COMPREHENSIVE STUDY REPORT UNDER THE CANADIAN ENVIRONMENTAL ASSESSMENT ACT

1. PROJECT IDENTIFICATION

Project title:	Municipality of Weedon – Upgrading of the Drinking Water Supply System		
Location:	Weedon	Lat: 45°42'44" N	Long: 71°27'25" W
EA start date:	January 11, 2007	**Date of Notice of Commencement:**	January 11, 2007
Canadian Environmental Assessment Registry No. (CEAR):	07-03-24704	**Amendment of Notice of Commencement (latest version):**	N/A
CEAR contact:	Suzie Roy, Canada Economic Development	**Telephone:**	(514) 283-1120
RA number:	TICQ 4877		

2. IDENTIFICATION OF PROPONENT REPRESENTATIVES

Proponent:	Émile Royer Municipality of Weedon 525 2nd Avenue (Highway 112) Weedon, Quebec J0B 3J0	**Telephone:**	(819) 877-2727
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		Fax:	(819) 563-3850

3. IDENTIFICATION OF FEDERAL AUTHORITIES

Federal authorities	Responsibility	Factors to be considered and scope	Representatives
Economic Development Agency of Canada for the Regions of Quebec	Responsible authority Financial contribution	All factors within the limits described in the scoping document	Suzie Roy Dominion Square Building 1255 Peel Street, 9th floor Montreal, Quebec H3B 2T9 (514) 283-1120
Natural Resources Canada	Expert department	Capacity and protection of the aquifer	Yanick Matteau 580 Booth Street, 3rd floor Ottawa, Ontario K1A 0E4 (613) 947-5861
Fisheries and Oceans Canada	Expert department	Fish habitat, including stream crossings	Maryse Lemire Maurice Lamontagne Institute 850 Route de la Mer Mont-Joli, Quebec G5H 3Z4 (418) 775-0726
Environment Canada	Expert department	Potential presence of species at risk Wetland crossings Protection of migratory birds	Stéfanie Larouche-Boutin Environment Canada Environmental Conservation Branch 1141 Route de l'Église Sainte-Foy, Quebec G1V 4H5 (418) 648-2272
Canadian Environmental Assessment Agency	Federal environmental assessment coordinator		Dominique Lagueux Canadian Environmental Assessment Agency 1141 Route de l'Église, 2nd floor Sainte-Foy, Quebec G1V 4B8 (418) 649-6104

4. PROJECT OVERVIEW

4.1 Project description

Quebec municipalities have until June 28, 2008, to bring their facilities into line with the *Regulation Respecting the Quality of Drinking Water*. Therefore, the goal of the project is to upgrade the drinking water system in the Municipality of Weedon. The project will be carried out within the boundaries of the Municipality, which is located in the Estrie administrative region.

The project involves the installation of a new drinking water supply point to serve about 1,250 people. The population to be served is located in the Weedon Centre area. Water needs have been estimated up to

the year 2035 based on a 1% annual flow increase over the flow in 2005. According to a summary estimate, the population to be served will be about 1,685 people in 2035.

The work involves the construction of two side-by-side, interconnected wells (a main well and a backup well), with a total pumping capacity of 2,000 m^3/d (730,000 m^3/yr). The project also involves construction of a 915-m^3 drinking water reservoir, a manganese removal system, a chlorination system and the installation of pipes to connect the new reservoir to the existing system.

4.2 Project Schedule

The Municipality plans to begin the project in summer 2008 and operation of the facilities in fall 2008. The detailed schedule is presented in Chapter 3 of the impact study submitted by the proponent (Appendix 1 of this document).

5. REGULATORY CONTEXT

The project to upgrade the drinking water supply system in the Municipality of Weedon will be financed by the Canada-Quebec Infrastructure Works Program (CQIW), for which the prime contractor is Quebec's Department of Municipal Affairs and Regions (MAMR) and the federal co-manager is the Economic Development Agency of Canada for the Regions of Quebec (CED). The tripartite program was established in 2000 between Quebec, Canada and the applicant to improve urban and rural infrastructures in Quebec.

The *Canadian Environmental Assessment Act* (CEAA) applies to federal authorities when they contemplate some action in relation to a project that would enable the project to proceed in whole or in part. A federal environmental assessment may be required when a federal authority:

- is the proponent of a project;
- provides financial assistance;
- makes federal lands available for the project;
- issues permits, licences or other approvals.

Because CED plans to provide funding for the project, an environmental assessment had to be completed before a final decision could be made. No other CEAA triggers were identified for the implementation of the project.

Paragraph 10 of Section III of the *Comprehensive Study List Regulations* also stipulates that a comprehensive study is required for the construction of a facility that will extract 200,000 m^3/yr or more of groundwater. The project to upgrade the drinking water supply system in the Municipality of Weedon includes the installation of wells with a total capacity of approximately 700,000 m^3/yr. Therefore a comprehensive study was completed.

As the responsible authority for this comprehensive study, CED must:

- coordinate the consultation and documentation components of the study;
- make a recommendation to the federal Environment Minister (the Minister) on the potential for the planned work related to the project to have significant adverse effects on the environment.

A number of federal authorities (FA) with the expertise or knowledge required to provide advice and information in support of the environmental assessment have been identified since the comprehensive study process began. The following FAs were consulted for the study: Natural Resources Canada, Fisheries and Oceans Canada and Environment Canada. The expert FAs have no decision-making responsibility in terms of the environmental assessment of the project.

6. SCOPE

The scope establishes the limits of an environmental assessment. It identifies which components of the project are examined and which environmental aspects the analysis addresses. The following sections list the components that were considered by CED in the environmental assessment.

6.1 Project scope

The project scope includes the work and operating activities related to the wells that will possibly be funded by CED. The scope includes all phases of the project: construction, operation, modifications, maintenance and closing of the facilities. It is specifically defined as follows:

- groundwater prospecting activities: pumping tests and discharge of pumped water;
- construction of two permanent wells (one main well and one backup well) with a total capacity of 2,000 m^3/d;
- construction of a complete service building, including:
    - a pumping mechanism;
    - telemetry controls;
    - drinking water supply treatment system for the removal of manganese;
    - chlorination system;
- landscaping, including the installation of a safety fence around the well;
- construction of access roads;
- installation of a pipe measuring about 2.7 km connecting the new wells to the new reservoir;

- construction of a new reservoir with a vertical turbine pumping station;
- transmission main measuring approximately 300 m, connecting the new reservoir to the existing water supply system;
- operation of main well;
- restoration of the site (roads); and
- closure and decommissioning of the well at the end of the operational life of the facilities.

The detailed description of the project is presented in Chapter 3 of the impact study submitted by the proponent (Appendix 1 of this document).

6.2 Scope of environmental assessment

6.2.1 Factors to be considered

Pursuant to subsections 16(1) and 16(2) of the CEAA, the following factors were considered by CED in the comprehensive study:

- the purpose of the project;
- alternative means[1] of carrying out the project that are technically and economically feasible and the environmental effects of any such alternative means;
- the environmental effects of the project, including the environmental effects of malfunctions or accidents that may occur in connection with the project and any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out;
- the significance of the adverse environmental effects noted in the previous point;
- the capacity of renewable resources that are likely to be significantly affected by the project to meet present and future needs;
- comments from the public in this regard that are received in accordance with this Act and the regulations;
- technically and economically feasible measures that would mitigate any significant adverse environmental effects of the project;

[1] Alternative means refers to the other means of carrying out the project (described in section 7.3). The proponent also provided an analysis of alternatives (presented in section 7.2) to reach the project objective.

- the need for, and the requirements of, any follow-up program in respect of the project.

6.2.2 Scope of factors to be considered

Analysis of the effects is based on the existing state of the environment in the area of the study prior to project implementation.

The following are proposed temporal boundaries for the project:

- The short-term temporal boundary of the project lasts approximately six months and includes the construction and commissioning phases of the project and the following activities: water prospecting, construction of access roads, construction and commissioning of the new well, construction of the service building, construction of the reservoir, construction of the drinking water supply treatment system for the removal of manganese and the chlorination system, installation of pipes.
- The medium-term temporal boundary of the project is expected to be in the two to three year range and includes activities such as: possible accidents and malfunctions (for example, failure of water mains, chemical spills, etc.) associated with operation of the water system and possible adverse effects of groundwater withdrawal on components listed in the table.
- The long-term temporal boundary for the project would extend up to the operational life expectancy of the project and includes the operation, maintenance and eventual decommissioning of the project, in addition to activities such as: possible accidents and malfunctions (for example, failure of new water mains, chemical spills, etc.) associated with operation of the water system and possible adverse effects of groundwater withdrawal on components listed in the table.

The following table lists the environmental components that were considered in the comprehensive study, as well as their scope and spatial boundaries.

Physical components	Scope	Spatial boundaries
Aquifer characteristics	• Hydraulic conductivity • Transmissivity • Storativity • Flow direction • Conditions at the natural boundaries of the groundwater basin	N/A
Groundwater quality	• Physical, chemical and biological characteristics • Comparative analysis of the quality in terms of drinking water criteria	N/A
Surface water	• Hydrographic network, including rivers, streams, lakes and ponds	Area of influence of groundwater prospecting Area of influence of groundwater drawdown and recharge Area of influence of infrastructure construction
Surface water / groundwater exchange	• Presence and characteristics of exchanges	Area of influence of groundwater prospecting Area of influence of groundwater drawdown and recharge
Wildlife	• Migratory birds and their habitat • Fish and their habitat • Terrestrial wildlife and their habitat	Area of influence of groundwater prospecting Area of influence of infrastructure construction
Flora	• Woodlands targeted by work and their characteristics • Aquatic vegetation • Wetlands • Other plant environments of interest	Area of influence of groundwater prospecting Area of influence of groundwater drawdown and recharge Area of influence of infrastructure construction
Species at risk	• Species of concern, including species at risk within the meaning of subsection 2(1) of the *Species at Risk Act*	Area of influence of groundwater prospecting Area of influence of infrastructure

Physical components	Scope	Spatial boundaries
		construction
Groundwater and surface water intakes	• Inventory and location of intakes and underground wells (private and municipal) • Operation and use	Area of influence of groundwater prospecting All zones likely to serve as groundwater recharge areas
Sources of contamination	• Inventory of contaminated land • Inventory of sanitary landfill sites • Inventory of all potential sources of contamination	Hydraulically upstream of capture point All areas likely to serve as groundwater recharge areas
Land use	• Local neighbourhood and residents	Area of influence of groundwater prospecting All areas likely to serve as groundwater recharge areas Area of influence of infrastructure construction
Aboriginal use of land and resources for traditional purposes		Area of influence of infrastructure construction
Heritage, historical, archaeological and paleontological resources		Area of influence of infrastructure construction

This comprehensive study report also addresses the potential adverse effects of the project on the following environmental components:

- seismic activity;
- climate change;
- impact of infiltration from water bodies, specifically the Saint-François River, on groundwater quality; and
- potential sources of contamination (contaminated land, sanitary landfill sites, land use).

Finally, this comprehensive study report addresses the potential adverse effects related to accidents or malfunctions, such as accidental spills of dangerous materials and other emergency situations.

A detailed description of the environmental components is presented in Chapter 4 of the impact study submitted by the proponent (Appendix 1 of this document).

7. PURPOSE OF THE PROJECT, ALTERNATIVE SOLUTIONS AND OTHER TECHNICALLY AND ECONOMICALLY FEASIBLE MEANS OF CARRYING IT OUT, AND THE ENVIRONMENTAL EFFECTS OF ANY SUCH ALTERNATIVE MEANS

7.1 Purpose of the project

The Municipality of Weedon's drinking water supply currently comes from a surface water intake on Fer-à-Cheval Lake, near the municipal boundary between Weedon Township and Dudswell Township, in the Estrie area. The lake has a surface area of about 0.4 km² and is approximately 2.7 m (9 feet) deep where the water intake pipe is located.

The presence of green foam at the bottom of the lake indicates biological activity that could cause tastes and odours. In addition, the iron content of the water causes corrosion problems, forcing the Municipality to flush its system regularly. The only treatment applied to this raw water is provided at the chlorination facility and consists of the addition of the following substances:

- about 2 barrels/year of sodium polyphosphate as a corrosion inhibitor for the water system;
- sodium hypochlorite (12% bleach solution) as a disinfectant; and
- sodium carbonate (Na2CO3) to increase water alkalinity and slightly reduce corrosiveness.

There are certain problems with the water's taste and sludge odour beginning in May when the water temperature rises; rotten fish odours are present all summer long (when the water is warmer).

Although water quality is assured by a water treatment system, the water is not filtered; this approach does not meet the requirements set out in Quebec's new *Regulation Respecting the Quality of Drinking Water*.

The Municipality plans to construct a well in the Weedon Centre area to ensure the water supply. The capacity of the well has been estimated at 1,925 m^3/d by means of long-term pumping tests (72 hours). A storage reservoir will be built to accommodate the Municipality's water supply needs (about 2,160 m^3/d). This reservoir will make it possible to distribute enough water for peak consumption hours and to maintain a sufficient water supply for fire-fighting purposes.

According to the studies and analyses conducted by the Municipality, the well water is of very high quality and is not directly affected by surface water. However, the level of dissolved manganese and total manganese exceed the 0.05 mg/L criterion. Even though this criterion is an aesthetic one, a system for

removing manganese will be necessary. In addition, a chlorination system will be installed because of the storage reservoir.

Lastly, a 2.7-km pipe will be installed connecting the well to the reservoir and a 300-m pipe will connect the reservoir to the existing water supply system.

The project objectives and justification are presented in Chapter 2 of the impact study submitted by the proponent (Appendix 1 of this document).

7.2 Alternative solutions that could meet project objectives

The project as it is now has undergone many changes in the last seven years. The latest solutions studied are the following:

- Treatment of water from Fer-à-Cheval Lake (the Municipality's current drinking water source), with fire protection
- Conventional treatment (sedimentation/filtration)
- Treatment using the DaguaFlo-UMF process (ozonation / membrane filtration / UV)
- Groundwater supply
- Treatment of manganese by oxidation/filtration
- Treatment of manganese by biological manganese removal (Degrémont's Mangazur process)

The events at Walkerton (Ontario) in 2000 led Quebec provincial authorities to strongly suggest groundwater extraction projects for smaller municipalities. This type of facility requires less stringent monitoring, is generally safer than surface water treatment facilities and limits bacteriological and viralogical contamination problems by natural, subsurface filtration of the groundwater.

Given the new design principles applied to surface water and the knowledge obtained on the aquifer that could be pumped, stakeholders from the Municipality of Weedon opted for a groundwater supply rather than a surface water supply from Fer-à-Cheval Lake.

7.3 Other means of carrying out the project

7.3.1 Pipe route

The proponent studied two route options, which are illustrated in Figure 2 of the impact study submitted by the proponent (Appendix 1, Chapter 3). The following table compares the environmental effects of these two options.

Table 1 – Comparison of the environmental effects of each pipe route

Valued Ecosystem Component	Option A (2.37 km of pipeline)	Option B (2.48 km of pipeline)	Considerations
Groundwater quantity and quality	Negligible/none	Negligible/none	Neither option should have an effect.
Surface water quantity and quality	Negligible/none	Negligible/none	Risk of transport of suspended solids and erosion during construction. These effects could be minimized through standard mitigation measures.
Migratory birds and their habitat Terrestrial wildlife and habitat, woodlands, wetlands and plant environments of interest	0.56 ha of lost habitat, including 0.3 ha of woodland and 0.26 ha of uncultivated land with shrubs or trees Negligible/none	1.63 ha of lost habitat, including 1.19 ha of woodland and 0.44 ha of uncultivated land with shrubs or trees Negligible/none	Both options would require the removal of vegetation, the effect of which could be minimized through standard mitigation measures.
Fish and their habitat	Stream crossing Negligible/none	Stream crossing (two sites) Negligible/none	The effects could be minimized through standard mitigation measures.
Species of special concern including species at risk within the meaning of subsection 2(1) of the *Species at Risk Act*	Negligible/none	Presence of two vulnerable plant species that are of horticultural value Negligible	Option B would cause the disturbance and destruction of species of special concern; the effect could be minimized through standard mitigation measures.
Land use	Could cause permanent damage to field drainage on the Fontabel farm Significant	Negligible/none	Option B is supported by the agricultural community and CPTAQ.*
Groundwater and surface water intakes	None	None	Neither option should have an effect.
Aboriginal use of land and resources	Negligible/none	Negligible/none	Neither option should have an effect.

Valued Ecosystem Component	Option A (2.37 km of pipeline)	Option B (2.48 km of pipeline)	Considerations
Heritage, cultural and historical resources	Unknown	None	We have obtained a guarantee that option B should not have any effect.

* Commission de protection du territoire agricole du Québec [Quebec agricultural land protection commission]

The proponent chose option B because it minimizes the effects of the project on agricultural land use. The other effects can all be reduced through standard mitigation measures. Option B is also the least costly option for the proponent.

7.3.2 Groundwater treatment system: manganese removal

The following two groundwater treatment options were analyzed:

- Greensand filter
- Biological filtration

A detailed description of these options is presented in the impact study submitted by the proponent (Appendix 1, Chapter 3). The following table compares the environmental effects of these two options.

Table 2 – Comparison of the environmental effects of the groundwater treatment systems

Valued ecosystem component	Scenario 1: greensand filter	Scenario 2: biological filtration	Considerations
	Anticipated effects		
Groundwater quantity and quality	None	None	Neither option should have an effect.
Surface water quantity and quality	None	None	Neither option should have an effect.
Migratory birds and their habitat, terrestrial wildlife and habitat, woodlands, wetlands and plant environments of interest	None	None	Neither option should have an effect.
Fish and their habitat	None	None	Neither option should have an effect.
Species of special concern including species	None	None	Neither option should have

Valued ecosystem component	Scenario 1: greensand filter	Scenario 2: biological filtration	Considerations
	Anticipated effects		
at risk within the meaning of subsection 2(1) of the *Species at Risk Act*			an effect.
Land use	None	None	Neither option should have an effect.
Groundwater and surface water intakes	None	None	Neither option should have an effect.
Aboriginal use of land and resources	None	None	Neither option should have an effect.
Heritage, cultural and historical resources	None	None	Neither option should have an effect.

In conclusion, neither of the two options under study should have an effect on the environment. Of the two options, the greensand filtration technology is more technically and economically advantageous for the proponent.

8. Comments from the public regarding the environmental aspects of the project

8.1 Public consultation on the scope

The purpose of the public consultation, held in accordance with subsection 21(1) of the CEAA, was to gather the public's comments on the scoping document on the comprehensive study of the project to upgrade the drinking water supply system in the Municipality of Weedon. The draft version of the document included information on the purpose of the project, the environmental assessment process, opportunities for the public to comment on the scope and other opportunities for public participation. The document was posted in French and English on the Canadian Environmental Assessment Registry and CED Web sites and was also submitted to the office of the Municipality of Weedon. A notice announcing the consultation period was published in four newspapers, including one English paper:

- *L'Éveil du citoyen*, January 25, 2007;
- *La Tribune*, January 27, 2007;

- *The Record*, January 26, 2007;
- *Journal régional Le Haut Saint-François*, January 27, 2007.

The same notice was posted on the Internet site of the Canadian Environmental Assessment Registry.

During the consultation period (January 25 to February 16, 2007), the public was invited to share their comments related specifically to the following points:

- the scope of the project in terms of the environmental assessment, the factors to be considered within the framework of the assessment and the scope of these factors;
- whether conducting the environmental assessment process through a comprehensive study was the best way to allow the public to share their concerns regarding the project to upgrade the drinking water supply system in the Municipality of Weedon.

CED did not receive any comments on the scope of the environmental assessment during the public consultation.

8.2 Public participation in the environmental assessment

Under subsection 21(2) of the CEAA, CED is required to ensure that, in addition to the public consultations stipulated in subsection 21(1) and section 22, the public is given an opportunity to participate in the comprehensive study.

CED registered all documents related to the project's comprehensive study in the Canadian Environmental Assessment Registry. No comments or requests were received in connection with the registry.

On April 25, 2007, a public information session was held in Weedon with the residents affected by the project. The session provided the public with an opportunity to share their concerns regarding the environmental aspects of the project. The following points were addressed:

- A brief description of the existing facilities
- History of steps taken
- Project justification
- Description of proposed construction work
- Construction and taxation costs
- Project schedule

During the joint presentation (Municipality of Weedon – Department of Sustainable Development, Environment and Parks (MDDEP) – Teknika HBA Inc.) of the project to Municipality of Weedon Centre residents, no environmental or social concerns were raised by anyone present at the information meeting (Email from Jean-Paul Morin, MDDEP, December 18, 2007).

Because no comments were received via the CEAR and no concerns were raised by the public during the information session, CED considers that the opportunities for public participation were sufficient in the circumstances.

8.3 Period for public comments on the comprehensive study report

As stipulated in section 22 of the CEAA, the public will have a third opportunity to comment on the project and the related environmental assessment during a period dedicated to examining this report. At that time, the Canadian Environmental Assessment Agency (CEAA) will facilitate public access to the comprehensive study report and oversee the formal consultation period. All comments made by the public will be forwarded to CED and added to the public registry pertaining to the project.

8.4 Aboriginal consultations

Canada Economic Development has a legal obligation to consult and, if appropriate, accommodate when its planned measures could be detrimental to Aboriginal[2] and Treaty[3] rights[4] (potential or established), as guaranteed by section 35 of the *Constitution Act* of 1982. Therefore, CED conducted an analysis to determine whether a consultation with aboriginal groups was necessary for the project.

The Aboriginal groups located nearest to the project are the Abenakis and Mohawks. The Odanak and Wolinak Abenaki reserves are located on the south shore opposite of Trois-Rivières, 162 km and 101 km away, respectively. Both groups signed an agreement with the Quebec government in September 2001 regarding hunting and trapping activities for food, ritual or social purposes and another agreement in May 2001 regarding fishing activities.[5] The land covered by the two agreements takes in most of Estrie and therefore includes the project area. In 1996, these same Abenaki groups submitted a specific claim regarding the former Crespieul Reserve, located northwest of La Tuque. This claim does not involve the project area.

[2] Hunting, fishing, trapping, gathering, self-government and cultural rights (archeological sites, cemeteries).

[3] Practices, traditions and customs integral to the distinctive culture of the Aboriginal group claiming the right that existed prior to contact with the Europeans.

[4] Rights that are defined by the terms of a historic treaty, rights set out in a modern land claims agreement or certain aspects of some selfgovernment agreements.

[5] Taken from http://www.mrnfp.gouv.qc.ca/ministere/affaires/affaires-ententes.jsp on June 18, 2008.

The Kahnawake Mohawk Reserve is located south of Montreal, 222 km from Weedon. The Mohawks claim ownership of the former Sault Saint Louis Seigniory lands, which are located outside the proposed project area.

There are currently no rights claims in litigation in the Estrie region (B. Marion, INAC, pers. comm.).

The nature of the work related to the project will not have any permanent effects on fishing, gathering or trapping. During the work, which will last a few days per section, fishing activities could be affected at stream crossings. However, given the mitigation measures that will be implemented during the work, the impact would be short-term and would not have any significant subsequent adverse effects on fishing success. Furthermore, the archaeological study conducted for the project did not reveal any archaeological sites or Aboriginal cemeteries.

Given the information provided in this document, Canada Economic Development considers that the project will not have any adverse effects on Aboriginal rights, claims or demands. Therefore, Aboriginal consultations were deemed unnecessary. Furthermore, no comments regarding the project were received from Aboriginal groups during the first consultation on the scope of the project.

9. ENVIRONMENTAL EFFECTS AND MITIGATION MEASURES

9.1 Impact methodology

On the basis of the understanding of the area acquired through the compilation of inventories, the environmental components identified were examined in relation to the project components to determine the environmental effects of the project. The project components were identified by taking the various phases of the project into consideration: construction, operation, maintenance of the infrastructures to be built, closure and decommissioning of the wells at the end of the operational life of the infrastructures. The evaluation of the significance of the adverse environmental effects of the project rests mainly on three parameters: the severity of the effect (i.e., the relationship between the environmental value of the component and the degree of disturbance); the extent of the effect (scope or relative surface area on which the effect has an impact: localized, local or regional) and the duration of the effect (temporary in the short term, temporary in the medium term or permanent). The evaluation also considered the likelihood of occurrence of the environmental effect.

The environmental effects of the project, including the cumulative effects and the mitigation measures, were addressed by the proponent. The federal authorities involved in the project provided their expert advice based on the information provided by the proponent and on their own expertise and analysis of the situation.

It is on the basis of all of this information that CED presents its conclusions on the environmental effects of the project.

Table 3 - Summary of the environmental effects of the project

Environmental component	Environmental effects analysis					Residual effects	
	Potential adverse effects			Potential for full mitigation		Are effects significant?	
	Yes	No	Uncertain	Yes	No	Yes	No
Physical and natural environment							
Groundwater quantity and quality	x			x			x
Surface water quantity and quality	x			x			x
Migratory birds and their habitat	x				x		x
Fish and their habitat	x			x			x
Terrestrial wildlife and habitat, woodlands, wetlands and plant environments of interest	x				x		x
Species of special concern including species at risk within the meaning of subsection 2(1) of the *Species at Risk Act*	x				x		x
Capacity of renewable resources (aquifer)	x			x			x*
Human environment							
Land use	x			x			x
Groundwater and surface water intakes		x					x
Aboriginal land and resource use		x					x
Heritage, cultural and historical resources		x					x

Environmental component	Environmental effects analysis					Residual effects	
	Potential adverse effects			Potential for full mitigation		Are effects significant?	
	Yes	No	Uncertain	Yes	No	Yes	No
Environmental conditions							
Seismic activity		x					x
Climate change	x			x			x*
Impact of infiltration from water bodies, specifically the Saint-François River, on groundwater quality		x					x
Potential sources of contamination (contaminated land, sanitary landfill sites, land use)	x			x			x**
Accidents, malfunctions and adverse conditions							
Accidental spills of hazardous materials	x			x			x
Other urgent situations	x			x			x

*Follow-up is recommended to complete the data collection required to adjust operational flow in order to guarantee sustainable extraction of the resource and address climate change.

**Follow-up is recommended to complete the analysis of the water source.

9.2 Groundwater quantity and quality

The sand and gravel aquifer in question seems to be the ideal site for a production well. It is well protected against surface contamination by a thick layer of clay and till and the recharge area is uninhabited. Given the description of the aquifer provided by the proponent, it is unlikely that the well would be supplied by surface water from the Saint-François River because the river is not deeply incised and because there is even a thick, probably continuous layer of clay and till under the river. The screens will also be below this layer.

Transmissivity[6] in the sand and gravel unit is very high and is sufficient for the needs of the Municipality. The groundwater is mainly recharged via the first few (fractured or even altered) metres of the schist northwest of the wells, but it is likely that part of the recharge also comes from the schist at depth (as suggested by the presence of arsenic) and the thick layer of clay. The physicochemical quality of the groundwater meets the requirements of Quebec's new *Regulation Respecting the Quality of Drinking Water*. The characteristics of the aquifer therefore demonstrate a good capacity for sustaining the types of withdrawals planned for in the project and for supplying water that meets quality requirements.

Although the aquifer is naturally well protected, there is always a risk of contamination at the well site. If the wells are not properly protected, they can provide an entry point for contaminants into the aquifer. Overpumping of the aquifer can also reduce the quantity of available water.

In order to protect the aquifer during all phases of the project, the following mitigation measures will be implemented:

- Obtain certificates of authorization from the provincial authorities before carrying out any work on the installation of the wells and pipelines. The proponent must comply with all mitigation measures required in the certificates of authorization issued for the work. A copy of the certificates is to be forwarded to the CED representative.

- Levelling of soil inside the immediate well protection area must be carried out in such a way as to prevent surface water runoff toward the wells.

- Prohibit all activities, facilities or storage of materials or objects that could contaminate the groundwater, with the exception of equipment necessary for construction of the intake systems and building.

- Establish a fenced protection area with a minimum radius of 30 m directly around each well.

- Post a sign indicating the presence of a groundwater source that supplies water intended for human consumption on the site.

- Prohibit all activities, facilities or storage of materials or objects that could contaminate the groundwater, except the intake system equipment, once it is securely installed. If an emergency generator (diesel motor) is required, the generator and its tank must be installed on a clean base with a containment structure to confine spills and/or spatter that could occur during maintenance. The concrete containment structure must be designed to hold more than 100% of the tank's capacity.

- Maintain an operational flow that does not exceed 1,337 L/min.

[6] The coefficient of transmissibility, T, indicates the capacity of an aquifer as a whole to transmit water, and is equal to the hydraulic conductivity multiplied by the saturated thickness of the aquifer, b, in feet.

- At the end of its operational life, the main well will be sealed in accordance with MDDEP's *Guide technique de captage des eaux souterraines et traitement des eaux usées des résidences isolées* [technical guide on groundwater collection and the treatment of wastewater from isolated dwellings] or any other guide recognized by the provincial authorities at the time of closure.

Given the mitigation measures, CED considers that the project should not have any significant adverse effects on groundwater quantity or quality.

9.3 Surface water quantity and quality

As previously mentioned, given the description of the aquifer provided by the proponent (Appendix 1, Chapter 4), it is unlikely that the well would be supplied by surface water from the Saint-François River because the river is not deeply incised and because there is even a thick, probably continuous layer of clay and till under the river (and the screens are below this layer). There is no risk that surface water quantity will be affected by groundwater use.

Drainage ditches, swamps and small intermittent or permanent streams are present at various locations at the well site and along the pipe route. The release of suspended materials during the work could reduce the quality of water in these features.

In order to protect surface water quality during all phases of the project, the following mitigation measures will be implemented:

- Equip the site with all necessary waste recovery equipment (portable chemical toilets, waste receptacles, bins, etc.).

- Identify a temporary storage area on the worksite. Clean the site and dispose of liquid and solid waste regularly in accordance with existing regulations.

- The contractor's work area (trailers, machinery and equipment storage) will be located more than 60 m away from all streams.

- Burying of construction waste will not be permitted on the site.

- Fires and burning on or near the worksite will be prohibited at all times.

- Dispose of construction waste and scrap (depending on their nature) in an area approved by provincial authorities. Dispose of hazardous waste (oil, grease, etc.) or other materials that pose a risk to the environment (creosote treated wood, etc.) in a site that has been approved by provincial authorities to receive this type of waste. Submit a copy of the delivery slips to the CED representative.

- Apply the 3R-R principle (reduce at source, reuse, recycle, reclaim) to manage construction scraps.

- Mark work areas and restrict movement of construction equipment to these areas.

- Avoid leaving soils bare and, if required, implement suspended solids control measures (membranes, geotextiles, straw bales, settling ponds, filter berms, etc.) to prevent suspended solids input to surface water, drainage ditches or storm drains during the work. Apply this measure at the end of every workday, for example, by spreading a layer of straw on bare areas susceptible to erosion. This measure is particularly important for work conducted near streams.

- Avoid carrying out work during heavy rain.

- Dispose of excavated materials in a site approved to receive such materials (depending on their quality) and in accordance with existing regulations. Submit delivery slips for disposal of excavated materials at approved sites to the CED representative.

Other applicable measures are also listed in the "Fish and their habitat" section.

Given the mitigation measures, CED considers that the project should not have any significant adverse effects on surface water quantity or quality.

9.4 Migratory birds and their habitat

Several migratory bird species nest and feed in the woodlands that will be affected by the project. If carried out during the nesting period, forest clearing could cause the destruction of nests. Forest clearing along the pipe right-of-way (1.6 ha) and at the well site (1.5 ha) will also cause an estimated bird habitat loss of 3.1 ha.

In order to protect migratory birds and their nests during all phases of the project, the following mitigation measures will be implemented:

- The nesting period of certain migratory bird species can last until August 31. Forest clearing activities must only be conducted after this date in order to reduce the risk of impacts and comply with the *Migratory Birds Regulations*.

In terms of habitat (woodlands and uncultivated lands), several protection measures have been established and are presented in section 9.6 (Terrestrial wildlife and habitat, woodlands, wetlands and plant environments of interest). Despite the implementation of these measures, woodland habitat loss will be permanent because an easement along the pipe route intended for emergency response purposes will be kept free of trees and shrubs. The residual effects will be minor, however, because the area is small, and similar environments are available nearby. Given the mitigation measures that will be implemented during the work, CED considers that the project is not likely to have any significant adverse effects on this component.

9.5 Fish and their habitat

Brook trout and cyprinids are the most common species found in Estrie streams. No other fish species were observed in the inventories conducted by the proponent in the study area. There is little to no risk of fish mortality; however, damage to the banks during the work could disrupt the habitat, for example, through the release of suspended materials.

In order to protect the fish and their habitat during all phases of the project, the following mitigation measures will be implemented:

Pipe stream crossings (cofferdams and trenches)

- Work related to these activities that is carried out in the stream must be performed in dewatered conditions. Consequently, in order to protect the fish habitat, work is to be performed between June 1 and September 15, outside the heavy rainfall period.

- A supervisor must be present on the worksite at all times while the trench is being dug in the stream bed. A spare pump with sufficient capacity must be available.

- Ensure that the flow management system (pumping of water in the trench or work area) is not a source of suspended solids and does not cause erosion of the bed or bank.

- Filter water containing suspended solids originating in the work area in order to purify it before releasing it into the stream.

- In order to avoid disturbing the stream, do not operate machinery below the natural high water mark. For crossing the stream, only one machinery crossing site is authorized. The crossing must only be wide enough to allow one piece of equipment to cross at a time (one lane).

- The materials used to fill the trench serving as the stream crossing must be free of fine particles.

- Stream banks and crossing approaches disturbed by these activities must be stabilized immediately upon completion of the work.

- Once installation of the pipe is complete, the trench excavated in the stream can be partially filled with foundation materials. In order to restore the stream bed to its initial condition, the upper part of the trench (15-20 cm) must be filled with materials matching the natural grain size in the stream.

- The materials used to build the cofferdams must be free of fine particles (clean stone, sand bags, etc.). These materials must be fully recovered upon completion of the work.

- Install a sufficiently strong geotextile membrane to maintain the original condition of the bed and bank.

Management of fish confined in the work area

- Remove fish before the work area is dewatered in order to prevent them from being killed.

- Equip the end of the pump system suction pipe with an appropriate device in order to avoid drawing up or injuring fish (see the Freshwater Intake End-of-Pipe Fish Screen Guideline at: http://www.dfo-mpo.gc.ca/oceans-habitat/habitat/water-eau/pipe/index_e.asp).

Work on stream banks

- On the banks, avoid stripping the soil and grubbing (NHWM[7] + 30 m) in the right-of-way near the stream. Only soil in bank areas required for equipment crossings and pipe installation is to be stripped.

- Dispose of materials excavated from more than 30 m above the NHWM of all streams. Non-contaminated materials (characterization conducted to verify quality) can be reused to restore the work areas, respecting the natural slope profile and initial grain size.

- In order to avoid disturbing the stream, do not operate machinery below the natural high water mark. Only one return trip with machinery is permitted in the river.

- Wash, service, park and refuel construction machinery and store fuel and other hazardous materials more than 30 m from the NHWM or at a greater distance that is sufficient to prevent any deleterious substances from entering the water.

- Ensure that machinery is clean and free of leaks and that it is maintained in this condition throughout the work period.

- Keep oil spill kits on the worksite in case of emergencies.

- Know how to use emergency equipment in case of an accidental spill. In the event of an accidental spill of oil or any other harmful substance, call the Environment Canada (1-866-283-2333) and MDDEP (1-866-694-5454) emergency numbers immediately.

- Ensure contaminated substrates, used oil and recovered oil are transported to a designated site.

- Maintain appropriate sediment and erosion control measures throughout the duration of the work and until the disturbed areas are restored.

- In streams, avoid transporting any fine particles outside of work areas.

- Remove debris accidentally introduced into the aquatic environment, bank or flood plain as soon as possible.

- Rehabilitate the banks using recognized vegetation stabilization techniques that take into account the stability, sensitivity to erosion, slope and height of the bank. Revegetation must be conducted as soon as possible once the earthworks operations are completed. Indigenous species should be used.

Given the mitigation measures, CED does not feel that the project should have any significant adverse effects on this component.

[7] NHWM: Natural high water mark

9.6 Terrestrial wildlife and habitat, woodlands, wetlands and plant environments of interest

Forest clearing in the pipe right-of-way will cause a loss of wildlife habitat (approximately 1.6 ha), but this type of habitat is abundant in the Weedon Centre area. The disturbed habitats border cultivated agricultural land.

In order to protect terrestrial wildlife and habitat, woodlands, wetlands and plant environments of interest during all phases of the project, the following mitigation measures will be implemented:

- Obtain certificates of authorization from provincial authorities before carrying out any work in wetlands. The proponent must demonstrate compliance with all mitigation measures and compensation plans required in the certificates of authorization issued for the work. Copies of the certificates are to be forwarded to the CED representative.
- The permanent pipe right-of-way must be limited to 8 m.
- The temporary right-of-way (for the duration of the work) must be no more than 6 m wider than the permanent right-of-way (reduce width where possible).
- Clearly mark the forest clearing boundaries in the field.
- A qualified biologist will complete and maintain wetland boundary marking and identification.
- Routine monitoring of wetland crossings must be carried out by a qualified biologist.
- Forest clearing and pruning outside the right-of-way are prohibited without written authorization from the landowner and the worksite manager.
- Forest clearing will be carried out in such a way as to protect all trees, shrubs and other vegetation outside the right-of-way from damage or mutilation.
- Properly dispose of materials and debris produced by clearing the forest, cutting vegetation to the ground, carrying out removal operations and grubbing. If possible, plant debris must be chipped and reused. No burning will be permitted on site.
- Wood of commercial value that is cut in the right-of-way remains the property of the landowner.
- Separate the various soil types found inside the trenches and replace them according to the original stratigraphy; this work will be conducted under the supervision of a qualified biologist or agronomist.
- Place a clay plug around the pipe at wetland inlets and outlets to prevent the infiltration of surface water toward the pipe.
- Materials used to build machinery access roads in the temporary or permanent pipe right-of-way will not include fine materials and they will be completely removed once the work is completed.

- Carry out work during the dry season.
- Maintain equipment in good working condition in order to prevent accidents and leaks of fuel, oil and grease.
- Restrict the movement of vehicles and machinery to the proposed roadways, which must be clearly identified.
- The temporary right-of-way must be restored and revegetated upon completion of the work.
- General maintenance and fuelling of vehicles must be conducted in areas designated for this purpose that are located more than 30 m from streams, wells and wetlands, away from excavations in areas where there is no risk of contaminating the aquatic environment (via storm sewers or agricultural ditches).
- Implement suspended solids control measures (sedimentation basin, filter barrier will be installed as needed).
- At the end of the operational life of the equipment, all surface structures related to the well will be dismantled (i.e., the pumping station and all pumping and treatment facilities), all installations will be removed and foundations and slabs will be buried.

Despite the implementation of these measures, woodland habitat loss will be permanent because an easement along the pipe route intended for emergency response purposes will be kept free of trees and shrubs. The residual effects will, however, be minor because the area is small and similar environments are available nearby. Given the mitigation measures that will be implemented during the work, CED does not feel that the project is likely to have any significant effects on this component.

9.7 Species of special concern including species at risk within the meaning of subsection 2(1) of the *Species at Risk Act*

Two ostrich fern sites and one two-leaved toothwort site are present in the pipe route right-of-way. In Quebec, these species have been designated vulnerable under the *Act respecting threatened or vulnerable species* (L.R.Q., c. E-12.01) since 2005. Because these sensitive species are not rare in Quebec (common in Estrie) and their disappearance is not a concern at present, they are not under any special monitoring in the province. However, the removal of large quantities of whole specimens does exert significant pressure on wild populations of the species. Prohibited practices related to these species are limited, however, to the collection of more than five whole specimens or belowground parts in the natural environment and to the sale of a single specimen. The Regulation does not prohibit partial or complete destruction of a population by activities other than harvesting (i.e., infrastructure projects).

No species protected under the *Species at Risk Act* have been inventoried in the work area.

In order to protect species of special concern during all phases of the project, the following mitigation measures will be implemented:

- Obtain certificates of authorization from provincial authorities before carrying out any work in wetland habitats of species listed under the *Act respecting threatened or vulnerable species*. The proponent must demonstrate compliance with all mitigation measures and compensation plans required in the certificates of authorization issued for the work. Copies of the certificates are to be forwarded to the CED representative.

- Ostrich fern and two-leaved toothwort populations located in the temporary right-of-way must be marked as permanent no-access areas. The marking must be done by a biologist who has the knowledge necessary to identify the species. This measure will apply to other wetlands crossed where these species are identified.

Despite the implementation of these mitigation measures, the project will cause the loss of a few specimens located along the edge of the pipe right-of-way. However, CED considers that the residual adverse effects of the project on the species will not be significant.

9.8 Groundwater and surface water intakes

The pumping test conducted by the proponent showed rapid and significant drawdown over a large area. However, wells at depths of less than 30 m were not affected by pumping. Therefore, available drawdown for the users' wells is acceptable given the drawdown induced by pumping.

CED considers that there will not be any significant adverse effects on this component.

9.9 Land use

The project will be carried out in an agricultural area. The pipe crosses agricultural land, a few areas of uncultivated land and some shrub and tree-covered uncultivated land. Forest cutting was recently carried out the wooded portion of the pipe route located just north of the main well.

The reservoir and drinking water treatment facility site is located near residences along Route 112, in a municipal area. The reservoir site is in an agricultural area.

The project could lead to a loss of agricultural production capacity as a result of soil compaction and changes to drainage. The project could also cause annoyances such as noise and dust.

In order to protect land use during all phases of the project, the following mitigation measures will be implemented:

- Obtain authorization from the Commission de protection du territoire agricoles du Québec (CPTAQ) before conducting any work related to the installation of pipelines or other associated works in agricultural areas. The proponent must demonstrate compliance with all mitigation measures required by CPTAQ.

- Notify residents of the area in advance of the start date and anticipated duration of the work. Work must be restricted to normal hours of work, between 7:00 a.m. and 6:00 p.m.

- Take appropriate measures to limit dust, such as placing tarpaulins over materials transported by trucks and applying dust suppressants more than 30 m from streams (dust suppressants must be suitable for agricultural environments).

- Upon completion of the work, remove unused materials, waste, scraps, pebbles, rubble and woody, stump or root debris from the right-of-way. Dispose of these materials in accordance with existing regulations.

- Burning will be prohibited on the construction site.

- Ditches obstructed or disturbed by the work must be restored.

- Repair or rebuild fences and other essential structures that are removed or damaged.

- In the cultivable portion of the route, the pipe must be buried at a sufficient depth so as not to interfere with surface and subsurface drainage of agricultural land.

- In order to avoid adverse effects on agricultural productivity, topsoil and subsoil must be piled separately from the deeper layers during installation of the pipe. Soil must be replaced in its original sequence.

- Remediate soil compaction upon completion of the work.

Given the mitigation measures, CED considers that the project should not have a significant effect on this component.

9.10 Aboriginal land and resource use

The Aboriginal groups located nearest to the project are the Abenakis and Mohawks. The Abenakis of Odanak and Wolinak signed an agreement with the Quebec government in September 2001 concerning hunting and trapping activities for food, ritual or social purposes, and another agreement in May 2001 concerning fishing activities.[8] The land covered by the two agreements takes in most of Estrie and therefore includes the project area.

However, given the mitigation measures, CED considers that there will not be any significant adverse effects on this component.

9.11 Heritage, archaeological, historical and paleontological resources

Given the high potential of the archaeological sector in Weedon Centre, an archaeologist was hired by the proponent to conduct an assessment of the actual archaeological potential of the worksite right-of-way in a high-potential area. The inventory did not reveal any remains.

[8] Drawn from http://www.mrnfp.gouv.qc.ca/ministere/affaires/affaires-ententes.jsp on June 18, 2008.

CED considers that there can be no significant adverse effects on this component.

10. Effect of the environment on the project

This section addresses the environmental changes that could affect the project and presents the outcomes of these effects and the risks they pose.

10.1 Seismic activity

The Estrie region is outside the seven seismic zones listed by Natural Resources Canada in eastern Canada.

Furthermore, the non-consolidated nature of the aquifer formation makes it less sensitive to mechanical and seismic impacts, and there is very little to no risk of groundwater flow pattern changes.

CED considers that this component will not have any significant adverse effects on the project.

10.2 Climatic conditions

The main concerns regarding the effects of climate change on the project are the following:

- Heat waves in southwestern Quebec will increase in frequency, intensity and duration. The total number of days in excess of 30 degrees Celsius will increase. On the other hand, the number of cold-weather days will decrease.

- The number of extreme weather events including storms, freezing rain and hot days will increase.

- Surface water levels will drop. Moreover, spring runoff will be reduced and occur earlier. This could affect the water balance of the groundwater recharge and, as a result, consumption rates.

- The effects of drought on water sources could lead to decreased water availability. Less rainfall could also increase the need for irrigation in southwestern Quebec.

The hydrogeological study completed for the project demonstrates that the aquifer can meet long-term drinking water needs, provided water demand follows anticipated trends and groundwater recharge rates remain at current levels. If groundwater recharge rates were to decrease to levels that could no longer meet the Municipality's water needs, additional hydrogeological studies would be necessary to examine various solutions to the problem (improvements to the well system, identification of new water sources, implementation of rigorous water conservation measures, increased reservoir capacity, etc.)

CED considers that this component will not have any significant adverse effects on the project.

10.3 Impact on groundwater quality of infiltration from water bodies, specifically the Saint-François River,

Given the description of the aquifer provided by the proponent, it is unlikely that the well is supplied by surface water from the Saint-François River. The wells are approximately 200 m from the river, which is not deeply incised. The presence of a thick, probably continuous layer of clay and till (40 m) even under the river and the fact that the screens are at depths of approximately 50 m minimizes the risk of a connection between the river and the aquifer.

In order to confirm this conclusion, bacteriological analyses should be conducted (on a regular basis) during the long-term pumping test, particularly during the summer months, to see if organisms indicative of surface water, such as *Giardia* cysts or *Cryptosporidium* oocysts are present.

CED considers that this component will not have any significant adverse effects on the project.

10.4 Potential sources of contamination (contaminated land, sanitary landfill sites, land use)

As reported in the impact study provided by the proponent (Appendix 1, Chapter 4), no officially mapped constraints specific to land use have been identified in the study area (landfill site, dump, etc.). The wells are, however, in an agricultural area (agroforestry, largely dominated by forest).

The immediate well site is well protected against surface contamination by the presence of a clay and till layer (present in the four drill holes competed). The *Groundwater Catchment Regulation* (RCES) prohibits the spreading of manure, farm compost or fertilizers in a bacteriological protection area deemed vulnerable according to the DRASTIC index (more than 100). Given the DRASTIC index of 87, no restrictions will be imposed on the southeast end of the agricultural land on lot 11-4.

The surface water that drains the agricultural land upstream from the wells is collected in a drainage ditch and directed across the Fontabel farm lots toward the road ditch (Appendix 1, Chapter 3, Fig. 2). By extrapolating from stratigraphic conditions, LNA (2006) concluded that these ditches are impermeable.

Nevertheless, the entire recharge area must be considered in order to determine whether the water could one day be contaminated by nitrates, de-icing salts, industrial waste or other contaminants. Based on the assumption that much of the recharge is from the surface-altered schist northeast of the site, there is currently almost no risk of contamination because this sector is uninhabited.

As a result, CED considers that the adverse environmental effects on this component would not be very significant. However, given the lack of soil stratigraphy data, CED considers that the Municipality should create a protection area approximately 3.5 km wide that would include the entire rocky area to the northwest as far as its summit (watershed divide) and extend southeast (toward the river) as far as possible, to where the clay layer was observed. This area would allow the Municipality to control the risks of contamination by compensating for the lack of precise stratigraphic data on the entire recharge area.

11. Malfunctions and accidents

CED assessed the possibility of malfunctions and accidents during construction, operation, modification, decommissioning, abandonment and all other work related to the project, as well as the potential adverse environmental effects of such malfunctions or accidents. Malfunctions and accidents are related to spills of hazardous materials or other situations related to operation of the wells.

11.1 Accidental spills of hazardous materials

The release of contaminants can be linked to construction equipment and handling and storage of hazardous materials at all phases of the project and can result in soil, groundwater and surface water contamination.

In order to reduce the effects on the environment, the following measures must be implemented.

General measures

- The mitigation measures will be included in the construction specifications. A copy of the relevant sections of the specifications will be forwarded to the CED representative.

- The contractor will be made aware of the mitigation measures to be implemented during the work. These measures will be presented to the contractor during the initial site meetings, for which an agenda item will be included to this effect. A copy of the site meeting agenda will be submitted to the CED representative.

- A manager responsible for verifying the implementation of the environmental mitigation measures will be present at all times while the work is being carried out. This worksite manager will be in charge of writing a full monitoring report that describes the implementation of the mitigation and compensation measures. The report will be sent to the CED representative once the work is completed.

- The CED representative will immediately be notified of all problems that could cause environmental impacts.

Specific measures

- Repair faulty construction equipment and vehicles as soon as possible and at a distance of more than 30 m from a stream.

- Keep an emergency response kit on the work site at all times in case of an accidental spill.

- All handling of fuel, oil or other contaminants must be routinely supervised to prevent any spills.

- Take all measures necessary to stop an accidental spill and quickly confine the spilled product. Then recover the product, dispose of the waste and restore the area in accordance with existing regulations.

- Establish a spill prevention and response plan and clearly identify the responsible individuals and authorities, as well as the procedure to follow in case of an environmental emergency. Submit a copy of the prevention plan to the CED representative.

- Workers should be made aware of environmental emergency response measures and accidental spill prevention measures. This item must be included on a site meeting agenda or proof of certification of personnel in the implementation of emergency response measures must be provided.

- In the event of an oil spill or a spill any other harmful substance, immediately notify the Department of Sustainable Development, Environment and Parks (1-866-694-5454).

- Conduct a retrospective analysis to improve the prevention and response system in case of an accident.

- All hazardous materials must be transported safely and in accordance with existing regulations and standards.

- Wash, service, park and refuel construction machinery and store fuel and other hazardous materials more than 30 m from the NHWM or more than 30 m from the wells or at a greater distance that is sufficient to prevent any deleterious substances from entering the well protection areas.

- Ensure that machinery is kept clean, free of leaks and maintained in this condition throughout the work period. Submit a copy of the machinery inspection reports (most recent copy prior to start of work) to the CED representative.

- Do not pump water containing suspended solids or harmful substances into the wastewater or drainage systems.

- All temporary fuel tanks must be installed and dismantled in accordance with the *Petroleum Products Regulation*.

- Establish a fenced protection area with a minimum radius of 30 m directly around each well.

- A sign indicating the presence of a groundwater source of drinking water intended for human consumption must be posted on the site.

- Prohibit all activities, facilities or storage of materials or objects that could contaminate the groundwater, except the intake system equipment once it is securely installed. If an emergency generator (diesel motor) is required, the generator and its tank must be installed on a clean base with a

containment structure to confine spills and/or spatter that could occur during maintenance. The concrete containment structure must be designed to hold more than 100% of the tank's capacity.

- At the end of its operational life, the main well will be sealed in accordance with the MDDEP's *Guide technique de captage des eaux souterraines et traitement des eaux usées des résidences isolées* [technical guide on groundwater collection and the treatment of wastewater from isolated dwellings] or any other guide recognized by provincial authorities at the time of closure.

11.2 Other emergency situations

Interruption of the drinking water supply is not covered clearly in the Municipality of Weedon's current emergency plan.

Weedon's emergency plan must be improved to allow a better understanding of the description of measures to be taken in the event of emergency situations or problems related to operation of the system. The well operator must follow the procedures described in the plan. A copy of the plan will be left in the well pump station.

The emergency plan will establish the measures to be taken to mitigate adverse effects in the following general situations:

- supply and treatment problems (negative water quality analysis results, faulty chlorinator, etc.)
- distribution system problem (broken watermain, fire hydrant, etc.)
- hazardous materials storage facility problems (leak, structural failure, etc.)
- exceptional circumstances (security breach, fire or explosion, etc.)

If a drinking water reservoir supply line were to break once the new systems were in operation, the reservoir would have to be filled from a tank in accordance with the *Regulation Respecting the Quality of Drinking Water*. The distribution of bottled water could also be arranged.

The Municipality currently employs dry hydrants to fight fires and uses fire pumps to fill its tank trucks. The current system cannot fully handle this function, which is why the dry hydrants are necessary.

CED considers that because the emergency plan will include measures for dealing with malfunctions and accidents, the project should not have any significant adverse effects on the soil, groundwater or surface water.

12. Cumulative effects

Cumulative effects represent the combined impacts created by several projects on one component. The cumulative effects of past, present and future projects can create significant negative impacts on a valued

environmental component. The project to upgrade the drinking water collection and distribution system in the Municipality of Weedon does not involve any environmental issues. All environmental effects can be reduced to a minimum through the implementation of mitigation measures. The valued components that have been identified are (i) two plant species (ostrich fern, two-leaved toothwort) that have protection status in Quebec and (ii) groundwater quantity.

12.1 Cumulative effects of the project on the ostrich fern and two-leaved toothwort

Two ostrich fern sites and one two-leaved toothwort site have been identified along the edge of the projected intake pipe right-of-way. Mitigation measures to be implemented during the work will render the effect negligible. However, there is a possibility that the project could cause the loss of a few individual plants by destroying them directly or disturbing their habitat. Future projects in these woodlands could further reduce the habitat available to these species. No other projects have been confirmed in the woodland areas of the project where ostrich fern and two-leaved toothwort are found. The measures to be implemented during the work will provide optimal protection of the individual plants already present. Because these two species are quite common in Estrie, CED considers that the project will not create a significant cumulative impact on the ostrich fern and two-leaved toothwort.

12.2 Cumulative effects of the overlapping of area well drawdown cones on groundwater quantity

The pumping test conducted by the proponent showed rapid and significant drawdown over a large area. However, wells at a depth of less than 30 m were not affected by pumping. Therefore, the risks associated with overlapping of the well's drawdown cone with those of domestic wells present in the area of influence is nonexistent provided the wells are less than 30 m deep.

The proponent plans to build a backup well. Therefore, both wells will tap the same aquifer, but they will not operate simultaneously. The recommended operational flow is 1,337m^3/min, regardless of which well is used.

The operation of one or several high-capacity municipal wells could have negative impacts on municipal and private wells in the project area (increased drawdown, mutual interference effects, etc.). Any decision to increase total supply capacity must be supported by new hydrogeological studies showing that the construction of new municipal wells and/or the improvement of existing municipal wells would not have any adverse effects on the aquifer. Given the Municipality of Weedon's relatively low demographic growth and limited future needs in terms of increased water consumption, CED considers that the project is not likely to have significant cumulative effects on groundwater quantity. Section 13 of this document addresses this component in greater detail.

13. Capacity of renewable resources to meet present and future needs

The environmental assessment takes into consideration the renewable resources on which the project could have a significant impact. CED's analysis places particular emphasis on sustainable use of groundwater.

According to analyses conducted by Natural Resources Canada (NRCan), a production of 1,500 L/min (400 US gpm) and an available area of 8 km^2 are calculated to require a recharge rate of 100 mm/year, which seems relatively high for subsurface runoff in the first metres of the schist. Even combined, the different recharge sources (first metres of fractured rock, deeper rock and overlying clay) could not meet this demand.

According to the proponent, the drawdown curve as a function of time shows an impermeable boundary (schists). However, this analysis is not consistent with NRCan's theory of recharge from the upper (fractured) part of the schists. At depth, the schists must be relatively unfractured (with few connections), therefore representing an impermeable boundary in comparison with the very permeable sand and gravel unit. Net recharge cannot be precisely determined and the situation is therefore considered normal in the circumstances.

That said, as noted in the proponent's hydrogeological report, the piezometric surface (water level in the wells) will be monitored over the next few years to ensure the groundwater is not overpumped and to study the impact of pumping.

After examining the existing environmental context and considering the proponent's commitment to take into account well water level monitoring results in adjusting operational flow to recharge, CED has concluded that the project to upgrade the system should not have any significant adverse effects on the capacity of the groundwater to meet present and future needs.

14. SURVEILLANCE AND MONITORING PROGRAM

14.1 Surveillance program

Surveillance of the implementation of mitigation measures will be ensured as long as the worksite is active, occasionally, by the presence of a biologist for some of the more sensitive components, such as the plant species with protection status.

A surveillance report will be produced by the proponent upon completion of the work. The report will address the various activities involved in the surveillance of the implementation of the mitigation measures and the results obtained. A photographic report will be submitted with the surveillance report and will include photographs taken before, during and after the work, as well as photographs of some of the mitigation measures implemented (for example, suspended solids control measures, the fences marking the work site, wetlands and woodlands, etc.). A copy of the surveillance report will be forwarded to Canada Economic Development upon completion of the work. Quebec's Department of Municipal Affairs and Regions (MAMR) will also check with CED to ensure that the proponent has complied with the elements related to environmental surveillance.

14.2 Monitoring program

The proponent established a groundwater quantity and quality monitoring program in accordance with applicable legislative requirements. The monitoring program will make it possible to establish and implement adaptive management measures to minimize the project's impacts.

The monitoring program will include the following activities:

- long-term groundwater monitoring to observe decreases in the groundwater level in the years to come. Operational flows must be adjusted according to the findings of the monitoring to ensure sustainability of the resource;

- monitoring of water quality through regular sampling to identify changes over time. Analyses will mainly test for *Giardia* cysts and *Cryptosporidium* oocysts, as well as arsenic to ensure concentrations respect existing standards.

15. Conclusion and recommendations

The assessment of the project's impacts on the environment included the effects of accidents and malfunctions on the environment, the effects of the environment on the project, alternatives, the capacity of the renewable resources and the cumulative effects. CED has concluded that if the mitigation measures are implemented, the construction, operation and decommissioning activities related to the upgrading of the drinking water supply systems are unlikely to have any significant adverse effects on the environment. CED has also established a surveillance and monitoring program to ensure the accuracy of this conclusion.

REFERENCES

Documents

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Appendix 1

Excerpts from the impact study submitted by the proponent on upgrading to standards the drinking water collection and distribution system in the Weedon Centre area

In support of the comprehensive study by the Economic Development Agency of Canada for the Regions of Quebec

Municipality of Weedon

Impact Study on Upgrading to Standards the Drinking Water Collection and Distribution System in the Weedon Centre Area

REPORT
Final Version

Our file: WECM-059

By

Teknika HBA Inc.

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June 2008

Municipality of Weedon

Impact Study on Upgrading to Standards the Drinking Water Collection and Distribution System in the Weedon Centre Area

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Chantal Bouchard, M. Sc. (Biology)

Reviewed by:

_____
Patrice Bigras, M. Sc. (Geography)

Sherbrooke
June 20, 2008

Section I. PRÉSENTATION OF THE ENVIRONMENTAL STUDY		
To be completed by the promoter representative		
I acknowlege that the informations supplied in this actual form and its attached documents are exact and complete. As the promoter of this project, we commit to implement the mitigation measures as described in this actual presentation of the environmental study.		
Signature :	[signature]	Date : July 15th 08
Name:	*Émile Royer* or	*Jean-Claude Dumas*
Title	General director	Mayor
Organism :	Municipality of Weedon	
Phone n° :	(819) 877-2727	
To be completed by the project manager of the consulting firm that made the environmental study		
I acknowlege that the informations supplied in this actuel form and its attached documents are exact and complete		
Signature :	[signature]	Date : July 16th 08
Name:	*Jean-Pierre Fortier, P. Eng.*	
Title :	Project manager	
Organism :	Teknika HBA inc.	
Tel n° :	(819) 562 3371 poste 2302	

3. PROJECT DESCRIPTION

From the outset, several solutions were considered for solving the Municipality''s drinking water problem. Because of the high cost of treating surface water, whether from Lac Fer-à-Cheval or the Saint-François River, the decision was made to explore the option of a groundwater source of supply for the Weedon Centre area of the Municipality of Weedon, as explained in the previous sections. Groundwater prospecting revealed favourable hydrogeological conditions in Weedon Centre, and so a test well was constructed with a view to supplying residents with groundwater (Teknika, 2004). The test well, WD/PE-1-06, was kept as the main well, and borehole WD/FE-3-06 was identified as a backup well.

The option of supplying the Weeden-Centre area with groundwater is the one recommended in context of the upgrading to standards of the drinking water collection and distribution system. The source for the future well (near the Saint-François River) is the opposite of the current supply source (Fer-à-Cheval Lake) (Figure 1), which means that the operation of the water supply system will be changed in the coming months when the new drinking water source begins to be used. The water will first have to be pumped, which had never been necessary in the past, and a drinking water reservoir will be required for distribution of enough water for peak consumption hours and maintenance of a sufficient water supply for fire-fighting purposes. Figure 1 shows the location of the new well and the preferred location for the future drinking water reservoir based on implementation of the previously cited study.

The general operational plan for the facilities is as follows:

- The new well (as well as the backup well) will supply only the new reservoir, in accordance with its water level.
- The water supply system will be supplied only by the drinking water reservoir. It will be possible to bypass the drinking water reservoir, but only under exceptional circumstances.

The entire project consists of two wells (the main well and a backup well), a pipe connecting the wells to the reservoir, a building housing the equipment needed to collect water and monitor water quality in the wells, an underground reservoir, a building for water treatment (removal of manganese and chlorination), and a pipe connecting these facilities to the existing water supply system for the Municipality of Weedon. More specifically, the scope of the project comprises the following work and activities:

- Groundwater prospecting activities: pumping tests and discharge of pumped water;
- Construction of a permanent well with a capacity of 1,337 L/min, as well as a backup-well, including:
    - a complete service building;
    - pumping mechanism;
    - telemetry controls;
    - landscaping, including the installation of a safety fence around the well;
    - construction of access roads;
    - installation of a pipe measuring about 2.8 km connecting the new well to the new reservoir;
- construction of a reservoir with a vertical turbine pumping station;

- water treatment system for the removal of manganese;
- chlorination system;
- drinking water line measuring approximately 300 m connecting the reservoir to the existing water supply system;
- operation of the well;
- site restoration (roads);
- closure and decommissioning of the well at the end of the operational life of the facilities.

The work involved in this project requires deforestation and/or excavation activities.

Estimates for the work are as follows:

- Area around the wells (including groundwater prospecting)
  - Forest clearing: 1.55 ha
  - Excavated material: 940 m³
  - Fill: 720 m³
- Pipe connecting the wells to the reservoir
  - Forest clearing: 1.63 ha
  - Class B excavated material: 4,900 m³
  - Class A excavated material: 1,450 m³
  - Class B fill: 4,800 m³
- For the drinking water reservoir
  - Forest clearing: 0 ha
  - Class A excavated material: 2,200 m³
  - Class B fill: 425 m³

Throughout the work, excavated materials will generally be piled a safe distance away from the excavations. As much as possible, surplus materials will be reused on the site. Materials not reused will be removed from the site in accordance with the clause in the specifications covering materials not recovered.

The machinery used for the work will be the responsibility of the contractor. However, the following is a general approximation of what will be required:

- Wells and pipe installation
  - One mechanical shovel, 1.25 m³
  - One mechanical shovel, 2 m³
  - One loader
  - One bulldozer
  - One or more bulk trucks
  - Vibrating plate
  - Hydraulic impact hammer and/or blasting equipment (if necessary)

- Drinking water reservoir
  - Concrete pump
  - Mechanical shovel, 2 m^3
  - Bulldozer
  - Vibrator
  - Vibrating plate
  - One or more bulk trucks

3.1 Location

Work on this project will be carried out in the Weedon Centre area of the Municipality of Weedon, in the Haut-Saint-François RCM in Estrie. The study region covers the catchment area for the main well (approximately 8.58 km^2), from Vaseaux Lake in the north to the Saint-François River in the southeast. The region also extends just over 2 km southwest of Saint-Janvier Street in the northeast (Figure 1). However, the study area per se is limited to the area affected by the installation of the wells, pipe, reservoir and water treatment facility, extending from north of Route 112 southeast approximately 600 m to Route 257 (Figure 1).

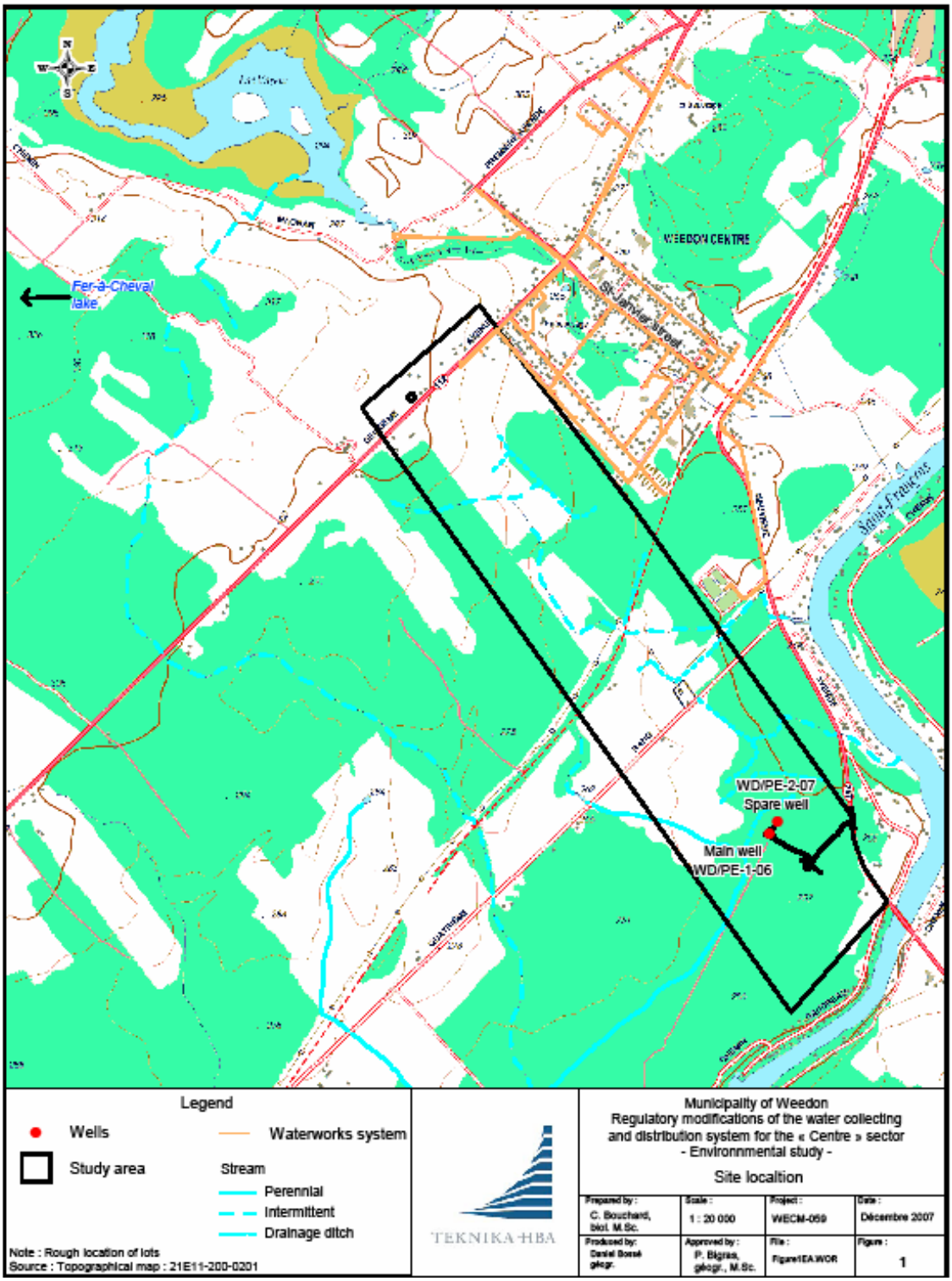
The new wells (main well and backup well) are located in a wooded area between 4th Rang Road and Route 257 (Figure 2). The main well (WD/PE-1-06) is located on lot 11-7 (part), owned by Fontabel Farm, about 830 m south of the intersection of Route 257 and 4th Rang Road. The first backup well planned for lot 11-3 (part), 950 m south of the same intersection, was ultimately abandoned. The backup well that was finally chosen is located 60 m northeast of the main well on lot 11-7 (part), about 800 m south of the intersection of Route 257 and 4th Rang Road. The location chosen for the reservoir is north of Route 112 on lot 11C (part). The pipe connects the two wells, the reservoir and the existing water supply system (see section 3.2.2, Pipe) (Figure 2).

3.2 Description of the work planned

3.2.1 Groundwater prospecting

Various studies have been carried out to date to assess such aspects as drinking water flow requirements in the Weedon Centre area. A study conducted in June 2004, entitled *Étude comparative entre l'alimentation en eau de surface (lac Fer-à-Cheval) ou en eau souterraine (secteur A)* (comparative study of surface-water (Fer-à-Cheval Lake) and groundwater supply (area A)), described drinking water consumption in Weedon Centre and suggested future flow rates as a guide to groundwater prospecting. The upgrading to standards study conducted in 2007 by Teknika HBA refined the estimate of flow rates. Table 1 presents the design flow rates used in this project.

Figure 1
Project Components and Land Subdivision



As indicated above, efforts to seek an appropriate solution to the Municipality's drinking water problems began several years ago. For example, an initial hydrogeological study conducted in 1996 by HE Hydro-Conseil Inc. identified the following two areas of strong hydrogeological potential:

- Area A, located where Route 257 crosses the Saint-François River. The hydrogeologist found the overburden to be thickest in this area and composed of deposits that are probably the most favourable for supplying groundwater;
- Area B, located between Route 257, Fontainebleau Road and the Saint-François River. The bedrock in this area consists of reef limestones, less conducive to supplying large quantities of groundwater.

The hydrogeologist's report recommended that groundwater prospecting begin in area A, starting with geophysical work to identify drilling targets, followed by exploratory drilling and installation of a test well. At the end of 2002, the MAMM also asked the Municipality to investigate in this area.

Table 1
Design Flow Rates

Time Horizon	Average Flow Rate (m^3/d)	Peak Daily Flow Rate (m^3/d)	Peak Hourly Flow Rate (m^3/min)
2005	888 (1)	1,750 (1)	2.08 (3)
2015	981 (4)	2,000 (2)	2.30 (4)
2025	1,084 (4)	2,200 (2)	2.54 (4)
2035	1,197 (4)	2,420 (2)	2.80 (4)

(1) Actual measured values.
(2) Values calculated and suggested in previous studies, including the study comparing surface-water (Fer-à-Cheval Lake) and groundwater supply (area A) released by Teknika HBA on June 25, 2004.
(3) Peak hourly flow rate is calculated with a peak factor of 3.38 for the flow in 2005 (Ref.: *Distribution et collecte des eaux*, deuxième édition, François G. Brière).
(4) Flows calculated on the basis of the 2005 flow combined with an annual increase of 1%.

From LNA (2006)

3.2.1.1 Exploratory drilling

The hydrological report by LNA (2006) presents a history of the exploratory drilling carried out for this project. Before the fieldwork began, requests were sent to the relevant departments for information on mineral rights and protected species (fauna and flora). The drilling sites selected were characterized by the predominance of unconsolidated deposits. A total of four exploratory dill holes were needed to describe the hydrogeological setting in the study area by vertical electrical resistivity sounding. The total depth of each drill hole ranged from 45 to 77 m. Drill holes WD/FE-1-03, WD/FE-2-05 and WD/FE-3-06 are located on lot 11-3 (part), while drill hole WD/FE-4-06 is located on Part lot 11-7 (part). The new backup well (WD/PE-02-07) is also located on this lot. Forest clearing was required in order to allow construction of an access road to the drilling site.

Groundwater prospecting began in 2003 with geophysical surveys and an exploratory drill hole. The results of this initial work revealed a critical concentration of arsenic in the groundwater sampled at exploratory drill hole WD/FE-1-03. An overall characterization of the amount of arsenic in the water in residential wells within approximately a 1-km radius of the first exploratory drill hole was used to determine the potential of the sector (thickness of the overburden and lack of arsenic in certain wells). This was followed by new geophysical surveys and another exploratory drill hole (WD/FE-2-05). At 0.015 mg/L, arsenic was also a problem in this drill hole. Additional work was therefore carried out to find a well that meets the Municipality's needs and future arsenic standards (existing regulations set the arsenic concentration at 25 µg/L, but a tightening of the standard to 10 µg/L is anticipated in the near future). Two additional drill holes (WD/FE-3-06 and WD/FE-4-06) were completed. On the basis of the stratigraphy, it was decided to install a screen in drill hole WD/FE-3-06.

The machine used for the exploratory drilling is a Foremost drill, combining simultaneous rotation and percussion. This drilling method makes it possible to sample overburden in a representative manner. Throughout the exploratory drilling, water samples were collected *in situ* to identify arsenic concentration as a function of depth (6-m intervals between samples, or with each change in lithology). The samples were filtered the same day in the analytical laboratory. Drilling continued until bedrock was encountered. Grain-size analyses of deposits collected from the drill holes were also performed to describe soil stratigraphy. These analyses are used in the selection of the screen to be installed in the well.

Water prospecting and well installation work led to the clearing of a 1.55-ha area, consisting of 0.95 ha of forested land and 0.60 of uncultivated land with shrubs or trees.

3.2.1.2 Main well

Arsenic analyses performed during the drilling work and more comprehensive water analyses on residential wells confirmed the absence of arsenic in the sand and gravel unit to a depth of approximately 60 m. It was therefore decided to continue the water prospecting with a test well (WD/PE-1-06) near drill hole WD/FE-4-06 (on lot 11-7 (part)). The same machinery was used for the test well as for the exploratory drill holes. The diameter of the well is 250 mm down to bedrock, reached at a depth of 66.16 m. The test well screen, made of stainless steel wire, has two types of opening slots: 2 mm by 1.5 m and 4.06 mm by 1.5 m. The screen was installed at the base of the sand and gravel unit. A sealing ring ensures a watertight seal between the tubing and the screen. The well was capped with a high-security cover (LNA 2006).

In order to intersect the same stratigraphy and obtain the same water quality, the test well was drilled 2 m from the fourth exploratory drill hole (WD/FE-4-06), which served as a second piezometer. However, the verticality of the exploratory drill hole had not been checked, and the well intercepted the adjacent drill hole at a depth of 42.6 m. Drill hole WD/FE-2-05 was then used as an alternate reading point.

Well development operations then began and continued for a period of 16.2 hours. The water cleared quickly and by the end was free of particles. Before the start of the long-term pumping test, a partial inventory of residential wells in the vicinity of this well was carried out with the municipal inspector. In all, about a dozen wells were identified. The six residential wells inventoried in the hydrogeological report (LNA, 2006) (Table 2) are representative of accessible wells finished at the same depth in the overburden, and located near well WD/PE-01-

06. No other well inventory is needed before phase-in of the future municipal wells. It is recommended that the residential wells listed in the October 2007 hydrogeological report (LNA, 2007) be monitored to identify fluctuations in the aquifer pumped and assess the impact of the project on users. However, other than those identified in the hydrogeological report, no additional wells are required to assess the impact of the project, which is not expected to be significant.

Table 2
Inventory and Characteristics of the Residential Wells Selected for Monitoring

Well No.	Property Address	Well Type	Distance from PE-1	Depth	Diameter	Water Level	Other
1	1935 Fontaine Road	Overburden	904 m	_	150 mm	Flowing	_
2	2788 Julienne Road	Overburden	582 m	26.8 m	150 mm	0.42 m	Submersible pump
3	1904 Chemin de la Marina	Overburden	460 m	40.8 m	150 mm	0.44 m	Submersible pump
4	1859 Lavertu Road	Overburden	752 m	54.6 m	150 mm	0.91 m	Jet pump
5	1825 Chemin de la Marina	Overburden	518 m	92.3 m	150 mm	3.94 m	Submersible pump
6	1736 Gaudreau Road	Overburden	840 m	7.6 m	150 mm	1.90 m	Jet pump

Table taken from LNA (2006)

The long-term pumping test provides information on transmissivity and the radius of influence of the well, as well as the presence of aquifer boundaries (impermeable or recharge). On the basis of these results, it is possible to project an operational flow for a time horizon of 19 years and to calculate areas to be protected. Aquifer and water quality characteristics are discussed in section 4.2.4 (Hydrogeology and groundwater quality).

3.2.1.3 Choice of backup well

Although the main well (WD/PE-1-06) can meet the water needs of the residents of Weedon Centre, the Municipality of Weedon wants to add a backup well to ensure secure groundwater supply facilities. This second source of production would make it possible to meet the needs of the population if the use of well WD/PE-1-06 had to be suspended for purposes of maintenance, repair, backwashing, etc. The following two options were considered:

Option 1: Construction of a new well approximately 60 m away from test well WD/PE-1-06 in a direction along the axis of the buried valley.

Option 2: Use of exploratory drill hole WD/FE-3-06 as a backup operating well.

The advantages/disadvantages of these options as identified by Laforest NOVA AQUA (LNA, 2006) are listed in Table 3.

Table 3
Advantages and Disadvantages of the Two Backup Well Options

	Option 1 (New backup well)	Option 2 (Drill hole WD/FE-3-06)
Advantages	▪ Would meet maximum daily consumption requirement ▪ Less land to be acquired ▪ Higher overall flow rate than option 2	▪ Less costly than option 1 ▪ Greater distance between wells than option 1, reducing their shared vulnerability
Disadvantages	▪ More costly than option 2 ▪ The two wells would be closer to each other, increasing their shared vulnerability	▪ Would not meet maximum daily consumption requirement ▪ More land to be acquired ▪ Will require additional work in terms of access and other developments to the site
Estimate (excluding taxes and incidental costs)	$167,000.00	$151,000.00

Given the overall advantages and disadvantages and the small cost difference between the two options, the hydrogeologist recommended option 1. However, on the basis of cost and time constraints, the Municipality decided on option 2.

The hydrogeologist worked on the exploratory drill hole (WD/FE-3-06) from June 21 to 22 and July 3 to 4, 2007. The drill hole was drilled by two methods: hydraulic jetting and air injection directly into the screen. The drilling did not proceed properly because of the possible presence of an interbedded aquifer formation that continuously released fine particles into the drill hole, preventing the creation of a natural filter during the development process; hence, it became necessary to turn to the other option, i.e., to establish the backup well near the main well (WD/PE-1-06). A new hole, WD/PE-02-07, was therefore drilled for the backup well, 63 m northeast of the main well (LNA, 2007d). Additional details concerning this new backup well can be found in section 4.2.4.

The diameter of the backup well is 250 mm (10") to the bedrock, reached at a depth of 66.99 m. The bedrock consists of black shist. The drill-hole stratigraphy is presented in Annex I to LNA, 2007c. The water-bearing zone is found in the sand and gravel unit. The permeable deposits, intersected at a depth of 53.64 m, yielded a flow rate of 2,600 L/min (687 USGPM) according to the estimates of the drilling foreman. At 60 m, the flow rate was estimated at between 1,300 L/min (343 USGPM) and 1,500 L/min (396 USGPM), and between 61.87 and 63.40 m, a flow rate of between 1,500 L/min (396 USGPM) and 1,900 L/min (502 USGPM) was estimated (LNA, 2007d).

During the drilling, soil samples were collected, a number of which were chosen for grain-size analyses. The depth of the samples selected is indicated in the stratigraphic description, and the results of the grain-size analyses are presented in Annex II to LNA, 2007d. Grain-size analyses are used to characterize in-situ soil and to determine the specifications for the well screen to be installed in the well. The screen design is based on the D50 diameter of the soil samples analyzed. The screen is 6.09 m long, and the uppermost 1.52 m is without openings.

It is made of 304 SS (stainless steel) wire and has 3.30 mm (0.130") openings in the lowermost 4.57 m. The screen is installed between 51.90 m and 58 m below the surface, and the openings are located in the depth interval between 53.40 m and 58 m. A sealing ring creates a watertight seal between the tubing and the screen (LNA 2007d).

Once the screen was in place, development operations began. In all, 36.5 hours of development were completed. The screen was developed by downhole air jetting, stopping and starting at successive intervals (LNA, 2007d). As part of the construction of backup well WD/PE-02-07, only a step-drawdown test was carried out to verify the performance of the pumping apparatus. The characteristics of the aquifer, normally determined through a long-term pumping test, were identified at the time of construction of well WD/PE-01-06, located near WD/PE-02-07, in the same sand and gravel aquifer. The results of the step-drawdown test are presented in section 4.2.4.

3.2.1.4 Well protection areas

The immediate protection area is located within a 30-m radius around the drinking water supply well. A secure fence at least 1.8 m high must be installed around the edges of this area of protection. A sign indicating the presence of a groundwater source that supplies drinking water for human consumption must be posted at the site. Within the immediate protection area, any activities, facilities or storage of materials or objects that could contaminate the groundwater are prohibited, with the exception, once safely installed, of the equipment required to operate the intake structure. Within the protection area, the ground surface must be graded in such a way as to prevent surface water runoff toward the wells (LNA, 2006).

Adjacent protection areas (bacteriological and viral) lie within the theoretical distance that water would travel to reach the intake structure in a sufficient length of time to allow bacterial or viral contamination to be resolved. The migration time was set at 200 days for the bacteriological protection area, and 550 days for the virological protection area. Calculations for a new catchment area and new protection areas were completed on the basis of the pumping tests and surveying work necessitated by the construction of a new backup well. All the protection areas identified apply to the main well (WD/PE-01-06) and the backup well (WD/PE-02-07), which are 63 m apart (Figure 2) and seem to tap the same aquifer (Annex J). The new protection areas are substantially different from those initially calculated, with the radius for the bacteriological protection area increasing from 173 m to 200 m, and the radius for the virological protection area from 312 m to 387 m. Activities and uses in these areas are summarized in Table 4.

Surface water that drains agricultural land upstream collects in a drainage ditch and is directed toward the road ditch across the Fontabel farm lots (Figure 2). According to LNA (2006), it is possible to extrapolate from the soil stratigraphy to conclude that these ditches are impermeable.

The recharge zone is probably protected by the presence of a clay layer of variable thickness that appears to underlie the recharge zone and by the depth of the aquifer being used (vertical transfer time not included in the 200 and 550 days). Only the protection areas will be subject to restrictions on activities as stipulated by the *Groundwater catchment regulation* (RCES).

Table 4
Landowners Affected by the Protection Areas

	Landowner	Lot No.	Use
Municipality of Weedon	Fontabel Farm	12W	Woodland
	Fontabel Farm	11-7 (part)	Woodland (2/3) and farmland (1/3)
	Fontabel Farm	11-8 (part)	Woodland
	Fontabel Farm	11-4	Farmland (2/3) and woodland (1/3)
	Gérard Gaudreau	11-3 (part)	Woodland

Table taken from LNA (2006)

Most of the lots included in the protection areas are part of the Fontabel Farm. The owner has been growing cereal crops for a few years following the recent purchase and restoration of abandoned farmland. Only a small part of the farm's land is affected by the bacteriological protection area.

The *Groundwater catchment regulation* (RCES) prohibits the spreading of animal waste, farm compost or fertilizing substances within a bacteriological protection area assessed as vulnerable according to the DRASTIC index (greater than 100). On the basis of the 1987 DRASTIC index, no restrictions will be imposed on the southeast edge of the farmland on lot 11-4. As a preventive measure, LNA suggests that the landowners affected by the protection areas be invited to a meeting at which the situation could be explained to them. This approach is currently used in the United States in the context of a "source protection plan."

3.2.2 Pipe

Two options (A and B) were initially considered for the route for the pipe connecting the main well to the reservoir. Modifications were then made in route B. Figure 2 illustrates route A and the modified route B.

Option A is the most direct route for the pipe between the well and the reservoir site and requires little forest clearing. This route connects the main well and the backup well, continues along the lot line between lots 11.4 and 11-7 (part) and then along the southwest edges of lots 11M (part), 110 and 11T to Route 112 (length of the pipe: 2.37 km). However, there is a significant problem associated with this route, according to the owner of lots 11-4 and 11-7 (part) (Fontabel Farm), because it takes the pipe across the centre of the field on these lots. Because the overburden in the area is 50 to 70 m thick, the owner of the lots fears irreversible compaction at depth will have a permanent impact on the drainage of the field in question, despite surface rehabilitation work.

The initial route B for the pipe went around the field in question on the northeast along the edge of a woodlot (lot 12W (part)). From there, the route followed a Hydro-Québec easement from the northeast side to Route 112. This means that the pipe would cross lots 12X and 1 (part), the railway easement (Quebec Central) and lot 11T (part) (length of the pipe: 2.36 km). However, the final route B was slightly different. The modification was only prompted by a specific request made by the current owner of lot 11T (part) during negotiations for the acquisition of easements. In an agreement reached with this landowner, the final part of the route was changed. The landowner wanted the easement to run parallel to his lot line from the area currently under cultivation, rather than

parallel to the existing Hydro-Québec easement. Hence, the final route will branch off where it exits the woodlot toward a line parallel to the common lot line with lot 1 (part), ending at Route 112. No additional technical or environmental impact is anticipated as a result of this modification.

The portion of the pipe connecting the treatment plant and the reservoir to the existing water reservoir will pass to the south of Route 112 (lot 11T (part)).

It was estimated that route A would result in the clearing of approximately 0.56 ha, 0.3 ha of which is forested, and 0.26 ha of which is uncultivated land with shrubs or trees. It should be noted that distances and surface areas are approximate, particularly in the case of route A, because rights-of-way were never accurately determined. In the case of route B, the area to be cleared was estimated at approximately 1.63 ha, of which 1.19 ha is forested, and 0.44 ha is uncultivated land with shrubs or trees. In both cases, the areas where clearing would take place are largely peri-agricultural ecotone areas (transition zones) on the edge of forest stands ranging in age from 10 to 50 years. It should be noted that areas of shrub vegetation were included in the calculations of areas to be cleared and that the value of the wood in such areas is minimal.

An intermittent stream is also crossed in one location by route A and in two locations by route B. The northern branch of the stream, which is affected by the proposed work (route B), was excavated to divert it from its original bed toward the drainage ditch that follows the northeastern edge of lot 11T (part). A very small portion of the water from the stream percolates toward the original bed, which was also deeply excavated and serves as a drainage ditch for the fields that it crosses. The stream returns to a more natural bed south of the railway in the centre of the study area (see the Photographic Report in Appendix A).

However, only the temporary right-of-way for route B goes through a population of a species that is vulnerable in Quebec (horticultural value). With regard to the ecological impact of route B on the two rare plant species present in the fir-alder grove located southeast of 4th Rang Road, the current situation is clearly described in sections 4.3.2 and 4.3.1 of this report. All the advantages and disadvantages of the two routes are presented in Table 5.

Table 5
Advantages and Disadvantages of the Two Options for the Proposed Pipe

	Option A (2.37 km of pipe)	Option B (2.48 km of pipe)
Advantages	• Most direct route. • Smaller area cleared (0.56 ha, of which 0.3 ha is woodland and 0.26 ha is uncultivated land with bushes or trees). • Does not affect any known threatened or vulnerable plant species.	• Less expensive than option A. • Crosses a smaller area of cropland • Affects deep drainage of a smaller area of cropland. • Farther away from the two single-family homes southwest of the study area.
Disadvantages	• More expensive than option B. • Crosses a larger area of cropland. • Likely to cause more or less permanent harm to deep drainage under cropland. • Crosses a stream (one location). • Crosses at least two known wetlands, one of which has a hydraulic connection (1 and 5). • Runs beside two single-family homes.	• Larger area of land to be cleared (1.63 ha, of which 1.19 ha is woodland and 0.44 ha is uncultivated land with bushes or trees). • Presence of a vulnerable species in the temporary worksite right-of-way, and two other vulnerable species populations near the right-of-way. • Crosses a stream (two locations). • Crosses two wetlands (3 and 5) and runs beside two other wetlands (2 and 4) that have no hydraulic connection.
Estimated cost (excluding taxes incidental costs)	$719,600.00(1)	$685,300.00(2)

(1) Estimate based on the route proposed from an orthophoto (less accurate).
(2) Estimate based on the topographical map of the site.

Given all the environmental, human and economic aspects, route B was considered the preferred route.

3.2.3 Reservoir

The October 2006 study entitled "Plan directeur des conduites d'eau potable élaboré par balancement hydraulique pour le secteur Weedon-Centre" [master plan for water mains based on hydraulic balancing in the Weedon Centre area] made it possible to set preferred targets for a drinking water reservoir and to validate the technical aspects of the work. The site chosen for the reservoir is located on lot 11C (part). The groundwater production well planned to supply the residents of Weedon Centre with drinking water was designed to withdraw the equivalent of the maximum daily consumption by the population, but not to distribute the hourly peak or the desired 1,000 USGPM for fire-fighting purposes. Hence a drinking water reservoir is essential for distribution of these flows. In the context of the current project, the well is intended only to supply the drinking water reservoir, and water is only to be distributed to the water supply system from the reservoir.

Reservoir volume is normally established by adding the operating reserve and the fire reserve, in cases where the system is used for fire protection. The operating reserve is used to meet hourly flow variations in the distribution system and to respond to specific events, such as broken water mains, a broken pump or treatment plant failure. When the reservoir is supplied on a continuous basis (24 hours a day), the operating reserve must be the equivalent of 12 to 24 hours of average daily consumption (typically between 14 and 20 hours of average daily

consumption). In the case of Weedon Centre, a 14-hour operating reserve was chosen, which represents a volume of 632 m³.

The fire flow for a building depends on the building floor space, type of construction, use, neighbourhood and protection systems. In general, the water supply to systems used to provide fire protection should be established in accordance with the technical rules specified in *Water Supply for a Public Fire Protection, a Guide to Recommended Practice, 1999*, of the Fire Underwriters Survey of the Insurers Advisory Organization. Calculations for a fire flow and a dedicated fire reserve were made in a previous study (Teknika HBA, 2004), which estimated the dedicated fire reserve within the reservoir at 525 m³ for the specific case of the Weedon residential and long-term care centre.

Finally, a dedicated water disinfection reserve will be set aside within the drinking water reservoir in order to ensure the regulatory inactivation of 4 log (99.99%) of viruses.

The drinking water reservoir will have a capacity equal to the sum of the operating reserve, fire reserve and dedicated reserve, or 1,290 m³ (632 m³ + 525 m³ + 133 m³), which can be rounded to 1,300 m³. To facilitate its maintenance, the reservoir will be divided into two compartments that can be isolated in such a way that half the reservoir can be cleaned while the other half is in operation. The reservoir design will also include a series of baffles (walls that improve the circulation of drinking water inside the reservoir). Finally, it should be noted that the reservoir volume remains the same regardless of the treatment method recommended for the removal of manganese.

3.2.4 Infrastructure construction

3.2.4.1 Main and backup wells

At this stage, the plan is to reuse the existing access road as an access road to the new well. A 15-m-wide right-of-way is also suggested for the entire length of the access road (approximately 350 m).

Start-up of the main well (WD/PE-1-06) and the backup well (WD/PE-2-07) requires the following work:

- Installation of the pump in each well, including the column pipe, piezometric probe and accessories.
- Installation of the wellheads.
- Installation of the pipes between the wells and the planned service building.
- Construction of a small service building (preliminary dimensions: 5 m x 5 m) for supplying electricity to the equipment, including installation of two meters and monitoriong and safety equipment (e.g., two flow-control valves, a release valve, an air valve, etc.).
- Provision of the accessories required for connecting a chlorine-metering pump (for maintenance operations only).
- Electrical work, including bringing the electrical power line to the well and connecting it.
- Work related to instrumentation and control functions for starting/stoping pumps according to reservoir water level.
- Road repairs to make the road useable.

- Installation of a 1.8-m safety fence around the immediate protection area of the two wells.
- Installation of the facilities necessary to allow connection of a portable generator, if required.
- Placement of a sign identifying the drinking water catchment area.
- Installation of a septic tank and a relatively small leaching bed to handle the grey water from the building sink and drain. The leaching bed must be installed more than 30 m from the well.
- Excavation to ensure adequate drainage of runoff.
- Acquisition of the land required for the works.

3.2.4.2 Hook-up of the new well

The pipe route chosen in the context of this impact study is a modified version of option B (Figure 2). The pipe leading to the drinking water reservoir will be approximately 2,469 m in length. A second section of the pipe leaves the reservoir and connects to the existing water supply system at Biron Street (length: 525 m). In total, the pipe that follows route B should be 2,994 m in length. Several properties are crossed by this pipe (Figure 2). At this stage, a permanent 8-m easement is to be acquired for the pipe. During the construction work, it is suggested that a temporary easement of an additional 6 m be obtained (for a total of 14 m during the work).

The following work is required to hook up the wells:

- Installation of a 200 mm ø (8-in) PVC pipe over a distance of approximately 2.3 km.
- Installation of purge devices for cleaning the transmission line (3 posts planned).
- Railway track crossing.
- Intermittent stream crossing.

3.2.4.3 Work involved in construction of the reservoir

At this stage, acquisition of a property approximately 38 m by 42 m beside Route 112 is planned for the drinking water reservoir. The following work will be necessary if the reservoir is built at this location:

- Construction of an underground concrete reservoir with sufficient storage capacity for the drinking water volumes required.
- Construction of a storage tank for dirty water to adjust its release to the sewer.
- Construction of a service building for the drinking water treatment equipment and booster pumps.
- Water treatment equipment (manganese removal and chlorination).
- Connection of the reservoir to the Centre area drinking water system via a 250 mm diameter pipe, including service lines (if required).
- Sewer hookup for wash water to the sanitary sewer system, including service lines (if required).
- Installation of booster pumps (2 supply pumps + one fire pump) for supplying the network of water mains.

- The electrical work, including connection of the electrical and telephone line for the existing building, as well as a generator.
- Work related to instrumentation and control functions, including field instruments, programmable controller, etc.
- Installation of an access road with turning area.
- Installation of a heating and ventilation system in the building.
- Installation of a plumbing system with toilets, sink, emergency shower, etc.
- Excavation work for adequate drainage of runoff and excavation of the ditches required.
- Installation of a pressure maintenance valve upstream of the reservoir to maintain a minimum pressure of 20 psi in the fill line.
- Installation of a safety fence for the drinking water treatment facilities.
- Placement of signs in compliance with regulations.
- Acquisition of the properties required for the works.

3.2.4.4 Decommissioning of the water supply line from Fer-à-Cheval Lake and of the chlorination station

The existing water supply line from Fer-à-Cheval Lake should be disconnected from the distribution system as soon as the groundwater supply system is commissioned in order to avoid any possibility of contamination. Chlorination in the existing building will also be stopped.

At the present time, two users are connected to this line: the chlorination station belonging to the Municipality of Weedon, and a resident living near the chlorination station. The approximate distance between each of these users and the main Weedon system is over 500 m. This large distance, combined with the low flow in the 250 mm and 150 mm-diameter pipes supplying the users could promote the proliferation of total coliform and/or atypical bacteria in the water supply system. To avoid such problems, consideration was given to removing these two users from the system and digging individual wells to supply them with drinking water, or installing a flushing system at the end of the 150 mm-diameter system. After discussions with the owners in question, it was decided to take the existing line out of service and connect the two owners to the new water supply system with a 150-mm line.

Finally, all drinking water treatment equipment at the chlorination station will be dismantled once the new facilities are operational. However, the Municipality of Weedon will retain the building for a use unrelated to drinking water production.

3.2.5 Operation of the well and production of drinking water

On the basis of the various analyses, the hydrogeologist recommends a maximum operational flow of 1,337 L/min (353 USGPM) for the main and backup wells. With respect to estimated future consumption, the operational flow

matches daily average consumption until at least 2035, but does not accommodate maximum daily consumption after about 2013, hence the need for a reservoir and backup well to supplement the the flow in the main well.

The physico-chemical quality of the groundwater is generally very good. No health-related parameter exceeds the standards of the new drinking water quality regulation (see section 4.2.4). Only one aesthetic parameter, manganese, exceeds the Health Canada standard. The results of analyses of water from wells WD/PE-1-06 and WD/PE-02-07 revealed the presence of dissolved manganese at concentrations ranging from 0.38 to 0.42 mg/L in the main well and from 0.47 to 0.51 mg/L in the backup well. The maximum concentration recommended by Health Canada is 0.05 mg/L. Note that this is an aesthetic parameter and poses no hazard to the health of users, but it can cause stains on clothing, plumbing equipment and fittings when it oxidizes (e.g., with bleach). Major aesthetic and maintenance problems would therefore quickly arise with disinfection of the water in the Weedon Centre area because the disinfectant used would oxidize the dissolved manganese.

On the basis of the quality of the water analyzed during the long-term pumping tests, the drinking water must be treated to remove manganese before it is distributed. Because of the age of the distribution system and the occasional presence of total coliform bacteria in certain places, a state-of-the-art chlorination system will be used to be on the safe side, although it is not mandatory given the low DRASTIC index of the well.

To significantly reduce the problems associated with the presence of manganese in groundwater, we have used two types of treatment systems for manganese removal: biological filtration and greensand oxidation.

3.2.5.1 Removal of manganese by biological filtration

This technique uses biological filtration to assist natural bacteria in oxidizing manganese or iron particles. When both manganese and iron are present in water, two filters are required: a first to remove the iron, followed by a second to remove the manganese. In the specific case of Weedon Centre, only manganese is a problem, requiring only a single filter for removal (Degrémont Ltd.'s Mangazur process). Filtration equipment is mounted on a skid with the following overall dimensions: length 2.74 m, width 3.66 m and height 3.96 m. It comprises the following:

- A vertical pressure filter measuring 3.048 m in diameter by 2.34 m in height for an operating pressure of 100 lb/ft^2
- Internal filter components, nozzles, subfloor and Biolite media
- A Reoxazur installed on the filter inlet to oxygenate the raw water
- Front piping and butterfly on-off valves equipped with pneumatic actuators
- Wash-water control valve, with two flow rates

Beside the skid, the following equipment is supplied:

- A scour-air booster
- A duplex air compressor to provide process air and instrument air c/w a horizontal storage tank, the active charcoal and coalescing pre-filters, air dryer and switching panel
- Process instruments include the following:

- an oxygen analyzer
- a magnetic raw water flow meter
- a differential pressure transmitter
- a series of pressure indicators
- a control panel equipped with a PLC controller and operator interface

The Mangazur is designed for stop-start operation without flow rate modulation. The filter can be backwashed with raw water. The above unit has a design flow rate of 90.8 m^3/h and an average flow rate of 80 m^3/h. At the design flow rate, the filtration rate is 25 m/h. The total filtration surface area is 3.6 m^2. Required wash water flow rates are 29 m^3/h at 8 m/h and 72 m^3/h at 20 m/h for about thirty minutes, once a week, at most (Teknika HBA, 2007). However, in time, a problem could arise in connection with the possible increase of arsenic in water from the main well. Theoretically, this technique eliminates arsenic, but the supplier is unable to provide the necessary documentation on the subject.

3.2.5.2 Removal of manganese by greensand oxidation

Greensand filtration technology is effective for the simultaneous removal of iron and manganese at concentrations of up to 10 mg/L for iron and 5 mg/L for manganese, which far exceed those observed in water from the main well.

The oxidant most commonly used is potassium permanganate ($KMnO_4$), a powerful and effective oxidant, although in certain situations, chlorine, ozone, chlorine dioxide and hydrogen peroxide can be used. In this process, iron and manganese are oxidized by sodium hypochlorite and potassium permanganate, which form precipitates. The precipitates are removed by filtration through greensand, which is used as the filter medium.

In the context of this study, in order to achieve a reduction that complies with Health Canada requirements for this aesthetic parameter, we considered a greensand filtration system with continuous regeneration of potassium permanganate for manganese reduction. Oxidation-filtration treatment will prevent the problem of rust and/or grey/black coloration of the drinking water as a result of oxidation. Use of excess quantities of permanganate must be avoided because the surplus reactant can cause the water in the supply system to take on a pink colour when the residual concentration exceeds 0.05 mg/L. At this stage, the treatment system for a flow rate of 1,520 L/min (400 USGPM) comprises the following:

- Duplex greensand filter, model FSV 9672 ADPD, comprising:
  - 2 steel tanks (2.44 m ø x 1.83 m in height) containing the filtration media
  - valves, pipes and accessories
  - control panel with programmable controller
- A unit for injection of sodium hypochlorite (oxidation)
- A unit for injection of potassium permanganate
- Two static mixers
- A colour monitor
- A water softener
- An air compressor

The system occupies approximately 8 m by 3.3 m of floor space and will perform a backwash and a rinse as follows:

- Backwash rate: 136 m³/h (602 USGPM)
- Duration of backwash: 10 minutes
- Wash rate: 45.5 m³/h (200 USGPM)
- Duration of wash: 5 minutes
- Volume of water per wash: 26.6 m³ (7,020 US gal)
- Theoretical wash frequency: 1 filter per day

3.2.5.3 Arsenic level

As noted above, arsenic levels at the screen in water from well WD/PE-1-06 are below the 5-µg/L threshold we have set. However, according to the hydrogeologist's report, higher concentrations have been found at higher levels, in water from below the clay level. In other words, no barrier exists between this zone and the pumping zone. It should be noted that the arsenic results were obtained from three samples collected during the 72-hour pumping test. After a number of months of pumping, it is possible that the zone of influence could expand to capture water from the higher level, thereby raising arsenic levels. Once the well is in operation, it will be very important to monitor this parameter specifically.

In case arsenic treatment is required in the future, it would be advisable to consider the impact of such treatment on both technologies. Arsenic is removed by a method involving precipitation or by adsorption on a specific ion exchange resin. Precipitation is fastest with iron oxides. When iron levels in the water are low (as in the case of well WD/PE-1-06), iron sulphate must be added. Therefore, if greensand technology is used, total removal of the arsenic could be achieved by simply adding a ferric sulphate injection system before the filters (20:1 ratio). If the Mangazur process is chosen, the same approach could probably be used, with caution, but would require more frequent washings. Moreover, use of this technology to remove arsenic is not frequently documented in the literature, and its effectiveness in this regard has not been demonstrated at any Quebec facility. However, according to the equipment supplier, a number of U.S. facilities are treating for arsenic with the Mangazur process. Degrémont Ltd., which distributes the equipment, is to provide additional data on this in the near future. At this stage, although less well documented than the greensand filter, this alternative is not being ruled out. However, before a choice is made, it must be scrutinized carefully from the point of view of the treatment of arsenic.

3.2.5.4 Preliminary cost estimate for manganese removal

For this report, we have prepared two preliminary cost estimates for the following options:

Option 1: Completion of the proposed work with manganese removal by means of greensand filters.

Option 2: Completion of the proposed work with manganese removal by biofilters.

It is important to point out that treatment systems designed to remove manganese are installed only to remove this element, which is of concern for aesthetic reasons. The presence of manganese at the concentrations currently

observed in the Weedon Centre area will cause significant problems of an aesthetic nature, and the parameter must be treated on the basis of its concentration, which exceeds the concentration recommended by Health Canada by a factor of approximately eight. Finally, we have compiled the costs associated with construction of the backup well for each option. Table 6 presents a summary of the preliminary cost estimates for the work.

Table 6
Preliminary Cost Estimates for Each Option(1)

	Option 1 With Greensand Filters	Option 2 With Biofilters
Preliminary estimate	$3,231,550.00	$3,349,150.00
Contingencies (10 %)	$323,155.00	$334,915.00
Sub-total (before taxes)	$3,554,705.00	$3,684,065.00
GST (6%)	$213,282.30	$221,043.90
Sub-total	$3,767,987.30	$3,905,108.90
QST (7.5%)	$282,599.05	$292,883.17
TOTAL (rounded)	$4,051,000.00	$4,198,000.00

(1) Excluding incidental costs

3.2.5.5 Advantages and disadvantages of the processes

Mangazur (biofiltration)

- Advantages
  - Recognized and approved technology
  - No chemicals added
  - Could precipitate and retain arsenic without the need for additional costly equipment
  - Limited size
  - Competitive price
  - Very low operating costs

- Disadvantages
    - Relatively lengthy start-up
    - Little information on its capacity to eliminate arsenic

Greensand (oxidation and filtration with greensand)

- Advantages
    - Recognized and approved technology
    - Precipitates arsenic without the need for additional costly equipment
    - Lowest price
- Disadvantages
    - At least two chemicals must be added
    - Higher operating costs
    - Bulkier in size

Oxidation and filtration with greensand is the option selection for treatment of groundwater in the Weedon Centre area.

3.2.5.6 Disinfection of the water

As mentioned above, the Municipality of Weedon wishes to disinfect drinking water with sodium hypochlorite because of the age of the distribution system. The sodium hypochlorite dosing system would be installed in the service building near the reservoir. The size of the chlorination equipment has not yet been assessed. However, the following equipment will be required for water disinfection in Weedon Centre:

- A softener for preparation of solutions
- Two metering pumps on a mounting base, including safety valve, back-pressure valve and related accessories
- An injection lance
- A solution preparation tank
- A solution storage tank
- A manual mixer
- A spill tank
- Related pipes, valves and accessories
- A chlorine, pH and temperature analyzer

Once a chlorination facility is installed, 4-log virus removal will be required before the first consumer (Teknika HBA, 2007).

3.2.6 Site restoration work

Clean-up and restoration of the site will be carried out in accordance with article 7.11 of the 2007 edition of the *Cahier des charges et devis généraux pour les infrastructures routières* (MTQ, 2007), which states the following:

"[translation] On completion of the work, the contractor must remove its own equipment from the right-of-way together with any unused materials, waste and refuse, cobbles and broken stone, and debris consisting of wood, stumps or roots; clean any sites where materials and equipment have been located; restore any ditches and streams that it has obstructed; repair or rebuild any fences and other necessary structures that it has demolished or damaged and dispose of all materials without damaging the worksite area or related structures. Finally, it must repair any other damage or injury that it has caused to public or private property on the worksite that has been affected by its work, to water bodies, campsites, equipment storage sites, storage compounds or supply sites, the environment, forested land or farmland."

3.2.7 Well abandonment

At the end of their operating lives, the municipal and backup wells will be plugged in accordance with the *Guide technique de captage des eaux souterraines et traitement des eaux usées des résidences isolées*, published by the Quebec Department of Sustainable Development, Environment and Parks (2005).

3.3 Schedule

Construction of the wells and the reservoir is scheduled to take place between early September 2007 and mid-March 2008. Construction of the pipe between the well and the reservoir is planned to take place from mid-October 2007 to the end of January 2008. The planned project schedule is as follows:

- ✓ Plans and specifications for the well, reservoir and pipe: .....Spring 2008
- ✓ Start of work: .....Early August 2008
- ✓ Operation:.....Late March 2009

Work will normally be carried out from Monday to Friday, between the hours of 7:00 a.m. and 7:00 p.m.

4. SITE DESCRIPTION

4.1 Site history

Aerial photographs available for the period from 1949 to 1998 were consulted to compile a land-use history for the study site. Table 7 summarizes the main points and observations that can be obtained from this photographic record.

Table 7
Site Use History from 1949 to 1998

Year	Number and Scale	Observations
1949	A9371-96 to 98 1: 20,000	Wells: The study area is wooded and there is a bog on the far west side. The area around the wells seems to be occupied by what may be wetlands. A boundary ditch runs north-south across the wooded area. Pipe: On both sides of 4th Rang Road, the land is being used for agricultural purposes. There are two farms on the land. The existing railway is present. The Hydro-Québec substation and the power line that leads to Route 112 to the north are missing. A permanent stream crosses the study area in the field south of Route 12, forming a small wetland in the middle of the slope. A small sandpit is located just to the north of this wetland. Reservoir: The area is agricultural. There is a farm on the lot where the reservoir is to be installed.
1955	1195-99 to 101, 1195-58 and 59 1: 15,840	Wells: No observable change since 1949, except the bog and the possible wetland areas are more wooded. Pipe: The electrical substation and power line running from 4th Rang Road to Route 112 can be seen. The small sandpit is being operated on a larger scale. Reservoir: No observable change since 1949.
1966	Q66349-62 and 63 1: 15,840	Wells: No observable change since 1955, except the bog is more wooded. Pipe: No observable change since 1955, except the small wetland south of Route 112 is being drained for agricultural use. Reservoir: No observable change since 1949.
1976	Q76344-141 and 142, Q76344-36 to 38 1: 10,000	Wells: No observable change since 1955, except the bog is more wooded (mature conifer forest); the perimeter is unchanged, but consists increasingly of forested peatland. Pipe: The stream that feeds the bog is visible in the field north of the bog. Crops are no longer being grown in the eastern and western parts of the wetland south of Route 112. Reservoir: No observable change since 1949, except there are more homes between the farm and Weedon Centre. There appears to be a sand bank on the site where the reservoir is to be constructed.

Year	Number and Scale	Observations
1980	Q80517-79 and 80 1: 15,000	Wells: The bog is more wooded. The forested area northwest of the wells has been cut. Pipe: No observable change since 1976, although crops are no longer being grown in the small wetland area south of Route 112. Reservoir: No observable change since 1976, other than expansion of the municipality.
1988	Q88117-54 to 56 1: 15,000	Wells: The area northwest of the wells is reverting to forest, but another forested area to the east of the wells is being cleared. The bog is largely forested. Pipe: The lot to the west of the wetland south of Route 112 has been planted. The sandpit is gone. The crops south of the railway and east of the farm located on the north side of 4th Rang Road have been abandoned. The field north of the wells is uncultivated. Reservoir: No observable change since 1980, although what was presumed to be a sand bank has disappeared.
1993	HMQ93126-235 to 237 1: 15,000	Wells: The bog is almost entirely wooded and the area to the east of the wells is regenerating. Pipe: No observable change since 1988, except uncultivated areas on the north side of 4th Rang Road, east of the farm, are larger. Reservoir: No observable change since 1988.
1998	HMQ98117-54 to 56 1: 15,000	Wells: Trees in the area north of the wells have been cleared as far as the bog. Pipe: No observable change since 1993, except crops are once again being grown in the field north of the wells, and the uncultivated land north of 4th Rang Road is more wooded. Reservoir: No observable change since 1988.

4.2 Physical environment

4.2.1 *Physiography*

The Weedon area is located in the St. Lawrence Platform and Appalachians area of Quebec. More specifically, the study region is part of the Appalachian Orogen physiographic unit. It corresponds to the Sherbrooke regional landscape unit, where rolling terrain is formed by the gently sloping hills that are characteristic of the Appalachians (average slope of 6%). The average elevation of the unit is 266 m, but in the Weedon area, elevations reach 300 to 400 m (Robitaille et Saucier, 1998). The elevation of the study area ranges from 255 m in the vicinity of the wells to 305 m at the reservoir. A 50-m drop in elevation is observed from one side of the study area to the other, which represents a distance of about 2.45 km.

Each year, approximately 450 earthquakes occur in eastern Canada. Of this number, perhaps four will exceed magnitude 4. A magnitude 5 event is generally the threshold of damage. The causes of earthquakes in eastern Canada are not well understood. Unlike plate boundary regions, where the rate and size of seismic activity are directly correlated with plate interaction, eastern Canada is part of the stable interior of the North American Plate. Seismic activity in areas like these seems to be related to the regional stress fields. Although earthquakes can occur throughout most of eastern Canada, years of instrumental recordings have identified certain clusters of earthquake activity: Northeastern Ontario, the Southern Great Lakes, West Quebec, Charlevoix-Kamouraska, the

Lower St. Lawrence, the Northern Appalachians, and the Laurentian Slope. In these clusters, earthquakes occur at depths varying from surface to 30 km. The Estrie region, and more specifically the area around the Municipality of Weedon, is characterized by low seismic activity and is not associated with any of the seven earthquake zones of eastern Canada (Ressources naturelles Canada, 2006). In addition, the unconsolidated nature of the aquifer formation means that it is relatively unaffected by the mechanical impact of seismic activity.

4.2.2 Geology and geomorphology

The study region is underlain primarily by glacial deposits (undifferentiated till, greater than a metre in thickness). These deposits consist of a variety of sediments (clay to sand) and constituents of all sizes (blocks, cobbles, stones). Codominant glacial deposits consist of thin undifferentiated till (0.25 to 1 m).

Analysis of the sections produced for the preliminary hydrogeological study (LNA, 2007c) shows that in the case of wells 17 and 30 on the east side of the river, bedrock is 5 m from the surface. Wells 16 and 26 are also finished in bedrock, with only 1 m of overburden, as is well 14, with only 2 m of surficial clay. A description of the stratigraphy of the wells can be found in LNA, 2006. LNA produced a cross-section based on drilling data, wells in the SIH (Quebec's hydrogeological information system), the map of Quaternary deposits and the topographic map. Section A- A' shows that the sand and gravel unit tapped by well WD/PE-01-06 and by the backup well (WD/PE-02-07) is enclosed in bedrock. The map seems to indicate that these deposits were laid down in the former channel of the St-François River or the Rivière aux Saumons. The depositional facies of the former drainage channel are reflected in the heterogeneity of the granular deposits in the area. The cross-section extrapolates only between the facies encountered, resulting in a certain amount of uncertainty in the interpretation between facies.

According to the stratigraphy revealed by the exploratory drilling carried out by LNA (2006), there is a 5 to 7-m surface layer of relatively impermeable gravelly and sandy clay in the area of the wells. This layer is underlain by a gravel and sand unit, itself underlain by another clay layer at depths between 17 and 22 m. This clay layer tends to become increasingly compacted and impermeable. Another layer of sand and gravel follows at depths between 43 and 47 m, and it is in this layer that water is encountered. The underlying bedrock is approximately 77 m below the surface and consists of black schist.

Essentially the same stratigraphy is reflected by the drilling data for the new backup well, which reveal the presence of a compacted clay layer between depths of 25.9 and 45.2 m. Below this clay layer, the stratigraphy alternates between layers of sand and gravel with relatively significant amounts of clay and silt. In the backup well, the aquifer zone is found in the sand and gravel below the clay unit.

4.2.3 Hydrography

The hydrographic network in the Sherbrooke regional landscape unit has a dendritic structure. It is dominated by the Saint-François River, which runs from east to west across the landscape unit toward the St. Lawrence River (Robitaille et Saucier, 1998). The Saint-François River watershed, part of which is located in the United States (14%), covers a total area of 10,230 km^2 (MDDEP, 1995). Numerous water bodies lie between the hills in the southern part of this landscape unit.

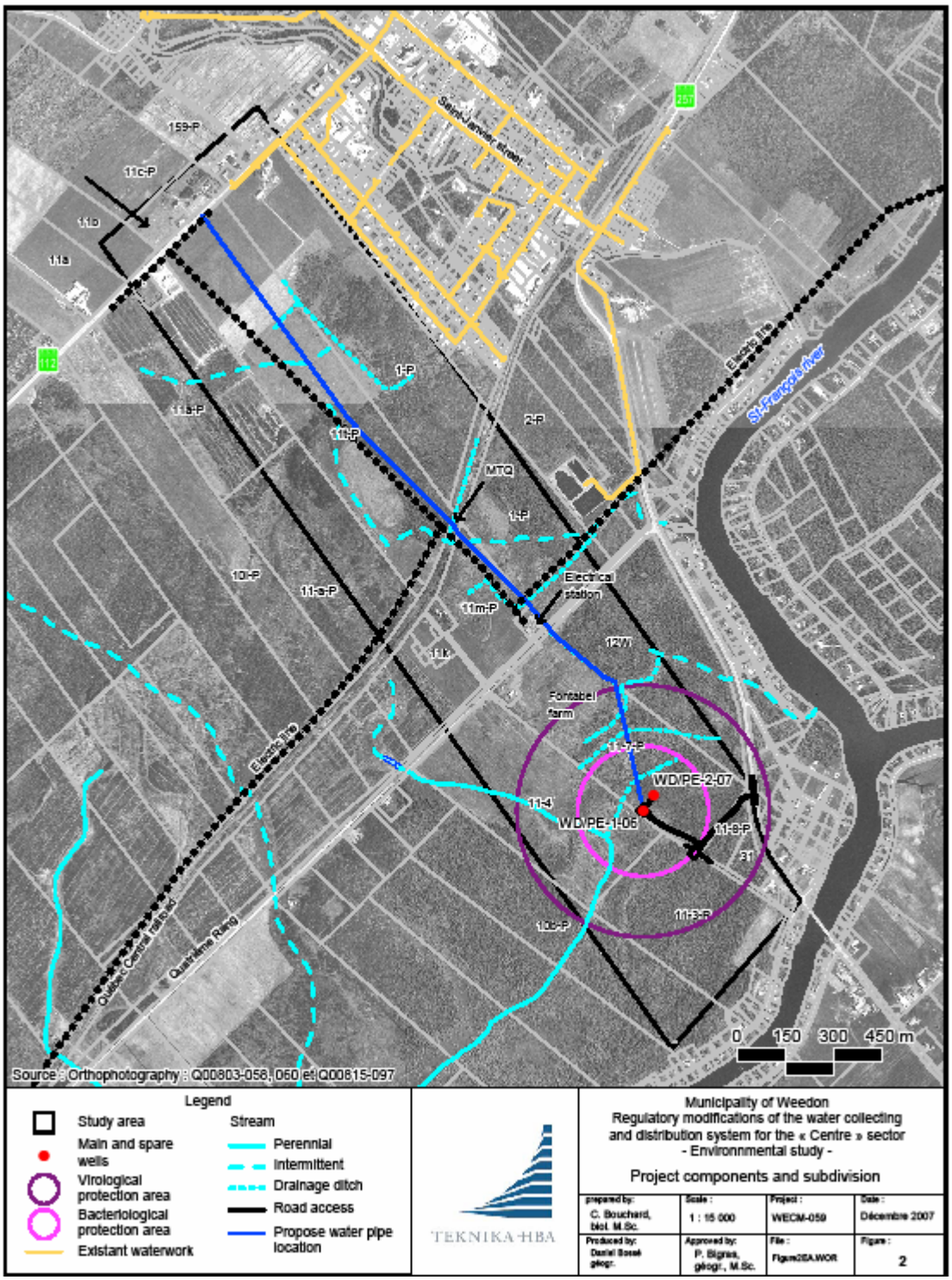
The study region is located near two lakes (Fer-à-Cheval and Vaseux) and a river (Saint-François). Vaseux Lake marks the region's northern boundary, while Lac Fer-à-cheval is located approximately 1.4 km northwest of its northern edge. The Saint-François River forms the southwest boundary and is located approximately 600 m southeast of the main and backup wells.

Parts of six streams (four intermittent and two permanent) cross the study region (Figure 1). Only two of the streams cross the study area per se: a permanent stream that feeds a small fen approximately 100 m west of the main well (not affected by the work), and a second, intermittent stream that runs from west to east across the portion of the study area between Route 112 and 4th Rang Road and then continues toward the southeast, skirts the agricultural grassland toward the southeast (Figure 1). This second stream will be crossed by the pipe in two locations: immediately southeast of the railway, and slightly further north, in the lower third of the field located on lot 11T (part) (new arm of the stream dug to divert it toward the east). The route of the new arm is shown in figures 2 and 3. It should be noted that because of the presence of a natural stream crossed in two locations by the pipe (route B), the project is subject to section 22 of the *Environment Quality Act* since work must be carried out in the stream. An application for a certificate of authorization for work to be carried out in a watercourse was submitted on February 26, 2008. A number of drainage ditches are also present on lots 11-4 and 11-7 (part) and northwest of 4th Rang Road (lots 11M (part) and 11P (part)) (Figure 2).

It should also be noted that the clay content of the surface soil in the study area interferes with surface drainage. As a result, in areas of low to zero slope, it is fairly common to see water at the surface, indicative of imperfect to poor drainage.

A number of wetland areas are present along pipe routes A and B and are described in greater detail in section 4.3.2 of this report.

Figure 2
Location of Forest Stands, Rare Species and Other Biophysical Components



4.2.4 Hydrogeology

4.2.4.1 Long-term pumping test of the main well

The long-term pumping test on the main well was conducted for 72 hours, non-stop, at a pumping rate of 1,514 L/min. Flow remained constant (±2.5%) throughout the test. The pumped water was discharged at a distance of over 30 m from the test well, in a ditch flowing east toward the highway ditch. The long-term pumping test makes it possible to calculate transmissivity and the radius of influence of the well, and to locate the potential aquifer boundaries (impermeable or recharge). These results can be used to set an operational flow for a 19-year time horizon and to calculate protection areas.

During the long-term pumping test, the dynamic water level in the area around the main well was monitored in two test wells (WD/FE-1-03 and WD/FE-2-05) and in the six residential wells in the area. By the end, drawdown had still not stabilized in the test well, or in the wells at 1904 and 1825 Chemin de la Marina.

The following conceptual model was developed on the basis of the pumping test and monitoring of the residential wells in the area:

- Wells finished above the clay layer (i.e., up to 30 m in depth) were not affected by the pumping test. The clay layer plays a role in protecting the aquifer pumped.
- The wells on the east side of the river were not affected by pumping. The river is likely a permeable boundary.
- New values for K, T and S were calculated on the basis of the first slope.
- The natural weekly variation in water level is 0.2 m. This figure was obtained by installing a levelogger combined with a barologger in well WD/FE-02-05 one week before the long-term pumping test.
- Surface ponding is indicative of the low permeability of the surficial materials.
- The zone of influence of well WD/PE-1-06 corresponds to a radius of 1.237 m centred on the well. The zone of significant influence (drawdown = 0.5 m) corresponds to a radius of 1,000 m centred on the main well. It should be emphasized that this zone of influence applies only to neighbouring wells using the same aquifer formation in the surficial materials.

An operational flow can be established on the basis of the following factors:

- Static level at 3.40 m. This factor varies over time as a function of droughts, regional aquifer usage, type of recharge and other unpredictable events.
- Available drawdown of 55 m. This drawdown is closely related to the static level and is therefore variable over time. It also varies with the type and depth of installation of pumping equipment in the wells.
- Sustainability of the resource (19 years) at 16.5 m with an operational flow of 1,514 L/min (400 USGPM). Considering the lack of steady-state conditions during the long-term pumping test of well WD/PE-01-06, the sustainability of the resource will require adjustments in the operational flow over time.

- Condition of the screen: for purposes of the estimated operational flow and sustainability of the resource, the screen must remain intact throughout the 19 years. For this well, this is expected to be the case.

On the basis of the analyses carried out, the proposed groundwater well will be able to deliver the maximum daily flow, but not specifically the hourly peak consumption. Therefore, the hydrogeologist recommends an operational flow of de 1,337 L/min (353 USGPM) for the main well. The operational flow matches estimates of future daily average consumption until at least 2035, but does not cover the maximum daily consumption after about 2013. This condition remains plausible if the well retains its initial capacity. We note, however, that efforts by the Municipality of Weedon to repair leaks in the water supply system have significantly reduced average consumption in recent years, which should also translate into a decrease in maximum daily consumption.

We also note, however, that at this stage, this flow appears to be sufficient to meet the needs of the Weedon Centre area. If the pumped flow decreases in the future, the groundwater supply situation could become critical. In such a case, the backup well will be able to secure Weedon Centre's drinking-water collection facilities and its installation is therefore absolutely necessary.

With regard to the potential impact of climate change, extrapolation of the pumping data shows that the foreseeable drawdown after 19 years (without rain) would be 16.5 m, which represents 30% of the available drawdown. The potential of this aquifer formation seems to significantly exceed the current and future (10 years) needs of the municipality, making the project relatively less sensitive to climate variations.

On the basis of a Jacob plot of the drawdown measured at well WD/PE-1-06, the hydrogeologist extrapolated to the sustainability limit (19 years or 10,000,000 minutes). The extrapolation does not take into account the presence of negative or positive boundaries that could be intercepted by pumping beyond 4,320 minutes, but it does, however, provide a good indication of the potential of the aquifer formation that will be tapped by the municipal well. The extrapolation shows that without recharge, 30% of the available drawdown would be used after 19 years of pumping. Based on his experience and intuition, he believes that the aquifer formation could supply a flow of 4,800 m³/day, which is approximately 300% higher than the current maximum daily flow.

Groundwater vulnerability in the vicinity of the main well was evaluated by the DRASTIC method (one of the most commonly used methods in North America). The DRASTIC index takes into account depth to the water table, net recharge, aquifer medium, soil medium, topography, vadose zone and hydraulic conductivity of the aquifer. Calculation of the DRASTIC vulnerability index for the main well gives a rating of 87, which indicates an aquifer of low vulnerability. This rating is particularly influences by the presence of a clay layer between the depths of 30 and 40 m. As discussed earlier, the presence of this geological unit in all test wells and the lack of variation in the piezometric levels of the wells finished above this unit are indications that the unit is protecting the aquifer. As a result, disinfection is not mandatory, but because of the presence of certain non-pathogenic bacteria in the existing water system, it is preferable to plan for it in order to avoid any risk of contamination.

4.2.4.2 Step pumping test of the backup well

Backup well WD/PE-02-07 is located 63 m northeast of production well WD/PE-01-06. The stratigraphy intersected during drilling indicates that the well is located in the same aquifer as well WD/PE-01-06. This assumption is supported by other factors such as the geochemical signature of the water, its physicochemical

parameters and the step pumping test data. Since both wells draw from the same aquifer, only a step pumping test was done on well WD/PE-02-07. The aquifer characteristics were determined on the basis of the long-term pumping test of well WD/PE-01-06. The recharge areas and protection zones for well WD/PE-02-07 were adjusted to the position of the well, under the assumption that the backup well will be pumped at the same rate recommended for well WD/PE-01-06.

A step pumping test is mainly used to determine the specific capacity of a pumped well. A minimum of three steps is required for the test, and the flow rate must increase at each successive step. One step is pumped at a constant rate for a maximum of 120 minutes, or until the water level stabilizes. The data and graphs for the step pumping test are available in annex IV of LNA (2007), which is included in Appendix J.

The backup well was pumped at the following steps: 379 L/min (100 USGPM), 757 L/min (200 USGPM), 1,136 L/min (300 USGPM) and 1,514 L/min (400 USGPM). The flow rates selected meet the design standards for the screen and the water requirements of the municipality. Since the drawdown was not stabilized during the step pumping test, the method of Hantush (1964) and Bierschenk (1963) was used to interpret capacity (LNA, 2007c).

For each metre of drawdown, approximately 0.5 m^3/min can be pumped if the trend is maintained after 120 minutes of pumping. According to this calculation, the well can meet the needs of the municipality; however, pumping must not exceed the capacity of the screen. On the basis of grain size analyses, the well screen was designed to provide a flow (50% of ultimate capacity) of 1,500 L/min (396 USGPM). However, given that the boundaries of the protection zone are based on the values obtained for well WD/PE-01-06, it is recommended that the well be pumped at the same maximum flow rate as that set for well WD/PE-01-06, or 1,337 L/min (353 USGPM) (LNA, 2007).

To calculate the operational flow of backup well WD/PE-02-07, several factors were taken into account, some of which will remain constant, while others will vary over time. The temporal variations can be estimated, but it is only by monitoring pumping operations that the operational flow can be adjusted according to the factors that vary with time. Since the backup well should only be used when the operation of well WD/PE-01-06 is interrupted, variations in the factors that can affect the operational flow of the main well must be taken into account and applied to the operational flow of the backup well (LNA, 2007).

- Static level: A level of 6.08 m is used to calculate the operational flow.
- Available drawdown: A drawdown of 41 m is estimated for calculation of the operational flow. In this estimate, a total height of 4 m is assigned to the equipment and the safety margin above the screen.
- Sustainability of the resource (19 years): Given the estimated flow rate for the main well, sustainability of the resource is assured because the current estimate of the available drawdown for well WD/PE- 02-07 is 41 m.
- Interception of a boundary: For the estimate of the operational flow, none of the boundaries mentioned above were considered. However, one such boundary could appear, given time. Again, the appearance of a boundary when production well WD/PE-01-06 is pumped is very likely, and the boundary will have to be taken into account in the operation of the backup well.

- Condition of the screen: For the estimate of the operational flow and the sustainability of the resource, the condition of the screen must remain unchanged for the entire 19 years. This factor could vary over time.

On the basis of these assumptions, LNA recommends an operational flow for the backup well of 1,337 L/min (353 USGPM) given that the aquifer characteristics and the boundaries of the protection area are based on values obtained for well WD/PE-01-06. By monitoring the operation of the main production well, it will be possible to adjust the operational flow in the backup well as a function of the variation in temporal factors (LNA, 2007).

It is important to make it clear that the two wells (main and backup) will not be pumped at the same time and that they draw water from the same aquifer. The recommended operational flow is therefore 1,337 L/min, regardless of the well being used. On the basis of the step pumping test, the specific capacity of the main well is estimated at 398 L/min/m of drawdown, while the backup well has a specific capacity of 405 L/min/m of drawdown. The two specific capacities are of the same order of magnitude.

4.2.4.3 Recharge area

The recharge area for the main and backup wells consists of the area over which the aquifer being pumped is replenished. This area can be bounded by a permeable boundary, such as a river, or an impermeable boundary like a watershed. The estimated size of the recharge area for the main well (WD/PE-1-06) is 8.58 km^2 (Figure 3 of LNA, 2007c).

Following the step pumping test of the backup well, the hydraulic gradient was recalculated on the basis of a survey carried out by land surveyors and the static groundwater levels. The direction of the hydraulic gradient (i) is opposite to the direction of flow of the St-François River and is defined as follows: 62°N and i = 0.3952% (see Figure 3 of LNA, 2007c). New recharge areas and protection zones were then established on the basis of an actual groundwater gradient i = 0.004. LNA considered that the slope break is related to an impermeable boundary and that the transmissivity of the pumped aquifer must be calculated from the first slope. The second slope had initially been chosen for representing T along the impermeable boundary, but no reference was provided in support of this theory. Given the possibility that we are dealing with a semi-confined aquifer and that the water is coming from less permeable deposits overlying the aquifer (slope break representing a change from high to low permeability), LNA considers it appropriate to use the T for this unit for the protection zones. For the pumped aquifer, T is therefore $6*10^{-3}$ m^2/s. A thickness of 25 m was used to calculate permeability.

According to LNA, the pumped water comes primarily from the overburden. The recharge area cannot consist solely of the rocky area to the northwest. The overburden is more permeable than the bedrock; moreover, the axial plane of the folds is oriented parallel to the Logan Fault (see the geological map in Appendix G). It is difficult to identify the source of the groundwater exactly because the overburden reflects the fluvial depositional facies. On the basis of the information obtained to date, no conclusions can be drawn about the vertical permeability of the deposits overlying the aquifer and the longitudinal extent of the protective unit. Nevertheless, LNA remains convinced that the overburden is more permeable than the bedrock and that the water pumped from the well originates from surface water infiltration to groundwater.

If the recharge area is covered by clay, this could cause a problem in terms of aquifer recharge because reserves will be depleted over time; because the vertical permeability of clay is lower than the horizontal permeability of

sand and gravel, water will not reach the well as quickly as it can be pumped. However, if drawdown proceeds at the same pace as during the 72-hour pumping test, we have estimated that there are sufficient reserves to sustain 19 years of pumping. This drawdown may increase if the cone meets another impermeable boundary. It is also possible that deposits underlying the St-François River are permeable enough to allow a certain amount of recharge, which would reduce or stabilize drawdown. Finally, it is possible that the deposits in the recharge area are sufficiently permeable to allow an equilibrium to be reached with pumping. Only a very long-term pumping test (3 to 6 months, for example) could identify the sustainability of the resource. At the present time, it is not known whether the well will stabilize, whether the drawdown will increase or decrease. Until steady-state conditions are reached, the manner in which the aquifer is recharged will remain unknown, as will all its boundaries. They can only be estimated. For this reason, LNA recommends a pumping test be carried out for least three to six months or until steady-state conditions are reached with the permanent pumping equipment that will be installed. According to LNA, monitoring the water table while the well is being operated is not sufficient because flow will vary, and interpreting the results of this type of monitoring would be mathematically difficult, if not impossible. The very long-term pumping test would enable us to determine the sustainable yield. The maximum available drawdown is used when the resource is being pumped. The sustainable yield and the final adjustment of the depth of the pump will be confirmed by LNA only after completion of the very long-term pumping test.

In effect, aquifer recharge was calculated on the basis of precipitation, evapotranspiration and runoff. The detailed calculation can be found in LNA, 2007c. MétéoMédia statistics provided data on precipitation and hours of sunshine. Two equations were used: Turc (1961) and Thorthwaite (1948). To reflect the influence of the low permeability of the clay on recharge, the DRASTIC calculation was based on an estimated 150 mm of water.

The recharge area and protection zones were recalculated with the new gradient and the new permeability. The equations of Bears (1979) and Todd (1980) were used (see the calculation in Appendix G). Figure 3 of this appendix shows the presence of two recharge areas: one calculated and one estimated. The dimensions of the calculated recharge area were determined using the Todd (1980) formula. The estimated recharge area is larger in size and includes the calculated recharge area as well as the residential wells that responded during the 72-hour pumping test. This area is delineated by assuming that the source of the water is infiltration through the overburden to the aquifer being pumped. LNA is not of the view that the bedrock transports all the water pumped by the well.

4.2.5 Groundwater quality

A potential problem exists involving the presence of arsenic in the groundwater in the Weedon Centre area. During groundwater prospecting, a maximum arsenic concentration of 0.005 mg/L was the objective set for determining the presence or absence of this parameter in the groundwater pumped. The current standard of 0.025 mg/L will change with a tightening of the regulation (0.01 mg/L is likely). Results of several arsenic analyses carried out during the exploratory drilling showed that the concentration of this element decreases with depth (Table 8). Moreover, arsenic is not found in the Saint-François River where it passes through the study area. Because the well screen was placed at a depth between 63 and 66 m, the results obtained during the pumping tests confirm those seen in exploratory drillholes WD/FE-3-06 (backup well) and WD/FE-4-06, namely that at these

depths, arsenic is not a constraint. During the long-term pumping test of the main well, the concentration of arsenic remained stable at 0.002 mg/L in analyses at 24 and 72 hours.

It should be noted that in all the exploratory drilling, arsenic concentrations exceeded the target value above a depth of 55 m, while remaining below the regulatory level. This depth is below the clay layer, and there is therefore no physical barrier preventing the arsenic concentration from rising, after the well has been in operation for some time, and reaching levels exceeding 5 or even 10 µg/L. This finding is particularly important in terms of the selection of the technology to be used for manganese removal. It is important to note that we cannot confirm that the concentration of arsenic will increase over time. However, it would have been unwise to disregard the possibility in this study.

During the long-term pumping test of the main well, the pumped water was analysed after 24, 48 and 72 hours of pumping. Bacteriological and physicochemical analyses were carried out on each sampling sequence in order to compare the findings with the concentrations that are acceptable under the various applicable standards and regulations. Analyses were also carried out at the end of the 4th step of the step pumping test of backup well WD/PE-02-07. The results obtained at these three pumping times for the main well and at the last step for the backup well are presented in Table 9.

Table 8
Arsenic Concentration as a Function of Depth

Sampling Depth (m)	Arsenic Concentration (mg/L)			Standards and Criteria	
	WD/FE-3-06	WD/FE-4-06		WD/FE-3-06	WD/FE-4-06
49.7		0.007		0.01	< 0.005
50.0	0.021*				
56.1		< 0.002			
56.4	0.012*				
62.5	0.005	< 0.002			
68.6	< 0.002				
74.7	< 0.002				
80.0	< 0.002				
N/A			< 0.002		

* Result exceeds standard; table taken from the LNA hydrologic report (2006).

Table 9
Results of Water Quality Analyses for the Main and Backup Wells and Current Standards for the Various Criteria

Parameters	WD/PE-1-06 976318 (24 hrs) April 19, 2006	WD/PE-1-06 976361 (48 hrs) April 20, 2006	WD/PE-1-06 976371 (72 hrs) April 21, 2006	WD/PE-2-07 1278695 (end 4th step) Sept. 27, 2007	Standards and Criteria	
					Max. Conc.	
Atypical bacteria (CFU/Mem.)	0	0	0	0	200	0

Parameters	WD/PE-1-06 976318 (24 hrs) April 19, 2006	WD/PE-1-06 976361 (48 hrs) April 20, 2006	WD/PE-1-06 976371 (72 hrs) April 21, 2006	WD/PE-2-07 1278695 (end 4th step) Sept. 27, 2007	Standards and Criteria	
					Max. Conc.	
Enterococci bacteria			0	0	0	0
Fecal coliforms (CFU /100 mL)	0	0	0	0	0	0
Total coliforms (CFU /100 mL)	0	0	0	1	10	0
E. Coli (CFU /100 mL)	0	0	0	0	0	0
Coliphage virus			Absent	Absent	0	0
UV absorbance @ 254 nm (%)	0.004	0	0	0.009	-	-
Total alkalinity (mg/L $CaCO_3$)	97	101	110	120	30 - 500	< 500
Phenolphthalein alkalinity (mg/L $CaCO_3$)	0		0		-	-
Antimony (mg/L)	< 0.001		< 0.001	<0.001	0.006	< 0.0002
Arsenic (mg/L)	0.002		0.002	0.003	0.01	< 0.005
Ammonia nitrogen (mg/L-N)	< 0.05	< 0.05	< 0.05	<0.02	0.5	< 0.01
Kjeldahl nitrogen (mg/L-N)	< 0.9	< 0.9	< 0.9	<0.9	-	-
Barium (mg/L)	0.013		0.013	0.009	1	< 0.1
Bicarbonates (mg/L $CaCO_3$)	97		113		250	-
Boron (mg/L)	0.008		0.007	125	5	< 0.01
Bromides (mg/L)	0.04		< 0.02	<0.02	-	-
Cadmium (mg/L)	< 0.0004		< 0.0004	0.0008	0.005	< 0.001
Calcium (mg/L)	35	35	34	38	200	< 75
Carbonate (mg/L $CaCO_3$)	0		0		-	-
Dissolved organic carbon (mg/L)	0.46	0.42	0.4		< 3	< 3
Total organic carbon (mg/L)	0.46	0.5	0.4	0.52	< 3	< 3
Chlorides (mg/L	< 1.00		< 1.00	<1	250	-
Total dissolved chromium (mg/L	< 0.002		< 0.0020	<0.002	0.05	0.0002
Conductivity (µS/cm)	230		230	160	< 1 500	-
True colour (TCU)	< 5	< 5	< 5	<5	12	-
Copper (mg/L)	< 0.0010		< 0.0010	<0.004	1	-
Cyanides (mg CN/L)	< 0.006		< 0.006	<0.006	0.2	< 0.002
Chlorine demand (mg/L)	1	0.6135	0.599	0.8	-	-
Total hardness (mg/L $CaCO_3$)	110	140	130	129	180	< 120
Dissolved iron (mg/L)	0.015	0.013	0.022	0.022	0.3	< 0.05
Total iron (mg/L)	0.039	0.038	0.032	0.064	1.3	< 0.06
Fluoride (mg F/L)	0.07		0.1	0.09	1.5	< 1
Hydroxide (mg/L $CaCO_3$)	< 10		< 10		-	-
Magnesium (mg/L)	8.5	8.5	8.4	8.3	150	< 50
Dissolved manganese (mg/L)	0.38*	0.4	0.42	0.47	0.05	< 0.01
Total manganese (mg/L)	0.43	0.43	0.42	0.51	1.05	< 0.02
Mercury (mg/L)	< 0.0002		< 0.0002	<0.0002	0.001	< 0.0002
Nitrates and nitrites (mg/L-N)	0.04	< 0.02	0.05	<0.02	10	< 0.001
Nitrites	0.01	0.01	0.02	<0.02	1	-
pH	8	7.8	8.1	7.8	5.5 - 8.5	< 0.001
Lead (mg/L Pb)	< 0.002		< 0.002	<0.002	0.01	< 0.002
Selenium (mg/L Se)	< 0.002		< 0.002	<0.002	0.01	-

Parameters	WD/PE-1-06 976318 (24 hrs) April 19, 2006	WD/PE-1-06 976361 (48 hrs) April 20, 2006	WD/PE-1-06 976371 (72 hrs) April 21, 2006	WD/PE-2-07 1278695 (end 4th step) Sept. 27, 2007	Standards and Criteria	
					Max. Conc.	
Sodium (mg/L Na)	2.7		2.8	2.4	200	-
Dissolved solids (mg/L)	123	134	128	162	-	-
Total solids (mg/L)	154	137	137	164	< 500	< 150
Sulphates (mg/L SO_4)	6.2		6.3	13	500	-
Sulphides (mg/L H_2S)	0.012	< 0.010	< 0.010	<0.01	0.05	-
Temperature (°C)	7.9	7.8	7.5	7.9	15°	-
THM (mg/L)				0.021	0.08	
Transmittance (% @ 254 nm)	99	100	100		-	-
Turbidity (UTN)	0.2	< 0.1	< 0.1	1.8	5	< 0.1 - 1
Uranium (mg/L U)	< 0.003		< 0.003	<0.003	0.02	< 0.001
Zinc (mg/L Zn)	0.007		0.002	0.005	5	-

* Result exceeds standard; table taken from the LNA hydrologic report (2006 and 2007d).

Note that all the results compiled in the above table were obtained from the official certificates of analysis for wells WD/PE-1-06 (main well) and WD/PE-02-07 (backup well) annexed to the LNA hydrogeological report (2006) and to the report on the backup well (LNA, 2007d).

During the pumping test, no particular odour was noted. The water was clear and particle-free. The temperature of the pumped water varied from 7.5 to 7.9°C, which is typical for groundwater.

A Piper diagram can be used to determine the chemical composition of the water from the analytical results. In the wells in question, the groundwater has a calcium-magnesium-bicarbonate composition. Moreover, both wells have the same geochemical signature, supporting the hypothesis that they are both completed in the same aquifer. As well, a comparison of all the physicochemical parameters for the water in well WD/PE-02-07 with those of sample No. 976371 collected from well WD/PE-01-06 after 72 hours of pumping (results presented in Table 9) shows a similarity in the characteristics of the water from both wells. This similarity also supports the hypothesis that the two wells tap into the same aquifer.

- Bacteriological quality of the groundwater

Bacteriological analyses of the three samples collected at 24-hour intervals in the main well revealed no bacteriological contamination of the water. All results are zero, even for atypical colonies. A microscopic observation of the water was also carried out on the sample collected after 72 hours of pumping. The results show an absence of algae, larvae and debris of any kind. Only inorganic particles were detected. On the basis of the analysis of these results, no bacteriological problems are foreseen at intake facilities (LNA, 2006).

However, a total coliform result of 1 CFU/100 mL indicates the presence of bacteria in the water from the backup well. This result can be explained by the fact that the well was never disinfected between the time it was developed and the step pumping test because a pumping period of only 8 hours before collection of the sample for analysis would not have completely eliminated the injected chlorine, which would have had the effect of distorting

the test results. The presence of bacteria in the well water can therefore be attributed to contamination of the water by the drilling equipment rather than the presence of bacteria in the aquifer water.

- Physicochemical quality of the groundwater

The physicochemical quality of the groundwater from the main and backup wells is generally good. No health-related parameter exceeds the standards of the new regulation on drinking water quality. Only one aesthetic parameter, manganese, exceeds the standard set by Health Canada. At the end of the long-term pumping test, the concentration of dissolved and total manganese was 0.42 mg/L, or 8.4 times higher than the standard for the municipal well. In the backup well, groundwater in the area was found to have dissolved and total manganese levels of 0.47 mg/L and 0.51 mg/L, respectively, whereas the maximum recommended concentration is 0.05 mg/L. Given that all the manganese is in dissolved form, treatment equipment to remove this parameter will be installed to totally eliminate all associated drawbacks. The hydrogeologist stresses the fact that groundwater quality in the main well does not appear to be affected by surface activities (LNA, 2006 and 2007d).

The arsenic concentrations observed (0.002 mg/L in the main well and 0.003 mg/L in the backup well) are below the 0.025 mg/L standard as well as the new guideline value of 0.005 mg/L that will soon be in effect. It is recommended, however, that arsenic concentrations in the water from both wells be monitored, given the problem associated with this parameter put into perspective above.

Groundwater turbidity values are excellent and therefore comply with the applicable regulatory requirements. We note that the regulation on drinking water quality requires a turbidity of less than 5 UTN for unchlorinated water and less than 1 UTN for chlorinated groundwater. Values below the detection limit (0.1 UTN for the main well and 1.8 UTN for the backup well) indicate that there are no constraints imposed by this parameter.

Measuring UV absorbance involves comparing the quantity of ultraviolet light absorbed through a 1-cm thickness of the water with the amount of ultraviolet light absorbed by a pure water standard. Transmittance, on the other hand, represents the opposite of absorbance (1/absorbance). For all the water samples from the main well that were analyzed, transmittance was 99 to 100%, indicating that the water is of high quality and is easy to disinfect.

Concentrations of iron found in the groundwater were approximately 10 times lower than Health Canada criteria for this aesthetic parameter. The total hardness of the water is associated with the presence of calcium and magnesium ions in solution (Ca^{2+}, Mg^{2+}). Soft water (hardness below 75 mg $CaCO_3$/L) can sometimes lead to corrosion and dissolution of metals in distribution systems, while hard water (hardness above 180 – 200 mg/L) can cause scale problems. The analytical results for both wells are characteristic of a balanced water with hardness ranging from 129 to 140 mg $CaCO_3$/L. Langelier indices can also be used to determine the scale-forming characteristics of the water. At 10°C, which is the approximate temperature of the groundwater at the time of pumping, the Langelier index for the water is assessed at -0.09, indicating that it is almost balanced.

The chlorine demand, which represents the amount of chlorine that will be consumed by the oxidation of all dissolved substances in the water, is ± 0,6 mg/L. Given the very low levels of nitrogen and oxygen, the main source of chlorine demand is the oxidation of manganese, and the value will be reduced at least 50% by the treatment for manganese removal.

All other parameters conform to standards and criteria. Heavy metals are present in only trace amounts, and the low levels of nitrogen (organic and mineral in nature) and carbon (as indicated by TOC) tend to indicate that the groundwater is not affected by surface water. The clay layer found between 30-40 m depth serves as a protective barrier (LNA, 2006).

Given this description of the groundwater and the measures implemented to remove manganese (and arsenic) and to chlorinate the water, the residual impact on water quality is considered to be low to moderate (positive).

4.2.6 Noise environment

The main sources of noise in the study area are farming activities and traffic on routes 112 and 257 and 4th Rang Road. Other human activities, including property maintenance and a number of commercial activities (Route 112) also contribute to the noise environment in the study area. In the context of the proposed project, only the water prospecting activities and the activities related to construction of the various components of the project will temporarily increase noise levels in the study area. A number of homes are located along Route 112 and 4th Rang Road within the study area, and residents there may be temporarily affected by the work. Hence, the impact is considered to be low.

4.2.7 Air quality

The study area is in an agri-forest zone and there is no industry in the vicinity. Only a few homes and small businesses are found along Route 112 and 4th Rang Road (one home). Much of the work zone right-of-way is located in cropland (agricultural grassland) or uncultivated areas. The remainder of the right-of-of way is wooded. A paved, national-level traffic route is located northwest of Route 112 in the study area. Traffic on that route is light to moderate, depending on time of day. Automobile traffic on 4th Rang Road, which is an unpaved local traffic route, is relatively light. Finally, Route 257 is located on the southeast edge of the study area and is a paved regional traffic route, with light to moderate automobile traffic similar to Route 112. Farming activities also have a local and temporary impact on air quality in the study area. During the period of the work, the project will increase the level of air pollution locally by a small amount. The movement of trucks and heavy machinery in the work zone right-of-way and on the roads that cross the study area will raise the level of dust in the air locally and produce engine emissions. However, these small increases will occur over a brief period of time and will be limited primarily to the work zone right-of-way.

4.3 Biological environment

4.3.1 Vegetation

The study area is located in the northern temperate zone, dominated by hardwood and mixed stands. The subarea is deciduous forest, consisting primarily of northern hardwood species dominated by the sugar maple, followed by mixed stands (MRNF, 2003). Located in the Sherbrooke regional landscape unit, the study area lies in the sugar maple-basswood bioclimatic domain. However, the Weedon area lies on the boundary between this

domain and the sugar maple-yellow birch domain. The climate is primarily moderate subhumid, continental, and the growing season is long (180 to 190 days). Annual precipitation is in the range of 1,000 to 1,100 mm.

Sugar maple-basswood stands constitute the potential vegetation on mesic slope sites. Mesic sites are also occupied by balsam fir-yellow birch stands, which are much more common in the southern part of the area, where vegetation is closer to that of the sugar maple-yellow birch domain because of the higher elevation. Xeric sites are occupied by red spruce-balsam fir dominated stands. Poorly drained sites are occupied by balsam fir-eastern white cedar and black ash, while-cedar swamps as well as balsam fir stands with black spruce and sphagnum are found on organic deposits (Robitaille et Saucier, 1998).

Most of the Sherbrooke regional landscape unit is forested, although agriculture is practised in the wider valleys. In the Weedon Centre area, farming is fairly common, particularly on the edge of the municipality and along Route 112 and 4th Rang Road.

Biologists Julie Lapalme and Chantal Bouchard conducted inventories in the study area in the summer of 2006 (well area: Julie Lapalme, September 20, 2006), spring of 2007 (entire study area: Chantal Bouchard, May 18 and 22, 2007) and summer of 2007 (pipe area: Chantal Bouchard, September 6, 2007) in order to characterize the vegetation and identify the presence of rare plants. The results of the inventories show that the well area is forested (see Photographic Report, Appendix A), the pipe area is an agri-forest landscape (see Photographic Report, Appendix A) and the area around the reservoir consists of bare soil (see Photographic Report, Appendix A). The inventories focussed primarily on the work zone. Transects of the plant formations were walked in a "W" pattern. In each stratum (tree, shrub and herbaceous), all the species found and identifiable at the time of the inventories were recorded. All unknown species were collected for later identification. Table 10 presents the dominant tree species found in forest stands in the work zone of the pipe route B right-of-way, at the reservoir site and in the vicinity of the wells.

Table 10
Forest Stands Observed in the Study Area

Stand	Dominant Species	Codominant species
A. Bog (spruce forest with sphagnum, over 30 cm of organic matter)	Red spruce Tamarack	Balsam fir White birch
B. Balsam fir stand with sphagnum (15 to 20 cm of organic matter)	Balsam fir	Red maple White birch
C. Immature tamarack forest with sphagnum (clearcut, 15 to 20 cm of organic matter, imperfectly drained)	Tamarack Red spruce	Balsam fir
D. Uncultivated land with shrubs (clearcut, area of alder wetland regrowth)	Grey birch Balsam fir	Red maple Eastern white cedar White birch Speckled alder Willow Black ash Yellow birch

E. Balsam fir wetland (isolated forest swamp)	Balsam fir Trembling aspen	Eastern white cedar Willow Balsam poplar
F. Uncultivated land with shrubs (farmland)	Trembling aspen Willow	Balsam poplar Balsam fir
G. Red maple (sometimes dry, sometimes imperfectly drained)	Red maple Grey birch	Balsam fir Trembling aspen Yellow birch
H. Cedar grove (isolated forest swamp)	Eastern white cedar	Balsam fir
I. Fir-alder stand	Speckled alder Balsam fir	Willow Eastern white cedar Black ash
J. Tamarack forest	Tamarack Balsam fir	Eastern white cedar Trembling aspen Speckled alder

A total of ten different forest stands were identified in the work zone. The remainder of the surface of the work area consists of farmland or uncultivated land with herbaceous plants. Swampy areas are also noted in certain locations along the pipe route (Figure 3). The forest stands outside the work zone are indicated on the ecoforestry map (No. 21E11-200-201). The water prospecting work (drilling and wells), construction of the access road to the wells, 2.8 km pipe and related facilities will require clearing of approximately 3.2 ha occupied by disturbed or adjacent stands (2.1 ha of woodland and 1.1 ha of uncultivated land with shrubs or trees). Cut wood with commercial value will be the property of the owners of the various lots affected by clearing. No clearing or trimming can be undertaken outside the right-of-way without written permission from the property owner.

The study area also includes a small wetland and a fen. Figure 3 shows the locations of the forest stands, uncultivated lands, cropland, the marsh, the fen and the isolated forest swamp areas located along the various infrastructures planned for the project in the study area.

It should be noted that drainage is impeded almost everywhere in the study area. This can be explained by the presence of a clay layer approximately 1 m below the surface, which is typical of the soil in this part of Weedon Centre. Stands A, C, D, E, H and I coincide at least partially with a fen, balsam fir wetlands, a cedar wetland and alder wetlands. Outside the work area, the boundaries of the fen and certain forest swamps were not determined as accurately as in the area affected by the work.

A list of plant species identified in the study area is presented in Appendix B. Each plant species is associated with a plant formation in which it was identified. In all, 165 vascular plant species were identified in the study area (150 down to species level) during the inventories of September 20, 2006 (well), May 18 and 22, 2007 (entire study area), and September 6, 2007 (pipe area). Two of these species have been designated as vulnerable in Quebec, but have no federal status designation.

4.3.1.1 Plant species at risk

According to CDPNQ (Quebec Natural Heritage Data Centre) data supplied by the Department of Sustainable Development, Environment and Parks (MDDEP), the Weedon Centre area of the Municipality of Weedon is home to three sensitive species: the folliculate sedge (*Carex folliculata*, likely to be designated threatened or vulnerable), swamp valerian (*Valeriana uliginosa*, likely to be designated threatened or vulnerable) and wild leek (*Allium tricoccum*, vulnerable) (Robert, 2005). None of these species has a federal status designation.

A total of six occurrences of these three species were identified. Two of the occurrences in the study region were discovered near the study area per se: one occurrence of wild leek, one occurrence of folliculate sedge and another of swamp valerian. The wild leek occurrences date back over 30 years, as does the occurrence of swamp valerian in the study region. However, the other occurrences of folliculate sedge (2000: study area, and 2001) and swamp valerian (1997) in the Weedon Centre area are recent. Table 11 presents the phenology and habitat of these three plant species. The potential for the presence of the three species in the study area is estimated at low to moderate (swamp valerian = moderate, folliculate sedge = moderate, wild leek = very low).

Table 11
At-risk Plant Species Potentially Present in the Study Area, their Status, Priority Rankings in Quebec, Phenology and Habitat.

Common Name	Latin Name	Status*	Ranking**	Phenology	Detailed Habitat Description
Wild leek	*Allium tricoccum*	V	S3	Spring (May) to early summer (July)	Forests dominated by sugar maple; found at mid-slope, on lower slopes and at the edge of streams in rich soils, mixed forests.
Folliculate sedge	*Carex folliculata*	S	S2	Summer	Marshes and wetlands, deciduous forests, shrub swamps.
Swamp valerian	*Valeriana uliginosa*	V	S2	Early summer (mid June to late July)	Fens and openings in cedar groves or tamarack forests with sphagnum.

* Status: T = Threatened, V = Vulnerable, L = Likely to be designated threatened or vulnerable.
** Ranking: S1 to S3 = priority, S4 and S5 = species of less concern.

Van Brunt's Jacob's ladder (*Polemonium vanbruntiae*, designated as threatened at both the provincial and federal level) is a species that seeks out riparian areas or open marshes. In Quebec, it is seen only in the Centre-du-Québec and Estrie administrative regions. There are no known occurrences of this species in the Weedon area. The potential for the species' presence in the study area is associated with the uncultivated land and the intermittent stream in the vicinity of the railway. However, until recently (about fifteen years ago), this uncultivated land was farmland and there is therefore very little to zero likelihood that the species is present in the study area.

The spring inventories targeted wild leek in particular, and the summer inventories folliculate sedge and swamp valerian, especially in stands E, G, H and I. However, the entire work zone was also visited to complete the list of species present and ensure that no rare plant species are found there. The four species were not observed in spring and summer inventories conducted in the study area.

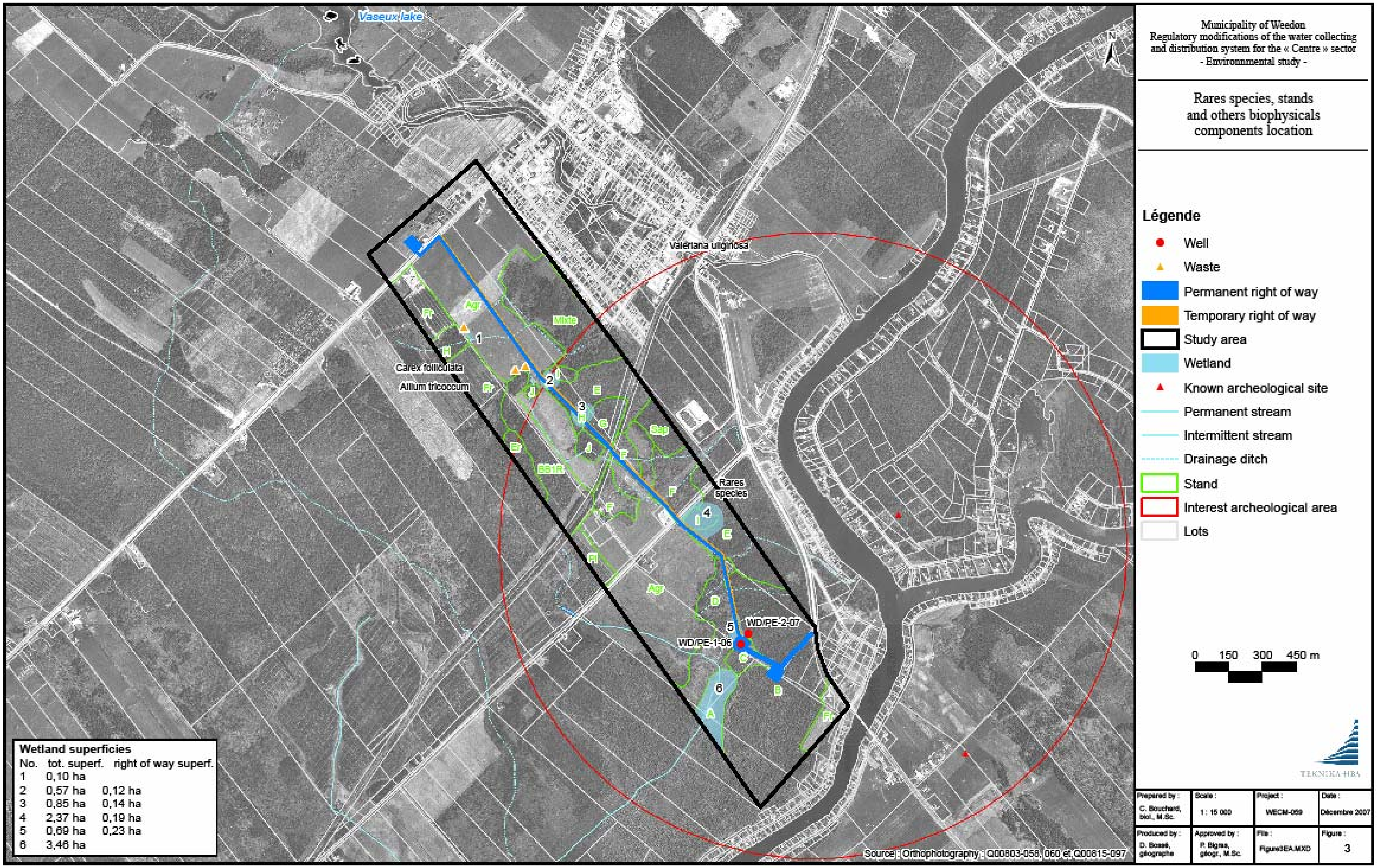
However, when Chantal Bouchard visited the site on May 22 and September 6, 2007, two vulnerable species (priority ranking S5 for one and S4 for the other, where S1 represents a very rare species and S5 a species that is not of concern) were observed in the area of the pipe route B right-of-way (Figure 3). It should be noted that only species of priority ranking S1 to S3 are monitored in Quebec.

More specifically, two populations of the first vulnerable species (covering approximately 150 m^2 and approximately 100 m^2, respectively) were found on lot 12W in the area of the pipe right-of-way. This sensitive species is located in an isolated shrub swamp, unconnected to the hydrologic network, where the first population is dominated by the willow (*Salix sp*.), speckled alder (*Alnus rugosa*), sensitive fern (*Onoclea sensibilis*) and skunk cabbage (*Symplocarpus foetidus*), and the second population is dominated by the same species as well as the balsam fir (*Abies balsamea*). Forest cutting has recently been carried out in this area (within the past 10 years), which seems to be affected by the presence of a farm drainage ditch that forms the boundary between the agricultural grassland and the wooded area. Fill excavated from the ditch was piled alongside it, inside the alder grove and balsam fir stand. The first population is located about 15 m northeast of the permanent and temporary rights-of-way for the pipeline and will not be affected by the work. The second population is located within the temporary pipe right-of-way and will be affected by the planned work. Neither population is very dense, and the plants are relatively small.

This sensitive species is typically found in shady and moist habitats in rich decidious forests, in flood plains and in ditches. This sensitive species is not rare in Quebec (common in Estrie) and its disappearance is not a concern at present. As a result, the species is not being monitored in Quebec. However, collection of large quantities of whole specimens exerts a significant pressure on wild populations of the species, which are therefore protected under the *Act respecting threatened or vulnerable species*. Prohibited practices related to this species are limited, however, to the collection of more than five whole specimens or belowground parts in a natural environment and the sale of a single specimen (MDDEP, 2007a). The partial or complete destruction of a population as a result of an activity other than harvesting, including an infrastructure project, is not prohibited under the Regulation (see Division 5, 2nd paragraph).

The second vulnerable species is located in the same stand as the first species, namely the isolated shrub swamp, and covers only a small area of approximately 30 m^2. This population is located approximately 20 m northeast of the permanent and temporary rights-of-way for pipe route B and will not be affected by the planned work.

This second sensitive species is usually found in sugar maple-hickory stands, sugar maple-basswood stands and sugar maple-yellow birch stands, and sometimes even in elm groves and ash woodlands. Although its extinction is not a concern for now, certain factors are contributing to its scarcity: browsing by whitetail deer, timber harvesting, certain inappropriate forest management practices and destruction of its habitat by urban and agricultural development. The collection of whole specimens is placing significant pressure on wild populations of the species. Designated as vulnerable in Quebec in 2005, this sensitive species is now protected under the *Act respecting threatened or vulnerable species*. Prohibited practices related to this species are limited, however, to the collection of more than five whole specimens or belowground parts in a natural environment and the sale of a single specimen (MDDEP, 2007a). As in the case of the first sensitive species, the partial or complete destruction of a population as a result of an activity other than timber harvesting, including an infrastructure project, is not prohibited under the Regulation (see section 5, 2nd paragraph).


Vaseux lake
Valeriana uliginosa
Carex folliculata
Allium tricoccum
Rares species
WD/PE-2-07
WD/PE-1-06
Wetland superficies
No. tot. superf. right of way superf.
1 0,10 ha
2 0,57 ha 0,12 ha
3 0,85 ha 0,14 ha
4 2,37 ha 0,19 ha
5 0,69 ha 0,23 ha
6 3,46 ha
Source : Orthophotography : Q00803-058, 060 et Q00815-097
Municipality of Weedon
Regulatory modifications of the water collecting and distribution system for the « Centre » sector
- Environmental study -
Rares species, stands and others biophysicals components location
Légende
Well
Waste
Permanent right of way
Temporary right of way
Study area
Wetland
Known archeological site
Permanent stream
Intermittent stream
Drainage ditch
Stand
Interest archeological area
Lots
0 150 300 450 m
Prepared by : C. Bouchard, biol., M.Sc.
Scale : 1 : 15 000
Project : WECM-059
Date : Décembre 2007
Produced by : D. Bossé, géographe
Approved by : P. Bignas, géogr., M.Sc.
File : Figure3EA.MXD
Figure : 3

Hydrous environment

After various visits to the site, a stream and four isolated forest swamps (no hydrological connections), as defined under the *Politique de protection des rives, du littoral et des plaines inondables* [Quebec's policy on shoreline, littoral zone and floodplain protection], were observed along pipe route B (Figure 3). A second stream, a small marsh and a fen were also identified within the study area (Appendix A, Photographs 4 and 5), but outside the work zone. As mentioned above in section 4.2.3, the presence of a surface clay layer in the study area is responsible for imperfect to poor drainage in several plant formations described in the study area. The sloped relief and the presence of depressions and benches also encourage the accumulation of water in certain areas, as does timber harvesting, forest trails and other anthropogenic activities in the study area that have contributed to local drainage modifications (railway, ATV trails, power line). A number of farm drainage projects have also been implemented in several places in the study area, causing local changes in stream patterns and drainage.

The boundaries of certain wetlands (alder and balsam fir wetlands) were identified in the work area, but were not precisely defined further away from the pipe right-of-way. It should be noted that the isolated forest swamps in the study area are fed mainly by snowmelt, precipitation and runoff and dry up completely during the summer. Figure 3 shows the location of each of these wetland areas. The surface areas of the four isolated swamps numbered 2 to 5 in Figure 3 are, respectively, 0.57 ha (0.12 ha in the work area right-of-way), 0.85 ha (0.14.ha in the right-of-way), 2.37 ha (0.19 ha in the right-of-way) and 0.69 ha (0.3 in the right-of-way) (Figure 3 and Appendix A, Photographs 6 to 9). The total surface area within the work area is 0.68 ha. The surface area of the marsh is 0.1 ha and the surface area of the bog within the study area is 3.46 ha. None of the isolated swamps has a hydrological connection to any streams, as defined in the *Politique de protection des rives, du littoral et des plaines inondables*. However, the last forest swamp (MH 5) has a connection to a drainage ditch that empties into a stream (Figure 3).

The bog was not affected by the drilling work, nor will it be by the work involved in installing the well, pipe and other infrastructures planned for the project. However, the operation of the well could affect groundwater recharge to the bog. It should be noted, however, that the suface clay deposits in the area probably isolate the aquifer being pumped from the surface water that supplies the bog (permanent creek). The marsh will not be affected by the planned work because it is located upstream of the work zone (135 m west of the work area right-of-way, route B). This marsh is highly disturbed because work has been done on it in the past to drain it to allow for crops. It is also situated in an agricultural grassland that has been planted with crops and, for several years, has been used as a dump by the owner of the field (presence of various types of waste around the edge of the marsh) (Appendix A, Photograph 4). Plant diversity in the marsh is weak, although a number of bird species, as well as the spring peeper and snapping turtle are present. The presence of a snapping turtle is surprising, however, given the level of disturbance of the marsh and the lack of a connection to the St-François River. Finally, both the bog and the marsh have a connection to a stream.

There are no rare wildlife or plant species in these wetlands, other than in the alder grove southeast of 4th Rang Road, where small numbers of two vulnerable species were found.

Because of the level of disturbance of these wetlands in recent years (timber cutting, draining, forest trails, waste) and their largely agricultural origin, they are considered environments with moderate to low potential to support

rare wildlife or plant species. Only the fir-alder stand southwest of 4th Rang Road is home to three small populations of two species that are vulnerable in Quebec, but the significance is limited because the swamp is a disturbed environment (recent timber cutting, presence of a ditch and fill between the stand and the adjacent field). Hence, the ecological significance of the wetlands in the study area is considered low, with the exception of the bog, which has been relatively undisturbed until recently (forest cutting in its north and west sections), and the fir-alder stand, which supports two vulnerable species.

When the work planned for the project affects a stream, a wetland with or without a hydrological connection, or a ditch draining a surface area of 100 ha or more, the project then becomes subject to section 22 of the *Environment Quality Act*, and a certificate of authorization must first be obtained from MDDEP. The presence of an intermittent stream that is crossed in two locations by the pipe (route B) makes the project subject to this legislation. A 10-m protective belt is required for the two streams present in the study area, the marsh and the bog (hydrological connection), but no protective belt is required for the isolated forest swamps (no hydrological connection) under the *Politique de protection des rives, du littoral et des plaines inondables* (MDDEP, 2006). There are also a number of drainage ditches south of lots 11-4 and 11-7 (part) and northwest of 4th Rang Road (lots 11M (part) and 11P (part)) (Figure 3), but they drain an area of less than 100 ha.

When work is carried out within a wetland, an application for project approval must be submitted to MDDEP. In the case of a project in the Estrie region located outside the St. Lawrence Lowlands sector, in an area where a wetland is present, MDDEP analyzes the project on the basis of three possible situations before giving approval (Table 12). The approach is based on the *Environment Quality Act* and is found in an MDDEP information brochure (2007a). The three situations are based on the surface area of the wetland, hydrological connections to a stream or lake and the presence of wildlife and plant species designated as threatened or vulnerable. Isolated wetlands or, in other words, wetlands without a hydrological connection, are not subject to the *Politique de protection des rives, du littoral et des plaines inondables* (MDDEP, 2006). If the wetland does not match the criteria for situations 1 and 2, or if the wetland is a bog, it is automatically analyzed according to situation 3.

Table 12
MDDEP Approach to Wetland Project Approval

Situation 1	Situation 2	Situation 3
Surface area less than 1 ha and No hydrological connections and No threatened or vulnerable species	Surface area between 1 and 10 ha and No hydrological connections and No threatened or vulnerable species	Surface area greater than 10 ha or Presence of hydrological connections or Presence of threatened or vulnerable species or Bog
The certificate of authorization is issued on the basis of written confirmation by an ecologist or a biologist to the effect that the stated conditions have been met.	The certificate of authorization is issued following an analysis based on two mitigation principles: *avoid* (alternative project or site) and *minimize* (if no other solution exists, losses must be compensated).	Once MDDEP authorities give their approval, the regional office issues the certificate of authorization following an analysis based on two mitigation principles: *avoid* and *minimize*. The project then undergoes a comprehensive and territorial evaluation.

In the case of this project, the application for work in three of these wetland environments (MH 2 and 5) will be processed according to situation 1 in Table 9: the certificate of authorization will be issued on the basis of written confirmation by an ecologist or a biologist that the wetlands meet the stated conditions. However, the application for authorization for the fourth wetland (the 2.37-ha isolated alder swamp supporting two vulnerable plant species) will be processed according to situation 3 of the MDDEP information brochure (2007a) pursuant to the *Environment Quality Act*. In this case, the procedure will involve an initial approval to be received from MDDEP authorities. The certificate of authorization can then be issued by the regional office following an analysis based on two mitigation principles: *avoid* (this step involves prevention of impacts on the wetland by the selection of an alternative project or project site) and *minimize* (this step is acceptable only if the applicant demonstrates that no reasonable alternative site exists for the project. The compensation ratio for losses that are considered inevitable must be proportional to the ecological value of the wetland destroyed or disturbed. In order of preference, the location for the site chosen to compensate these losses will be the project site itself, a site adjacent to the project, elsewhere in the same watershed or in the same municipality).

In conclusion, we note that during construction of the various components, the project will have no direct effect on the bog in the vicinity of the wells, but the operation of the wells could affect groundwater supply to the bog. However, the surface clay deposits present in the area probably isolate the aquifer being pumped from the surface water that supplies the bog (permanent stream).

4.3.2 Terrestrial and aquatic wildlife

4.3.2.1 Fish

Two streams—one permanent and the other intermittent—run through the study area (Figure 1). According to Roy (2007), brook trout is found in most streams in the Estrie region. It also occurs in the Saint-François River. It is therefore more than likely that it is found in the permanent stream and may occur in the intermittent stream downstream from barriers preventing upstream migration. Small streams and ditches connected to the hydrologic system also provide breeding habitat for cyprinids, species of some commercial importance as bait fish. In the inventories, no fish species were observed in the streams or ditches. Given that the intermittent stream affected by the work is no longer connected to a permanent stream, the potential for the presence of fish species in its northern section is considered virtually nil (Appendix A, Photograph 10). The southern section is connected to the Saint-François River. However, given that it is intermittent (Appendix A, Photographs 11 and 12), has been straightened in several locations, runs along a field and power line (ditch habitat without shelter), and runs through a road culvert and across railroad tracks (possible barrier to upstream migration), its potential for supporting these species is considered to be very low.

4.3.2.2 Birds

According to the *Atlas des oiseaux nicheurs du Québec* published by the Association québécoise des groupes d'ornithologues, 23 bird species are confirmed as breeding in the Municipality of Weedon, 20 species are probable breeders and 44 species are possible breeders. The breeding potential of four species present in the area has not been determined (Table 13). A total of 91 different bird species occur in the Weedon area. None of them have the status of threatened species, vulnerable species or species likely to be designated threatened or vulnerable. On the basis of a review of the database of at-risk bird species of Quebec (SOS-POP), Regroupement QuébecOiseaux (RQO – AQGO) (Fradette, 2006) has determined that there are no known breeding sites of at-risk bird species in the Weedon area. Vaseux Lake is an aquatic bird gathering area (Figure 3) (MRC Haut-Saint-François, 1998). This lake is not within the study area, but 500 m northwest of it.

Table 13
List of Bird Species Present in the Weedon Area and their Breeding Status According to the *Atlas des oiseaux nicheurs du Québec* (AQGO, 2006)

English name	*Latin name*	Breeder	English name	*Latin name*	Breeder
Song sparrow	*Melospiza melodia*	Confirmed	Northern harrier	*Circus cyaneus*	Possible
American black duck	*Anas rubripes*	Confirmed	Spotted sandpiper	*Actitis macularia*	Possible
Rose-breasted grosbeak	*Pheucticus ludovicianus*	Confirmed	Ruby-throated hummingbird	*Archilochus colubris*	Possible
Red-winged blackbird	*Agelaius phoeniceus*	Confirmed	American crow	*Corvus brachyrhynchos*	Possible
European starling	*Sturnus vulgaris*	Confirmed	American kestrel	*Falco sparverius*	Possible
Ruffed grouse	*Bonasa umbellus*	Confirmed	Blue jay	*Cyanocitta cristata*	Possible
Bobolink	*Dolichonyx oryzivorus*	Confirmed	Swainson's Thrush	*Catharus ustulatus*	Possible
Hermit thrush	*Catharus guttatus*	Confirmed	Wood thrush	*Hylocichla mustelina*	Possible
Cliff swallow	*Hirundo pyrrhonota*	Confirmed	Veery	*Catharus fuscescens*	Possible
Tree swallow	*Tachycineta bicolor*	Confirmed	Evening grosbeak	*Coccothraustes vespertinus*	Possible
Barn swallow	*Hirundo rustica*	Confirmed	Hooded merganser	*Lophodytes cucullatus*	Possible
Cedar waxwing	*Bombycilla cedrorum*	Confirmed	Dark-eyed junco	*Junco hyemalis*	Possible
American robin	*Turdus migratorius*	Confirmed	Gray catbird	*Dumetella carolinensis*	Possible
House sparrow	*Passer domesticus*	Confirmed	Northern mockingbird	*Mimus polyglottos*	Possible
Alder flycatcher	*Empidonax alnorum*	Confirmed	Brown thrasher	*Toxostoma rufum*	Possible
Eastern phoebe	*Sayornis phoebe*	Confirmed	Least flycatcher	*Empidonax minimus*	Possible
Chestnut-sided Warbler	*Dendroica pensylvanica*	Confirmed	Yellow-rumped warbler	*Dendroica coronata*	Possible
Ovenbird	*Seiurus aurocapillus*	Confirmed	Black-throated green warbler	*Dendroica virens*	Possible
Common yellowthroat	*Geothlypis trichas*	Confirmed	Blackburnian warbler	*Dendroica fusca*	Possible
Hairy woodpecker	*Picoides villosus*	Confirmed	Nashville warbler	*Vermivora ruficapilla*	Possible
Yellow-bellied Sapsucker	*Sphyrapicus varius*	Confirmed	Magnolia warbler	*Dendroica magnolia*	Possible
Killdeer	*Charadrius vociferus*	Confirmed	Black-throated blue warbler	*Dendroica caerulescens*	Possible
Eastern kingbird	*Tyrannus tyrannus*	Confirmed	Northern waterthrush	*Seiurus noveboracensis*	Possible
American woodcock	*Scolopax minor*	Probable	Canada warbler	*Wilsonia canadensis*	Possible
Common snipe	*Gallinago gallinago*	Probable	Black-and-white warbler	*Mniotilta varia*	Possible
White-throated sparrow	*Zonotrichia albicollis*	Probable	Broad-winged hawk	*Buteo platypterus*	Possible
Lincoln's sparrow	*Melospiza lincolnii*	Probable	Eastern wood-pewee	*Contopus virens*	Possible
Savannah sparrow	*Passerculus sandwichensis*	Probable	Common grackle	*Quiscalus quiscula*	Possible
Chipping sparrow	*Spizella passerina*	Probable	Rusty blackbird	*Euphagus carolinus*	Possible
Red-tailed hawk	*Buteo jamaicensis*	Probable	Ruby-crowned kinglet	*Regulus calendula*	Possible
Mallard	*Anas platyrhynchos*	Probable	Purple finch	*Carpodacus purpureus*	Possible
American goldfinch	*Carduelis tristis*	Probable	Blue-winged teal	*Anas discors*	Possible
Chimney swift	*Chaetura pelagica*	Probable	White-breasted nuthatch	*Sitta carolinensis*	Possible
Olive-sided flycatcher	*Contopus borealis*	Probable	Red-breasted nuthatch	*Sitta canadensis*	Possible
American redstart	*Setophaga ruticilla*	Probable	Eastern meadowlark	*Sturnella magna*	Possible
Yellow warbler	*Dendroica petechia*	Probable	Scarlet tanager	*Piranga olivacea*	Possible
Mourning warbler	*Oporornis philadelphia*	Probable	Mourning dove	*Zenaida macroura*	Possible
Northern flicker	*Colaptes auratus*	Probable	Winter wren	*Troglodytes troglodytes*	Possible
Rock dove	*Columba livia*	Probable	Brown-headed cowbird	*Molothrus ater*	Possible
Golden-crowned kinglet	*Regulus satrapa*	Probable	Blue-headed vireo	*Vireo solitarius*	Possible
Marsh wren	*Cistothorus palustris*	Probable	Warbling vireo	*Vireo gilvus*	Possible
Great Crested flycatcher	*Myiarchus crinitus*	Probable	Ring-billed gull	*Larus delawarensis*	Present
Red-eyed vireo	*Vireo olivaceus*	Probable	Great blue heron	*Ardea herodias*	Present
Horned lark	*Eremophila alpestris*	Possible	Bohemian Waxwing	*Bombycilla garrulus*	Present
Northern Goshawk	*Accipiter gentilis*	Possible	Belted kingfisher	*Ceryle alcyon*	Present
Swamp sparrow	*Melospiza georgiana*	Possible			

During the inventories conducted in the study area on September 20, 2006 (Julie Lapalme, area around the wells), May 18 and 22, 2007 (Chantal Bouchard, entire study area) and September 6, 2007 (Chantal Bouchard, area around the water supply pipe), the bird species heard or seen in the study area were noted or recorded for later identification with a Sony M-100Mc Mic'n Micro "Clear Voice" microphone. No systematic inventories were conducted. The bird species identified in the study area were American crow, black-capped chickadee (*Parus atricapillus*), American robin, common grackle, white-throated sparrow, eastern kingbird, eastern wood-pewee, blue jay, common raven (*Corvus corax*), red-winged blackbird, yellow warbler, common yellowthroat, song sparrow, American goldfinch, ovenbird and northern flicker (seen or heard).

The forest stands, ecotones, old fields and fields present in the study area represent high-quality habitat for many common species of forest, field and peri-urban birds. The few species seen and/or heard in the area are common in these habitats.

4.3.2.3 Amphibians and reptiles

According to data from the *Atlas des amphibiens et reptiles du Québec* (AARQ), 21 observations of 13 different amphibian and reptile species were made in the Weedon area: yellow-spotted salamander (*Ambystoma maculatum*), northern two-lined salamander (*Eurycea bislineata*), American toad (*Anaxyrus americanus*), spring peeper (*Pseudacris crucifer*), American bullfrog (*Lithobates catesbeianus*), green frog (*Lithobates clamitans*), pickerel frog (*Lithobates palustris*), mink frog (*Lithobates septentrionalis*), wood frog (*Lithobates sylvaticus*), painted turtle (*Chrysemys picta*), common snapping turtle (*Chelydra serpentina*), redbelly snake (*Storeria occipitomaculata*) and common garter snake (*Thamnophis sirtalis*). Eight of these species were observed in Weedon Centre, namely the American toad, northern two-lined salamander, spring peeper, green frog, pickerel frog, mink frog, redbelly snake and common garter snake. Of these species, only the pickerel frog appears on the list of vertebrates likely to be designated threatened or vulnerable. However, it has no federal status. This species is found in Vaseux Lake in the northwestern part of the study area (Figure 3).

The part of the study area that has the greatest potential for use by salamanders and anurans (frogs and toads) is the area around the wells, which is quite moist (alder stand, creek). The agricultural sector, particularly the drainage ditches, may also provide breeding habitat for certain anuran species. The sector targetted for the installation of the drinking water pipes between 4th Rang Road and Route 112 is less suitable for use by anurans and salamanders (old field, fields and wooded areas with a greater drop in elevation). However, this sector provides some habitat for redbelly and garter snakes.

During the summer inventory of September 20, 2006, conducted by Julie Lapalme in the area around the wells, only one American toad was observed. During the spring inventory of May 18 and 22, 2007, conducted in the entire study area by Chantal Bouchard, only one spring peeper was heard in a small marsh in the study area. Lastly, in the summer inventory of the area around the water supply pipe (September 6, 2007), a wood frog was observed in the alder stand south of 4th Rang Road and a common snapping turtle was observed in the small marsh south of Route 112. None of these species has provincial or federal legal status.

4.3.2.4 Mammals

The large mammals of the Estrie region include white-tailed deer (*Odocoileus virginianus),* black bears (*Ursus americanus*) and moose (*Alces alces*). Given the location of the study region in the St. Lawrence plain, its mild winters and its agricultural and forestry characteristics, conditions in the area are favourable to the establishment of an abundant white-tailed deer population. The Weedon area has considerable potential as black bear habitat, in that it contains large wooded areas and shrubby old fields with an abundant supply of small fruit. Moose also occur at sites where there are relatively large wooded areas with little urban development (FAPAQ, 2002). The area of Weedon Centre offers suitable habitat for white-tailed deer, moose and black bears. However, the habitat in the study area is suitable for use primarily by white-tailed deer. The area around the well could also support moose and possibly black bears.

Other mammal species that occur in the Estrie region include snowshoe hare (*Lepus americanus*), red squirrel (*Tamiasciurus hudsonicus*), eastern chipmunk (*Tamias striatus*), northern flying squirrel (Glaucomys sabrinus), porcupine (*Erethizon dorsatum*), coyote (*Canis latrans*), muskrat (*Ondatra zibethicus*), woodchuck (*Marmota monax*), beaver (*Castor canadensis*), striped skunk (*Mephitis mephitis*), red fox (*Vulpes vulpes*), raccoon (*Procyon lotor*) and bobcat (*Lynx rufus*). Of these species, only the bobcat has the status of a species likely to be designated threatened or vulnerable in Quebec. No white-tailed deer yards, moose yards or beaver ponds were inventoried in the study region (Roy, 2007). However, Vaseux Lake provides muskrat habitat (Figure 3) (MRC Haut-Saint-François, 1998). This lake is not part of the study region, but forms the northern boundary of the region.

Several species of small mammals occur in the Estrie region (Table 14), including two at-risk species: southern bog lemming and woodland vole.

No systematic inventories of mammals were conducted in the area. All wildlife information (tracks, scat, observations and other) collected during the field visits was noted. Table 15 presents the mammal observations made in the area during the field visits of September 20, 2006 (well area), May 18 and 22, 2007 (entire study area) and September 6, 2007 (area around the water pipe). No species of mammals with designated status were observed in the study area during the spring and summer field visits.

Table 14
Small Mammals of the Estrie Region

Group	Species (English name)	Latin name
Shrews (Soricidae)	Northern short-tailed shrew	*Blarina brevicauda*
	Masked shrew	*Sorex cinereus*
	Smoky shrew*	*Sorex fumeus*
	Water shrew	*Sorex palustris*
	Pygmy shrew	*Sorex (Microsorex) hoyi*
Moles (Talpidae)	Star-nosed mole	*Condylura cristata*
	Hairy-tailed mole	*Parascalops breweri*
Lemmings and voles (Cricetidae)	Red-backed vole	*Clethrionomys gapperi*
	Southern bog lemming*	*Synaptomys cooperi*
	Meadow vole	*Microtus pennsylvanicus*
	Woodland vole* **	*Microtus pinetorum*
	White-footed mouse	*Peromyscus leucopus*

Group	Species (English name)	Latin name
	Deer mouse	*Peromyscus maniculatus*
Rats and mice (Muridae)	Norway rat	*Rattus norvegicus*
	House mouse	*Mus musculus*
Jumping mice (Zapodidae)	Woodland jumping mouse	*Napaeozapus insignis*
	Meadow jumping mouse	*Zapus hudsonius*

* *Species likely to be designated threatened or vulnerable in Quebec*
** *Species of special concern in Canada*

Table 15
Mammal Observations Made in the Study Area on September 20, 2006 (Wells), May 18 and 22, 2007, and September 6, 2007, Municipality of Weedon - Centre

English name	Latin name	Type of observation
White-tailed deer	*Odocoileus virginianus*	Tracks, trails, beds, scat, dead animal remains (spring and summer)
Star-nosed mole	*Condylura cristata*	Burrows (spring)
Red squirrel	*Tamiasciurus hudsonicus*	Observed and heard (spring and summer)
Snowshoe hare	*Lepus americanus*	Tracks, scat, observed (spring and summer)
Woodchuck	*Marmota monax*	Observed, burrows (spring)
Moose	*Alces alces*	Tracks (spring)
Black bear	*Ursus americanus*	Scat (spring)
Porcupine	*Erethizon dorsatum*	Scat (spring)
Raccoon	*Procyon lotor*	Tracks (spring)

4.3.2.5 At-risk species

According to data from the Quebec Department of Natural Resources and Wildlife (MRNF) (data from the CDPNQ), Regroupement QuébecOiseaux and the *Atlas des amphibiens et reptiles du Québec*, no rare species occur in the study area proper. However, pickerel frogs are found in Vaseux Lake (a species likely to be designated threatened or vulnerable in Quebec). In addition, according to the assessment of habitat potential in the study area, four species that are likely to be designated threatened or vulnerable in Quebec are potentially present: pickerel frog, bobcat, woodland vole and southern bog lemming. The woodland vole has also been designated a species of special concern in Canada.

Pickerel frogs are primarily terrestrial in the summer, but often remain close to water. They inhabit forests near beaver ponds, clear streams and bogs and also occur in open, grassy areas. They are generally associated with mountainous terrain (Desroches and Rodrigue, 2004). The bog and marsh are the only areas that could potentially support this species. The potential for the presence of this species on the site is considered low to nil, despite the presence of one record north of the study region.

Bobcats inhabit primarily natural wooded areas and prefer mature boreal forests and dense understory thickets and windfall areas. However, this carnivorous species is found in other habitats if there is minimal forest cover and an adequate supply of prey, particularly snowshoe hares, but also rabbits, rodents, deer and birds, types of prey

that are found on the project site. Since hare populations increase in regenerating forests, particularly following clearing, these regenerating forest ecosystems may be favourable to bobcat populations. As a result, the potential for the presence of this species on the project site is considerate moderate.

With respect to small mammals, the woodland vole occurs in relatively diversified wooded habitats with dense plant cover. It prefers well-drained areas characterized by malleable, friable, often sandy soil covered with a thick layer of humus. It is found in deciduous forests (e.g., beech, maple, oak and linden), as well as in mixedwood forests, eastern hemlock stands, orchards with dense vegetation, fields, forest edges and sometimes brushy dunes (Desrosiers et al., 2002; EC, 2004; MRNF, 2004). The study area is characterized by relatively clayey soils, which results in imperfect drainage. This type of habitat is not favourable to woodland voles (potential for the presence of the species is low to nil).

The southern bog lemming occurs in sphagnum bogs and heath bogs, grassy marshes and mixedwood forests surrounding bogs. This small rodent is active year round and builds reserves of sedges, which it scatters along burrow runways excavated in humus. Although it is very prolific (two to four litters a year), is also the prey of a large number of snakes, carnivorous mammals (e.g., raccoons, red and grey foxes, striped skunks) and raptors (red-tailed hawks, northern harriers) (Desrosiers et al., 2002; MRNF, 2001). In the study area, only the fen has moderate potential for supporting this species.

The potential for the presence of these two small mammal species on the project site is considered moderate to very low, depending on the type of drainage and the various stands that exist on the site. There are no known occurrences of these species in the study area. In addition, the bog is not affected by the work planned as part of this project. As a result, no specific inventory is considered to be necessary for the southern bog lemming. With respect to woodland voles, the habitats affected by the work offer little potential for use by this species. Moreover, the impact of the proposed on the potential habitats will be localized, given that only the work area right-of-way will be disturbed. As a result, no specific inventory for woodland voles was considered necessary.

Lastly, no at-risk species were observed in the study area during the spring and summer field visits.

4.4 Human environment

4.4.1 Socioeconomic features

Farming has been and remains a major development activity in the Haut-Saint-François RCM. At the present time, there are close to 600 farms in the RCM, and farming forms a major part of the regional economy. Forests cover almost 80% of the area and are an important resource to the RCM, generating a large number of jobs. Occupying almost 55% of the manufacturing workforce, forest product processing is a key sector of the economy of the Haut-Saint-François RCM. Most manufacturing jobs are related to the paper, wood and furniture sectors (MRC Haut-Saint-François, 2007).

Population demographics of the Municipality of Weedon show very little change. In 2006, there were 2,739 residents in Weedon compared with 2,646 in 2001. Between 2001 and 2006, the population grew by 3.5%, having increased by only 1% between 1996 and 2001. More specifically, in the Weedon Centre area of the Municipality (formerly the Municipality of Weedon Centre), the population decreased by 2.2% between 1996 and 2001 (from

1,213 to 1,186). Statistics for the Municipality of Weedon Centre are not available for 2006 because the Municipality amalgamated with other municipalities to form the Municipality of Weedon in 2000. Since 1996, population change for Weedon has remained below the percent population change for Quebec (between 2001 and 2006: 4.3%; between 1996 and 2001: 1.4%). The unemployment rate was also relatively high for the period from 1996 to 2001 (Weedon: 12.2%; Weedon Centre: 14.3%). In 2006, the unemployment rate for Weedon dropped considerably (7.3%), but remained slightly above the average for Quebec (7.3%) (Statistique Canada, 2002, 2007).

4.4.2 Land-use planning

The revised development plan for the Haut-Saint-François RCM (1998) indicates that the area under study straddles six land use categories: industrial, residential, municipal, rural and agricultural. We note that the first three land use categories listed are located in the Weedon Centre area itself and occupy only a small portion of the surface area of the area under study. The last four land use categories listed are also found in the study area: the rural land use category covers approximately 60% of the study area, followed in decreasing order of area by the agricultural, resort and municipal land use categories. With few differences, the rural, agricultural and resort land use categories allow for low-density settlement, resource use and recreational activities, as well as certain types of business and industry. The municipal land use category allows for lodging, commercial, industrial, institutional, residential and tourist activities, and excludes resource use activities. The wells are in a rural zone, the pipe runs through rural, resort and agricultural zone, and the reservoir is in an agricultural zone.

An application for CPTAQ (Commission de protection du territoire agricole du Québec) approval to carry out work on agricultural land is required and was submitted on October 31, 2007. The final decision was rendered on April 14, 2008, in favour of route B.

4.4.3 Land use and tenure

The study area is an agroforestry area, and there are no industries located nearby. The site planned for the construction of the reservoir and the drinking water treatment building is not far from a number of commercial and service activities. A few homes are also located on the north side of Route 112 (1891, 1911 and 75 Route 112) and there are two homes on the south side of this road (1880 and 1864 Route 112). Two more homes are located on the north and south sides of 4th Rang Road (on the north side, at 1827 Pilon Street; on the south side, an abandoned house at 1220 4th Rang Road).

The study area is forested in the vicinity of the wells. However, the access road and drilling sites have been cleared and developed (Appendix A, Photograph 1). The lots are privately owned and hence, in certain parts of the forest, timber has been cut in several locations at different times in the past.

The pipe route runs mainly throough agricultural areas. It also crosses areas of uncultivated land and uncultivated land with shrubs and trees. Trees have recently been harvested in the wooded portion of the pipe route located immediately to the north of the main well.

The site of the reservoir and the drinking water treatment building is near the homes along Route 112 in the municipal sector. The site where the reservoir is to be located is in an agricultural setting; it is currently bare and covered with piles of stones (Appendix A, Photograph 3).

4.4.4 Infrastructure and equipment

Route 112 and 4th Rang Road are the two main roads in the study area, crossing it from west to east. Route 112 is a national road that links the Municipality of Weedon and other regional municipalities to the City of Sherbrooke. The 4th Rang Road is a local road serving most of the homes in the sector. This road connects with Route 112 and Route 257, which is a collector road. Route 257 forms the southeast boundary of the study area. The three roads receive moderate to light local (4th Rang Road), regional (Route 257) and national (Route 112) traffic.

A railway crosses the study area from west to east around the centre of the pipe route; the railway was initially owned by the Quebec Centrail Railway and has been the property of the MTQ (Quebec Transportation Department) since the summer of 2007. It is still in operation, but is not used at present (Figure 2). A Hydro-Québec power line crosses the study area, from a substation on 4th Rang Road to Route 112 (Figure 2). The route selected for the pipe will run along the west side of this power line. A second power line runs northeast from the substation. No water supply or sewer lines cross the study area at present. The homes located in the study area obtain water from artesian wells and discharge wastewater to septic tanks.

In the context of the project, applications for power line and railway rights-of-way crossings were submitted to Hydro-Québec and the MTQ and approved by both parties.

4.4.5 Archaeological and cultural heritage

According to the revised development plan for the Haut-Saint-François RCM (1998), the vicinity of the wells and part of the pipe are located in an area of archaeological interest (Figure 3). The area is a centre of high potential associated with two prehistoric archaeological sites located at the confluence of the Rivière au Saumon and the Saint-François River. A report by Aménatech and Ethnoscop (1986) entitled *Les zones d'intérêt archéologique des MRC du Haut-Saint-François, du Val-Saint-François et de l'Or-Blanc* [areas of archaeological interest in the Haut-Saint-François, Val-Saint-François and Or-Blanc RCMs] ranks the potential of the area around these two sites as very high.

The two sites are located on private property and their Borden numbers are BkEu-3 and BkEu-4. They were discovered by chance in the early 1960s. Site BkEu-3 is located on a low terrace approximately 2 m above the water surface that extends to the beach. This site consists of two main areas of occupancy and covers a very large surface area (estimated at approximately 22,000 m^2). The site has been partially disturbed by farming, erosion and looting. It is a Laurentian Archaic site and has yielded numerous remains in the form of chipped and polished stones. The second site (BkEu-4) is located near the first site, on the north shore at the mouth of the Rivière au Saumon. The site is on a low terrace, approximately 0.30 m above the water surface. The site has an estimated surface area of 1,000 m^2 and has been significantly disturbed by erosion and various infilling activities.

It is probably a Middle Woodland site (more recent than the previous site). Approximately fifty ceramic fragments and a few stone tools have been discovered there.

Given the high potential of the archaeological centre in Weedon Centre, between August 13 and 16, 2007, the actual archaeological potential of the worksite right-of-way was evaluated in a zone of high potential by archaeologist Éric Graillon. The resulting report (Graillon, 2007) confirms that no undiscovered historic or prehistoric archaeological horizons will be harmed or destroyed by the work planned in the context of this project in the area identified by Aménatech and Ethnoscop (1986) as having archaeological potential. No specific protective measures must therefore be implemented during the course of the work. However, should a discovery be made while the work is being carried out, the contractor is required under Quebec's *Cultural Property Act* to declare it and take the necessary steps to protect the area in question.

4.4.6 Areas under natural or anthropogenic pressure

According to the revised development plan for the Haut-Saint-François RCM (1998), no natural pressures have been identified in the study area (no officially mapped flood-prone or landslide-prone areas).

No officially mapped, specific land-use constraints have been identified in the study area (landfill site, former dump sites, etc.). However, according to the revised development plan for the Haut-Saint-François RCM (1998), three dump sites that were closed in the late 1970s and early 1980s are located outside the study region, but within the municipalities of Saint-Gérard and Weedon: a dump site located on lot 100 of the cadastre of the village of Lac-Weedon (on 7th Rang in Saint-Gérard), and two dump sites in the Municipality of Weedon on lot 15H of the cadastre of Weedon Canton (on 5th Rang) and on lots 147P, lot 4P (part) and lot 5P (part) of the cadastre of the village of Weedon Centre. All are located outside the new recharge area calculated by LNA. The last site identified is the one closest to the calculated recharge area.

It should also be noted that trash (barbed wire, plywood, tires, clothing, plastic, branches, sheet metal, etc.) has been observed in three locations in the study area: on the edge of the small marsh (Appendix A, Photograph 4), on the southern edge of the field with the woodlot located on lot 11T (part) and in the ditch east of the same woodlot on the same lot (Figure 3).

The phase 1 environmental site assessment on the study area revealed signs of real and potential contamination associated with the following elements:

- The presence over the years of several service stations along 2nd Avenue;
- An automobile dealership with a gas bar beside 2nd Avenue from the 1960s to the 1980s;
- A railway has crossed the study area for over 130 years and at the time of the visit, an overturned lubricant dispenser was observed close to the study area.

It should be noted, however, that the service stations and the automobile dealership with the gas bar were located outside the area where the work associated with the project is to be carried out.

4.4.7 Traditional Aboriginal uses of the land

The lands in the study area are not used for any traditional Aboriginal purposes. The lands in the study area are privately owned, and none of the property owners in question is of Aboriginal descent.

APPENDIX A
PHOTOGRAPHIC REPORT

Photograph 1: Access road to main well and bordering vegetation; looking south (May 2007).

Photograph 2: Northern portion of pipe route B; looking southeast (May 2007).

Photograph 3: Bare ground and piles of earth materials on the site planned for the reservoir and the drinking water treatment facility; looking east (May 2007).

Photograph 4: Marsh (1) and trash on its west side; looking south (May 2007).

Photograph 5: Bog (5) near the wells; looking southwest.

Photograph 6: Alder grove (2) along the power line north of route B; looking south (May 2007).

Photograph 7: Cedar grove along the power line north of route B; looking west (May 2007).

Photograph 8: Alder grove (4) in the middle of route B; looking east.

Photograph 9: Balsam fir wetland (4) in the area of the wells; looking south (May 2007).

Photograph 10: New route of the north arm of the intermittent stream in the worksite area; looking northeast (May 2007).

Photograph 11: Southern stretch of the intermittent stream in the worksite area; looking east (May 2007).

Photograph 12: Upstream part of the worksite, southern portion of the intermittent stream with the railway in the background; looking northwest (May 2007).

APPENDIX C
SUMMARY TABLE OF ENVIRONMENTAL IMPACTS

PHASES ET ACTIVITÉS	PHASES AND ACTIVITÉS
Recherche en eau	**Water Prospecting**
Déboisement, aménagement du chemin d'accès et forage exploratoire	Forest clearing, construction of the access road and exploratory drilling
Construction	**Construction**
Déboisement	Forest clearing
Circulation et transport	Traffic and transportation
Aménagement des puits et des infrastructures connexes	Installation of the wells and related infrastructure
Excavation, installation de la conduite et des infrastructures, connexes, terrassement	Excavation, installation of the pipe and related infrastructure, earthworks
Aménagement du réservoir et de l'usine de traitement de l'eau potable	Installation of the reservoir and water treatment facility
Exploitation	**Operations**
Exploitation de l'aquifère	Pumping of the aquifer
Entretien du réseau d'eau potable	Maintenance of the drinking water system
Traitement de l'eau et entreposage du chlore	Treatment of the water and storage of chlorine
Désaffectation	**Decommissioning**
Désaffectation des puits et autres infrastructures connexes	Decommissioning of the well and other related infrastructures
COMPOSANTES ENVIRONNEMENTALES	ENVIRONMENTAL COMPONENTS
Milieu Physique	**Physical Environment**
Air	Air
Ambiance sonore (bruit)	Noise environment
Qualité de l'air	Air quality
Eau	Water
Hydrographie (cours d'eau et milieux humides)	Hydrography (streams and wetlands)
Qualité des eaux de surface	Surface water quality
Qualité des eaux souterraines	Groundwater quality
Bilan hydrogéographique	Hydrogeographic system
Sol	Soils
Qualité des sols	Soil quality
Milieu Biologique	**Biological Environment**
Faune	Wildlife
Faune aquatique (poissons et herpétopfaune) et habitat	Aquatic wildlife (fish, amphibians and reptiles) and habitat
Faune avienne et habitat	Birds and their habitat
Faune terrestre et habitat	Terrestrial wildlife and habitat
Flore	Flora
Couvert végétal	Plant cover
Espèces florisques rares	Rare plant species
Milieux humain et social	**Human and Social Environments**
Utilisation du sol	Land use
Espace agricole	Farmland
Infrastructures	Infrastructure
Circulation et sécurité routière	Traffic and traffic safety
Population	Population
Économie (emploies)	Economy (employment)
Santé-sécurité	Healty-safety
Patrimoine culturel	Cultural heritage
Site archéologique	Archaeological site

				PHASES ET ACTIVITÉS									
				Recherche en eau	construction					Exploitation			Désaffectation
				Déboisement, aménagement du chemin d'accès et forage exploratoire	Déboisement	Circulation et transport	Aménagement des puits et des infrastructures connexes	Excavation, installation de la conduite et des infrastructures, connexes, terrassement	Aménagement du réservoir et de l'usine de traitement de l'eau potable	Exploitation de l'aquifère	Entretien du réseau d'eau potable	Traitement de l'eau et entreposage du chlore	Désaffectation des puits et autres infrastructures connexes
COMPOSANTES ENVIRONNEMENTALES	Milieu Physique	Air	Ambiance sonore (bruit)	X	X	X		X	X				
			Qualité de l'air	X		X		X	X				
		Eau	Hydrographie (cours d'eau et milieux humides)	X	X		X	X					
			Qualité des eaux de surface	X				X					
			Qualité des eaux souterraines				X			X			X
			Bilan hydrogéographique							X			
		Sol	Qualité des sols	X	X		X	X	X				
	Milieu Biologique	Faune	Faune aquatique (poissons et herpétofaune) et habitat					X					
			Faune avienne et habitat	X	X								
			Faune terrestre et habitat	X	X		X	X					
		Flore	Couvert végétal	X	X								
			Espèces floristiques rares		X			X					
	Milieux humain et social	Utilisation du sol	Espace agricole					X					
		Infrastructures	Circulation et sécurité routière	X		X							
		Population	Économie (emploies)	X	X		X	X	X		X		
			Santé-sécurité									X	
		Patrimoine culturel	Site archéologique	X			X	X					

APPENDIX D
DESCRIPTION OF ENVIRONMENTAL EFFECTS AND MITIGATION MEASURES

DESCRIPTION OF EFFECTS AND MITIGATION MEASURES				
Description of project components or activities	**Environmental components affected by the project**	**Description of environmental effects**	**Mitigation and/or compensation measures**	**Description and magnitude of residual impacts**
• Groundwater prospecting, forest clearing and construction	Noise environment and air quality	The dust and noise created by the work involved in groundwater prospecting, forest clearing and construction will have a temporary impact on the quality of life of nearby residents. LOW IMPACT	Notify residents of the area in advance of the start date and anticipated duration of the work. Noisy work must be restricted to normal hours of work, beween 7:00 a.m. and 7:00 p.m. Use equipment that is in good working order and as quiet as possible. Take appropriate measures to limit dust, e.g., spraying surfaces and using dust suppressants. Cover fine materials with securely attached tarpaulins during transport.	NEGLIGEABLE
	Hydrography (streams and wetlands)	The work involved in drilling and well installation contributed to the loss of a small area of wetland 5 (0.23 ha). LOW IMPACT Construction of the pipe will require the clearing of 1.63 ha of wooded and uncultivated land, including 0.45 ha of wetland. LOW IMPACT A small intermittent stream with low wildlife potential will be crossed in two locations. LOW IMPACT	Clearly identify the boundaries of the work area. Avoid leaving soils bare and implement measures to control suspended solids (membranes, geotextiles, straw bales, settling ponds, filter berms, etc.) to prevent sediment input to the wetland and to ditches during the work. Excavation work is not carried out during periods of heavy rain. At the conclusion of the work, the site muFst be restored to its natural condition, taking into account any restrictions on timing related to fish. The work must be carried out quickly and during low-water periods. Use bank stabilization methods and bioengineering techniques, if necessary. Dispose of plant materials and debris properly. Salvage wood with commercial value. Implement all DFO protection measures described in section 5.2.1.7.	NEGLIGEABLE

DESCRIPTION OF EFFECTS AND MITIGATION MEASURES				
Description of project components or activities	**Environmental components affected by the project**	**Description of environmental effects**	**Mitigation and/or compensation measures**	**Description and magnitude of residual impacts**
	Surface and groundwater quality	The work involved in constructing the access road, drilling and discharging pumped water is associated with a risk of soil erosion that can temporarily reduce surface water quality through the input of significant amounts of suspended solids via drainage ditches. LOW IMPACT The movement and maintenance of machinery and the use of petroleum products pose a hydrocarbon contamination risk during the groundwater-prospecting phase and can affect surface water quality, wetlands and soil. LOW IMPACT Exploratory drilling can affect groundwater wells that share the same aquifer. LOW IMPACT	Obtain certificates of authorization from the provincial authorities before carrying out any work on the installation of the wells and pipelines. The proponent must comply with all mitigation measures required in the certificates of authorization issued for the work. Copies of the certificates are to be forwarded to the CED representative. Follow the well disinfection procedure when the drilling work is completed and install a waterproof cap in compliance with standards. Soil inside the immediate well protection area was levelled in such a way as to prevent surface water runoff toward the wells. Equip the site with all necessary waste recovery equipment (portable chemical toilets, waste receptacles, bins, etc.). Identify a temporary storage area on the worksite. Clean the site and dispose of liquid and solid waste regularly in accordance with existing regulations. The contractor's work area (trailers, machinery and equipment storage) will be located more than 60 m away from all streams. Burying of construction waste will not be permitted on the site. Fires and burning on or near the worksite are prohibited at all times. Dispose of construction waste and scrap (depending on their nature) in an area approved by provincial authorities. Dispose of hazardous waste (oil, grease, etc.) or other materials that pose a risk to the environment (creosote treated wood, etc.) in a site that has been approved by provincial authorities to receive this type of waste. Submit a copy of the delivery slips to the CED representative. Apply the 3R-R principle (reduce at source, reuse, recycle, reclaim) to manage construction scraps. Mark work areas and restrict movement of construction equipment to these areas.	

DESCRIPTION OF EFFECTS AND MITIGATION MEASURES				
Description of project components or activities	**Environmental components affected by the project**	**Description of environmental effects**	**Mitigation and/or compensation measures**	**Description and magnitude of residual impacts**
			Avoid leaving soils bare and, if required, implement suspended solids control measures (membranes, geotextiles, straw bales, settling ponds, filter berms, etc.) to prevent suspended solids input to surface water, drainage ditches or storm drains during the work. Apply this measure at the end of every workday, for example, by spreading a layer of straw on bare areas susceptible to erosion. This measure is particularly important for work conducted near streams. Avoid carrying out work during heavy rain. Ensure equipment is in good working condition in order to prevent accidents and leakage of fuel, oil and grease. Restrict the movement of vehicles and heavy machinery to the proposed roadways, which must be clearly identified General maintenance and fuelling of vehicles must be conducted in areas designated for this purpose that are located more than 30 m from streams and wells, and away from excavations, in areas where there is no risk of contaminating the aquatic environment (via storm sewers or agricultural ditches). Establish an accidental spill prevention plan and ensure that absorbent materials and clearly identified airtight containers designed to hold oil residue and waste are kept on site. All handling of fuel, oil or other contaminants must be routinely supervised to prevent any spills. Keep an emergency response kit on the worksite at all times in case of an accidental spill. Dispose of construction waste and scrap (depending on their nature) in an area approved by provincial authorities. Dispose of hazardous waste (oil, grease, etc.) or other materials that pose a risk to the environment (creosote treated wood, etc.) in a site that has been approved by provincial authorities to receive this type of waste. Submit a copy of the delivery slips to the CED representative.	

DESCRIPTION OF EFFECTS AND MITIGATION MEASURES				
Description of project components or activities	**Environmental components affected by the project**	**Description of environmental effects**	**Mitigation and/or compensation measures**	**Description and magnitude of residual impacts**
			Apply the 3R-R principle (reduce at source, reuse, recycle, reclaim) to manage construction scraps. Mark work areas and restrict movement of construction equipment to these areas.	NEGLIGEABLE
	Soil quality	The work involved in constructing the access road, drilling and discharging pumped water is associated with a risk of soil erosion that can temporarily reduce surface water quality through the input of significant amounts of suspended solids via drainage ditches. LOW IMPACT The presence of workers generates waste, which can result in a temporary, local deterioration in soil and surface or groundwater quality. LOW IMPACT Disposing of construction waste improperly and in locations not intended for this purpose can affect the safety of the public and the workers and lead to soil and water degradation. LOW IMPACT Installing the pipe across an intermittent stream (excavation work) is associated with the risk of soil erosion that can temporarily reduce surface water quality through the input of significant amounts of suspended solids. LOW IMPACT The movement and maintenance of machinery and the use of petroleum products pose a hydrocarbon contamination risk during the groundwater-prospecting phase and can affect surface water quality, wetlands and soil. LOW IMPACT Exploratory drilling can affect groundwater wells that share the same aquifer. LOW IMPACT	Equip the site with all necessary waste recovery equipment (portable chemical toilets, waste receptacles, bins, etc.). Identify a temporary storage area on the worksite. Clean the site and dispose of liquid and solid waste regularly in accordance with existing regulations. The contractor's work area (trailers, machinery and equipment storage) will be located more than 60 m away from all streams. Burying of construction waste will not be permitted on the site. Fires and burning on or near the worksite are prohibited at all times. Dispose of construction waste and scrap (depending on their nature) in an area approved by provincial authorities. Dispose of hazardous waste (oil, grease, etc.) or other materials that pose a risk to the environment (creosote treated wood, etc.) in a site that has been approved by provincial authorities to receive this type of waste. Submit a copy of the delivery slips to the CED representative. Apply the 3R-R principle (reduce at source, reuse, recycle, reclaim) to manage construction scraps. Mark work areas and restrict movement of construction equipment to these areas. Avoid leaving soils bare and, if required, implement suspended solids control measures (membranes, geotextiles, straw bales, settling ponds, filter berms, etc.) to prevent suspended solids input to surface water, drainage ditches or storm drains during the work. Apply this measure at the end of every workday, for example, by spreading a layer of straw on bare areas susceptible to erosion. This measure is particularly	NEGLIGEABLE

DESCRIPTION OF EFFECTS AND MITIGATION MEASURES				
Description of project components or activities	**Environmental components affected by the project**	**Description of environmental effects**	**Mitigation and/or compensation measures**	**Description and magnitude of residual impacts**
			important for work conducted near streams Avoid carrying out work during heavy rain. Dispose of excavated materials in a site approved to receive such materials (depending on their quality) and in accordance with existing regulations. Submit delivery slips for disposal of excavated materials at approved sites to the CED representative. If contamination is detected or suspected during the work, the proponent must implement the following measures: Immediately notify the CED representative of the situation. Create a soil and groundwater characterization plan that includes a sampling scheme (number of samples, site location, depths analyzed, etc.) and a description of the type of contaminants to be analyzed (hydrocarbons, metals, PAHs, etc.) depending on the nature of the suspected contamination. Have the characterization plan approved by the appropriate authorities and the CED representative. Have a specialized firm complete a soil and groundwater characterization plan. Determine the sources of contamination, the nature of the contaminants and the extent of the contamination (phase 3). Create a contamination management plan in accordance with applicable legislation, based on the use criteria of the site in question. Have the compliance of the plan substantiated by the appropriate authorities and the CED representative. Apply the management measures from the management plan, including the rehabilitation measures stipulated in the plan. Produce a report of the rehabilitation results and submit a copy to the CED representative. The report must show the methods used by the proponent to ensure use criteria were met. In the event of a malfunction or accident:	

DESCRIPTION OF EFFECTS AND MITIGATION MEASURES				
Description of project components or activities	**Environmental components affected by the project**	**Description of environmental effects**	**Mitigation and/or compensation measures**	**Description and magnitude of residual impacts**
			Repair faulty construction equipment and vehicles as soon as possible and at a distance of more than 30 m from a stream. Keep an emergency response kit on the worksite at all times in case of an accidental spill. All handling of fuel, oil or other contaminants must be routinely supervised to prevent any spills. Take all measures necessary to stop an accidental spill and quickly confine the spilled product. Then, recover the product, dispose of the waste and restore the area in accordance with existing regulations. Establish a spill prevention and response plan and clearly identify the responsible individuals and authorities, as well as the procedure to follow in case of an environmental emergency. Submit a copy of the prevention plan to the CED representative. Workers should be made aware of environmental emergency response measures and accidental spill prevention measures. This item must be included on a site meeting agenda, or proof of certification of personnel in the implementation of emergency response measures must be provided. In the event of an oil spill or a spill any other harmful substance, immediately notify the Department of Sustainable Development, Environment and Parks (1-866-694-5454). Conduct a retrospective analysis to improve the prevention and response system in case of an accident. All hazardous materials must be transported safely and in accordance with existing regulations and standards. Wash, service, park and refuel construction machinery and store fuel and other hazardous materials more than 30 m from the NHWM or more than 30 m from the wells or at a greater distance that is sufficient to prevent any deleterious substances from entering the well protection areas.	

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			Ensure that machinery is kept clean, free of leaks and maintained in this condition throughout the work period. Submit a copy of the machinery inspection reports (most recent copy prior to start of work) to the CED representative. Do not pump water that contains suspended solids or harmful substances into the wastewater or drainage systems. All temporary fuel tanks must be installed and dismantled in accordance with the *Petroleum Products Regulation*.	
	Plant cover Birds and their habitat Terrestrial wildlife and habitat Aquatic wildlife and habitat	For the work involved in constructing the access road to the exploratory drilling sites, it was necessary to clear 1.55 ha of woodland, resulting in an equivalent loss of bird and terrestrial wildlife habitat. LOW IMPACT Construction of the pipe will require the clearing of 1.63 ha of wooded and uncultivated land, representing an equivalent area of wildlife habitat. LOW IMPACT Wildlife and aquatic habitats may be affected by the possible input of suspended sediments into the natural hydrographic network. LOW IMPACT	Clearly identify the boundaries of the work area. Recover and dispose of plant debris outside the site and salvage wood with commercial value. <u>Pipe stream crossings (cofferdams and trenches)</u> Work related to these activities that is carried out in the stream must be performed in dewatered conditions. Consequently, in order to protect the fish habitat, work is to be performed between June 1 and September 15, outside the heavy rainfall period. A supervisor must be present on the worksite at all times while the trench is being dug in the streambed. A spare pump with sufficient capacity must be available. Ensure that the flow management system (pumping of water in the trench or work area) is not a source of suspended solids and does not cause erosion of the bed or bank. Filter water containing suspended solids originating in the work area in order to purify it before releasing it into the stream. In order to avoid disturbing the stream, do not operate machinery below the natural high water mark. For crossing the stream, only one machinery crossing site is authorized. The crossing must only be wide enough to allow one piece of equipment to cross at a time (one lane). The materials used to fill the trench serving as the stream crossing	NEGLIGEABLE

DESCRIPTION OF EFFECTS AND MITIGATION MEASURES				
Description of project components or activities	**Environmental components affected by the project**	**Description of environmental effects**	**Mitigation and/or compensation measures**	**Description and magnitude of residual impacts**
			must be free of fine particles. Stream banks and crossing approaches disturbed by these activities must be stabilized immediately upon completion of the work. Once installation of the pipe is complete, the trench excavated in the stream can be partially filled with foundation materials. In order to restore the streambed to its initial condition, the upper part of the trench (15-20 cm) must be filled with materials matching the natural grain size in the stream. The materials used to build the cofferdams must be free of fine particles (clean stone, sand bags, etc.). These materials must be completely recovered upon completion of the work. Install a sufficiently strong geotextile membrane to maintain the original condition of the bed and bank. Management of fish confined in the work area Remove fish before the work area is dewatered in order to prevent them from being killed. Equip the end of the pump system suction pipe with an appropriate device in order to avoid drawing up or injuring fish (see the Freshwater Intake End-of-Pipe Fish Screen Guideline at: http://www.dfo-mpo.gc.ca/oceans-habitat/habitat/water-eau/pipe/index_e.asp). Work on stream banks On the banks, avoid stripping the soil and grubbing (NHWM + 30 m) in the right-of-way near the stream. Only soil in bank areas required for equipment crossings and pipe installation is to be stripped. Dispose of materials excavated from more than 30 m above the NHWM of all streams. Non-contaminated materials (characterization conducted to verify quality) can be reused to restore the work areas, respecting the natural slope profile and initial grain size. In order to avoid disturbing the stream, do not operate machinery below	

DESCRIPTION OF EFFECTS AND MITIGATION MEASURES				
Description of project components or activities	**Environmental components affected by the project**	**Description of environmental effects**	**Mitigation and/or compensation measures**	**Description and magnitude of residual impacts**
			the natural high water mark. Only one return trip with machinery is permitted in the river. Wash, service, park and refuel construction machinery and store fuel and other hazardous materials more than 30 m from the NHWM or a greater distance that is sufficient to prevent any deleterious substances from entering the water. Ensure that machinery is clean and free of leaks and that it is maintained in this condition throughout the work period. Keep oil spill kits on the worksite in case of emergencies. Know how to use emergency equipment in case of an accidental spill. In the event of an accidental spill of oil or any other harmful substance, call the Environment Canada (1-866-283-2333) and Department of Sustainable Development, Environment and Parks (1-866-694-5454) emergency numbers immediately. Ensure contaminated substrates, used oil and recovered oil are transported to a designated site. Maintain appropriate sediment and erosion control measures throughout the duration of the work and until the disturbed areas are restored. In streams, avoid transporting any fine particles outside of work areas. Remove debris accidentally introduced into the aquatic environment, bank or flood plain as soon as possible. Rehabilitate the banks using recognized vegetation stabilization techniques that take into account the stability, sensitivity to erosion, slope and height of the bank. Revegetation must be conducted as soon as possible once the earthworks operations are completed. Indigenous species should be used. <u>Wetlands</u> Obtain certificates of authorization from provincial authorities before	

DESCRIPTION OF EFFECTS AND MITIGATION MEASURES				
Description of project components or activities	**Environmental components affected by the project**	**Description of environmental effects**	**Mitigation and/or compensation measures**	**Description and magnitude of residual impacts**
			carrying out any work in wetlands. The proponent must demonstrate compliance with all mitigation measures and compensation plans required in the certificates of authorization issued for the work. Copies of the certificates are to be forwarded to the CED representative The permanent pipe right-of-way must be limited to 8 m. The temporary right-of-way (for the duration of the work) must be no more than 6 m wider than the permanent right-of-way (reduce width where possible). Clearly mark the forest clearing boundaries in the field. A qualified biologist will complete and maintain wetland boundary marking and identification. Routine monitoring of wetland crossings must be carried out by a qualified biologist. The locations of vulnerable species populations in the temporary right-of-way (wetland #4) must be marked as no-access areas at all times. The marking must be done by a biologist who has the knowledge necessary to identify the species. This measure will apply to other wetlands crossed where these species are identified. Forest clearing and pruning outside the right-of-way are prohibited without written authorization from the landowner and the worksite manager. Forest clearing will be carried out in such a way as to protect all trees, shrubs and other vegetation outside the right-of-way from damage or mutilation. Properly dispose of materials and debris produced by clearing the forest, cutting vegetation to the ground, carrying out removal operations and grubbing. If possible, plant debris must be chipped and reused. No burning will be permitted on site. Wood of commercial value that is cut in the right-if-way remains the	

DESCRIPTION OF EFFECTS AND MITIGATION MEASURES				
Description of project components or activities	**Environmental components affected by the project**	**Description of environmental effects**	**Mitigation and/or compensation measures**	**Description and magnitude of residual impacts**
			property of the landowner. Separate the various soil types found inside the trenches and replace them according to the original stratigraphy; this work will be conducted under the supervision of a qualified biologist or agronomist. Place a clay plug around the pipe at wetland inlets and outlets to prevent the infiltration of surface water toward the pipe. Materials used to build machinery access roads in the temporary or permanent pipe right-of-way will not include fine materials and they will be completely removed once the work is completed. Carry out work during the dry season. Maintain equipment in good working condition in order to prevent accidents and leakage of fuel, oil and grease. Restrict the movement of vehicles and machinery to the proposed roadways, which must be clearly identified. The temporary right-of-way must be restored and revegetated upon completion of the work. General maintenance and fuelling of vehicles must be conducted in areas designated for this purpose that are located more than 30 m from streams and wells, and away from excavations, in areas where there is no risk of contaminating the aquatic environment (via storm sewers or agricultural ditches). Implement suspended solids control measures (sedimentation basin, filter barrier will be installed as needed).	
	Rare plant species	Clearing of the right-of-way for pipe construction could destroy a small population of a species at risk in wetland 4 (temporary right-of-way). MODERATE IMPACT	Obtain certificates of authorization from provincial authorities before carrying out any work in wetland habitats of species listed under the *Act Respecting Threatened or Vulnerable Species*. The proponent must demonstrate compliance with all mitigation measures and compensation plans required in the certificates of authorizations issued for the work. Copies of the certificates are to be forwarded to the CED	NEGLIGEABLE

DESCRIPTION OF EFFECTS AND MITIGATION MEASURES				
Description of project components or activities	**Environmental components affected by the project**	**Description of environmental effects**	**Mitigation and/or compensation measures**	**Description and magnitude of residual impacts**
			representative. Mark the vulnerable species habitat as a permanent no-access zone in the plans and specifications and install fences around the area.	
	Farmland	The pipe will be constructed along an area of agricultural grassland that is 955 m long and 14 m wide. Depending on the timing of the work, it could conflict with farming activities and affect deep drainage. LOW IMPACT	Obtain authorization from the Commission de protection du territoire agricoles du Québec (CPTAQ) before conducting any work related to the installation of pipelines or other associated works in agricultural areas. The proponent must demonstrate compliance with all mitigation measures required by CPTAQ. Notify residents of the area in advance of the start date and anticipated duration of the work. Work must be restricted to normal hours of work, between 7:00 a.m. and 7:00 p.m. Take appropriate measures to limit dust, such as placing tarpaulins over materials transported by trucks and applying dust suppressants more than 30 m from streams (dust suppressants must be suitable for agricultural environments). Upon completion of the work, remove unused materials, waste, scraps, pebbles, rubble and woody, stump or root debris from the right-of-way. Dispose of these materials in accordance with existing regulations. Burning will be prohibited on the construction site. Ditches obstructed or disturbed by the work must be restored. Repair or rebuild fences and other essential structures that were removed or damaged. In the cultivable portion of the route, the pipe must be buried at a sufficient depth so as not to interfere with surface and subsurface drainage of agricultural land. In order to avoid adverse effects on agricultural productivity, topsoil and subsoil must be piled separately from the deeper layers during installation of the pipe. Soil must be replaced in its original sequence. Remediate soil compaction upon completion of the work.	LOW to NEGLIGEABLE

DESCRIPTION OF EFFECTS AND MITIGATION MEASURES				
Description of project components or activities	**Environmental components affected by the project**	**Description of environmental effects**	**Mitigation and/or compensation measures**	**Description and magnitude of residual impacts**
			Heavy machinery traffic and storage of construction materials should be limited to within the boundaries of the worksite right-of-way.	
	Traffic safety	During groundwater prospecting and construction of the pipe and the reservoir, traffic will be temporarily disrupted on routes 112 and 257 and on the 4th Rang Road in the vicinity of the work. LOW IMPACT	Restrict vehicle and heavy machinery traffic to the proposed roadways, which must be clearly identified. This impact can be mitigated through the use of suitable traffic signals at the construction site approach and by planning work in such a way that fill and waste materials are transported via the proposed worksite right-of-way.	NEGLIGEABLE
	Economy	The clearing and development work associated with groundwater prospecting and construction of the various project infrastructure components will make a slight contribution to regional employability. LOW IMPACT		LOW (positive)
	Health and safety	Use of equipment in poor working order constitutes a human health and safety risk. LOW IMPACT	Repair construction equipment and faulty vehicles as soon as possible.	NEGLIGEABLE
	Archaeological resource	Development of the access road to the exploratory drilling site and construction of the pipe could disturb a site with high archaeological potential. LOW IMPACT	In the event of the chance discovery of artefacts, all work will be stopped immediately and the discovery will be reported in accordance with Quebec's *Cultural Property Act*.	NEGLIGEABLE
• Operation of the facilities and the well and decommissioning at the end of their operational life	Air quality Soil quality Surface water quality	Contaminant transport to the wells can affect the quality of the pumped water, and improper pumping rates can lead to premature aquifer depletion. LOW IMPACT In the event of spills, use of certain apparatus and various chemicals (cleaners, chlorine, oils and greases, etc.) in the water filtration and treatment building could lead to contamination of municipal storm sewers and could have a downstream impact. LOW IMPACT	Obtain and comply with certificates of authorization from provincial authorities before operation of wells begins. Establish a fenced protection area with a minimum radius of 30 n directly around each well Post a sign indicating the presence of a groundwater source that supplies water intended for human consumption on the site Prohibit all activities, facilities or storage of materials or objects that could contaminate the groundwater, except the intake system equipment, once it is securely installed. If an emergency generator (diesel motor) is required, the generator and its tank must be installed	NEGLIGEABLE

DESCRIPTION OF EFFECTS AND MITIGATION MEASURES				
Description of project components or activities	**Environmental components affected by the project**	**Description of environmental effects**	**Mitigation and/or compensation measures**	**Description and magnitude of residual impacts**
			on a clean base with a containment structure to confine spills and/or spatter that could occur during maintenance. The concrete containment structure must be designed to hold more than 100% of the tank's capacity. Maintain an operational flow that does not exceed 1,337 L/min. The drinking water treatment facilities and the storage areas are designed in accordance with the MDDEP's Guide de conception des installations de production d'eau potable [guide for designing drinking water production facilities]. More specifically, the chemical metering and storage facilities are designed in accordance with Chapter 15 of Volume 2, which is available on the MDDEP Web site.	
	Hydrography (bog), groundwater quality, hydrographic system	Pumping water from the aquifer could affect the water level in the bog and the availability and quality of the resource for other users. LOW IMPACT Decommissioning of the wells could affect groundwater quality if the wells are abandoned without being properly sealed. LOW IMPACT	Monitor the water level in the bog. Conduct a long-term pumping test (3 to 6 months) before the municipality begins operating the wells. Monitor water levels in municipal wells and other designated wells near the municipal wells. Monitor manganese and arsenic concentrations in the pumped water. Operate wells in accordance with recommended flows (1,337 L/min). Respect protection areas and inform owners of affected lots of restrictions issued. At the end of its operational life, the main well will be sealed in accordance with MDDEP's *Guide technique de captage des eaux souterraines et traitement des eaux usées des résidences isolées* [technical guide on groundwater collection and the treatment of wastewater from isolated dwellings] or any other guide recognized by provincial authorities at the time of closure.	NEGLIGEABLE
	Economy	Operation of the well and start-up of the filtration plant will make a slight contribution to regional employability. LOW IMPACT		LOW (positive)

DESCRIPTION OF EFFECTS AND MITIGATION MEASURES				
Description of project components or activities	**Environmental components affected by the project**	**Description of environmental effects**	**Mitigation and/or compensation measures**	**Description and magnitude of residual impacts**
	Quality of pumped groundwater	Operation of the well and start-up of the filtration plant will help improve the quality and quantity of drinking water available to residents. MODERATE IMPACT		MODERATE (positive)
	Health and safety	Use and accidental spills of hazardous materials can result in contamination of soil and water and affect human health, air quality, habitats and resources. NON-SIGNIFICANT IMPACT	The drinking water treatment facilities and the storage areas are designed in accordance with the MDDEP's Guide de conception des installations de production d'eau potable [guide for designing drinking water production facilities]. More specifically, the chemical metering and storage facilities are designed in accordance with Chapter 15 of Volume 2, which is available on the MDDEP Web site. It is prohibited to emit, dispose of, release or discharge hazardous waste or to mix it with a solid or dilute it with a liquid, such as wastewater or rainwater. Chlorine is only to be used to treat drinking water. Empty containers and packaging that held hazardous materials are to be removed from the site. Ensure that appropriate materials for absorbing accidental spills and for the personal protection of workers are kept on site at all times. Take all measures necessary to stop an accidental spill and quickly confine the spilled product. Then, recover the product, dispose of waste and restore the area. Establish a spill prevention and response system and clearly identify the responsible individuals and authorities, as well as the procedure to follow in case of an environmental emergency. Do not pump water containing suspended solids or harmful substances into the wastewater or drainage systems. Do not store or handle hazardous products near bodies of water. All temporary fuel tanks must be installed and dismantled in accordance with the *Petroleum Products Regulation*. Workers should be made aware of environmental emergency response	NEGLIGEABLE

DESCRIPTION OF EFFECTS AND MITIGATION MEASURES				
Description of project components or activities	**Environmental components affected by the project**	**Description of environmental effects**	**Mitigation and/or compensation measures**	**Description and magnitude of residual impacts**
			measures and accidental spill prevention measures. Conduct a retrospective analysis to improve the prevention and response system in case of an accident. All hazardous materials must be transported safely and in accordance with existing regulations and standards.	