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Current State of Understanding of Potential Environmental and Social Risks of Pig Farming in the James Bay Municipality, near Chapais

Report to

Oujé-Bougoumou Eenuch Association
Waswanipi First Nation
Cree Board of Health and Social Services

Prepared by :

Alain N. Rousseau Ph.D., ing.
Simon Ricard ing. Jr., M.Sc.
Renaud Quilbé, D.Sc.

Centre Eau Terre et Environnement
Institut National de la Recherche Scientifique (INRS-ETE)
490 de la Couronne, Quebec (Quebec), G1K 9A9

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SUMMARY

Initiated in 2000 by the *Corporation de Développement Économique de Chapais*, the pig farming project known as the "Quebec Northern Agri-Food Project in the Production and Transformation of Natural Pork Meat" has been proposed along the Obatogamau River, 11 to 20 km south-west of the town of Chapais, in the James-Bay Municipality, on the Trapping Territory of Mr. Malcom Dixon of Waswanipi Cree Community. Representing a 75-M$ investment, the integrated pig farming project will require the construction of 43 buildings over a four-year period and will, according to the promoter, boost the local economy by creating 135 direct jobs. Once completed, the Chapais pig farm will house around 70,000 animals, which represents the largest pig farm project in Quebec. The pig slurry will be treated using the Biofertile ® technology. Biosolids will be used as either: (i) a combustible for the cogeneration plant of Chapais, (ii) a fertilizer for surrounding and remote cropland or (iii) a fertilizer for the surrounding logged areas. The treated effluent will be discharged into the Obatogamau River.

In 2002, a moratorium was established on pig farm development and a provincial-wide, public consultation was initiated to develop a sustainable framework to enhance social acceptability. In December 2004, Bill 54 was introduced in combination with a partial lifting of the moratorium, that is authorization certificates for the establishment of new pig farms were issued by the Quebec Government only in those 339 municipalities (the James-Bay Municipality being one of them), where on-farm nutrients are not exceeding crop requirements. Moreover, Bill 54 provides municipalities with new administrative powers and responsibilities, one of them being the obligation to hold public consultations to inform citizens and to define additional measures to reduce the environmental and social impact of pig farming. It is noteworthy that municipalities and public consultations do not have the legal capacity to evaluate project relevancy nor environmental impacts. Nevertheless, in accordance with directives given by the Provincial Administrator, the James Bay Northern Quebec Agreement, the conditions established in the Regulation Respecting Agricultural Operations and any relevant Municipal Bylaws, the proposed pig farming project in the James Bay Municipality, near Chapais, must be supported by an impact study

Covering most of the Northern Quebec Territory, the boreal forest is characterized by a significantly sensitive environment. In Northern Quebec landscapes and ecosystems, water quality is good and water resources are mostly used for hydroelectricity, mining and logging. Given the harsh climatic conditions characterizing the boreal region and a significant remoteness from major markets, agricultural activities are scarce. Field observations and measurements from several studies have shown that clear cutting has important short-term impacts on streamflow, with increased annual runoff and peak flows; as well as on the quality of surface waters, with increased sediment, nutrient, dissolved organic carbon, and mercury concentrations in rivers and lakes. The latter is modulated by the extent of the watershed harvested area, and is particularly important for lakes with a high drainage ratio (small lakes and large watersheds), as in the case of the Boreal Shield Region. Consequently, there is an effect on aquatic life and, in the case of mercury, contamination all along the food chain, although there is still a lack of information about long-term impacts. Overall human pressure on the numerous lakes and large watersheds is low but water management problems exist and they are related to obsoletes, or complete lack of, sanitation infrastructures in some municipalities and to environmental impacts from the logging and mining industries.

Intensive pig farming has been associated with undesirable impacts on the environment and society. Inappropriate practices are often responsible for contaminated waters, eutrophication of aquatic ecosystems, poor soil quality, and exposure to harmful gases for workers and surrounding populations. In 2003, the BAPE Commission on pig farming development in Quebec recommended a modification of the decision process by increasing public participation. *ROBERT HAMELIN & associés* was contracted by *Consultant LEGOFF Groupe inc.* to conduct the impact study of the pig farming project in Chapais. Using a matrix approach, both project and environment were desegregated into components to identify potential impacts. Semi-quantitative criteria were then used to evaluate the potential impacts and mitigation measures were suggested. Basically the most important positive impact is economic. Most significant negative impacts are related to olfactory pollution and water quality. The promoters are committed to constrain as much as possible the undesirable impacts. However, due to scientific methodological limits, a certain level of subjectivity and uncertainty characterizes the impact study. Hence, social interpretation of environmental risks will depend on access to relevant information and the distribution of benefits and undesirable impacts. Namely the following elements needs to be further clarified by the promoters: (i) pig slurry management plan (biosolids and effluent); (ii) impacts of the discharge of the slaughterhouse effluent into Chapais municipal sewer system; and (iii) accountability and response measures related to environmental monitoring. Complementary analyses of geographical data related to hydrology, topography, nature of soils of the area affected by the pig farming project reinforce the idea that the targeted environment is sensitive to potential disturbances related to intensive pig farming.

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ANC	Chapaisiens Natural Foods *(Aliments Naturels Chapaisiens)*
BAPE	Environmental Public Hearings Office *(Bureau d'audiences publiques sur l'environnement)*
BOD	Biological oxygen demand
CDEC	Economic Development Committee of Chapais *(Comité de développement économique de Chapais)*
COMEV	Evaluation Committee of QMDDEP
COMEX	Expert Committee of QMDDEP
CREAQ	Quebec Economical References in Agriculture Committee *(Comité de références économiques en agriculture du Québec)*
DOC	Dissolved organic carbon
QFAPA	Quebec Society for Wildlife and Parks *(Société de la faune et des parcs du Quebec)*
FMQ	Quebec Municipalities Federation *(Fédération Québecoise des Municiplités)*
JBDB	James Bay Development Board
JBNQA	James Bay Northern Quebec Agreement
HQ	Hydro Quebec *(Hydro-Québec)*
LAU	Land Use Planning and Development Law *(Loi sur l'aménagement et l'urbanisme)*
LPTAA	Preservation of Agricultural Land and Activities Protection Law *(Loi sur la protection du territoire et des activités agricoles)*
QMAMSL	Quebec Ministry of Municipal Affairs, Sports and Leisure *(Ministère des Affaires municipales, Sports et Loisirs)*
QMAPA	Quebec Ministry of Agriculture, Fishing and Alimentation

	(Ministère de l'Agriculture, Pêcheries et Alimentation)
QMRNFP	Quebec Ministry of Natural Resources, Wildlife and Parks *(Ministère des Ressources naturelles, de la Faune et des Parcs)*
MRC	County Regional Municipality *(Municipalité Régionale de Comté)*
OAQ	Quebec Order of Agronomists *(Ordre des Agronomes du Québec)*
OECD	Organisation for Economic Co-operation and Development
QMDDEP	Quebec Ministry of Sustainable Development, Environment and Parks *(Ministère du Développement durable, de l'Environnement et des Parcs)*
RAQ	Regulation Respecting the Quality of the Atmosphere *(Règlement sur la qualité de l'atmosphère)*
REA	Regulation Respecting Agricultural Operations *(Règlement sur les exploitations agricoles)*
SIEF	Ecoforester Information System *(Système d'information écoforestières)*

1 INTRODUCTION

1.1 BACKGROUND INFORMATION

The boreal forest of Canada accounts for about 40% of the world's boreal forest, with a larger proportion of virgin forest than any other country. The forests, interlaced with large rivers, lakes and wetlands, provide habitats for large numbers of mammals and birds. The coniferous tree species of the boreal forest have excellent properties for paper production, dimensional lumber and plywood or other panelling, which accounts for approximately 60% of the Canadian economic activity in forest products [Burton *et al.*, 2003]. Other commercial uses of the boreal forest have been mostly concentrated around mining and hydroelectricity.

Harsh climate conditions, natural cycles of disturbances and successions of wildfire or insect outbreaks, and poor soil conditions have discouraged significant agricultural development and human settlement. Through *millenia*, boreal forests have been home to Indigenous people who live off the land by fishing and hunting, and who are increasingly participating in local economic development such as commercial forestry and eco-tourism. Non-native settlements are few and located around current and old mining sites, saw mills, and hydroelectric power plants. In all settlements, agricultural production is marginal since the boreal environment is established on glacial till or the land is characterized by shallow-soils and infertile uplands alternating with wetlands and poorly drained organic soils with significant nitrogen limitations to plant productivity [Burton *et al.*, 2003].

In 2000, the *Corporation de Développement Économique de Chapais* (CDEC) initiated the Northern Quebec Agri-Food Project to Produce and Process Natural Pork Meat (*Projet Agro-Alimentaire du Nord Québécois en Production et en Transformation de Viande de Porc Naturel*) in the James Bay Municipality, near Chapais, Quebec. On behalf of the CDEC, *Consultant LEGOFF Groupe inc.* [1] recently completed an impact study in accordance to the COMEV directive with respect to Section 22 of James Bay Northern Quebec Agreement (JBNQA), the Regulation Respecting Agricultural Operations (REA), and any relevant Municipal Bylaws.

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[1] 2190, 4^{e} Rue, Saint-Romuald (Quebec), G6W 5M6, Téléphone : (418) 834-8488, FAX : (418) 834-1788

1.2 SCOPE OF THIS REPORT

Considering the remoteness from major markets, it is somewhat surprising that a promoter is planning a large-scale, pig farming project within a northern boreal environment. On behalf of the Council of the Oujé-Bougoumou Cree Nation, the Waswanipi First Nation and the Cree Board of Health and Social Services, this report presents a study on the current understanding of potential environmental and social risks of pig farming in the James Bay Municipality, near the non-native town of Chapais. This study will be used as a discussion paper and will form the basis for a presentation at the upcoming public consultation on the project.

1.3 ORGANIZATION OF THIS REPORT

This report is organized into six Sections corresponding to Chapters Two through Eight. Figure 1.1 presents a schematic representation of the report's structure.

- **Chapter Two** describes the large-scale pig farming project proposed by the CDEC.

- **Chapter Three** presents an up-to-date summary of jurisdictional considerations related to pig farming development in Quebec.

- **Chapter Four** summarizes the current state of knowledge of the impacts of forest disturbances, such as clear cutting, on surface waters of the boreal environment of Canada.

- **Chapter Five** describes the water management portrait of Northern Quebec as reported in 2000 in the proceedings of the public consultation on water management in Quebec conducted by the BAPE (*Bureau d'audience publique du Québec*).

- **Chapter Six** presents a summary of relevant results and findings of the BAPE's public consultation on sustainable development of pig farming in Quebec, that is the environmental (water, soil, air, wildlife habitats) and social impacts (social climate, health risks to workers and surrounding population).

- **Chapter Seven** describes the findings of the impact study conducted by the promoter as provided for in the JBNQA.

- **Chapter Eight** discusses the impact study produced by the promoter and analyzes complementary information and data in terms of the ensuing ecological risks caused by the future implementation of the pig farming project.

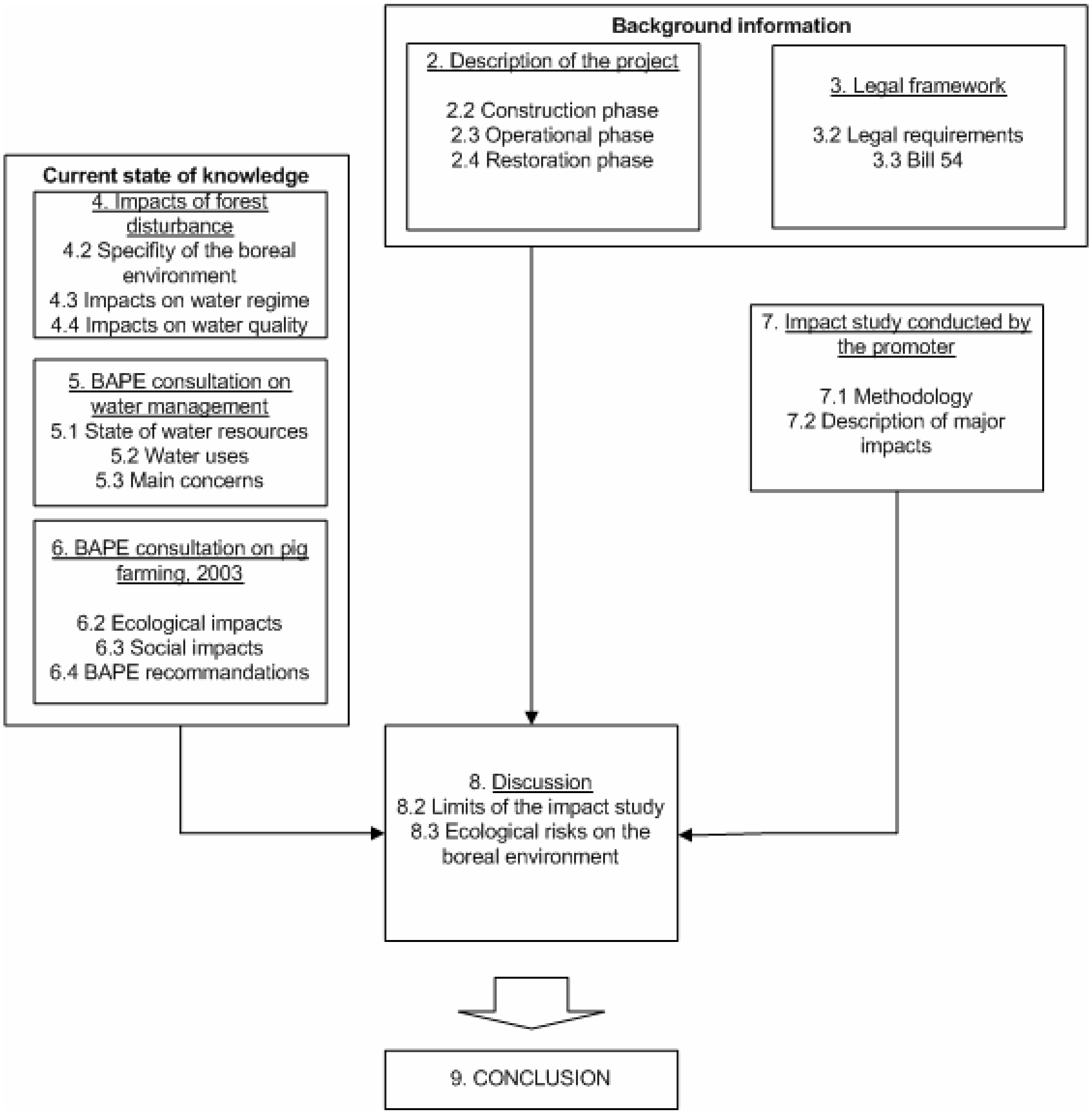

Figure 1.1 Schematic representation of the report.

2 DESCRIPTION OF THE PIG FARMING PROJECT PROPOSED BY CDEC

2.1 BACKGROUND INFORMATION

2.1.1 Pig Farming in Quebec

Until the 1970s, pig production in Quebec was characterized by a relatively constant and slow growth (roughly 2% per year since 1920). Then, production suddenly exploded and the growth rate reached 20% annually between 1976 and 1981 (overall, a total growth of 325%). With a total livestock population of 4.3 million pigs, 1.13 billion dollars in sales receipts, and 28,000 workers (2001), pig farming now represents the second largest agricultural activity in Quebec, right behind dairy farming. This rapid evolution, combined with the pressure of demand-driven market liberalisation, forced Quebec's pig producers to quickly adapt their production methods to focus on productivity, industrialization and specialisation. This resulted in the intensification of pig production (more pigs produced by less farms) with an average size of 1,556 pigs per enterprise (compared to 79.4 in 1971). The agricultural production areas are mainly located in central Quebec where feed is easily accessible. Figure 2.1 presents the distribution of the total pig livestock population in Quebec. Three quarters of pig farms are located in *Montérégie, Chaudière-Appalache* and *Centre du Quebec*. With only four specialized pig farms (the average in Quebec being 157 per administrative region), the *Abitibi-Témiscamingue* region is the second smallest pig producing region.

2.1.2 Pig Farming Models

According to the BAPE Commission on pig farming development in Quebec [BAPE, 2003], it is hard to characterize pig farming, but specific, non-exclusive, elements can be used:

(i) Producer's status, that is, either autonomous or integrated. In the first case, the producer owns all goods required for pig production: land, infrastructures and animals, allowing producers to freely select suppliers. An integrated producer acts mostly as a manager on behalf of others. While the producer has the land and the infrastructures, the integrated producer provides the animals and all the other inputs. The integrated producer is generally in charge of marketing.

(ii) Relationship with the land, that is, a producer either owns cropland, or not.

(iii) Specialization status, that is, the producer is either involved in all production steps (from birth to finishing), or in a few steps.

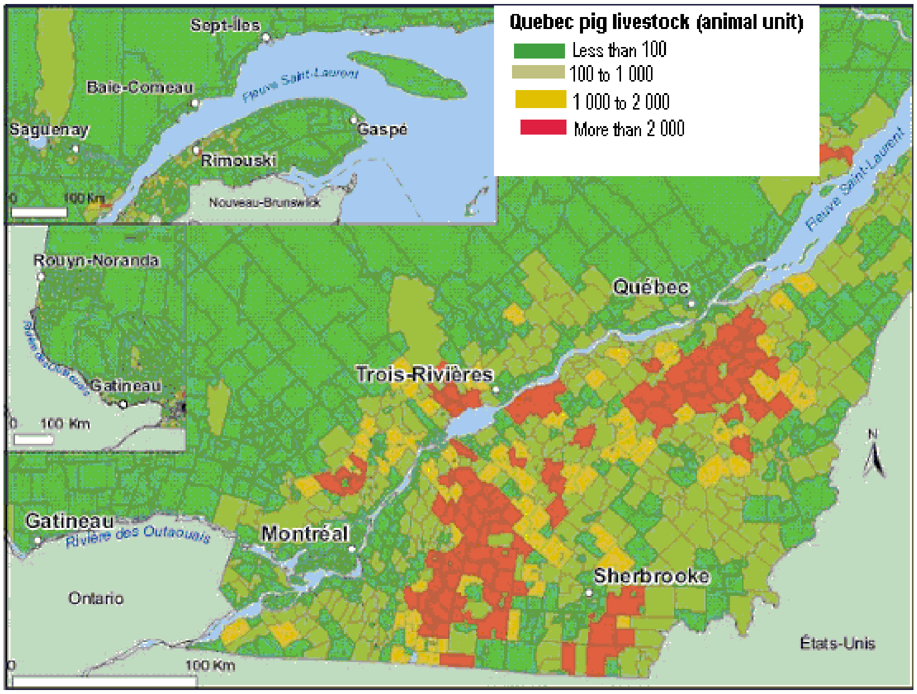

Figure 2.1 Distribution of pig livestock population in Quebec ([BAPE, 2003], volume I, p. 67, adapted from PROD93)

2.1.3 History of the Proposed Pig Farming Project in Chapais

Since the closing down of the Opemisca Mine in 1998, the economic situation has significantly worsened in the Chapais Region. Facing a high unemployment rate (up to 17% at Chapais) and an exodus of the labour force, the un-diversified local economy mostly depends on forest exploitation (timber). Created in 2000 and led by Mr. Jacques Bérubé, Mayor of Chapais, the CDEC is an organisation promoting development of the regional economy[2]. Focusing on economic benefits, the CDEC proposed a project known as the "Quebec Northern Agri-Food Project in the Production and Transformation of Natural Pork Meat", an initiative of the *Groupe Les Aliments Naturels Chapaisiens Inc.* (a.k.a., Goupe A.N.C. Group). Over ten years, the CDEC and the *Consultant LEGOFF Groupe inc.*[3] and *Viandes Kamouraska Packers inc.* are planning to invest 75M$, creating 300 direct and permanent job opportunities.

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[2] More information on the CDEC's projects and development strategies can be found on Ville de Chapais's website: www.villedechapais.com/developecono.htm.

[3] 2190, 4e Rue, Saint-Romuald (Quebec), G6W 5M6, Téléphone : (418) 834-8488, Fax : (418) 834-1788

Construction of the complex is planned over a four-year period and is characterized by an integrated approach to the operation, which, according to the promoters, will ease the management and monitoring procedures. Once completed, the agricultural complex will hold around 70,000 animals (sows, weaned piglets and pigs), much larger than the average pig farm in Québec (1,556 animals).

For now, *Consultant LEGOFF Groupe inc.* and *Viandes Kamouraska Packers inc.* are the only identified promoters of the project with regard to investment, professional training, operations, slaughtering, transformation and marketing. *Consultant LEGOFF Groupe inc.* completed in February 2005 a study on the potential environmental impacts of the project [Consultants LEGOFF Groupe inc., 2005]. The study presents exhaustive information related to the project phases, the environment, public concerns, potential impacts and attenuation measures. The following sections present a brief description of the pig farming project while evaluation of the environmental impacts will be discussed in Chapter 7.

2.2 CONSTRUCTION PHASE

2.2.1 Location

According to the promoters, the project will be located on Category III Public Lands, mostly forested. Breeding sites will be located on a land strip roughly located along the Obatogamau river South-West of Chapais (11 and 20 km, see Appendix A), corresponding to the centre of W-23 Trapping Territory of Mr. Malcom Dixon of Waswanipi Cree Community. The major selection criteria for this location, as justified by the promoters, are:

(i) potential spacing between buildings offers increased sanitation security;

(ii) strategic location regarding prevailing winds reduces the spreading of odours towards the city; and

(iii) current road access[4].

Other buildings include a grain storage facility, a feed mill, an administration office, and a garage on the South-West outskirt of Chapais. A slaughterhouse will be located in the city's industrial park.

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[4] A complete list of criteria is presented in [Consultants LEGOFF Groupe inc., 2005], p. 13

2.2.2 Preparation Works

Clearing works (tree cutting, branch burning, stump extraction and grading) will need to be done before undertaking the construction of the main infrastructures. According to the promoters, the total cleared area is estimated at 32 ha.

2.2.3 Buildings

The construction of the pig farm infrastructures will take place over a four-year period in three major phases (Phases I, II, III). Table 2.1 chronologically summarizes the description and functions of the buildings. The specific location of each item is presented in Appendix A.

Table 2.1 Infrastructure characteristics

Building Function	Number	Dimension *l-w-h* (Feet and inches)	Distance from Chapais (km)	Stripped area (m²)	Buildings per phase		
					I	II	III
Quarantine	1	190’4” - 58’6” - 17’	24.0	4,400	1		
Artificial insemination center	1	149’8” - 48’ - 16’	25.3	5,600	1		
Selection-multiplication				31,200			
Birth	1	278’5” - 101’2” - 20’	24.9		1		
Nursery-finishing	1	500’11” - 104’3” - 21’	24.9		1		
Slurry treatment plant	6		17.0-23.5	?	2	2	2
Building A		77’6” - 61’4” - 37’2”					
Building B		40’8” -16’4” - 20’					
Building C (bioreactor)		94’8”(diam) - 20’					
Office and garage	1	88’8” - 42’9” - 25’	4.8	750	1		
Other garage	1	60’ - 42’9” - 25’	20.0		1		
Grain storage facility and feed mill	1	48’ - 40’ - 80’	4.7	1,950		1	
Birth							
Gestation	3	437’2” - 81’6” - 20’	22.2-23.5	108,000	1	1	1
Maternity	3	267’4” - 92’ 5” - 20’	22.2-23.5		1	1	1
Nursery	8	209’8” - 47’10” - 16’	20.3	43,200	3	3	2
Finishing	15	235’4” - 103’10” - 21’	17.0-19.8	117,600	5	5	5
Slaughterhouse	1	207’6” - 161’4” - 26’	0.0	7,500		1	
Slaughterhouse wastewater treatment plant	1		0.0	?		1	
Building A		77’6” - 61’4” - 37’2”					
Building B		40’8” - 16’4” - 20’					
Building C		94’8” (diam) – 20’					
Incinerator	1	?	18.7	?	1		
Total	43			320,200	17	15	11

Source: [Consultants LEGOFF Groupe inc., 2005], p. 31 and 35.

Detailed information related to construction techniques and building site organization is available in the environmental analysis conducted by Consultants LEGOFF Groupe inc. [2005; pages 29 to 65].

2.2.4 Related Infrastructures

2.2.4.1 Water Supply

Water will be supplied by artesian wells at each site or in surrounding eskers. The construction of reservoirs will provide a 24-hour water supply. In October 2004, a brief analysis was conducted to evaluate ground water yields. Results showed a pumping capacity of 10 to 45 gallons per minute. The minimum required yield to meet livestock needs is 10 gallons per minute. The promoters will conduct a more in-depth analysis if the project gets final approval.

2.2.4.2 Access Roads

An enlargement of the current gravel road (see Appendix A) is required over a 5.2 km stretch. An equivalent distance is needed for the construction of access roads leading to all buildings.

2.2.4.3 Protection against Fire

In case of fire at the breeding sites, ten firemen and one fire truck would be available in Chapais. Moreover, implementing a sprinkler system is not an option because of the quantity of water required. Thus, to ensure protection against fire spreading in the surrounding areas, the promoters will implement security measures such as:

(i) annual fire fighting training of some workers;

(ii) construction of two 750-m^3 water dugouts close to the birth and finishing sites;

(iii) ensure the permanent presence of fire trucks (bought by the promoters) close to finishing sites and the main access road; and

(iv) creation of a 30-m fire barrier and a 20-m buffer zone[5].

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[5] Quebec Ministry of Natural Resources, Wildlife and Parks (QMRNFP) required a 10-m fire barrier and a 20-m buffer zone.

2.3 OPERATIONAL PHASE

The operational phase refers to actual activities involved in pig farming. Figure 2.2 illustrates the processes related to this specific phase and synthesizes the complex interrelations of the livestock production cycle. Four major steps are described below: feeding (2.3.1), production (2.3.2), slurry management (2.3.3) and waste management (2.3.4).

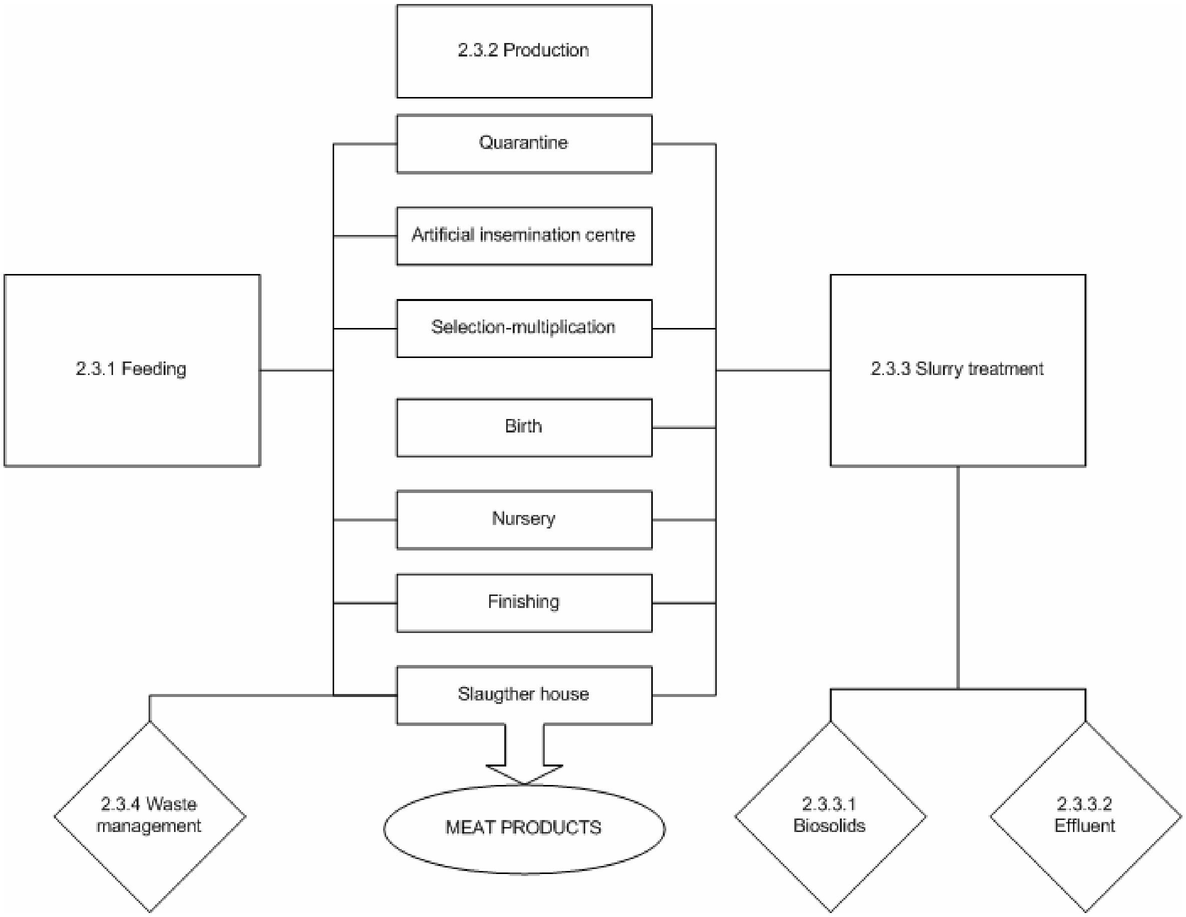

Figure 2.2 Schematic representation of the operational phase ([Consultants LEGOFF Groupe inc., 2005], p.43, Simplified version)

2.3.1 Feeding

The first step of the operational phase is supplying grain and other raw materials to the feed mill. For the producer, the diet is a key factor to cost effectiveness, representing up to 75% of the variable costs of the enterprise. The ration composition is based on energy (corn, barley, wheat, oat), protein (soy oil cakes and peas) and minerals, salts and other supplements. It allows for a controlled administration of food and medication to the animals depending on gender, weight, age and genetic considerations. According to the promoters, for a few days, medication will be added to the rations of weaned piglets.

The grains will be transported from surrounding crop production areas (*e.g.* Saguenay, Lac Saint-Jean, Abitibi, Southern Quebec) to the feed mill by train or truck. To ensure a certain level of sanitary control, the area around the grain storages will be cleaned and extermination measures will be undertaken in the area surrounding the mill and buildings. The total annual feed supplied is estimated at 43,503 tons per year, a daily supply of eleven 15-ton trucks.

2.3.2 Production

The production step refers to livestock development. It involves a complex "animal migration scheme" from one building to another, depending on growth stage. Production management in a large pig farming project is increasingly supported by software where energy optimization and genetic control are key factors. Two livestock groups, each one evolving along different production paths, exist: multi-reproduction livestock and commercial livestock.

Multi-reproduction livestock is composed of gilts and boars for reproduction. Gilts start out at the multiplication site, while the boars wait at the insemination site. Once inseminated and after approximately 100 days of gestation, mature sows are relocated to the birth site. The sows will have up to 13 piglets (destined for the commercial livestock facility upon weaning). While developing the multi-reproduction livestock, measures are necessary to prevent contamination and to ensure a good genetic reproduction.

The commercial livestock is composed of piglets available for slaughtering and transformation into meat products. After 21 days of suckling in parturition cages, weaned piglets are transferred to the nursery site where they will grow up to 20 kg (about 45 days). Afterwards, they will spend 100-120 days in the finishing site (up to 115 kg).

Gilts and boars not required for reproduction, as well as, mature pigs from the commercial livestock facility, are taken to the slaughterhouse to be slaughtered, transformed (chopped, wrapped and frozen) and transported by refrigerated trucks to distribution centres (mostly Montréal).

Table 2.2 gives quantitative details on both multi-reproduction livestock and commercial livestock. The total number of animals in the Chapais pig farming project is estimated at 70,010 animal (equivalent to 6,563 animal units). According to Brouillet [2005], the proposed size will be the largest pig farming project in Quebec.

2.3.3 Slurry Management

2.3.3.1 Biosolids

A slurry treatment process called Biofertile®, designed by Envirograin and authorized by the Quebec Ministry of Sustainable Development, Environment and Parks (QMDDEP), will be implemented at all six treatment plants and the slaughterhouse. Thus, the bisolids of the feces and slaughterhouse sewage will be filtered and dehydrated to produce a valuable and reusable material for agriculture. According to Envirograin, this process provides the following benefits: low production cost, less odour, reduced volume, and good agronomic value.

Table 2.2 Livestock of the Chapais pig farming project

Site	Livestock	Total number of animals	Animal Units[6]
Multi-reproduction livestock			
Quarantine	Gilts	460	71.9
Artificial insemination center	Boars	60	9.1
Multi-birth	Sows	740	145.1
Multi-nursery	Weaned piglets	2,450	62.8
Multi-finishing	Finishing gilts	2,900	483.4
Commercial livestock			
Birth (3 buildings)	Sows	5,520	1,082.4
Nursery (8 buildings)	Weaned piglets	20,480	525.1
Finishing (15 buildings)	Finishing pigs	37,500	4,213.5
Total		**70,010**	**6,563**

Source: [Consultants LEGOFF Groupe inc., 2005], p.47.

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[6] Evaluated in accordance with the *Comité de références économique en agriculture du Québec* (CREAQ) [1991]

On a daily basis, 50 m^3 of biosolids, containing 25% dry matter, will be produced. A telemetric system will remotely control all operations, allowing rapid intervention and continuous monitoring. Samples will be taken and analyzed every other week. In case of breakdowns, the treatment system will have a 35-day retention capacity.

Three options are being considered for valuing the biosolids:

(i) Biosolids could be used as fuel compounds for the Chapais cogeneration plant. This option would reduce odour production by avoiding biosolid stockpiling. This operation requires transportation of significant quantities of biosolids to Chapais. However, the technical and environmental feasibility of this option has not yet been demonstrated.

(ii) Given the limited cropland in the Chapais region, it is impossible to locally agronomically value all biosolids produced by the pig farming complex unless new agricultural projects are undertaken. Drying and transporting of biosolids to remote agricultural regions would be expensive for the promoters.

(iii) Biosolids could also be used to fertilize the neighbouring logged area left by the Chapais-Barette timber harvesting activities, upgrading harvesting efficiency and improving soil quality. As for option (i), no methodology has been approved.

2.3.3.2 Effluent

The Biofertile® technology allows for the separation of slurry into biosolids and liquids - valuing the effluent represents a great challenge. Considering the poor drainage properties of the soil, the option considered by the promoters is the treatment and the discharge of the effluent into surface waters. The pig farming complex is expected to produce 500 m^3/day of effluent – 350 m^3/day, after biological and electrochemical treatments (described below) at the six treatment plants, and 140 m^3/day from slaughterhouse. Effluent discharge requires an authorization of the QMDDEP.

Once separated form the slurry, the effluent will be directed into a decantation basin where it will undergo three treatment processes. First, aerobic, biological treatment will take place to capture organic nitrogen and get rid of ammonia-nitrogen. This process produces gas nitrogen (N_2), a non-toxic and non-greenhouse effect gas. A second advanced biological process (FLAIR®) will provide for a refined water filtration as well as an air filtration, reducing odour spreading. A final electrochemical polishing treatment (POLIPUR®, patent pending) will catalyze the decantation of residual phosphorus, suspended matter and pathogenic microorganisms. All solid decanted residues will be combined with the biosolids.

Part of the treated effluent will be reused for washing the gutters, the rest will be discharged into the Obatogamau River (from the treatment plants) and into Chapais' municipal sewer system (from the slaughterhouse). To avoid damage from freezing and thawing, underground pipelines will be installed at the treatment plants and along the river bank. Ground water quality will be monitored using piezometers located around the treatment plants and the other buildings.

2.3.4 Waste Management

Wastes at the slaughterhouse include animal carcasses, placentas, fat and blood. On an annual basis, 135,200 pigs will be slaughtered representing 3,380 tons of organic matter. Most organic wastes will be directly shipped to an incinerator (morgue, incinerators and ash storage facilities) located close to the finishing centres (kilometre 18.7, see Appendix A). Fourteen incinerators (burning capacity of 75 kg/hour) will operate up to 12 hours a day, five days a week. The amount of ashes produced annually is estimated at 125 tons (more or less 1 m^3/week). Ashes will be stockpiled in a horizontal storage facility (260-m^3 capacity) and will be shipped to a dump site 20 km from Chapais. Greases and blood are by-products of pig slaughtering that can be valued. To extract grease and blood, note that a biological treatment, similar to Biofertile®, can be applied to the slaughterhouse wastewater.

2.4 RESTORATION PHASE

After cleaning and demolishing the buildings, part of residual materials will be recycled or transported at a local dumpsite. Potentially contaminated soils will be removed and restoration work will be implemented over areas where the buildings were. The promoters are committed to invest in a restoration fund, ten years after beginning operation, equivalent to 10% of the estimated restoration costs.

3 LEGISLATIVE FRAMEWORK

3.1 BACKGROUNG INFORMATION

Quebec laws with regard to pig farming are characterized by a parallel evolution of two regimes. Both introduced in the late seventies, the Preservation of Agricultural Land and Activities Protection Law (*Loi sur la protection du territoire et des activités agricoles – LPTAA*) and the Land Use Planning and Development Law (*Loi sur l'aménagement et l'urbanisme – LAU*) established a complex jurisdictional system of overlapping administrative powers. Since then, many attempts have been made to harmonize these laws, introducing principles favouring producers such as the lawsuit immunity of 1989 and the agricultural activities protection of 1997. Nevertheless, observing the tensed debate regarding to pig farm establishment, one can conclude that there is a lack of agreement and an increase in political tension, due to a rigid jurisdictional framework, insufficient information being conveyed to the public, and a lack of transparency in the whole decision process [BAPE, 2003].

In June 2002, the pig farming restriction Law *(Loi sur la restriction de l'élevage des porcs* – L.Q. 2002, c.18) imposed a moratorium on the development of pig farming in Quebec. The REA [MENV, 2003a,b; Gazette Officielle du Quebec, 2004] [a.k.a., *Règlement sur les exploitations agricoles* (REA)] was enforced, right away mandating the BAPE (see Chapter 6) to define a sustainable development framework for pig farming in Quebec, that takes into account environmental, social and economical issues. The BAPE report on pig farming was released in 2003 [BAPE, 2003], with one of the main recommendation being: "[…] the implementation of an environmental and social impacts analysis process involving public participation […]."

3.2 LEGAL REQUIREMENTS

The CDEC*,* for the ANC. Group, mandated *Consultants LEGOFF Groupe inc.* to conduct the impact study[7] in accordance with the directive given by the Provincial Administrator [COMEV, 2003]. The directive defines the nature, extent and scope of the environmental and social impact study that the developer must carry out, as provided for in the JBNQA. The directive must consider the following guidelines of Section 22, specifically [COMEV, 2003]: (i) reduction of the impact of development activities on the Native people and their territory; (ii) protection of the Native people, their societies, communities, and economy from

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[7] This study was officially completed on February 25, 2005 [Consultants LEGOFF Groupe inc., 2005].

development activities affecting their territory; (iii) protection of wildlife resources, physical and biological environment, and ecosystems, from development activities affecting their territory; (iv) respect the rights and interests, whatever they may be, of non-Aboriginal people; and (v) respect the right to proceed with development, a right that individuals acting lawfully on the territory have.

The impact study required by the Provincial Administrator [COMEV, 2003] must describe characteristics of the project and explain the purpose, taking into account the environment in which the project will take place and how this environment will be affected during the construction phase of the project, as well as during full operation. This exercise provides the basis for examining alternative means and their impacts on the environment while minimizing or eliminating any negative impacts on the environment, the resources, and the quality of life of the individuals and communities. The impact study must also propose monitoring and follow-up programs to comply with government requirements and the proponent's commitments as well as follow the dynamics of specific components of the environment affected by the project.

In addition, the proposed pig-farming project must abide by:

(i) conditions established in the *REA*, particularly that livestock waste is subject to complete treatment - this means that the waste must be transformed into solid matter of a different nature (*i.e.*, fertilizing granules or mature compost), whereby the bacteria contained therein are destroyed;

(ii) Municipal Bylaws respecting minimal distances between livestock buildings as well as spreading activities on cropland and urban areas as well as single housings in rural areas.

3.3 BILL 54

The Act to amend various legislative provisions concerning municipal affairs (Bill 54) came into effect in November 2004, modifying the LAU[8] and partially removing the moratorium on pig farming development imposed in 2002. In municipalities characterized by the production of farm nutrients in excess of crop requirements (overall 228 municipalities), only expansion is allowed in compliance with specific conditions. In the other 339 municipalities, all new pig farming projects are able to get authorization certificates by QMDDEP.

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[8] http://www2.publicationsduquebec.gouv.qc.ca/dynamicSearch/telecharge.php?type=5&file=2004C20F.PDF

MRCs (*Municipalité Régionale de Comté* or County Regional Municipality) are provided with more legislative flexibility with respect to zoning of livestock operations, minimal separating distances, and protection of woodlots, riparian zones, and sensitive areas. The Quebec Government partially tightened application of various environmental laws and regulations before the moratorium on pig farming was removed on December 15, 2004.

3.3.1 New Requirements

New Municipal Bylaws, as stated in Bill 54, namely municipalities [FQM, 2004], are required or have the right to:

(i) hold a public consultation before expansion or establishment of certain pig production facilities;

(ii) impose supplemental requirements; and

(iii) regulate and set quotas for pig production in their territory.

All projects of expansion or establishment of pig production facilities proposed to a municipality must be supported by several documents including: a nutrient management plan signed by a member of the Quebec Order of Agronomists (OAQ, *Ordre des Agronomes du Quebec*), fertilization rates on each cropland, spreading activities including application techniques, proposed application dates, names of municipalities where applications will take place and annual production of P_2O_5 should all be specified in the plan.

3.3.2 Public Consultations

According to Bill 54, a public consultation must take place prior to the emission of a construction permit by a municipality and within 30 days following transmission of the aforementioned QMDDEP authorization certificate to the municipality. The objectives related to such a process are to:

(i) provide information to concerned citizens;

(ii) answer their questions;

(iii) hear their concerns; and

(iv) elaborate mitigation concerns.

The ministry insists on clarifying the goal of the consultation process:

"[…] the public consultation is not an opportunity to judge the relevancy of authorizing or not the project, neither to weigh up the impacts on environment as all unacceptable projects, with regards to municipal or QMDDEP rules, will have already been rejected.[9]"

The Mayor acts as the president of the commission/council in charge of the public consultation. Two members of the municipal council, the promoter or project spoke person, as well as representatives of the QMAPA (Quebec Ministry of Agriculture, Fisheries and Food, *Ministère de l'Agriculture, des Pêcheries et de l'Alimentation*), QMDDEP, and the regional director of Public Health. During the public consultation, members of the commission will be there to hear and answer any citizens or group of citizens who have decided to voice their concerns with the pig farming project. Within 30 days following the end of the public consultation, the commission will publish a report including specific recommendations and supplemental requirements for the emission of a construction permit. The consultation may be held by a MRC if the municipality wants, however, it is the municipality that is responsible for the supplemental requirements attached to the construction permit (*e.g.*, construction of a roof over a slurry storage tank to reduce emission of odours, soil incorporation of slurry within 24 hours following spreading activities, minimal separating distances, rows of trees acting as odour screen, water saving equipment). In cases where the promoter disagrees with the list of supplemental requirements, a conciliator will be appointed by the QMAMSL (Quebec Ministry of Municipal Affairs, Sports and Leisure, *Ministère des Affaires Municipales, Sports et Loisirs*). The conciliator will report the discussion results within 30 days of his/her appointment. However, the final list of requirements will be issued by the municipality.

3.3.3 Quotas

Since June 2002, municipalities have the power to regulate and set quotas for pig production in their territory. This may be done by delineating production zones in terms of a maximum number of identical or similar pig farm production facilities, minimal distances between these facilities, and maximal floor surfaces or land areas for breeding and rearing activities. This power may also be granted to MRCs through interim control regulation that will be or have been accounted for in the MRC land-use planning. In fact, it is the recommended framework to face any expansion or establishment project of certain pig production facilities that could be granted a QMDDEP authorization certificate following the lifting of the moratorium. Once there is a new MRC land-use planning, a local municipality may then invoke the new quotas for pig production in their territory.

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[9] Muni express p.3

4 IMPACTS OF FOREST DISTURBANCES ON WATERS OF THE BOREAL ENVIRONMENT

4.1 BACKGROUND INFORMATION

The implementation of a large-scale, pig farm project in the boreal environment will probably result in some direct deforestation (estimated at 32 ha by the promoters). Moreover, as it is the case in regions of southern Quebec with intensive pig production, additional or new cropland may be necessary for the disposal of pig slurry as an organic fertilizer. This will probably lead to further deforestation in order to develop agriculture where soil conditions may or may not be favourable.

Forest exploitation has several impacts/effects on river morphology, streamflow, water quality and aquatic ecosystems. The nature and extent of these impacts depend on climate, geology, topography as well as forest structure and composition. Boreal forests are fragile ecosystems with a slow dynamic and any disturbance such as wildfire and logging can have strong adverse effects on these ecosystems, taking time to recover from. However, there is very little data about these effects. Most studies on the impact of wildfire and logging in the Canadian boreal forest are concerned with ecosystems, wildlife and soils. Very little information related to water quality has been collected at the watershed scale.

4.2 SPECIFICITY OF THE BOREAL ENVIRONMENT

Canadian boreal forests are divided into six subregions based on geological and climatic characteristics. This section reports on the subregion of interest, the Boreal Shield of central and eastern Canada.

An important specificity of Northern Boreal Shield is the presence of wetlands, which cover about 10% of the landscape. Surface waters are located on bedrock covered by thin glacial deposits. Most lakes are small (0.15 – 0.81 km^2) and shallow. The hard rock formation (granite, basalt) of the Boreal Shield makes the soil less sensitive to erosion than in sedimentary landscapes. Consequently, fewer nutrients are transported via runoff and surface water is more diluted than elsewhere, such as the Boreal Plain. Lakes are mostly oligotrophic and acidic. Algal communities are dominated by flagellated algae, like small chrysophytes, diatoms, dinoflagellates, and cryptophytes.

A study which investigated 47 undisturbed lakes and their watersheds in northern Quebec showed that nutrient concentrations, water clarity and greenness are mainly controlled by drainage ratio (watershed area divided by lake volume) and watershed slope, which implies that lakes of large and flat watersheds are richer in nutrients and ions than those of small watersheds, and may be more susceptible to enrichment from watershed disturbances [Carignan *et al.*, 2000].

4.3 IMPACTS OF LOGGING ON WATER REGIME

4.3.1 General Concerns

With regard to the hydrological regime, deforestation systematically induces an increase in annual runoff, with a direct link between the proportion of the area being clear cut and the change in annual runoff [Plamondon, 1993]. This effect is changes with the time of the year; the increase is greater in summer because of the drastic reduction of evapotranspiration after clear cutting and the resulting change in water balance. Data from Ontario and New Brunswick showed increases varying between 100% and 200% of summer base flow [Ordre des ingénieurs forestiers du Quebec, 1996]. The main consequence of deforestation is an increase of low water peak flows [Beschta *et al.*, 2000; Caissie *et al.*, 2002 in Lavigne *et al.*, 2004]. This increase in water discharge dynamics has consequences on river morphology, notably by modifying erosion processes. These effects can be modulated by the proportion of forest harvested and, in a lesser extent, the presence of buffer strips. A literature review by Plamondon [2004] showed that the cut area must exceed 50% of the watershed to have an effect on peak flow that can alter aquatic habitat.

4.3.2 Specific Data for Boreal Shield Forest

The effects of clear cutting on runoff and streamflow are roughly the same in Boreal forest as in mixed forest of southern Canada. Several studies have confirmed this using field data. For Plamondon [1993], the increase of annual runoff after clear cutting varied between 15% when annual precipitation exceeds 1,400 mm, and 50% when annual precipitation is lower than 900 mm. This increase was found to be as high as 300% for Nicolson *et al.* [1982].

4.4 IMPACTS OF LOGGING ON WATER QUALITY

4.4.1 General Concerns

Many studies in North American forests have shown that the impacts of deforestation on several water quality parameters may include:

- Increased mean temperature and the difference between minimal and maximal temperatures [Feller, 1981]. This applies to rivers rather than lakes [Plamondon, 1993].
- Increased water acidity.
- Increased sediment concentration due to water erosion on bare soil, as well as erosion of river banks and river bed.
- Decreased dissolved oxygen, linked with an increase in biological oxygen demand (BOD) and temperature.
- Increased dissolved organic carbon (DOC), coming from forest organic soils and carried by runoff and erosion. This is accompanied by an increase in turbidity.
- Increased nutrient (N and P) concentrations that are no longer being utilized by trees and are, therefore, available for transport via runoff and erosion. Consequently, conditions favourable to eutrophication of rivers and lakes are enhanced. It should be noted that this contamination might also affect ground water, especially for nitrates - it has been shown that nitrate concentrations in ground water could undergo a 200 fold increase after cutting [Sollins and McCorison, 1981].
- Increased mineral ions such as calcium (Ca^{2+}), sulphur (S^{4+}), magnesium (Mg^{2+}), potassium (K^{+}), sodium (Na^{+}), iron (Fe^{2+}) and mercury (Hg^{+}), which become more mobile due to the absence of vegetation.

4.4.2 Specific Data for Boreal Shield Forest

Most of the information introduced in this section comes from Prepas *et al.* [2003]. These authors analyzed available data about the effects of watershed disturbances (logging and wildfires) in the Canadian boreal forest. This data mainly concerns lakes. In the context of this study, the focus will be on changes due to logging rather than wildfires.

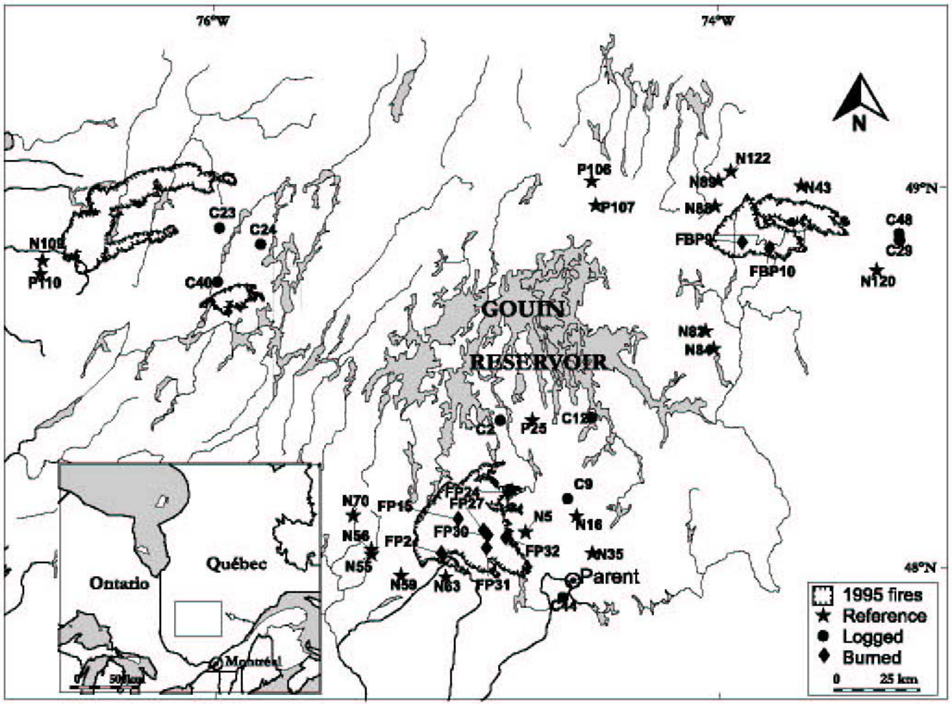


Figure 4.1 Map of the studied region with the location of the reference, burnt and logged lakes [Carignan *et al.*, 2000].

Three upland-dominated lakes in northwestern Ontario were investigated five years before and three years after harvesting 65% of watershed forest (CLEW project, Steedman [2000], Steedman and Kushneriuk [2000]). Clear cutting induced a small increase (5% or less) in mid-lake wind speed and a decline of water clarity of 25% after three years. One year after logging, concentrations of chlorophyll, total N, K^+, Cl^- and Si had increased as much as 40% over predisturbance levels, while Ca^{2+} and Mg^{2+} declined by 25%. No effect was measured on greenness in lake water as well as on adult trout habitat. However, an increase in DOC was observed after high precipitation.

In northern Quebec, impacts of wildfire and logging on lake water quality and biota were also evaluated in 22 lakes located in Haute-Mauricie, near the Gouin Reservoir (see Figure 4.1). The experimental sites are not far from Chapais, in the same geological and biogeographic region, making the results transposable to the watersheds that would be disturbed by the project.

Clear cutting involved 40% of the watershed and 20-m wide buffer strips were left along lake shorelines, permanent streams, and wetlands. The results showed a strong increase in total P (up to three fold larger), total organic N (two fold larger), dissolved organic carbon (DOC, up to three fold larger), K^+ and Cl^- (up to six fold larger) as compared to similar reference lakes on undisturbed watersheds [Carignan *et al.*, 2000]. The effect on DOC, which was confirmed by Pinel-Alloul *et al.* [2002], persisted over three years of measurements following the clearing. This consequently limits photosynthesis in lake water and explains why no significant increase in greenness was observed despite the large increase in nutrient concentration [Planas *et al.*, 2000]. Only some algae species (cryptophytes, chrysophytes) increased. Moreover, a 43% reduction in grazer (calanoid copepods) population, as well as small yellow perch and white sucker populations, was observed [Patoine *et al.*, 2000; St-Onge and Magnan, 2000]. Finally, a strong increase in mercury concentrations was also observed. This contaminates the aquatic biota via bioaccumulation and biomagnifications through the food chain, and concentrations almost two fold larger were found in northern pike, reaching values above the World Health Organization safe consumption limit [Garcia and Carignan, 2000].

These changes were related to the extent of clear cutting and drainage ratio (watershed area divided by lake volume). Some studies showed that clear cutting could affect lake water quality if more than 30% of the watershed is harvested [Carignan *et al.*, 2000]. This is an average value as some impacts were observed in shallow lakes (maximum depth less than 5 m) when less than 30% of the watershed was disturbed. The drainage ratio is a key indicator of the sensitivity of surface water to watershed disturbance, a high ratio indicating high sensitivity. Impacts of forest disturbance on water quality are more detectable when the drainage ratio of the lake is larger than four. Finally, if buffer strips around water bodies can prevent increases in mid-lake wind speed, there is no evidence of a similar protective impact on water quality.

Similarities in comparing the impact of logging on lake water quality to the impact of a wildfire exist, such as the increase in total P concentrations and a decrease in the abundance of young fish. However, some differences can be pointed out: (i) for logged watersheds, decrease in large grazer population and increase in DOC concentration but no increase for burnt watersheds, while (ii) for burnt watersheds, increase in algae growth but no increase for logged watersheds.

It is important to stress that these findings come from short term studies (less than three years after disturbance) and that water quality was found to be affected throughout this length of time. This suggests that impacts may be long lasting, however, information is lacking on the length of time required for recovery of surface water quality from disturbances in Boreal forests associated with logging and forest fires.

4.4.3 Effects on Aquatic Life

The aforementioned changes in physical and chemical characteristics of water bodies have different dynamics, and can be observed either just after clear cutting or over one year later.

These characteristics are all key parameters of ecological habitats of plant and animal species, and their modification implies changes in aquatic life. Generally, primary productivity in surface waters is stimulated after cutting, due to the increase in nutrient concentrations, despite the adverse effects of sediments and lower water clarity. Consequently, the distribution and composition of secondary production species are modified, with a decrease of some species and an increase of others. All these modifications have disturbing effects on fish populations, for instance, turbidity causes filling of gills, food chain and degradation of laying areas.

5 CURRENT STATE OF WATER RESOURCES, WATER USES AND CONCERNS OF THE POPULATION OF NORTHERN QUEBEC

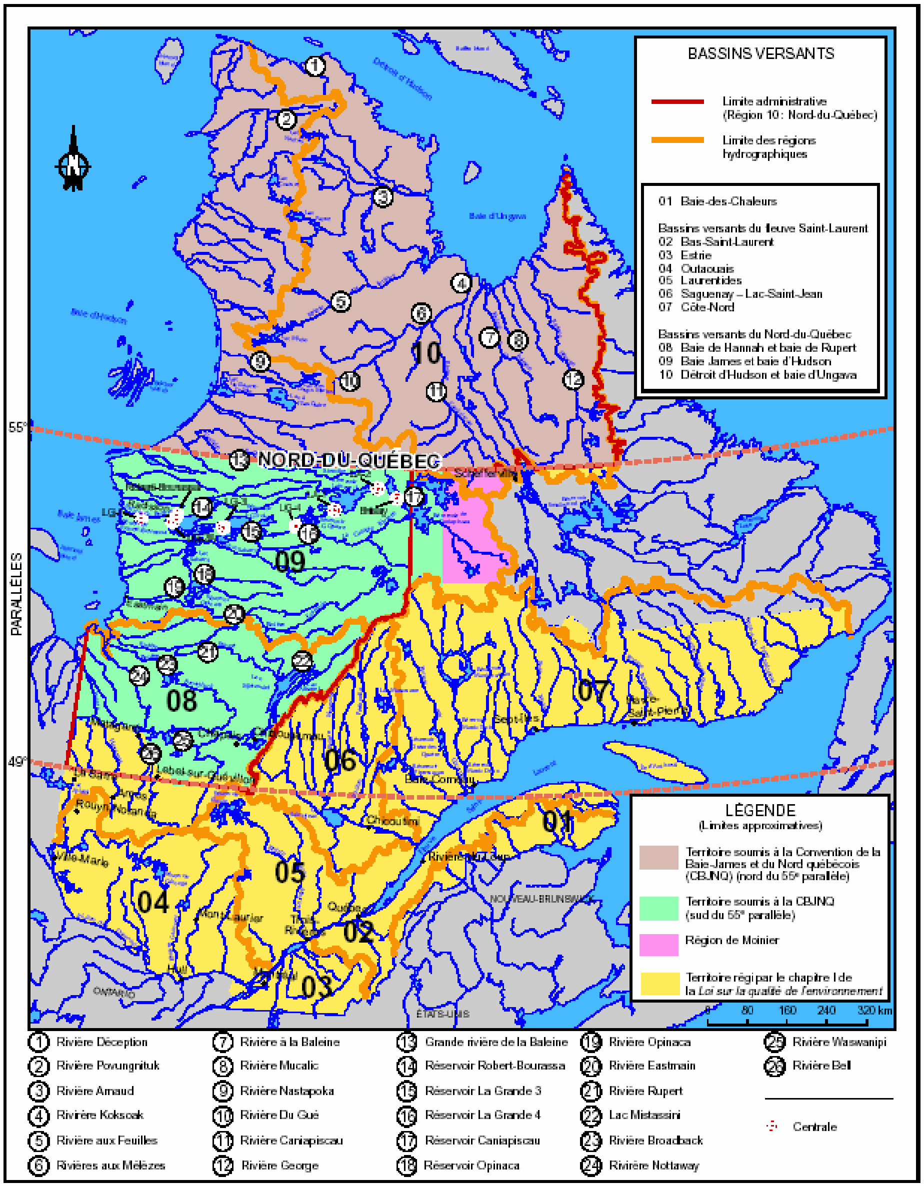
5.1 STATE OF WATER RESOURCES

The BAPE (*Bureau d'audiences publiques du Québec*) completed in 2000 a public consultation on water management in Quebec [BAPE, 2000]. For the BAPE consultation, the QMDDEP produced a water portrait of Northern Quebec. This region is located between the 49th and the 55th parallel excluding the Saguenay - Lac-St-Jean and the North Coast regions (see Figure 5.1 for the geographical location of the region).

5.1.1 Surface Water

In Northern Quebec, water is predominant in landscapes and ecosystems. Watersheds are very large (nine of them are larger than 20,000 km^2), and lakes are numerous and large (Mistassini, 2,113 km^2, is the largest natural lake in the province). This region also contains four of the most important hydroelectric reservoirs of Quebec: La Grande-2, La Grande-3, La Grande-4 and Caniapiscau.

In this region, the QMDDEP does not have any water quality stations. The only source of water quality data comes from Hydro-Quebec (HQ). According to HQ, surface water quality is generally good due to low human pressure. The main water quality problem could be acidification of lake water due to acid rain but in fact, among the 228 lakes sampled, 2.2% are acidic, 8.8% are in transition and 89% are non-acidic [BAPE, 2000]. However, the implementation of hydroelectric dams has considerably changed the hydrology of the region's watersheds, with important consequences for aquatic ecosystems and their physicochemical and biological characteristics. An important change was the increase of bioavailable mercury concentration, under the form of methylmercury, due to the decomposition of submerged organic matter. This leads to a contamination of the food chain (plankton, fishes, mammals and birds). The major impact was observed for the dam on La Grande River, which resulted in the rerouting of the Eastmain, Opinaca and Caniapiscau rivers.



Source : adaptée de la carte *Les régions administratives*, ministère des Ressources naturelles, Service de la cartographie, et de *L'évaluation environnementale au Canada. Sommaire des pratiques actuelles* - 1988, Bureau fédéral d'examen des évaluations environnementales, p. 42.

Figure 5.1 Major watersheds in Quebec and location of the region of interest located between the 49th and the 55th parallel excluding the Saguenay - Lac-St-Jean and the North Coast regions [BAPE, 2003]

5.1.2 Ground water

The number of wells in the region is estimated to be around 500. Among those, only 120 have been registered in the QMMDEP hydrogeologic information system. These wells supply 14% of the population and are often for individual use (38%). Uranium concentrations above the water quality standard have been detected in some sectors of the region, for example North of Matagami and La Grande-4. However, this contamination is supposed to be localized, natural and limited to ground water.

In 1999, two projects of ground water exploitation for commercial distribution were explored, one of them by the Cree community of Oujé-Bougoumou. Moreover, a project for a ground water pumping station in the city of Chapais is also under study, in order to upgrade the quality of the drinking water.

5.2 WATER USES

In northern Quebec, surface waters are used for transportation, fishing, drinking, hydroelectric production, mining, industry, forest exploitation and recreational activities. Moreover, it is crucial to consider the role of water in the native way of life to better understand the impacts of any disturbance in water quality. In addition to the ecological, hydrological or chemical factors, water also has spiritual and cultural values. In the James Bay territory, there are nine Cree communities (population around 12,000) as well as non-native people (population 8,000).

5.2.1 Municipal Services: Drinking Water and Wastewaters

All municipalities south of the 55th parallel have drinking water distribution systems. More than 80% of northern Quebec residents are supplied by surface water with, for the majority, chlorination treatment. However, a monitoring program detected concentrations of trihalomethane above the drinking water standard in the municipalities of Chibougamau, Lebel-sur-Quévillon, Matagami and Chapais. Concerning wastewater, 92% of non-native population is connected to a wastewater network. However, in some cities, such as Chapais, drinking water and wastewater infrastructures are old and deficient. According to the Chapais authority, the fact that the water infrastructures are not adequate for implementation of new industries stops economic development in the region. Moreover, some municipalities do not treat wastewater; they are discharged directly in the environment. This is the case for Chapais, where wastewaters are discharged into a ditch that drains into the Obatogamau, Chibougamau and Waswanipi rivers.

All nine Cree communities of the James Bay territory are connected to a drinking water supply network (chlorinated surface water or non treated ground water) as well as a wastewater network. Wastewater is treated by aerated ponds, except for the community of Whapmagoostui which discharges wastewaters directly into Hudson Bay. It should also be noted that some Cree families will not drink chlorinated water and continue to drink water from unanalyzed natural sources.

5.2.2 Industry

This region ranks third in Quebec for mining. This activity uses huge quantities of water and has important impacts on water quality, such as acidification due to accumulation areas of mining residues, heavy metals contamination and wind erosion. Only half of the inactive accumulation areas have been restored because of high treatment costs. This is a priority for the QMRNFP together with the QMDDEP and the mining industry.

Forest exploitation is another major economic activity in the region. Logging focuses on fir, pine, spruce (*e.g.*, black spruce represents 90% of the wood supply of the Barette-Chapais Ltd sawmill) and larch, and has a direct impact on surface water quality, even though precise information is scarce (see Chapter 4). Moreover, the region has several lumber mills that use and pollute water. For example, a pulp and paper factory located in the municipality of Lebel-sur-Quévillon discharges 75,000 m^3/day (data of 1996) of treated wastewater directly into the Quévillon River [BAPE, 2000]. Moreover, lixiviation waters coming from a non-active and non-restored wood residue plant contains a lot of organic chemicals that can contaminate surface and ground waters (phenols and resin acids). Watson and St. Lucie lakes, as well as the Plamondon and Kistabiche rivers, are the water bodies most affected by this kind of contamination. In St. Lucie Lake, a decrease of fish stocks has been observed in both the lake and the river downstream. In order to resolve this problem, a guide for best management practices is being prepared [BAPE, 2000].

5.2.3 Agriculture and Recreational Activity

Agriculture is scarce, and there are very few farms in this region, all located in the municipalities of Val Paradis, Ville-Bois and Beaucanton. Therefore, the environmental impact of agricultural activities is low in James-Bay territory. Due to numerous streams and lakes, an important economic activity in the region is related to recreational activities, especially fishing, done on natural water bodies, in a nature preserve or in artificial ponds.

5.2.4 Role of Water in First Nation Life and Culture

For First Nations, people are a component of the territory and coexist with other components: plants, animals and minerals. They see themselves in a proprietary role of the land, responsible for helping to maintain its equilibrium. In this sense, they consider that the needs of plants and animals should be taken into account together with human needs in every water management decision. Therefore, they are highly concerned with any action that could disturb the territory, the landscape, the ecosystems and the resources.

Water resources are not only a source of life, supplying the primary needs of subsistence and hygiene, but they also play a key role in transport, business, political organization and land use. They are essential to maintain cultural identity and also constitute a means of development. In this context, first nations consider that they have rights and power regarding water management, as they occupy large territories on which exploitation of natural resources could be a means of defining their place in modern world.

5.3 MAIN CONCERNS

5.3.1 Concerns of the James Bay Development Board

The impacts of water uses described above, as well as a lack of knowledge about surface water and ground water quality in this region, represent sources of preoccupation for the population, both native and non-native people. Public opinion is that water management will improve the knowledge of lakes and rivers in the region and there is a need to set up an integrated water management framework.

JBDB also wishes to establish an agreement with the QMDDEP and other regional groups (native and non-native people) in order to elaborate a water use framework and develop the integrated water management of the region, emphasizing the importance of developing more interaction with the Cree nation.

Finally, climatic changes and their effect on water demand, is another source of preoccupation for JBDB. Indeed, an increase in water demand could lead to massive water exportation or water diversion from James Bay, especially towards some American states. Because of the potential impacts on ecosystems of any water diversion or exportation project, the board states, it is crucial that the Cree nation, as well as the non-native population, should be "informed, consulted, concerted and involved in the decision-making process".

5.3.2 Concerns of the BAPE Commission

The Commission of the BAPE [2000] made some observations that should be prioritized by the citizens of Chibougamau and Radisson:

(i) The Commission found it disturbing that municipal wastewater from a city with a population of 2,000, like Chapais, is discharged directly into the environment without treatment, even given the inherent difficulties in treatment (*i.e.*, inadequate infrastructures).

(ii) The Commission suggested legislative modifications to give municipalities the ability to take the necessary steps to guarantee a safe drinking water supply. Moreover, the Commission requested that government financial assistance takes into account the restricted budget of small and isolated municipalities. Note that in June 2001 the Government of Quebec published a new Drinking Water Regulation that has introduced new requirements concerning microbial inactivation/removal and other water quality parameters, utility characteristics and personnel training [Gouvernement du Quebec, 2001].

(iii) The Commission was convinced of the need for inventory, restoration and valorization of ligneous and mine residue areas in order to reduce water contamination.

5.3.3 Concerns of the Cree Nation

In the James Bay territory, the JBNQA governs land and water management. Several organizations have been created to allow the Cree nation to self manage some public services such as education, health and social services, as well as environmental protection. However, this has not always been true in practice, and the Cree consider that the government should recognize their right to play a central role in water and land management.

Cree people have noticed some problems such as: problems supplying good drinking water in some communities, trihalomethanes formation (chlorination by-products) in drinking water, and uranium contamination in some areas; but the main problem emphasized is contamination of freshwater by methylmercury due to implementation of dams and flooding of large territories. They ask that the national water policy takes into consideration the social, cultural and health impacts of this contamination in the future. More generally, they ask for more rigorous environmental laws to regulate industrial activities, for improved preservation of their territory and environment.

6 SUMMARY OF RESULTS AND FINDINGS OF THE BAPE CONSULTATION ON SUSTAINABLE DEVELOPMENT OF PIG FARMING IN QUEBEC

6.1 BACKGROUND INFORMATION

In 2003, the BAPE (*Bureau d'audiences publiques du Quebec*) completed a public consultation on the sustainable development of the pork industry in Quebec [BAPE, 2003]. Its mandate was to: (i) examine the strengths and weaknesses of the current agricultural models in Quebec; (ii) establish a framework for the sustainable development of pig farming, taking into account environmental, social and economical issues; and (iii) suggest production models to support a harmonious co-existance of agricultural activities.

This Chapter presents the principal results and findings as published in [BAPE, 2003]. After a brief overview of pig farming in Quebec, issues concerning sustainable development will be discussed, emphasizing information on the environmental and social impacts of pig farming. Note that some of the information conveyed in the following subsections comes from the agri-environmental information synthesis produced by the QMDDEP [MENV, 2003a] for the BAPE public consultation on sustainable development of pig farming in Quebec. For further information, the reader should consult the BAPE report [BAPE, 2003].

6.2 ECOLOGICAL IMPACTS

From a scientific perspective, it is difficult to distinguish the impacts caused by a specific type of agricultural production, like pig farming, on water, air, soil, wildlife and flora, when compared to other livestock production or crop production. For this reason, this section covers the impacts caused by agricultural activities in general.

6.2.1 Water

In this Section, nitrogen (N) and phosphorus (P) are the parameters used to evaluate pollution of either subsurface or surface waters. These nutrients can come from agricultural, municipal, industrial or natural sources. When their concentration is too large, these elements can not only limit water usability, like drinking water, aquatic and recreational activity, but also create a human health risk and disturb ecosystems [BAPE, 2003]. Table 6.1 presents estimates of N and P contribution to water pollution in four Quebec Rivers draining agricultural areas.

Table 6.1 shows that for N and P, the most important contribution comes from agricultural sources. According to the QMDDEP, agricultural activities "[…] have substantial impacts on water quality and constitute the main factor of water pollution by nutrients" [BAPE, 2003]… "any increase in agricultural production based on cash crops (like corn) and livestock could have negative consequences on water quality" [BAPE, 2003]. The main environmental issues associated with agricultural activities are fertilization in excess of crop requirements, soil erosion and use of pesticides. Soil erosion and transport to streams of soil particles on which pesticides and nutriments could be adsorbed represent a real threat to aquatic ecosystems. In 1995, the QMDDEP compared the water quality of 16 rivers in agricultural watersheds with 30 rivers in forested environments. N and NO_3 concentrations were five to seven times larger in the agricultural environment than in the forested environment. Furthermore, a connection between P in agricultural soils and P concentration in rivers was established by a second survey on 19 watersheds presenting annual P balance in excess of crop requirements. Results showed that the P concentration in rivers increased with increases in the average P content of agricultural soils. This increase is more rapid if there is a high percentage of the watershed in an agricultural zone [BAPE, 2003].

Table 6.1 Relative N and P contributions of different sectors of the economy to water pollution measured at the outlet of Quebec rivers draining agricultural land

	Watershed	**Agricultural**	**Municipal & Industrial**	**Natural Resources**
		[%]	[%]	[%]
P Flux	Yamaska	75	17	8
	L'Assomption	52	35	13
	Chaudière	56	23	21
	Boyer	63	20	17
N Flux	Yamaska	73	15	12
	L'Assomption	48	33	19
	Chaudière	34	26	40
	Boyer	76	9	15

Surface water pollution caused by P is characterized by proliferation of algae and macrophytes (aquatic plants). This proliferation can cause eutrophication of surface waters, which is accompanied by odour problems and important degradation. Eutrophication is harmful to aquatic life and recreational activities. "Anthropogenic impacts of cyanobacteria are felt in the ecologic, esthetic, organoleptic, socio-economic, tourist and recreational fields (*e.g.*, decline in property values, reduced occupancy at campgrounds, *etc.*). Furthermore, cyanobacteria or their toxins when found in large quantities, can affect human health" [BAPE, 2003]. Pollution caused by N is harmful to aquatic life and can lead to unsafe drinking water. Degradation caused by P and N can complicate treatment of drinking water. Furthermore, the chlorine used in water treatment processes reacts with organic matter to form carcinogenic and toxic by-products.

According to a 2002 study by QMDDEP [MENV, 2003a], P concentration and fecal coliform count at the majority of water quality sampling stations have decreased between 1988 and 1998. This reduction results from implementation of water purification policies and programs as well as slurry management programs. On the other hand, other studies by QMDDEP indicate that between 1998 and 2001¸ P standard was exceeded for the majority of the six sampled rivers. Watersheds consisting of mainly agricultural land still experience water quality problems. However, even though it is still substandard, water quality in the main agricultural watersheds of Yamaska, Saint-François and Chaudière rivers has improved.

6.2.2 Soil

Soils provide nutrients to crops, act as water and biomass reservoirs and as water filters. In agricultural areas, soil quality is affected by cropping practices; bad practices can cause soil compaction, soil erosion and fertilization in excess of crop nutrients. Timber harvesting may also degrade soil quality.

Natural fertilizers like pig slurry support crop production and can improve physical properties of soils including the capacity to retain soil elements and moisture. However, according to several studies, if soil management is deficient, environment and health risks exist [BAPE, 2003]. Naturally occurring nutrients are necessary for growth of biological organisms. Improper fertilization can result in excessive nutrients in the environment that can cause an increase in soil P content potentially resulting in a higher risk of water pollution. An experiment carried out by the T. Sen Tran, D. Côté and A. N'Dayegamiye in 1996 (researchers at *Institut de Recherche en AgroEnvironnement, a.k.a. IRDA*) on the long-term effects of slurry indicates that: "A significant addition of farm slurry over the course of several years increased P soil content in the top 20 cm to an extremely rich level. Soluble P content and soil P saturation also increased at an excessively high level [BAPE, 2003]." These changes can be the cause of water pollution by P losses due to runoff or soil erosion. Another risk for the environment comes from pathogenic microorganisms. The fresher the slurry is, the more likely it contains a substantial quantity of pathogenic microorganisms, thereby increasing the risk of water, crop and pasture bacteriological contamination.

6.2.3 Air

Atmospheric emissions from livestock buildings and slurry management can take the form of gases or dust that may contain microorganisms. These products can be harmful to the health of workers and surrounding populations and may also contribute to climatic and ecosystems changes. Produced all year long, odours caused by gases, vapours and dusts can spread outside of buildings. According to the QMDDEP, these emissions would be responsible for 58% of all odours coming from farm buildings [BAPE, 2003]. According to the agri-environnemental portrait of Quebec farms, in 1998 the risk of odours originating and spreading from farm buildings is high for pig farms. One of the reasons for this situation is the fact that only 40 to 60% of the porcine enterprises respect the minimal distance regulations for residential dwellings [BAPE, 2003]. The principal gases produced include: ammonia (NH_3), methane (CH_4), nitrous oxide (N_2O), carbon dioxide (CO_2) and hydrogen sulfide (H_2S). All these gases can have harmful impacts on health and wildlife. Furthermore, gases like methane, nitrous oxide and carbon dioxide are greenhouse gases that contribute to the disintegration of the ozone layer.

6.2.4 Wildlife Habitats

The use of pesticides and fertilizers on agricultural land contributes to water degredation, thus, it has an important impact on water resources. For example, in some eutrophic water bodies, the use of oxygen by plant respiration and by decomposition of vegetal biomass causes fish mortality. In fact, in one of the last smelt spawning grounds in the Fouquette River, on the south shore of the St. Lawrence River, water highly charged with P was responsible for the high mortality coefficient of smelt eggs [BAPE, 2003]. Also, a repulsive effect on smelt olfaction could be responsible for their disappearance from the Boyer River on the South shore of the St. Lawrence River [BAPE, 2003]. Presence of pig slurry in streams can cause important fish kill and can also be harmful to fish nourishment and aquatic animal reproduction, as well as increase vulnerability to bacterial diseases. According to the QFAPA (Quebec Society for Wildlife and Parks, *Société de la faune et des parcs du Quebec*), some herbicides and hormones present in poultry and pig slurry can have a direct impact on wildlife population, affecting development, reproduction and growth [BAPE, 2003]. In Quebec, arable lands have been drained to increase crop production and cultivation practices. In 1998, drainage of agricultural land was done by 47% of pig farmers over 52% of their total cropland [BAPE, 2003]. Drainage increases runoff rate into streams and can cause the loss of shelter, spawning grounds and hatching zones. According to QFAPA, around 34% (1228 ha) of wetland losses along the St. Lawrence River between 1945 and 1988 can be attributed to agricultural development, particularly to drainage of riparian zones [BAPE, 2003]. In the last decade, increasing deforestation in agricultural regions has raised concerns over endangerment to wildlife in these zones. Researchers of the Canadian Wildlife Services have warned that in the mixed forest of the St. Lawrence Valley, as many as 480 animals and plant species could be in danger. They consider that, beyond 50% deforestation, the residual forested surface is victim of fragmentation due to the isolation of small, forested zones and would have an impact on shelters, animal populations and biodiversity [BAPE, 2003].

6.3 SOCIAL IMPACTS

The effects of pig farming on the local population and health risks to workers and society are presented in the following subsections.

6.3.1 Social Impacts

Announcement of a new pig farm project in most regions of Quebec has the potential to create a source of conflict between producers and the surrounding population. In several Quebec municipalities, these conflicts have created social situations that affect the quality of life of all [BAPE, 2003]. People equate incoming agricultural projects with a reduction in their quality of life. The ensuing issues include: environmental effects (odours, noises, dust), environmental and health risks, local and regional economic consequences, impacts on other activities, and lack of local input on the project development. Often, conflicts emerge even if the projected infrastructures conform to regulations [BAPE, 2003]. According to the Forget Aubin Study on cohabitation, project compliance to standards does not guarantee a harmonious development situation [BAPE, 2003]. Considering their relationship with the land, on which they still rely for subsistence, aboriginal communities are potentially more vulnerable to the negative impacts of pig farming activities.

6.3.2 Health Risks to Workers and Surrounding Population

Agriculture constitutes one of the most high-risk sectors for workers. According to surveys made by the Ministry of Health and Social Services on agricultural mortality and morbidity rates in industrial countries, this sector would rank between first and fourth. In several countries, the rate of fatal agricultural accidents is twice the average rate for all other sectors combined [BAPE, 2003]. Health problems stem from two causes; either the manipulation of agricultural equipment or the presence of contaminants in the immediate farm environment. Contaminants can be of biological, physical or chemical nature and their effects on health are multiple. Resulting health risks come from direct contact with animals, air in farm buildings, toxins, and stress.

6.3.2.1 *Risk Related to Direct Contact with Animals*

Farm animals are frequently hosts of pathogenic microorganisms that may be transmitted to humans and cause adverse health effects. Zoonosis is a disease of vertebrate animals transmitted to humans. Table 6.2 presents zoonosises that can be transmitted to pig farm workers.

6.3.2.2 *Risk Related to Air Quality of Pig Farm Buildings*

Dusts found in confined pig housings are composed of biologically active particles that can have toxic, infectious and immunogenic properties. Agricultural dusts can cause different allergic reactions and are responsible for breathing problems. Some gases emitted by agricultural production are toxic and can, at high concentrations, cause death.

Table 6.2 Zoonosises transmitted to pig farming workers

Infectious Agent	Disease (Symptoms)	Occurrence in Pig	Issue
Salmonella sp (bacterium)	*Salmonellosis*	Known	Transmission by direct contact of animals or their excrements.
Leptospira interrogans (bacterium)	*Leptospirosis*	Rare	Transmission by skin contact
Giardia lamblia (parasite)	*Giardasis*	Low	Transmission by direct contact but low probability of zoonosis
Influenza A (virus)	*Influenza*	Known	Transmission by contact or promiscuous contact with animal
Hepatitis (virus)	*Hepatitis*	High	Possible emergence and probable transmission by direct contact with animals

6.3.2.3 Risks of Toxic Effects on Workers

Gas exposure in closed spaces can result in a toxic environment for agricultural workers. These toxic gases, resulting from slurry fermentation, are composed of ammonia (NH_3), methane (CH_4), nitrous oxide (N_2O), carbon dioxide (CO_2) and hydrogen sulfide (H_2S). Table 6.3 presents the possible effects of these gases at various concentrations.

The risk to workers can also come from exposure to pesticides that are used on cropland. According to some studies, pesticides might be responsible for certain forms of cancer, neurological and neuromuscular attacks, respiratory diseases, psychiatric troubles, fertility problems, skin irritations and various allergies. From 1978 to 1997, there was a high rate of health problems in pork production, including five incidents that directly resulted in death [BAPE, 2003].

Contaminants generated by agricultural activities can have serious effects on the surrounding population. In fact, populations are at risk with respect to the presence of contaminants in both water and air. The effects may vary from diarrhea, nausea and dizziness to liver problems.

Table 6.3 Health effects of gas in an enclosed environment [BAPE, 2003]

Gas	**Concentration (ppm)**	**Effects**
Ammonia (NH_3)	100 to 500	Irritation of the mucous membranes within 30 minutes
	5,000	Airway Spasms (*Bronchospasm*), death
Methane (CH_4)	500,000	Asphyxiation
Carbon dioxide (CO_2)	20,000 to 30,000	Accelerated breathing acceleration (*Tachypney*)
	40,000	Sleepiness, headaches
	100,000	Fast breathing, dizziness, sweating, numbness
	300,000	Death within 30 minutes
Hydrogen sulphide (H_2S)	0,2	Olfactive threshold
	5	Stingy odour
	50	Irritation of airways and eyes
	150	Paralysis of the olfactive nerve, death within four hours
	200	Pulmonary oedema, death within four hours
	700	Immediate death

6.4 BAPE RECOMMANDATIONS

Following the sustainable development model and collected information, the BAPE Commission released a number of recommendations to improve the current decision making framework for pig farming development in Québec. Theses recommendations aim to enhance social acceptability and environmental protection while ensuring economical viability of pig farming.

The BAPE believes that social issues can be minimalized by appropriate land use practices and improved dialogue between rural actors and stakeholders. To do so, the quantity and quality of the information transmitted to citizens needs to be improved. Innovative initiatives should be used to improve the public participation process. The BAPE recognizes a lack of knowledge regarding pig slurry management, diffused pollution and impact of pig farming on human health (workers and surrounding populations) and, thus, recommends more research in these domains in order to develop reliable biophysical indicators to evaluate the quality of the environment. The BAPE also recommends that the QMDDEP intensifies inspections and controls to raise awareness regarding the risks of fertiliser spreading on water quality and human health.

The BAPE directs government authorities to pay attention to the related effects of environmental and social measures on production costs and economical viability of the pig farming industry. Finally, the BAPE supports the “ecoconditionality” principle, which forces promoters to respect environmental regulations in order to receive subsidies.

7 SYNTHESIS OF THE IMPACT STUDY CONDUCTED BY THE PROMOTER

7.1 METHODOLOGY

To evaluate the environmental impacts of the proposed pig farming project, *ROBERT HAMELIN & associés* used a matrix approach [Leopold *et al.*, 1971]. This methodology, considered standard for such purpose, allows for coverage of a wide range of considerations from a multidisciplinary perspective. However, this implies a significant level of uncertainty due to a lack of quantitative information and, thus, many conclusions are evaluated on semi-quantitative/qualitative data. Figure 7.1 summarizes the methodology.

7.1.1 Identification of Interrelations

The first step was to identify potential interrelations between the project and the environment, the term interrelation referring to reciprocal interactions between two elements. To do so, both the project and the environment were desegregated into relevant components, which were inserted into a matrix (table). Table 7.1 presents the desegregated components for the pig farming project in Chapais. The rows refer to the project components and describe the activities related to the establishment phases: construction, operation and restoration (as described in Chapter 2). The columns refer to the environmental components categorized with respect to their nature, that is, physical, biological and human (see Chapters 4, 5 and 6).

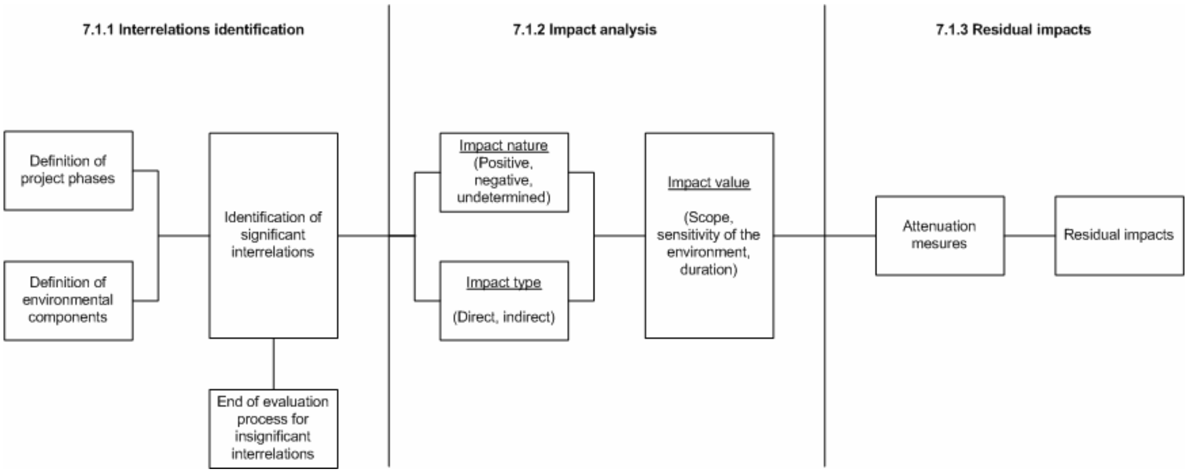


Figure 7.1 Schematic representation of the matrix approach methodology ([Consultants LEGOFF Groupe inc., 2005], p.179, simplified version)

Based on gathered information and scientific analysis, all potential interrelations were analyzed. The significant interrelations were considered for potential impact and will be analyzed in the next section. The insignificant interrelations were not considered in further evaluation.

7.1.2 Impact Analysis

Once an interrelation was considered significant, *ROBERT HAMELIN & associés* analyzed the resulting impact value on the environment. To do so, four criteria were applied:

(i) nature (positive, negative or undetermined) and type of impact (direct or indirect);

(ii) scope (intensity, range, probability and frequency);

(iii) sensibility of the environment (ability to cope with disturbances); and

(iv) global value of the impact, based on criteria (ii) and (iii) and impact duration.

It is important to note that the impact analysis is a complex procedure depending on the amount and the quality of available data. In the case of the pig farming project, the analyst (*HAMELIN & associés)* formed a multidisciplinary workgroup to evaluate the impact values. Their work was based on semi-quantitative charts where criteria were classified as severe, moderate, or low.

7.1.3 Residual Impact

To reduce the related impact value and, as requested by the law on LAU (see Chapter 3), the promoter must put in place attenuation measures and monitoring procedures on each environmental component. Table 7.1 introduces a summary of the major residual impacts throughout the realization of all three phases of the project. Green squares identify the positive impacts while the red squares identify the negative impacts. These impacts will be further discussed in the following sections, but, overall, the economic spin-off represents the major positive impact during all phases of the projects while odour production and water contamination represent the dominant negative impacts.

Table 7.1 Synthesized impact matrix of the pig farming project in Chapais

Environmental component		**Physical**					**Biological**		**Human**				
Project phases	Section of this report	Dust and particles	Odour	Noise	Soils	Water	Vegetation	Wildlife	Traffic	Economy	Tourism	Traditional activities	Quality of life
Construction phase	2.2								🟥	🟩			🟩
Preparation works	2.2.2	🟥	🟥	🟥				🟥					
Infrastructures	2.2.3						🟥	🟥					🟥
Operational phase	2.3			🟥					🟥	🟩	🟥	?	🟩🟥
Feeding	2.3.1	🟥											
Production	2.3.2												
Slurry management	2.3.3		🟥		🟩								
Effluent management	2.3.4		🟥			?							
Restoration phase	2.4				🟩		🟩			🟩		?	

Source: [Consultants LEGOFF Groupe inc., 2005], p.254 (adapted version)

7.2 DESCRIPTION OF THE MAJOR IMPACTS

Table 7.2 presents a detailed description of the most important residual impacts as defined in the previous section. The impacts are classified as being positive or negative and characterized by their value and the resulting attenuation measure. Positive impacts are mostly related to the economic spin-off and the added value of the *biosolids* resulting from treatment of pig slurry. According to the promoters, mitigation measures will diminish all negative impacts to a moderate (low) level. The following sections describe all these residual impacts.

Table 7.2 Synthesis of the most important residual impacts of the pig farming project

	Region of influence	Duration	Impact value	Attenuation[10]	Residual value
7.1.1 Positive impacts					
7.1.1.1. Economic spin-off	Regional	Long term	High	NA	High
7.1.1.2. Improvement of soil quality	Local croplands	Long term	Low	NA	Low
7.1.2 Negative impacts					
7.1.2.1. Odours	Local (Cavan lake)	Long term	High (major social concern)	Biofertile® technology; rapid slurry treatment; appropriate separating distances.	Low
7.1.2.2. Water quality	Local (Obatogamau river and surrounding cropland)	Long term	High	Biofertile ® technology; agro-environmental fertilization plan.	Low
7.1.2.3. Soil disturbance	Local	Long term	Low	Site restoration	Low
7.1.2.4. Vegetation and wildlife	Local	Long term	Moderate (lack of information)	Inventory; infrastructures relocation; site restoration.	Low
7.1.2.5. Dust and particles	Local	Long term	High (uncertainty)	Rapid slurry treatment; modelling	Low
7.1.3 Ambiguous impacts					
7.1.3.1. Quality of life	Regional	Long term	Ambiguous	NA	NA
7.1.3.2. Traditional activities	Local	Long term	Not defined	NA	NA

7.2.1 Positive Impacts

7.2.1.1 Economic Spin-Off

The economical spin-off due to the establishment of the pig farming project is by far the only significant positive impact of the project. The estimated total investment of nearly 75M$ is expected to enhance local and regional economies for at least 20 years (life expectancy of the agricultural complex). The operational phase will generate 135 direct jobs corresponding to annual wages of 5M$. Moreover, 45 indirect and other temporary jobs (for the construction and the cleaning phases) will be created.

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[10] Or reinforcement for positive impacts

To strengthen the local economy, the promoters are committed to adopt measures, namely:

(i) if equally qualified, hire from local population;

(ii) if prices are competitive, to buy from local suppliers;

(iii) to reserve a job portion exclusively for native people; and

(iv) to create a fund to ensure the demolition and restoration of the site.

7.2.1.2 Soil Quality

The positive impact regarding soil quality is related to the production and spreading of biosolids resulting from the pig slurry treatment (see Chapter 2). Rich in nutrients and minerals, the spreading of biosolids will enhance the quality of surrounding soils. However, the value of this impact should be considered low given the limited availability of cropland in the region (25 ha).

7.2.2 Negative Impacts

7.2.2.1 Odours

The promoters acknowledge that the emanation of odours produced by the pig farming project represents a major concern for local population. The related impact on the environment is at first considered high, but according to the promoter, appropriate separating distances and slurry treatment technology will significantly diminish the residual impact on the population. Four main odour sources have been identified: pig slurry treatment from breeding centers, incineration of slaughterhouse wastes, ration production at the feed mill, and the combustion of biosolids at the cogeneration plant.

The promoters will reduce most gas emissions produced by the pig slurry treatment plants by implementing the Biofertile® solution. According to Pelletier [2003], the process rapidity, reducing slurry stockpiling duration, brings down gas emission by up to 75%. Based on atmospheric and meteorological data, an odour dispersion modeling[11] analysis was conducted by Groupe conseil LaSalle. Figure 7.2 shows a projection of the areas affected by odour nuisance. In the surrounding environment of Cavan Lake, the odour will be noxious up to 15 hours per year. According to the modelling, the spread of noxious odours should not reach the town of Chapais. To ensure a control on odour spreading, the promoters are committed to implement a monitoring program to analyze the undesirable events.

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[11] ISCST3, recognized by QMDDEP

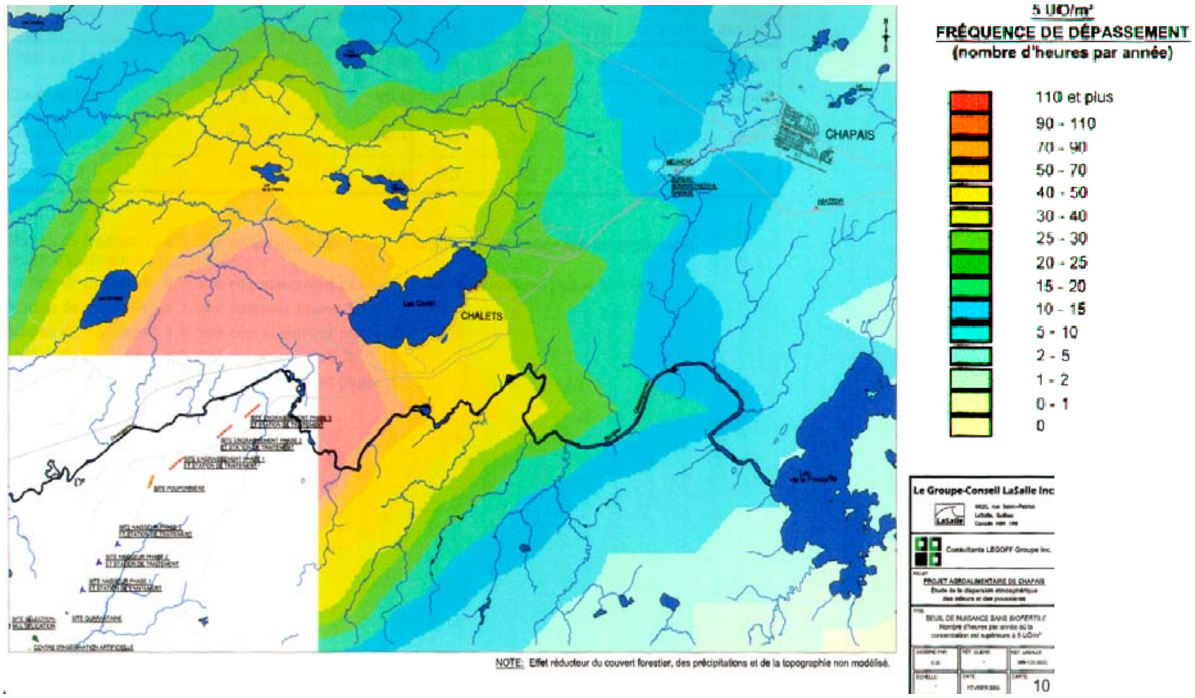

Figure 7.2 Projection of the potential areas of odour nuisance ([Consultants LEGOFF Groupe inc., 2005], p.166)

7.2.2.2 Soil Quality

During the construction phase, land stripping and spreading of aggregates will have a direct negative impact on soils. Moreover, a risk of fuel spillage during production activities needs to also be considered. Including building locations, access roads and the fire barrier zones, the global area affected by construction activities is estimated at 32 ha. Considering the relatively small area affected and the nature of the soils (undifferentiated tills and organic deposits), which are considered neither rare nor unique, the impact of construction activities on soils is considered moderate.

Many attenuation measures are proposed by the promoters. On one side, security measures related to construction activities will be implemented: constraining circulation of vehicles, restricting fuel supply to a security zone, and providing intervention equipment in case of fuel spillage. Moreover, the promoters are committed to restore the sites after operation of the pig farm.

7.2.2.3 *Water Quality*

Impacts on water quality have to be evaluated distinctively for both surface and ground waters. The construction activities of the pig farming project and the discharge of the effluent resulting from the pig slurry treatment will affect the quality of the receiving surface waters while wells supplying the breeding sites will affect ground water resources.

Land stripping and grading activities related to the construction activities will produce a rise in suspended matter in the Obatogamau River. The value of this impact is considered low because the activity is local and discrete. Stockpiling of ligneous wastes 20 m from the Obatogamau River (60 m for all other materials) is considered as a relevant attenuation measure. The promoters are also committed to implement stabilization work on soils vulnerable to erosion, reducing the risk of increasing suspended matter in the river.

A more significant impact on surface waters will come from the discharge of the effluent resulting from the pig slurry treatment. On a daily basis and for at least 20 years, more than 350 m^3 of treated effluent will be discharged from four sites in the Obatogamau River. Surprisingly, the evaluation of this impact is not discussed in LEGOFF's analysis (see question mark in Table 7.1). A dilution analysis conducted by Groupe conseil LaSalle - after estimating the flow and dimensions of the studied river segment - indicates that the resulting pollutant concentrations will meet the QMDDEP criteria. However, there was no mention of the intended use of water targeted by this modelling exercise.

7.2.2.4 Vegetation and Wildlife

Land stripping and grading activities, as well as the installation of underground effluent pipes, will increase the amount of suspended matter in Obatogamau River, producing sand deposits on the riverbed. The environmental disturbance will reduce local biodiversity of the benthic wildlife (organisms living in river sediments), which is already poor (less than 1,000 individuals per square meter) and little diversified. This local and temporary negative impact is considered low given the natural ability of benthic organisms to regenerate due to inputs of upstream nutriments. Adapted culverts and drainage ditches will also reduce this impact: planning construction activities after spring flood, avoiding many constructions on one river simultaneously, and locating culverts on straight sections of the river (avoiding meanders).

The presence of infrastructures will also have a negative impact on vegetation and wildlife habitats. The global stripped area (32 ha) represents less than 1% of the land logged by Barrette-Chapais and should not represent a major reduction of biodiversity. The impact on vegetation related to the land stripping is low because the construction sites are located in an undisturbed area. The impact on wildlife habitats is undetermined because inventories are unavailable. For animals having a large vital territory (such as wild cats, wolverines and peregrine falcons), a relatively small reduction of their habitats should not compromise their ability to survive. For smaller animals (such as shrews and bats) with smaller vital territory, the impact would be stronger, indeed critical. As a mitigation measure, the promoters are committed to conduct an inventory of sturgeon spawning zones and small mammal habitats to investigate the presence of rare or threatened species, to evaluate the survival potential of each species, and to redefine, if necessary, building locations.

7.2.2.5 Dust and Particles

Small suspended particles are known to cause smog and cancer among the exposed population. During preparation works, burning of wood debris and trees, road enlargement and truck traffic will increase the amount of suspended matter. However, these activities will be constrained to construction sites and access roads and should not produce a significant long-term impact on air quality, which is already very good in the region of Chapais. To reduce this impact, the promoters are committed to respect provincial policies on granular material transportation, speed limits on access roads, and obtain a burning authorization from the QMRNFP.

Pig slurry treatment plants produce ammoniac, which, through complex and underrated physicochemical phenomena, enhances particle formation. Moreover, incinerating activities and ration production at the feed mill will also produce suspended matter. The evaluated particles discharge of the incinerator (70$\mu g/m^3$) is in accordance with Regulation Respecting the Quality of the Atmosphere (*Règlement sur la qualité de l'atmosphère* - RQA). By extension from modelling results of odour spreading for the pig slurry treatment plants (see above-mentioned section on odours), populations should not be significantly exposed to suspended particles.

7.2.3 Ambiguous Impacts

7.2.3.1 Quality of Life

Many distinct impacts presented by LEGOFF and referring to human environment can be enclosed into one generic theme called "Quality of life": tourism and recreational activities, traffic, landscape aesthetic, holidays and cultural heritage. Mostly referring to subjective perception, the evaluation of the overall impact of these components is beyond the scope of scientific expertise. .

At first, the establishment of the pig farming project in Chapais, with related investments and job opportunities, will produce an increase of leisure activity values. However, the odour issue might counterbalance this positive impact. It is hard to tangibly predict the resulting impact of pig farming on recreational activities.

7.2.3.2 Traditional Activities

The impact of incinerator discharges on Cree traditional trapping, hunting and fishing activities has not been significantly considered. The Trapping Territory W-23 belongs to Mr. Malcom Dixon. The change in land use (from trapping to agricultural activities) will require, from the promoters, an authorization. According to the promoters, no information has been received from the Cree community.

8 DISCUSSION OF THE IMPACT STUDY AND POTENTIAL RISKS OF PIG FARMING IN A BOREAL ENVIRONMENT

8.1 BACKGROUND INFORMATION

8.1.1 The Concept of Impact Study

André *et al.* [1999] defines an "environmental impact" as the effect, for a given duration and a finite space, of a human activity on an environmental component in comparison with the probable situation where the project would not have been implemented. An impact corresponds to a defined area and must be evaluated with respect to three characteristics: scope, importance, and significance. To meet such a wide definition, OECD [1992] suggested elements that should be considered as environmental impacts:

(i) effects on human health and population well-being;

(ii) effects on climate and atmosphere;

(iii) use of natural resources;

(iv) waste recycling and elimination; and

(v) other related and transborder effects.

The European Environment Agency (EEA) defines "environmental impact study" as a *survey conducted to ascertain the conditions of a site prior to the realization of a project, to analyze its possible impacts and compensative measures*[12]. According to André *et al.* [1999], an impact study is an administrative tool supporting a decision process in agreement with the sustainable development paradigm. The impact study defines both positive and negative impacts of a project on the environment, society, and economy and aims to:

(i) define appropriately project options, locations, and technologies;

(ii) define environmental impact of the selected option;

(iii) evaluate impact values;

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[12]: http://glossary.eea.eu.int/EEAGlossary/E/environmental_impact_study

(iv) judge project justifications considering both positive and negative impacts;

(v) elaborate an optimized scenario with regards to environmental considerations; and

(vi) make a well documented decision.

Evaluating all aspects of a project and their complex interrelations with biophysical and human environments is, however, impossible. An environmental impact study must be understood as a simplification of the reality based on assumptions and, partly, qualitative evaluations. According to some critics[13], impact studies are insufficient palliatives or even accomplices of economical development. Pretending to be objective, impact studies reduce environmental problematic to exclusively scientific and technical points of view, that being applied on a reductive project scale. Thus, judging ability and decisional power are kept away from non-scientists while wider issues on development and policy impacts are set aside.

Notwithstanding these limits and critics, impact studies have been internationally recognized for 30 years as being a valuable, long-term, planning tool. Introducing environmental considerations in planning processes is definitively a significant step forward to protect ecosystems and human health. However, environmental sustainability involves wider considerations such as risk management, social values and macroscopic cumulative impacts, which are still quite unconsidered and constantly evolving.

8.1.2 The Notion of Risk

Despite the fact that the BAPE [2003] public consultation has recommended specific actions for sustainable pig farming in Quebec, the most significant and most ignored element of sustainability is the role of risk. This notion is, moreover, not considered in a conventional impact study.

Risk is a subjective concept that can be defined, with regards to environmental impact study, as *a probability that undesirable or unfavourable effect might occur from a given exposure to a pollutant*[14]. A "zero risk" project being impossible, one must introduce in a risk evaluation as a complementary notion that is the expected benefits. While evaluating environmental risks, an

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[13] Jurdant(1988 :162)

[14] Grand dictionnaire terminologique de la langue française : http://www.granddictionnaire.com/btml/fra/r_motclef/index1024_1.asp

accurate adequacy must be conducted between value and probability of both benefits and undesirable impacts. This risk evaluation adequacy is simplified in Figure 8.1.

The left side represents evaluation of benefits while the right side refers to the undesirable impact. Both values are defined by two parameters ; respective value (defined by an impact study) and probability of occurrence. A promoter must consider that the value of expected benefits must be greater than the sum of potential negative impacts.

There is though a significant limitation in defining, with accuracy, a quantitative value of probability. This evaluation process can only be conducted when an event is independently occurring many times given similar conditions. With regards to risks related to the pig farming project in Chapais, limitations to define environmental risks are high considering the fact that there is no precedent for such an initiative in a boreal environment.There are a significant number of large pig farming projects in Quebec that can be used as reference to evaluate potential risks, but none are located in similar environmental conditions.

Social perception of risk basically depends on uncertainty, as well as, distribution of benefits and undesirable impacts. A good understanding of the situation is necessary to take a measured risk. However, gathering accurate information related to a project and conducting relevant studies is very expensive. Interpretation of impact studies is thus, often (even always) characterized by a given level of uncertainty. Environmental risk management also implies a partition of damages and benefits among many social actors (roughly promoters and citizens). The decision process through which the risk is managed is highly politicized. If risk partition is perceived as unfair (*e.g.*, one group enjoys benefits while another suffers related inconveniences), social tensions between actors and stakeholders will most likely arise. Public consultations aim to create a tribune where social actors and stakeholders can build a common vision of risk, by providing information, conducting discussions and suggesting modifications, to provide a fair partition of benefits and damages.

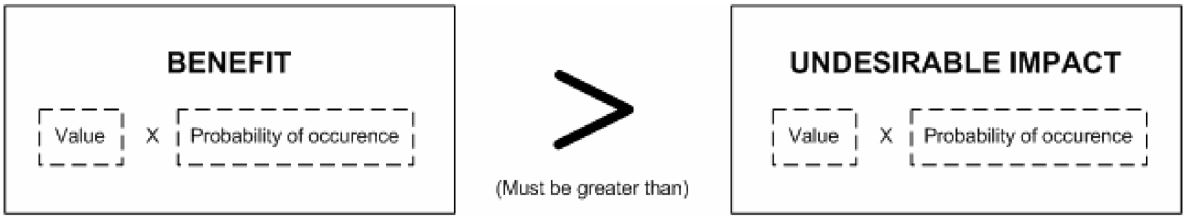


Figure 8.1 Risk evaluation equation

According to the BAPE Commission [BAPE, 2003], three main attitudes were observed in Quebec when facing uncertainties related to pig farming development.

(i) The first attitude appears when uncertainty is used to deny a potential risk. A risk does not exist as long as it has not been undoubtedly demonstrated. This argument has been mostly used by pig farming promoters arguing that being in agreement with government standards is environmentally sufficient to ensure an acceptable level of undesirable impacts.

(ii) On the other side, environmental and citizen groups (generally against pig farming development) will rigidly refer to the precaution principle to reject the project as a whole. Thus, uncertainty is directly extrapolated that is, if there is uncertainty, there will be an impact. An analysis demonstrating without a doubt the absence of impact is requested. Considering that a zero-impact project is impossible, this vision, when extended to an extreme point, becomes regressive because no project can be initiated.

(iii) Finally a scientific approach will try to reduce uncertainties related to risks, by providing information and modelled projections of potential impacts. Scientific analyses are, however, constrained by methodological limits and cannot respond in an absolute fashion to denial or precaution detractors. Scientific analyses can only support a decision based on the current state of knowledge and reasonable doubt.

8.2 LIMITS OF THE IMPACT STUDY CONDUCTED BY THE PROMOTER

The impact study conducted by *ROBERT HAMELIN & associés*, represents a well documented analysis of potential environmental impacts. The impact study is currently being evaluated by a comity of experts of the QMDDEP (*COMEX*) to judge its conformity with regard to current environmental legislation on pig farming (see Chapter 3). Regardless of the COMEX conclusions, some elements can be discussed here in order to improve the understanding and to help him grasp a wider picture of the impact study provided by the promoters.

8.2.1 Methodology

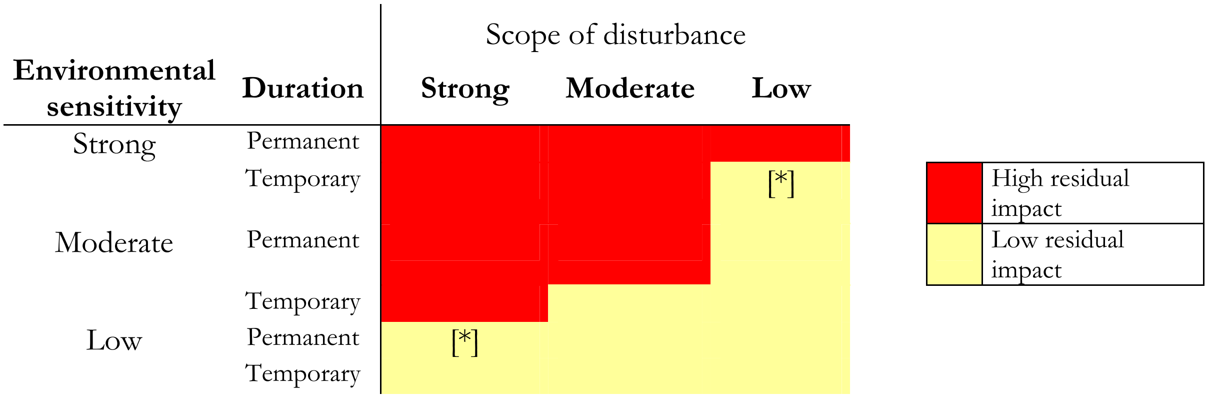
There is no scientific methodology officially recognized by the Quebec government to conduct environmental impact studies, although the matrix approach adopted by the promoters (see section 7.1) is commonly used by the scientific community. This methodology has the advantage of being flexible, to include multidisciplinary perspectives, and to provide a visually clear and easy way to understand project impacts (see Table 7.1). However, some elements are constraining the approach.

8.2.1.1 High Level of Subjectivity

According to André *et al.* [1999], subjectivity cannot be completely avoided while evaluating environmental impacts. However, evaluation should be based on environmental data as well as scientific and traditional knowledge. To reduce subjectivity while evaluating the potential scope of disturbances, environmental sensitivities and residual impact values, the promoters used charts such as that presented in Table 8.1.

Although the impact evaluation remains partially subjective and hard to understand for non-scientists, results are supported by detailed justifications, referring constantly to these charts. However, there is a bias in the way the impact values are distributed (see[*] in Table 8.1): there are more scenarios where residual impacts are considered low. Of course, this is a subtle demonstration, but it demonstrates a potential subjective bias in the way potential impacts are evaluated in favour of the promoter. Table 8.2 presents a comparison of positive and negative residual impacts, as evaluated by the promoters.

Table 8.1 Chart used by the promoter to evaluate residual impact value



		Scope of disturbance		
Environmental sensitivity	**Duration**	**Strong**	**Moderate**	**Low**
Strong	Permanent	🟥	🟥	🟥
	Temporary	🟥	🟥	🟨 [*]
Moderate	Permanent	🟥	🟥	🟨
	Temporary	🟥	🟨	🟨
Low	Permanent	🟨 [*]	🟨	🟨
	Temporary	🟨	🟨	🟨

🟥	High residual impact
🟨	Low residual impact

Source : [Consultants LEGOFF Groupe inc., 2005], p. 205.

Table 8.2 Comparison of positive and negative residual impact values

	Positive impacts	**Negative impacts**
High residual value	Economic spin-off Quality of life	None
Low residual value	Soil quality	Dust Noise Odour Vegetation and wildlife Traffic Landscape esthetical Water quality Traditional activities

8.2.1.2 Diffuse and Long-Term Effects

Another limit of the promoters impact study, is that the project is considered as an isolated system. That means that little effort has been devoted to consider cumulative impacts of the project within the overall regional development plans or project related activities. Causes of diffused pollution are hard to evaluate precisely, but their existence is undeniable. Activities such as timber harvesting by Barrette-Chapais, municipal wastewater discharges or other development projects such as ballistic experiments by SNC-TECH[15] will produce a cumulative pressure on the regional environment. This problem might not seem presently relevant, considering the low regional economic activity, but will become more and more important as industrial activities increase in the region. Moreover, the project life expectancy is estimated at twenty years and, as put forth by Abramowicz and Burton [2003], there is no way to predict with certainty if a practice or plan is sustainable in the long run because of fluctuations in ecological and socioeconomic systems, as well as limits to present knowledge.

8.2.1.2 Comparison with Other Pig Farming Project

There exist many other pig farming projects in Quebec and environmental analyses were in all likelihood conducted. Based on scientific studies, the BAPE [2003] Commission on pig farming documented many social and environmental problems related to pig farming (see Chapter 6). This information, which could have helped the reader to evaluate the project, was neither directly nor sufficiently used in the impact study conducted by the promoters.

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[15] see Chapais web site : http://www.villedechapais.com/developecono.htm

8.2.2 Modelling

To predict impacts related to odour spreading and effluent discharge resulting from pig slurry treatment, the promoters reported a modelling study (see section 7.2.2.1). The models used are recognized as being accurate for these specific uses. However, some points should be discussed.

Regarding the odour spreading model:

(i) odour produced by the incinerator was not evaluated;

(ii) cumulative effects were not evaluated (neither within the project infrastructures nor with other regional activities); and

(iii) noxious effects were evaluated according to dominant wind distribution, while odour perceptions are more significantly felt during calm periods.

Regarding the wastewater discharge model:

(i) results are in agreement with government requirements but do not ensure environmental sustainability; and

(ii) efficacy of the pig slurry treatment is based on the process rapidity that implies human factors (procedural faults, incompetence) which cannot be modelled.

8.2.3 Points to be Clarified

For many reasons, some points are neither completed nor sufficiently explained in the impact study, the following Section provides details on these points.

8.2.3.1 Biosolids Management Plan

According to REA, the pig farming project must be supported by a nutrient management plan signed by a member of the OAQ (see Chapter 3). To treat the pig slurry, the promoters selected the Biofertile ® technology (little information is provided on the processes related to this technology in the impact study), which has been authorized by the Government. This treatment technology presents many advantages such as low treatment cost, odour reduction, production of biosolids with a high agronomic value. To value these biosolids (50 m^3/day), the promoters is currently considering three options: using biosolids as a combustible for the Chapais cogeneration plant, as an agricultural fertilizer exported to remote areas or as a forest fertilizer for surrounding logged areas. None of these options has yet to be thoroughly analyzed.

The technical and environmental feasibility of the cogeneration option needs to be done. Moreover, biosolids produced by Biofertile® present a major disadvantage of having a weak market value for energy purposes. Moreover, this option implies transportation towards the town of Chapais, and resulting odours have neither been considered in the modelling study nor has gas emitted from the cogeneration plant.

Surrounding croplands do not provide enough area to value the amount of produced biosolids and exporting as a fertilizer might be a costly and risky operation for the promoters. Neither a management plan nor a market study has been done yet. Confronting a high transportation cost to manage biosolids, it is legitimate to anticipate that the promoters might consider converting current land use into cropland to value the biosolids. Related impacts on water (see Sections 4.3 and 4.4) are not considered in the impact study provided by the promoters.

Finally, using biosolids to fertilize logged areas needs to be supported by analyses and expertise that were not provided for by the promoters.

8.2.3.2 Monitoring Measures

The promoters will hire and train an environmental technician to monitor ground water quality and the agro-environmental management plan. Observation wells will be dug around treatment plants and breeding centers to collect water samples on a seasonal basis. Moreover, the technician will ensure appropriate operations (management of slurry, transportation of biosolids and animal carcasses, incinerator operation) to reduce the amount of noxious gases produced. An operation register will be updated and available.

Even though a technician will be responsible for monitoring measures, there should be provisions for an external and neutral monitoring.

8.2.3.3 Impact on Traditional Activities

To be aware of the concerns of the Cree Native Communities, the promoter conducted, on July 28th 2004, a meeting with the Band Council. A visit of the Biofertile® technology at a teaching facility in Saint-Anselme was also conducted for native representatives. However, only two commentaries and one question were collected which does not represent a thorough analysis of the concerns raised by Cree Communities. Moreover, impacts on traditional trapping activities have not been evaluated because the Dixon family has provided no information to the promoters.

8.3 ECOLOGICAL RISKS ON THE BOREAL ENVIRONMENT

The following subsections are based on the current state of knowledge regarding the impacts of forest disturbances on waters of the boreal environment (Chapter 4), the current state of water resources, water uses and concerns of the population of Northern Quebec (Chapter 5) and the results and findings of the BAPE consultation on sustainable development of pig farming in Quebec (Chapter 6). Taking into account complementary information and concepts defined in section 8.1, risks related to the proposed pig farming project will be discussed in terms of Northern Quebec environmental specificities.

8.3.1 Ecological Polygons

To illustrate the distribution of environmental characteristics of the Chapais region, and more precisely the area affected by the pig farming project, a map of the ecological polygons of Northern Quebec produced by the QMDDEP was analyzed. This approach disaggregates a studied area (a watershed for example) into smaller geographical units called polygons. Afterwards, each polygon is characterized with respect to available data and defines "local environmental properties". For each polygon, a quantitative value is given in terms of hydrological characteristics, nature of soils, topography and vegetation.

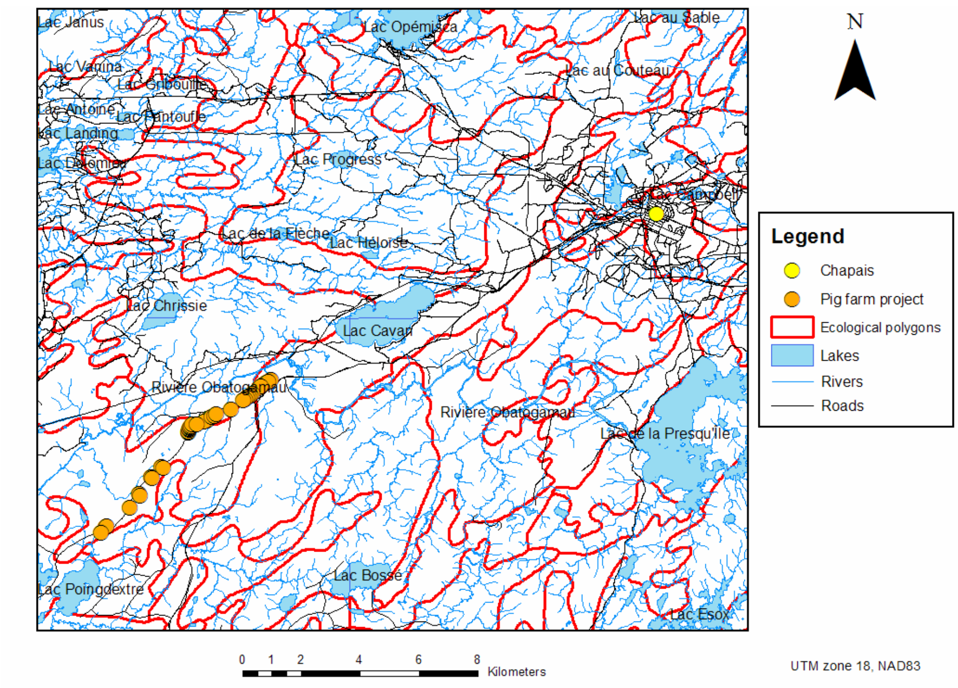

Figure 8.2 Ecological polygons for region of Chapais

Table 8.3 Description of the four ecological polygons affected by the pig farming project

	Polygons			
Characteristic	**1**	**2**	**3**	**4**
Relief	Corrugated	Hummocky	Corrugated	Hummocky
Soil thickness	Thick	Thick and thin	Thick	Thick
Soil dominant material	Till	Till	Till	Till
Surface dominant material	Fluvio-glavial sediments	Till	Glacio-lacustrine sediments	Undefined
Type of aquatic ecosystem	Less than 5% composed of water bodies	More than 15% composed of lakes < 250 ha	Less than 5% composed of water bodies	Less than 5% composed of water bodies
Abundance of brooks	None or little	None or little	Little	None or little
Abundance of wetlands	None or little	Little	None or little	None or little

Total coverage of the area affected by these characteristics provides key information to draw a portrait of the ecological conditions of the studied area. Figure 8.2 presents the distribution of ecological polygons for the Chapais region. Table 8.3 provides detailed information for the four ecological polygons directly affected by the pig farming project (orange points). It is noteworthy that till represents the dominant soil material and this material is poorly drained and tends to have a propensity to produce surface runoff.

8.3.2 Water

During a meeting conducted by LEGOFF with Chapais' population on the 29th of July 2004, a citizen expressed a concern regarding surrounding water quality: « My summerhouse is located nearby Cavan Lake. Is there a contamination risk for my domestic well? ». Pig slurry is a source of contaminants (nitrates, disinfection by-products, microorganisms, nitrogen and phosphorus see Section 6.2) that can be introduced in surface waters and produce a significant undesirable impact on environment and human health. Two main sources of water pollution can be identified in the project: a probability of accidental spillage of untreated slurry from treatment plants or transportation and inappropriate spreading of biosolids on surrounding cropland. The following sections describe the current state of water resources in the surroundings of Chapais and aim to determine potential risks of pig farming and related activities on water quality.

8.3.2.1 Description of Waswanipi River Watershed

Waswanipi River watershed is presented in Figure 8.3. This somewhat circular area of 100 km in diameter is divided into five subwatersheds (red lines). A dense and intertwined hydrological network, major lakes being Lake Chibougamau, Lake au Goéland, Lake Waswasnipi among others, characterize this area.

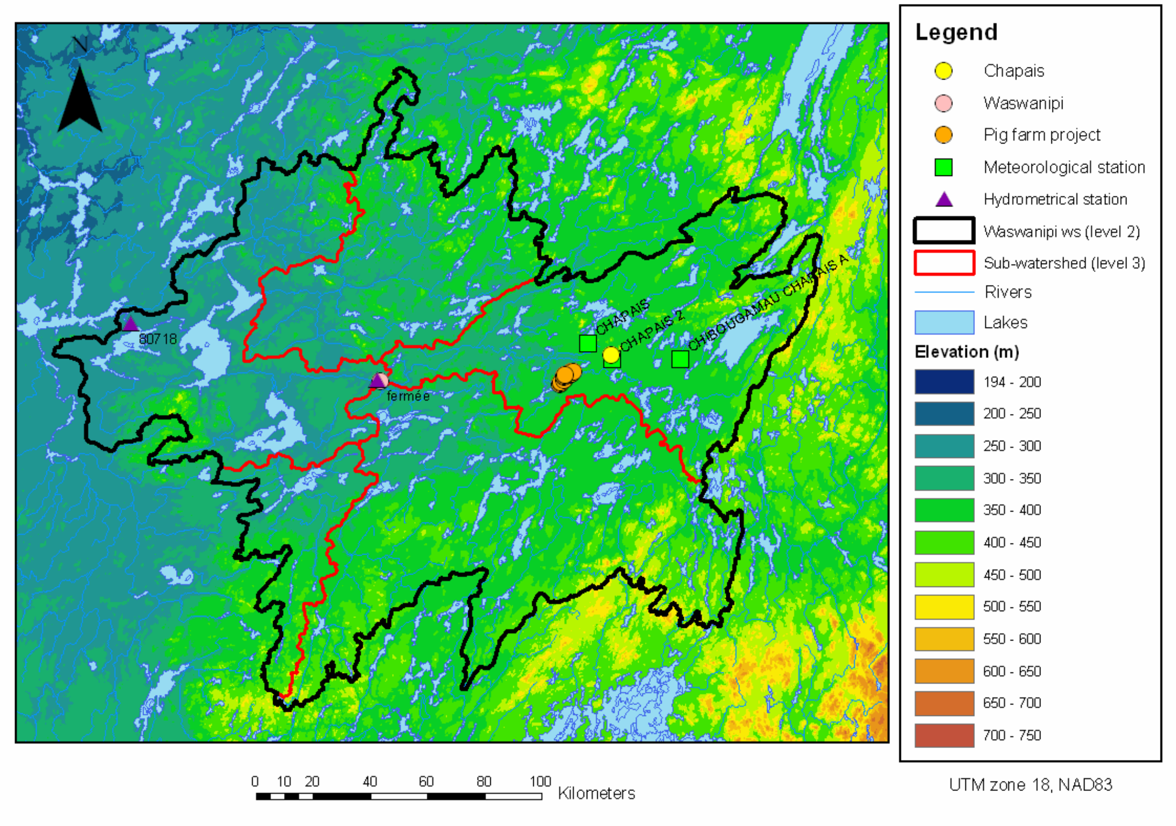

Figure 8.3 Waswanipi River watershed

The Waswanipi River watershed is mostly part of the James Bay Municipality, but is also covered by other municipal territories, such as Waswanipi, Chapais, Chibougamau, Mistissini, Oujé-Bougoumou (see Appendix B). The town of Chapais (yellow point) as well as the pig farming project (orange points) are located in the eastern subwatersheds. Table 8.4 summarizes the hydrological information provided for by the distribution of ecological polygons. Appendix C introduces the climatic and hydrological conditions of the watershed.

Table 8.4 Hydrological information of Wawasnipi Riverwatershed

Aquatic Ecosystem Category	Covered area of Wawanipi watershed (%)
Less than 5% of area composed by water bodies	58.65
5 to 15% of area composed by lakes < 250 ha	11.57
More than 15% of area composed by lakes < 250 ha	7.86
More that 5% of area composed by rivers	6.71
More than 15% of area composed by lakes > 2500 ha	5.20
More than 15% of area composed by lakes > 250 and < 500 ha	4.26
More than 15% of area composed by lakes > 500 and < 1000 ha	3.02
More than 15% of area composed by lakes > 1000 and < 2500 ha	2.27
Others	0.45
Brook abundance	
None or very little	53.38
Little	33.39
Moderate	11.95
Abundant	1.28
Wetland abundance	
None or very little	15.18
Little	49.16
Moderate	31.62
Abundant	3.86
Very abundant	0.17

8.3.2.2 Description of the Pig Farm Watershed

The area affected by the pig farming project refers to a part of the eastern subwatershed of Waswanipi River watershed. Figure 8.4 presents the locations of the pig farming (orange points, along Obatogamau River) and the affected watershed (green zone). Both upstream (red) and downstream (beige) watersheds are also indicated. Lake de la Presqu'île is located in the eastern part of the watershed, upstream of Obatogamau River, which embodies an hydrological barrier between the pig farm location and Cavan Lake. Figure 8.5 presents the wetland distribution, which represents around 20% of the targeted area. One can observe a sparse south-east zone from the pig farm location, this corresponding to Barette-Chapais timber harvesting area.

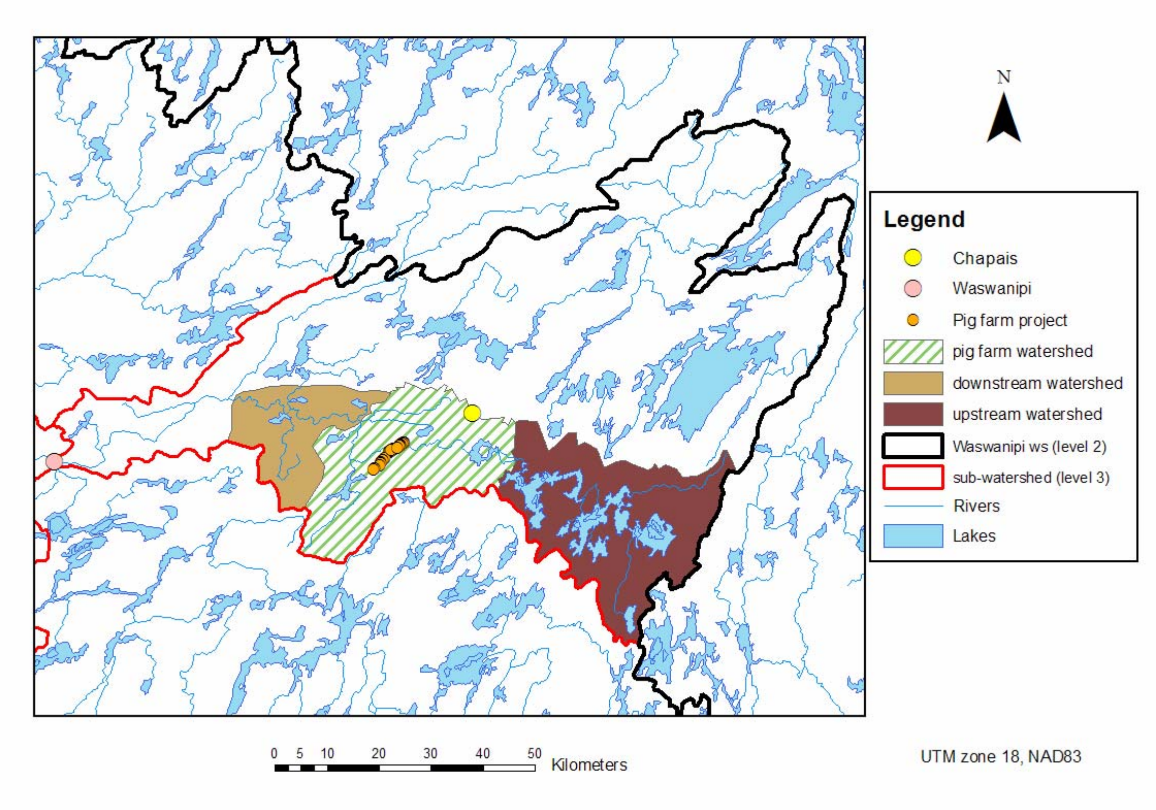

Figure 8.4 Pig farm watershed in surroundings of Chapais

Ecological polygons for watersheds affected by the pig farming project provide specific information with regards to local hydrological characteristics. For all three watersheds, approximately half of the area is covered by surfaces having less than 5% of water bodies and one contains between 14.66 and 33% of the watershed area covered by lakes smaller than 250 ha. Brooks are rare or absent in most of the considered area (around 93%), ditto for wetland (except for the downstream watershed where 65% is covered by a moderate wetland presence). When comparing to the hydrological information characterizing the Waswanipi River watershed (Table 8.2), one can say that the area affected by the pig farm project contains a large concentration of larger lakes, a dense brook network and a high wetland density in the downstream watershed.

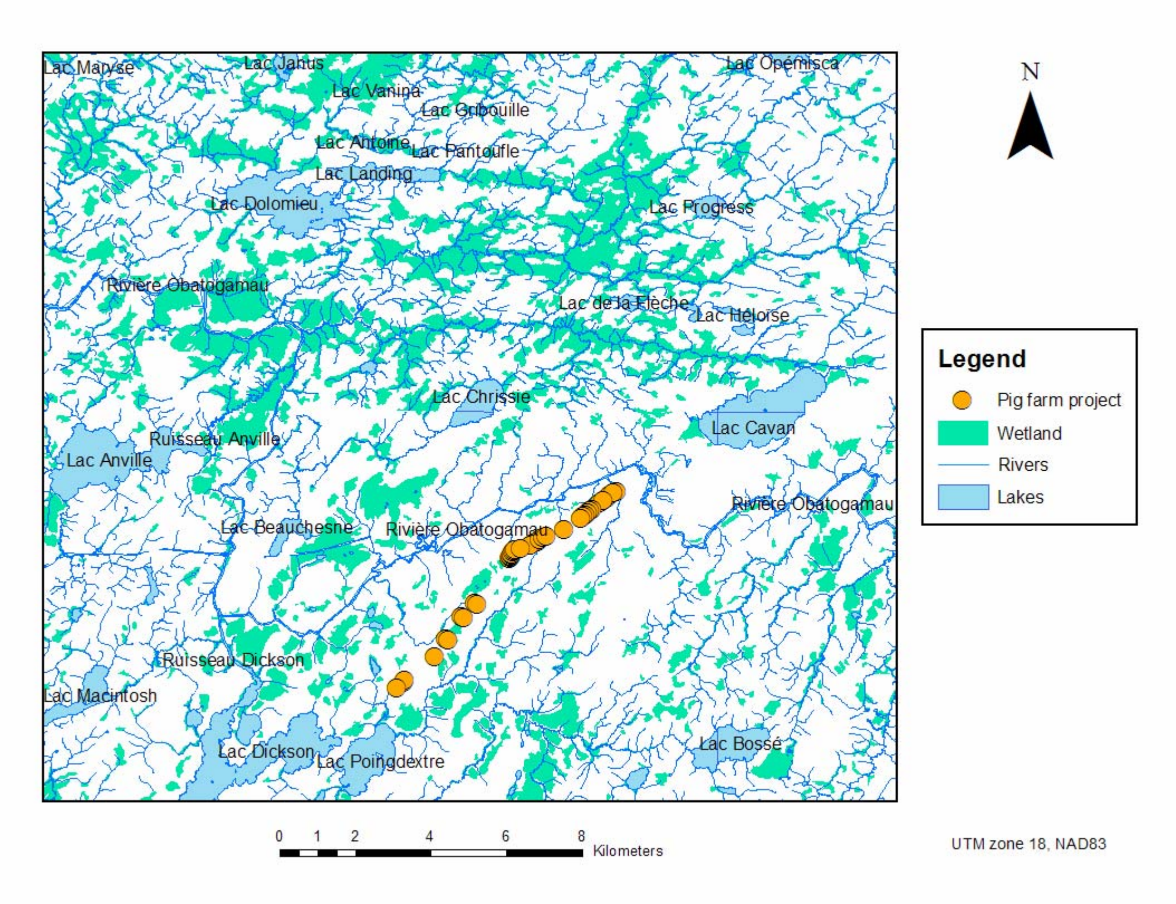

Figure 8.5 Distribution of wetlands

8.3.2.3 QMDDEP Study on Water Quality in Agriculturally Intensive Regions

A study conducted by Rousseau *et al.* [2004] analyzed seven watersheds in Central Quebec in order to establish correlations between agricultural intensity, water quality and occurrence of related diseases. Water samples were collected in 2,070 domestic wells and 144 municipal water supplies (both surface water and ground water).

Results of this study demonstrated that intensive agricultural activity produces an impact on surrounding water quality. In intensively cultivated areas, nitrates contaminated more wells than in non-intensive zones, this proportion being even greater for surface wells (less than 8-m deep). Moreover, municipal water supplies collecting ground water presented higher ammonia-nitrogen concentrations, while those collecting surface waters presented larger phosphorus and nitrate concentrations. Even if the presence of noticeable contaminant concentrations in municipal water supply systems has been demonstrated, observed concentrations were below an alarm threshold. Moreover, correlation between water quality and occurrence of gastroenteritis could not be scientifically demonstrated.

8.3.2.4 Risks of Pig Farming on Water Quality

Applying the QMDDEP conclusions to the pig farming project in Chapais must be done with caution and direct extrapolation should be avoided. The analysis expresses broad interrelations based on agricultural intensity at a regional scale without specifically identifying pollution sources. Chapais agriculture is sparse and the pig farm project would represent a discrete, potential source of pollution that should not drastically increase regional water contaminant concentrations. Moreover, specific attenuation measures will be applied. One can definitively expect that a large-scale pig farming project will discharge contaminant into surrounding waters. The main issues being faced are the migration patterns from pollutant sources (treatment plants and croplands) and potential zones where risks for human health could be, in the long run, significant.

8.3.3 Soils

8.3.3.1 Description of the Soil in the Waswanipi River Watershed

The Waswanipi River watershed presents a mostly corrugated and hummocky relief (97% of the area). Sparse flat and uneven lands can also be observed (less than 3%). Surface soils are thick (66% of the area presents soils thicker than one meter) mostly composed of tills (33%), characterized by a low porosity and poor drainage capacity, and different kinds of sediment deposits (53%). Tills are the dominant material (54%) and can be embedded in rocks or disposed in plated layers. Other sediment deposits (fluvial, glacio-lacustrine, better drainage capacity) are mostly located in plains or surface layers. Table 8.5 summarizes geographical data related to soils.

Table 8.5 Distribution of soils in Waswanipi watershed

Relief	**Covered area of Wawanipi watershed (%)**
Corrugated	78.37
Hummocky	19.67
Uneven	2.03
Flat	0.49
Mountainous	0.45
Soil thickness	
Thick (>1m)	66.62
Thin and thick	17.59
Thick and thin	11.35
Thin	2.10
Others	2.35
Dominant material	
Till	54.46
Fluvial and glacio-lacustrine sediments	28.13
Organic minerotrophe sediments	11.14
Fluvio-glacial sediments	5.64
Others	0.63
Surface material	
Till	30.32
Organic sediments	25.50
Fluvial and glacio-lacustrine sediments	22.95
Fluvio-glacial sediments	6.17
Others or undefined	15.17

8.3.3.2 Description of the Soil in the Area Affected by the Pig Farming Project

As for the Waswanipi River watershed, the relief surrounding Chapais is mostly hummocky and corrugated, but has more areas classified as uneven (between 8 and 11% of surface compared to 2% for the whole watershed). Soils covering this area are mostly composed of tills (up to 78% of the area) disposed in thick embedded layers of (up to 45% of the surface). Surface soils are more diversified in the downstream watershed where sediment deposits (plains or plated layers) cover 70% of the area.

8.3.3.3 Risk of Pig Farming on Soil Quality

Activities of the pig farming project should not directly produce a significant negative impact on soil quality. In fact, related activities such as increase of croplands to agronomically value biosolids and use of pesticides might produce more significant impacts. The poor soil quality (dominated by tills), with respect to agriculture, would imply greater logged areas for a given amount of slurry to be spread. Moreover, as discussed in Chapter 4, large and flat watersheds are more vulnerable to nutriment enrichment.

The probability of the promoters converting forest area into cropland depends on the slurry management plan. The promoters are legally bound to observe strict environmental restrictions and are not currently planning to do so. However, the viability of the options presented by the promoters, still needs to be demonstrated. There is no guaranty yet that any of these will be feasible. As long as the slurry management plan is not settled, the probability of an undesirable impact on soil quality is significant and represents an environmental risk.

8.3.4 Wildlife Habitats and Vegetation

8.3.4.1 Description of the Ecoforester Environment Within the Pig Farm Watershed

The area affected by the pig farming project is located in the superior boreal bioclimatic zone. SIEF (*Système d'information écoforestière* – Ecoforester Information System) data were gathered on part of the pig farm watershed (see Figure 8.6). This softwood cover is densely populated with groups such as black or red spruce strands (38% of the surface), grey pine forests with red or black spruces (15%), grey pine strands (14.86%) and grey pine forests (13.49%).

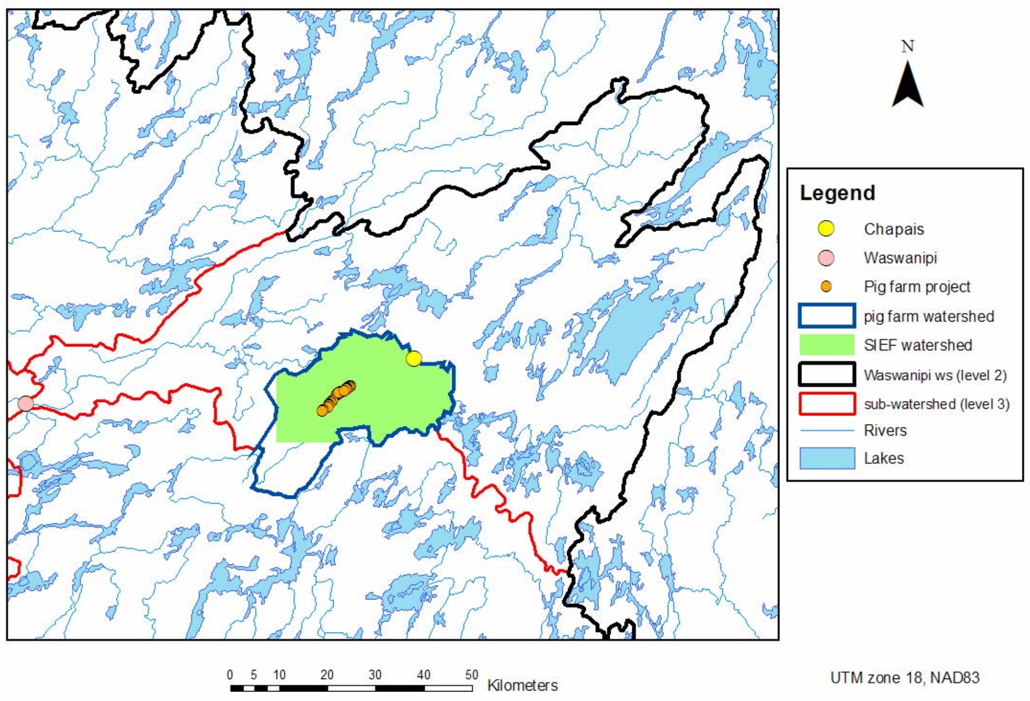

Figure 8.6 Area covered by SIEF data

The forest is a mature and dense forest where 77% of the area is covered (between 40% and 80%) with vegetation. 61% of the forest cover present dominant and co-dominant trees between 12- to 17-m high and most trees (66%) are at least 70 years old. Null or weak slopes are observed on 82% of territory and drainage capacity is mostly low or moderate.

9 CONCLUSION

This report has presented an overview of the current understanding of potential environmental and social risks associated with the proposed pig farming project initiated by CDEC. As shown in Figure 2.1, this report started by providing background information and outlined the current state of knowledge with regard to the northern boreal environment and the potential environmental and social impacts of pig farming as observed in Southern Quebec. The major elements and conclusions from each Chapter are listed below.

Located 11 to 20 km from the town of Chapais, on the Trapping Territory of Mr. Malcom Dixon of Waswanipi Cree Community, the large-scale, pig farming project is characterized by:

(1) a 70,000-animal capacity, which would represent the largest pig farming project in Quebec;

(2) a 75-M$ investment, supporting local economy by creating 135 direct jobs;

(3) a production of biosolids that will be used as either a combustible for the cogeneration plant of Chapais, a fertilizer for surrounding and remote cropland or a fertilizer for the surrounding logged areas;

(4) a discharge of treated effluent into the Obatogamau River.

The promoters must respect directives given by the Provincial Administrator, the JBNQA, the conditions established in the REA and Municipal Bylaws. The adoption of Bill 54 in November 2004 and the partial removal of the moratorium on pig farming development will:

(5) allow emission of authorization certificates by the Quebec Government in 339 municipalities characterized by the production of farm nutrients in deficit of crop requirements, the James-Bay Municipality being one of them;

(6) force municipalities to hold public consultations to inform citizens and define additional mitigation measures; and

(7) constrain the legal capacity of municipalities and public consultations to the evaluation of the relevancy of the project and the impacts on the environment.

A review of current knowledge was done using accessible information with regard to specific characteristics of the boreal environment, water uses in Northern Quebec and documented impacts of pig farming in Southern Quebec. The review brought a broader understanding of observed and potential environmental and social impacts of pig farming, namely:

(8) the boreal environment is significantly sensitive to any clear cutting related to cropland expansion, producing undesirable impacts on water quality and aquatic systems;

(9) even though Northern Quebec is characterized by an abundance of water resources of good quality, populations are concerned by the lack of sanitation infrastructures and diffused pollution from forest and mining industry;

(10) inappropriate agricultural practices have been associated with undesirable impacts on water, air and soil quality, as well as health risks for workers and surrounding populations, generating social tensions;

(11) in Southern Quebec, intensive agricultural activity has an impact on surrounding water quality, contaminating wells and municipal water supplies; and

(12) no similar project, with regard to size, has ever been developed in the Northern Quebec boreal environment, constraining a scientific evaluation of the scope of undesirable impacts.

A well documented impact study was conducted by the promoters. Major impacts on economy, society and environment, both positive and negative, were identified for all project phases. The promoters suggested attenuation measures to limit, as much as possible, impacts related to pig farming activities:

(13) odour spreading will be mitigated by appropriate separating distances;

(14) pig slurry will be treated using a Biofertile® technology, reducing gas emission and producing an agronomically high valued biosolids and clean effluents; and

(15) inventories of threatened species will be conducted and may justify a relocation of infrastructures.

The impact study provided by the promoters led to a list of elements that will need to be further clarified:

(16) pig slurry management plan;

(17) impacts of the discharge of the slaughterhouse effluent into Chapais' municipal sewer system which does not have a sanitation system;

(18) accountability and responsive measures related to environmental monitoring;

(19) cumulative impacts and impacts produced by activities related to the project, such as cropland expansion;

(20) concerns of the First Nations.

Moreover, impact studies are constrained by scientific limits such as:

(21) the incapacity to evaluate with a perfect accuracy all long-term impacts related to a project, creating uncertainty;

(22) a given level of subjectivity; and

(23) the fact that mitigation measures in accordance with governmental standards do not ensure definitively environmental sustainability.

The notion of risk management is grossly neglected by the promoter, especially with regard to:

(24) expected benefits must be greater than undesirable impacts which depends on the probability of occurrence of those undesirable impacts;

(25) social acceptance of the risks depends on distribution of benefits and undesirable impacts;

(26) impact study focuses on reducing uncertainty related to risk in order to enlighten decision processes.

Complementary geographical data support the idea that the Chapais boreal environment is potentially vulnerable to intensive pig farming activities. Related arguments are:

(27) a low drainage ratio (small lakes combined with large watersheds) and low watershed slopes increase nutrient concentrations in water;

(28) nature of soils is inappropriate to cropland expansion;

(29) not enough information is available on vegetation and wildlife.

Finally, the information gathered in this document demonstrated that the proposed pig farming project is linked to a significant environmental risk. This conclusion is enhanced by the vulnerability of the boreal environment, the size of the project and results from other scientific studies conducted in Southern Quebec. However, uncertainty related to the risk assessment is high, considering how little information is available on the local environment, the monitoring measures, the agricultural practices, and the slurry management plan. Considering that Oujé-Bougoumou Eenuch Association and Waswanipi First Nation Cree Board of Health and Social Services are on record as being opposed to the project, two main recommendations are listed below:

(i) insist on receiving accurate and transparent information from the promoters and CDEC;

(ii) support an integrated, watershed-scale, management approach to ensure regional development viability.

However, the purpose and findings of this report should not be used to decide whether or not the pig farming project is "good" or "bad", but rather to provide relevant information to guide the actors and the promoters during their discussions at the upcoming public consultation. Considering the legal inability to question the relevancy of neither the project nor the impacts on the environment, that being the task of the Expert Committee of QMDDEP (COMEX), we list below second order recommendations, which might be considered following the potential project approval:

(iii) outline a socially acceptable distribution of risk, that is balance of undesirable impacts and benefits with the promotors;

(iv) require an impartial and neutral monitoring program through which local population could be involved;

(v) call for commitments from the promoters to ensure the implementation of sound mitigation measures and good agricultural practices (best management practices).

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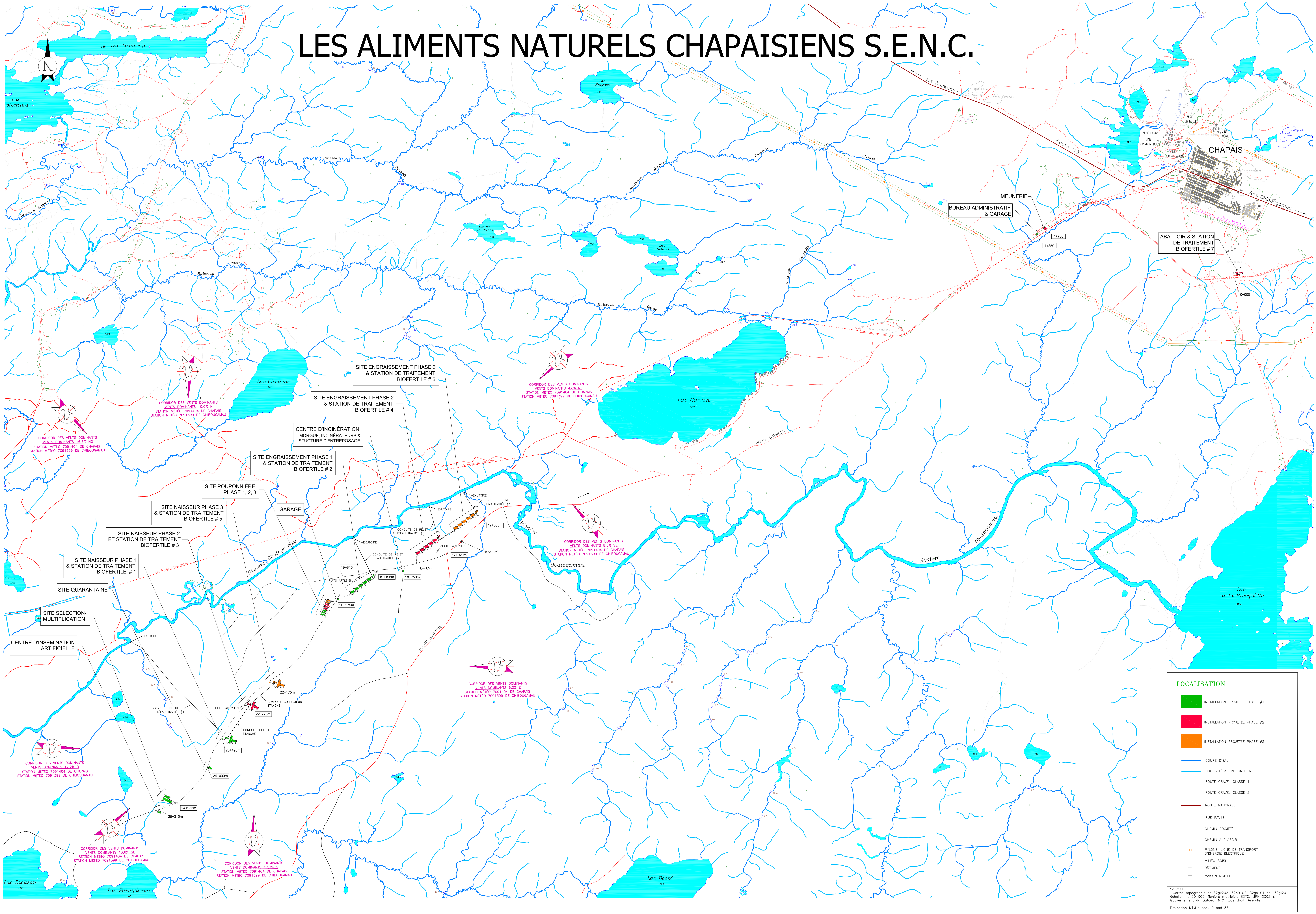
APPENDIX A. LOCATION PLAN PROVIDED BY THE PROMOTER

LES ALIMENTS NATURELS CHAPAISIENS S.E.N.C.



Sources:
–Cartes topographiques 32gk202, 32n0102, 32go101 et 32gj201, échelle 1 : 20 000, fichiers matriciels BDTQ, MRN 2002, © Gouvernement du Québec, MRN tous droit réservés;

Projection MTM fuseau 9 nad 83

Corporation de développement économique de Chapais

CORPORATION DE DÉVELOPPEMENT ÉCONOMIQUE DE CHAPAIS

PROMOTEUR: LES ALIMENTS NATURELS CHAPAISIENS S.E.N.C.

CORPORATION DE DÉVELOPPEMENT ÉCONOMIQUE DE CHAPAIS ET YVES LEGOFF

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Tout intervenant doit s'assurer de respecter les directives générales du projet ci-joint. (structure et mécanique) En cas de contradiction, les plans ont priorité sur les directives générales du projet.

ÉTAPE	DATE	DESCRIPTION

COLLABORATEURS

ROBERT HAMELIN & associés

Envirogain INNOVER. VALORISER. PROTÉGER.

LaSalle

consultants LEGOFF groupe inc.
2190, 4ième RUE, ST-ROMUALD,
QC, CANADA, G6W 5M6
SANS FRAIS: 1-877-953-4633
TÉL.: (418) 834-8488
TÉLEC.: (418) 834-1788
SITE INTERNET: www.legoff.ca COURRIEL: info@legoff.ca

PROJET

LES ALIMENTS NATURELS CHAPAISIENS S.E.N.C.

TITRE

PLAN DE LOCALISATION
DES INFRASTRUCTURES

PRÉPARATION CONSULTANTS LEGOFF GROUPE INC.

DESSINÉ PAR
MARTIN GOUDREAU

SUPERVISÉ PAR
YVES LEGOFF

Conception
M2C s.a.
approuvé

DATE	NO. DOSSIER
FÉVRIER 2005	534ET04
ÉCHELLE	**FEUILLE NO.**
1 : 20 000	Carte 3

APPENDIX B. COMPLEMENTARY MAPS

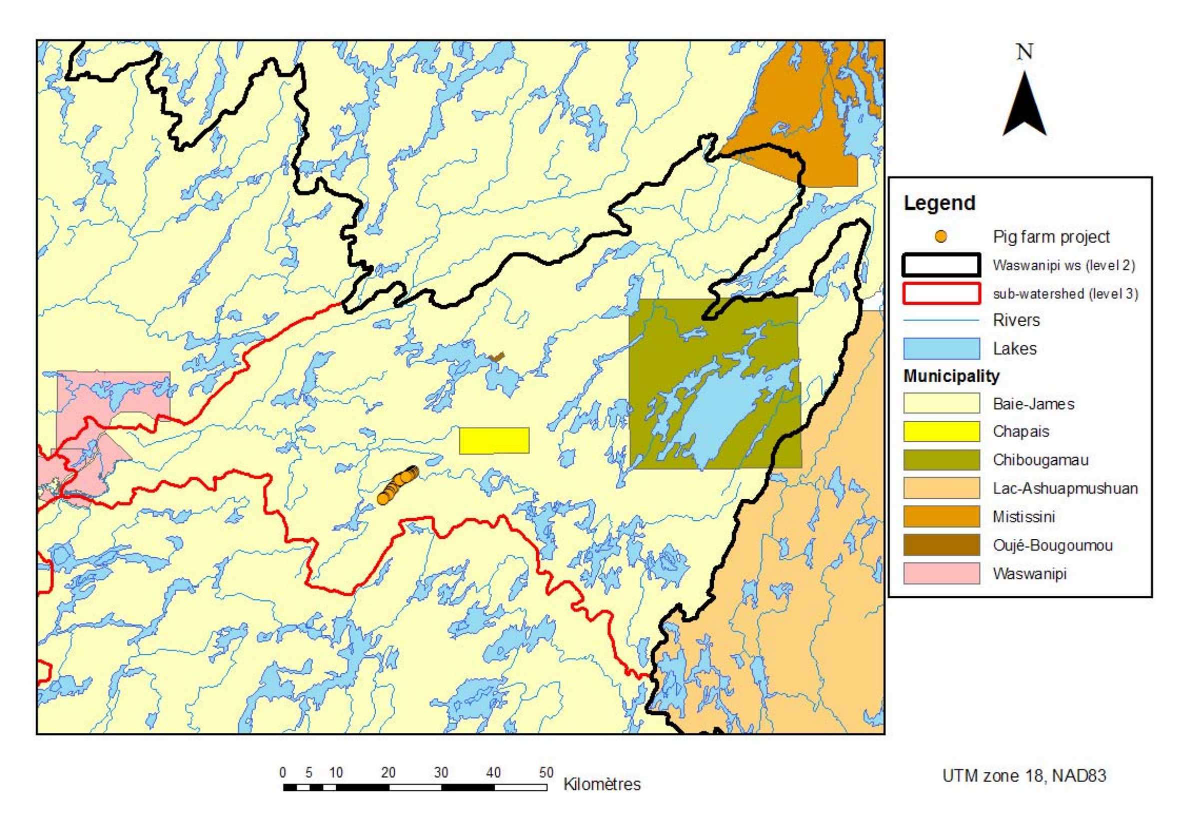

Figure B.1 Municipal territories

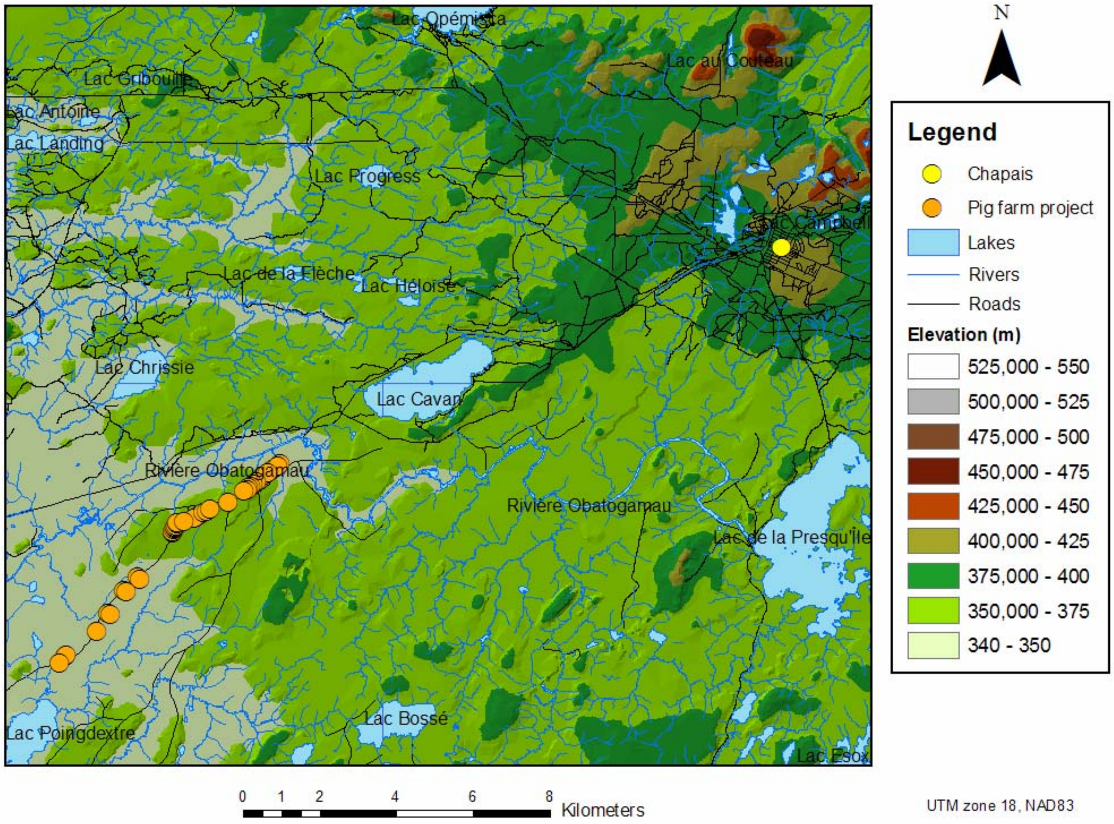

Figure B.2 Topography of the Chapais region

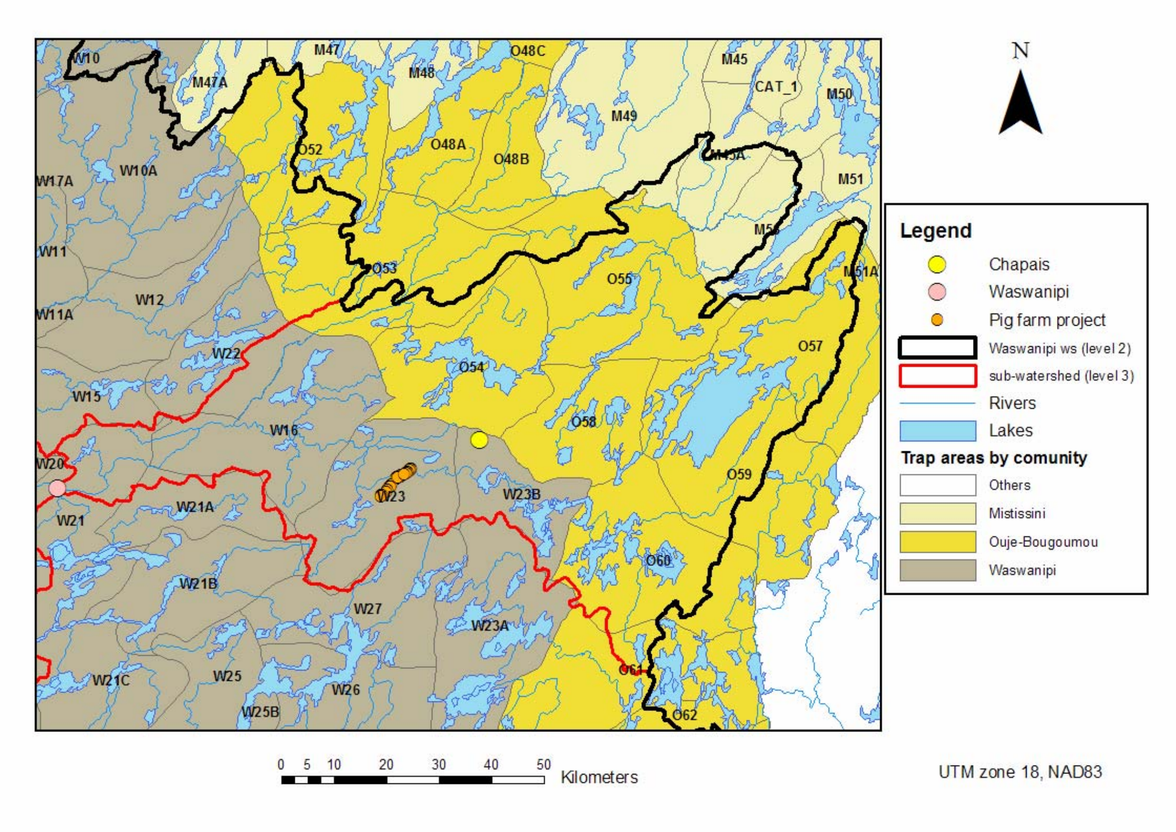

Figure B.3 Distribution of trapping territories

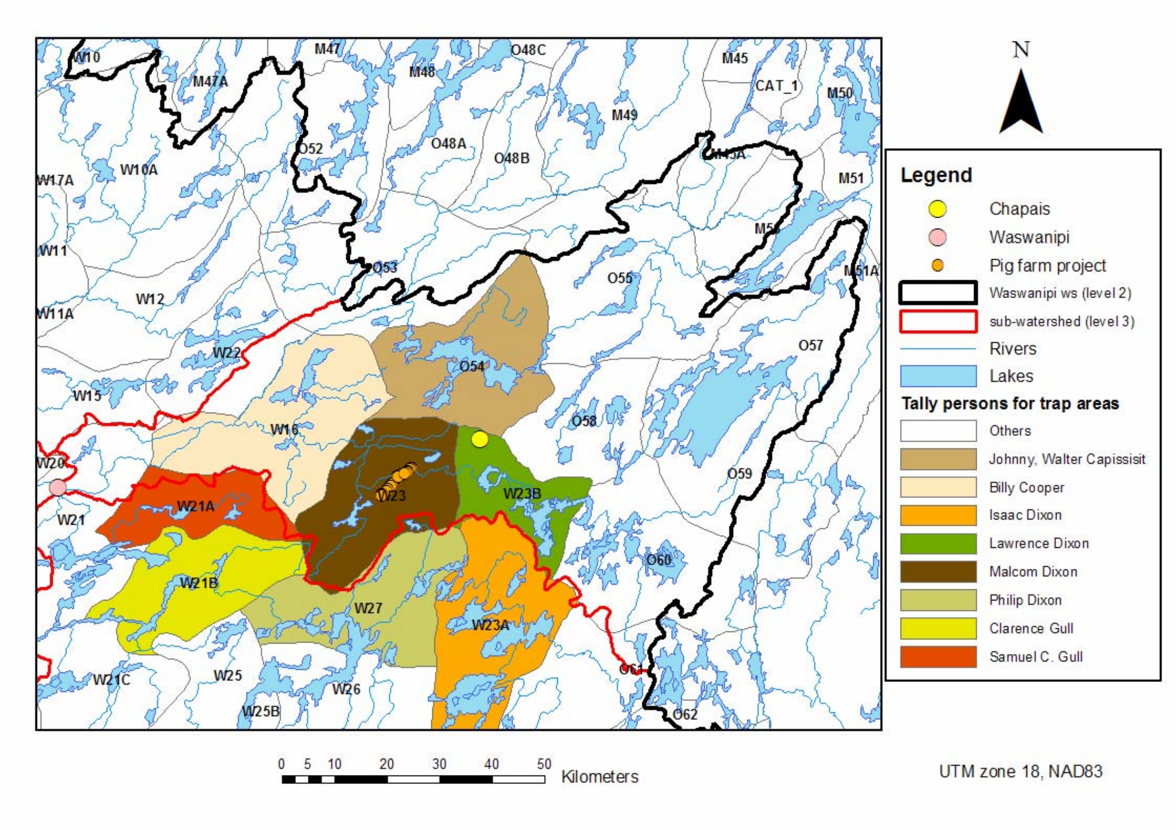

Figure B.4 Distribution of trapping territories

APPENDIX C. CLIMATIC AND HYDROLOGICAL DESCRIPTION OF WASWANIPI RIVER WATERSHED

Over the last 50 years, three meteorological stations collected local temperature data. Annual and monthly distributions observed in the Waswanipi watershed are presented in Figures C.1 and C.2., respectively. Between 1950 and 2000, maximum annual temperatures roughly varied between 5°C and 8°C while minimum annual temperatures varied between -3°C and -8°C. Monthly temperatures show a sinusoidal distribution, where minimum temperature reaches -25°C in January and maximum temperature reaches 21°C in July.

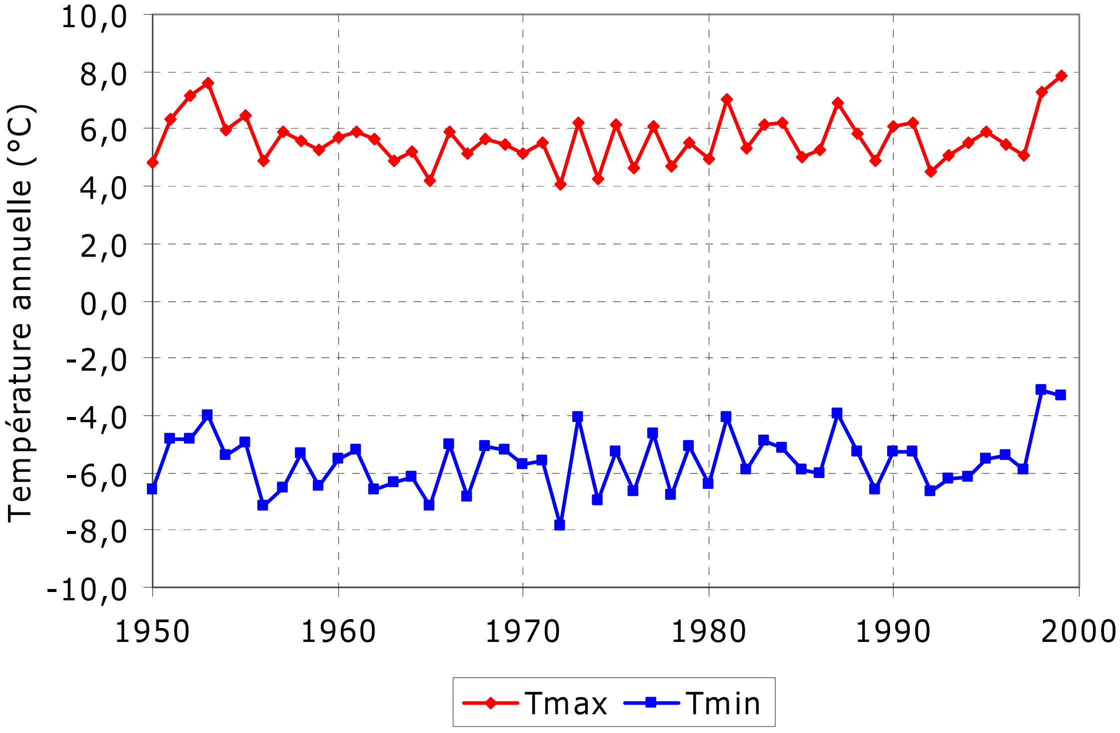

Figure C.1 Annual temperature distribution, Waswanipi River watershed

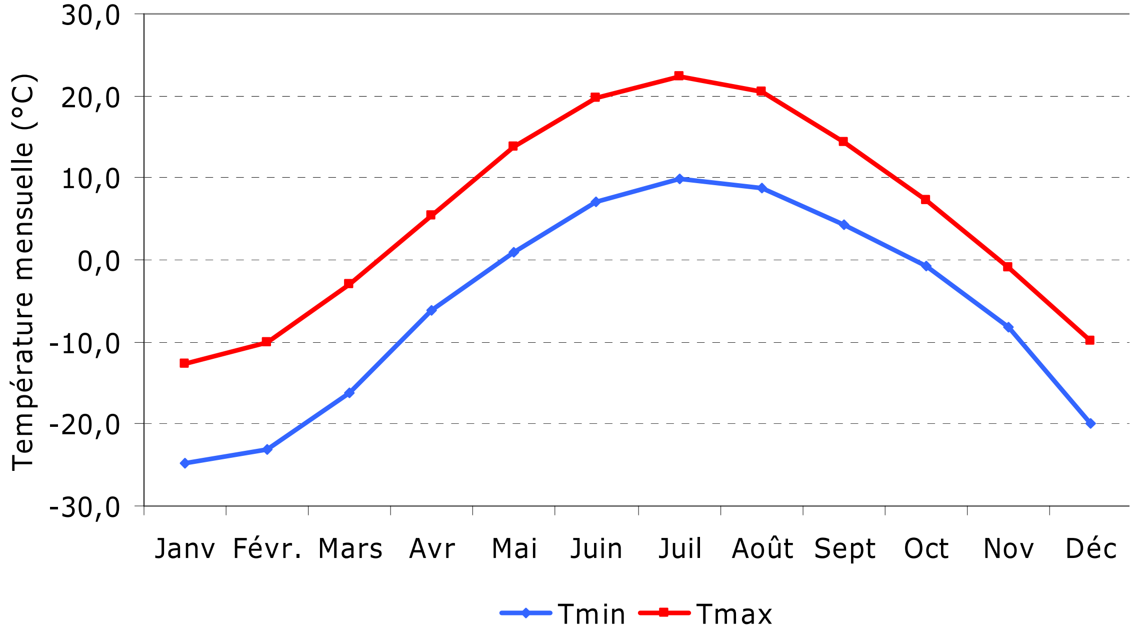

Figure C.2 Monthly temperature distribution, Waswanipi river watershed

Streamflow data were also collected on the Waswanipi River from three different gauge stations (080718, 080702 and 080704, see Figure C.3) located upstream from the Opawica River and near the town of Waswanipi. Figures C.3 and C.4 present distributions of annual and monthly runoff height, respectively. Annual runoff generally varies between 1.4 and 2 mm per day. Peaks can rarely be observed: runoff was maximal (2.3 mm/day) in 1980 and minimal (1.2 mm/day) in 1972. Moreover, cyclic variations seem to have decreased since 1980. Monthly runoff from these three stations shows the same hydrological pattern. Runoff is minimal during winter (down to 0.5 mm/day in March), reaches a peak after the snow melt period (up to 3.8 mm/day in June) and decreases to a relatively stable level during fall (around 1.7 mm/day from September to November).

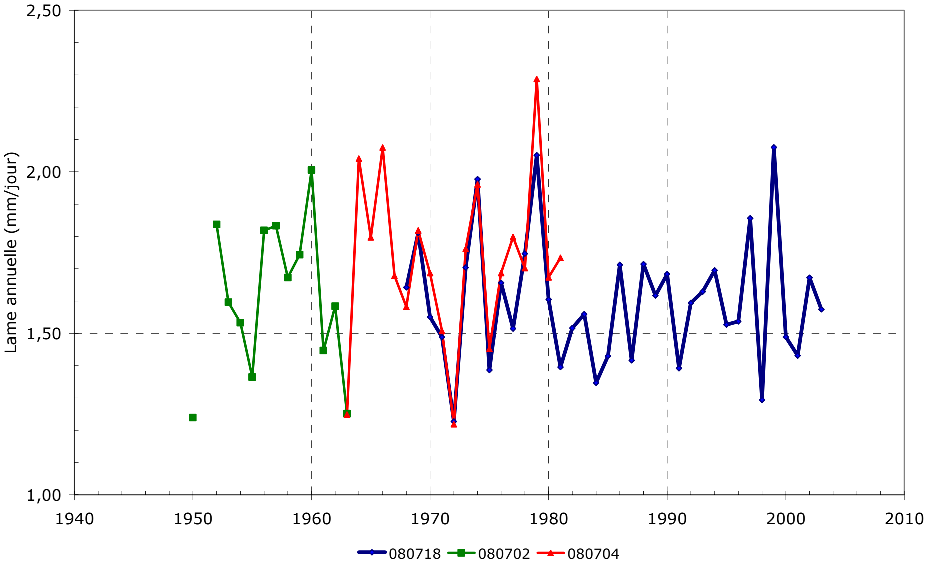

Figure C.3 Monthly runoff distributions, Waswanipi River

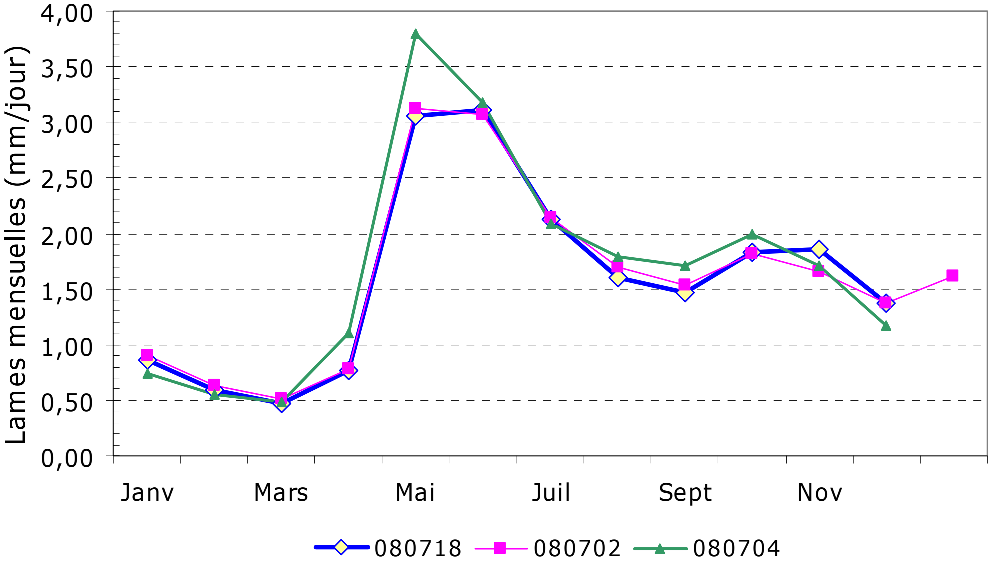

Figure C.4 Monthly runoff distributions, Waswanipi River

Total monthly precipitation in Chapais (rain and snow combined, see Figure C.5) reaches a peak during summer and early fall of up to 120 mm. Total precipitation slowly decreases during winter (around 60 mm). Temperature distribution is equivalent to the one observed at the watershed scale.

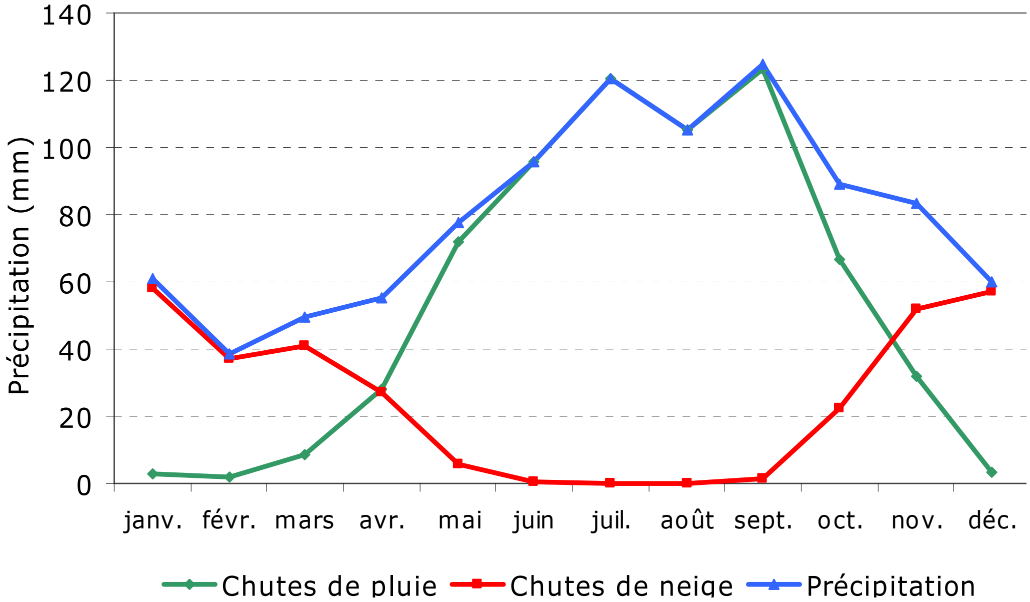

Figure C.5 Total monthly precipitation in Chapais