



CONSTRUCTION OF A LNG RECEIVING TERMINAL ON THE SAINT-LAURENT

PRE-FEASIBILITY OF THE JETTY COMPONENT OF THE PROJECT

(CLIENT REFERENCE: 92500137)



FINAL REPORT

ROCHE

A Shaw Group Company



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LIST OF ABBREVIATIONS

CAPEX	Capital expenditure
CCG	Canadian Coast Guard, Fisheries and Oceans Canada
CHS	Canadian Hydrographic Services, Fisheries and Oceans Canada
CIS	Canadian Ice Bureau, Environment Canada, Ottawa
GRT	Gross registered tonnage of a ship
HQ	Hydro Quebec
LNG	Liquified natural gaz
LPA	Laurentian Pilotage Authority
NBCC	National Building Code of Canada
OCIMF	Oil Companies International Marine Forum
OPEX	Operating expenditure
Cardinal directions:	
E, W	east, west
N, NE, NW	north, northeast, northwest
S, SE, SW	south, southeast, southwest

EXECUTIVE SUMMARY

On September 10, 2003, Gaz Metro – Enbridge – Gaz de France appointed Roche Ltd, Consulting Group, to conduct a pre-feasibility study for the construction of a LNG maritime terminal on the south shore of the Saint Lawrence River, at a site to be selected among the three following locations proposed by the project proponent:

- Ville Guay, located about 10 km north east and across the river from Quebec City, in front of Île d'Orléans. The site is situated within the limits of the port of Quebec City;
- Pointe Saint-Denis, located near the municipality of Rivière-Ouelle, approximately 120 km north east of Quebec City;
- Gros Cacouna, a small village located some 15 km east of the city of Rivière-du-Loup, at 220 km north east of Quebec City. The LNG terminal would be located in the immediate vicinity of the existing commercial port.

SCOPE OF STUDY

The purpose of the study is to evaluate the various technical and environmental characteristics of each site, such as topography and bathymetry, wind and wave conditions, tides and tidal currents, ice dynamics and mechanics, geotechnical properties of soils, seismicity. Various aspects of the physical, biological and human environment have also been examined: quality of sediments, riverbank erosion, riparian vegetation, fish, marine mammals, birds, landscape, land use, archeological value, acceptability for local populations, etc.

This report focuses on the marine facilities included in the project. Land facilities, comprised mainly of LNG storage, vaporization plant, pipelines and cryogenic lines, process equipment to be installed on the jetty, are therefore not covered in this report.

The main activities conducted in the course of this study are summarized as follows:

- Review of the existing documentation on the project;
- Development of site selection criteria and terminal design parameters;

- Recommendation on the preferred site for the jetty, taking into account technical, environmental, operational, navigational and safety aspects as well as construction and operating costs;
- Provision of preliminary technical specifications and layout drawings of the jetty;
- Determination of total cost estimates of the jetty and all work associated with the construction and access of this jetty, including capital expenditures (CAPEX) and operational expenditures (OPEX) to an approximate accuracy level of +/- 25% or better;
- Preparation of preliminary project development program, project schedule and cashflow over the future stages of engineering and environmental studies and construction work.

COMPARISON WITH THE 1980 ARCTIC PILOT PROJECT

The current project is in some ways a revised version of the “Arctic Pilot Project (APP)” that was submitted to public hearings under the jurisdiction of the Quebec Government “Bureau d’audiences publiques sur l’Environnement (BAPE)” in the early 1980s. Although the Arctic Pilot project presented important technical, social and economic differences with the current one, it also included some relevant similarities and therefore, many of the Commission’s comments and recommendations can be used as guidelines for the development of the present LNG receiving terminal.

CONCLUSION OF THE STUDY

The Ville Guay site appears to be the one that offers the most interesting conditions as a whole:

- being located close to the Port of Quebec, an area where there are already intensive navigation activities all year round, it is an area for which pilots consulted in the course of this study have shown good knowledge and have expressed positive opinions;
- the icebreaking and tugboating services are close at hand in Quebec City, since this is the Canadian Coast Guard’s regional base and Ocean Group’s headquarters. This appears to be an important advantage since these services are essential to ensure the reliability and effectiveness of commercial maritime operations in general;
- the general climatic and hydrodynamic conditions make this site more sheltered than the others. The wind, wave, tidal current and visibility conditions are all within acceptable limits and not likely to cause any disruption of maritime traffic. As for floating ice,

according to the ice studies (PCAI, 2003), it is expected that an ice jam capable of stopping traffic for a few days could occur in the Quebec City area with a probability of once in 20 years; such an ice jam is however unlikely to occur at Ville Guay;

- it is also the preferred site from an environmental viewpoint;
- it is the site for which both construction and operational costs are the lowest;
- One of the constraints related to this site is the presence of the North Channel, a restricted section of the seaway situated at the east end of Île d'Orléans, that must be gone through to access the site. This constraint is deemed acceptable considering the foreseen low frequency of LNG ships (one per week) compared to the commercial traffic already existing on the Saint Lawrence, between Les Escoumins and Quebec City, which is in the range of 5 000-7 000 ships per year or 15-20 ships per day. The other two sites are not touched by similar constraints since they are located in wider areas of the Saint Lawrence;
- the main concern about this site is the public safety issue. Although not directly included in the current mandate, it is clear that the safety of the neighbouring populations has to be addressed in detail in an in-depth risk analysis to be carried out during the feasibility study.

Gros Cacouna could also be an acceptable choice, although it presents some disadvantages:

- the tugboating service is complicated and expensive, due to the distance between Gros Cacouna and Quebec City where the closest tugboat fleet is based. The preliminary calculations presented in Chapter 5 demonstrate the very important effect of this distance on regular service cost. The reliability and flexibility of the tugboating service can also be affected.

As an alternate approach, a dedicated fleet of 4 tugboats exclusively to servicing the LNG vessels may be acquired. However the acquisition costs are very high, on the order of \$ 15 M per unit, for a total of about \$ 60 M. Adding the operating costs of a dedicated fleet for only one LNG vessel arrival per week, this solution appears to be non viable;

- icebreaker assistance may also necessitate longer delays; despite regular trips to Cacouna, as required by current traffic requirements, icebreakers do not maintain a permanent presence there;
- climatic conditions may be somewhat more restrictive, from an operational viewpoint, than the Ville Guay conditions. Based on a preliminary assessment of the various data available,

and assuming 104 ship arrivals / departures at the terminal per year (1 call per week), delays in berthing / unberthing manoeuvres would be expected approximately 14 to 16 times per year due to strong wind (8 times / year), ice accumulations (3-4 times / year) or poor visibility conditions (3-4 times per year).

This preliminary evaluation of climatic conditions could be determined more accurately, at the feasibility stage, by including refraction effects in a complete wave climate analysis, by assessing more thoroughly the ice dynamics issue and by conducting an extensive study of all available Environment Canada's datasets on visibility distances (these are not readily available and would have to be purchased from Environment Canada).

The acceptability of this site is highly dependent on the acceptable down time limit that has to be established by Client. A value of 5% has been used as a preliminary guideline in the current study. Based on this value, Gros Cacouna would hardly meet the reliability target of the marine terminal;

- construction and operational costs are significantly higher than at Ville Guay.

As to the Pointe-Saint-Denis site, it is obviously the least interesting on all aspects.

PROJECT SCHEDULE

The preliminary schedule proposed in this study is as follows:

2004: pre-engineering and environmental impact study;

2005: public hearings and approval; detailed engineering;

2006: tender call; construction;

2007: construction, tests and start-up.

REGULATORY APPROVAL PROCESS

In order to obtain all the information required for the purpose of the study and verify the acceptability of the project, preliminary consultations have been conducted with numerous government bodies likely to be involved in some way in the overall regulatory approval process to be followed in developing the project. Parties consulted include:

Quebec Ministry of the Environment (including BAPE, the provincial Office for environmental public hearings);

Environment Canada (including the Canadian Environmental Agency, the federal Office for environmental public hearings);

Canadian Coast Guard (Fisheries and Oceans Canada);

Protection of Fish Habitat (Fisheries and Oceans Canada);

Transport Canada - Environmental Intervention (Terminal certification - Emergency plan)

- Navigable Waters Protection
- Maritime Traffic (Ship size vs St. Lawrence Seaway width);

The Port of Quebec Authority;

The St. Lawrence Pilots Association.

Although no major obstacle was identified, an in-depth assessment will have to be completed in compliance with the TERMPOL review process requirements. This review shall address properly all issues related to the safety of LNG carrier ships and terminal as well as the safety of navigation in general on the Saint Lawrence.

1. MANDATE

1.1 INTRODUCTION

On September 10, 2003, Gaz Metro appointed Roche Ltd, Consulting Group, to conduct a pre-feasibility study for the construction of a LNG maritime terminal on the south shore of the Saint Lawrence River, at a site to be selected among the three following locations proposed by the Client, as shown on Figure 1.1:

- Ville Guay, located about 10 km north east and across the river from Quebec City, in front of Île d'Orléans. The site is situated within the limits of the port of Quebec City;
- Pointe Saint-Denis, located near the municipality of Rivière-Ouelle, approximately 120 km north east of Quebec City;
- Gros Cacouna, a small village located some 15 km east of the city of Rivière-du-Loup, at 220 km north east of Quebec City.

As stated in the terms of reference issued by the Client, the technical studies to be conducted in developing the current project will be subdivided into the following three phases:

- Phase I - Refinement of the concept – Pre-feasibility Study
- Phase II – Feasibility and Development of the project, including FEED (Front End Engineering and Design) study
- Phase III – Project Execution on an EPCM (Engineering, Procurement and Construction Management) basis.

This report applies specifically to the Phase I study of the marine facilities only. Land facilities, including LNG storage, vaporization plant, pipelines and cryogenic lines, including the process equipment to be installed on the jetty, are therefore not covered in this report.

1.2 SCOPE OF PRE-FEASIBILITY STUDY

The services to be provided in this pre-feasibility study are:

- a) Review of the existing documentation on the project. The analyses must be carried out on the basis of existing data since no on-site surveys are included at the present stage of studies;

- b) Development of site selection criteria and recommendation on the preferred site for the jetty, taking into account technical, environmental, operational, navigational and safety aspects as well as construction and operating costs;
- c) Provision of pre-feasibility level technical specifications and layout drawings of the jetty;
- d) Total costs estimates of the jetty and all work associated with the construction and access of this jetty (dredging, temporary installation, etc.), including capital expenditures (CAPEX) and operational expenditures (OPEX) to an approximate accuracy level of +/- 25% or better.

Various data were provided by the Client as inputs in the pre-feasibility assessment:

- Maps of the potential implementation sites for the terminal,
- Preliminary marine condition data, including:
 - wind;
 - tidal current direction and velocity;
 - wave height, period and occurrence frequencies;
 - water levels;
 - bathymetric data;
 - weather conditions;
 - ice conditions;
- Environmental scoping at the selected sites for the on-shore portion of the project;
- Various data on gas characteristics and gas distribution equipment.

1.3 STUDY METHODOLOGY

Considering the accuracy level of this study, the work has been carried out on the basis of already available data and existing studies. A list of the various publications used as references is provided at the end of this report. No on-site surveys were conducted in the course of the present mandate.

In order to obtain information most pertinent for the purpose of the study, consultations have been conducted with numerous government bodies likely to be involved in some way in the overall regulatory approval process that will have to be followed in developing the project. Parties

consulted during this study include Transport Canada, Canadian Coast Guard, Environment Canada, Fisheries and Oceans Canada, Quebec Ministry of the Environment, Port of Quebec Authority, St. Lawrence Pilots Association.

This project pre-feasibility assessment comprises the following elements:

- Definition of the main design parameters of a LNG receiving port terminal, among which principal dimensions of the carrier ships (length, capacity, draft, air draft, etc), location and design criteria for the jetty, berth, mooring and special equipment. These items are described in Chapter 2;
- Review of physical, climatic and hydrodynamic conditions of each one of the three proposed sites: wind, waves, tide, current, ice, geotechnics, seismicity. This is covered in Chapter 3;
- Review of the environmental aspects in connection with the project. This review includes a description of the physical, biological and human environment and points out the most sensitive elements that will have to be addressed in the environmental impact study to be carried out in a future stage of the project studies. This environmental review is presented in Chapter 4;
- Chapter 5 presents a description the terminal layout and structural design proposals specific to each of the port locations. This presentation points out technical features of the proposed solutions, as well as an evaluation of construction and operational costs related to each;
- A comparative analysis of the three sites under study is then presented in Chapter 6. This comparison includes technical, environmental, operational and cost aspects and it leads to the identification of the most suitable site for the development of a LNG receiving marine terminal;
- Various issues related to the development of the project are discussed in Chapter 7 : a description of the regulatory approval process listing the various authorizations to be obtained from federal and provincial ministries; a project development program identifying the various studies to be carried out in order to attain successful completion of the project; a project schedule and estimated cashflow for the complete development period, including the engineering and studies as well as the construction period, from the beginning of 2004 until the end of 2007.

This study has led to preliminary selection of a preferred site for the construction of a LNG receiving port terminal after a comparative assessment that brought out the pros and cons of each site considered by the Client. The conclusions of this study are to be used in conjunction with the Client's evaluation of the land-based facilities required to connect the terminal to the gas distribution network.

1.4 HISTORY OF SITE SELECTION

1.4.1 Quebec Ministry of Energy 1979

The idea of developing a LNG receiving terminal on the Saint Lawrence River has been studied a number of times over the last three decades.

In June 1978, the Quebec Government issued its energy policy in which, among other considerations, it expressed a desire to increase the share of natural gas within the total energy budget of the province.

In March 1979, a siting pre-selection work report issued by the Quebec Ministry of the Energy presented various considerations about physical, technical, environmental and land use aspects regarding the development of a LNG receiving terminal on the Saint Lawrence. This work was based on numerous studies carried out previously by the Quebec Government in which up to 15 sites had been considered. It went a step further into a comparative site selection analysis on twelve of these potential sites located along the Saint Lawrence River. The 15 sites considered at the beginning are shown on Figure 1.1:

On the north shore:

On the south shore:

Cap-aux-Oies / St-Simeon	(A)	Lauzon / Pointe-de-la-Martinière	(A)
St-Irénée	(R)	Montmagny / Pointe-de-la-durantaye	(R)
Port au Saumon	(R)	Pointe-aux-Orignaux	(A)
Les Escoumins	(A)	Grande Île (Kamouraska)	(R)
Baie-Comeau	(R)	Gros cacouna	(A)
Cap de la Tête au Chien	(R)	Île Verte	(R)
Port of Sept-Îles	(R)	Rimouski	(R)
		Matane	(R)

Following this assessment, five of the sites considered were deemed acceptable (marked A above) whereas the seven others were rejected (R).

1.4.2 Arctic Pilot Project 1979-80

In 1979-1980 the “Arctic Pilot Project” was developed by Trans-Canada Pipelines and partners. The project consisted in producing natural gas at Melville Island, in the Canadian Arctic. After production the gas was to be transported in liquid form in icebreaking transport vessels. These vessels would have been specifically designed and built for this unique application. LNG would be brought to market at a receiving terminal to be built on the Saint Lawrence. Eight potential sites were then analysed, among which two on the north shore and six on the south shore (see Figure 1.1):

On the north shore:

Cap-aux-Oies

Sault-au-Cochon

On the south shore:

Pointe-de-la-Martinière

Pointe-Saint-Michel

Pointe-aux-Orignaux

Gros Cacouna

Grande Île (Kamouraska)

Île Verte

This project was developed on technical bases significantly different from the Rabaska project. The LNG carrier vessels to be used were purpose built Class 7 icebreaker type, 374 m in length. In the Rabaska project LNG is to be imported from producing countries (Algeria, Bahamas, Nigeria, others) with the use of vessels already existing in the international fleet. The typical length of these vessels is 300 m. During the winter period, it is foreseen that carrier vessels reinforced for navigation in ice infested waters would be required. However these need not be icebreaker class.

The Arctic Pilot project was submitted to public hearings in front of the Quebec BAPE (Bureau des Audiences Publiques) and received approval by the Quebec Government to implement the proposed marine terminal at the Gros Cacouna site.

The project was finally abandoned by the proponent for economic reasons.

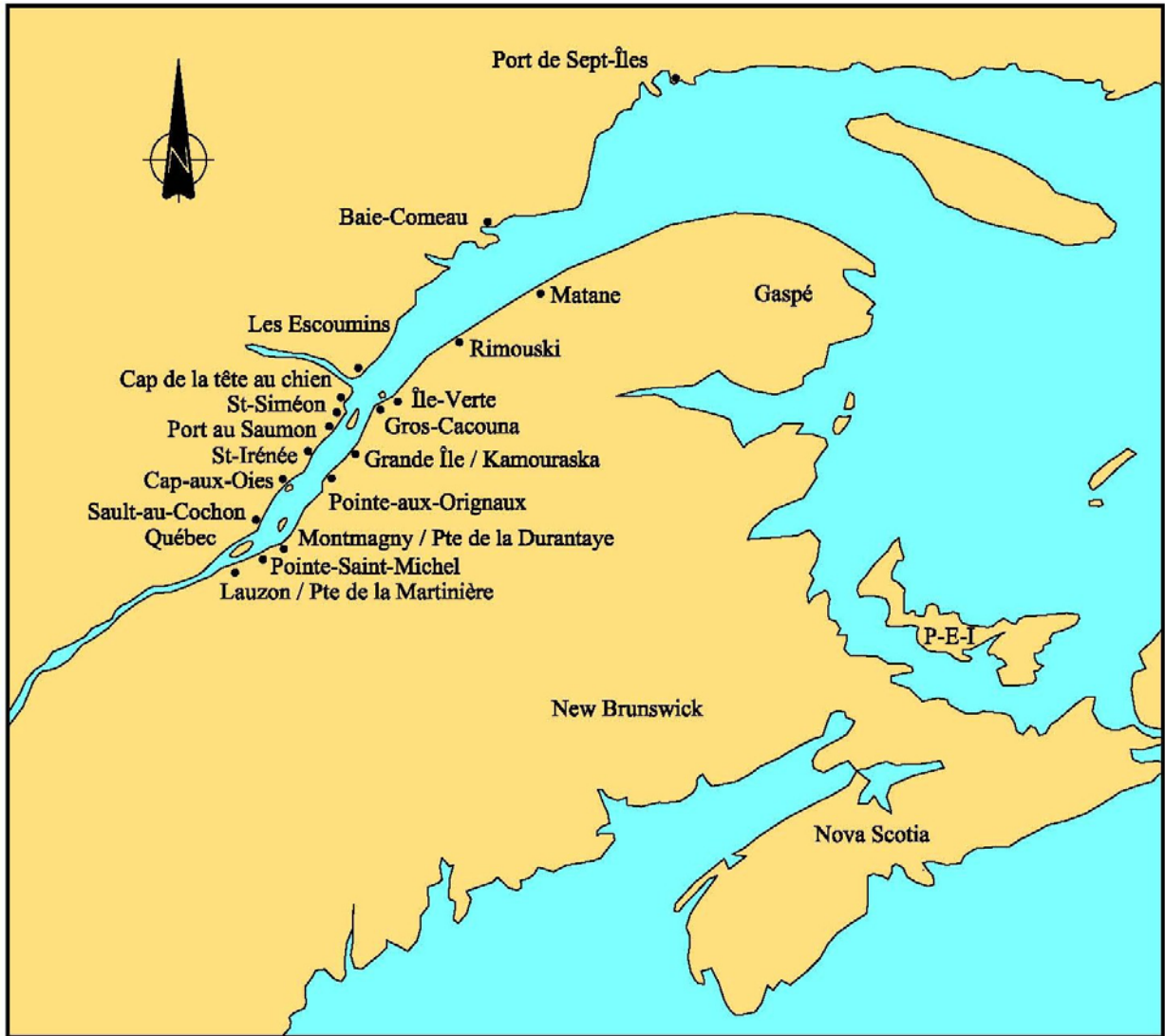


Figure 1.1 - Potential LNG terminal locations studied over past decades.

1.5 GENERAL DESCRIPTION OF THE THREE SITES UNDER CONSIDERATION

The general location map of the three sites considered in the present study is presented in Figure 1.2. Figures 1.3 to 1.8 show more detailed locations maps and photographs of each of the sites. The geographic coordinates, along with the approximate width of the St. Lawrence river, are indicated in the following table:

Site	Latitude	Longitude	Width of river (km)
Ville-Guay	N 46° 50.2'	W 71° 06.5'	2
Pointe Saint-Denis	N 47° 35'	W 69° 58'	17
Gros Cacouna	N 47° 58'	W 69° 32'	20

Ville Guay

The Ville Guay site, shown on the general map of Figure 1.3 and photographs of Figure 1.5, is located within a territory identified for future industrial and port development, according to the Land Use Master Plan developed by Desjardins Regional Municipality (Figure 1.4). The site proposed for the implementation of the LNG port terminal is located approximately 1,3 km west of a Hydro-Quebec high voltage power line crossing from the south shore to Île d'Orléans. Even though highway 132, a provincial road, passes a few hundred metres south of the river, the only land access to the site available at present is by foot, along a pedestrian path and stairway leading to the shore. The steep cliff at this location is approximately 70 m high.

Pointe-Saint-Denis

Pointe-Saint-Denis is shown on the location map of Figures 1.6 and photographs of Figure 1.7. It is located a few kilometers east of the village of Rivière-Ouelle. It consists of a rocky point projecting out into the St. Lawrence River. It can be accessed only by a private road approximately 1,5 km in length connected to public Shore Road.

Gros Cacouna

The Gros Cacouna site is located next to the rock-fill breakwater which marks the northeast limit of the existing commercial port, as shown in Figures 1.8 and 1.9. The LNG land-based facilities would be developed on the industrial area east of the harbour. This flat area was produced by the excavation of rock from the island, when the port and breakwaters were built in the late 1960s and early 1970s. The area is occupied by a cement storage silo for which there is little use at present.