas where threats can occur

The areas where a potential threat is or would be significant, moderate or low are illustrated on Maps 7.6 through 7.8. According to the Technical Rules:

- Areas with a vulnerability score of 8 or greater has the potential for a significant, moderate or low threat.
- Areas with a vulnerability score of 6 or greater has the potential for a moderate or low threat to occur.*
- Areas with a vulnerability score of 4 or greater has the potential for a low threat to occur.*
- Areas with a vulnerability score of less than 4 cannot contain a drinking water threat.*

*DNAPLs are an exception because they are always a significant threat in WHPA-A, B, C/C1 regardless of the vulnerability score.

Managed Lands

The storage, handling and application of agricultural source material, non-agricultural source material, pesticides and fertilizers can result in potential contamination of municipal water supplies. The methodology used to calculate percentage of managed lands in the vulnerable areas is described in Chapter 2.

The percentage of managed lands in the Inco 1 wellhead protection area was assessed to be under 40% (low) and between 40 and 80% (moderate) for the Orell wellhead protection areas. Results are illustrated on Map 7.9.

Impervious Surfaces

Impervious surfaces are measured as an indicator of the amount of area where road salt can be applied. The percentage of surface area within a vulnerable area which will not allow surface water or precipitation to be absorbed into the soil is measured. According to these calculations, most of the wellhead protection area for the Garson Well 2 has a 1-8% impervious area, while most of the wellhead protection area for the Garson Wells 1 & 3 has a 8-80% impervious area, as shown on Map 7.10. The calculation of impervious surfaces resulted in the vulnerable area being designated as a moderate threat or a low threat for the application of road salt depending on the vulnerability score, as shown in Table 7.6. It is noted in Section 39.4 that the Garson wells consistently have sodium levels above 20 mg/L, but there is insufficient data to determine if there is a significant increasing trend.

The methodology used to calculate percentage of impervious surfaces in the vulnerable areas is described in Chapter 2.

Livestock Density

The calculation of livestock density is based on the calculation of nutrient units per acre of agricultural managed lands. The methodology used to calculate the livestock density in the vulnerable areas is described in Chapter 2. There are no agricultural lands in the Garson wellhead protection areas, therefore the area has a score of under 0.5 nutrient units per acre. The results are illustrated on Map 7.11.

The combination of livestock density and managed land calculations assigns a threat rating for the application of commercial fertilizer. Table 7.6 shows the number of occurrences of this threat in different vulnerability areas.

Enumeration of Threats

Table 7.6 lists an estimate of the current number of significant, moderate and low drinking water quality threats in the drinking water system in accordance with the Drinking Water Threats Tables.

Table 7.6 – Drinking water quality threats for the Garson drinking water system

Drinking Water Threat Category	Number of Occurrences with Threat Classifications		
	Significant	Moderate	Low
WHPA A & B – Areas with a vulnerability score of 10			
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.		1	
The application of commercial fertilizer to land.		2	
The application of road salt.		2	

The handling and storage of fuel.	1	1	
Local threat: Transportation of hazardous substances along transportation corridors.	2	1	
WHPA B & C – Areas with a vulnerability score of 8			
The application of commercial fertilizer to land.			2
The application of road salt.			2
WHPA C – Areas with a vulnerability score of 6			
The application of road salt.			2
The handling and storage of an organic solvent.			1
Local threat: Transportation of hazardous substances along transportation corridors.			2

39.3 Garson Drinking Water Threats Conditions

A drinking water condition is a situation resulting from a past activity and meeting the criteria laid out in Chapter 2. For a more detailed review of methodology for identifying drinking water conditions, please refer to Part 1, Chapter 2.

The areas where a significant, moderate or low threat condition could exist are the same as the areas where a potential threat could occur. For an illustration, please see Maps 7.6 through 7.8.

Currently, there are no identified conditions within the Garson vulnerable areas. However, recent information received on April 27, 2011, and discussed in section 39.4 below may lead to two sites being identified as conditions. Information is currently being collected on these sites and if these areas of past activities meet the criteria for addition as a condition they can be added in an amendment or in a scheduled update to the assessment report. More investigation is needed to determine whether this concern should be identified as a drinking water issue or a concern under the source protection program.

39.4 Garson Drinking Water Quality Issues

Drinking water quality issues were assessed based on the methodology outlined in Chapter 2 and Rules 114 and 115.

The Garson wells have sodium levels consistently above 20 mg/L. Currently, there is insufficient data to determine if there is a significant increasing trend.

Information received on April 27, 2011, from the MOE Sudbury District Office indicated a rising trend of trace levels of tetrachloroethylene in treated water samples taken from the Orell wells 1 and 3. Tetrachloroethylene is used primarily as a solvent for the dry cleaning and metal cleaning industries. It can be found in groundwater after improper disposal or dumping of cleaning solvents. The results may suggest some possible historical impact from service stations that would have operated in the vicinity of the wells at one time.

The recommended maximum acceptable concentration for tetrachloroethylene in drinking water is 30 ug/L. Data collected by the City of Greater Sudbury between 1999 and 2012 indicates that the amount found in the raw and treated water ranges from 0.05 to 5.7 ug/L and 0.05 to 3.4 ug/L respectively. A thorough examination also highlights that concentrations of 2 ug/L or higher of tetrachloroethylene have consistently been observed in the raw water data collected between 1993 and 2012.

In response to a request from the Ministry of the Environment, the City of Greater Sudbury has increased monitoring of raw water and treated water. The source protection committee will continue to monitor this concern. If the concentration of tetrachloroethylene trends upwards it may be identified as an issue in an amendment or in a scheduled update to the assessment report. Recent testing results from the Drinking Water System Inspection Report for 2011 measured the level of tetrachloroethylene in treated water at these wells at 0.05 and 3.4 ug/L.

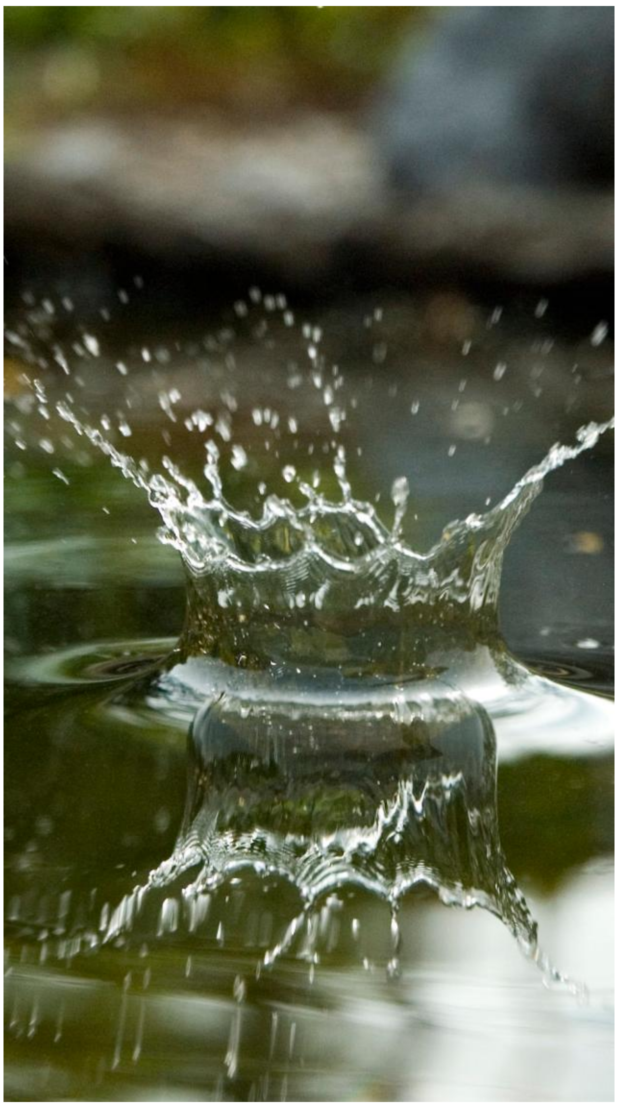
Chapter 40 - Data Availability

The analyses for this drinking water system were carried out using the best data available to meet the assessment report requirements. Completing scientific assessments on the quality and quantity of water undoubtedly raises a number of questions and uncertainties regarding the methodologies used, availability of data, reliability of data and overall outcome. As new information arises, either from increased or continuous monitoring, improved models, or a change in methodology, the results from this report will need to be updated to reflect the additional information.

The assessment report is a continually evolving document as new information becomes available and refinements in approaches are made. Changes in land use will also impact the identification of potential threats to water quality and quantity.

Part Eight

Falconbridge Drinking Water System



The Falconbridge well supply is a groundwater system comprised of three drilled wells – Wells #5, 6 and 7 – with a serviced population of approximately 750.

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Chapter 41 - Falconbridge Drinking Water System

The Falconbridge Well Supply is a groundwater system comprised of three drilled wells (Wells #5, 6 and 7), each of which is 457 cm in diameter and 54 m deep. The raw water at these wells is treated using chlorine gas for disinfection.

Treated water from the pumphouse enters one of two distribution lines. The first is the "Eastern" main, which is the primary distribution line. It is approximately 10 km in length and supplies the Town of Falconbridge as well as a number of industrial sources, including the Xstrata Nickel Smelter Complex. The second transmission line is the "Western" main, which is approximately 1.5 km in length and supplies the Nickel Rim Mining Complex.

This distribution system was originally constructed by Falconbridge Limited in 1961. It is now owned and operated by the City of Greater Sudbury. The serviced population is approximately 720. Operations of the system are monitored online by City of Greater Sudbury operators at the Wanapitei Water Treatment Plant. See Map 8.1 for the distribution system. Table 8.1 summarizes water usage within the Falconbridge drinking water system between 2002 and 2007.

Table 8.1 – Summary of water usage in the Falconbridge drinking water system for 2002-2007

	Wells 5, 6 and 7
Daily Permitted Amount (m^3/day)	4,251
Monthly Permitted Amount (m^3/month)	129,301
Average Actual Monthly Volume (m^3/month)	59,943
Percentage of Monthly Permitted Volume	46%
Maximum Actual Monthly Volume (m^3)	79,142
Percentage of Monthly Permitted Volume	61%
95th Percentile (m^3)	74,058
Percentage of Monthly Permitted Volume	57%

Chapter 42 - Falconbridge Contributing Area

The Falconbridge wells are not impacted by the presence of surface water; therefore, the watershed for the wells was estimated as the boundary of the contributing aquifer.

The aquifer is located along the Wanapitei Esker. Bedrock topography slopes to the east and west of the aquifer. Rainfall and snowmelt that run off from the bedrock slopes contribute recharge to this aquifer, resulting in the contributing catchment including the adjacent hilltops. The southern limit was defined by the estimated groundwater divide and the northern boundary was set as a 500 m buffer down gradient of the delineated capture zone. The estimated catchment area to these wells was calculated to be 57 km^2. See Map 8.2 for the contributing area.

Chapter 43 - Water Budget and Quantity Assessment

The Falconbridge drinking water system lies within the Wanapitei watershed. As previously described in Chapter 23, the Wanapitei watershed was given a water quantity stress level of low and did not need to progress to the next level of a water quantity assessment. Given the isolated nature of the municipal wells, it was decided by the Greater Sudbury Source Protection Area technical team that a Tier 1 water budget should be completed for each drinking water system. The methodology applied is described in greater detail in Chapter 3.

43.1 Falconbridge Water Budget

A summary of the water budget is illustrated in Table 8.2. No major streamflows were identified in this area. The average annual recharge in the Falconbridge well area was calculated to be 412 mm, equivalent to the annual water surplus.

Table 8.2 – Water budget for the Falconbridge watershed

	Water Balance Element (mm)							
Month	Rainfall	Snowfall	Snowmelt	Total Input	PET*	AET**	Water Surplus	Water Deficit
January	2.8	61.8	6.1	8.9	0.0	0.0	8.9	0.0
February	3.1	48.4	13.8	16.9	0.0	0.0	16.9	0.0
March	19.5	45.6	68.2	87.7	0.0	0.0	87.7	0.0
April	51.2	13.0	126.3	177.5	19.5	19.5	158.0	0.0
May	80.8	1.0	8.6	89.3	75.0	73.6	15.7	0.0
June	78.4	0.0	0.0	78.4	110.7	101.8	0.0	-23.4
July	78.8	0.0	0.0	78.8	130.5	107.7	0.0	-28.9
August	85.3	0.0	0.0	85.3	112.5	91.2	0.0	-6.0
September	107.1	0.0	0.0	107.1	69.3	67.2	39.9	0.0
October	81.9	2.4	2.4	84.4	30.1	30.1	54.3	0.0
November	45.1	33.3	19.4	64.4	0.8	0.8	63.6	0.0
December	9.8	55.8	15.0	24.8	0.0	0.0	24.8	0.0
Annual Total	643.7	261.3	259.9	903.5	548.3	491.8	469.9	-58.2
Annual Recharge							**411.7**	

*PET – Potential Evapotranspiration
**AET – Actual Evapotranspiration

43.2 Falconbridge Water Quantity Stress Assessment

The summary of the water quantity stress assessment is presented in Table 8.3. For these wells, it was assumed that water pumped was 100% consumed from the groundwater aquifer system. In 2005, approximately 20% of the water removed by these three wells was distributed to the town of Falconbridge, while the remainder was provided to industrial operations. The water removed by all the municipal groundwater wells was approximately 13 mm in 2005, which represented about 40% of the permitted pumping rate.

Groundwater stress was calculated to be relatively consistent throughout the year, as demand does not show seasonal variation. Monthly maximum groundwater stress was 6.5% in June for present conditions. This stress level was increased to 6.6% under the future municipal demand scenario. On an annual basis, average groundwater stress was 5.3% under the present scenario and increased to 5.4% under the future demand scenario. Each calculated groundwater stress level was well below the 20% monthly maximum and 10% annual average thresholds. As such, the Falconbridge contributing area was characterized as 'low' stress.

Table 8.3 – Water quantity stress assessment for the Falconbridge watershed

	Supply (m^3/s)		Demand (m^3/s)				Stress (%)	
Month	Recharge	Reserve	Municipal	PTTW	Total	Forecast	Present	Forecast
January	0.55	0.06	0.004	0.019	0.02	0.02	4.70	4.78
February	0.55	0.06	0.004	0.018	0.02	0.02	4.38	4.46
March	0.55	0.06	0.004	0.017	0.02	0.02	4.30	4.38
April	0.55	0.06	0.005	0.022	0.03	0.03	5.37	5.47
May	0.55	0.06	0.004	0.016	0.02	0.02	4.06	4.13
June	0.55	0.06	0.006	0.026	0.03	0.03	6.46	6.57
July	0.55	0.06	0.005	0.022	0.03	0.03	5.57	5.66
August	0.55	0.06	0.006	0.025	0.03	0.03	6.13	6.24
September	0.55	0.06	0.006	0.024	0.03	0.03	5.95	6.05
October	0.55	0.06	0.005	0.021	0.03	0.03	5.31	5.40
November	0.55	0.06	0.004	0.019	0.02	0.02	4.73	4.81
December	0.55	0.06	0.006	0.026	0.03	0.03	6.41	6.52
Annual	**0.55**	**0.06**	**0.005**	**0.02**	**0.03**	**0.03**	**5.28**	**5.37**

43.3 Water Budget and Stress Assessment Uncertainty

Uncertainty in the Tier 1 process takes into account the quality of the available data. Municipal water removals and water use trends were obtained from the City of Greater Sudbury and from industry, and large volume permits to take water were checked for actual use and active status. For each Tier 1 water budget, the water surplus was in the range of that reported in the literature (e.g. Richards 2002). For all groundwater sources the estimated uncertainty is low.

Chapter 44 - Falconbridge Water Quality Risk Assessment

The following sections provide the results for the water quality risk assessment process for the Falconbridge drinking water system.

44.1 Falconbridge Wellhead Protection Areas and Vulnerability Scoring

The wellhead protection areas were delineated according to Rules 47 through 50 and followed the methodology outlined in Chapter 2. The resulting vulnerable areas are illustrated on Map 8.3 for each well in the Falconbridge drinking water system. The maximum time of travel to the Falconbridge wells is less than five years, therefore for these wells, there is only WHPA-A, WHPA-B and WHPA-C.

Vulnerability scoring for the wellhead protection areas followed Rules 82 through 85 and the methodology outlined in Chapter 2. Map 8.4 illustrates the vulnerability scoring for the Falconbridge drinking water system.

The variability in vulnerability scores in the Falconbridge WHPA, as illustrated on Map 8.4, is a reflection of the intrinsic susceptibility index for this area. There is higher groundwater vulnerability in the west part of the WHPA where the higher intrinsic susceptibility index is high, and likewise, lower groundwater vulnerability in the east part of the WHPA where the intrinsic susceptibility index is lower. More detail on the intrinsic susceptibility index is available in Chapter 2 and on Map 2.9.

Table 8.4 – Summary of wellhead protection area delineation uncertainty for the Falconbridge drinking water system

Geological Factors	Depth to aquifer, thickness of overburden	Sufficient data from MOE, MNDMF, Vale and City of Greater Sudbury databases
	Soil and Rock Characteristics	Data entry estimations, reporting inconsistencies, averaging by assigning Geologic Survey of Canada codes, very few grain size analyses
Hydrogeological Factors	Hydraulic Parameters	Difference between calculated hydraulic conductivity and value assigned in the model, low density of data, no porosity data
	Hydraulic Head Measurements	Questionable accuracy of values in WWIS, no data from some areas
	Recharge	Recharge assigned according to top layer
	Boundary Conditions	Rivers assigned constant head; no sensitivity analyses
Methodological Factors	Model Used for WHPA Delineation	MODFLOW /MODPATH are industry standards. Only saturated zone flow considered. Natural attenuation not considered.
	Model Calibration and Sensitivity Analysis	Calibrated hydraulic conductivity and recharge only; no sensitivity analyses
	Pump Rate Used for Model	95th percentile of monthly pumping rate is considered a conservative estimate
	Capture Zones Delineation	Low uncertainty because steady state reached within 5 years.

Uncertainty Level

High Uncertainty | Moderate Uncertainty | Low Uncertainty

Vulnerable Area Delineation Uncertainty

Modeling groundwater flow is complex and requires good information and adequate data to be certain of the model results. The groundwater model represents a first step in providing a general understanding of groundwater flow conditions. A degree of uncertainty is always present when using a model to interpret real world situations. In general, geological, hydrogeological and methodological factors contribute to the level of uncertainty within a model. Table 8.4 summarizes the uncertainty in these factors for the Falconbridge drinking water system. For a detailed description of each factor, refer to Appendix 2.

As described in Table 8.4, there is generally a moderate level of uncertainty related to the groundwater model. The delineation of the wellhead protection areas used a conservative approach and thereby overestimates the size of the protection area. In general, the uncertainty associated with the groundwater model increases with the relative size of the protection area as the number of compounding factors increase. The Falconbridge wellhead protection areas are less than a 5 year time of travel and the overall uncertainty of the delineation is low.

Vulnerability Assessment Uncertainty

The vulnerability scores are based on the Intrinsic Susceptibility Index (ISI) and the wellhead protection area (as explained in Chapter 2). Therefore, the uncertainty associated with each score is a function of these two variables. The uncertainty of the wellhead protection areas has been described above.

The ISI score is based in part on the presence or absence of an aquitard or confining layer above the aquifer. In the Falconbridge contributing area, there is no, or a very thin, aquitard, resulting in a highly vulnerable ISI score. There is great reliability in this information; therefore, the uncertainty of this score is low.

44.2 Falconbridge Drinking Water Quality Threats Activities

The assessment of potential threats to drinking water quality followed Technical Rules 118 to 125 and the methodology is outlined in Chapter 2. The list of prescribed drinking water threats is located in Table 1.7 in Part 1 of this report.

List of circumstances of all is or would be threats

As required under O.Reg. 287/07 subsection 13, a list of references for all is or would be significant, moderate or low threats in each vulnerable area is provided in Table 8.5. Tables listing is or would be threats can be found in Appendix 5.

Table 8.5 – Table references for all is or would be threats and associated circumstances in the Falconbridge drinking water system

Score	Significant	Moderate	Low
10	**CW10S -** Chemicals in a WHPA with a vulnerability score of 10 where threats are significant **PW10S -** Pathogens in WHPA A, B with a vulnerability of 10 where threats are significant **DWAS -** DNAPLS in WHPA A, B, C, C1, with any vulnerability where threats are significant	**CW10M -** Chemicals in a WHPA with a vulnerability score of 10 where threats are moderate **PW10M -** Pathogens in WHPA A, B with a vulnerability of 10 where threats are moderate	**CW10L -** Chemicals in a WHPA with a vulnerability score of 10 where threats are low
8	**CW8S-** Chemicals in a WHPA with a vulnerability score of 8 where threats are significant **DWAS-** DNAPLS in WHPA A, B, C, C1, with any vulnerability where threats are significant	**CW8M -** Chemicals in a WHPA with a vulnerability score of 8 where threats are moderate **PW8M -** Pathogens in WHPA A, B with a vulnerability of 8 where threats are moderate	**CW8L -** Chemicals in a WHPA with a vulnerability score of 8 where threats are low **PW8L -** Pathogens in WHPA A, B with a vulnerability of 8 where threats are low

Identification of areas where threats can occur

The areas where a potential threat is or would be significant, moderate or low are illustrated on Map 8.4. According to the Technical Rules:

- Areas with a vulnerability score of 8 or greater can have the potential for a significant, moderate or low threat.
- Areas with a vulnerability score of 6 or greater can have the potential for a moderate or low threat to occur.*
- Areas with a vulnerability score of 4 or greater can have the potential for a low threat to occur.*
- Areas with a vulnerability score of less than 4 cannot contain a drinking water threat.*

*DNAPLs are an exception because they are always a significant threat in WHPA-A, B, C/C1 regardless of the vulnerability score.

Managed Lands

The storage, handling and application of agricultural source material, non-agricultural source material, pesticides and fertilizers can result in potential contamination of municipal water supplies. The methodology used to calculate percentage of managed lands in the vulnerable areas is described in Chapter 2.

The percentage of managed lands in the Falconbridge wellhead protection areas was assessed to be under 40% (low) and is illustrated on Map 8.5.

Impervious Surfaces

Impervious surfaces are measured as an indicator of the amount of area where road salt can be applied. The percentage of surface area within a vulnerable area which will not allow surface water or precipitation to be absorbed into the soil is measured. According to these calculations, most of the Falconbridge WHPA has a 1-8% impervious area, as shown on Map 8.6. The calculation of impervious surface resulted in the vulnerable area being designated as a moderate threat or a low threat for the application of road salt depending on the vulnerability score, as shown in Table 8.6.

Livestock Density

The calculation of livestock density is based on the calculation of nutrient units per acre of agricultural managed lands. The methodology used to calculate the livestock density in the vulnerable areas is described in Chapter 2. There are no agricultural lands in the Falconbridge wellhead protection area, therefore the area has a score of under 0.5 nutrient units per acre. The results are illustrated on Map 8.7.

The combination of livestock density and managed land calculations assigns a threat rating for the application of commercial fertilizer. Table 8.6 shows the number of occurrences of this threat in different vulnerability areas.

Enumeration of Threats

Table 8.6 lists as estimate of the number of moderate and low drinking water quality threats in the Falconbridge drinking water system in accordance with the Drinking Water Threats Tables. At this time, there are no known significant drinking water threats for this system.

Table 8.6 – Drinking water quality threats for the Falconbridge drinking water system

Drinking Water Threat Category	Number of Occurrences with Threat Classification		
	Significant	Moderate	Low
WHPA A & B, Areas with a vulnerability of 10			
The application of commercial fertilizer to land.		1	
The handling and storage of fuel.		1	
The application of road salt.		1	
WHPA B & C, Areas with a vulnerability of 8			
The application of commercial fertilizer to land.			1
The application of road salt.			1
Local threat: Transportation of hazardous substances along transportation corridors.		1	1
WHPA C, areas with a vulnerability of 6			
The application of road salt.			1

44.3 Falconbridge Drinking Water Threats Conditions

A drinking water condition is a situation resulting from a past activity and meeting the criteria laid out in Chapter 2. For a more detailed review of methodology for identifying drinking water conditions, please refer to Part 1, Chapter 2.

The areas where a significant, moderate or low threat condition could exist are the same as the areas where a potential threat could occur. For an illustration, please see Map 8.4.

Currently, there are no known conditions within the Falconbridge vulnerable areas.

44.4 Falconbridge Drinking Water Quality Issues

Drinking water quality issues were assessed based on the methodology outlined in Chapter 2 and Rules 114 and 115.

Currently, there are no known drinking water quality issues in the Falconbridge wells.

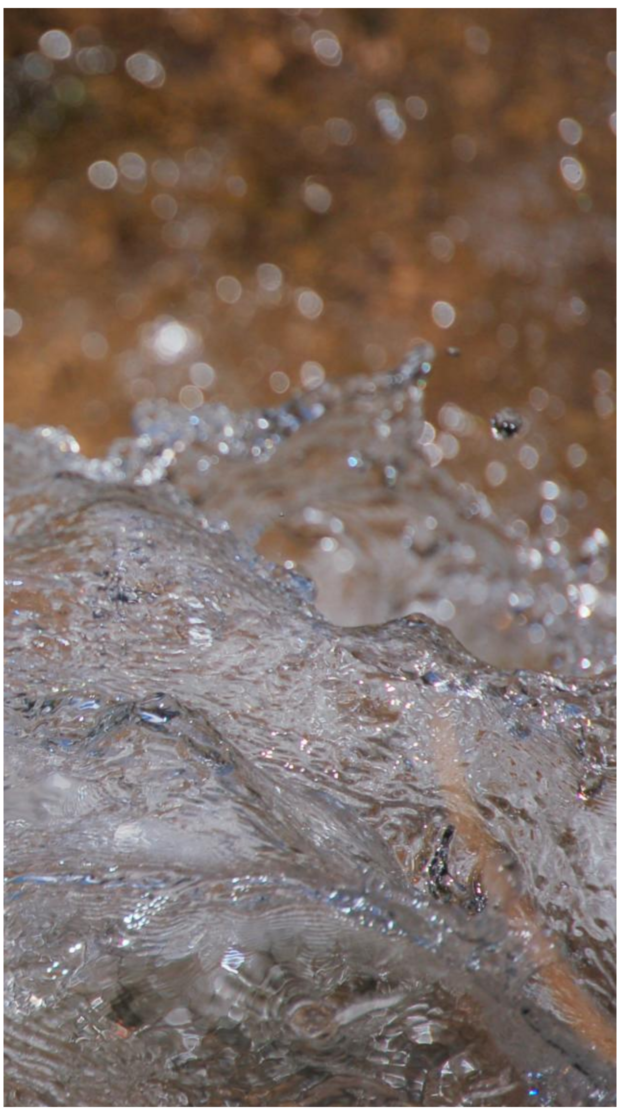
Chapter 45 - Data Availability

The analyses for this drinking water system were carried out using the best data available to meet the assessment report requirements. Completing scientific assessments on the quality and quantity of water undoubtedly raises a number of questions and uncertainties regarding the methodologies used, availability of data, reliability of data and overall outcome. As new information arises, either from increased or continuous monitoring, improved models or a change in methodology, the results from this report will have to be updated to reflect the additional information.

The assessment report is a continually evolving document as new information becomes available and refinements in approaches are made. Changes in land use will also impact the identification of potential threats to water quality and quantity.

Part Nine

Onaping Drinking Water System



The Onaping drinking water system consists of three wells located close to Highway 144 and supplies approximately 2,150 residents in the towns of Onaping and Levack.

Approved on September 2, 2014

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Chapter 46 - Onaping Drinking Water System

The Onaping drinking water system consists of three wells located close to Highway 144. Wells #3, 4 and 5 are located within the Wickwas pumphouse and are also commonly known as the Hardy wells. Water is drawn from deep drilled wells and is treated with chlorine gas.

Well #5 was added to the system in late 2009 and was part of a large upgrade to connect the Onaping and Levack distribution systems. Historically, Xstrata owned and operated Wells #3 and 4 to supply Onaping, while Vale owned and operated the Levack wells to supply Levack. As of November 2009, the City of Greater Sudbury gained ownership of the Onaping drinking water system, which now supplies approximately 2,150 residents in the towns of Onaping and Levack. The Levack wells are no longer connected to the municipal system and currently only serve Vale's operations, therefore source protection planning work was not required for the Levack system. See Map 9.1 for the distribution system. Table 9.1 presents pumping rates for the Onaping drinking water system from 2002-2007.

Table 9.1 – Summary of water usage in the Onaping drinking water system for 2002-2007

	Wells 3 and 4*
Daily Permitted Amount (m^3/day)	5,237
Monthly Permitted Amount (m^3/month)	159,292
Average Actual Monthly Volume (m^3/month)	58,993
Percentage of Monthly Permitted Volume	37%
Maximum Actual Monthly Volume (m^3)	79,303
Percentage of Monthly Permitted Volume	50%
95^{th} Percentile (m^3)	73,711
Percentage of Monthly Permitted Volume	46%

*At the time of this assessment, well #5 was not in use yet and thus was not included in this summary.

Chapter 47 - Onaping Wells Contributing Area

The contributing area for the Onaping wells was developed as part of the City of Greater Sudbury Municipal Groundwater Study. The capture zones for the wells intersected with Windy Lake and the contributing area was therefore extended to include the Windy Lake catchment. The southern and eastern limits of the contributing area were defined as a 500 m buffer added to the developed capture zones. The estimated contributing area to these wells is 89 km^2. See Map 9.2 for an illustration of the contributing area.

Chapter 48 - Water Budget and Stress Assessment

The Onaping drinking water system lies within the Vermilion watershed. As previously described in Chapter 28, the Vermilion watershed was given a water quantity stress level of low and therefore did not need to progress to the next level of a water quantity assessment. Given the isolated nature of the municipal wells, it was decided by the Greater Sudbury Source Protection Area technical team that a Tier 1 water budget should be completed for each drinking water system. The methodology applied is described in greater detail in Chapter 3 and in Appendix 2.

48.1 Onaping Watershed Water Budget

The water balance for the Onaping drinking water system was based on the delineated watershed described in the previous chapter. Table 9.2 summarizes the elements of the water balance estimate. There are no major streamflows in this watershed and Windy Lake covers approximately 13% of the contributing area. As described in Table 9.2, the average annual recharge was calculated to be the average annual water surplus, 408 mm.

Table 9.2 – Water budget for the Onaping watershed

	Water Balance Element (mm)							
Month	Rainfall	Snowfall	Snowmelt	Total Input	PET*	AET**	Water Surplus	Water Deficit
January	2.8	61.8	6.1	8.9	0.0	0.0	8.9	0.0
February	3.1	48.4	13.8	16.9	0.0	0.0	16.9	0.0
March	19.5	45.6	68.2	87.7	0.0	0.0	87.7	0.0
April	51.2	13.0	126.3	177.5	19.5	19.5	158.0	0.0
May	80.8	1.0	8.6	89.3	75.0	73.7	15.6	0.0
June	78.4	0.0	0.0	78.4	110.7	102.5	0.0	-24.1
July	78.8	0.0	0.0	78.8	130.5	109.2	0.0	-30.4
August	85.3	0.0	0.0	85.3	112.5	92.5	0.0	-732
September	107.1	0.0	0.0	107.1	69.3	67.3	39.8	0.0
October	81.9	2.4	2.4	84.4	30.1	30.1	54.3	0.0
November	45.1	33.3	19.4	64.4	0.8	0.8	63.6	0.0
December	9.8	55.8	15.0	24.8	340.0	0.0	24.8	0.0
Annual Total	643.7	261.3	259.9	903.5	548.3	495.6	469.7	-61.7
Annual Recharge							**408.0**	

*PET – Potential Evapotranspiration **AET – Actual Evapotranspiration

48.2 Onaping Watershed Stress Assessment

The water quantity stress assessment results are provided in Table 9.3. For Wells #3 and 4, it was assumed that the permitted pumping rates were 100% consumed from the groundwater system[1]. Municipal demand calculated for this contributing catchment included the municipal demand in the community of Levack. The calculated water removed by the Onaping groundwater wells was approximately 0.8 mm, which represented 14% of the permitted pumping rate. In addition, there are several other groundwater removals in the Onaping watershed, including the industrial water use in Levack.

Groundwater recharge was assumed as equal throughout the year. Recharge rates were two orders of magnitude above demand and monthly stress did not exceed 2% in this watershed. Stress level was calculated to be just below 2% under the current and future municipal demand forecast. On an annual basis, calculated groundwater stress levels were about 1.7% at present and future scenarios, respectively. Therefore, the Onaping watershed was characterized as 'low' stress level under all monthly and annual scenarios. See Appendix 2 for more details.

48.3 Water Budget and Stress Assessment Uncertainty

Uncertainty in the Tier 1 process takes into account the quality of the available data. Municipal water removals and water use trends were obtained from the City of Greater Sudbury and from industry, and large volume permits to take water were checked for actual use and active status. For each Tier 1 water budget, the water surplus was in the range of that reported in the literature (e.g. Richards 2002). For all groundwater sources the estimated uncertainty is low.

Table 9.3 – Water quantity stress assessment for the Onaping watershed

	Supply (m^3/s)		Demand (m^3/s)				Stress (%)	
Month	Recharge	Reserve	Municipal	PTTW	Total	Forecast	Present	Forecast
January	1.15	0.12	0.01	0.01	0.02	0.02	2.13	2.19
February	1.15	0.12	0.01	0.01	0.02	0.02	2.20	2.28
March	1.15	0.12	0.01	0.01	0.02	0.03	2.34	2.42
April	1.15	0.12	0.01	0.01	0.02	0.02	2.14	2.21
May	1.15	0.12	0.01	0.01	0.02	0.02	1.83	1.89
June	1.15	0.12	0.01	0.02	0.03	0.03	2.47	2.55
July	1.15	0.12	0.01	0.01	0.02	0.02	1.92	1.98
August	1.15	0.12	0.01	0.01	0.02	0.02	2.11	2.17
September	1.15	0.12	0.01	0.02	0.03	0.03	2.47	2.56
October	1.15	0.12	0.01	0.01	0.02	0.02	1.86	1.92
November	1.15	0.12	0.01	0.01	0.02	0.02	2.02	2.08

[1] At the time of this assessment, Well #5 was not in use and therefore not included in the estimates. However, permitted water removal rates for the Onaping Drinking Water System have not changed, and therefore the estimates are still accurate.

December	1.15	0.12	0.01	0.02	0.02	0.03	2.39	2.47
Annual	**1.15**	**0.12**	**0.01**	**0.01**	**0.02**	**0.02**	**2.16**	**2.23**

Chapter 49 - Onaping Water Quality Risk Assessment

The following sections provide the results for the water quality risk assessment process for the Onaping drinking water system.

49.1 Onaping Wellhead Protection Areas and Vulnerability Scoring

The wellhead protection areas were delineated according to Rules 47 through 50 and followed the methodology outlined in Chapter 2. The resulting vulnerable areas are illustrated on Map 9.3 for each well in the Onaping drinking water system. The maximum time of travel to the Onaping wells is less than two years, therefore there is only WHPA-A and WHPA-B for these wells.

Vulnerability scoring for the wellhead protection areas followed Rules 82 through 85 and the methodology outlined in Chapter 2. Map 9.4 illustrates the vulnerability scoring for the Onaping drinking water system.

Vulnerable Area Delineation Uncertainty

Modeling groundwater flow is complex and requires good information and adequate data to be certain of the model results. The groundwater model represents a first step in providing a general understanding of groundwater flow conditions. A degree of uncertainty is always present when using a model to interpret real world situations. In general, geological, hydrogeological and methodological factors contribute to the level of uncertainty within a model. Table 9.4 summarizes the uncertainty in these factors for the Onaping drinking water system. For a detailed description of each factor, refer to Appendix 2.

As illustrated in Table 9.4, there is generally a moderate level of uncertainty related to components of the groundwater modeling process. The delineation of the wellhead protection areas used a conservative approach and thereby overestimates the size of the protection area. In general, the uncertainty associated with the groundwater model increases with the relative size of the protection area as the number of compounding factors increase. The Onaping wellhead protection areas are less than a 2 year time of travel and therefore the overall uncertainty of the delineation is low.

Vulnerability Assessment Uncertainty

The vulnerability scores are based on the Intrinsic Susceptibility Index (ISI) and the wellhead protection area (as explained in Chapter 2). Therefore, the uncertainty associated with each score is a function of these two variables. The uncertainty of the wellhead protection areas has been described above.

Table 9.4 – Summary of the wellhead protection area delineation uncertainty for the Onaping drinking water system

Geological Factors	Depth to aquifer, thickness of overburden	Sufficient data from Vale database in northern portion of the model. Sparse data density through most of model including near water supply wells.

	Soil and Rock Characteristics	Data entry estimations, reporting inconsistencies, averaging by assigning Geologic Survey of Canada codes, very few grain size analyses
Hydrogeological Factors	Hydraulic Parameters	Difference between calculated hydraulic conductivity and value assigned in the model, low density of data, no porosity data
	Hydraulic Head Measurements	Questionable accuracy of values in WWIS, no data from some areas
	Recharge	Recharge assigned according to top layer
	Boundary Conditions	Rivers assigned constant head; no sensitivity analyses
Methodological Factors	Model Used for WHPA Delineation	MODFLOW / MODPATH are industry standards. Only saturated zone flow considered. Natural attenuation not considered.
	Model Calibration and Sensitivity Analysis	Calibrated hydraulic conductivity and recharge only; no sensitivity analyses
	Pump Rate Used for Model	95th percentile of monthly pumping rate is considered a conservative estimate
	Capture Zones Delineation	Low uncertainty because steady state is reached within 2 years

Uncertainty Level

High Uncertainty | Moderate Uncertainty | Low Uncertainty

49.2 Onaping Drinking Water Quality Threats Activities

The assessment of potential threats to drinking water quality followed Technical Rules 118 to 125 and the methodology is outlined in Chapter 2. The list of prescribed drinking water threats is located in Table 1.7 in Part 1 of this report.

List of circumstances of all is or would be threats

As required under O.Reg. 287/07 subsection 13, a list of references for all is or would be significant, moderate or low threats in each vulnerable area is listed in Table 9.5. Tables listing is or would be threats can be found in Appendix 5.

Table 9.5 – Table references for all is or would be threats and associated circumstances in the Onaping drinking water system

Score	Significant	Moderate	Low
10	**CW10S** - Chemicals in a WHPA with a vulnerability score of 10 where threats are significant **PW10S** - Pathogens in WHPA A, B with a vulnerability of 10 where threats are significant **DWAS** - DNAPLS in WHPA A, B, C, C1, with any vulnerability where threats are significant	**CW10M** - Chemicals in a WHPA with a vulnerability score of 10 where threats are moderate **PW10M** - Pathogens in WHPA A, B with a vulnerability of 10 where threats are moderate	**CW10L** - Chemicals in a WHPA with a vulnerability score of 10 where threats are low

Identification of areas where threats can occur

The areas where a potential threat is or would be significant, moderate or low are illustrated on Map 9.4. According to the Technical Rules:

- Areas with a vulnerability score of 8 or greater has the potential for a significant, moderate or low threat.
- Areas with a vulnerability score of 6 or greater has the potential for a moderate or low threat to occur.*
- Areas with a vulnerability score of 4 or greater has the potential for a low threat to occur.*
- Areas with a vulnerability score of less than 4 cannot contain a drinking water threat.*

*DNAPLs are an exception because they are always a significant threat in WHPA-A, B, C/C1 regardless of the vulnerability score.

Managed Lands

The storage, handling and application of agricultural source material, non-agricultural source material, pesticides and fertilizers can result in potential contamination of municipal water supplies. The methodology used to calculate percentage of managed lands in the vulnerable areas is described in Chapter 2.

The percentage of managed lands in the Onaping wellhead protection area was assessed to be under 40% (low) and is illustrated on Map 9.5.

Impervious Surfaces

Impervious surfaces are measured as an indicator of the amount of area where road salt can be applied. The percentage of surface area within a vulnerable area which will not allow surface water or precipitation to be absorbed into the soil is measured. According to these calculations, the Onaping wellhead protection area has less than 1% impervious area, as illustrated on Map 9.6. The calculation of impervious surface resulted in the vulnerable area being designated as a low threat for the application of road salt, as shown in Table 9.6.

The methodology used to calculate percentage of impervious surfaces in the vulnerable areas is described in Chapter 2.

Livestock Density

The calculation of livestock density is based on the calculation of nutrient units per acre of agricultural managed lands. The methodology used to calculate the livestock density in the vulnerable areas is described in Chapter 2. There are no agricultural lands in the Onaping wellhead protection area, therefore the area has a score of under 0.5 nutrient units per acre. The results are illustrated on Map 9.7.

The combination of livestock density and managed land calculations assigns a threat rating for the application of commercial fertilizer. In the Onaping WHPA, it is considered a moderate threat, as shown in Table 9.6.

Enumeration of Threats

Table 9.6 lists as estimate of the number of significant, moderate and low drinking water quality threats in the Dowling drinking water system in accordance with the Drinking Water Threats Tables.

Table 9.6 – Drinking water quality threats for the Onaping drinking water system

Drinking Water Threat Category	Number of Occurrences with Threat Classification		
	Significant	Moderate	Low
WHPA A & B - Areas with a vulnerability score of 10			
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposed of sewage.	2		
The application of commercial fertilizer to land.		1	
The handling and storage of fuel.		1	
The application of road salt.			1
Local threat: Transportation of hazardous substances along transportation corridors.	2	2	

49.3 Onaping Drinking Water Threats Conditions

A drinking water condition is a situation that results from a past activity and meets the criteria laid out in Chapter 2. For a more detailed review of methodology for identifying drinking water conditions, refer to Part 1, Chapter 2.

The areas where a significant, moderate or low condition could exist are the same for as the areas where a potential threat could occur. For an illustration, please see Map 9.4.

Currently, there are no known conditions within the Onaping vulnerable areas.

49.4 Onaping Drinking Water Quality Issues

Drinking water quality issues were assessed based on the methodology outlined in Chapter 2 and Rules 114 and 115.

Currently, there are no known drinking water quality issues in the Onaping drinking water system.

Chapter 50 - Data Availability

The analyses for this drinking water system were carried out using the best data available to meet the assessment report requirements. Completing scientific assessments on the quality and quantity of water undoubtedly raises a number of questions and uncertainties regarding the methodologies used, availability of data, reliability of data, and overall outcome. As new information arises, either from increased or continuous monitoring, improved models, or a change in methodology, the results from this report will have to be updated to reflect the additional information.

The assessment report is an ever evolving document as new information becomes available and refinements in approaches are made. Changes in land use will also impact the identification of potential threats to water quality and quantity.

Part Ten

Dowling Drinking Water System

The Dowling drinking water system consists of two wells located in the community of Dowling, close to the Onaping River, and services approximately 1,850 people.

Approved on September 2, 2014

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Chapter 51 - The Dowling Drinking Water System

The Dowling drinking water system consists of two wells located in the community of Dowling, close to the Onaping River, and services approximately 1,850 people. Riverside (Well #1) is located on Riverside Drive and Lionel (Well #2) is located at the end of Lionel Avenue. Construction of the system occurred in two phases; the first well was built in 1975 and the second well in 1983. Map 10.1 illustrates the distribution system for the community of Dowling.

Both wells have been determined to be Groundwater Under the Direct Influence of surface water (GUDI) wells with effective in situ infiltration (Golder 2002). Water taking from the Riverside and Lionel Wells is alternated remotely from the Wanapitei Water Treatment Plant. Treatment consists of disinfection with U.V. treatment, chlorine gas and the addition of fluoride.

Water use figures are presented in Table 10.1. An elevated storage tank with a holding capacity of 1,360 m^3 is included in the system and is operated by staff at the Wanapitei Water Treatment Plant. It takes approximately 9 hours to fill the tank and, based on current usage rates, the tank could sustain the community for approximately 2.4 days.

Table 10.1 – Summary of water usage in the Dowling drinking water system for 2002-2007

	Lionel	Riverside
Daily Permitted Amount (m^3/day)	3,600	3,600
Monthly Permitted Amount (m^3/month)	109,500	109,500
Average Actual Monthly Volume (m^3/month)	6,272	9,361
Percentage of Monthly Permitted Volume	6%	9%
Maximum Actual Monthly Volume (m^3)	12,524	16,517
Percentage of Monthly Permitted Volume	11%	15%
95^{th} Percentile (m^3)	11,229	14,052
Percentage of Monthly Permitted Volume	10%	13%

Chapter 52 - The Dowling Contributing Area

The Dowling drinking water system, as described in the previous chapter, is subject to the influence of surface water and is thus deemed to be a Groundwater Under the Direct Influence of surface water (GUDI) well. The delineation of the contributing area for the wells includes the surface water system upstream from the two wells and is truncated at the point where the Vale wells begin in Levack[1].

The Dowling watershed is estimated to be approximately 1,567 km^2 and includes a number of points of interest. Onaping Falls, or A.Y. Jackson lookout, is a major attraction offering walking trails and lookouts for fall colour viewing. The watershed includes the towns of Onaping and Levack and continues to the headwater area of Moose Lake. The majority of the watershed is forested with bedrock dominating the geology of the area. Map 10.2 illustrates the contributing area for the Dowling wells.

[1] The Levack wells were part of the municipal drinking water system for the Town of Levack until November 2009. The Hardy wells in Onaping currently serve as the Levack drinking water supply and the original Levack wells are in operation for mining purposes only.

Chapter 53 - Water Budget and Quantity Assessment

The Dowling drinking water system lies within the Vermilion watershed. As previously described in Chapter 28, the Vermilion watershed was given a water quantity stress level of low and therefore did not need to progress to the next level of a water quantity assessment. Given the isolated nature of the municipal wells, it was decided by the Greater Sudbury Source Protection Area technical team that a Tier 1 water budget should be completed for each drinking water system. The methodology applied is described in greater detail in Chapter 3 and in Appendix 2.

53.1 The Dowling Wells Contributing Area Water Budget

The water balance for the Dowling drinking water system was based on the delineated watershed described in the previous chapter. Table 10.2 summarizes the elements of the water balance estimate. The soil water holding capacity was weighted over this delineated watershed and streamflow was measured at the closest gauging station located on the Onaping River (02CF010) and prorated to the outlet of the watershed.

As described in Table 10.2, the average annual recharge was calculated to be 188 mm, and the annual water surplus was calculated to be 410 mm. Estimated annual recharge was greater than estimated baseflow, which may be a result of processes such as interflow, which move water to surface water sources (e.g. wetlands) prior to releasing to rivers.

Table 10.2 – Water budget for the Dowling watershed

	Water Balance Element (mm)										
Month	Rainfall	Snow-fall	Snow-melt	Total Input	PET*	AET**	Stream-flow	Base-flow	Runoff	Water Surplus	Water Deficit
January	2.3	61.2	5.8	8.1	0.0	0.0	10.3	5.2	5.2	0.0	-2.2
February	2.9	48.5	13.5	16.4	0.0	0.0	8.1	4.0	4.0	8.3	0.0
March	20.0	46.7	67.2	87.1	0.0	0.0	10.8	3.2	7.5	76.4	0.0
April	52.0	13.4	129.2	181.1	19.2	19.2	50.0	10.0	40.0	112.0	0.0
May	80.8	1.0	8.8	89.6	74.5	73.2	47.9	7.2	40.7	0.0	-31.5
June	77.1	0.0	0.0	77.1	110.5	102.0	20.3	4.1	16.2	0.0	-45.1
July	78.0	0.0	0.0	78.0	130.3	108.5	9.4	4.2	5.2	0.0	-39.9
August	84.9	0.0	0.0	84.9	112.7	92.2	5.7	2.6	3.1	0.0	-12.9
September	106.4	0.0	0.0	106.4	69.0	67.0	7.5	3.0	4.5	32.0	0.0
October	82.3	2.5	2.5	84.8	30.2	30.2	16.4	5.7	10.6	38.2	0.0
November	45.4	33.3	19.0	64.4	0.7	0.7	20.0	7.0	13.0	43.7	0.0
December	9.3	55.5	15.2	24.6	0.0	0.0	15.6	6.2	9.4	9.0	0.0

Annual Total	641.5	262.1	261.2	902.7	547.0	493.0	221.8	62.4	159.4	319.5	-131.6
Annual Recharge											**187.9**

*PET – Potential Evapotranspiration
**AET – Actual Evapotranspiration

53.2 The Dowling Wells Water Quantity Stress Assessment

The water quantity stress assessment results are provided in Table 10.3. For the Lionel and Riverside wells, it was assumed that the permitted pumping rates were 100% consumed from the groundwater system. Municipal demand calculated for this contributing catchment included the municipal demand in the community of Levack. The calculated water removed by the Dowling groundwater wells was approximately 0.8 mm, which represented 14% of the permitted pumping rate. In addition, there are several other groundwater removals in the Dowling watershed including the industrial water use in Levack.

Groundwater recharge was assumed as equal throughout the year. Recharge rates were two orders of magnitude above demand, and monthly stress did not exceed 2% in this watershed. Stress level was calculated to be just below 2% under the current and future municipal demand forecast. On an annual basis, calculated groundwater stress levels were about 1.7% at present and future scenarios, respectively. Therefore, the Dowling watershed was characterized as 'low' stress level under all monthly and annual scenarios.

Table 10.3 – Water quantity stress assessment for the Dowling watershed

	Supply (m^3/s)		Demand (m^3/s)				Stress (%)	
Month	Recharge	Reserve	Municipal	Other	Total	Forecast	Present	Forecast
January	9.4	0.94	0.02	0.11	0.13	0.13	1.52	1.54
February	9.4	0.94	0.02	0.11	0.13	0.13	1.51	1.53
March	9.4	0.94	0.02	0.11	0.13	0.13	1.54	1.56
April	9.4	0.94	0.02	0.12	0.13	0.13	1.57	1.58
May	9.4	0.94	0.02	0.12	0.13	0.13	1.57	1.59
June	9.4	0.94	0.02	0.13	0.15	0.15	1.78	1.80
July	9.4	0.94	0.02	0.14	0.16	0.16	1.87	1.89
August	9.4	0.94	0.02	0.15	0.17	0.17	1.96	1.98
September	9.4	0.94	0.02	0.14	0.16	0.16	1.85	1.87
October	9.4	0.94	0.02	0.12	0.14	0.14	1.61	1.63
November	9.4	0.94	0.02	0.12	0.13	0.14	1.58	1.60
December	9.4	0.94	0.02	0.12	0.13	0.14	1.59	1.60
Annual	**9.4**	**0.94**	**0.02**	**0.12**	**0.14**	**0.14**	**1.66**	**1.68**

53.3 Water Budget and Stress Assessment Uncertainty

Uncertainty in the Tier 1 process takes into account the quality of the available data. Municipal water removals and water use trends were obtained from the City of Greater Sudbury and from industry, and large volume permits to take water were checked for actual use and active status. For each Tier 1 water budget, the water surplus was in the range of that reported in the literature (e.g. Richards 2002). For all groundwater sources the estimated uncertainty is low.

Chapter 54 - Dowling Water Quality Risk Assessment

The following sections provide the results for the water quality risk assessment process for the Dowling drinking water system.

54.1 Dowling Wellhead Protection Areas and Vulnerability Scoring

The wellhead protection areas were delineated according to Rules 47 through 50 and followed the methodology outlined in Chapter 2. The resulting vulnerable areas are illustrated on Map 10.3 for each well in the Dowling drinking water system. The maximum time of travel for the Dowling wells is less than five years, therefore there is no WHPA-D.

Both Dowling wells are considered Groundwater Under the Influence of Surface Water (or GUDI) which requires the delineation of a WHPA-E (Rule 49). A WHPA-F was not delineated as no water quality issues are present at the well. The WHPA-E was delineated using HEC-RAS to model a one in two year storm event on the Onaping River. Appendix 2 details the methodology.

Vulnerability scoring for the wellhead protection areas followed Rules 82 through 85 and the methodology outlined in Chapter 2. Map 10.4 illustrates the vulnerability scoring for the Dowling drinking water system.

The vulnerability scoring for the WHPA-E follows the same methodology for an IPZ-2 for a Type C intake. For the Dowling wells, the source vulnerability factor was given a score of 0.9 (out of a possible 0.9 or 1.0) as the wells are not vulnerable to exposure. The area vulnerability factor was given a score of 8 (out of a range of 7-9) as land cover in the area is mostly forested, but the lower reaches are urban residential, and due to the distance and time water must travel to enter the well. The overall vulnerability score for WHPA-E is 7.2, or moderate.

Vulnerable Area Delineation Uncertainty

Vulnerable area delineation for wellhead protection areas A – D was completed together, while wellhead protection area E was delineated separately.

Wellhead Protection Areas A – D

Modeling groundwater flow is complex and requires good information and adequate data to be certain of the model results. The groundwater model represents a first step in providing a general understanding of groundwater flow conditions. A degree of uncertainty is always present when using a model to interpret real world situations. In general, geological, hydrogeological and methodological factors contribute to the level of uncertainty within a model. Table 10.4 summarizes the uncertainty in these factors for the Dowling drinking water system. For a detailed description of each factor, refer to Appendix 2.

Table 10.4 – Summary of wellhead protection area delineation uncertainty for the Dowling system

Geological Factors	Depth to aquifer, thickness of overburden	Sufficient data from MOE, MNDM databases
	Soil and Rock Characteristics	Data entry estimations, reporting inconsistencies, averaging by assigning Geologic Survey of Canada codes, very few grain size analyses
Hydrogeological Factors	Hydraulic Parameters	Difference between calculated hydraulic conductivity and

		value assigned in the model, low density of data, very few porosity data
	Hydraulic Head Measurements	Questionable accuracy of values in WWIS, no data from some areas
	Recharge	Recharge assigned according to top layer
	Boundary Conditions	Rivers assigned constant head; no sensitivity analyses
Methodological Factors	Model Used for WHPA Delineation	MODFLOW /MODPATH are industry standards. Only saturated zone flow considered. Natural attenuation not considered.
	Model Calibration and Sensitivity Analysis	Calibrated hydraulic conductivity and recharge only; no sensitivity analyses
	Pump Rate Used for Model	95^{th} percentile of monthly pumping rate is considered a conservative estimate
	Capture Zones Delineation	High uncertainty due to long, narrow WHPAs

Uncertainty Level

High Uncertainty | Moderate Uncertainty | Low Uncertainty

As described in Table 10.4, there is generally a moderate to high level of uncertainty related to the various components of the groundwater modeling process. The uncertainty in the WHPA-A delineations is lower because they are defined by the Technical Rules as a fixed radius. Generally, the uncertainty in delineating the non-fixed WHPAs decreases closer to the wellhead as there is less compounding of errors. The overall uncertainty for the WHPA-B and WHPA-C delineations is assessed to be high.

Wellhead Protection Area-E

The level of uncertainty associated with the WHPA-E delineation can be assessed by defining the quantity and quality of data as well as the methodology employed. Data can be divided into the following categories: topographic and bathymetric data, hydrometric data and roughness data. Methodological factors can be categorized as the following: model used, boundary conditions, calibration and sensitivity analysis, and capture zone delineation. Table 10.5 summarizes the level of uncertainty assigned to each of these categories and the rationale behind the assessment. Appendix 2 provides additional detail.

Table 10.5 – Summary of WHPA-E uncertainty analysis for the Dowling drinking water system

Data Factors	Topographic and Bathymetric Data	Detailed topography available: bathymetric data based on visual interpretation of aerial photography
	Hydrometric Data	No hydrometric data available within modeled section. HYDAT station with 26 years of data is located 1.8 km upstream
	Roughness Data	Based on interpretation of aerial photography
Methodological Factors	Model Used for Protection Zones Delineation	HEC-RAS is industry standard code for modeling flow in rivers
	Boundary Conditions	Critical depth appropriate for river
	Model Calibration and Sensitivity Analysis	No calibration or sensitivity analysis could be conducted
	Capture Zones Delineation	High uncertainty due to lack of bathymetry data and field observed Manning's data

Uncertainty Level		
High Uncertainty	Moderate Uncertainty	Low Uncertainty

The surface water flow model simulations provide a general understanding of the surface water flow conditions in the Onaping River. As explained in Table 10.5, uncertainty related to the various components of the surface water modeling process ranges from low to high. Due to the lack of bathymetry data and the lack of field testing, the overall uncertainty is high.

Vulnerability Assessment Uncertainty

The vulnerability scores are based on the Intrinsic Susceptibility Index (ISI) and the wellhead protection area. Therefore, the uncertainty associated with each score is a function of these two variables. The uncertainty of the wellhead protection areas has been described above.

The ISI score is in part based on the presence or absence of an aquitard or confining layer above the aquifer. In the Dowling contributing area, there is no, or a very thin, aquitard, therefore, the ISI score is highly vulnerable. There is a great amount of reliability in this information; therefore, the uncertainty of this score is low.

54.2 Dowling Drinking Water Quality Threats Activities

The assessment of potential threats to drinking water quality followed Technical Rules 118 to 125 and the methodology is outlined in Chapter 2. The list of prescribed drinking water threats is located in Table 1.7 in Part 1 of this report.

List of circumstances of all is or would be threats

As required under O.Reg. 287/07 subsection 13, a list of references for all is or would be significant, moderate or low threats in each vulnerable area is shown in Table 10.6. Tables listing is or would be threats can be found in Appendix 5.

Table 10.6 – Table references for all is or would be threats and associated circumstances in the Dowling drinking water system

Score	Significant	Moderate	Low
10	**CW10S -** Chemicals in a WHPA with a vulnerability score of 10 where threats are significant **PW10S -** Pathogens in WHPA A, B with a vulnerability of 10 where threats are significant **DWAS -** DNAPLS in WHPA A, B, C, C1, with any vulnerability where threats are significant	**CW10M -** Chemicals in a WHPA with a vulnerability score of 10 where threats are moderate **PW10M -** Pathogens in WHPA A, B with a vulnerability of 10 where threats are moderate	**CW10L -** Chemicals in a WHPA with a vulnerability score of 10 where threats are low
8	**CW8S-** Chemicals in a WHPA with a vulnerability score of 8 where threats are significant **DWAS-** DNAPLS in WHPA A, B, C, C1, with any vulnerability where threats are significant	**CW8M -** Chemicals in a WHPA with a vulnerability score of 8 where threats are moderate **PW8M -** Pathogens in WHPA A, B with a vulnerability of 8 where threats are moderate	**CW8L -** Chemicals in a WHPA with a vulnerability score of 8 where threats are low **PW8L -** Pathogens in WHPA A, B with a vulnerability of 8 where threats are low
7.2	N/A	**CIPZWE7.2M -** Chemicals in an IPZ or WHPA E where the vulnerability score is 7.2 where threats are moderate **PIPZWE7.2M** - Pathogens in an IPZ or WHPA E with a vulnerability of 7.2 where threats are moderate	**CIPZWE7.2L** - Chemicals in an IPZ or WHPA E where the vulnerability score is 7.2 where threats are low **PIPZWE7.2L** - Pathogens in an IPZ or WHPA E with a vulnerability of 7.2 where threats are low

Note: The table references refer to the provincial tables of circumstances (listed in Appendix 5).

Identification of areas where threats can occur

The areas where a potential threat is or would be significant, moderate or low are illustrated on Map 10.4. According to the Technical Rules:

- Areas with a vulnerability score of 8 or greater has the potential for a significant, moderate or low threat.
- Areas with a vulnerability score of 6 or greater has the potential for a moderate or low threat to occur.*
- Areas with a vulnerability score of 4 or greater has the potential for a low threat to occur.*
- Areas with a vulnerability score of less than 4 cannot contain a drinking water threat.*

*DNAPLs are an exception because they are always a significant threat in WHPA-A, B, C/C1 regardless of the vulnerability score.

Managed Lands

The storage, handling and application of agricultural source material, non-agricultural source material, pesticides and fertilizers can result in potential contamination of municipal water supplies. The methodology used to calculate percentage of managed lands in the vulnerable areas is described in Chapter 2.

The percentage of managed lands in the Dowling wellhead protection areas was assessed to be under 40% (low) and is illustrated on Map 10.5.

Impervious Surfaces

Impervious surfaces are measured as an indicator of the amount of area where road salt can be applied. The percentage of surface area within a vulnerable area which will not allow surface water or precipitation to be absorbed into the soil is measured. According to these calculations, the area immediately around Riverside Well has a 8-80% impervious area, while the area immediately around Lionel Well has a 1-8% impervious area.

It is noted in Section 54.4 that both the Lionel and Riverside wells consistently have sodium levels in the range from 20 – 30 mg/L, but there is insufficient data to determine if there is a significant increasing trend. The percentage of impervious area is illustrated on Map 10.6.

The methodology used to calculate percentage of impervious surfaces in the vulnerable areas is described in Chapter 2.

The impervious surface calculations result in the application of road salt being designated as a moderate threat in WHPA A, B and C, and a low threat in WHPA-E, as shown in Table 10.7.

Livestock Density

The calculation of livestock density is based on the calculation of nutrient units per acre of agricultural managed lands. There are no agricultural lands in the Dowling wellhead protection area, therefore the area has a score of under 0.5 nutrient units per acre. The results are illustrated on Map 10.7.

The combination of livestock density and managed land calculations assigns a threat rating for the application of commercial fertilizer. The results show that the application of commercial fertilizer is a moderate threat in WHPA A, B and C, and a low threat in WHPA-E, as illustrated in Table 10.7.

Enumeration of Threats

Table 10.7 lists an estimate of the number of significant, moderate and low drinking water quality threats in the Dowling drinking water system in accordance with the Drinking Water Threats Tables.

Table 10.7 – Drinking water quality threats for the Dowling drinking water system

Drinking Water Threat Category	Number of Occurrences with Threat Classification		
	Significant	Moderate	Low
WHPA A, B & C			
The establishment, operation or maintenance of a system that collects, stores, transmits, treats or disposes of sewage.		1	
The handling and storage of fuel.		1	
The application of commercial fertilizer to land.		2	
The application of road salt.		2	
Local threat: Transportation of hazardous substances along transportation corridors.	1	1	
WHPA E			
The application of commercial fertilizer to land.			2
The application of road salt.			2
Local threat: Transportation of hazardous substances along transportation corridors.		1	3

54.3 Dowling Drinking Water Threats Conditions

A drinking water condition is a situation that results from a past activity and meets the criteria laid out in Chapter 2. For a more detailed review of methodology for identifying drinking water conditions, please refer to Part 1, Chapter 2.

The areas where a significant, moderate or low threat condition could exist are the same as the areas where a potential threat could occur. For an illustration, please see Map 10.4.

Currently, there are no known significant conditions present in the Dowling vulnerable areas.

54.4 Dowling Drinking Water Quality Issues

Drinking water quality issues were assessed based on the methodology outlined in Chapter 2 and Rules 114 and 115.

The Lionel and Riverside wells have sodium levels in the range from 20 – 30 mg/L. Currently, there is insufficient data to determine if there is a significant increasing trend.

Chapter 55 - Data Availability

The analyses for this drinking water system were carried out using the best data available to meet the assessment report requirements. Completing scientific assessments on the quality and quantity of water undoubtedly raises a number of questions and uncertainties regarding the methodologies used, availability of data, reliability of data and overall outcome. As new information arises, either from increased or continuous monitoring, improved models or a change in methodology, the results from this report will have to be updated to reflect the additional information.

The assessment report is an ever evolving document as new information becomes available and refinements in approaches are made. Changes in land use will also impact the identification of potential threats to water quality and quantity.

Part 11

Appendices

This section includes a glossary, report references, public consultation materials, technical reports and provincial Tables of Circumstances that were used in the compilation of the assessment report.

Proposed Update to the Assessment Report, February 28, 2014

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Appendix 1 – Glossary

Abandoned Well - a well that is deserted because it is dry, contains non potable water, was discontinued before completion, has not been properly maintained, was constructed poorly, or it has been determined that natural gas may pose a hazard.

Activity - one or a series of related processes, natural or anthropogenic that occurs within a geographical area and may be related to a particular land use.

Aquifer - a water-bearing layer (or several layers) of rock or sediment capable of yielding supplies of water; typically consists of unconsolidated deposits of sandstone, limestone or granite, and can be classified as confined, unconfined or perched. The water in an aquifer is called groundwater.

Aquifer System - a group of two or more aquifers that are separated by aquitards or aquicludes.

Aquitard - a confining bed and/or formation composed of rock or sediment that retards but does not prevent the flow of water to or from an adjacent aquifer. It does not readily yield water to wells or springs, but stores groundwater.

Assessment Report - the assessment report is a science based report generated locally for each Source Protection Area to comply with the *Clean Water Act, 2006*. The Report will identify the watersheds and the vulnerable areas within the Source Protection Area. Threats to the vulnerable areas will be assessed and determined whether they pose a significant threat to municipal residential drinking water systems.

Attenuation - the soil's ability to lessen the amount of, or reduce the severity of groundwater contamination. During attenuation, the soil holds essential plant nutrients for uptake by agronomic crops, immobilizes metals that might be contained in municipal sewage sludge, and removes bacteria contained in animal or human wastes.

Baseflow - the sustained flow (amount of water) in a stream that comes from groundwater discharge or seepage. Groundwater flows underground until the water table intersects the land surface and the flowing water becomes surface water in the form of springs, streams/rivers, lakes and wetlands. Baseflow is the continual contribution of groundwater to watercourses and is important for maintaining flow in streams and rivers between rainstorms and in winter conditions.

Bedrock - solid or fractured rock usually underlying unconsolidated geologic materials; bedrock may be exposed at the land surface.

Benthos - the plant and animal life whose habitat is the bottom of a body of water.

Capture Zone - a term used to represent an area where water originates and moves to a water well. Typically, capture zones are a two dimensional representation of a three dimensional space.

Chemical Contaminant - a substance used in conjunction with, or associated with, a land use activity or a particular entity, and with the potential to adversely affect water quality.

Clean Water Act - the *Clean Water Act, 2006* was passed as Bill 43 to protect drinking water at the source. The *Act* requires the development of a watershed based source protection plan.

Conceptual Water Budget - a written description of the overall system flow dynamics for each watershed in the Source Protection Area, taking into consideration surface water and groundwater features, land cover (e.g. proportion of urban vs. rural uses), man-made structures (e.g. dams, channel diversions, water crossings) and water takings.

Condition - the presence of a substance in a vulnerable area that results from a past activity and that also constitutes a drinking water threat.

Contaminant (pollutant) - an undesirable substance that makes water unfit for a given use when found in sufficient concentration.

Contaminant of Concern - a chemical or pathogen that is or may be discharged from a drinking water threat, a chemical or pathogen that is or may become a drinking water threat as identified by the Ontario Ministry of Environment.

Data Gaps - the lack of site specific information for a geographical area and/or specific type of information.

Dense Non-Aqueous Phase Liquid (DNAPL) - an organic chemical in concentrations greater than its aqueous solubility and more dense than water. Such a chemical will sink in groundwater and accumulate in aquifer depressions.

Designated System - a drinking water system that is included in a terms of reference, pursuant to resolution passed by a municipal council under subsection 8(3) of the proposed *Clean Water Act, 2006*.

Developed/Developable - reference to the useable portion of a parcel of land that meets the regulatory zoning provisions, particularly those pertaining to defining the area of occupation for buildings, structures, facilities and infrastructure.

Discharge Area - an area where groundwater emerges at the surface; an area where upward pressure or hydraulic head moves groundwater towards the surface to escape as a spring, seep, or base flow of a stream.

Drainage Area - the area which supplies water to a particular point.

Drainage Basin - the area of land, surrounded by divides, that provides runoff to a fluvial network that converges to a single channel or lake at the outlet.

Drinking Water - 1. Water intended for human consumption. 2. Water that is required by an Act, regulation, order, municipal by-law or other document issued under the authority of an Act, (a) to be potable, or (b) to meet or exceed the requirements of the prescribed drinking water quality standards.

Drinking Water Issue - a substantiated condition relating to the quality or quantity of water that interferes or is anticipated to soon interfere with the use of a drinking water source by a municipality. As defined in *Technical Rule 114*, regarding the quality of water in a vulnerable area: 1) The presence of a parameter in water at a surface water intake or well, at a concentration that may result in deterioration of the water quality or where there is a trend of increasing concentrations of a parameter. 2) The presence of a pathogen at a concentration that may result in deterioration of the water quality or there is a trend of increasing concentrations of the pathogen.

Drinking Water System - a system of works, excluding plumbing, that is established for the purpose of providing users of the system with drinking water and that includes, (a) anything used for the collection, production, treatment, storage, supply or distribution of water, (b) anything related to the management of residue from the treatment process or the management of the discharge of a substance into the natural environment from the treatment system, and (c) a well or intake that serves as the source or entry point of raw water supply for the system.

Drinking Water Threat - An existing activity, possible future activity or existing condition that results from a past activity, (a) that adversely affects or has the potential to adversely affect the quality or quantity of any water that is or may be used as a source of drinking water, or (b) that results in or has the potential to result in the raw water supply of an existing or planned drinking water system failing to meet any standards prescribed by the regulations respecting the quality or quantity of water, and includes an activity or condition that is prescribed by the regulations as a drinking water threat.

Effluent - the discharge of a pollutant in a liquid form, often from a pipe into a stream or river.

Environmental Protection Act - the purpose of this *Act* is to provide for the protection and conservation of the natural environment. R.S.O. 1990, c. E.19, s. *3*.

Esker - a ridge of glacial sediment deposited by a stream flowing in and under a melting glacier.

Evaporation - the process by which water or other liquids change from liquid to vapour; evaporation can return infiltrated water to the atmosphere from upper soil layers before it reaches groundwater or surface water, and occur from leaf surfaces (interception), water bodies (lakes, streams, wetlands, oceans), and small puddled depressions in the landscape.

Evapotranspiration - the combined loss of water from a given area and during a specific period of time by evaporation from the soil surface and water bodies and by transpiration from plants.

Flood - an overflow or inundation that comes from a river or other body of water and causes or threatens damage. It can be any relatively high streamflow overtopping the natural or artificial banks in any reach of a stream. It is also a relatively high flow as measured by either gauge height or discharge quantity.

Floodplain - a strip of relatively level land bordering a stream or river. It is built of sediment carried by the stream and dropped when the water has flooded the area. It is called a water floodplain if it is overflowed in times of high water, or a fossil floodplain if it is beyond the reach of the highest flood.

Flow - the volumetric rate of water discharged from a source, given in volume with respect to time. Measured in cubic metres per second (m^3/s).

Fluvial - pertaining to rivers and streams or to features produced by the actions of rivers and streams.

Geology - the study of science dealing with the origin, history, materials and structure of the earth, together with the forces and processes operating to produce change within and on the earth.

Glaciofluvial - pertaining to rivers and streams flowing from, on or under melting glacial ice, or to sediments deposited by such rivers and streams.

Groundwater - the water below the water table contained in void spaces (pore spaces between rock and soil particles, or bedrock fractures). Water occurring in the zone of saturation in an aquifer or soil.

Groundwater Basin - the underground area from which groundwater drains. The basins could be separated by geologic or hydrologic boundaries.

Groundwater Recharge Area - The area where an aquifer is replenished from (a) natural processes, such as the infiltration of rainfall and snowmelt and the seepage of surface water from lakes, streams and wetlands, (b) from human interventions, such as the use of storm water management systems, and (c) whose recharge rate exceeds a threshold specified in the regulations.

Groundwater Vulnerability - the probability of contaminants propagating to a specified region in the groundwater system after introduction at some location above the uppermost aquifer.

Hazard - a contaminant and/or pathogen threat.

Hazard Rating - the numeric value which represents the relative potential for a contaminant of concern to impact drinking water sources at concentrations significant enough to cause human illness. This numeric value is determined for each contaminant of concern in the Threats Inventory and Issues Evaluation of the Assessment Report.

Highly Vulnerable Aquifer (HVA) - an aquifer that can be easily changed or affected by contamination from both human activities and natural process as a result of: a) its intrinsic susceptibility, as a function of the thickness and permeability of overlaying layers, or; b) by preferential pathways to the aquifer.

Hydrogeology - the study of the interrelationships of geologic materials and hydraulic processes.

Impact - often considered the consequence or effect. The impact should be measurable and based on an agreed set of parameters. In the case of Drinking Water Source Protection, the parameters may be an acceptable list of standards which identify maximum raw water levels of contaminants and pathogens of concern. In the case of water quantity, the levels may relate to a minimum annual flow, piezometric head or lake level.

Impermeable - not allowing water to pass through.

Infiltration - the process of water moving from the ground surface vertically downward into the soil.

Intake Protection Zone - The contiguous area of land and water immediately surrounding a surface water intake, which includes:

- the distance from the intake;
- a minimum travel time of the water associated with the intake of a municipal residential system or other designated system, based on the minimum response time for the water treatment plant operator to respond to adverse conditions or an emergency;
- the remaining watershed area upstream of the minimum travel time area (also referred to as the Total Water Contributing Area) – applicable to inland water courses and inland lakes only.

Intrinsic Susceptibility Index (ISI) - a numerical indicator of an aquifer's intrinsic susceptibility to contamination expressed as a function of the thickness and permeability of overlying layers.

Land Use - a particular use of space at or near the earth's surface with associated activities, substances and events related to the particular land use designation.

Leachate - liquid formed by water percolating through contaminated soil or soluble waste as in a landfill.

Local Area - in Tier Three Water Budget and Risk Assessments, Local Areas are defined for the water supply system. Local areas were developed using the MOE Technical Rules and considered the area of land that would be required to provide the wells with the water removed at specified pumping rates; the drawdown created by the assigned pumping rates; and recharge area as represented by the drawdown contour (zone of influence) that most closely matched the area of recharge under existing development conditions and also under planned development conditions as scheduled in the Official Plan.

Model - an assembly of concepts in the form of mathematical equations or statistical terms that portrays the behaviour of an object, process or natural phenomenon.

Monitoring Well - a non-pumping well, generally of small diameter, that is used to measure the elevation of a water table or water quality.

Municipal Residential System a drinking water system or part of a drinking water system;

a) That is owned by a municipality or by a municipal service board established under the Municipal Act, 2001 or a city board established under the City of Toronto Act, 2006,

b) That is owned by a corporation established under sections 9, 10 and 11 of the Municipal Act 2001, in accordance with section 203 of that Act or under sections 7 and 8 of the City of Toronto Act, 2006 in accordance with sections 148 and 154 of that Act,

c) From which a municipality obtains or will obtain water under the terms of a contract between the municipality and the owner of the system, or

d) That is in a prescribed class.

Nitrate (NO3) - a chemical formed when nitrogen from ammonia (NH3), ammonium (NH4) and other nitrogen sources combine with oxygenated water. An important plant nutrient and type of inorganic fertilizer (most highly oxidized phase in the nitrogen cycle). In water, the major sources of nitrates are septic tanks, livestock feed lots and fertilizers.

Nitrite (NO2) - product in the first step of the two-step process of conversion of ammonium (NH4) to nitrate (NO3).

Non-Point Source Pollution - pollution of the water from numerous locations that are hard to identify as point source, like agricultural activities, urban runoff and atmospheric deposition.

Official Plan - a land use policy document adopted by a municipality to guide the wise and logical development of its area for the benefit of its citizens.

Operational Plan - a document based on the requirements of the Drinking Water Quality Management Standard. The plan will document the owner and operating authority's quality management system.

Outflow - the flow out of or through a waterpower facility, control structure, pond, reservoir or lake.

Pathogen - an organism capable of producing disease.

Permit to Take Water - any person that takes more than 50,000 litres of water per day from any source requires a permit issued by the Ministry of the Environment Director under the Ontario Water Resources Act, unless they meet the criteria for certain exempted water takings.

pH - a numerical measure of acidity, or hydrogen ion activity used to express acidity or alkalinity. Neutral value is pH 7.0, values below pH 7.0 are acid, and above pH 7.0 are alkaline.

Potable Water - water that is safe for drinking.

Raw Water - water in its natural state, prior to any treatment; not the same as 'pure' water which does not exist in nature. Raw water is water that is in a drinking-water system or in plumbing that has not been treated in accordance with: (a) the prescribed standards and requirements that apply to the system, or (b) such additional treatment requirements that are imposed by the license or approval for the system.

Raw Water Supply - water outside a drinking water system that is a source of water for the system.

Recharge Area - an area in which water infiltrates and moves downward into the zone of saturation of an aquifer; area that replenishes groundwater.

Risk - the likelihood of a drinking water threat: (a) rendering an existing or planned drinking water source impaired, unusable or unsustainable, or; (b) compromising the effectiveness of a drinking water treatment process, resulting in the potential for adverse human health effects.

Runoff - the portion of precipitation which is not absorbed by the ground surface and finds its way into surface stream channels and becomes the flow of water from the land to oceans or interior basins by overland flow and stream channels.

Safe Drinking Water Act - the *Safe Drinking Water Act, 2002* provides for the protection of human health and prevention of drinking water health hazards through the control and regulation of drinking water systems and drinking water testing.

Septic System (Conventional) - used to treat household sewage and wastewater by allowing solids to decompose and settle in a tank, then flow by gravity or pump/siphon to a drainage or tile field for soil absorption.

Significant Groundwater Recharge Area - an area within which it is desirable to regulate or monitor drinking water threats that may affect the recharge of an aquifer.

Source Protection - a program of education, stewardship, planning, infrastructure, and regulation activities that together serve to help prevent the contamination or overuse of source water.

Source Protection Area – lands and waters that have been defined under Ontario Regulation 284/07 as the "study area" for an assessment report and a source protection plan under the *Clean Water Act, 2006*.

Source Protection Authority - A Conservation Authority or other person or body that is required to exercise powers and duties under the Clean Water Act, 2006.

Source Protection Committee - a group of individuals who have been appointed under the *Clean Water Act, 2006* by a Source Protection Authority to coordinate source protection planning activities for a Source Protection Area. The Greater Sudbury Source Protection Committee is composed of a provincially appointed Chair plus nine other members who were appointed from within the watershed by the Greater Sudbury Source Protection Authority.

Source Protection Plan - a document that is prepared by a source protection committee under Section 22 of the *Clean Water Act, 2006* and O. Reg 287/07 to direct source protection activities in a Source Protection Area. Each source protection plan is approved by the Minister of the Environment.

Source Water - untreated water in streams, rivers, lakes or underground aquifers which is used for the supply of raw water for drinking water systems (see raw water supply).

Source Water Protection - action taken to prevent the pollution and overuse of drinking water sources, including groundwater, lakes, rivers and streams. Source water protection involves developing and implementing a plan to manage land uses and potential contaminants.

Stream Flow - the discharge that occurs in a natural channel. The term stream flow is more general than runoff, as stream flow may be applied to discharge whether or not it is affected by diversion or regulation.

Subwatershed - a watershed subdivision of unspecified size that forms a convenient natural unit.

Surface Runoff (overland flow) - precipitation that cannot be absorbed by the soil because the soil is already saturated with water (soil capacity); precipitation that exceeds infiltration; the portion of rain, snow melt, irrigation water, or other water that moves across the land surface and enters a wetland, stream, or other body of water (overland flow). Overland flow usually occurs in urban settings (pavement, roofs, etc.) or where the soils are very fine textured or heavily compacted.

Surface Water - all water above the surface of the ground including, but not limited to lakes, ponds, reservoirs, artificial impoundments, streams, rivers, springs, seeps and wetlands.

Table of Drinking Water Threats - a document released by the MOE that contains a listing of all potential threat activities and circumstances under which these activities may be considered to be significant, moderate or low risks to water supply sources in the province of Ontario.

Terms of Reference - the work plan and budget, as approved by the Minister of Environment, for the preparation of the assessment report and source protection plan, as defined by the "Clean Water Act". The terms of reference outlines the responsibilities assigned to the source protection committee, source protection authority, Conservation Authority and member municipalities in each source protection area, in order to produce the assessment report and source protection plan.

Threat Assessment - Tier One - preliminary examination of drinking water threats based on readily accessible information.

Threat Assessment - Tier Two - advanced examination of drinking water threats through accessing more detailed information, interviews and perhaps when warranted, additional monitoring, modeling or studies.

Tier One, Two and Three Water Budgets - numerical analysis at the watershed (Tier One), subwatershed (Tier Two) or local (Tier Three) level considering existing and anticipated amounts of water taken from the watershed, as well as quantitative flow between components such as recharge/discharge areas and rates.

Time of Travel - (a) in respect of groundwater, the length of time that is required for groundwater to travel a specified horizontal distance in the saturated zone; and (b) in respect of surface water, the length of time that is required for surface water to travel a specified distance within a surface water body.

Vulnerable Area - areas related to a water supply source that are susceptible to contamination and for which it is desirable to regulate or monitor drinking water threats that may affect the water supply source. Vulnerable areas are (a) a significant groundwater recharge area, (b) a highly vulnerable aquifer, (c) a surface water intake protection zone, or (d) a wellhead protection area.

Water Budget - a description and analysis of the overall movement of water within each watershed in the Source Protection Area, taking into consideration surface water and groundwater features, land cover (e.g. proportion of urban versus rural uses), human-made structures (e.g. dams, channel diversions, water crossings), and water takings.

Water Quality - a term used to describe the chemical, physical and biological characteristics of water, usually in respect to its suitability for a particular purpose, such as drinking.

Watershed - the land area from which surface water and groundwater drains into a stream system; the area of land that generates total runoff (surface flow, interflow, and baseflow) for a particular stream system. Also referred to as drainage area, basin or catchment area for a watercourse.

Watershed Characterization - a characterization of the physical geography and human geography of the watershed and the characterization of the interactions between the physical geography and human geography.

Water Supply - any quantity of available water.

Water Table - the point where the unsaturated zone meets the zone of saturation is known as the water table. Water table levels fluctuate naturally throughout the year based on seasonal variations and are the reason why some wells go dry in the summer. In addition, the depth to the water table varies. For example, in (select an area in the watershed or community) the water table is “x” metres below the surface. The water table is the surface below which the soil is saturated with water.

Well - a vertical bore hole in which a pipe-like structure is inserted into the ground in order to discharge (pump) water from an aquifer.

Wellhead - the structure built above a well.

Wellhead Protection Area (WHPA) - the surface and subsurface area surrounding a water well or well field that supplies a municipal residential system or other designated system through which contaminants are reasonably likely to move so as to eventually reach the water well or wells. Wellhead protection area (WHPA) is the surface and subsurface area within which the municipal well’s groundwater sources are vulnerable to surface threats.

Appendix 2 – Technical Reports

The following Technical Reports can be found on the DVD labeled Appendix 2:

Groundwater Vulnerability Assessment

- WESA Groundwater Vulnerability Assessment, Revised Final Report, January 2010
- WESA Addendum Regarding Garson Vulnerability, December 2010

Surface Water Vulnerability Assessment

- Intake Characterization, Determination of Intake Protection Zones, and Assigned Vulnerability Scores, for Ramsey Lake Intake, March 2008
- NDCA Revised Final IPZ-2 Update Wanapitei and Vermilion Rivers, March 2011
- Intake Characterization, Determination of Intake Protection Zones, and Assigned Vulnerability Scores, for Inland River Intakes within the City of Greater Sudbury, January 2008
- Multi-Dimensional System Modelling in the Anthropogenically Impacted Watershed of Ramsey Lake - Francois Prevost, 2005

Water Budget

- Conceptual Water Budget Report June 2006
  - Figures
  - Maps
  - Photos
  - Tables
- Tier 1 Water Budget and Water Quantity Stress Assessment, February 2008
  - Maps
  - Tables
- Tier 1 Water Budget Addendum, September 2009
  - Figures
- Ramsey Lake Tier 1 / Tier 2 Water Budget and Stress Assessment, April 2009
  - Figures
  - Ramsey Lake Figures from 1987 and 1988
  - Engineering Report on Sinkholes at Moonlight Beach Ramsey Lake, October 1987
  - Lake Evaporation and Sublimation Methodology, April 2009
- Ramsey Lake Tier Three Water Budget and Local Area Risk Assessment, November 2011
- Valley East Tier 2 Water Budget and Stress Assessment, May 2009
  - Figures
  - Maps
  - Appendix A – Groundwater Model
  - Appendix B – Potential/Planned Future Municipal Source, Wanapitei Lake
- Valley Drinking Water System Tier Three Water Budget and Water Quantity Risk Assessment, January 2012

Appendix 3 – References

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Appendix 4 – Public Consultation

Draft Proposed Assessment Report

Figures 11.1 and 11.2 show the draft proposed assessment report notice, which was published in local newspapers on Tuesday, March 16 and Wednesday, March 17 in both official languages. Copies of this notice were made available at six branches of the Greater Sudbury Public Library, the Nickel District Conservation Authority main office and the City of Greater Sudbury's main municipal building. Clerks in each municipality identified in the terms of reference received a copy of the notice, along with Chiefs of both local First Nations and 45 individuals identified as engaging in activities that are or would be a significant drinking water threat.

The notice includes the website where the draft can be viewed on the internet, times and locations the draft is available, dates and times of public meetings and information on how to submit written comments.

On March 16, 2010, letters were mailed to municipal clerks in each municipality in the terms of reference list notifying them of the draft proposed assessment report. This included the City of Greater Sudbury, Town of Espanola, Municipalities of Killarney and Markstay-Warren, and the Township of Nairn and Hyman. Figures 11.3 and 11.4 show copies of these letters.

In addition, the Chiefs of both local First Nations, Atikameksheng Anishnawbek (Whitefish Lake) and Wahnapitae, received letters notifying them of the draft proposed assessment report. A sample of these letters can be seen in Figure 11.5.

HELP PROTECT LOCAL DRINKING WATER SOURCES

The Greater Sudbury Source Protection Committee invites you to review and comment on the Draft Assessment Report for the Greater Sudbury Source Protection Area by **April 20, 2010.**

The Assessment Report is an important step in developing a Drinking Water Source Protection Plan for the Greater Sudbury area. It describes the local watersheds and available water supply, identifies vulnerable areas where drinking water sources might face the risk of contamination or depletion and assesses threats to drinking water within these vulnerable areas.

The Committee will be hosting **two public meetings** to provide an opportunity for the public to learn more about the report and provide comments:

Tuesday, April 6, 2010
Howard Johnson Plaza Hotel
50 Brady Street, Sudbury
2:30 p.m. to 4:30 p.m. and 6:30 p.m. to 8:30 p.m.
Presentations at 3:00 p.m. and 7:00 p.m.

Thursday, April 8, 2010
Howard Armstrong Recreation Centre
4040 Elmview Drive, Hanmer
6:30 p.m. to 8:30 p.m.
Presentation at 7:00 p.m.

The Draft Proposed Assessment Report can be viewed online at **www.sourcewatersudbury.ca** during the 35-day comment period or in hardcopy at one of the following locations. Call your library for hours.

Nickel District Conservation Authority Office
8:30 a.m. - noon and 1:00 p.m. - 4:30 p.m.
200 Brady Street, Sudbury

Capreol Public Library
9 Morin Street, Capreol

Dowling Public Library
79 Main Street, Dowling

Garson Public Library
214 Orell Street, Garson

Levack/Onaping Public Library
1 Hillside Drive, Onaping

Lively Public Library
15 Kin Drive, Lively

Valley East Public Library
4100 Elmview Drive, Hanmer

Please provide written comments by **April 20, 2010,** by letter, fax or email to:

The Greater Sudbury Source Protection Committee
c/o Nickel District Conservation Authority
200 Brady Street, Sudbury, ON P3E 5K3
Email: sourcewater@greatersudbury.ca
Fax: (705) 674-7939

DRINKING WATER SOURCE PROTECTION
DE L'EAU POTABLE À LA SOURCE

Ontario

Figure 11.1 – Draft proposed assessment report notice which appeared in the Sudbury Star and Northern Life, Tuesday, March 16, 2010.
Note: This figure is not to scale. Actual notice size is 6.875" x 12.73"

AIDEZ À PROTÉGER LES SOURCES D'EAU POTABLE LOCALES

Le Comité de protection des sources d'eau potable du Grand Sudbury vous encourage d'examiner l'Ébauche du rapport d'évaluation proposée pour la zone de protection des sources d'eau potable du Grand Sudbury avant **le 20 avril 2010** et de fournir des commentaires.

Le rapport d'évaluation constitue une étape importante de l'élaboration d'un plan de protection des sources d'eau potable pour la région du Grand Sudbury. Il décrit les bassins hydrographiques locaux ainsi que les sources d'approvisionnement en eau qui sont disponibles, il indique les zones vulnérables où les sources d'eau potables sont susceptibles d'être contaminées ou appauvries et il évalue les menaces contre l'eau potable dans ces zones vulnérables.

Le Comité organisera **deux réunions publiques** afin d'offrir au public une occasion de se renseigner davantage sur le rapport et de fournir des commentaires :

Le mardi 6 avril 2010
Howard Johnson Plaza Hotel
50, rue Brady, Sudbury
De 14 h 30 à 16 h 30 et de 18 h 30 à 20 h 30
Les présentations auront lieu à 15 h et à 19 h.

Le jeudi 8 avril 2010
Centre récréatif Howard Armstrong
4040, chemin Elmview, Hanmer
De 18 h 30 à 20 h 30
La présentation aura lieu à 19 h.

Durant la période de commentaires de 35 jours, il sera possible de consulter l'Ébauche du rapport d'évaluation proposée en ligne à **www.sourcewatersudbury.ca** et d'en obtenir une copie imprimée aux adresses suivantes :

Bureau de l'Office de protection de la nature du District du Nickel
De 8 h 30 à 12 h et de 13 h à 16 h 30
200, rue Brady, Sudbury

Bibliothèque publique de Capreol*
9, rue Morin, Capreol

Bibliothèque publique de Dowling*
79, rue Main, Dowling

Bibliothèque publique de Garson*
214, rue Orell, Garson

Bibliothèque publique de Levack/Onaping*
1, chemin Hillside, Onaping

Bibliothèque publique de Lively*
15, chemin Kin, Lively

Bibliothèque publique de Valley East*
4100, chemin Elmview, Hanmer

*Veuillez consulter votre succursale pour obtenir les heures d'ouverture.

Nous vous demandons de soumettre, d'ici **le 20 avril 2010**, vos commentaires dans une lettre envoyée par la poste, par télécopieur ou par courriel à :

Comité de protection des sources d'eau potable du Grand Sudbury
a/s de l'Office de protection de la nature du District du Nickel
200, rue Brady, Sudbury (Ontario) P3E 5K3
Courriel : sourcewater@grandsudbury.ca
Télécopieur : (705) 674-7939

DRINKING WATER SOURCE PROTECTION
DE L'EAU POTABLE À LA SOURCE

Ontario

Figure 11.2 – Draft proposed assessment report notice which appeared in Le Voyageur, Wednesday, March 17, 2010.
Note: This figure is not to scale. Actual notice size is 6" x 14"

DRINKING WATER SOURCE
PROTECTION
DE L'EAU POTABLE À LA SOURCE

Nickel District Conservation Authority

March 16, 2010

Angie Hache, Municipal Clerk; and
Doug Nadorozny, Chief Administrative Officer
City of Greater Sudbury

RE: DRINKING WATER SOURCE PROTECTION
DRAFT PROPOSED ASSESSMENT REPORT

This letter serves as your official notice under Ontario Regulation 287/07.

The purpose of this letter is to inform you that the Draft Proposed Assessment Report for the Greater Sudbury Source Protection Plan is now available for review and posted online for a 35-day public review period. The three municipal staff members on the source protection committee were involved in the review of this document as it was being developed. If you have any comments on the report, please send them to sourcewater@sudbury.ca or the address below no later than April 20, 2010.

The purpose of the Proposed Assessment Report is to identify vulnerable areas near municipal wells and intakes, the types and number of threats to water quality and quantity near wells and intakes, and rank the potential threats as low, moderate or significant. The priority risks identified in the Assessment Report will be the first ones considered during the development of the Source Protection Plan, which is scheduled to be completed by 2012. The Proposed Assessment Report will be submitted to the Ontario Minister of the Environment for approval on June 8, 2010.

Two public meetings will be held to provide the public with an opportunity to learn more about the report and provide comments. The attached document outlines the dates and locations for these meetings. The current schedule for public consultation for the Draft Proposed Assessment Report is provided below.

Anticipated timeline for Assessment Report

Circulation of Draft Proposed Assessment Report to Municipality, First Nations and public with 35-day comment period.	March 16, 2010
Comments due	April 20, 2010
Incorporation of comments	April 20 – May 6, 2010
Consultation period for proposed assessment report – 30 days	May 7, 2010
Submission to Ministry of Environment	June 8, 2010
Review and approval by Ministry of Environment	Fall/Winter 2010

Nickel District Conservation Authority
200 Brady Street, Sudbury, Ontario P3E 5K3
Tel: (705) 674.5249 Fax: (705) 674.7939
www.nickeldistrict.ca

Figure 11.3 – Copy of letter to City of Greater Sudbury municipal clerk (Page 1 of 2).

In addition to the three municipal committee members, Paul Baskcomb, Nick Benkovich and Stephen Monet, there are four elected municipal members on the board of the Nickel District Conservation Authority, which was deemed the Greater Sudbury Source Protection Authority with the passage of the *Clean Water Act.*

Thank-you for your continued support of the Drinking Water Source Protection Program. If you have any questions about the Draft Proposed Assessment Report or the program in general, please feel free to contact either myself or Judy Sewell, Project Manager for the Drinking Water Source Protection Program.

Sincerely,

Nels Conroy, Chair
Greater Sudbury Source Protection Committee

Enclosure: Draft Proposed Assessment Report Notice
Draft Proposed Assessment Report on CD

2

Figure 11.3 – Copy of letter to City of Greater Sudbury municipal clerk (Page 2 of 2).

DRINKING WATER SOURCE PROTECTION
DE L'EAU POTABLE À LA SOURCE

Nickel District Conservation Authority

March 16, 2010

Joel MacKenzie, Clerk-Treasurer / Administrator
Town of Espanola
100 Tudhope St.
Espanola, ON P0P 1C0

RE: DRINKING WATER SOURCE PROTECTION
DRAFT PROPOSED ASSESSMENT REPORT

This letter serves as your official notice under Ontario Regulation 287/07.

The purpose of this letter is to inform you that the Draft Proposed Assessment Report for the Greater Sudbury Source Protection Plan is now available for review and posted online for a 35-day public review period. If you have any comments on the report, please send them to sourcewater@sudbury.ca or the address below no later than April 20, 2010.

The purpose of the Proposed Assessment Report is to identify vulnerable areas near municipal wells and intakes, the types and number of threats to water quality and quantity near wells and intakes, and rank the potential threats as low, moderate or significant. The priority risks identified in the Assessment Report will be the first ones considered during the development of the Source Protection Plan, which is scheduled to be completed by 2012. The Proposed Assessment Report will be submitted to the Ontario Minister of the Environment for approval on June 8, 2010.

Two public meetings will be held to provide the public with an opportunity to learn more about the report and provide comments. The attached document outlines the dates and locations for these meetings. The current schedule for public consultation for the Draft Proposed Assessment Report is provided below.

Anticipated timeline for Assessment Report

Circulation of Draft Proposed Assessment Report to Municipality, First Nations and public with 35-day comment period.	March 16, 2010
Comments due	April 20, 2010
Incorporation of comments	April 20 – May 6, 2010
Consultation period for proposed assessment report – 30 days	May 7, 2010
Submission to Ministry of Environment	June 8, 2010
Review and approval by Ministry of the Environment	Fall/Winter 2010

The *Clean Water Act* applies to municipal residential drinking water systems. We realize that the Town of Espanola does not have any municipal residential drinking water systems in the Greater Sudbury Source

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200 Brady Street, Sudbury, Ontario P3E 5K3
Tel: (705) 674.5249 Fax: (705) 674.7939
www.nickeldistrict.ca

Figure 11.4 – Copy of letter to Espanola Clerk-Treasurer. Similar letters were sent to the Municipalities of Killarney and Markstay- Warren, and the Township of Nairn and Hyman (Page 1 of 2).

Protection Area. However, a portion of the Municipality is within the Whitefish River watershed and the Clean Water Act requires that the Source Protection Authority provide notice to the Municipality. As you know, if the Town of Espanola wishes to pursue source protection for any municipal residential drinking water system, this would be done by directly contacting the Minister of the Environment.

If you have any questions about the Draft Proposed Assessment Report or the program in general, please feel free to contact either myself or Judy Sewell, Project Manager for the Drinking Water Source Protection Program.

Sincerely,

Nels Conroy, Chair
Greater Sudbury Source Protection Committee

Enclosure: Draft Proposed Assessment Report Notice
Draft Proposed Assessment Report on CD

2

Figure 11.4 – Copy of letter to Espanola Clerk-Treasurer. Similar letters were sent to the Municipalities of Killarney and Markstay- Warren, and the Township of Nairn and Hyman (Page 2 of 2).

DRINKING WATER SOURCE PROTECTION
DE L'EAU POTABLE À LA SOURCE

Nickel District Conservation Authority

March 16, 2010

Chief Steven Miller
Atikameksheng Anishnawbek
P.O. Box 39
Naughton, Ontario
P0M 2M0

RE: DRINKING WATER SOURCE PROTECTION
DRAFT PROPOSED ASSESSMENT REPORT

This letter serves as your official notice under Ontario Regulation 287/07.

The purpose of this letter is to inform you that the Draft Proposed Assessment Report for the Greater Sudbury Source Protection Plan is now available for review and posted online for a 35-day public review period. Vivian Naponse, your source protection representative, is familiar with the development of this draft document. I draw your attention to Section 7.6, First Nations Perspectives. If you have any comments on any aspect of this report, please send them to sourcewater@sudbury.ca or the address below by April 20, 2010.

The purpose of the Proposed Assessment Report is to identify vulnerable areas near municipal wells and intakes, the types and number of threats to water quality and quantity near wells and intakes, and rank the potential threats as low, moderate or significant. The priority risks identified in the Assessment Report will be the first ones considered during the development of the Source Protection Plan, which is scheduled to be completed by 2012. The Proposed Assessment Report will be submitted to the Ontario Minister of the Environment for approval on June 8, 2010.

Two public meetings will be held to provide the public with an opportunity to learn more about the report and provide comments. The attached document outlines the dates and locations for these meetings. The current schedule for public consultation for the Draft Proposed Assessment Report is provided below.

Nickel District Conservation Authority
200 Brady Street, Sudbury, Ontario P3E 5K3
Tel: (705) 674.5249 Fax: (705) 674.7939
www.nickeldistrict.ca

Figure 11.5 – Copy of letter to Atikameksheng Anishnawbek (Whitefish Lake) First Nation Chief. A similar letter was sent to the Chief of Wahnapitae First Nation (Page 1 of 2).

Anticipated timeline for Assessment Report

Circulation of Draft Proposed Assessment Report to Municipality, First Nations and public with 35-day comment period.	March 16, 2010
Comments due	April 20, 2010
Incorporation of comments	April 20 – May 6, 2010
Consultation period for proposed assessment report – 30 days	May 7, 2010
Submission to the Ministry of the Environment	June 8, 2010
Review and approval by Ministry of the Environment	Fall/Winter 2010

If you have any questions about the Draft Proposed Assessment Report or the program in general, please contact either myself or Judy Sewell, Project Manager for the Drinking Water Source Protection Program. We would also be pleased to come out and discuss the draft report with your Band Council or your community if you feel this would be beneficial.

I would also like to take this opportunity to thank you for your on-going participation in this important drinking water source protection program.

Sincerely,

Nels Conroy, Chair
Greater Sudbury Source Protection Committee

Enclosure: Draft Proposed Assessment Report Notice
Draft Proposed Assessment Report on CD

2

Figure 11.5 – Copy of letter to Atikameksheng Anishnawbek (Whitefish Lake) First Nation Chief. A similar letter was sent to the Chief of Wahnapitae First Nation (Page 2 of 2).

Summary of Comments and Responses

The following is a summary of comments received during the public consultation period for the draft proposed assessment report and responses to the comments.

Public Comment #1, Received April 6, 2010

Waste management – very poor sorting of discarded material in Sudbury. Visited Frobisher Street depot and feels they are receiving non-satisfactory materials. Glad to see that receptacles are being placed at bus stops. Suggested appropriately placed receptacles would help.

Response: Suggested this individual contact the City's Environmental Services Department as they are responsible for the collection of solid waste within the community and the management of local clean-up initiatives.

Public Comment #2, Received April 6, 2010

Concern regarding new development near Ramsey Lake increasing road salt, fertilizers, phosphates, soap, etc. draining even quicker into the ditch and ultimately into the lake; also concerned with increased seagull and goose feces into lake.

Response: Noted that these are concerns that the source protection committee has discussed during the development of the assessment report and will consider how to deal with them while developing the source protection plan.

Public Comment #3, Received April 8, 2010

Comment 1: Can we not use a friendlier de-icer as opposed to road salt to minimize environmental impact and undue stress on our drinking water?

Response: The application of road salt is included in the Ministry of the Environment's list of 21 prescribed drinking water threats and is a topic that the source protection committee has discussed many times during the preparation of the assessment report. The Committee will consider how to deal with road salt while completing the source protection plan for Greater Sudbury. In areas where the application of road salt is a significant threat, the committee will be developing policies to minimize or eliminate this threat.

Comment 2: Does it not stem to reason that protection from influents to storm collection systems should be prioritized around our drinking water sources first then other less important areas next?

Response: The source protection committee discussed this comment at their last meeting and decided to write to the City asking them to use drinking water sources as a criterion in determining the sequence in which streets are swept.

Comment 3: The new receptors that are being placed at various discharge points are they not the result of poor catchbasin sump cleaning and storm system deteriorations due to lack of financial resources and less frequent maintenance?

Response: The source protection committee is not in a position to respond to this comment as the receptor project is a City-led initiative. Suggested this individual speak with personnel working for the City of Greater Sudbury's Infrastructure Department to obtain more information.

Public Comment #4, Received April 8, 2010

When I clean my paint brushes, is there any special way I should go about it and what amount of fertilizer should I use on my lawn?

Response: Provided individual with information on best management practices for these two concerns.

Public Comment #5, Received April 8, 2010

Looking for specific information with regards to agricultural threats and how to manage them. Would like to contact someone with regards to doing an assessment sooner rather than later.

Response: Replied that the Sudbury Source Protection team is currently in discussion with OMAFRA regarding completion of agricultural assessments by OMAFRA representatives relating to the ODWSP program. Will follow up with this individual once an agreement is reached with OMAFRA.

Public Comment #6, Received April 8, 2010

City purchased 2.5 acres of land from this individual to put in a new well. The rest of their property is inside two well areas. Wants to know why the City doesn't buy the entire property as he has a hobby farm.

Response: We are aware the City purchased land for two new wells, but we are not aware of the City buying any land that is located within Wellhead Protection Areas. Land purchase is currently not part of the Stewardship Program. Suggested this individual contact either the City's Real Estate or Legal Department if they would like more information regarding their land purchasing policies.

Public Comment #7, Received April 14, 2010

A number of concerns, including motorized vehicles on Ramsey Lake, runoff into Ramsey Lake, railroad tracks, septic systems, road salt, and bird and animal waste.

Response: The source protection committee has discussed these topics during the development of the assessment report and will determine how to deal with them while creating the source protection plan.

Public Comment #8, Received April 22, 2010

The Ministry of the Environment submitted a number of comments at the end of the public consultation period. The Source Protection team has addressed most of these comments in this proposed assessment report; however, the team is still working on addressing these comments and will discuss responses with the source protection committee to be included in either the June 8, 2010, submission or the June 8, 2011, updated version.

Proposed Assessment Report

The proposed assessment report was posted on www.sourcewatersudbury.ca on May 7, 2010, for a 30-day public consultation period. It was also submitted to the Greater Sudbury Source Protection Authority on May 7, 2010. Figure 11.6 shows the transmittal letter that was sent with the proposed assessment report. There were no unresolved municipal or First Nation comments to note.

On May 7, 2010, letters were mailed to the municipalities and First Nations in the ToR list advising them that the proposed assessment report was available for a 30-day consultation period. A copy of the proposed assessment report was included with each of these letters. There were no unresolved First Nation concerns to note.

Notices asking for public review and comments on the proposed assessment report were placed in local newspapers. These notices are shown in Figures 11.7 and 11.8.

DRINKING WATER SOURCE PROTECTION
DE L'EAU POTABLE À LA SOURCE

Nickel District Conservation Authority

May 7, 2010

Mr. Bob Rogers, Chair
Greater Sudbury Source Protection Authority

RE: Proposed Assessment Report for the Greater Sudbury Source Protection Plan

The proposed Assessment Report for the Greater Sudbury Source Protection Plan is attached on CD. The Greater Sudbury Source Protection Committee will be posting this document online for public review May 7, 2010, and will provide a copy to the five municipalities that are entirely or in part within the Greater Sudbury Source Protection Area, as well as to the Wahnapitae and Whitefish Lake First Nations.

We are asking that you review the comments on the Proposed Assessment Report, and submit the Proposed Assessment Report, together with any comments you may have and any comments received during the upcoming 30 day consultation period, to the Minister of the Environment for approval. We request that you submit these items to the Minister on or before June 8, 2010.

The Draft Proposed Assessment Report has already been reviewed by the public once. It was posted on our website on March 16, 2010, and sent to the five municipalities and the two First Nations. Two public meetings were also held during the review period – one at the Howard Johnson in Sudbury and one in Hanmer at the Howard Armstrong Recreation Centre.

Approximately 22 members of the public and seven source protection committee members attended the public meeting at the Howard Johnson and 13 members of the public and five committee members attended the one in Hanmer. All drinking water source protection staff attended both meetings.

Six comment forms were received during the public meetings and two emails were received during the review period. A response to each comment and letter has been drafted. A copy of all comments, letters and responses is available at the NDCA office. The following types of comments were received:

1. Increasing number of cars and trucks on Ramsey Lake, polluting it during the winter months.
2. Request for information regarding agricultural threats and how to manage them.
3. Increase in road salt, fertilizers, phosphates, etc. along Greenwood Avenue due to new development.

Nickel District Conservation Authority
200 Brady Street, Sudbury, Ontario P3E 5K3
Tel: (705) 674.5249 Fax: (705) 674-7939
www.nickeldistrict.ca

Figure 11.6 – Copy of notification letter to Greater Sudbury Source Protection Authority Chair (Page 1 of 2).

4. Increase in seagull and goose feces into lake.
5. Use of road salt along Highway 17 through Wahnapitae. Is there friendlier de-icer that could be used?
6. Could spring street sweeping order be determined based upon drinking water sources?

Thank you for supporting the Source Protection Committee during the development of the Proposed Assessment Report. If you would like to discuss any aspect of the Assessment Report or the source protection program, please feel free to contact either myself or Judy Sewell. I look forward to continuing to work with you during the development of the Source Protection Plan.

Sincerely,

Nels Conroy, Chair
Greater Sudbury Source Protection Committee

cc Greater Sudbury Source Protection Authority members
Greater Sudbury Source Protection Committee members

Enclosure: Proposed Assessment Report on CD

Figure 11.6 – Copy of notification letter to Greater Sudbury Source Protection Authority Chair (Page 2 of 2).

HELP PROTECT LOCAL DRINKING WATER SOURCES

The Greater Sudbury Source Protection Committee invites you to review and comment on the Proposed Assessment Report for the Greater Sudbury Source Protection Area by **June 7, 2010.**

The Assessment Report is an important step in developing a Drinking Water Source Protection Plan for the Greater Sudbury area. It describes the local watersheds and available water supply, identifies vulnerable areas where drinking water sources might face the risk of contamination or depletion and assesses threats to drinking water within these vulnerable areas.

The Proposed Assessment Report can be viewed online at **www.sourcewatersudbury.ca** during the 30-day comment period or in hardcopy at the following location:

Nickel District Conservation Authority Office
8:30 a.m. - noon and 1:00 p.m. - 4:30 p.m.
200 Brady Street, Sudbury

Please provide written comments by **June 7, 2010,** by letter, fax or email to:

The Greater Sudbury Source Protection Committee
c/o Nickel District Conservation Authority
200 Brady Street, Sudbury, ON P3E 5K3
Email: sourcewater@greatersudbury.ca
Fax: (705) 674-7939

DRINKING WATER SOURCE PROTECTION
DE L'EAU POTABLE À LA SOURCE

Nickel District Conservation Authority

Ontario

Figure 11.7 – Proposed assessment report notice which appeared in The Sudbury Star, Saturday, May 8, 2010 and the Northern Life Tuesday, May 11, 2010.
Note: This figure is not to scale. Actual notice size is 6.875” x 6.357”

AIDEZ À PROTÉGER LES SOURCES D'EAU POTABLE LOCALES

Le Comité de protection des sources d'eau potable du Grand Sudbury vous encourage d'examiner l'Ébauche du rapport d'évaluation proposée pour la zone de protection des sources d'eau potable du Grand Sudbury avant **le 7 juin 2010** et de fournir des commentaires.

Le rapport d'évaluation constitue une étape importante de l'élaboration d'un plan de protection des sources d'eau potable pour la région du Grand Sudbury. Il décrit les bassins hydrographiques locaux ainsi que les sources d'approvisionnement en eau qui sont disponibles, il indique les zones vulnérables où les sources d'eau potables sont susceptibles d'être contaminées ou appauvries et il évalue les menaces contre l'eau potable dans ces zones vulnérables.

Durant la période de commentaires de 30 jours, il sera possible de consulter l'Ébauche du rapport d'évaluation proposée en ligne à **www.sourcewatersudbury.ca** et d'en obtenir une copie imprimée à adresse suivante :

Bureau de l'Office de protection de la nature du District du Nickel
De 8 h 30 à 12 h et de 13 h à 16 h 30
200, rue Brady, Sudbury

Nous vous demandons de soumettre, d'ici **le 7 juin 2010**, vos commentaires dans une lettre envoyée par la poste, par télécopieur ou par courriel à :

Comité de protection des sources d'eau potable du Grand Sudbury
a/s de l'Office de protection de la nature du District du Nickel
200, rue Brady, Sudbury (Ontario) P3E 5K3
Courriel : sourcewater@grandsudbury.ca
Télécopieur : (705) 674-7939

DRINKING WATER SOURCE PROTECTION
DE L'EAU POTABLE À LA SOURCE

Office de protection de la nature du District du Nickel

Ontario

Figure 11.8 – Proposed assessment report notice which appeared in Le Voyageur, Wednesday, May 12, 2010.

2011 Updated Assessment Report

During preparation of the amended proposed assessment report, Microcystin LR (blue green algae) and sodium were identified as issues for the Ramsey Lake system. A letter and legal notification regarding these issues were sent to 4,556 landowners on April 8, 2011. See Figures 11.9 and 11.10.

On February 22, a letter was sent to Greater Sudbury City Council advising them of the newly identified threats in the Ramsey Lake system. See Figure 11.11. A follow-up presentation was given at the March 31, 2011, City Council meeting. The same letter was sent to both MPPs representing Greater Sudbury on April 8.

On April 8, 2011, notices were mailed to municipal clerks in each municipality on the terms of reference list notifying them that the amended assessment report would be available for review and comment. This included the City of Greater Sudbury, Town of Espanola, Municipalities of Killarney and Markstay-Warren, and the Township of Nairn and Hyman. Figure 11.12 shows a copy of this notice.

Copies of this notice were also made available at two branches of the Greater Sudbury Public Library, the Nickel District Conservation Authority main office and the City of Greater Sudbury's main municipal building. Chiefs of both local First Nations and 4,634 individuals identified as engaging in activities that are or would be a significant drinking water threat also received a copy of the notice.

Three open houses were held to provide the public an opportunity to learn about the report and provide input. These were on May 3, 4 and 5th 2011 and 52 people attended. Details are listed in Figure 11.12. Approximately 50 people attended these open houses.

Figures 11.13 and 11.14 show the amended assessment report notice, which was published in local newspapers on Monday, April 18, Tuesday, April 19 and Wednesday, April 20 in both official languages. The notice includes the website where the amended assessment report can be viewed on the internet, times and locations the draft is available, dates and times of public meetings and information on how to submit written comments.

Monthly updates regarding the status of the report and the work being done were provided to the Source Protection Authority. The Committee Chair and Project Co-ordinator also gave a presentation at the March 30 Authority meeting.

DRINKING WATER SOURCE
PROTECTION
DE L'EAU POTABLE À LA SOURCE

Nickel District Conservation Authority

April 8, 2011

Dear Landowner,

You are receiving this letter because your property is located within the Ramsey Lake watershed, which contributes to a source of municipal residential drinking water. Areas around municipal drinking water sources have been identified as "vulnerable areas" under Ontario's *Clean Water Act* and activities occurring in these areas have the potential to negatively affect the quality and quantity of municipal drinking water.

The *Clean Water Act, 2006* prompted the formation of the Greater Sudbury Source Protection Committee. The mandate of this Committee is to develop a science-based Source Protection Plan to ensure the protection of municipal drinking water sources. The Greater Sudbury Source Protection Committee has identified a number of threats to the Ramsey Lake municipal drinking water source including the runoff of phosphorus and sodium (salt). Rainwater carries these substances from lawns, driveways and streets and they are sent directly into Ramsey Lake. Under the *Clean Water Act*, the Greater Sudbury Source Protection Committee is required to notify you that if there is phosphorus or salt in the runoff from your property, it would be a contributor to these threats.

Approximately 4,600 properties in the Greater Sudbury Source Protection Area have been identified as possible contributors to threats to drinking water sources; this includes all properties located in the Ramsey Lake watershed. The enclosed flyer will explain to you what significant threat designation means and how to become involved in the protection process. Also enclosed are the official notices required under the *Clean Water Act*.

Please be assured that this planning process is governed by privacy legislation. Personal information collected will be held in confidence and will not be disclosed to the public. This information will be used by the Source Protection Committee to develop the local Source Protection Plan and shared with the Greater Sudbury Source Protection Authority and the City of Greater Sudbury, as they will be responsible for monitoring and enforcing the Plan.

There will be a number of opportunities for you to participate in the planning process. Public meetings are planned for May 2011; please see the attached invitation for details. Should you require further information or have any questions, please contact Judy Sewell, Drinking Water

Nickel District Conservation Authority
200 Brady Street, Sudbury, Ontario P3E 5K3
Tel: (705) 674.5249 Fax: (705) 674.7939
www.nickeldistrict.ca

Figure 11.9 – Copy of letter sent to Ramsey Lake watershed landowners (Page 1 of 4).

Source Protection Project Manager, at judy.sewell@sudbury.ca or 705-674-5249. Information can also be found by visiting our website at www.sourcewatersudbury.ca

Sincerely,

Nels Conroy
Chair, Greater Sudbury Source Protection Committee

Attachments: Official Notices under O.Reg 287/07 and Prescribed Instruments definitions
Public Meeting invitation
Flyer – Protecting Our Drinking Water at the Source

Page 2 of 4

Figure 11.9 – Copy of letter sent to Ramsey Lake watershed landowners (Page 2 of 4).

DRINKING WATER SOURCE PROTECTION
DE L'EAU POTABLE À LA SOURCE

Nickel District Conservation Authority

Le 8 avril 2011

Madame, Monsieur,

Vous avez reçu la présente lettre car votre terrain se situe dans le bassin hydrographique du lac Ramsey, ce qui contribue à une source d'eau potable municipale résidentielle. Les zones entourant les sources d'eau potable municipales ont été désignées comme étant des « zones vulnérables » en vertu de la *Loi sur l'eau saine* de l'Ontario, et les activités qui ont lieu dans ces zones peuvent exercer une incidence négative sur la qualité et la quantité de l'eau potable municipale.

L'adoption de la *Loi sur l'eau saine, 2006* a donné lieu à la création du Comité de protection des sources du Grand Sudbury. Ce Comité a pour mandat d'élaborer un plan de protection des sources basé sur des données scientifiques afin de veiller à la protection des sources d'eau potable municipales. Le Comité de protection des sources du Grand Sudbury a déterminé de nombreuses menaces pour la source d'eau potable municipale du lac Ramsey, y compris l'eau de ruissellement qui contient du phosphore et du sodium (sel). L'eau de pluie transporte ces substances à partir de pelouses, d'entrées de cours et de rues, puis elle les déverse directement dans le lac Ramsey. En vertu de la *Loi sur l'eau saine*, le Comité de protection des sources du Grand Sudbury doit vous aviser que si l'eau de ruissellement provenant de votre terrain contient du phosphore ou du sel, elle contribue à ces menaces.

Environ 4 600 terrains dans la zone de protection des sources du Grand Sudbury ont été identifiés comme pouvant contribuer aux menaces pour les sources d'eau potable, ce qui comprend tous les terrains situés dans le bassin hydrographique du lac Ramsey. Le dépliant ci-joint explique en quoi consiste une menace importante et comment il est possible de participer au processus de protection des sources d'eau potable. Vous trouverez également ci-joint les avis officiels exigés en vertu de la *Loi sur l'eau saine*.

Sachez que ce processus de planification est régi par la législation relative à la protection de la vie privée. Les renseignements personnels recueillis demeureront confidentiels; ils ne seront pas divulgués au public. Cette information sera utilisée par le Comité de protection des sources afin d'élaborer le plan de protection des sources, et elle sera diffusée à l'Office de protection des sources du Grand Sudbury ainsi qu'à la Ville du Grand Sudbury car ils seront responsables de surveiller et d'appliquer le Plan.

Vous aurez de nombreuses occasions de participer au processus de planification. Des réunions publiques auront lieu en mai 2011. Les détails se trouvent dans l'invitation ci-jointe. Si vous avez besoin de plus amples renseignements ou si vous avez des questions, n'hésitez pas à communiquer avec Judy Sewell, directrice du projet de Protection des sources d'eau potable, par

Page 3 of 4

Figure 11.9 – Copy of letter sent to Ramsey Lake watershed landowners (Page 3 of 4).

courriel à judy.sewell@sudbury.ca ou par téléphone au 705-674-5249. Vous pouvez également obtenir de l'information en visitant notre site Web à www.sourcewatersudbury.ca.

Veuillez agréer, Madame, Monsieur, l'expression de mes salutations distinguées.

Nels Conroy
Président, Comité de protection des sources

Pièce jointe : Avis officiels en vertu du Règlement de l'Ontario 287/07 et définitions des actes prescrits
Invitation à une réunion publique
Dépliant – Protégeons notre eau potable à la source

Page 4 of 4

Figure 11.9 – Copy of letter sent to Ramsey Lake watershed landowners (Page 4 of 4).

DRINKING WATER SOURCE PROTECTION
DE L'EAU POTABLE À LA SOURCE

Nickel District Conservation Authority

OFFICIAL NOTICE UNDER *CLEAN WATER ACT:* PROPERTY DESIGNATION

Sodium levels have been rising in Ramsey Lake; sources of sodium may be both natural and human-related. Human-related sources of sodium in the watershed would be the **handling and storage of road salt** and the **application of road salt.**

In recent years, cyanobacteria (blue-green algae) blooms have been observed on Ramsey Lake. Microcystin is a toxin that is sometimes produced by certain species of cyanobacteria and if it occurs in excess of the maximum acceptable level under the Ontario Drinking Water Quality Standards, it constitutes a drinking water issue. Phosphorus contributes to the production of cyanobacteria, therefore, any activities occurring in the Ramsey Lake watershed which can contribute to the input of phosphorus to Ramsey Lake are considered a threat to municipal drinking water.

Activities that could contribute to phosphorus in Ramsey Lake include **septic systems** and the **application of commercial fertilizer to land,** which would include fertilizing your lawn or garden with any fertilizer containing phosphorus that is commercially available.

As it is possible that these activities may be occurring on your property, this letter is required under the *Clean Water Act* to inform you that the activity of applying a phosphorus fertilizer on your property and/or the handling, application and storage of road salt and/or a septic system has been identified as a significant threat. To learn more about this, please attend the public meetings listed on the attached invitation.

NOTICE UNDER O.REG.287/07 SECTION 19 – SOURCE PROTECTION PLAN PREPARATION IN THE GREATER SUDBURY SOURCE PROTECTION AREA

In addition, we would like to advise you regarding the upcoming preparation of a Source Protection Plan for significant drinking water threat activities in the Greater Sudbury Source Protection Area. This letter serves as a notice under Ontario Regulation 287/07, Section 19.

Preparation of the Source Protection Plan for the Greater Sudbury Source Protection Area is now commencing. The Source Protection Plan will build upon the information collected for the Assessment Report and, more specifically, it will outline:

- Policies and programs to address existing significant threats and to prevent new threats from developing.
- Activities in the Intake Protection Zones and Wellhead Protection Areas, including activities that are prohibited and activities that are allowed with conditions (Risk Management Plans).
- Public education and outreach programs and programs to develop voluntary action regarding best practices.

The Greater Sudbury Source Protection Committee would like to advise you that the Source Protection Plan will contain policies that may affect your activity(s). Policies will also be developed for all other vulnerable areas where these threats have been identified. You will be notified when draft policies are available for public review. The Committee would like to know if the identified activity(s) is governed by a prescribed instrument, as prescribed by the regulation. Should the activity(s) be governed by a prescribed instrument, the Committee requests that you provide the instrument number and a description of the applicable provisions regulating the activity(s).

DEFINITION OF PRESCRIBED INSTRUMENTS

Under the Clean Water Act, "prescribed instrument" means an instrument that is issued or otherwise created under a provision prescribed by the regulations of:

(a) the *Aggregate Resources Act*,
(b) the *Environmental Protection Act*,
(c) the *Nutrient Management Act, 2002*,
(d) the *Safe Drinking Water Act, 2002*,
(e) the *Ontario Water Resources Act*,
(f) the *Pesticides Act*, or
(g) any other Act or regulation prescribed by the regulations; ("acte prescrit")

For a list of provisions prescribed for the purposes of the definition of "prescribed instrument" under Ontario Regulation287/07, contact the Drinking Water Source Protection Program at sourcewater@sudbury.ca or 674-5249.

Figure 11.10 – Copy of legal notification sent to Ramsey Lake watershed landowners notifying them of significant threat status. It also notified landowners that planning has begun.

DRINKING WATER SOURCE PROTECTION

DE L'EAU POTABLE À LA SOURCE

Nickel District Conservation Authority

February 22, 2011

Mayor Matichuk and Members of City Council:

The Greater Sudbury Source Protection Committee has commenced preparation of a Source Protection Plan which will include policies to protect municipal drinking water sources from significant threats.

The Committee has identified **approximately 4,600 possible threats** in the Ramsey Lake watershed and **24 possible threats** adjacent to the wells located in Valley East, Garson, Onaping and Dowling. We will be issuing letters to these landowners in early April to notify them of this threat designation. Previously, **41 landowners** were notified of possible threats on their properties and they will be kept abreast of the Plan development.

The committee is planning to update the N.D.C.A. Greater Sudbury Source Protection Authority and City Council regarding these activities later in March. Since notifications to 41 property owners will occur prior to this planned briefing, the committee would like to ensure that council is aware of this upcoming activity.

As these notifications to landowners may generate questions to the Mayor or members of Council, we are available to answer any queries you may have regarding the source protection planning process. You can contact either myself or Judy Sewell, Drinking Water Source Protection Co-ordinator, through the Nickel District Conservation Authority at 705-674-5249.

Yours truly,

Nels Conroy

Nels Conroy
Chair, Greater Sudbury Source Protection Committee

cc. Bob Rogers, Chair, Nickel District Conservation Authority/Greater Sudbury Source Protection Authority
Members, Greater Sudbury Source Protection Authority
Members, Greater Sudbury Source Protection Committee
Ian Smith, Source Protection Programs Branch, MOE
Doug Nadorozny, Greater Sudbury CAO
Greg Clausen, General Manager of Infrastructure Services
Bill Lautenbach, General Manager of Growth and Development

Nickel District Conservation Authority
200 Brady Street, Sudbury, Ontario P3E 5K3
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www.nickeldistrict.ca

Figure 11.11 – Copy of letter sent to Greater Sudbury City Council, February 22, 2011.

Help Protect Local Drinking Water Sources

The Greater Sudbury Source Protection Committee invites you to review and comment on the amended Assessment Report for the Greater Sudbury Source Protection Area by **May 17, 2011**.

The Committee will be hosting **public meetings** to provide an opportunity for the public to learn more about the report and provide comments:

Tuesday, May 3, 2011
Tom Davies Square
200 Brady Street
Room C-12
1:00 p.m. to 8:00 p.m.

Wednesday, May 4, 2011
Howard Armstrong Recreation Centre
4040 Elmview Drive, Hanmer
4:00 p.m. to 8:00 p.m.

Thursday, May 5, 2011
Tom Davies Square
200 Brady Street
Room C-11
1:00 p.m. to 8:00 p.m.

Please provide written comments by **May 17, 2011,** by letter, fax or email to:

The Greater Sudbury Source Protection Committee
c/o Nickel District Conservation Authority
200 Brady Street, Sudbury, ON P3E 5K3
Email: sourcewater@greatersudbury.ca
Fax: (705) 674-7939

The amended Assessment Report can be viewed online at **www.sourcewatersudbury.ca** during the 30-day comment period or in hardcopy at one of the following locations:

Nickel District Conservation Authority Office
8:30 a.m. - noon and 1:00 p.m. - 4:30 p.m.
200 Brady Street, Sudbury

Valley East Public Library*
4100 Elmview Drive, Hanmer

Main Public Library*
74 MacKenzie Street, Sudbury

*Please consult your local branch for business hours.

Ontario

DRINKING WATER SOURCE PROTECTION
DE L'EAU POTABLE À LA SOURCE

Nickel District Conservation Authority

Figure 11.12 – Copy of amended assessment report notice sent to municipalities, First Nations and 4,634 landowners identified as having significant threats on their properties (Page 1 of 2).

Aidez à protéger les sources d'eau potable locales

Le Comité de protection des sources d'eau potable du Grand Sudbury vous encourage d'examiner l'Ébauche du rapport d'évaluation pour la zone de protection des sources d'eau potable du Grand Sudbury avant le **17 mai 2011** et de fournir des commentaires.

Le Comité organisera **des réunions publiques** afin d'offrir au public une occasion de se renseigner davantage sur le rapport et de fournir des commentaires :

Le mardi 3 mai 2011
Place Tom Davies
200, rue Brady
Salle C-12
De 13 h à 20 h

Le mecredi 4 mai 2011
Centre récréatif Howard Armstrong
4040, chemin Elmview, Hanmer
De 16 h à 20 h

Le jeudi 5 mai 2011
Place Tom Davies
200, rue Brady
Salle C-11
De 13 h à 20 h

Nous vous demandons de soumettre, d'ici le 17 mai 2011, vos commentaires dans une lettre envoyée par la poste, par télécopieur ou par courriel à :

Comité de protection des sources d'eau potable du Grand Sudbury
a/s de l'Office de protection de la nature du District du Nickel
200, rue Brady, Sudbury (Ontario) P3E 5K3
Courriel : sourcewater@grandsudbury.ca
Télécopieur : (705) 674-7939

Durant la période de commentaires de 30 jours, il sera possible de consulter l'Ébauche du rapport d'évaluation en ligne à **www.sourcewatersudbury.ca** et d'en obtenir une copie imprimée aux adresses suivantes :

Bureau de l'Office de protection de la nature du District du Nickel
De 8 h 30 à 12 h et de 13 h à 16 h 30
200, rue Brady, Sudbury

Bibliothèque publique de Valley East*
4100, chemin Elmview, Hanmer

Bibliothèque publique Centrale
74, rue Mackenzie, Sudbury

*Veuillez consulter votre succursale pour obtenir les heures d'ouverture.

Ontario

DRINKING WATER SOURCE PROTECTION
DE L'EAU POTABLE À LA SOURCE

Nickel District Conservation Authority

Figure 11.12 – Copy of amended assessment report notice sent to municipalities, First Nations and 4,634 landowners identified as having significant threats on their properties (Page 2 of 2).

HELP PROTECT LOCAL DRINKING WATER SOURCES

The Greater Sudbury Source Protection Committee invites you to review and comment on the amended Assessment Report for the Greater Sudbury Source Protection Area by May 17, 2011.

The Committee will be hosting **public meetings** to provide an opportunity for the public to learn more about the report and provide comments:

Tuesday, May 3, 2011
Tom Davies Square
200 Brady Street
Room C-12
1:00 p.m. to 8:00 p.m.

Wednesday, May 4, 2011
Howard Armstrong
Recreation Centre
4040 Elmview Drive, Hanmer
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Thursday, May 5, 2011
Tom Davies Square
200 Brady Street
Room C-11
1:00 p.m. to 8:00 p.m.

The amended Assessment Report can be viewed online at **www.sourcewatersudbury.ca** during the 30-day comment period or in hardcopy at one of the following locations. Call your library for hours.

Nickel District Conservation Authority Office
8:30 a.m. - noon and 1:00 p.m. - 4:30 p.m.
200 Brady Street, Sudbury

Valley East Public Library
4100 Elmview Drive, Hanmer

Main Public Library
74 MacKenzie Street, Sudbury

Please provide written comments by **May 17, 2011,** by letter, fax or email to:

The Greater Sudbury Source Protection Committee
c/o Nickel District Conservation Authority
200 Brady Street, Sudbury, ON P3E 5K3
Email: sourcewater@greatersudbury.ca
Fax: (705) 674-7939

Ontario

DRINKING WATER SOURCE PROTECTION
DE L'EAU POTABLE À LA SOURCE

Nickel District Conservation Authority

Figure 11.13 – Amended assessment report notice, which ran in the Sudbury Star Monday, April 18, and The Northern Life Tuesday, April 19.

AIDEZ À PROTÉGER LES SOURCES D'EAU POTABLE LOCALES

Le Comité de protection des sources d'eau potable du Grand Sudbury vous encourage d'examiner l'Ébauche du rapport d'évaluation pour la zone de protection des sources d'eau potable du Grand Sudbury avant le **17 mai 2011** et de fournir des commentaires.

Le Comité organisera **des réunions publiques** afin d'offrir au public une occasion de se renseigner davantage sur le rapport et de fournir des commentaires :

Le mardi 3 mai 2011	Le mecredi 4 mai 2011	Le jeudi 5 mai 2011
Place Tom Davies 200, rue Brady Salle C-12 De 13 h à 20 h	Centre récréatif Howard Armstrong 4040, chemin Elmview, Hanmer De 16 h à 20 h	Place Tom Davies 200, rue Brady Salle C-11 De 13 h à 20 h

Durant la période de commentaires de 30 jours, il sera possible de consulter l'Ébauche du rapport d'évaluation en ligne à **www.sourcewatersudbury.ca** et d'en obtenir une copie imprimée aux adresses suivantes :

Bureau de l'Office de protection de la nature du District du Nickel
De 8 h 30 à 12 h et de 13 h à 16 h 30
200, rue Brady, Sudbury

Bibliothèque publique de Valley East
4100, chemin Elmview, Hanmer

Bibliothèque publique Centrale
74, rue Mackenzie, Sudbury

Nous vous demandons de soumettre, d'ici le **17 mai 2011,** vos commentaires dans une lettre envoyée par la poste, par télécopieur ou par courriel à :

Comité de protection des sources d'eau potable du Grand Sudbury
a/s de l'Office de protection de la nature du District du Nickel
200, rue Brady, Sudbury (Ontario) P3E 5K3
Courriel : sourcewater@grandsudbury.ca
Télécopieur : (705) 674-7939

DRINKING WATER SOURCE PROTECTION
DE L'EAU POTABLE À LA SOURCE

Nickel District Conservation Authority

Ontario

Figure 11.14 – Amended assessment report notice, which ran in Le Voyageur Wednesday, April 20.

Summary of Public Consultation Comments

During the 30-day public consultation period, 13 written comments were submitted to the source protection committee. These comments were reviewed by the source protection committee and did not result in any changes being made to the content of the amended proposed assessment report. The following is a summary of the comments received.

Public Comment #1

Concerned about a proposed subdivision to be developed in Skead – Skead Point in Massey Bay. This peninsula consists of granite rock with very little topsoil. The effluent from septic systems will go in to the water. Drilling will most likely alter the water table in the area, affecting many wells in the area.

Response: The response stated that the proposed subdivision was out of scope of the Clean Water Act since the area does not rely on municipal drinking water. The letter provided an alternate contact to provide comment to.

Public Comment #2

What is the threat risk of a submerged truck/car etc. in Ramsey Lake? If it is a concern, why are trucks/cars allowed on the ice in winter?

Response: These issue is not covered in the Ministry of the Environment's legislation on threats to drinking water sources. Provided link to local stewardship groups that could provide additional information.

Public Comment #3

Concerned with curb fouling diverting rainfall, emptying pools/hot tubs into street, use of salt by city crews, need maximum land use per lot that cannot be built on, and excessive car parking on front lawns.

Response: Road salt is one of the significant threats listed under the *Clean Water Act*, which governs the work of the source protection committee, and therefore will be addressed in the source protection plan being prepared by the committee. The other concerns listed are not covered in the Ministry of the Environment's *Clean Water Act*, and are therefore beyond the scope of the committee.

Public Comment #4

It is impossible to believe that the committee is relevant. Power boats are on Lake Ramsey, houses with septic systems continue to flourish around the lake and other lakes as well, and commerce is more important than water or health despite the good intentions of groups such as yours. Do you really have any power to influence who uses what on the lake?

Response: We replied that the Committee is covered by the *Clean Water Act*. The use of power boats are not covered by the Act. Septic systems are one of the 21 specific threat activities and the Committee is in the process of developing policies to deal with private septic systems.

Public Comment #5

Regarding the stress assessment for the Wanapitei River: doesn't recall seeing any mention of the impact the proposed four-lane highway will have on this drinking water source if the Ministry of Transportation northern routes are chosen as preferred sites. Also states that good salt management policies do not prevent contaminants from seeping into the watershed; salt will be used on a new highway north of the intake, posing a threat.

Response: The response explained the NDCA has commented on the Study Design Report for the proposed four-lane highway between Markstay and Sudbury and continues to stay informed of the project as it develops. Both the application of road salt and transportation of hazardous substances along transportation corridors have been identified as significant threats for the Wanapitei River intake. The Committee is currently in the process of developing policies to address both current and future occurrences of these threats locally.

Public Comment #6

The report is considerably scientific and technical. Easier readability would be enhanced with a "more reader friendly executive summary" of each watershed. Feels the Ramsey Lake Watershed is the most important to the largest number of Sudburians and also is the most fragile, and the most quickly affected of the three watersheds, due to its intensity of urban impact, and the rocky nature of this particular watershed. Believes the Ramsey Lake Watershed should receive the most protection.
Asked if there are security measures in place for the David Street pumping station location?
Sediment runoff within the sanded winter street area of The Ramsey Lake Watershed is significant- already drainage streams and ditches are being in filled at shocking rate, with resultant impact both upstream, and of course higher sediment levels accumulating downstream (in the lake). Will these drainage courses not require dredging in the near future?

Response: The source protection committee appreciates your suggestions about an executive summary for each watershed and high levels of protection for the Ramsey Lake watershed. The Water and Wastewater Department has security measures in place for the David Street pumping station, and could provide you with more information about this. The committee is also working with the city to develop policies for the source protection plan to reduce the impact of runoff into Ramsey Lake and prioritize street sweeping in areas nearby municipal drinking water sources. If in the meantime, if dredging would be required for any drainage courses, this would also be carried out by the city.

Public Comment #7

Has property in the Ramsey Lake watershed and requested public input when policies are developed. Also wanted to know if a certain neighbourhood has municipal water/wastewater service.

Response: Once draft policies are in place, we will consult with landowners who may be affected by the policies, along with the general public. We plan to post draft policies to address the significant threats identified for the Greater Sudbury Source Protection Area in early 2012. All landowners within the Ramsey Lake watershed will receive a notification once the draft policies are ready.

Public Comment #8

Suggested keeping an un-landscaped waterfront buffer to reduce fertilizer runoff into the lake; have the municipality pass policy to provide an incentive for residents, ie. reduction in property taxes for those with a waterfront buffer.

Response: It is beyond the scope of the source protection committee to address a tax reduction for residents who keep a green shoreline. The City of Greater Sudbury has a zoning by-law requirement for a minimum 12 metre setback for buildings from waterbodies when lots are being developed, and for a natural vegetated shoreline buffer leaving three quarters of the natural vegetation intact for residential lots.

Public Comment #9

Provide tax rebate incentive for lakeshore residents who maintain a green shoreline. Stop road salt use south of the Kingsway. Development of new subdivisions increases fertilizer use, which is then washed into Ramsey Lake. Provide free consultation to lakeside property owners to minimize impact on lake. Control population of seagulls and geese.

Response: While it is beyond the scope of the source protection committee to address a tax reduction for residents who keep a green shoreline and to address the population of seagulls and geese, we are aware that the City of Greater Sudbury Parks department is recommencing their geese deterrent program this year and beaches along Ramsey Lake are among the areas they are targeting. The City has a shoreline program similar to that mentioned. Both application of fertilizer and road salt are enumerated threats and policies will be written by the committee to address these in the source protection plan.

Public Comment #10

Has been living near Ramsey Lake for 60 years. Feels that the quality of the water in the lake has been declining over time; often, can't swim at the beaches as they are closed due to bacteria in the water. Feels that the fowl living on the lake have made a strong impact on the declining quality of the water. There is an island in the lake nicknamed Seagull Island and their flight path results in droppings landing in the lake.

Response: Seagull and goose feces are a concern that the source protection committee hears about regularly from residents. This issue is not covered in the Ministry of the Environment's guidelines on threats to drinking water quality; therefore, it is beyond the scope of the committee to address this issue. It has come to our attention however, that the City of Greater Sudbury Parks department is recommencing their geese deterrent program this year.

Public Comment #11

No cars, trucks on Ramsey in winter.

Reponse: This is a concern that the source protection committee hears often. This concern is not covered in the Ministry of the Environment's guidelines on threats to drinking water quality.

Public Comment #12

Has long been worried about the amount of road salt used in winter, so is not surprised regarding elevated levels of sodium in Ramsey Lake. Is also concerned regarding gasoline that is put into the lakes by the extensive boating that occurs during the summer months and about the harm boat wakes are causing to wildlife habitats along the lake and feels that boats are contributing to the spread of milfoil.

Response: Road salt, commercial fertilizer containing phosphorous and septic systems have all been identified as significant threats for the Ramsey Lake watershed. The source protection committee is in the process of developing policies to address these concerns. A concern with gasoline going into the lakes by boating was also noted. This is a concern that the committee hears often. This issue of boating and gasoline leakage is not covered in the Ministry of the Environment's legislation on threats to drinking water sources.

In regards to your comments regarding the use of weevils to control milfoil in Ramsey Lake and sewer and water lines being laid along South Bay Road, both of these projects would be undertaken by the municipality. Contact information was provided.

Public Comment #13

Railway tracks bordering a section of Ramsey Lake pose two concerns: the residue from the rail bed and the trains which run on these tracks; and the risk of a major chemical spill directly into the lake in the event of a derailment. Was dismayed to learn at the meeting that the storm sewers collecting runoff in the Ramsey Lake watershed empty directly into Ramsey Lake. Constant and growing amount of motorized traffic on the lake is a concern – boats, seadoos and airplanes in the summer, and trucks, cars, skidoos, four-wheelers in the winter. Residue from this traffic is deposited into our drinking water.

After review of the Ministry's identified threats, feels the main focus is agricultural-related sources of risk. Non-agricultural sources of risks found in Sudbury need to be addressed in the guidelines.

Response: The response letter explained that some of the concerns, motorized vehicles on the lake, residue from the rail bed, are outside of the scope of the Clean Water Act. A request has been submitted to include transportation of hazardous substances as a local threat.

Ministry of the Environment Review Comments

The amended proposed assessment report was submitted to the Ministry of the Environment on May 31, 2011. The Ministry reviewed the report and provided written comments on August 4, 2011. The comments were related to threats and issues in the Ramsey Lake watershed. Figure 11.15 is a summary of the comments and how they have been addressed in this report. Figure 11.16 is a copy of the August 4, 2011, MOE review comments and Figure 11.17 is a copy of the letter to source protection committee members describing how the source protection authority proposed to address the MOE comments.

MOE Comments on the Greater Sudbury Source Protection Area May 31, 2011 Amended Proposed Assessment Report; and the Source Protection Authority Response to the Comments

#	MOE Comment	SPA Response	May 31st AR Page #	August 31st AR pg.#
1	(a) Revise the Amended Proposed AR text and Map 3.10 to limit the boundaries of the issues contribution area (ICA) for Ramsey Lake to the vulnerable areas (IPZ-1, 2 or 3) as per technical rule 115(3) and as per Section 15 of the Act, which lists areas where activities can be threats to one of the four vulnerable areas. (b) If any change is made in the ICA, the enumeration of SDWT's must also be updated	– Revised Map 3.10, Issue Contributing Area; ICA reduced to be the same as intake protection zones-1, 2 and 3 – Edited Table 3.17, which lists significant threats identified through the issues process - 6 property owners were removed as a result of reducing the size of the issue contribution area – Edited text related to issue contributing area	- Map 3.10 - Introduction pages 15, 17, 19, 20 - Page 3-26 - Table 3.17 - Page 3-24 (ICA text)	- Introduction pages 15, 17, 19, 20 - Page 3-27 - Table 3.17 - Page 3-24 (ICA text)
2	As per regulations, circumstances associated with the significant drinking water threats (SDWT's) within the ICA must be documented. The table listing threats listed only the prescribed threats and does not mention the circumstances. In addition, the discussion around what threats are significant in the ICA is inconsistent with the technical rules.	– Added a table of circumstances for threats identified through the issues process – Table 3.18 new in Section 19.5	- Section 19.5	- Table 3.18, p. 3-28 in Section 19.5
3	Revise the Amended proposed AR to align the enumeration of threats with the technical rules and circumstances around drinking water threats.	– Added septics as a threat for sodium in Table 3.17 – Removed individual household properties as a threat for the handling and storage of road salt	- Table 3.17 - Introduction p.17, p. 20	- Table 3.17, p. 3-24 - Introduction p. 17, p. 20

Page 1 of 4

August 31, 2011

Figure 11.15 – Table of MOE comments and Source Protection Authority responses (Page 1 of 4).

#	MOE Comment	SPA Response	May 31st AR Page #	August 31st AR pg.#
4	Once the AR is revised based on these directions, the Source Protection Authority shall consult with the Source Protection Committee and with those persons or bodies impacted by the changes in an appropriate manner before resubmitting the Amended Proposed AR in accordance with the Act and provide proof thereof with the resubmitted Amended Proposed AR.	- Updated website with a clear message on the front page indicating that the May 31, 2011 Amended Proposed Assessment Report was revised on August 31, 2011 and has updates related to the threats and issues for Ramsey Lake, and provided a link to a summary of those updates	- Not Applicable	- Not Applicable
		- Replaced the May 31, 2011 Amended Proposed AR with the August 31, 2011 Amended Proposed AR on website	- Not Applicable	- Not Applicable
		- Sent a letter to the SPC about the MOE comments and the proposed way to address the comments, and asked for feedback on this; a copy of this letter is included in the August 31, 2011 AR.	- Not Applicable	- Page 11-51
		- Will provide detailed updates to land owners when notifying them of public meetings / open houses to review the draft policies in the draft source protection plan in spring 2012	- Not Applicable	- Not Applicable
		- Proof of consultation in AR – placed a copy of this document in the AR, which provides a summary of MOE review comments and how comments were addressed so people can see quickly and easily what updates have been made to the report; also included a copy of MOE review comments in the August 31, 2011 AR	- Not Applicable	- Page 11-43

Page 2 of 4 August 31, 2011

Figure 11.15 – Table of MOE comments and Source Protection Authority responses (Page 2 of 4).

#	MOE Comment	SPA Response	May 31st AR Page #	August 31st AR pg.#
5	The SPA shall include with the Amended Proposed AR a memo or document outlining the changes made to the AR, as per these directions and any other major change that was made, including chapter references in the AR where changes were made	- Cover letter sent to MOE with a copy of this document describing changes made to the AR, including page number of those changes - Itemized other changes made		
		Other minor edits		
		- Title & spine (Aug. 31, 2011)	- Cover, spine, title	
		- Chapter references	- Page 3 to 5	- Page 3-5
		- List of tables	- Page 6-9	- Page 6-9
		- List of Tables - Table 3.14	- Page 7	- Page 7
		- ICA text	- Page 15	- Page 15
		- Table error	- Page 16	- Page 16
		- Table Spelling	- Page 17	- Page 17
		- ICA text (french)	- Page 19	- Page 19
		- Table Spelling	- Page 20	- Page 20
		- Spelling (up tp)	- Table 2.12	- Page 2-31
		- Table of contents	- Page 3-3	- Page 3-3
		- Table edits (circumstances)	- Table 3.13	- Page 3-21
		- Spelling edits	- Page 3-22	- Page 3-22
		- Footnote	- Table 3.14	- Page 3-23
		- Issues text	- Page 3-24	- Page 3-24
		- Issues text	- Page 3-25	- Page 3-25
		- Issues text	- Page 3-26	- Page 3-27
		- Table title	- Table 3.15	- Page 3-26
		- Table title	- Table 3.16	- Page 3-26
		- Spelling (Lilly)	- Page 3-27	- Page 3-29
		- Table edits (circumstances)	- Table 5.7	- Page 5-14
		- Table edits (circumstances)	- Table 6.11	- Page 6-19
		- Table edits (circumstances)	- Table 7.5	- Page 7-12
		- Table edits (circumstances)	- Table 8.5	- Page 8-11
		- Table edits (circumstances)	- Table 10.6	- Page 10-13
		- Appendix 5 edits	- Page 11-43 to 11-44	- Page 11-54 to 11-55

Page 3 of 4 August 31, 2011

Figure 11.15 – Table of MOE comments and Source Protection Authority responses (Page 3 of 4).

#	MOE Comment	SPA Response	May 31st AR Page #	August 31st AR pg.#
6	The SPA shall submit the Amended Proposed AR to the ministry in the form of both a hard copy and electronic version for the ministry's review.	- Hard copy to MOE - Electronic copy to MOE	Not Applicable	Not Applicable

Page 4 of 4

August 31, 2011

Figure 11.15 – Table of MOE comments and Source Protection Authority responses (Page 4 of 4).

Ministry of the Environment

Source Protection Programs Branch

14th Floor
40 St. Clair Ave. West
Toronto ON M4V 1M2

Ministère de l'Environnement

Direction des programmes de protection des sources

14e étage
40, avenue St. Clair Ouest
Toronto (Ontario) M4V 1M2

Ontario

Log: ENV1174IT-2010-155

August 4, 2011

Mr. Bob Rogers
Greater Sudbury Source Protection Area
Source Protection Authority Chair
Nickel District CA
200 Brady Street
Sudbury, ON
P3E 5K3

Mr. Nels Conroy
Greater Sudbury Source Protection Area
Source Protection Committee Chair
25 Makada Drive
Lively, ON
P3Y 1H8

Dear Mr. Rogers and Mr. Conroy:

You submitted your Amended Proposed Assessment Report for the Sudbury Source Protection Area on June 1, 2011. I have completed my review of the proposed Assessment Report and in accordance with my authority under Section 17(3) (b) of the *Clean Water Act, 2006*, I hereby direct that the Amended Proposed Assessment Report be further amended and resubmitted to me based on the direction below and in consultation with ministry staff, no later than **August 31, 2011**.

The ministry recognizes that the Source Protection Committee (SPC) has gone beyond the legislative requirements by conducting a full 30 day consultation period to notify the local residents of the amendments made to the Proposed AR. I appreciate the extra work that has been done to ensure that the Amended Proposed AR was made widely available in the local community. By doing so you have ensured that the source protection program continues to show its high degree of public transparency.

Based on ministry review of the work to address the directions in my letter of December 23, 2010, our review indicates that items #14 and # 16 from that letter have not been appropriately addressed. Direction #14 was completed for all issues with the exception of Ramsay Lake, and Direction #16 is Ramsay Lake specific. Below are the subsequent directions to make further changes to the Amended Proposed AR. Over these directions, the issues for both Direction #14 and #16 can be addressed. There are additional details and context provided where necessary to support the numbered directions but these additional details do not form part of the directions. Early notification of the one

Figure 11.16 – August 4, 2011, letter from Ministry of the Environment (Page 1 of 4).

Mr. Bob Rogers & Mr. Nels Convoy
Page 2

technical item was communicated to the SPA through the ministry Liaison Officer on July 5, 2011.

1. Revise the Amended Proposed AR text and Map 3.10 to limit the boundaries of the issues contributing area (ICA) for Ramsey Lake to the vulnerable areas (IPZ-1, 2 or 3) as per technical rule 115(3) and as per Section 15 of the Act, which limits areas where activities can be threats to one of the four vulnerable areas. If any change is made in the ICA, the enumeration of SDWTs must also be updated.

   Additional Details: The Amended Proposed AR states that the entire vulnerable area for Ramsey Lake is considered to be the ICA but Map 3.10 shows the entire Ramsey Lake watershed as the ICA. The IPZs of this intake extend to cover the watercourses in the watershed but do not cover land, except for the 120m setback, whereas Map 3.10 shows that the ICA covers the whole land area of the watershed. The delineated ICA can only fall in a vulnerable area (i.e. IPZ-1, 2 or 3) as set out in technical rule 115(3). This ICA should be clearly shown on a map. If, in the opinion of the SPC, the cause of the issues extends beyond the existing IPZs, then the committee can evaluate the delineation of the IPZ, and in accordance with the technical rules, modify the IPZ. As per the technical rules IPZ-2 or 3 can be extended through the presence of transport pathways under technical rule 72. This technical rule does not allow the IPZs to be extended into areas of future pathways. Since the SPA has indicated the ICA was extended to include areas where known future development is going to occur and where additional transport pathways would then warrant the extension of the IPZs this needs to be reassessed for current transport pathways.

   Map 3.10 and the text in the AR should be examined and modified to be consistent with the Act and the technical rule requirements for Threats and Issues. These modifications will likely result in a change (i.e., decrease) in the number of SDWTs identified. Therefore, the enumeration of threats shall be updated to reflect the changes incorporated into revised AR based on the changes to be made to the ICA.

2. As per the regulations, circumstances associated with the significant drinking water threats (SDWTs) within the ICA must be documented. The table listing threats listed only the prescribed threats and does not mention the circumstances. In addition, the discussion around what threats are significant in the ICA is inconsistent with the technical rules.

   Additional Details: The text of the AR identifies activities that are SDWTs within the ICA for sodium and phosphorous. Regulations require that the circumstances under which these activities are SDWTs also be included in the AR. The SPC is can identify the circumstance as any activity in the table of drinking water threats that have sodium or phosphorous as a chemical of concern are a SDWT in the ICA. This could be a simple reference to the circumstances in the tables of drinking water threats, which still apply to the activities with the exception of the quantity

11-875

Figure 11.16 – August 4, 2011, letter from Ministry of the Environment (Page 2 of 4).

Mr. Bob Rogers & Mr. Nels Convoy
Page 3

factor in many cases. There seems to be some confusion around how to interpret the circumstances as set out in comment 3.

3. Revise the Amended proposed AR to align the enumeration of threats with the technical rules and circumstances around drinking water threats.

   Additional Details: One area where this inconsistency in what the rules require and what has been done in the report is that septic systems are linked to sodium, yet they are only listed in Table 3-17 as a threat associated with microcystin. If septics are present and the SPC is aware of them and can count them for microcystin, then it is not appropriate to not also indicate they are an activity that is a SDWT with respect to sodium.

   For road salt handling and storage, the circumstance applies to storage sites only. They do not apply to storage in trucks while applying, nor does it apply to storage at a residence or business unless they have a salt storage pile that is exposed to precipitation. The road salt circumstances apply to road salt stored in a manner where it is not protected from precipitation and run off (ie it is outside), or it is stored in a facility designed for road salt storage (not in a household garage).

4. Once the AR is revised based on these directions, the Source Protection Authority shall consult with the Source Protection Committee and with those persons or bodies impacted by the changes in an appropriate manner before resubmitting the Amended Proposed AR in accordance with the Act and provide proof thereof with the resubmitted Amended Proposed AR;

5. The SPA shall include with the Amended Proposed AR a memo or document outlining the changes made to the AR, as per these directions and any other major change that was made, including chapter references in the AR where changes were made; and

6. The SPA shall submit the Amended Proposed AR to the ministry in the form of both a hard copy and electronic version for the ministry's review.

In addition, there are a few minor items that should be corrected in the Amended Proposed AR for purposes of clarity and accuracy either for this round of planning or a future round of planning, as determined by the SPA based on timing. A list of these will be provided separately to the Project Manager for the SPC/SPA by the Liaison Officer.

Under the authority of section 17(3) (b), the SPA shall resubmit the Amended Proposed AR including the changes above and the items provided in the updated AR workplan for the Sudbury Source Protection Area by **August 31, 2011**.

Please contact your Liaison Officer to arrange a meeting with ministry staff at the Source Protection Programs Branch to discuss these directions in more detail if required.

14-075

Figure 11.16 – August 4, 2011, letter from Ministry of the Environment (Page 3 of 4).

Mr. Bob Rogers & Mr. Nels Convoy
Page 4

Thank you for your work to protect Ontario's sources of drinking water.

Sincerely,

for

Ian Smith, Director
Source Protection Programs Branch
Ministry of the Environment

c: Paul Sajatovic, General Manager, Nickel District Conservation Authority
Judy Sewell, Project Manager, Sudbury SPA
Keith Willson, Manager, Source Protection Approvals
Neil Gervais, Liaison Officer, Source Protection Implementation
Melanie Ward, Group Leader, Source Protection Approvals
Charley Worte, Conservation Ontario
Mike Garraway, Ministry of Natural Resources

14-075

Figure 11.16 – August 4, 2011, letter from Ministry of the Environment (Page 4 of 4).

DRINKING WATER SOURCE PROTECTION
DE L'EAU POTABLE À LA SOURCE

Nickel District Conservation Authority

August 12, 2011

Memo to: Greater Sudbury Source Protection Committee Members

Subject: MOE Review of Amended Proposed Assessment Report

The Ministry of the Environment has reviewed the amended proposed assessment report and has provided comments. They asked that two changes be made to the report in order to be consistent with the Technical Rules; both are related to the threats that were identified through the issues process for the Ramsey Lake watershed and the issue contributing area for those threats:

MOE Comment # 1. We had delineated the entire Ramsey Lake watershed as the issue contributing area for the sodium and phosphorous/blue green algae issues. MOE pointed out that the issue contributing area must be the same as the vulnerable areas (IPZ-1, 2 and 3); and to update the significant threats if required after making this change; and

MOE Comment # 2. MOE indicated that we must add the circumstances associated with the threats that were identified through the issues process (circumstances for sodium and Microcystin LR / blue green algae).

We had several staff meetings; and then follow-up e-mails and a conference call with the MOE Liaison Officer and MOE technical staff to determine how best to meet these requirements. Paul Sajatovic and Nels Conroy participated in several of these meetings.

Discussion on Comment # 1. Our main concern with changing the issue contributing area was to ensure that policies for existing developed areas related to stormwater, sodium and phosphorous would apply to new and planned developments in the Ramsey Lake watershed. The results of our conversations with the MOE is that they would apply, as long as they connect to existing developments via a constructed transport pathway - ie, hooked into the existing stormwater system via a pipe, as opposed to via a natural drainage channel. We spoke with a drainage engineer at the City to confirm whether this would be the case, and he indicated that it would be, however, given that the design of stormwater systems have not been completed for all new or planned developments, he could not guarantee that this would always be the case. Given the technical rules, I think this is the best we can do for this situation. MOE did confirm that this approach is acceptable: "if they are using a stormwater collection system with stormwater drains

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www.nickeldistrict.ca

Figure 11.17 – August 12, 2011, letter to source protection committee members (Page 1 of 3).

etc, and those are planned to discharge into the IPZ itself, they can identify the discharge point of the pipe as a SDWT [safe drinking water threat] already. This would mean that the stormwater management system would not allowed to be constructed until they demonstrated the water quality at the discharge point wont impact the issue. so they can force actions up pipe as a result of that."

As a result of reducing the issue contributing area from the entire watershed to IPZ-1, 2, and 3 only, there are six property owners whose properties are no longer in the issue contributing area, so the number of current property owners whose activities could potentially contribute sodium or phosphorous to the lake is reduced from 4,556 to 4,550.

Discussion on Comment # 2 - threats and circumstances: The MOE indicated that it is acceptable to have the application of road salt as a significant threat for the sodium issue, but that the handling and storage of road salt should be removed for individual household properties. They also indicated that the septic systems that were included as threats for the Microcystin LR / blue green algae issue must also be added as a threat for the sodium issue. In addition, all of the circumstances associated with the threats that were identified through the issues process must be added to the report.

Most of the edits associated with this comment were straight forward, but there was one grey area which was resolved. It was quickly agreed that the Frobisher Depot would stay in as a threat for the handling and storage of road salt, and that individual households could be removed – note that he application of road salt is still a threat for all of these properties. After considerable discussion about how to handle large parking lots for apartment buildings or commercial properties where salt could be stored, the MOE resolved this in their formal comments by indicating that "The road salt circumstances apply to road salt stored in a manner where it is not protected from precipitation and run off (ie if it is outside)".

Consultation

In their August 4th letter, the MOE pointed out that there is a requirement to consult with the SPC and "with those persons or bodies impacted by the changes in an appropriate manner before resubmitting the Amended Proposed AR". This is the purpose of this letter to you – to explain the comments we received from MOE, to describe how we plan to address them, and to ask you if you have any comments or questions about the MOE comments or the planned response.
We will update our website to have a clear message on the front page indicating that the May 31, 2011 Amended Proposed Assessment Report has had some updates related to the threats and issues for Ramsey Lake, and provide a link to a summary of those updates (similar to the 2 page summary attached to this letter). This summary will show what the MOE comment was, what change was made as a result of the comment, and the AR page or pages that the updates are on. This summary will also be included in the public consultation appendix of the assessment report.

A more detailed update will be provided to land owners when we notify them about the open house for the draft policies and the source protection plan next spring. In this way, the updates can be put into context of how the updates will affect them – ie, what the related policies are. This will also give us time to obtain more information on the requirement to add septics to the

2

Figure 11.17 – August 12, 2011, letter to source protection committee members (Page 2 of 3).

list of threats for the sodium issue – as far as we know at this time, water softeners are the main source of sodium for septic systems and they are not used much here, but there may be other sources of sodium we are not aware of, or we may find out if the use of water softeners are more prevalent than we think.

A copy of the MOE comments on the amended proposed assessment report is attached. I have also attached a summary of their comments and how we intend to address them in the assessment report.

The revised assessment report must be submitted to MOE by August 31, 2011. If you have any comments on the proposed approach for addressing the MOE review, please provide them to me by August 22, 2011. Please feel free to contact me or Paul if you have any questions, if you would like more information or if you would like to discuss this in more detail.

Thank you for your review of this material.

Sincerely,

Judy Sewell

Judy Sewell, Co-ordinator
Drinking Water Source Protection Program

Attachments: August 4, 2011 Letter from MOE
Summary of MOE comments and proposed NDCA response

3

Figure 11.17 – August 12, 2011, letter to source protection committee members (Page 3 of 3).

2013 Updated Assessment Report

On December 13, 2013 notices were mailed to municipal clerks in each municipality informing them that the amended assessment report would be available for review and comment from December 16, 2013 until February 7, 2014. This included the City of Greater Sudbury, the Town of Espanola, the Municipalities of Killarney and Markstay-Warren and the Township of Nairn and Hyman. Notices were also mailed to the Sudbury East Planning Board and the two First Nations on the same date. Figures 11.18 and 11.19 are examples of the letters that were sent.

Figures 11.20 and 11.21 illustrate the newspaper ads which were published in both official languages on December 14 and 18, 2013. The newspaper ads include the website where the amended proposed assessment report can be found and provides information on how to submit written comments.

Additional letters were also sent to landowners with recently discovered threats on their properties; and to land owners who had purchased properties after previous owners were notified about threats in the past. All letters to affected bodies, municipalities, landowners or other groups included an invitation to meet with staff on January 16, 2014 to discuss questions or concerns. This focused approach to consultation was approved by the MOE Source Protection Programs Branch.

The purpose of the 2013 update was to add the Tier 3 water quantity analyses for the David Street system at Ramsey Lake and for the Valley groundwater system to the assessment report. Municipal Water and Wastewater staff were on the water quantity analysis project team, and no further comments or requests for changes were made during the public consultation period; nor were any comments or changes requested from the public.

DRINKING WATER SOURCE PROTECTION
DE L'EAU POTABLE À LA SOURCE

Nickel District Conservation Authority

December 13, 2013

Robert Deschene, Chief Administrative Officer
Township of Nairn and Hyman
64 McIntyre Street
Nairn Centre, ON P0M 2L0

**RE: DRINKING WATER SOURCE PROTECTION
DRAFT AMENDED ASSESSMENT REPORT AND UPDATED SOURCE PROTECTION PLAN**

This letter serves as your official notice under Ontario Regulation 287/07.

You are receiving this notice because a portion of the Township of Nairn and Hyman is within the Vermilion River watershed, which is within the Sudbury Source Protection Area. The purpose of this letter is to inform you that the Draft Amended Assessment Report and Draft Updated Source Protection Plan for the Sudbury Source Protection Area are posted online (www.sourcewatersudbury.ca) and available for public review until February 7, 2014.

The purpose for the assessment report amendment and the source protection plan update are to incorporate newly completed water quantity studies for the Ramsey Lake and Valley drinking water systems, and newly identified significant threats to water quantity for the Valley system and associated policies for the Valley area. Revisions resulting from the Ministry of the Environment review of the proposed source protection plan are also included.

The *Clean Water Act* applies to municipal residential drinking water systems. We realize that the Township of Naurn and Hyman does not have any municipal residential drinking water systems in the Sudbury Source Protection Area. However, the *Clean Water Act* requires that the Source Protection Authority provide notice to all municipalities within the Source Protection Area. If the Township of Nairn and Hyman wishes to pursue source protection for any Nairn/Hyman municipal residential drinking water system, you would do so by directly contacting the Minister of the Environment.

If you have any questions about this amendment, the Updated Source Protection Plan or the

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Tel: (705) 674.5249 Fax: (705) 674.7939
www.nickeldistrict.ca

Figure 11.18 –Copy of letter sent to municipalities (P. 1 of 2)

program in general, please contact me at the address on the previous page.

Sincerely,

Judy Sewell

Judy Sewell, Co-ordinator
Drinking Water Source Protection Program

Enclosure: Notice of Public Consultation for the Draft Amendment to the Assessment Report and the Draft Updates for the Proposed Source Protection Plan

2

Figure 11.18 –Copy of letter sent to municipalities (P. 1 of 2)

DRINKING WATER SOURCE PROTECTION
DE L'EAU POTABLE À LA SOURCE

Nickel District Conservation Authority

December 13, 2013

Chief Ted Roque
Wahnapitae First Nation
259 Taighwenini Trail Road
Capreol, Ontario
POM 1HO

RE: Drinking Water Source Protection
Draft Amended Assessment Report and Updated Source Protection Plan

This letter serves as your official notice under Ontario Regulation 287/07.

The purpose of this letter is to inform you that the Draft Amended Assessment Report and Draft Updated Source Protection Plan for the Sudbury Source Protection Area are posted online (www.sourcewatersudbury.ca) and available for public review until February 7, 2014. Cheryl Recollet, your source protection representative, has stayed current with these developments and is aware that the updates are primarily related to the City of Greater Sudbury's Ramsey Lake and Valley drinking water systems.

The purpose for the assessment report amendment and the source protection plan update are to incorporate water quantity studies for these two drinking water systems, and newly identified significant threats to water quantity for the Valley system and associated policies for the Valley area. Revisions resulting from the Ministry of the Environment review of the proposed source protection plan are also included.

The attached notice provides information about how the public, implementing bodies and others can comment on these draft documents. Once this public consultation period is over, the Source Protection Committee will consider revising the documents based on comments received before submitting them to the Ministry of the Environment for review and approval.

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Figure 11.19 –Copy of letter sent to First Nations (P. 1 of 2)

If you have any questions about this amendment, the updated source protection plan or the program in general, please contact me. We would be pleased to come out and discuss the draft report and updated plan with your Band Council or your community if you feel this would be beneficial. I would also like to take this opportunity to thank you for your on-going participation in the drinking water source protection program.

Sincerely,

Judy Sewell, Co-ordinator
Drinking Water Source Protection Program

Enclosure: Notice of Public Consultation for the Draft Amendment to the Assessment Report and the Draft Updates for the Proposed Source Protection Plan

2

Figure 11.19 –Copy of letter sent to First Nations (P. 2 of 2)

Help Protect Local Drinking Water Sources
OFFICIAL NOTICE under Ontario Regulation 287/07

The Greater Sudbury Source Protection Committee invites you to review and comment on the Draft Amended Assessment Report and Draft Updated Source Protection Plan for the Greater Sudbury Source Protection Area between December 16, 2013 and February 7, 2014.

The Amended Assessment Report and Updated Source Protection Plan can be viewed online at **www.sourcewatersudbury.ca** or in hardcopy at one of the following locations. Call your library for hours.

Conservation Sudbury - Nickel District Conservation Authority Office
8:30 a.m. - noon and 1:00 p.m. - 4:30 p.m.
199 Larch St, 4th floor, Sudbury

Sudbury Public Library, Main Branch
74 MacKenzie Street, Sudbury

Valley East Public Library
4100 Elmview Drive, Hanmer

Conservation Authority staff will be available to answer questions on **January 16, 2014** in meeting room C-13A from 1:30 to 4:30 at Tom Davies Square (200 Brady St.)

Please provide written comments by **February 7, 2014** by letter, fax or email to:

The Greater Sudbury Source Protection Committee
c/o Nickel District Conservation Authority
199 Larch St. Suite 401, Sudbury, ON P3E 5P9
Email: sourcewater@greatersudbury.ca
Fax (705) 674-7939

Figure 11.20 – Proposed amended assessment report notice, which ran in the Sudbury Star, Saturday December 14, 2013

Aidez à protéger les sources d'eau potables locales
AVIS OFFICIEL ,Réglement de l'Ontario 287/07

Le Comité de protection des sources d'eau potable du Grand Sudbury vous encourage d'examiner l'Ébauche du rapport d'évaluation proposée pour la zone de protection des sources d'eau potable du Grand Sudbury avant **le 7 février 2014** et de fournir vos commentaires.

Durant la période de commentaires, il sera possible de consulter les documents en ligne à **www.sourcewatersudbury.ca** et d'en obtenir une copie imprimée aux adresses suivante :

Bureau de l'Office de protection de la nature du District du Nickel
De 8 h 30 à 12 h et de 13 h à 16 h 30
199, rue Larch, 4ième étage, Sudbury

Bibliotèque publique centrale
74, rue MacKenzie, Sudbury

Bibliotèque de Valley East
4100, promenade Elmview, Hanmer

Membres du personel du bureau de la Protection de la Nature seront disponibles pour répondre à des questions le 16 janvier, 2014 dans la salle C-13A, de 13h00 à 16h30 à la Place Tom Davies (200, rue Brady).

Nous vous demandons de soumettre, d'ici **le 7 février 2014**, vos commentaires dans une lettre envoyée par la poste, par télécopieur ou par courriel à :

Comité de protection des sources d'eau potable du Grand Sudbury
a/s de l'Office de protection de la nature du District du Nickel
199, rue Larch Suite 401, Sudbury (Ontario) P3E 5P9
Courriel : sourcewater@grandsudbury.ca
Télécopieur : (705) 674-7939

Figure 11.21 - Proposed amended assessment report notice, which ran in Le Voyageur, Wednesday December 18, 2013

Appendix 5 – Provincial Tables of Circumstances

The following provincial Tables of Circumstances[1] list the circumstances in which prescribed threat activities are or would be significant, moderate or low threats in the Greater Sudbury Source Protection Area. The full tables can be found on the DVD labeled *Appendix 5*.

CW10S - Chemicals in a WHPA with a vulnerability score of 10 where threats are significant
CW8S - Chemicals in a WHPA with a vulnerability score of 8 where threats are significant
CW10M - Chemicals in a WHPA with a vulnerability score of 10 where threats are moderate
CW8M - Chemicals in a WHPA with a vulnerability score of 8 where threats are moderate
CW6M - Chemicals in a WHPA with a vulnerability score of 6 where threats are moderate
CW10L - Chemicals in a WHPA with a vulnerability score of 10 where threats are low
CW8L - Chemicals in a WHPA with a vulnerability score of 8 where threats are low
CW6L - Chemicals in a WHPA with a vulnerability score of 6 where threats are low
DWAS - DNAPLS in WHPA A, B, C, C1, with any vulnerability where threats are significant

PW10S - Pathogens in WHPA A, B with a vulnerability of 10 where threats are significant
PW10M - Pathogens in WHPA A, B with a vulnerability of 10 where threats are moderate
PW8M - Pathogens in WHPA A, B with a vulnerability of 8 where threats are moderate
PW8L - Pathogens in WHPA A, B with a vulnerability of 8 where threats are low

CSGRAHVA6M - Chemicals in an SGRA or HVA with a vulnerability score of 6 where threats are moderate
CSGRAHVA6L - Chemicals in an SGRA or HVA with a vulnerability score of 6 where threats are low

CIPZ10S - Chemicals in an IPZ with a vulnerability of 10 where threats are significant
CIPZWE9S - Chemicals in an IPZ or WHPA E where the vulnerability score is 9 where threats are significant
CIPZWE8S - Chemicals in an IPZ or WHPA E where the vulnerability score is 8 where threats are significant
CIPZ10M - Chemicals in an IPZ with a vulnerability of 10 where threats are moderate
CIPZWE9M - Chemicals in an IPZ or WHPA E where the vulnerability score is 9 where threats are moderate
CIPZWE8M - Chemicals in an IPZ or WHPA E where the vulnerability score is 8 where threats are moderate
CIPZWE7.2M - Chemicals in an IPZ or WHPA E where the vulnerability score is 7.2 where threats are moderate
CIPZWE7M - Chemicals in an IPZ or WHPA E where the vulnerability score is 7 where threats are moderate
CIPZWE10L - Chemicals in an IPZ with a vulnerability of 10 where threats are low
CIPZWE9L - Chemicals in an IPZ or WHPA E where the vulnerability score is 9 where threats are low
CIPZWE8L - Chemicals in an IPZ or WHPA E where the vulnerability score is 8 where threats are low
CIPZWE7.2L - Chemicals in an IPZ or WHPA E where the vulnerability score is 7.2 where threats are low
CIPZWE7L - Chemicals in an IPZ or WHPA E where the vulnerability score is 7 where threats are low
CIPZWE5.6L - Chemicals in an IPZ or WHPA E where the vulnerability score is 5.6 where threats are low

[1] Excerpt from the Ministry of the Environment's Provincial Table of Circumstances, March 2010

PIPZ10S - Pathogens in an IPZ with a vulnerability of 10 where threats are significant
PIPZWE9S - Pathogens in an IPZ or WHPA E with a vulnerability of 9 where threats are significant
PIPZWE8S - Pathogens in an IPZ or WHPA E with a vulnerability of 8 where threats are significant
PIPZWE10M - Pathogens in an IPZ with a vulnerability of 10 where threats are moderate
PIPZWE9M - Pathogens in an IPZ or WHPA E with a vulnerability of 9 where threats are moderate
PIPZWE8M - Pathogens in an IPZ or WHPA E with a vulnerability of 8 where threats are moderate
PIPZWE7.2M - Pathogens in an IPZ or WHPA E with a vulnerability of 7.2 where threats are moderate
PIPZWE7M - Pathogens in an IPZ or WHPA E with a vulnerability of 7 where threats are moderate
PIPZ6M - Pathogens in an IPZ with a vulnerability of 6 where threats are moderate
PIPZ10L - Pathogens in an IPZ with a vulnerability of 10 where threats are low
PIPZWE9L - Pathogens in an IPZ or WHPA E with a vulnerability of 9 where threats are low
PIPZWE8L - Pathogens in an IPZ or WHPA E with a vulnerability of 8 where threats are low
PIPZWE7.2L - Pathogens in an IPZ or WHPA E with a vulnerability of 7.2 where threats are low
PIPZWE7L - Pathogens in an IPZ or WHPA E with a vulnerability of 7 where threats are low
PIPZ6L - Pathogens in an IPZ with a vulnerability of 6 where threats are low
PIPZWE5.6L - Pathogens in an IPZ with a vulnerability of 5.6 where threats are low

CIPZWE6M - Chemicals in an IPZ or WHPA E where the vulnerability score is 6 where threats are moderate
CIPZWE6L - Chemicals in an IPZ or WHPA E where the vulnerability score is 6 where threats are low

Appendix 6 - Data Sources

Table 11.1 - Summary of Data Sources for Water Budget Studies

Author: Golder Associates Ltd		
Particular	Water Budget	Data Source
Precipitation	Tier One, Two, Three	Environment Canada - http://climate.weatheroffi ce.gc.ca
Regional Streamflow	Tier One, Two, Three	Environment Canada, Water Survey of Canada - http://www.wsc.ec.gc.ca
Evaporation	Tier One, Two, Three	Thornthwaite and Mather (1957), Ontario Geologic Survey (RUSS data)
Watershed Areas	Tier One, Two, Three	NDCA Mapping (NRVIS)
Water Usage (municipal)	Tier One, Two, Three	CGS annual water works reports, Vale (formerly Vale Inco), Xstrata
Water Usage (other)	Tier One, Two, Three	PTTW database
Population	Tier One, Two, Three	CGS Official Plan, CGS Planning Department Website
Snowmelt	Tier One, Two, Three	Environment Canada, Snowmelt Model 4 (Pysklywec et al 1968)
Baseflow	Tier One	USGS (Neff et al 2005)
Soil and Bedrock Mapping	Tier One, Two, Three	NOEGTS, Bajc (1997)
Groundwater Systems	Tier One, Two, Three	Municipal Groundwater Study (Golder 2005)
Agricultural Water Use	Tier One	DeLoe 2001 (Guidance Document)

Table 11.2 - Summary of Data Collected for Geographical Information Systems for Groundwater Vulnerability Studies

Data	Source	Use	Reliability	Scale
Topography (Ontario DEM V2)	MNR Ontario	IPZ-3 Delineation, ISI Aquifer Vulnerability Mapping	Reliable	1:20 000
Flow Direction in Ontario (WRIP Enhanced)	MNR Ontario	IPZ-3 Delineation ON – Flow Length Calculation and Catchment calculation	Reliable	1:20 000 derived from DEM v2
Stream Network in Ontario (WRIP)	MNR Ontario	IPZ-3 Delineation ON – Buffer extent 120m and flow tracing	Reliable	1:20 000 derived from EFD
Regional Surficial Geology of Sudbury	MNDM Ontario	ISI Aquifer Vulnerability Mapping	Reliable	1:20 000
NOEGTS – Northern Ontario Engineering Geology Technical Studies	MNDM Ontario	ISI Aquifer Vulnerability Mapping	Unreliable	1:100 000
Climate Data	Environment Canada Climate Stations	Used in Hydraulic Modeling, GUDI Delineation (HEC-RAS modeling)	Reliable	10 to 100 km
Hydat Data	Environment Canada Stream Gauge Data	Used in Hydraulic Modeling, GUDI Delineation (HEC-RAS modeling)	Reliable	1 to 10 cm
Hydraulic Models	HEC-2 models	GUDI Delineation (HEC-RAS modeling)	Reliable	Relatively low number of HEC-RAS cross sections
Bathymetry	Website information for Green's lake	Profile of river bottom for HEC-RAS modeling	Unreliable	Unknown
MOE WWIS Database	MOE Well Information Service	ISI Aquifer Vulnerability Mapping	Reliable	Variable
WESA Inco Well Database	WESA	ISI Aquifer Vulnerability Mapping	Reliable	Variable
Surface Drainage	DEM – MNR Ontario	Vulnerability Assessment	Reliable	1:20 000
Orthophoto Mosaic	City of Greater Sudbury	General cartography and identification of ground features	Reliable	1:10 000
Onaping and Vermilion River Area Topography 1:20 000	NDCA	Detailed topography for HEC-RAS Modeling	Reliable	1:20 000
Infrastructure Network – Storm and Sewer Data	City of Greater Sudbury	Vulnerability Assessment	Reliable	Unknown
Surface Drainage	MNR Ontario	Vulnerability Assessment	Reliable	1:20 000

Table 11.3 - Summary of Data Sources for Groundwater Vulnerability Studies

Author	Date	Title	Source ID
AMEC Earth and Environmental Ltd.	2003	Detailed Hydrogeological Assessment – Onaping Potable Water System	AMC Report TY23009
Barnett, P.J. and Bajc, A.F.	2002	Quaternary Geology; in The Physical Environment of the City of Greater Sudbury, Ontario Geological Survey	Special Volume 6, pp. 57-86, and Map 2 – Hillshaded Surficial Geology of the Former Municipality of Sudbury
Burwasser, G.J.	1979	Quaternary Geology of the Sudbury Basic Area, District of Sudbury	Ontario Geological Survey Report 181, 103p., Accompanied by Map 2397, scale 1:50 000 and 2 charts.
Gartner, J.F.	1978	Northern Ontario Engineering Geology Terrain Study Data Base Map, Cartier	Ontario Geological Survey, Map 5000
Gartner, J.F.	1978	Northern Ontario Engineering Geology Terrain Study Data Base Map, Capreol	Ontario Geological Survey, Map 5001
Gartner, J.F.	1978	Northern Ontario Engineering Geology Terrain Study Data Base Map, Espanola	Ontario Geological Survey, Map 5002
Gartner, J.F.	1978d	Northern Ontario Engineering Geology Terrain Study Data Base Map, Sudbury	Ontario Geological Survey, Map 5003
Gartner, J.F.	1980	Capreol Area (NTS 411/ND), Districts of Nipissing and Sudbury, Ontario Geological Survey	Northern Ontario Engineering Geology Terrain Study 95, 16p., Accompanied by Map 5001, scale 1:100 000
Golder	2002a	GUDI Hydrogeological Study, Capreol Water Supply, Wells J and M, Capreol, Ontario	Golder Report 021-9215
Golder	2002b	GUDI Hydrogeological Study, Dowling Water Supply, Wells 1 and 2, Dowling, Ontario	Golder Report 021-9219
Golder	2002c	Draft Report on the Falconbridge Water Supply North of Sudbury Airport, Sudbury, Ontario	Golder Report 021-9216
Golder	2005	Report on City of Greater Sudbury Municipal Groundwater Study	Golder Report 03-1192-025
OGS	2003	Surficial Geology – Regional Municipality of Sudbury, Ontario	Geological Survey Map, p.3399
Roed, M.A. and Hallett, D.R.	1979a	Northern Ontario Engineering Terrain Study Data Base Map, Westree	Ontario Geological Survey, Map 5022
Roed, M.A. and Hallett, D.R.	1979b	Northern Ontario Engineering Terrain Study Data Base Map, Maple Mountain	Ontario Geological Survey, Map 5023
Waters Environmental Geosciences Ltd.	2002	Status Report, Hydrogeological Investigation and GUDI Assessment – Valley East Groundwater Supply, City of Greater Sudbury, Ontario	
WESA	2009	Groundwater Characterization – Assessment of Potential Impacts to Existing Private Water Supply Wells – Garson Mine	WESA Report K-B6022

Appendix 7 – Local Threats

DRINKING WATER SOURCE
PROTECTION
DE L'EAU POTABLE À LA SOURCE

Nickel District Conservation Authority

August 19, 2010

Ian Smith
Director, Source Protection Programs Branch
2 St. Clair Ave. West, 8th Floor
Toronto ON
M4V 1L5

Re: Formal Request for the Addition of a Local Threat, Greater Sudbury Source Protection Area

Dear Mr. Ian Smith,

Major transportation corridors run through many of the municipal drinking water vulnerable areas within the Greater Sudbury Source Protection Area. These include railway corridors within IPZs 1 and 3 of the Ramsey Lake watershed, IPZs 1 and 2 for the Wanapitei River intake, and WHPA-B of the Onaping wellhead area. A number of major roadways also cross through vulnerable areas in the Ramsey Lake watershed, the Wanapitei River, the Valley East well fields, and the Garson and Dowling well areas. Dangerous and/or hazardous goods are transported on both the railway corridors and the roadways, and the potential exists for a spill.

Due to the potential for a spill to occur, the Greater Sudbury Source Protection Committee is requesting the transportation of hazardous substances along transportation corridors be included in the Greater Sudbury Source Protection Area Assessment Report as a non-prescribed threat, as suggested in your April 21, 2010 correspondence to the Source Protection Committee. The Committee feels it is important that the transportation of hazardous substances in areas of close proximity to municipal drinking water sources be considered a significant threat to enable the inclusion of appropriate mandatory policies in the Source Protection Plan.

Thank you for your consideration of our request. We anticipate your response to this information and look forward to including this as a threat in our updated Assessment Report.

Sincerely,

Nels Conroy

Nels Conroy, Chair
Greater Sudbury Source Protection Committee

Cc: Neil Gervais, MOE Liaison Officer
Greater Sudbury Source Protection Committee members

Figure 11.22 - Formal request for addition of a local threat (Page 1 of 3).

DRINKING WATER SOURCE PROTECTION
DE L'EAU POTABLE À LA SOURCE

Nickel District Conservation Authority

Addition of a Local Threat
Greater Sudbury Source Protection Area

Proposed land use activity: Transportation of hazardous substances

Circumstances:

Chemical:
1. Sulphuric acid is transported in a quantity that is more than 2,500 litres.
2. A spill of the fuel may result in the presence of sulphuric acid in groundwater or surface water.

1. Diesel fuel is transported in a quantity that is more than 2,500 litres.
2. A spill of the fuel may result in the presence of BTEX and petroleum hydrocarbons in groundwater or surface water.

Pathogen:
1. Transportation of sewage in any quantity.
2. A spill of sewage may result in the presence of one or more pathogens in groundwater or surface water.

Chemicals and pathogens of concern:

- Sulphuric acid
- BTEX
- Petroleum hydrocarbons
- Septage (pathogen)

The following factors, as listed in technical rules 120 or 121, will need to be scored in order to determine the hazard rating of the land use activity. The NDCA proposes to determine the factor scoring for chemicals of concern in the following ways:

(1) Toxicity of the parameter.
Toxicity for diesel fuel chemicals of concern (petroleum hydrocarbons and BTEX) are listed in the Threats Look-up Table databases. The toxicity of sulphuric acid will be determined through literature reviews and comparisons with existing toxicity scores in the Threats Look-up Table database.

(2) Environmental fate of the parameter.
The environmental fate for diesel fuel chemicals of concern (petroleum hydrocarbons and BTEX) are listed in the Threats Look-up Table databases. The environmental fate score for sulphuric acid will be determined through literature reviews and comparisons with existing environmental fate scores in the Threats Look-up Table database.

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Figure 11.22 - Formal request for addition of a local threat (Page 2 of 3).

(3) Quantity of the parameter.

In the Threats Look-up Table database handling of fuel over 2,500 L has a score of ten. This score will be used in the consideration of the proposed land-use activity. Transportation of such substances are done in much larger quantities. Large trucks typically have capacities ranging from 28,400 litres to 37,500 litres and tank cars on the railroads have capacities of 38,000 to 87,000 litres

(4) Method of release of the parameter to the natural environment.

In the Threats Look-up Table database there are no Chemical Method of Release circumstances to fit the transportation of hazardous substances along transportation corridors. Additional literature research would be needed to address this issue.

(5) Type of vulnerable area in which the activity is or would be located.

These scores are already determined in the Proposed Assessment Report.

The NDCA proposes to determine the factor scoring for pathogens in the following ways:

(1) Frequency of the presence of pathogens that may be associated with the activity

In the Threats Look-up Table database there are no pathogen activity circumstances that specifically fit the transportation of hazardous substances along transportation corridors. However, the following circumstance corresponds well and has an activity list factor of A. It would be considered when trying to determine scoring:

1. Land application of hauled sewage in any quantity.
2. The application may result in the presence of one or more pathogens in groundwater or surface water.

(2) Method of release of the pathogen to the natural environment

In the Threats Look-up Table database there are no method of release circumstances that specifically fit the transportation of hazardous substances along transportation corridors. However, the following circumstance corresponds well and has a method of release score of high for surface water and moderate for groundwater. It would be considered when trying to determine scoring:

1. Land application of hauled sewage in any quantity.
2. The application may result in the presence of one or more pathogens in groundwater or surface water.

(3) Type of vulnerable area in which the activity is or would be located.

These scores are already determined in the Proposed Assessment Report.

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Figure 11.22 - Formal request for addition of a local threat (Page 3 of 3).

Ministry of the Environment
Source Protection Programs Branch
14th Floor
40 St. Clair Ave. West
Toronto ON M4V 1M2

Ministère de l'Environnement
Direction des programmes de protection des sources
14e étage
40, avenue St. Clair Ouest
Toronto (Ontario) M4V 1M2

Ontario

Log: ENV1174IT-2010-257

November 26, 2010

Melanie Venne, MES
Source Water Protection Officer
Nickel District Conservation Authority
200 Brady Street, 1st Floor
Tom Davies Square
Sudbury ON P3E 5K3

Dear Ms. Venne,

We are in receipt of your request for the Director's opinion regarding the addition of transportation of hazardous substances along transportation corridors as a local drinking water threat.

In accordance with my authority under Rules 119, 120, or 121, I hereby provide the following Director's opinion for the hazard rating for the activity and circumstance as per the attached tables. The activity, circumstances, and hazard ratings are approved for local threats in the Greater Sudbury Source Protection Area.

A copy of this letter along with your rationale for the inclusion of these local threats must be included in your assessment report.

Sincerely,

Ian Smith, Director
Source Protection Programs Branch
Ministry of the Environment

Figure 11.23 – Local threat letter of approval and threat circumstances (Page 1 of 6).

c: Keith Willson, Manager, Source Protection Approvals
Paul Heeney, Manager, Source Protection Implementation
Heather Malcolmson, Manager, Source Protection Planning
Katie Fairman, Supervisor, Source Protection Implementation
Melanie Ward, Team Leader, Source Protection Approvals
Neil Gervais, Liaison Officer, CRCA, Source Protection Implementation

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Figure 11.23 – Local threat letter of approval and threat circumstances (Page 2 of 6).

ACTIVITY, CIRCUMSTANCE, AND HAZARD RATING

Greater Sudbury Source Protection Area
Addition of Local Threat – Transportation of materials
Chemicals and pathogens of concern:

- Sulphuric acid when transported in freight tanks
- BTEX when transported in liquid fuel in fuel tanker trucks or freight tanks
- Petroleum hydrocarbons transportation of liquid fuel in fuel tanker trucks or freight tanks
- Pathogens, when transported as septage

1) TRANSPORTATION OF SULPHURIC ACID – FREIGHT TANK

Activity	Vulnerability Score to produce a Significant DWT		Vulnerability Score to produce a Moderate DWT		Vulnerability Score to produce a Low DWT	
	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D
TRANSPORTION OF LIQUID FUELS – FREIGHT TANK						
1. The transportation of sulphuric acid. 2. The sulphuric acid is transported in a quantity that is more than 2,500 litres. 3. A spill of sulphuric acid may decrease the pH of groundwater or surface water to below the acceptable range of 6.5-8.5, as specified in Table 4 of the Technical Support Document for Ontario Drinking Water Standards, Objectives and Guidelines.	10	10	8-9	8	5.4-7.2	6

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Figure 11.23 – Local threat letter of approval and threat circumstances (Page 3 of 6).

2) TRANSPORTION OF LIQUID FUELS – FUEL TANKER TRUCKS

Activity	Vulnerability Score to produce a Significant DWT		Vulnerability Score to produce a Moderate DWT		Vulnerability Score to produce a Low DWT	
	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D
TRANSPORTION OF LIQUID FUELS – FUEL TANKER TRUCKS						
1. The transportation of liquid fuel. 2. The fuel is transported in a quantity that is more than 250, but not more than 2,500 litres. 3. A spill of the fuel may result in the presence of BTEX in groundwater or surface water.			9 - 10	10	6 – 8.1	6 - 8
1. The transportation of liquid fuel. 2. The fuel is transported in a quantity that is more than 250, but not more than 2,500 litres. 3. A spill of the fuel may result in the presence of Petroleum Hydrocarbons F1 (nC6-nC10) in groundwater or surface water.			10	10	6.3 - 9	8
1. The transportation of liquid fuel. 2. The fuel is transported in a quantity that is more than 250, but not more than 2,500 litres. 3. A spill of the fuel may result in the presence of Petroleum Hydrocarbons F2 (>nC10-nC16) in groundwater or surface water.			10	10	7 - 9	8
1. The transportation of liquid fuel. 2. The fuel is transported in a quantity that is more than 250, but not more than 2,500 litres. 3. A spill of the fuel may result in the presence of Petroleum Hydrocarbons F3 (>nC16-nC34) / F4 (>nC34) in groundwater or surface water.			10	10	6.4 – 9	8

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Figure 11.23 – Local threat letter of approval and threat circumstances (Page 4 of 6).

2) TRANSPORTION OF LIQUID FUELS – FREIGHT TANK

Activity	Vulnerability Score to produce a Significant DWT		Vulnerability Score to produce a Moderate DWT		Vulnerability Score to produce a Low DWT	
	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D
TRANSPORTION OF LIQUID FUELS – FREIGHT TANK						
1. The transportation of liquid fuel. 2. The fuel is transported in a quantity that is more than 2,500 litres. 3. A spill of the fuel may result in the presence of BTEX in groundwater or surface water.			8 – 10	8 – 10	5.4 – 7.2	6
1. The transportation of liquid fuel. 2. The fuel is transported in a quantity that is more than 2,500 litres. 3. A spill of the fuel may result in the presence of Petroleum Hydrocarbons F1 (nC6-nC10) in groundwater or surface water.			9 – 10	10	5.6 – 8.1	6 - 8
1. The transportation of liquid fuel. 2. The fuel is transported in a quantity that is more than 2,500 litres. 3. A spill of the fuel may result in the presence of Petroleum Hydrocarbons F2 (>nC10-nC16) / F3 (>nC16-nC34) / F4 (>nC34) in groundwater or surface water.			9 – 10	10	6 – 8.1	6 - 8

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Figure 11.23 – Local threat letter of approval and threat circumstances (Page 5 of 6).

3) TRANSPORTATION OF SEPTAGE

Activity	Vulnerability Score to produce a Significant DWT		Vulnerability Score to produce a Moderate DWT		Vulnerability Score to produce a Low DWT	
	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D	IPZ-1,2,3, WHPA-E	WHPA-A, B, C, C1, D
TRANSPORTATION OF SEPTAGE						
1. The transportation of septage. 2. The septage is transported in any quantity. 3. A spill of the septage may result in the presence of pathogens in groundwater or surface water.	8 - 10	10	6 – 7.2	8	4.2 – 5.6	6

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Figure 11.23 – Local threat letter of approval and threat circumstances (Page 6 of 6).