9.0 ENVIRONMENTAL EFFECTS ASSESSMENT

9.1 IMPACTS ON AND FROM LAND USE

The proposed development has the potential to affect existing land uses on and near the site, and can cause a conflict with municipal land use designations and planning objectives. In addition, the Provincial Terms of Reference for this EA expressed a concern for impacts from existing and past land uses, i.e. impacts from contaminated sites, former mine workings, and mine disposal areas.

Impacts on existing land uses and land uses designations are discussed below and refer to the actual Project site and immediately adjacent properties. The effects assessment is based on a review of the current Planning Strategy of the County of Guysborough, site visits and review and recent air photography.

The discussion of impacts from existing and past land uses has been addressed in Section 9.17 Geological Impacts.

9.1.1 Construction Phase

Impacts on Land Use are discussed together for all four Project components (i.e. LNG Facility, Petrochemical Complex, Cogeneration Plant, and Infrastructure) as no component-specific impacts were identified.

No significant land use conflicts have been identified associated with construction of any of the principal Project components. The Project site has been rezoned by the Municipality of the County of Guysborough to allow the planned construction. The site is currently vacant. The lands have been periodically cut but no conflicts with existing on-site land uses have been identified.

Rerouting of Marine Drive will divert traffic around Drum Head and Seal Harbour. Road access to these communities will be maintained through the remaining segments of Marine Drive. No land uses have been identified along the proposed route that are sensitive to the new road development.

The lands taken up by the Project and its components will remove the potential for mineral extraction from those areas. The potential value of these resources or the future impact of not extracting minerals from these lands is uncertain as no extensive exploration has taken place on the site nor has the area been actively mined for a number of years. The lands are not known to be actively used for recreation or hunting.

9.1.2 Operation Phase

During operation, none of the Project components is expected to cause impacts on existing and planned land uses for the same reasons that were discussed for the construction phase of the Project.

9.1.3 Conclusion

No effects have been identified for planned and existing land uses. Consequently, no mitigation measures are required.

9.2 IMPACTS ON ABORIGINAL USE OF LAND AND RESOURCES

Impacts on Mi'kmaq Lands and Resource Use are discussed together for all four Project components (i.e. LNG Facility, Petrochemical Complex, Cogeneration Plant, and Infrastructure) as no component-specific impacts were identified.

9.2.1 Construction Phase

Historic Mi'kmaq interests were generally located relatively distant from proposed project activities. Historic burial grounds were located at Isaac's Harbour and as well at Upper Country Harbour. These sites are discussed in detail in the archaeological section. In terms of continued traditional use, Mi'kmaq continue to undertake traditional activities throughout the Keltic Study Area. Some of the reported hunting and fishing areas include areas covered by the Keltic Facility. However, most of the areas that will be affected are smaller hunting areas that either encompass large areas of land or are located throughout areas of the various waterways.

The construction activities will only take place on portions of the identified hunting areas and should result in minimal impacts to the land and resource use. As well, the data gathered regarding the various resources that are harvested by Mi'kmaq found that, although these resources play an important role to Mi'kmaq, the high majority of them are found in other areas either within the Keltic Study Area, or in other areas of Nova Scotia. Mitigation of issues related to traditional Mi'kmaq land use in the Keltic Study Area is described in Section 10.

9.2.2 Operation Phase

During operation, none of the Project components is expected to cause impacts on traditional Mi'kmaq land uses and resources for the same reasons that were discussed for the construction phase of the Project.

9.2.3 Conclusion

Effects on traditional Mi'kmaq land uses and resources are expected to be minimal and therefore not significant. No particular mitigation measures are recommended other than those developed for the biophysical VECs (Table 9.2-1).

TABLE 9.2-1 Residual Environmental Effects Summary Mi'kmaq Lands and Resource Use

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance**	Likelihood of Occurrence ***	Level of Confidence***
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Not reversible)	Ecological/ Social-cultural and Economic Context			
CONSTRUCTION										
All Facility components (LNG Facility, Petrochemical Plant, Co-Gen Plant, Infrastructure)										
Potential for impacts on Mi'kmaq Land Use (Hunting, Fishing)	A	None, None, Mi'kmaq sea urchin harvesting may be limited in the area of the LNG terminal and marginal wharf, but there are adjacent sea urchin areas that will allow continued harvesting.	Low	Project site - $3.5km^2$	Construction Phase	NR	Area already impacted by historic and recent industrial uses. Also sufficient lands available outside the Project area.	Minimal		
Potential for impacts on Mi'kmaq Land Resources (Fish, Wildlife, Vegetation)	A	See mitigation for biophysical VECs	Low	Project site - $3.5km^2$	Construction Phase	NR	See above	Minimal		
OPERATION										
All Facility components (LNG Facility, Petrochemical Plant, Co-Gen Plant, Infrastructure)										
Potential for impacts on Mi'kmaq Land Use (Hunting, Fishing)	A	None, Mi'kmaq sea urchin harvesting may be limited in the area of the LNG terminal and marginal wharf, but there are adjacent sea urchin areas that will allow continued harvesting.	Low	Project site - $3.5km^2$	Operation Phase	NR	See above	Minimal		

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance**	Likelihood of Occurrence ***	Level of Confidence***
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Not reversible)	Ecological/ Social-cultural and Economic Context			
Potential for impacts on Mi'kmaq Land Resources (Fish, Wildlife, Vegetation)	A	See mitigation for Biophysical VECs	Low	Project site - 3.5km^2	Operation Phase	NR	See above	Minimal		

* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 7
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 7
*** Only addressed for significant effects

9.3 IMPACTS ON SOCIO-ECONOMIC ENVIRONMENT

This section focuses on the central aspects that define socio-economic conditions in a community (i.e. population, economic structure, labour supply and demand, income, and socio-economic planning objectives).

The effects on the tourism sector are discussed separately because the tourism sector is an amalgam of goods and services provided to visitors by the constituent elements of the economic structure and the "experience" (aesthetic, cultural, historical, community life, and so on) made available to visitors.

9.3.1 Construction Phase

9.3.1.1 Population Impacts

<u>**Guysborough County Area**</u>

Impacts on population due to construction activities is expected to be only short-term. It is unlikely that construction workers and their families will move into the area on a permanent basis as the construction project peak will be relatively short lived and there are no large construction projects that could retain these employees in the foreseeable future for the area. In addition, workers that would commute to the Goldboro area would likely prefer to retain their residence in the Antigonish County area to maintain their accessibility to construction work throughout the province and the rest of the Maritimes.

Construction and commissioning of the overall project will span about 36 months, that is, 13 quarters. The number of workers on-site during each quarter is outlined in Table 9.3-1.

TABLE 9.3-1 Workers On-site during Construction by Quarter

Quarter	Number of Workers On-site	Quarter	Number of Workers On-site
1st Quarter	335	8th Quarter	1890
2nd Quarter	1110	9th Quarter	2000
3rd Quarter	1445	10th Quarter	2000
4th Quarter	1670	11th Quarter	1445
5th Quarter	1890	12th Quarter	780
6th Quarter	2000	13th Quarter	110
7th Quarter	1890		

Construction employment related to LNG receiving terminal construction, petrochemical plant construction, cogeneration plant construction, site preparation, site services and support services will total about 4,775 people who will be employed for varying lengths of time. The occupation breakdown is outlined in Table 9.3-2.

TABLE 9.3-2 Occupation Breakdown During Construction

Occupation	Percentage	Occupation	Percentage
Pipe fitters	18.5%	Cleaners	0.3%
Welders	11.9%	Rock Drill Operators	0.3%
Labourers / Misc	10.8%	Surveyor's Assistants	0.3%
Electricians	8.9%	Cook	0.2%
Carpenters	8.1%	Cutters	0.2%
Iron Workers	4.2%	Dump Men	0.2%
Construction Management	3.9%	Finish Workers	0.2%
Insulation/Painting Workers	3.6%	Foremen	0.2%
Structural Iron Workers	3.3%	Grade Men	0.2%
General Contractor Management	3.0%	Medical Services Personnel	0.2%
Concrete Finishers	2.1%	Stores & Supplies Staff	0.2%
Millwrights	2.1%	Traffic Control Personnel	0.2%
Boilermakers	1.7%	Asphalt Spreader Operators	0.1%
Operators	1.3%	Blasters	0.1%
Truckers (Private)	1.3%	Boom Truck Drivers	0.1%
Crane Operators	1.1%	Chef	0.1%
Bricklayers	0.9%	Chipper Operators	0.1%
Security Personnel	0.9%	Divers	0.1%
Dozer Operators	0.8%	Feller-Buncher Operators	0.1%
Excavator Operators	0.8%	Forwarder	0.1%
Off-Road Truck Drivers	0.8%	Fuel Truck Drivers	0.1%
Housekeeping Staff	0.7%	Grader Operators	0.1%
Loaders	0.6%	Hay Thrower Operators	0.1%
Piling Workers	0.6%	Heavy Equipment Operators	0.1%
Bus Drivers	0.5%	Lube Truck Drivers,	0.1%
Kitchen Support Staff	0.5%	Material Transfer Device Operators	0.1%
Mechanics	0.5%	Processor	0.1%
Roller Operators	0.5%	Rakers	0.1%
Food Servers	0.4%	Shovellers	0.1%
Assistant Cook	0.3%	Steel Tier Workers	0.1%
Camp Maintenance Staff	0.3%	Surveyors	0.1%
Crusher Operators	0.3%	Water Truck Drivers	0.1%
Fire Department Personnel	0.3%		

Antigonish County Area

Given that Antigonish County is at some distance from the Goldboro project site, we expect only minor and short-term impacts on population due to construction activities. It is unlikely that construction workers, given the relatively short peak construction period, will move their families into the area on a permanent basis.

9.3.1.2 Economic Conditions

Guysborough County Area

Construction activity at the Project would serve to sustain, or even increase, the representation of the construction sector in the economic structure of Guysborough County. Peak activity will occur over a 21-month period. This relatively short peak period combined with the existing ability of the Guysborough County economy to supply additional construction services suggest that if the construction sector in the County does increase, the expansion will be modest and short-term.

Antigonish County Area

Construction activity at the Project would serve to sustain, or even increase, the representation of the construction sector in the economic structure of Antigonish County. The relatively short length of peak construction activity combined with the existing ability of the Antigonish County economy to supply construction services suggest that if the construction sector in the County does increase, the expansion will be modest and short-term.

9.3.1.3 Employment Impacts

Guysborough County Area

The relatively short time frame for peak construction activities mitigates against extensive training of the local labour force age group for employment in construction activities. Therefore, it would appear that construction activities will serve to help maintain, but not expand, the construction workforce in the Guysborough County area. We expect that the majority of the labour for construction will come from outside the Guysborough County area.

Antigonish County Area

The relatively short time frame for peak construction activities mitigates against extensive training of the local labour force age group for employment in construction activities. Therefore, it would appear that construction activities will serve to help maintain the construction workforce in Antigonish County.

9.3.1.4 Impacts Related to Income, Socio-Economic Planning, and Tourism

For a discussion of impacts related to Income, Socio-Economic Planning, and Tourisms please refer to Section 9.2.2, Operation Phase. The operation-related impacts on these components of the socio-economic environment are considered to include construction-related effects.

9.3.2 Operation Phase

9.3.2.1 Population Impacts

Table 9.3-3 provides an overview of the number and type of employment expected during full operation. Total employment at full operation will stand at about 624. The annual payroll of the facility will be about $37.4 million.

The facility will likely work on a four shift basis. Approximately 210 persons will be on-site during the day shift and about 140 will be on site during the afternoon and night shifts.

TABLE 9.3-3 Employment During Operation

Position	Wharf	LNG Plant	Tank	Polypropylene Plant	Polyethylene Plants	Ethylene	Cogeneration	Total
Cargo Ship Personnel								50
Chemical Process Operators		6	3	12	36	30	12	99
Electrical Engineering Technician		2	1	4	12	16	6	41
Environmental Technician		2		2	4	2	1	11
Fire Station Personnel	3	3		6	18	6	3	39
Building Cleaning Workers	2	2	2	5	10	8	3	32
Industrial Instrumentation Technician	1	3	1	4	8	6	4	27
Kitchen Staff								30
Marine Dock Workers	48							48
Millwrights				2	4	1	3	10
Pilot Boat And Pilots	6							6
Plant Maintenance Staff	2	4	2	6	18	12	6	50
Plumbers				1	2	1	1	5
Power Engineering Technician		2		9	9	6	3	29
Security	4	4	4	4	4	4	4	28
Steamfitter/Pipefitter	1	2		3	6	3	2	17
Transport Drivers								46
Tug Boat Personnel								16
Welders	1	1		2	2	2	1	9
Workplace Safety Management								3
Worker Safety Awareness								3
Office Staff								25
Total	**68**	**31**	**13**	**60**	**133**	**97**	**49**	**624**

We expect a significant portion of employees at the LNG facility and petrochemical plant to commute to work from the Antigonish County area.

It is reasonable to expect that some employees at the plant will move into the Guysborough County area. In addition, spending in the local area during construction and operation will improve business prospects in Guysborough and Antigonish Counties and therefore should also improve employment prospects.

Based on the occupation profile of the operating labour force and the current labour supply and skill level situation in Guysborough County we estimate, in order of magnitude terms, the following labour source breakdown:

- current residents of Guysborough County, 155;
- new residents to Guysborough County, 95;
- current residents of Antigonish County and beyond, 280; and
- new residents to Antigonish County, 94.

The addition of 30 families, at approximately 2.5 persons per family, would provide a population boost of almost 2.5% in the combined Counties.

The spin-off economic activities associated with the operation of the facility will further improve the employment picture and chances that new people will move into the area.

Capacity utilization of community infrastructure and retail and service operations are relatively low and therefore increased economic activity would first serve to absorb surplus capacity rather than immediately introducing the need for new costs of service provision.

<u>Antigonish County Area</u>

We expect, in order of magnitude terms, about 280 workers at the facility to commute to work from Antigonish County and areas beyond.

Given the size of the labour force and skill set in the Antigonish County area we estimate, that roughly, 94 workers could move into the area. Based on a typical household size of 2.5 persons this movement to the area would bring a total of about 235 persons.

In addition, spending in the local area during construction and operation, and the associate spin-off effects, will improve business prospects in Antigonish County and therefore should also improve prospects for increased employment and population growth. Given the relatively large population base of Antigonish County, the overall impact on population will be just under 2% of the current population.

Although not as underutilized as the infrastructure in Guysborough County, capacity utilization of community infrastructure and retail and service operations are still relatively low in Antigonish County. Therefore, increased economic activity would serve to absorb surplus capacity rather than introduce new costs of municipal service or a large number of new retail and service establishments. Mitigation related to population increase is described in Sections 10.3.2 and 10.3.3.

9.3.2.2 Economic Conditions

Guysborough County Area

The operation of the LNG facility and the petrochemical plant will continue to drive the representation of the manufacturing sector further above the provincial average. Increased transportation activities should also expand the transportation and warehousing sector to the point that it matches the provincial average.

Given current labour force numbers and skill levels we expect that about 155 residents of Guysborough County should be able to gain employment at the Project. Should education level improvement and training programs be successful members of the Guysborough County labour force age group will likely be able to improve their ability to win employment at the Project. These jobs will be relatively high paying and therefore will serve to bolster the retail and personal service sectors of the local economy.

Assuming about 95 persons move to the area to take work at the facility the proportion of the labour force involved in manufacturing would rise to almost 22%, more than double the provincial average.

Antigonish County Area

The operation of the LNG facility and the petrochemical plant will modestly increase the proportion of the labour force involved in the manufacturing sector. Current and new residents of Antigonish County could gain approximately 375 jobs at the facility. This increase in the manufacturing labour force of the County would bring the portion of its labour force involved in manufacturing close to that of the provincial average. Increased transportation activities should also provide a modest expansion of the proportion of the labour force involved in the transportation and warehousing sector. Relative to the current absolute size of the transportation sector in Antigonish County the increase in the number of transportation related jobs will be relatively small. We do not believe that the portion of the labour force involved in transportation will close much of the gap with respect to the Nova Scotia average.

The Town of Antigonish is a service centre for the North Shore area. Due to the employment of people from Guysborough County and Antigonish County during the construction and operation of Project we expect that retail and personal service sales will increase in town. Given that the jobs at the Project will be relatively high income jobs, we expect that there will be some closing of the gap between the Antigonish County and Nova Scotia percentage of the labour force involved in retail trade and services. Proposed mitigation for the effects of the Project on the economic structure is described in Sections 10.3.2 and 10.3.3.

9.3.2.3 Employment

Guysborough County Area

During the previous two decades job creation was a priority issue for the Nova Scotia economy. However, given the relatively strong job growth and emerging labour supply constraints the priority issue for at least the next decade will be labour supply and training rather than job creation. Hence, the LNG facility and the petrochemical plant could, like similar projects in Nova Scotia, find it more difficult to hire the skills they need than would have been the case in the recent past. This opens the way for upgrading of the local labour force in terms of its basic education and job skills. If the labour force age group in Guysborough County is to have a better chance to gain employment at the plant, local programs to upgrade basic education, if not available will need to begin or be expanded, followed quickly by skill specific training.

Antigonish County Area

During the previous two decades job creation was a priority issue for the Nova Scotia economy. However, given the relatively strong job growth and emerging labour supply constraints the priority issue for at least the next decade will be labour force supply and training rather than job creation. This situation is emphasized in Antigonish County, which has a relatively strong employment and labour for participation rate profile. Hence, the LNG facility and the petrochemical plant could, like similar projects in Nova Scotia, find it more difficult to hire the skills they need than in the recent past. This opens the way for upgrading of the local labour force in terms of its basic education and job skills. The County's relatively high education levels suggest that members of the labour force age group should, in general, be nearly job ready and good candidates for training programs. Mitigation related to the effects on the labour force is described in Sections 10.3.2.2 and 10.3.3.1.

9.3.2.4 Income Impacts

Guysborough County Area

It is assumed that up to 155 jobs at the facility may be available for current residents of the Guysborough County. This number may increase should efforts to improve the basic education level and job skills of the local labour force age group be implemented. People moving into the area to work at the plant will also add to the level of household income in the area.

Based on the assumption that about 250 people will live in Guysborough County and work at the facility, total annual household income in the area should rise by about $12 - $13 million. This increase in household income would raise total household income in the county by about 8.5%. It would potentially raise average household incomes by 5.8%, to $40,350.

Spin-off employment associated with the direct spending of the facility and re-spending of household income will further improve the income earning prospects for residents of Guysborough County.

Antigonish County Area

For Antigonish County it is assumed that the facility will generate up to 280 jobs. People moving into the area to work at the plant will also add to the level of household income in the area.

Based on the assumption that about 375 people will live in the County of Antigonish and work at the facility, total annual household income in the area should rise by about $18 - $19 million. This amount of new household income would raise total household income in Antigonish County by about 4.7%. Average household incomes would not change significantly because the average income is already quite high.

Spin-off employment associated with the direct spending of the facility and re-spending of household income will further improve the income earning prospects for residents of Antigonish County.

Given that household income in the County is well above the provincial level, the addition of well paid jobs will serve to boost retail and service sales across the board, but more so in the higher end and more discretionary lines of household spending. Proposed mitigation for the effects of the Project on income is described in Section 10.3.

9.3.2.5 Socio-Economic Planning Impacts

Guysborough County Area

This Project fits well within the strategic planning report of Guysborough County (Source: http://www.gcrda.ns.ca/pdf/RDA_July2004.pdf).

The vision statement the County sees:

> "…Guysborough County as a place where everyone has an opportunity to have a meaningful job but the environment is not harmed. Residents are healthy. Communities are safe with good infrastructure and services. Guysborough County is a place for young people to live and raise families."

The Guysborough County Regional Development Authority has a strategic plan that is based on three strategies:

- STRATEGY 1 Promotion of the Importance of Rural Living
- STRATEGY 2 Adding Value to Natural Resources in
  - 2.1 Forestry
  - 2.2 Fisheries
  - 2.3 Aquaculture
  - 2.4 Tourism, Heritage and Cultural Industries
  - 2.5 Mineral Resources
  - 2.6 Petroleum

- STRATEGY 3 Enhancing and Maintaining Infrastructure

The strategic plan makes specific note of the potential role for off and on-shore petroleum related development within the County.

The strategy recognizes that without a co-ordinated land use and economic planning process conflicts between the achievements of each strategy could develop. However, the strategic plan has tactics in place that anticipate potential conflicts and provide avenues to deal with those conflicts should they arise.

Success of the strategic development directions would help achieve the vision. Implicit in that vision is a Guysborough County that is more prosperous and a more attractive place to live. Such an achievement would bring with it increased residential property values and assessment values. Existing home and land owners will benefit from the increased value of their properties.

However, given the direct increase in commercial assessment created by the Project, the indirect impact on existing property values and the construction of new dwellings it does not necessarily follow that the actual amount of taxes paid by the average home owner or owner of commercial property will increase. There is potential for taxes to decrease due to economies of scale in providing municipal services to a larger population. For example, costs associated with road or recreation service maintenance will not likely increase on a per capita basis as many of the facilities are under-utilized due to the history of net out-migration from the County.

In addition, the Project, through the property tax revenue it will generate (directly through its own real property and indirectly via the increased the values of existing commercial property and addition of new commercial property that will come with the expansion and improvement of the local economy) will support the enhancement and maintenance of infrastructure (the third strategic direction of the plan).

Increases in the number of jobs in the Goldboro area will contribute to the importance and viability of rural living in Guysborough County.

<u>Antigonish County Area</u>

The inclusion of direct and indirect jobs and spending due to the Project will contribute to the following aspects of the County's economic strategy:

- to develop and enhance the quality of life for all parts of the community;
- to strive for economic growth that matches or exceeds the national average;
- to strive for a rural-urban balance with self reliance, year-round work and local input to the management of community change;
- to have educational and health institutions that provide amenities and services that are customer driven and the envy of smaller communities across Canada; and
- to create a diversified economy that builds upon local institutions and increasingly focuses on sustainable, value-added and knowledge based activities in the global marketplace.

The proposed Project will provide the County with opportunities to make progress on each of the strategic directions summarized above because it will:

- offer opportunities for people and businesses in all parts of the County;
- bring a growing and high value-added industry to the area;
- provide year-round opportunities for people and businesses in rural and urban areas;
- expand the tax base and raise household incomes that will help support improved education and health institutions and related amenities and services;
- diversify the economic base of the County;
- provide sustainable economic activity, via the petrochemical plant, as it imports raw material from around the world as inputs to its manufacturing processes; and
- participate in, and further expose the County to, the global marketplace.
- Refer to Section 10.3 for the mitigation proposed for socio-economical planning.

9.3.2.6 Tourism

The Guysborough County Heritage Association works to promote tourism, heritage, and culture in the region. One of the prime assets of the Eastern Shore tourism sector is its natural beauty. However, the sector also suffers from lack of accessibility which leads to reduced tourism flows and limited services for tourists.

Although, some components of the proposed development will be hidden from views along the highway, the new facility will be clearly visible and change the local visual character of the landscape from a rural, mostly natural setting to a landscape with industrial development. This is likely to affect outdoor oriented tourism in the immediate vicinity of the Project site.

The increased economic activity in the area caused by the new facility will bring about improvements in accommodations and food services, other personal services, and retail trade. The Eastern Shore has a limited supply of these services. Their expansion will make the general area more attractive to tourists and provide the potential for tourism related economic growth.

The Guysborough County Heritage Association is currently developing a marketing strategy that includes a website, brochures, and signage, to increase the profile of the region and highlight its heritage resources. The establishment of an interpretive centre at the facility would provide a reason for the travelling public to stop at or near the Project site. Currently most visitors are likely to just pass through the area due to a lack of infrastructure. Such interpretative centres are common features at industrial sites including automobile manufacturing plants, the Fundy Tidal Power Station, steel manufacturing plants and nuclear power generation facilities.

On balance, the Project should have minimal adverse effects on tourism near the Project site. Over the long term and on a regional scale, the effects may even be beneficial to the tourism. Recommended mitigation for the effects on tourism can be found in Section 10.3.

Keltic has established a liaison committee to help consult and inform communities in the area on several aspects of the Project, including socio-economic issues. This on-going community involvement is presented in Section 13.11.

9.3.3 Conclusion

Overall effects of the Project's construction and operation phase on the Socio-Economic environment are expected to be beneficial. Measures to maximize the positive effects are discussed in Section 11 and are summarized in Table 9.3-4.

9.4 IMPACTS ON RESIDENTIAL PROPERTY VALUES

A potential issue of concern is the effect of facility construction and operation on adjacent and nearby properties, the majority of which are residential. Nearby landowners may be affected by air emissions, noise, lights, and an altered view (of a large industrial development), as well as increased traffic, emissions, and noise along routes to the site. Effects from project construction are more likely to affect properties adjacent/near the site in Goldboro, Drum Head, Seal Harbour, and along the transport route.

Employment provided by construction and operation is expected to generate short term demand for local housing, causing a positive impact to property values. The potential negative impacts to properties adjacent, nearby, and with a view of the facility will depend on the visibility of the facility from these locations, and changes in air quality, noise levels and lights resulting from facility construction and/or operation.

9.4.1 Construction Phase

Construction-related nuisance impacts such as elevated noise and dust levels will be of short duration and are considered unlikely to negatively affect property values (see Section 9.6 and 9.7). The presence of approximately 3.000 workers and the expectation of long-term economic development at and near the site can be expected to increase demand for residential property and therefore potentially increase in property prices, in particular rental rates, during the construction period.

9.4.2 Operation Phase

Determination of the effect of the facilities' operation on the value of adjacent and nearby residential properties requires market analysis and is dependant on a number of variables, including:

- supply of, and demand for housing in the area;
- the condition of the home and property;
- the presence of services and amenities such as shopping areas, schools, playgrounds, parks and recreation areas;
- housing values in the region; and
- local economic conditions.

TABLE 9.3-4 Residual Environmental Effects Summary Socio-Economic Effects

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance	Likelihood of Occurrence *	Level of Confidence*
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Not reversible)	Ecological/ Social-cultural and Economic Context			
CONSTRUCTION										
All Facility components (LNG Facility, Petrochemical Plant, Co-Gen Plant, Infrastructure)										
Potential effects on population size	P (A)	Operate construction camp Major components to be manufactured off-site and transported to the site for installation	High	Communities adjacent to project site	Project construction phase (up to 36 months)	NA	Rural country side	Medium		
Potential effects on Economic Structure (increased employment opportunities and tax revenues; spin-off effects)	P	Purchasing and tendering policies to support local businesses	High	Antigonish and Guysborough Counties	Project construction period	NA	Rural, mainly resource based economy	Major	high	high
Potential effects on Labour Force (increased demand, employment and training opportunities)	P	Advise unions of the occupations and skill levels required unions will implement, or facilitate the implementation, of training programs	Moderate	Antigonish and Guysborough Counties	1 year before construction and during construction	NA	Currently high unemploym ent rate; rural, mainly resource based economy	Medium		

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance	Likelihood of Occurrence *	Level of Confidence*
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Not reversible)	Ecological/ Social-cultural and Economic Context			
Potential effects on Income (increased average income)	P	Purchasing and tendering policies to support local businesses	High	Mainly Guysborough County	Construction phase	NA	rural, mainly resource based economy	Major	high	high
Potential effects on Socio-Economic Planning (supportive of municipal strategic objectives)	P	None required	Medium	Antigonish and Guysborough Counties	Construction and operation phase	NA	rural, mainly resource based economy	Medium		
Potential effects on Tourism (loss of natural landscape character may reduce outdoor oriented tourism in site vicinity)	A	Use of dust suppressants if required Regular road cleaning at /near the construction access when required Establish information point/centre to inform on construction and future operation	Low	Marine Drive realigned around Project site	Construction phase	R	Not prime tourist destination	Minor		
OPERATION										
All Facility components (LNG Facility, Petrochemical Plant, Co-Gen Plant, Infrastructure)										
Potential effects on population	P	None required	low / moderate	Antigonish and Guysborough Counties	mainly in first five - seven years of operation	NA	Rural country side	Minor / Medium		

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance	Likelihood of Occurrence *	Level of Confidence*
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Not reversible)	Ecological/ Social-cultural and Economic Context			
Potential effects on Economic Structure (increased employment opportunities and tax revenues; spin-off effects)	P	purchasing and tendering policies examined to determine how to be organized to facilitate bidding by local businesses where practical, tender packages broken into sizes that can be bid on by local firms	Moderate	Antigonish and Guysborough Counties	One to two years prior to operation and throughout operation	NA	rural, mainly resource based economy	Medium		
Potential effects on Labour Force (increased demand, employment and training opportunities)	P	Advise unions and local development agencies of the number, type of occupations and skill levels required Work with unions and local development agencies to advertise employment opportunities and organise training programs	Moderate	Antigonish and Guysborough Counties, Nova Scotia	One to two years prior to operation and first two years of operation	NA	Currently high unemployment rate; rural, mainly resource based economy	Medium		
Potential effects on Income (increased average income)	P	Purchasing and tendering policies to support local businesses	Moderate	Antigonish and Guysborough Counties	Operation phase	NA	rural, mainly resource based economy	Medium / Major	High	High
Potential effects on Socio-Economic Planning (supportive of municipal strategic objectives)	P	None required	Moderate	Antigonish and Guysborough Counties	Operation phase	NA	rural, mainly resource based economy	Medium / Major	High	High

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance	Likelihood of Occurrence *	Level of Confidence*
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Not reversible)	Ecological/ Social-cultural and Economic Context			
Potential effects on Tourism (loss of natural landscape character may reduce outdoor oriented tourism in site vicinity; improved income and tax base likely to benefit tourism infrastructure in region)	A(local) P(region)	Establish interpretative centre at site	Unknown	Antigonish and Guysborough Counties	Operation phase	R	Not prime tourist destination	Minor (adverse effects) and Minor to Medium (beneficial effects)		

* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 7
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 7
*** Only addressed for significant effects

All components of the proposed development complex will be operating in compliance with applicable regulatory standards, licenses, and permits.

The number of dwelling spaces in the area closest to the Project, Goldboro, Drum Head, Seal Harbour, Cross Roads Country Harbour and Larrys River has a limited housing stock, in the order of 1,100 and has a history of population decline. The operation of the Project will bring opportunities for home renovation and construction due to increased incomes of current residents that will work at the Project and the influx of new residents. The local planning authorities will obviously need to ensure that their land use and servicing plans are in place for the addition of approximately 25 to 40 new dwellings, which would amount to an increase in occupied dwellings of about 3%, compared to the decline of about 4% from 1996 to 2001.

As noted earlier it is expected that the Project will lead to an increase in the local population. This is expected to result in a greater demand for residential property in the area, which is likely to increase prices for residential property.

9.4.3 Conclusion

Overall effects of the Project's construction and operation phase on property values are expected to be beneficial.

9.5 IMPACTS ON RECREATIONAL OPPORTUNITIES AND AESTHETICS

Potential for interaction between the proposed Project and recreational opportunities and the area's visual aesthetics relates primarily to the introduction of large buildings and infrastructure features to a mostly rural landscape and coastline. The resulting change in the visual aesthetics of the landscape can interfere with recreational uses near the Project and may also affect property values and the local economy.

This section focuses on the changes to the visual landscape aesthetics and the potential resulting effects on recreational uses. For effects on property values, refer to Section 9.4. The visual impact assessment is based on a review of the general visual characteristics of the features to be built at the site and an analysis of the potentially affected receptors, including those using near-by recreational opportunities.

9.5.1 Construction Phase

Over the course of the construction phase visual impacts of the Project are likely to increase as the height and mass of the new buildings gradually increases and with it their visibility. Near the end of the construction phase, visual impacts are expected to be similar to those associated with the operation phase. Consequently, no specific visual impact analysis was undertaken for the construction phase. Conclusions drawn for the operation phase are considered to similarly apply to the construction phase.

9.5.2 Operation Phase

The determination of the potential effects of the proposed undertaking on the area's visual aesthetics involved the following analytical steps:

- characterization of the existing visual quality;
- definition of the visual characteristics of the proposed development;
- identification of potential receptors; and
- visual impacts (changes in visual landscape character; effects on Potential Receptors).

The approach to, and results of, the individual steps are briefly discussed in the following. As mentioned before, the visual effects of the operation phase are considered to represent the worst case.

9.5.2.1 Existing Visual Quality

The visual landscape in the vicinity of the Project site (approximately 5 km radius) is characterized by the mostly forested rolling terrain and the natural shoreline and open waters of the Atlantic. Interspersed in this landscape are small residential and fishing communities, including Coddle Harbour, Seal Harbour, Drum Head, Goldboro, Isaac's Harbour, and Isaac's Harbour North, with residential, fishing and few other commercial building typical for rural Nova Scotia.

Currently the only industrial development is the existing gas plant of the Sable Project, which is situated between Goldboro and Seal Harbour, approximately 1.5 km to the north of Marine Drive. This set back distance from Marine Drive, as well as the local topography, provide for good visual screening, so that only the upper end of the flare stack are visible from some locations within the area, in particular from Seal Harbour.

Particular cultural landmarks and orientation points within this rural setting include:

- villages (Seal Harbour, Goldboro, and Isaac's Harbour);
- churches within these villages;
- Regional Medical Centre (Isaac's Harbour);
- senior citizen home (Isaac's Harbour North);
- Community Centre and picnic site at the Goldboro Wharf;
- lighthouse at the foot of Squinces Hill (south of Holly Point); and
- SOEP gas plant (flare stack).

Natural orientation points at the Project site are provided by the eroding sand cliffs at Red Head. At a greater distance are, Dolliver's Mountain (northwest, at end of the Isaac's Harbour inlet), Quinces Hill (to the west of the Project site, across the Isaac's Harbour inlet and west of Isaac's Harbour village). Out in the Atlantic, approximately 2 km southeast of the Project site, Harbour Island, and the western shore line of Country Harbour provide orientation.
This existing visual landscape can be described as a rather coherent, harmonious, and rural to natural due to the:

- extent of natural vegetation;
- extent of largely undisturbed natural shoreline;
- absence of visually dominating industrial and commercial infrastructure;
- small scale and coherent village architecture; and
- small scale road infrastructure.

The landscape offers a limited number of man-made orientation points, resulting in a somewhat “untouched”, “remote” landscape character.

The influence of the existing gas plant has very little effect on the existing landscape character, since the only component visible from public locations and residential areas is the flare stack.

9.5.2.2 Visual Characteristics of Proposed Development

The proposed development is described in Section 2. It will cover approximately 350 ha of land and will stretch over approximately 3.5 km, i.e. from approximately one km off the shore of Betty's Cove, to approximately 2.5 km inland at the existing SOEP gas plant. Immediately alongside the waterfront at Betty’s Cove, the development will extend over approximately two km.

Photographs of facilities, comparable to those proposed are presented in Section 2. Dimensions of key components, i.e. those representing the highest and largest single structures are listed below (Table 9.5-1). The approximate location of most of these features is shown in Figure 2.0-1.

The site elevation will range from about 15 m above sea level at the LNG tank farm to about 40 to 50 m above sea level at the SCVs and most other main components such as the ethylene plant, cracking furnace, fractionators, and co-generating plant, and about 70 m at the flare stacks. This will result in a total top elevation of approximately 150 1o 170 m above sea level for some of the key Project elements. The existing SOEI gas plant is located at an elevation of about 45m above sea level and has a flare stack height of about 100m.

The two high elevation emergency flare stacks are expected to be flaring for about 15 to 20 minutes one or twice a year. The flare at the SCV is also for emergency purposes only and will not be operating on a regular basis. The cooling tower is expected to operate 24/7 over the entire year.

The facility will be lit during night time. This includes lights along the perimeter fence, lighting of the marginal wharf, the marine terminal, the LNG storage units, Petrochemical plant, and cogeneration power plant.

TABLE 9.5-1 Key Project Components of Relevance for Visual Effects Assessment

Project Component	Approximate Height
Flare Stack 1 Flare Stack 2	100 m (300ft) 100 m (300ft)
Ethylene Plant (Cracking Furnace)	60 m (180ft)
LLPE (Gas Phase) Stripper	90 m (270ft)
Polypropylene Stripper	90 m (270ft)
Ethylene Fractionator	100 m (300ft)
Stack Thermal Oxidizer	25 m (75ft)
Incinerator Stack 1	65 m (200ft)
Incinerator Stack 2	65 m (200ft)
Stack- Cogeneration Power Plant	40 m (120ft)
Cooling Tower (CoGenerating Station; approx 15 in-line towers)	20 m (60ft)
SCV stacks (initially 7, later another 7 stacks)	15 m (45ft)
Flare at SCV	15 m (45ft)
LNG Storage Tanks (initially 3, later 6 tanks)	50 m (150ft)
Storage Silos (Marginal Wharf; 4 set, each 42 silos)	40 m (120ft)
LNG Tanker - deck height; max. two tankers	30 m (120ft)
LNG Tanker - pilot house; max. two tankers	38 m (160ft)

The height of the steam plume depends on wind and weather conditions. Based on experience with other comparable cooling towers, a 100 m high plume, occasionally extending up to 200 m can be expected. Where required, stacks will be equipped with aeronautical lights in accordance with TC regulations.

9.5.2.3 Potential Receptors, View Points

Potential receptors include the traveling public using Marine Drive as well as Isaac's Harbour Road. While Isaac's Harbour Road is used predominantly by local residents, Marin Drive is used by local residents and seasonally also by tourists traveling along the Nova Scotia's North Shore. Further, potential receptors are residents of the nearest communities, i.e. Goldboro, Isaac's Harbour, Drum Head, Seal Harbour, and Coddle Harbour. Commercial and recreational boaters entering Isaac's Harbour from off-shore are another group of potential receptors of visual impacts that the Project may cause.

Key view points in the area are considered to be associated with the:

- Goldboro picnic area;
- Goldboro church and cemetery;
- Goldboro community centre; and
- Isaac's Harbour church and cemetery.

9.5.2.4 Visual Impacts

Visibility

The proposed Project, in particular individual high elements of the Project (Table 9.5-1), are expected to be visible from the near-by communities of Goldboro, Isaac's Harbour, and Isaac's Harbour North and associated key view points. For Drum Head, Seal Harbour, and Coddle Harbour, the Project is expected to be less visible as a function of distance, topography and the screening effects of the vegetation cover. However, the top features, such as the flare stacks and fractionators, as well as the plume from the cooling tower are expected to be visible from all of these locations. During night time, reflections of the lighting in the night sky will also be visible from all of these locations.

For the traveling public along the rerouted Marine Drive, most, if not all of the Project's of the Petrochemical plant, and the Co-generation plant will be visible. Most of the development is also expected to be visible from boats approaching Isaac's Harbour from off-shore.

Changes in Visual Character

The impact of the Project on landscape character is a function of the contrast in form, height, colour, and shape between the landscape and the surrounding landscape. With the exception of the currently barely visible SOEI gas plant, the absence of similar structures (storage silos, tank facilities, exhaust stacks, vapour plumes) or other industrial facilities, the new development is expected to appear in contrast with the existing rural landscape.

The new elements are considered to permanently change the existing visual landscape character from a visually coherent rural landscape to a landscape composed of stark visual contrasts between rural and industrial elements.

Lighting

While the lighting levels have not been designed at this stage, they will be set to provide a low level of general lighting sufficient for security cameras. This level is not expected to provide task lighting and high masts with multi-unit high intensity fixtures will be avoided as much as possible. Where high mast lighting is required the illumination fixtures will be selected to direct light downward.

Light will be emitted from all components of the Project. The most noticeable will be from the Marine terminals, especially when vessels are at berth. This area is in the direct view plain of the communities of Goldboro, Isaac's Harbour, and Drum Head.

The area of the LNG storage tanks will be mostly in the view plain of the community of Isaac's Harbour. The lighting from the petrochemical plant would be similar to that from the SOEI gas plant but from a larger area due to the size of the facilities. This area should be out of the view plain of residential areas, as is the gas plant, with the exception of flare towers.

On the petrochemical plant site, all lighting, with the exception of those required for the flare stacks, will be focused on the area for which its need is intended, and the lights will, where possible, be shielded to ensure as little diffusion as possible to other areas, including the sky. It is anticipated that no direct lighting impacts from this site will impact the residents of the area, although there will be some inevitable 'skyglow' which will be noticeable, given the typical dark skies of a rural area.

Effects on Potential Receptors

For the traveling public along Marine Drive, the new development will dominate the views when driving along the re-routed Marine Drive. At the identified view points and for many residents in Isaac's Harbour and Goldboro, the new development will also be visible and may even dominate views for the closest locations (less than 2 km) due to the geographic extent of the Project and the dimensions of individual elements that cannot be "hidden" or "integrated" with the surrounding landscape. Without mitigation, the appearance of the new development may be experienced from these locations as "intrusive".

For the communities in Isaac's Harbour North, Drum Head, Seal Harbour and Coddles Harbour elements of the development are expected to be visible; however views are not expected to be dominated by the Project components due to the distance (more than 2km for most elements) and screening effects of topography and vegetation.

Given the dimension and nature of the proposed development, measures to avoid or minimize visual impacts are limited (see Section 11). Most effective approaches will relate to screening views at receptor locations. This could include i.e. road side plantings, plantings at key view points (i.e. Goldboro Community Centre) to screen views or to direct views away from the plant site. The provision of interpretive opportunities that promote and understanding of the facility are also considered useful tools in reducing negative perception.

9.5.3 Conclusion

The general visual characteristics of the landscape near the Project site (within approximately 3 km) could be significantly effected. It should be noted that the number of distant residents who can see the site may actually be very small since anyone further than 1.5 km away would not see the site over any intervening trees or buildings unless the obstruction was at least 500 m away. For the traveling public, the visual exposure to the development represents a rather short section along Marine Drive. Only nearby residents would generally be able to see the site over intervening trees and structures. Visual impact for near-by residences and travelers along Marine Drive are also expected to be major. However, the number of affected residences is very low given the small size of the communities (Isaac's harbour, Goldboro, Drum Head). While there will likely be an increase in local residents (plant workers) during construction and operation, it can be assumed that these residents will not be offended by the site of their workplace. Many current residents may also be tolerant of the visual intrusion, since the Project will be associated with local economic benefits. There will be an opportunity to rehabilitate the visual landscape following decommissioning, therefore the effects are not permanent.

Overall, the effects on visual quality are rated Medium. Measures to maximize the positive effects are discussed in Section 11 and are summarized in Table 9.5-2.

Petrochemical Complex and Cogeneration Power Plant

The proposed facility is approximately 500 m from the nearest residence, which is located along Marine Drive. The inland components of the site will be approximately 50 m higher in elevation than residences along Isaac's Harbour, with higher points of elevation in between. These changes in topography, as well as vegetation and distance will help to reduce impacts. The vapour plume generated by the cooling tower will likely be the most visible component of the plant and is expected to be visible from all communities within a 5 km radius of the facility.

LNG Facility and Marginal Wharf

The coastal and marine components of the Project will be visible to residences in Isaac's Harbour, although on the periphery of that view plane and at least 1 km distance. The back side of the facility may be visible from the community of Drum Head, although the view will be mitigated by vegetation and a distance of 2 km and greater.

Infrastructure (Meadow Lake Water Intake)

No effects have been identified. The water intake structure will be barely noticeable since most of the structure is below the new lake water level. In addition, recreational uses at Meadow Lake are minimal.

9.6 IMPACT ON AIR QUALITY

9.6.1 Construction Phase

Air quality related impacts associated with the construction of the facility will be comprised mainly of emissions from diesel-powered construction equipment and from marine vessels used to deliver equipment and materials to the site. There will also be emissions from private vehicles driven by the construction labour force (i.e. approximately 400 vehicles per day over the entire construction period). These emissions include NOx, SOx, particulates, and greenhouse gases however, these sources are relatively minor and will be of short duration.

Fugitive dust emissions will be generated as a result of excavation and earth moving activities as well as construction equipment traveling on paved and un-paved roads (i.e. dump trucks, cement trucks, watering trucks, bulldozers, graders, scrapers, compactors, front end loaders, and back hoes). A concrete batch plant will also be a source of fugitive dust emissions. These types of emissions will occur over a relatively brief period of time and will have only very localized impacts with the dust settling out generally within a few hundred metres of the activity.

As the site is fairly isolated from the residents, schools, and businesses of the area, the impacts to the public are expected to be insignificant, approaching background concentrations at off-site locations. Short term dust impacts during construction of the Route 316 realignment may be experienced by residents living along Goldbrook Road or in Seal Harbour while the intersections are under construction. Mitigation for impacts on air quality in all phases is described in Section 10.4. A discussion of the monitoring program for air quality can be found in Section 13.1.

TABLE 9.5-2 Residual Environmental Effects Summary for Recreational Opportunities and Aesthetics

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance**	Likelihood of Occurrence***	Level of Confidence***
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context			
Construction										
LNG Facility, Petrochemical Plant, Co-Gen Plant, Infrastructure (Meadow Lake Dam and Intake Structure)										
Effects on the local visual landscape character	A	See Operation Phase; construction-specific mitigation: Ensure good housekeeping Cleaning of road at and near site entrance when required During initial site clearing, maintain and protect tree and shrub buffer along site perimeter as visual screen	At end of construction phase: high	At end of construction phase approx 3 to 5 km	Construction Phase	R	Coherent, rural landscape	Major	High	High

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance**	Likelihood of Occurrence***	Level of Confidence***
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context			
Effects on the local visual landscape character *(Continued)*		Design "jogged" road access to prevent unobstructed views from public road into construction site								
Effects on receptors and receptor locations (including recreational opportunities)	A	See above and recommendations for Operation Phase	Medium	At end of construction phase approx 3 to 5 km	Construction Phase	R	Coherent, rural landscape; very few formal recreation opportunities within site vicinity	Medium		
Operation										
LNG Facility, Petrochemical Plant, Co-Gen Plant, Infrastructure (Meadow Lake Dam and Intake Structure)										
Effects on the local visual landscape character	A	Tree and shrub planting as visual screens along site perimeter and Marine Drive near the Project site	Medium	Approx 3 to 5 km around Project site	Construction Phase	R	Rural, fairly undeveloped coastal environment; existing gas plant with 300 ft stack adjacent to Project site	Major	High	High

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance**	Likelihood of Occurrence***	Level of Confidence***
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context			
Effects on the local visual landscape character *(Continued)*		Use of colour schemes for stacks and higher buildings that support blending in with background Minimal night lighting Location of flare stacks at back of sit								
Effects on receptors and receptor locations (recreational opportunities)	A	Tree and shrub plantings at receptor locations to screen views Along Marine Drive, provision of interpretive opportunities with information on the facility and its operation	Medium very few designated recreation sites within viewshed	Visibility beyond 3.5 km;	Construction Phase	R	Rural, fairly undeveloped coastal environment; existing gas plant with 300 ft stack adjacent to Project site; limited importance for recreation and tourism	Medium		

* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 7
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 7
*** Only addressed for significant effects

9.6.2 Operation Phase

The Project will consist of a Petrochemical Complex supported by LNG importation and vaporization facility and an electric co-generation plant.

The conceptual plan for the Project consists of the following major elements:

- LNG facility – LNG Extraction Unit, LNG storage; metering stations; marine terminal, tugs, and berthing facilities, LNG transfer, vessel movement, storage and vaporization facilities; vapour handling system and associated infrastructure/support facilities; including emergency shutdown system, hazard detection system, security system and facilities, and fire response system.
- Petrochemical facilities –Ethylene, Ethylene and Propylene storage (refrigerated), By-product storage, Derivative units of Polypropylene, HDPE, LDPE, and LLDPE; fuel gas and liquid systems; water and steam system; shipping and receiving facilities, including marginal wharf; and associated support facilities, including laboratories, administrative buildings, and security.
- Electrical co-generation plant (i.e. nominal 200 MW) and associated support facilities, which will be integrated with the LNG Extraction Unit and possibly the LNG vaporization facilities.
- Shipping, including vessel types and sizes, frequency of shipping and planned routes.
- Service water and drinking water systems.
- Administration and service buildings.
- Sanitary wastewater system.

The conceptual facility layout showing the locations of these units is provided in Figure 2.0-1.

9.6.2.1 Source Definition

The specific sources of continuous and intermittent air contaminant emissions during routine operation and malfunctions include the following:

- LNG facility:
  - LNG tanker (intermittent – 24 hours per delivery);
  - SCVs (continuous);
  - simple cycle combustion turbine for power supply (intermittent);
  - flare (at start up and at emergencies)
  - gas vent stacks (intermittent - malfunction only); and
  - LNG extraction plant fugitive emissions (continuous).
- Cogeneration facility:
  - simple cycle combustion turbine for power supply (intermittent);
- Petrochemical facility:

  - Ethylene plant:
    - cracking furnaces (continuous);
    - hydrogenation units (intermittent);
    - process vents (intermittent);
    - fugitive emissions from equipment leaks (continuous); and
    - flare (emergency operation only).
  - Linear LLDPE plant:
    - feed unit treater vents (intermittent);
    - catalyst activation off-gas vents (intermittent);
    - finishing area pelletization, driers, hoppers, silos, etc. (intermittent);
    - emergency releases to the main flare (intermittent) and low capacity process vents to cracking furnaces (intermittent); and
    - fugitive emissions from equipment leaks (continuous).
  - Polypropylene Plant vents (intermittent);
  - LDPE plant vents;
  - HDPE plant vents;
- Marine transportation equipment other than LNG tankers (intermittent).

The specific air pollutants emitted from some or all of these units that have been evaluated for their impacts consist of the following:

- SO_2, formed when fuel containing sulphur, such as coal and oil, is burned;
- NO_x, generated when fuel is burned at high temperatures as in a combustion process;
- CO, formed from the incomplete combustion of carbon-containing fuel;
- TSP, PM with PM_{10} and $PM_{2.5}$, terms for particles found in the air, including dust, dirt, soot, smoke, and liquid droplets; and
- VOCs.

Preliminary estimates of the emissions of these pollutants from the Project components are summarized in Table 9.6-1. The emission rates are based either on equipment vendor information or AP-42 emissions factors (USEPA, 2005). The maximum heat input rates to the combustion units and maximum operating capacity of process units are assumed in these emissions estimates along with estimates of operating hours. The PM_{10} and $PM_{2.5}$ emission rates include both filterable and condensable fractions. Table 9.6-2 gives further information on the parameters used for air quality modeling purposes. Stack heights for the Keltic facilities are from ground level at the particular source location, and elevation relative to sea level is also indicated. The model can be used to account for building downwash as the design for the building structures matures.

Furthermore, it should be noted that the air quality modeling impacts are, of necessity, based on conceptual design data which has been generated at this time. As more information evolves, further information will be delineated, including, but not limited to:

- building layouts and roof heights;
- unit process details, including additional process components; and
- emission control improvements.

For example, given the cooling water requirements for the petrochemical facility, it has been determined that a forced draft cooling tower will be needed, giving rise to potential particulate emissions, as well as vapour plumes. As the design progresses, specific dispersion modeling techniques will be used to determine the impact(s) of the tower. If required, the Project's Environmental Management Plan, will include provisions to mitigate any potential adverse effects associated with the operation of such tower. This typically includes such items as monitoring weather conditions and operation of a fog warning system along potentially affected roads. In addition, the need for a number of submerged combustion vaporizers is documented in Section 2, and when emission parameters are established, the air quality model will incorporate these units. (It is anticipated that the combined cycle generation facility, when online, will supplant the use of the SCVs, except in unusual circumstances.) The modeling will also establish the need for emission control systems and its specifications.

Nonetheless, the air quality dispersion modeling results presently available (Section 9.6.2.5) provide a contextual appreciation for the potential impacts of the facility. Keltic Petrochemical Inc. will, as part of its environmental permit application process, provide a full air quality modeling report based on the final facility design.

9.6.2.2 Impact Analysis

A dispersion modeling analysis has been conducted to estimate the impacts of the Project criteria air contaminant emissions on ambient air quality levels and sensitive receptors in the project area. This dispersion modeling analysis covers routine emissions during normal operation of the units at the facility as well as emissions associated with equipment malfunctions and mobile source emissions. It is noted that the potential emissions from the cargo vessels which will be tied up on occasion at the Marginal Wharf have not been included in the modeling analysis, since their sizes, configurations, and fuel types are unknown at present. However, estimated emissions from the LNG vessels while hoteling and unloading have been included. The impacts of their boiler emissions are not considered to have a significant impact on the dispersion results; however, the models may be run again at a later date when further information is available.

The USEPA "Guideline on Air Quality Models" (USEPA, 2004) was consulted for guidance in selecting the appropriate methodology for this analysis. The assessment includes the following steps:

- meteorological data selection, review and processing;
- land use analysis and receptor grid development;

TABLE 9.6-1 Air Emission Inventory

Process ID	Emission Point Description	Source Pollutant[1]	Emissions		Emission Factor	
			lb/hr[2]	tonnes/year	Source	lb/MMBtu[3]
Combined Cycle Plant	**Gas Turbines (4)**	SO_2	0.4	1.7	AP-42, Sec 3.1	0.0003
	Max. Gas Heat Input (Btu/hr[4]): 4.08E+08	TSP	10.8	42.8	AP-42, Sec 3.1	0.007
	Max. Gas Usage (MMcf/hr[5]): 0.40	$PM_{2.5}$	10.8	42.8	AP-42, Sec 3.1	0.007
	Max. Gas Usage (MMcf/yr[6]): 3504.0	NO_x	212.2	843.1	AP-42, Sec 3.1	0.130
	Hours of Operation per Year: 8,760	CO	49.0	194.5	AP-42, Sec 3.1	0.030
		VOC	3.4	13.6	AP-42, Sec 3.1	0.002
LNG Facility	**Simple Cycle Gas Turbine**	SO_2	0.05	0.004	AP-42, Sec 3.1	0.0003
	Max. Gas Heat Input (Btu/hr): 1.88E+08	TSS	1.24	0.08	AP-42, Sec 3.1	0.007
	Max. Gas Usage (MMcf/hr): 0.184	$PM_{2.5}$	1.24	0.08	AP-42, Sec 3.1	0.007
	Max. Gas Usage (MMcf/yr): 27.6	NO_x	13.9	0.94	Solar (25 ppm)	0.074
	Hours of Operation per Year: 150	CO	5.64	0.38	AP-42, Sec 3.1	0.030
		VOC	0.39	0.03	AP-42, Sec 3.1	0.002
LNG Facility	**LNG Tanker**	SO_2	82.6	142.1	Bergessen Worldwide	2.12
	Max. Heat Input (Btu/hr): 3.90E+07	TSP	12.1	20.8	AP-42	0.31
	Max. Oil Usage (gal/hr[7]): 286.4	$PM_{2.5}$	12.1	20.8	AP-42	0.31
	Max. Oil Usage (gal/yr[8]): 1,086,056	NO_x	82.6	142.1	Bergessen Worldwide	2.12
	Hours of Operation per Year: 3,792	CO	37.0	63.7	AP-42	0.95
		VOC	13.6	23.5	AP-42	0.35
Ethylene Plant	**Flare (emergency only)**	SO_2	0	0	Estimate	N/A
	Max. Gas Heat Input (Btu/hr): 1.76E+05	TSP	1.5	6.0	Estimate	N/A
	Hours of Operation: emergency/start up	$PM_{2.5}$	1.5	-	Estimate	N/A
		NO_x	339.7	-	Estimate	N/A
		CO	62.1	-	Estimate	N/A
		VOC	9.8	-	Estimate	N/A
Ethylene Plant	**Cracking Furnaces (7 on-line, 1 decoking)**	SO_2	24.2	93.5	NOVA Chem E3 Env. Permit Appl.	N/A
	Flue Gas Flow (NM³/hr[9]): 1.23E+06	TSP	17.6	68.0	"	N/A
	Hours of Operation: 8,520	$PM_{2.5}$	17.6	68.0	"	N/A
		NO_x	268.7	1038.5	"	N/A
		CO	17.6	68.0	"	N/A
		VOC	8.8	34.0	"	N/A
Ethylene Plant	**Gasoline Hydrogenation**	CO_2	0.0	0.0		N/A
	Flue Gas Flow (NM³/hr): 1,500					
	Hours of Operation: 64					
	Routed to furnaces					

Process ID	Emission Point Description	Source Pollutant[1]	Emissions		Emission Factor	
			lb/hr[2]	tonnes/year	Source	lb/MMBtu[3]
Ethylene Plant	**Mixed Hydrogenation**	CO_2	0.0	0.0		N/A
	Flue Gas Flow (NM^3/hr): 1,500					
	Hours of Operation: 48					
	Routed to furnaces					
Ethylene Plant	**Process Vents**	VOC	0.0	0.0		N/A
	Flue Gas Flow (NM^3/hr): 500					
	Hours of Operation: 50					
	Routed to furnaces					
LLDPE Plant	**Purification - Butene-1/ICA Degassing**	VOC	0.0	0.0	Univation Technologies	N/A
	Flue Gas Flow (kg/hr[9]): 5					
	Hours of Operation: 8,000					
	Routed to furnaces					
LLDPE Plant	**Purging & Vent Recovery**	VOC	0.0	0.0	Univation Technologies	N/A
	Flue Gas Flow (kg/hr): 1,290					
	Hours of Operation: 8,000					
	Routed to furnaces					
LLDPE Plant	**Pelleting Section**	VOC	0.0	0.0	Univation Technologies	N/A
	Flue Gas Flow (kg/hr): 2.2					
	Hours of Operation: 8,000					
	Routed to furnaces					
LLDPE Plant	**Fugitive Emissions**	VOC	0.0	0.0	Univation Technologies	N/A
	Flue Gas Flow (kg/hr): 1.5					
	Hours of Operation: 8,000					
	Routed to furnaces					
LDPE Plant	**Reactor Dumps and Purging**	VOC	0.0	0.0	ExxonMobil LDPE	N/A
	Flue Gas Flow (t/hr): 50					
	Hours of Operation: 8,000					
	Routed to furnaces					
LDPE Plant	**Purge Gas/Primary Compressor**	VOC	0.0	0.0	ExxonMobil LDPE	N/A
	Flue Gas Flow (t/hr):4.0					
	Hours of Operation: 8,000					
	Routed to furnaces					
LDPE Plant	**LDPE Finishing Section**	VOC	0.0	0.0	ExxonMobil LDPE	N/A
	Flue Gas Flow (t/hr): 100					
	Hours of Operation: 8,000					
	Routed to furnaces					

Process ID	Emission Point Description	Source Pollutant[1]	Emissions		Emission Factor	
			lb/hr[2]	tonnes/year	Source	lb/MMBtu[3]
LDPE Plant	**Fugitive Emissions**	VOC	6.9	24.9	ExxonMobil LDPE	N/A
	Flue Gas Flow (t/hr): 25					
	Hours of Operation: 8,000					
Polypropylene Plant	**Reaction Fugitive Emissions**	VOC	3.6	13.0	DOW Unipol polypropylene	N/A
	Flue Gas Flow (kg/hr): 1.6					
	Hours of Operation: 8000					
Polypropylene Plant	**Purging & Vent Recovery**	VOC	0.0	0.0	DOW Unipol polypropylene	N/A
	Flue Gas Flow (kg/hr): 449					
	Hours of Operation: 8000					
	Routed to furnaces					
Polypropylene Plant	**Pelleting - to Flare**	VOC	0.0	0.0	DOW Unipol polypropylene	N/A
	Flue Gas Flow (kg/hr): 21.0					
	Hours of Operation: 8000					
	Routed to furnaces					
Polypropylene Plant	**Pelleting - to Atmosphere**	VOC	41.0	147.0	DOW Unipol polypropylene	N/A
	Flue Gas Flow (kg/hr): 18.4					
	Hours of Operation: 8000					
HDPE Plant	**Purification - Butene-1/ICA Degassing**	VOC	0.0	0.0	Univation Technologies	N/A
	Flue Gas Flow (kg/hr): 1					
	Hours of Operation: 8,000					
	Routed to furnaces					
HDPE Plant	**Purging & Vent Recovery**	VOC	0.0	0.0	Univation Technologies	N/A
	Flue Gas Flow (kg/hr): 1,120					
	Hours of Operation: 8,000					
	Routed to furnaces					
HDPE Plant	**Pelleting Section**	VOC	0.0	0.0	Univation Technologies	N/A
	Flue Gas Flow (kg/hr): 2.2					
	Hours of Operation: 8,000					
	Routed to furnaces					
HDPE Plant	**Fugitive Emissions Incl. Analyzer Vents**	VOC	3.3	12.0	Univation Technologies	N/A
	Flue Gas Flow (kg/hr): 1.5					
	Hours of Operation: 8,000					

Process ID	Emission Point Description	Source Pollutant[1]	Emissions		Emission Factor	
			lb/hr[2]	tonnes/year	Source	lb/MMBtu[3]
Keltic Facility	**All Sources**	SO_2	107.25	237.304	N/A	N/A
		TSP	43.24	131.68	N/A	N/A
		$PM_{2.5}$	43.24	131.68	N/A	N/A
		NO_x	917.1	2024.6	N/A	N/A
		CO	171.34	262.88	N/A	N/A
		VOC	90.49	268.03	N/A	N/A
SOEP Gas Plant	**Flare**	SO_2	0.0	0.0	EC	N/A
	Flue Gas Flow (NM^3/hr): 6.20E+09	TSP	1.5	6.0	EC	N/A
	Hours of Operation: 8,760	$PM_{2.5}$	1.5	6.0	EC	N/A
		NO_x	339.7	1349.8	EC	N/A
		CO	62.1	246.6	EC	N/A
		VOC	9.8	38.8	EC	N/A

1. Notes: 1 – Typically $PM_{2.5}$ is a subset of TSP, however for the purpose of this study, we have considered the TSP and $PM_{2.5}$ to be equal.
2. 2 – lb/hr is a maximum rate, since not all units operate 8760 hours per year (i.e. LNG tankers, emergency flares, etc.)
3. 3 -lb/hr – pounds per hour
4. 4 - lb/mmBTU – pounds per million British thermal units
5. 5 - BTU/hr – British thermal units per hour
6. 6 - mmcf/hr – million cubic feet per hour
7. 7 - mmcf/yr – million cubic feet per year
8. 8 - gal/hr – gallons per hour
9. 9 - gal/yr – gallons per year
10. 10 -NM^3/hr – normal cubic metres per hour
11. 11 - kg/hr – kilograms per hour

TABLE 9.6-2 Air Emission Inventory – Additional Information on Parameters

TABLE 9.6-2 Air Emission Inventory – Air Emission Inventory – Additional Information On Parameters

Process ID	Source ID	Emission Point Description	Source Type	No. of Sources	Source Location	Source Pollutant	Potential Emissions lb/hr	Potential Emissions TPY	Emission Factor (lb/MMBtu)		Air Pollution Controls
Combined Cycle Plant	101 - 104	**Combined Cycle Gas Turbine (each)**	Stack	4	Combined Cycle Plant	SO_2	4.24E-01	1.86E+00	AP-42, Sec 3.1	2.60E-04	Natural Gas
		Max. Gas Heat Input (Btu/hr):				TSP	1.08E+01	4.72E+01	AP-42, Sec 3.1	6.60E-03	Natural Gas
		4.08E+08				PM-10	1.08E+01	4.72E+01	AP-42, Sec 3.1	6.60E-03	Natural Gas
		Max. Gas Usage (MMcf/hr):				NOx	2.12E+02	9.29E+02	AP-42, Sec 3.1	1.30E-01	Water Injection
		0.400				CO	4.90E+01	2.14E+02	AP-42, Sec 3.1	3.00E-02	Natural Gas
		Max. Gas Usage (MMcf/yr):				VOC	3.43E+00	1.50E+01	AP-42, Sec 3.1	2.10E-03	
		3504.0									
		Hours of Operation:									
		8760.0									
		Heat Content (Btu/cf):									
		1020									
		Stack Height (m): 18.29									
		Exit Diameter (m): 3.05									
		Exit Temperatue (K): 720									
		Exit Velocity (m/sec): 30									
		UTM(m): N 5002850; E 607200									
		Elev (m): 45									
LNG Facility	201	**Simple Cycle Gas Turbine**	Stack	1	LNG Facility	SO_2	4.89E-02	3.67E-03	AP-42, Sec 3.1	2.60E-04	Natural Gas
		Max. Gas Heat Input (Btu/hr):				TSP	1.24E+00	9.31E-02	AP-42, Sec 3.1	6.60E-03	Natural Gas
		1.88E+08				PM-10	1.24E+00	9.31E-02	AP-42, Sec 3.1	6.60E-03	Natural Gas
		Max. Gas Usage (MMcf/hr):				NOx	1.39E+01	1.04E+00	Solar (25 ppm)	7.40E-02	Water Injection
		0.184				CO	5.64E+00	4.23E-01	AP-42, Sec 3.1	3.00E-02	Natural Gas
		Max. Gas Usage (MMcf/yr):				VOC	3.95E-01	2.96E-02	AP-42, Sec 3.1	2.10E-03	
		27.6									
		Hours of Operation:									
		150.0									
		Heat Content (Btu/cf):									
		1020									
		Stack Height (m): 18.29									
		Exit Diameter (m): 3.05									
		Exit Temperatue (K): 720									
		Exit Velocity (m/sec): 30									
		UTM(m): N 5002125; E 608075									
		Elev (m): 35									
LNG Facility	202	**LNG Tanker**	Stack	1	LNG Facility	SO_2	8.26E+01	1.57E+02	Bergessen Worldwide	2.12E+00	None
		Max. Heat Input (Btu/hr):				TSP	1.21E+01	2.29E+01	AP-42	3.10E-01	
		3.90E+07				PM-10	1.21E+01	2.29E+01	AP-42	3.10E-01	
		Max. Diesel Usage (gal/hr):				NOx	8.26E+01	1.57E+02	Bergessen Worldwide	2.12E+00	
		286.4				CO	3.70E+01	7.02E+01	AP-42	9.50E-01	
		Max. Diesel Usage (gal/yr):				VOC	1.36E+01	2.59E+01	AP-42	3.50E-01	
		1086056.2									
		Heat Content (Btu/gal):									
		136065									
		Hours of Operation:									
		3792									

TABLE 9.6-2 Air Emission Inventory – Additional Information On Parameters

Process ID	Source ID	Emission Point Description	Source Type	No. of Sources	Source Location	Source Pollutant	Potential Emissions lb/hr	Potential Emissions TPY	Emission Factor (lb/MMBtu)	Air Pollution Controls
		Stack Height (m): 36.7								
		Exit Diameter (m):1.3								
		Exit Temperatue (K): 413								
		Exit Velocity (m/sec): 20								
		UTM(m): N 5000800; E 606350								
		Elev (m): 0								
Ethylene Plant	301	**Flare (emergency only)**	Flare	1	Ethylene Plant	SO_2	2.42E+01	1.21E-02	NOVA Chem E3 Env. Permit Appl.	None
		Max. Gas Heat Input (Btu/hr):				TSP	1.50E+00	7.50E-04	Estimate	
		1.76E+05				PM-10	1.50E+00	7.50E-04	Estimate	
		Hours of Operation:				NOx	3.40E+02	1.70E-01	Estimate	
		8760.0				CO	6.21E+01	3.11E-02	Estimate	
		Heat Content (Btu/cf):				VOC	9.80E+00	4.90E-03	Estimate	
		Stack Height (m): 31.4								
		Exit Diameter (m): 1.22								
		Exit Temperatue (K): 1000								
		Exit Velocity (m/sec): 33								
		UTM(m): N 5003600; E 606750								
		Elev (m): 65								
Ethylene Plant	302 - 309	**Cracking Furnaces (7 on-line, 1 decoking)**	Stack	8	Ethylene Plant	SO_2	2.42E+01	1.03E+02	NOVA Chem E3 Env. Permit Appl.	None
		Flue Gas Flow (NM^3/hr):				TSP	1.76E+01	7.50E+01	"	
		1.23E+06				PM-10	1.76E+01	7.50E+01	"	
		Hours of Operation:				NOx	2.69E+02	1.14E+03	"	
		8520.0				CO	1.76E+01	7.50E+01	"	
		Stack Height (m): 71				VOC	8.80E+00	3.75E+01	"	
		Exit Diameter (m): 2.64								
		Exit Temperatue (K): 448								
		Exit Velocity (m/sec): 10.5								
		UTM(m): N 5003375; E 607000								
		Elev (m): 65								
Ethylene Plant	311	**Gasoline Hydrogenation**	Stack	1	Ethylene Plant	CO_2	0.00E+00	0.00E+00		
		Flue Gas Flow (NM^3/hr):								
		1.50E+03								
		Hours of Operation:								
		64.0								
		Routed to furnaces								
Ethylene Plant	312	**Mixed Hydrogenation**	Stack	1	Ethylene Plant	CO_2	0.00E+00	0.00E+00		
		Flue Gas Flow (NM^3/hr):								
		1.50E+03								
		Hours of Operation:								
		48.0								

TABLE 9.6-2 Air Emission Inventory – Additional Information On Parameters

Process ID	Source ID	Emission Point Description	Source Type	No. of Sources	Source Location	Source Pollutant	Potential Emissions lb/hr	TPY	Emission Factor (lb/MMBtu)	Air Pollution Controls
		Routed to furnaces								
Ethylene Plant	313	**Process Vents**	Stack	1	Ethylene Plant	VOC	0.00E+00	0.00E+00		
		Flue Gas Flow (NM^3/hr):								
		5.00E+02								
		Hours of Operation:								
		50.0								
		Routed to furnaces								
LLDPE Plant	401	**Purification - Butene-1/ICA Degassing**	Stack	1	LLDPE Plant	VOC	0.00E+00	0.00E+00	Univation Technologies	
		Flue Gas Flow (kg/hr):								
		5.0								
		Hours of Operation:								
		8000								
		Routed to furnaces								
LLDPE Plant	402	**Purging & Vent Recovery**	Stack	1	LLDPE Plant	VOC	0.00E+00	0.00E+00	Univation Technologies	
		Flue Gas Flow (kg/hr):								
		1.29E+03								
		Hours of Operation:								
		8000								
		Routed to furnaces								
LLDPE Plant	403	**Pelleting Section**	Stack	1	LLDPE Plant	VOC	0.00E+00	0.00E+00	Univation Technologies	
		Flue Gas Flow (kg/hr):								
		2.20E+00								
		Hours of Operation:								
		8000								
		Routed to furnaces								
LLDPE Plant	404	**Fugitive Emissions**	Fugitive	1	LDPE Plant	VOC	0.00E+00	0.00E+00	Univation Technologies	
		Flue Gas Flow (kg/hr):								
		1.50E+00								
		Hours of Operation:								
		8000								
		Routed to furnaces								
LDPE Plant	501	**Reactor Dumps and Purging**	Stack	1	LDPE Plant	VOC	0.00E+00	0.00E+00	ExxonMobil LDPE	None
		Flue Gas Flow (t/hr):								
		5.00E+01								
		Hours of Operation:								
		8000								
		Routed to furnaces								
LDPE Plant	502	**Purge Gas/Primary Compressor**	Stack	1	LDPE Plant	VOC	0.00E+00	0.00E+00	ExxonMobil LDPE	None
		Flue Gas Flow (t/hr):								
		4.00E+00								
		Hours of Operation:								
		8000								
		Routed to furnaces								

TABLE 9.6-2 Air Emission Inventory – Additional Information On Parameters

Process ID	Source ID	Emission Point Description	Source Type	No. of Sources	Source Location	Source Pollutant	Potential Emissions lb/hr	Potential Emissions TPY	Emission Factor (lb/MMBtu)	Air Pollution Controls
LDPE Plant	503	**LDPE Finishing Section**	Stack	1	LDPE Plant	VOC	0.00E+00	0.00E+00	ExxonMobil LDPE	None
		Flue Gas Flow (t/hr):								
		1.00E+02								
		Hours of Operation:								
		8000								
		Routed to furnaces								
LDPE Plant	504	**Fugitive Emissions**	Fugitive	1	LDPE Plant	VOC	6.90E+00	2.75E+01	ExxonMobil LDPE	None
		Flue Gas Flow (t/hr):								
		2.50E+01								
		Hours of Operation:								
		8000								
Polypropylene Plant	601	**Reaction Fugitive Emissions**	Stack	1	Polypropylene Plant	VOC	3.60E+00	1.43E+01	DOW Unipol PP	
		Flue Gas Flow (kg/hr):							Strm #12 (ave.)	
		1.60E+00								
		Hours of Operation:								
		8000								
Polypropylene Plant	602	**Purging & Vent Recovery**	Stack	1	Polypropylene Plant	VOC	0.00E+00	0.00E+00	DOW Unipol PP	None
		Flue Gas Flow (kg/hr):							Strm #12 (ave.)	
		4.49E+02								
		Hours of Operation:								
		8000								
		Routed to furnaces								
Polypropylene Plant	603	**Pelleting - to Flare**	Stack	1	Polypropylene Plant	VOC	0.00E+00	0.00E+00	DOW Unipol PP	
		Flue Gas Flow (kg/hr):							Strm #12 (ave.)	
		2.10E+01								
		Hours of Operation:								
		8000								
		Routed to furnaces								
Polypropylene Plant	604	**Pelleting - to Atmosphere**	Stack	1	Polypropylene Plant	VOC	4.10E+01	1.62E+02	DOW Unipol PP	
		Flue Gas Flow (kg/hr):							Strm #12 (ave.)	
		1.84E+01								
		Hours of Operation:								
		8000								
HDPE Plant	701	**Purification - Butene-1/ICA Degassing**	Stack	1	HDPE Plant	VOC	0.00E+00	0.00E+00	Univation Technologies	None
		Flue Gas Flow (kg/hr):								
		1.00E+00								
		Hours of Operation:								
		8000								
		Routed to furnaces								
HDPE Plant	702	**Purging & Vent Recovery**	Stack	1	HDPE Plant	VOC	0.00E+00	0.00E+00	Univation Technologies	None

TABLE 9.6-2 Air Emission Inventory – Additional Information On Parameters

Process ID	Source ID	Emission Point Description	Source Type	No. of Sources	Source Location	Source Pollutant	Potential lb/hr	Emissions TPY	Emission Factor (lb/MMBtu)		Air Pollution Controls
		Flue Gas Flow (kg/hr):									
		1.12E+03									
		Hours of Operation:									
		8000									
		Routed to furnaces									
HDPE Plant	703	**Pelleting Section**	Stack	1	HDPE Plant	VOC	0.00E+00	0.00E+00	Univation Technologies		None
		Flue Gas Flow (kg/hr):									
		2.20E+00									
		Hours of Operation:									
		8000									
		Routed to furnaces									
HDPE Plant	704	**Fugitive Emissions Incl. Analyzer Vents**	Fugitive	1	HDPE Plant	VOC	3.30E+00	1.32E+01	Univation Technologies		
		Flue Gas Flow (kg/hr):									
		1.50E+00									
		Hours of Operation:									
		8000									
Total/ Combustion	All	**Turbines/Furnaces**	Stack		Keltic Petrochemicals	SO_2	1.07E+02	2.62E+02			
Sources						TSP	4.17E+01	1.45E+02			
						PM-10	4.17E+01	1.45E+02			
						NOx	5.77E+02	2.23E+03			
						CO	1.09E+02	3.60E+02			
						VOC	3.51E+01	1.16E+02			
All Fugitive	All		Fugitive		Keltic Petrochemicals	VOC	5.48E+01	2.17E+02			
All VOCs	All		All		Keltic Petrochemicals	All VOCs	8.99E+01	3.33E+02			
SOEI Gas Plant		Max. Gas Heat Input (Btu/hr):				SO_2	0.00E+00	0.00E+00	EC		
		6.20E+09				TSP	1.50E+00	6.60E+00	EC		
		Hours of Operation:				PM-10	1.50E+00	6.60E+00	EC		
		8760.0				NOx	3.40E+02	1.49E+03	EC		
		Heat Content (Btu/cf):				CO	6.21E+01	2.72E+02	EC		
		1020				VOC	9.80E+00	4.28E+01	EC		
		Stack Height (m): 65									
		Exit Diameter (m): 6.0									
		Exit Temperatue (K): 1,000									
		Exit Velocity (m/sec): 0.1									
		UTM(m): N 5003300; E 608800									
		Elev (m): 45									

- emissions inventory development;
- background air quality evaluation; and
- refined modeling to estimate air quality impacts in the project area and at sensitive receptors.

Modeling was performed with the Project at full capacity operation for the combustion turbines and cracking furnaces, as well as for expected mobile source activity. According to a 2003 emissions inventory reported by EC, the only other significant source of air pollutant emissions within 25 km of the site is the SOEP gas plant and M&NP metering station that is adjacent to the Keltic site. Therefore, the Keltic and SOEP gas plant emissions are both included in the modeling analysis to demonstrate compliance with Nova Scotia Air Quality Regulations and *CEPA* Ambient Air Quality Objectives as shown in Table 9.6-3. The SOEI gas plant emissions are included in Table 9.6-2.

TABLE 9.6-3 Nova Scotia Air Quality Regulations (*Environment Act*) and *Canadian Environmental Protection Act* Ambient Air Quality Objectives

Contaminant/Units	Averaging Period	Nova Scotia Maximum Permissible	Canada National Ambient Air Quality Objectives & Guidelines		
			Maximum Desirable	Maximum Acceptable	Maximum Tolerable
NO_2 µg/m³ (ppb)	1 hour	400 (213)	-	400 (213)	1000 (532)
	24 hour	-	-	200 (106)	300 (160)
	Annual	100 (53)	60 (32)	100 (53)	-
SO_2 µg/m³ (ppb)	1 hour	900 (344)	450 (172)	900 (344)	-
	24 hour	300 (115)	150 (57)	300 (115)	800 (306)
	Annual	60 (23)	30 (11)	60 (23)	-
Total Suspended Particulate (µg/m³)	24 hour	120	-	120	400
	Annual	70	60	70	-
$PM_{2.5}$ (µg/m³)	24 hour	30[1]	-	-	-
CO mg/m³ (ppm)	1 hour	34.6 (31)	15 (13)	35 (31)	-
	8 hour	12.7 (13)	6 (5)	15 (13)	20 (17)
Ozone µg/m³ (ppb)	1 hour	160 (82)	100 (51)	160 (82)	300 (153)
	24 hour	-	30 (15)	50 (25)	-
	Annual	-	-	30 (15)	-
Hydrogen Sulphide µg/m³ (ppb)	1 hour	42 (30)	-	-	-
	24 hour	8 (6)	-	-	-

Note: Canada Wide Standard

Refined dispersion modeling for the criteria air contaminant emissions utilizes the USEPA American Meteorological Society/Environmental Protection Agency (EPA) Regulatory Model (AERMOD) model with topographic considerations along with five years of hourly surface meteorological data collected at Halifax-Shearwater and twice-daily upper air data collected at Yarmouth. Project impacts on ozone concentrations are assessed by comparing the total project ozone precursor emissions (i.e. NO_x and VOC) with the regional precursor emissions that contribute to the ambient ozone concentrations in the District of Guysborough.

AERMOD modeling options are specified as follows in accordance with the USEPA guidance (USEPA, 2002). The options include:

- use of the elevated terrain algorithms requiring input of terrain height data;
- use of stack tip downwash (except for building downwash cases);
- use of the calms processing routines;
- use of the missing data processing routines; and
- no exponential decay of SO_2 for rural sources.

Building downwash effects are not considered in the impact analysis due to the lack of specific information on building dimensions at this time. However, building downwash effects are more important at close-in distances and would have no meaningful effect on the estimated impacts of the Project given the relatively large distances from low level sources to off-site areas.

9.6.2.3 Meteorological Data Selection, Review, and Processing

AERMOD requires hourly surface meteorological data and twice-daily upper air data for calculating downwind concentrations. The data required for each simulation are:

- wind speed;
- wind direction;
- dry-bulb temperature;
- cloud cover;
- ceiling height;
- station pressure; and
- vertical profiles of temperature, pressure, and relative humidity.

The proposed facility site does not have an on-site meteorological station. Therefore, meteorological data used in the analysis consists of 2000 - 2004 hourly surface observations taken at Halifax-Shearwater along with concurrent twice-daily upper air data collected at Yarmouth. Halifax-Shearwater is located approximately 160 km southwest of the Keltic site. This distance from the site supports its spatial representativeness since it places it in the same general synoptic flow regime as well as most mesoscale systems. The Halifax-Shearwater station is also located in a similar geographic setting as the Keltic site being situated on the northeast portion of an inlet and about 5 km north of the southeast coastline. This is the station closest to the Keltic site that monitors all of the meteorological parameters required for the AERMOD model. Other possible sources of the required meteorological data in the area, at Beaver Island and Hart Island, were found to have significant amounts of missing data that precluded their use. The monitoring locations are also islands that have localized microclimates caused by sea breeze circulations that are not particularly representative of the Goldboro site. A wind rose depicting the frequency of occurrence of the Halifax-Shearwater winds from each of 16 directions and frequency of wind speed ranges for each direction is provided in Figure 9.6-1 for the 2000 – 2004 time period.

The aforementioned meteorological data are processed using the AERMET pre-processor program along with the definition of the surface characteristics within the modeling domain. These surface characteristics of albedo (i.e. ratio of reflected to incident solar radiation), Bowen ratio (i.e. ratio of sensible to latent heat fluxes from the earth's surface) and surface roughness length (i.e. height above the ground at which the mean wind speed becomes zero) are specified by season as a function of distance and direction from the Keltic site based on land use information and the AERMOD User's Guide recommended values of these parameters.

9.6.2.4 Land Use Analysis and Receptor Grid Development

The area surrounding the site can be characterized as rural in nature with very little industrial activity with the exception of the SOEP gas plant and metering station. The Keltic site terrain elevations vary from sea level to about 75 m above sea level. Nearby hills are most prominent to the northwest and north of the site while areas to the east, southeast, south, and southwest are generally flat to gently rolling that do not exceed 60 m above sea level. The terrain elevations reach 100 m at a distance of about 5,000 m from the site to the north, 120 m at a distance of approximately 8,000 m to the northwest, and 150 m at a distance of approximately 12,000 m to the northwest and north. The highest elevation within 20 km of the station is 200 m at a distance of approximately 20 km to the northwest.

The modeling domain in terms of the receptor grid development is selected such that the impacts of both low level and elevated source facility emissions are correctly estimated and are relevant for the analysis. Topography of the project site and the modeling domain are obtained using digital topographic data for the site region.

The UTM coordinate system is used to generate a Cartesian receptor grid starting at the petrochemical facility extending out to a distance as needed such that the maximum air quality impacts are captured in the model runs. A 100 m grid spacing is used from the Keltic property boundary out to a distance of 2 km. The property boundary is specified as discreet receptors in order to provide the proper detailed coverage in the receptor grid. A grid spacing of 200 m is used from 2 km to 4 km followed by 1 km grid spacing from 4 km to 10 km to ensure that the maximum impacts are obtained. Receptors are also placed at sensitive receptors such as the Isaac's Harbour Villa Senior Apartments.

The topographic elevations for the receptors in the modeling domain are developed using the AERMAP pre-processor along with Digital Elevation Model equivalent terrain files covering the modeling domain.

9.6.2.5 Modeling Results

The AERMOD modeling is performed for the Keltic facility sources along with the SOEP gas plant emissions to estimate total air quality impacts of the Project. These impacts are used to verify that the Nova Scotia Air Quality Regulations and *CEPA* Ambient Air Quality Objectives would be met, along with consideration of the appropriate background air quality data. It is noted that the VOC emissions are not modeled, since no criteria are available for comparison, nor is information on the specification of the VOCs available. Given the emission rates, the ground level concentrations would certainly be below any health criteria, and it is expected that the distance to receptors will mitigate potential odours.

FIGURE 9.6-1 Halifax-Shearwater Wind Rose (2000-2004)

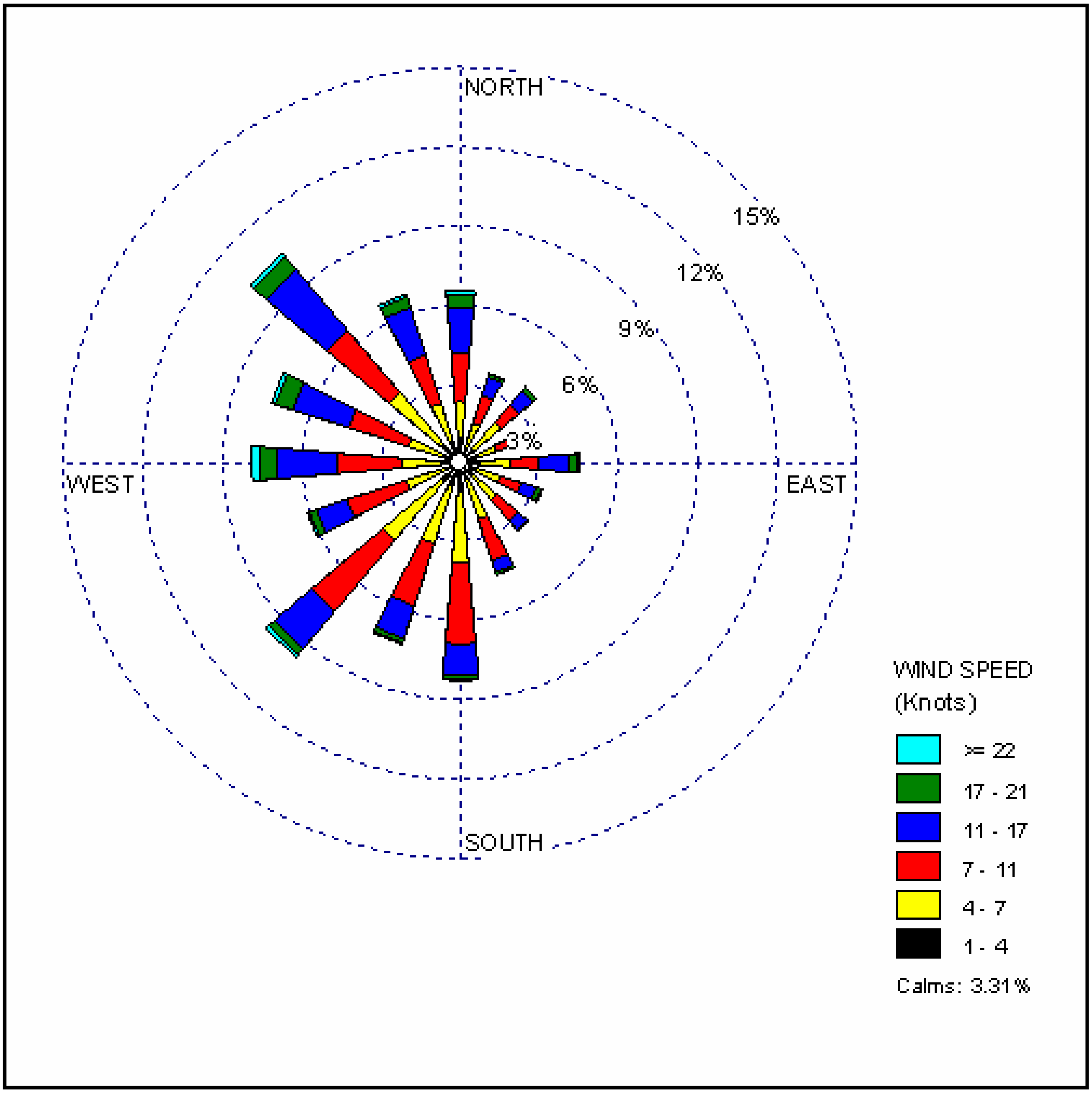


FIGURE 9.6-1
KELTIC PETROCHEMICALS INC.
HALIFAX SHEARWATER WINDROSE
(2000-2004)
JULY 2006

The background air quality used in the EA is based on short-term monitoring data collected by ExxonMobil at their Goldboro Gas Plant. Continuous monitoring for NO_2 and SO_2 near the Goldboro plant was conducted in Seal Harbour from June 10, 2004, through August 10, 2004. There are no other longer term background air quality data available that are representative of this area. The highest monitored 24-hour NO_2 concentration during this 2 month period was approximately 2.0 ppb and the highest SO_2 value was 4.0 ppb. Monitoring for TSP and $PM_{2.5}$ at Seal Harbour was conducted for three 24-hour periods in each of July, August, and September of 2004. The highest monitored 24-hour TSP concentration during this 3 month period was 19.8 $\mu g/m^3$ and the highest $PM_{2.5}$ value was 4.0 $\mu g/m^3$.

The results of the modeling analysis are summarized in Table 9.6-4 showing the overall highest predicted pollutant concentrations due to the routine operation of the Keltic facility and the SOEP gas plant separately. The total impacts reflect the highest combination of Keltic and SOEP impacts from among all off-site receptors, along with the background concentrations. The impacts during start-up/upset conditions with the ethylene flare operating on an emergency basis are also shown in this Table. Maximum sensitive receptor impacts are summarized in Table 9.6-5. Also, the NO_2 impacts are assessed by applying the empirically derived NO_2/NO_x ratio of 0.75 (i.e. annual national default) to the maximum predicted NO_2 impacts, as recommended in the USEPA "Guideline on Air Quality Models" (USEPA, 2004).

The highest NO_2 and CO offsite concentrations tend to occur to the southwest of the cogeneration plant near the property boundary due to the combined cycle gas turbine emissions. The highest SO_2, and TSP concentrations occur near the LNG tanker and in the area northwest of the ethylene unit near the property boundary. Figures 9.6-2 through 9.6-11 show the spatial distribution of the maximum Keltic facility NO_2, SO_2, TSP, and CO impacts for the various averaging times. The Keltic property boundary is outlined in black east of Isaac's Harbour and the SOEP boundary is just east of the Keltic facility.

The results indicate that the Nova Scotia Maximum Permissible Concentrations and Canada National Ambient Air Quality Objectives & Guidelines will be met in all cases.

Project impacts on ozone concentrations are assessed by comparing the total project ozone precursor emissions (i.e. NO_x and VOC) with the regional precursor emissions that contribute to the ambient ozone concentrations in the project area. From Table 9.6-1, the total annual project emissions of NO_x and VOC are estimated to be approximately 2,000 tonnes and 270 tonnes, respectively. According to EC's NPRI, the total NO_x and VOC emissions for the Province of Nova Scotia for the year 2003 were 70,749 t and 56,082 t, respectively. Therefore, the project emissions of NO_x and VOC are estimated to be approximately 2.8 and 0.5%, respectively, of the total province emissions. Such a small contribution to the regional emissions of ozone precursors will result in a negligible contribution to ozone concentrations in the project area, particularly since it has been estimated that 60-80% of the ozone found in Nova Scotia is due to long range transport.

As was noted in Section 8.6 (Table 8.6-3), lakes in this area typically exhibit fairly low pH values (4.3-5.5), which is not uncommon for Nova Scotia. These low values are likely the result of a number of factors, including the underlying geology of the area, the disposal/runoff with regard

TABLE 9.6-4 Maximum Predicted Overall Facility Impacts vs. Nova Scotia Air Quality Regulations and National Ambient Air Quality Objectives

Contaminant/Units	Averaging Period	Maximum Predicted Impacts				Nova Scotia Maximum Permissible	Canada National Ambient Air Quality Objectives & Guidelines		
		Keltic	SOEP	Total[1]	Upset[2]		Maximum Desirable	Maximum Acceptable	Maximum Tolerable
NO_2 µg/m^3	1 hour	155.9	274.1	274.5	276.2	400	-	400	1000
	24 hour	72.2	114.5	118.4	119.0	-	-	200	300
	Annual	4.7	17.7	19.1	20.2	100	60	100	-
SO_2 µg/m^3	1 hour	74.9	0.0	74.9	90.0	900	450	900	-
	24 hour	42.6	0.0	53.1	62.4	300	150	300	800
	Annual	5.3	0.0	5.3	6.1	60	30	60	-
TSP µg/m^3	24 hour	5.3	0.6	25.1	25.1	120	-	120	400
	Annual	0.8	0.1	0.3	0.8	70	60	70	-
$PM_{2.5}$ µg/m^3	24 hour	0.8	0.1	10.2	10.2	30[3]	-	-	-
CO mg/m^3	1 hour	0.048	0.067	0.067	0.067	34.6	15	35	-
	8 hour	0.031	0.052	0.052	0.052	12.7	6	15	20
Ozone µg/m^3	1 hour	N/A[4]	N/A	N/A	N/A	160	100	160	300
	24 hour	N/A	N/A	N/A	N/A	-	30	50	-
	Annual	N/A	N/A	N/A	N/A	-	-	30	-

12. Notes:
1. Total impacts reflect the highest combination of Keltic and SOEP impacts from among all off-site receptors and includes background concentrations (24-hour NO_2 of 3.8 µg/m^3, 24-hour SO_2 of 10.5 µg/m^3, 24-hour TSP of 19.8 µg/m^3 and 24 hour $PM_{2.5}$ of 4.3 µg/m^3) .
2. Reflects impacts during start-up/upset condition with ethylene flare in operation on emergency basis.
3. Canada Wide Standard assumes all particulate emitted by Keltic and SOEP is $PM_{2.5}$.
4. N/A = Not available

TABLE 9.6-5 Maximum Predicted Sensitive Receptor Impacts vs. Nova Scotia Air Quality Regulations and National Ambient Air Quality Objectives

Contaminant/Units	Averaging Period	Maximum Predicted Impacts (Keltic + SOEP)			Nova Scotia Maximum Permissible	Canada National Ambient Air Quality Objectives & Guidelines		
		Goldboro Interpretive Centre	Isaac's Harbour Villa Senior Aprts	Isaac's Harbour Medical Centre		Maximum Desirable	Maximum Acceptable	Maximum Tolerable
NO_2 µg/m^3	1 hour	87.5	73.4	79.2	400	-	400	1000
	24 hour	19.2	19.3	13.1	-	-	200	300
	Annual	1.7	1.4	1.1	100	60	100	-
SO_2 µg/m^3	1 hour	11.1	12.0	9.3	900	450	900	-
	24 hour	2.4	2.1	1.6	300	150	300	800
	Annual	0.4	0.3	0.2	60	30	60	-
TSP µg/m^3	24 hour	1.1	0.8	1.0	120	-	120	400
	Annual	0.1	0.1	0.09	70	60	70	-
$PM_{2.5}$ µg/m^3	24 hour	1.1	0.8	1.0	30[1]	-	-	-
CO mg/m^3	1 hour	0.014	0.013	0.013	34.6	15	35	-
	8 hour	0.005	0.003	0.005	12.7	6	15	20
Ozone µg/m^3	1 hour	N/A	N/A	N/A	160	100	160	300
	24 hour	N/A	N/A	N/A	-	30	50	-
	Annual	N/A	N/A	N/A	-	-	30	-

Notes:

1. Assumes all particulate emitted by Keltic and SOEP is $PM_{2.5}$.
2. Canada Wide Standard

FIGURE 9.6-2 Maximum 1-Hour NO_2 Impacts

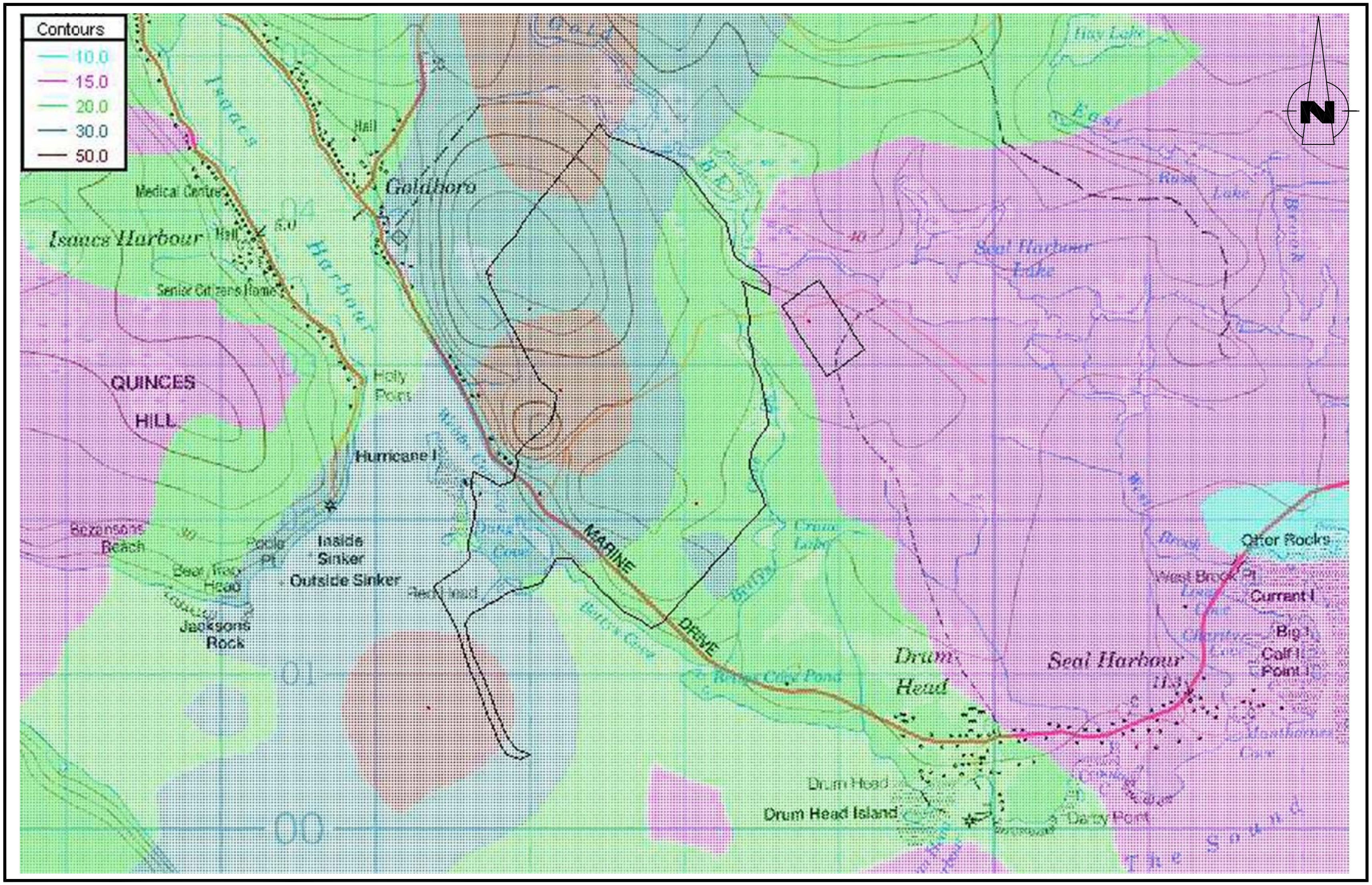


FIGURE No. 9.6-2
KELTIC PETROCHEMICALS INC.
MAXIMUM 1-HOUR NO_2 IMPACTS
JULY 2006

FIGURE 9.6-3 Maximum 24-Hour NO_2 Impacts

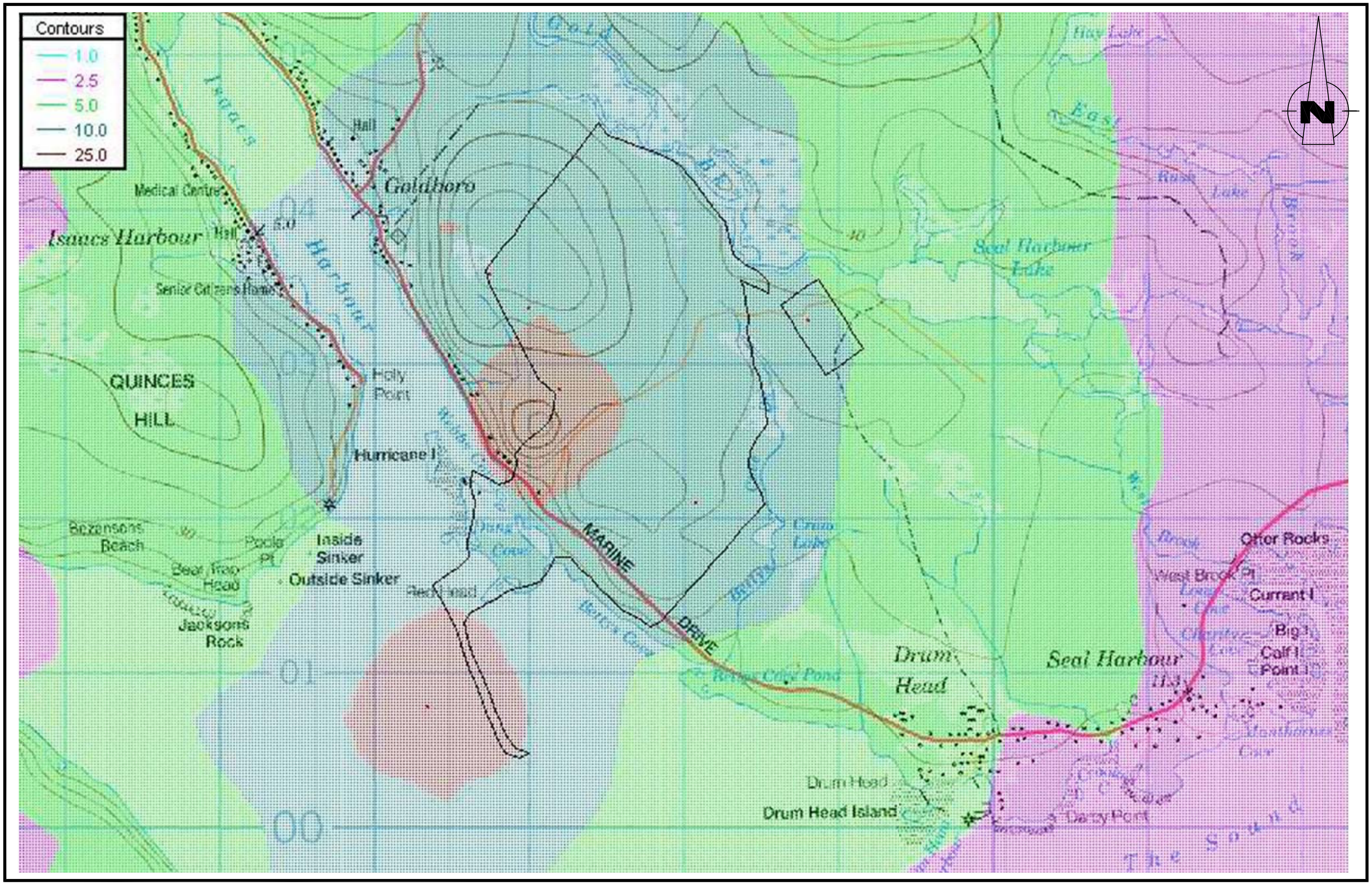


FIGURE No. 9.6-3
KELTIC PETROCHEMICALS INC.
MAXIMUM 24-HOUR NO_2 IMPACTS
JULY 2006

FIGURE 9.6-4 Annual Average NO_2 Impacts

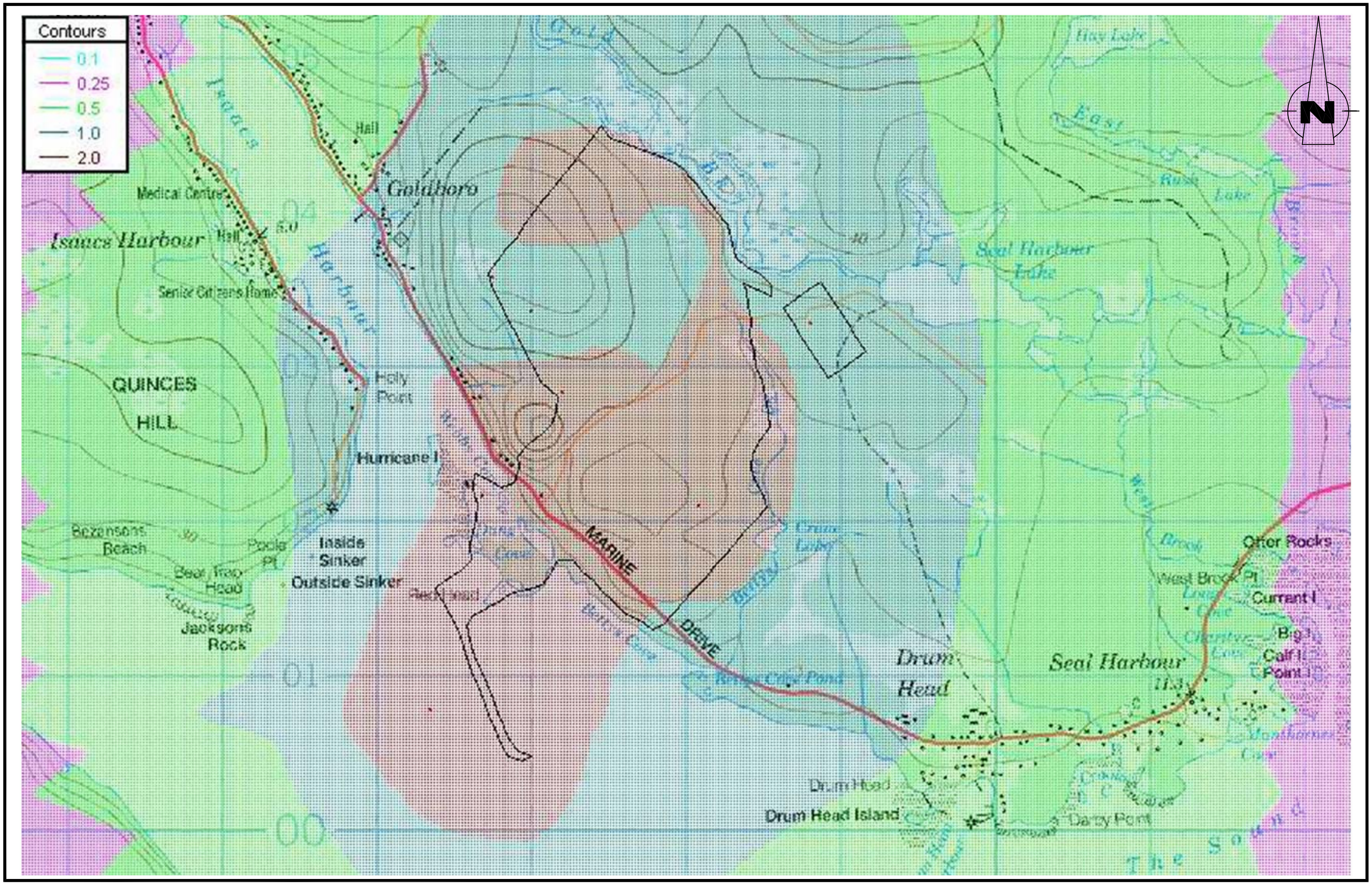


FIGURE No. 9.6-4
KELTIC PETROCHEMICALS INC.
ANNUAL AVERAGE NO_2 IMPACTS
July 2006

FIGURE 9.6-5 Maximum 1-Hour SO_2 Impacts

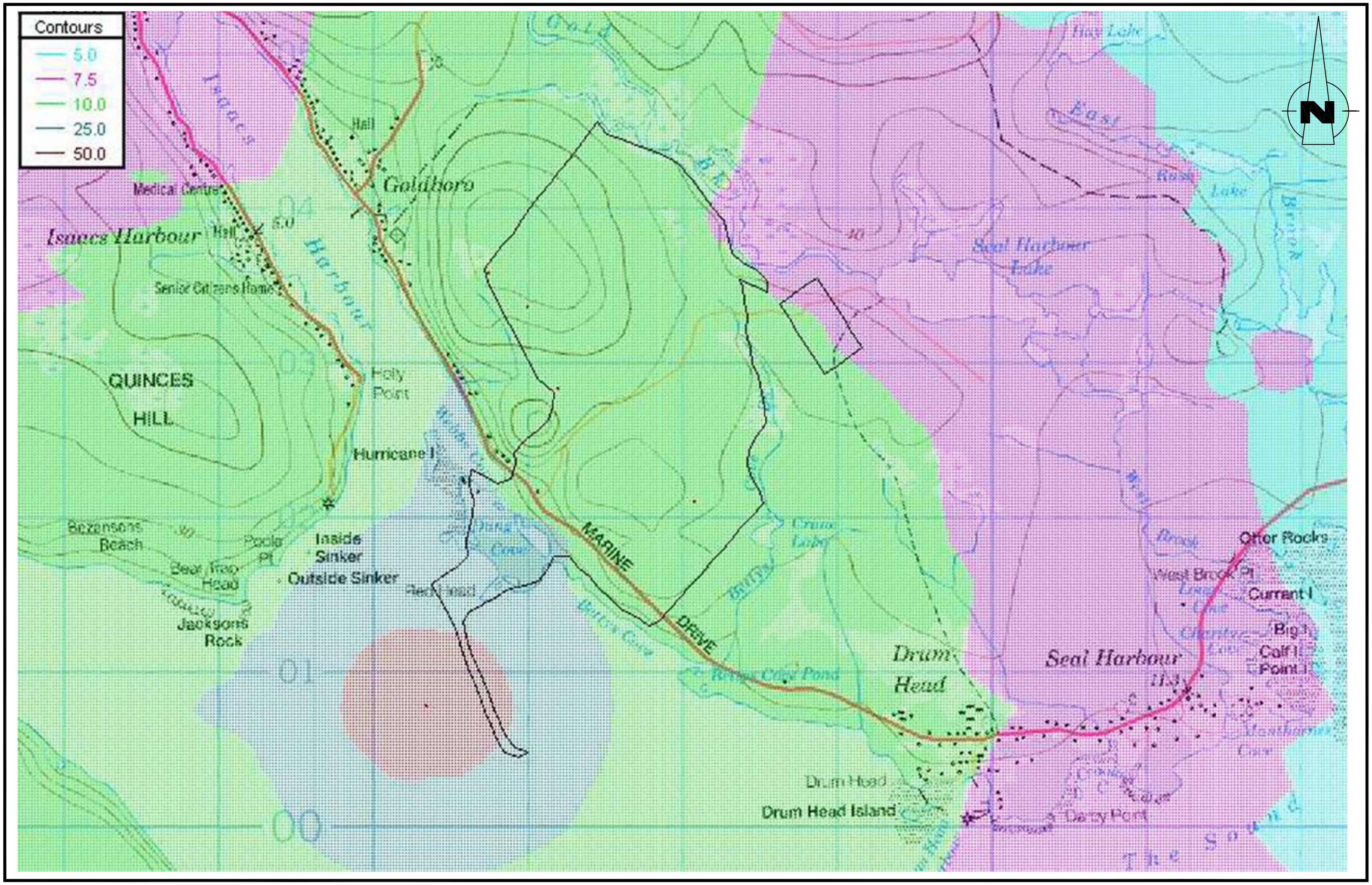


FIGURE No. 9.6-5
KELTIC PETROCHEMICALS INC.
MAXIMUM 1- HOUR SO_2 IMPACTS
July 2006

FIGURE 9.6-6 Maximum 24-Hour SO_2 Impacts

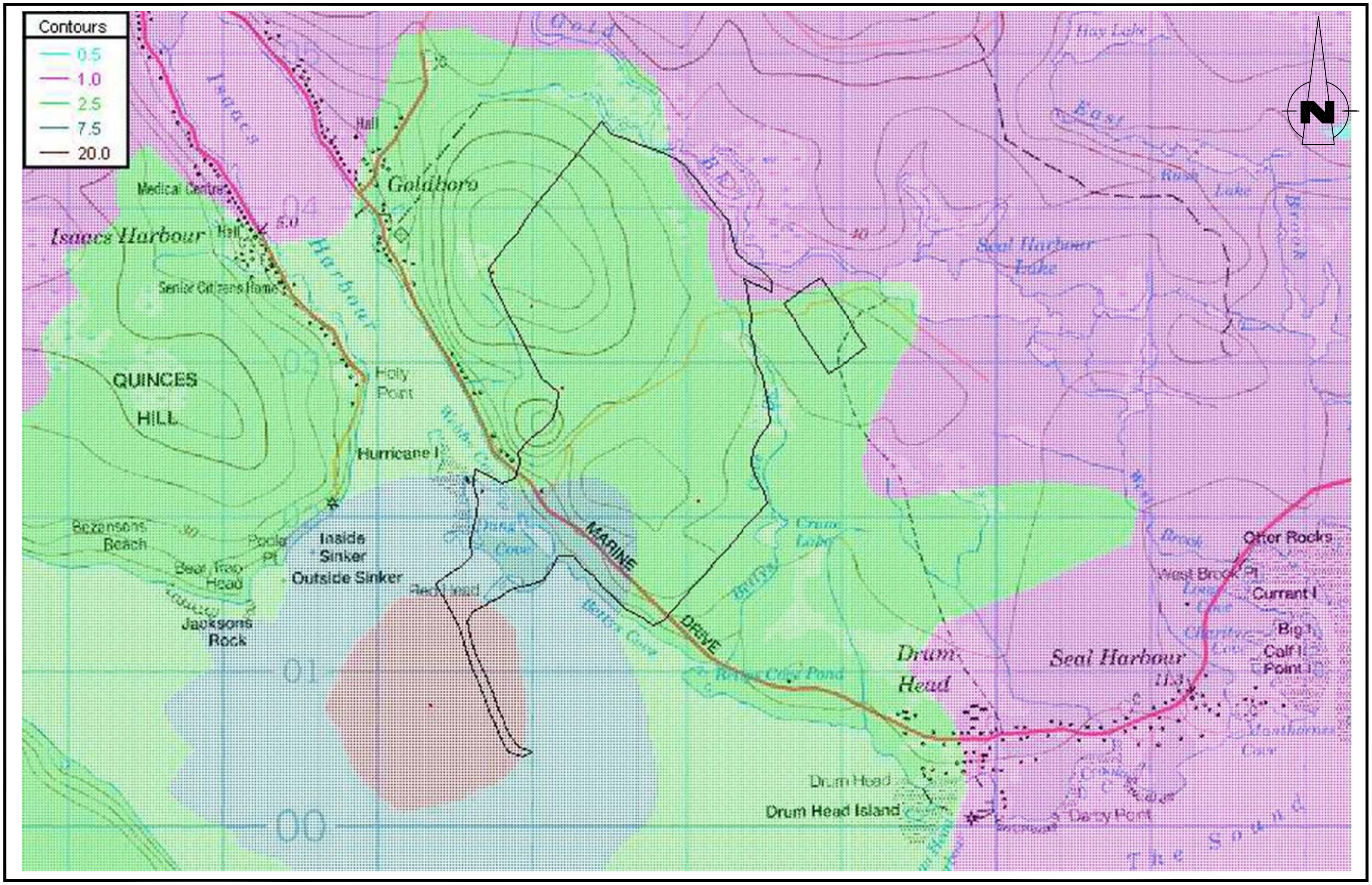


FIGURE No. 9.6-6

KELTIC PETROCHEMICALS INC.

MAXIMUM 24- HOUR SO_2 IMPACTS

July 2006

FIGURE 9.6-7 Annual Average SO_2 Impacts

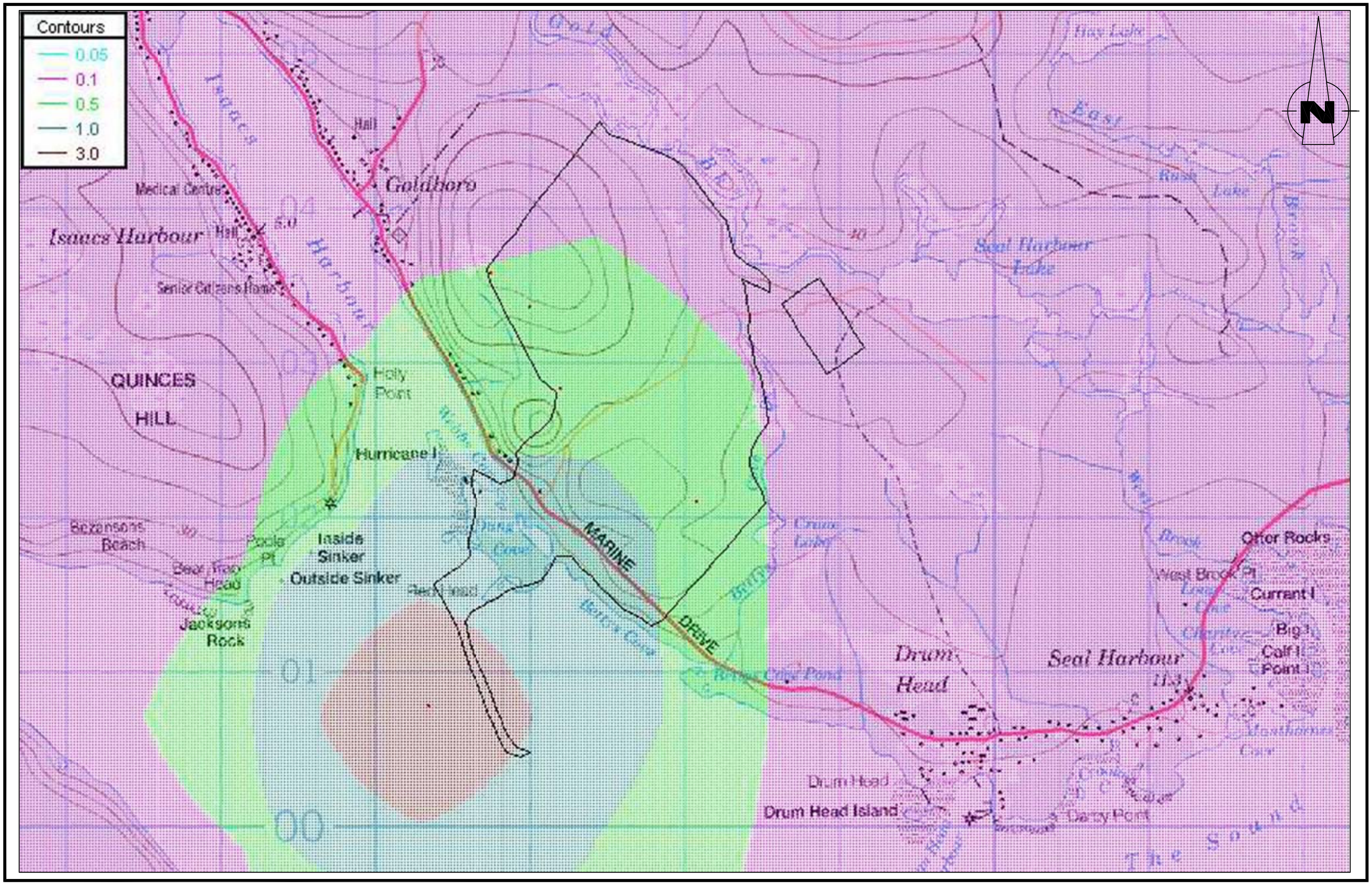


FIGURE No. 9.6-7
KELTIC PETROCHEMICALS INC.
ANNUAL AVERAGE SO_2 IMPACTS
July 2006

FIGURE 9.6-8 Maximum 24-Hour TSP Impacts

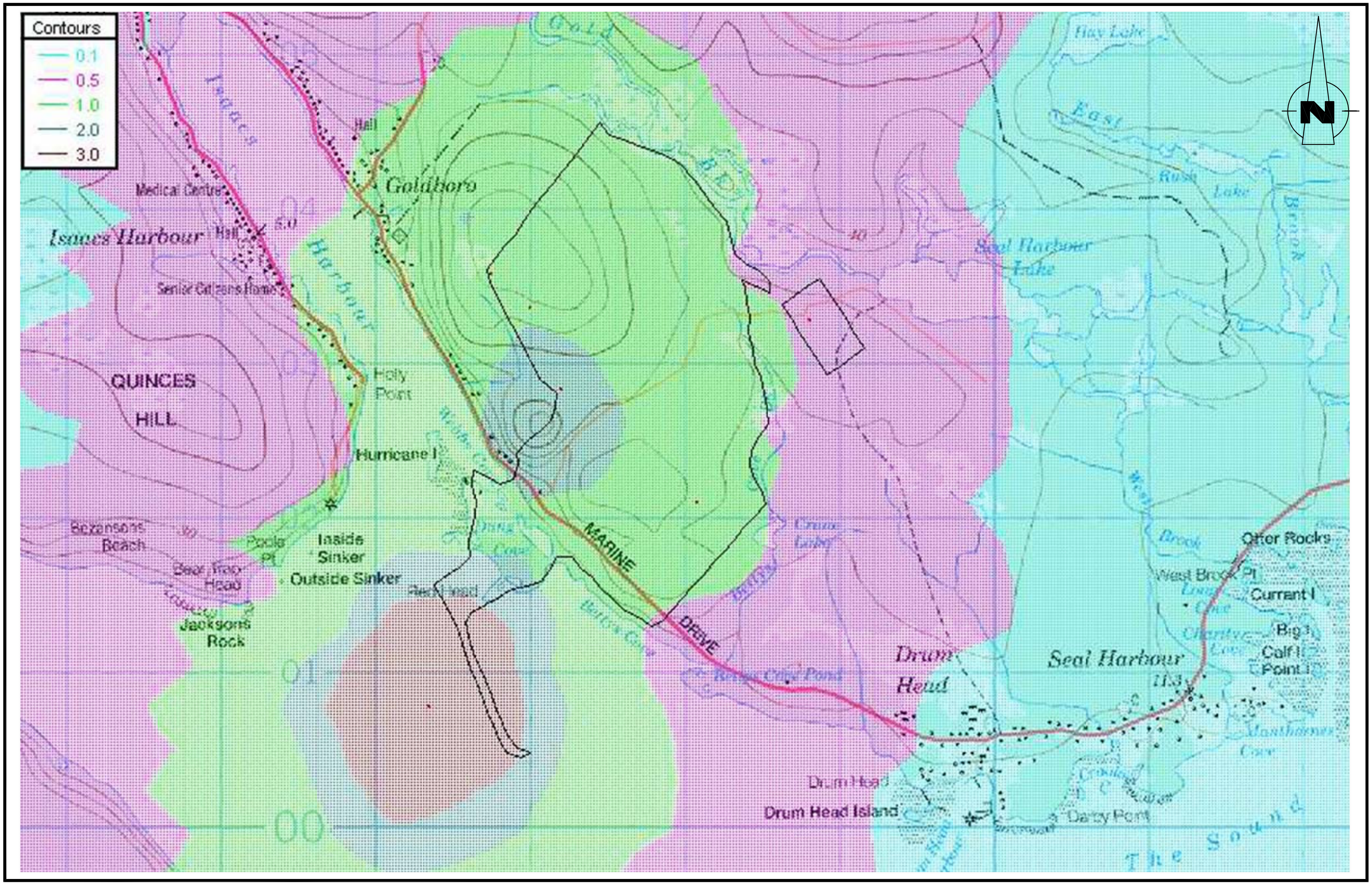


FIGURE No. 9.6-8

KELTIC PETROCHEMICALS INC.

MAXIMUM 24-HOUR TSP IMPACTS

July 2006

FIGURE 9.6-9 Annual Average TSP Impacts

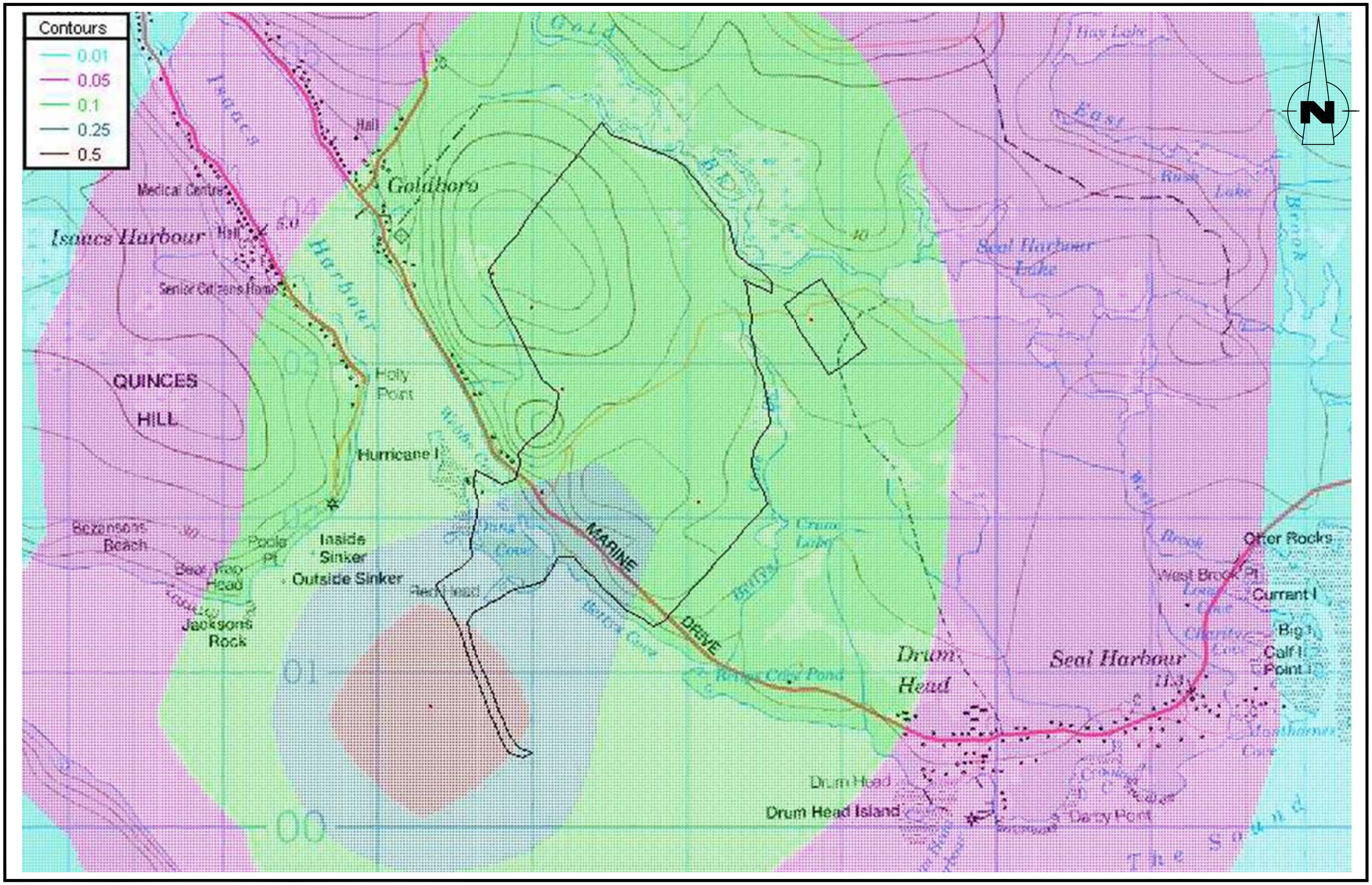


FIGURE No. 9.6-9
KELTIC PETROCHEMICALS INC.
ANNUAL AVERAGE TSP IMPACTS
July 2006

FIGURE 9.6-10 Maximum 1-Hour CO Impacts

FIGURE No. 9.6-10
KELTIC PETROCHEMICALS INC.
MAXIMUM 1- HOUR CO IMPACTS
July 2006

FIGURE 9.6-11 Maximum 8-Hour CO Impacts

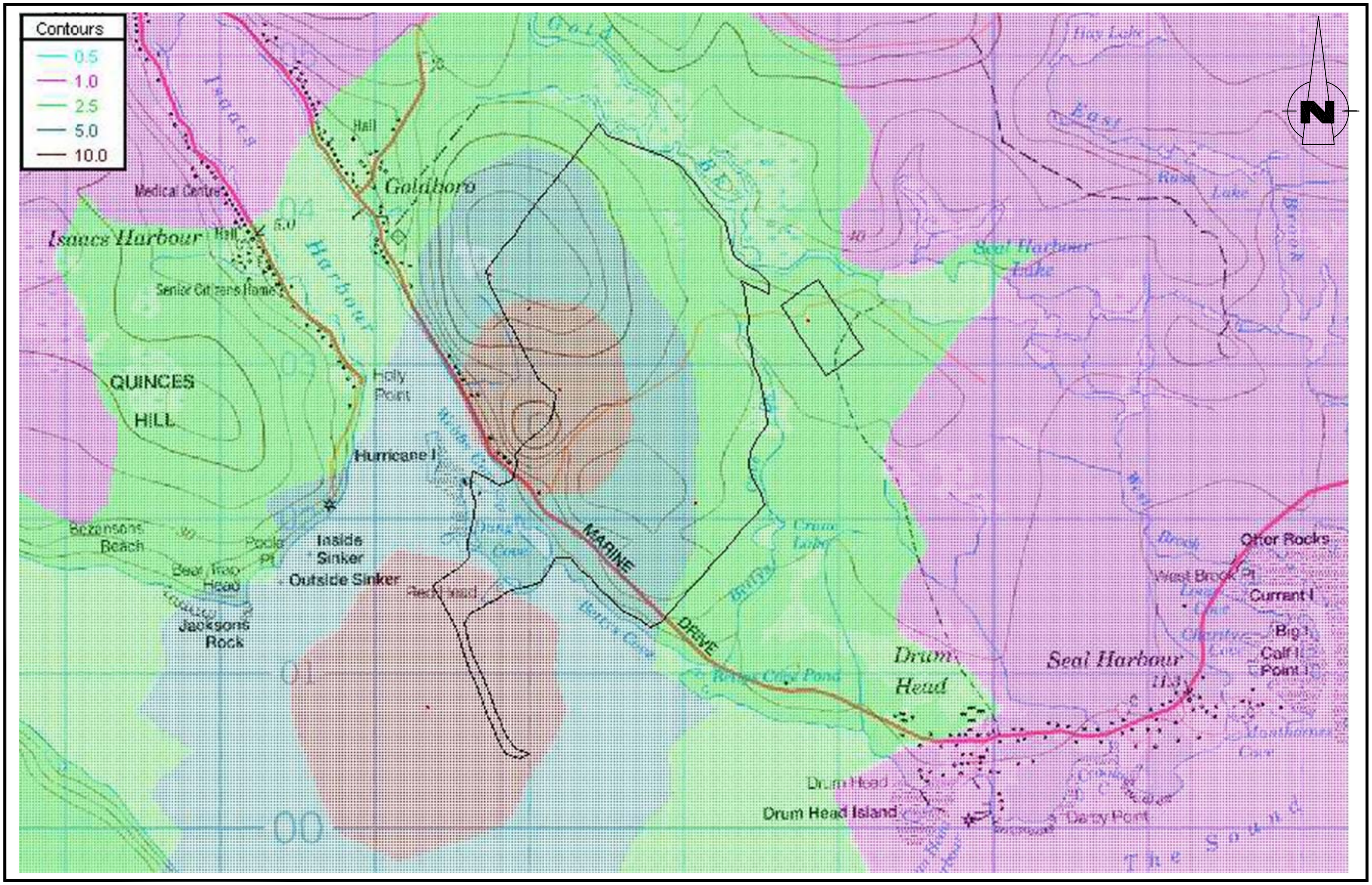


FIGURE No. 9.6-11
KELTIC PETROCHEMICALS INC.
MAXIMUM 8- HOUR CO IMPACTS
July 2006

to past mining activities, and acid precipitation. The total release of SO_2 in Nova Scotia is estimated to be approximately 166,000 t/year according to the NPRI. The relevant emissions from the Keltic operations would only constitute a small percentage of the total for Nova Scotia with respect to SO_2 (0.14%), and 2.8% with respect to NO_x. Furthermore, it is generally well-accepted that more than half of the acid deposition in eastern Canada originates from emissions in the USA as well as from Ontario and Quebec.

The wind rose shown in Figure 9.6-1 indicates that the winds in the region predominate from the northwest through the southwest, meaning that the emissions will most often be carried offshore. Since the chemical reactions that change SO_2 and NO_x to acid rain can take from several hours to several days, it is expected that the emissions will most often be carried well offshore before contributing to acidic precipitation.

With reference to climate change, the facilities main contributor to greenhouse gases will be the 200 MW co-generation plant. However, the release of CO_2 will be greatly minimized when compared to the alternative of taking power off the NSPI grid. Typically, one would expect CO_{2eq} to be approximately 1,000,000 tonnes per year from the 200 MW cogeneration facility, whereas the equivalent from a utility coal-fired plant would be in the order of 1,700,000 tonnes per year (not including allowances for transmission losses). This is due to both the inherent advantages of using natural gas as compared to coal and Bunker C, the avoidance of transmission losses, as well as the energy efficiencies gained from a combined cycle facility. The annual release of some 270 tonnes of VOCs will also contribute to GHGs; however, until specific compound speciation is known, i.e. between methane and non-methane VOCs, the actual CO_{2eq} cannot be appropriately estimated. These figures can be set in the context of Nova Scotia's total annual emissions of approximately 30,000,000 tonnes of CO_{2eq} per year.

9.6.3 Conclusions

The effects on air quality caused by the construction and operation of the plant are not expected to be significant with the mitigation measures described in Table 9.6-6 The site is fairly isolated from the public and the effects of air emissions are expected to be not significant at off-site locations. Effective emission control measures will be employed at all identified emissions sources and will ensure that concentrations of air emissions remain within applicable government standards and guidelines.

The development's contributions to greenhouse gas emissions represents approximately just over 3 % of the province's total annual GHG emissions and will minimized through energy efficient integration of the individual facility components and the on-site power generation via gas-fuelled co-generation plant.

TABLE 9.6-6 Residual Environmental Effects Summary for Air Quality

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects: Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context	Significance**	Likelihood of Occurrence***	Level of Confidence***
Construction										
LNG Facility, Petrochemical Plant, Co-Gen Plant, Infrastructure (Meadow Lake Dam and Intake Structure)										
Emissions of gaseous pollutants from diesel powered construction equipment and marine vessels delivering equipment as well as from private vehicles of workers	A	• Maintaining vehicles and equipment in good working condition; • Minimizing distance between transfer points; • Maintaining speed restrictions on roads; • Promote car pooling	Low	Construction envelope plus adjacent lands and transport routes	Construction Phase	R	Rural setting; sparsely populated; nearest residential receptors 300 to 500 m off site	Minimal		
Fugitive dust emissions from excavating and moving earth, construction equipment , and the concrete batch plant	A	• Cleaning the area around stored materials; • Covering stored materials, if necessary; • Vacuum sweeping or flushing roads; • Applying dust suppressant; • Reducing the working faces of material piles.	Low	Construction envelope plus adjacent lands	Construction Phase	R	Rural setting; sparsely populated; nearest residential receptors 300 to 500 m off site	Minimal		

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects: Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context	Significance**	Likelihood of Occurrence***	Level of Confidence***
Operation										
LNG Facility, Petrochemical Plant, Co-Gen Plant, Infrastructure (Meadow Lake Dam and Intake Structure)										
Emissions from LNG tankers, gas vent stacks, SCVs, and LNG extraction plant	A	• Monitoring and • maintenance of emission control system • Monitoring of • VOCs prior to and during operation • Maximize • efficiency of operations	Low (levels all within applicable regulatory standards)	> 3.5km^2	Construction phase	R	Rural setting; sparsely populated; nearest residential receptors 300 to 500 m off site	Minor		
Emissions from the cogeneration facility simple cycle combustion turbine for power supply	A	• Monitoring and • maintenance of emission control system • Maximize • efficiency of cogeneration plant	Low (levels all within applicable regulatory standards)	> 3.5km^2	operation phase	R	Rural setting; sparsely populated; nearest residential receptors 300 to 500 m off site	Minor		

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance**	Likelihood of Occurrence***	Level of Confidence***
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context			
Emissions from the Petrochemical facility (vents of plants for production of LLDPE, LDPE, and HDPE.	A	• Monitoring and • maintenance of emission control system • Monitoring of • VOCs prior to and during operation • Maximize • efficiency of operations	Low (levels all within applicable regulatory standards)	> 3.5km^2	operation phase	R	Rural setting; sparsely populated; nearest residential receptors 300 to 500 m off site	Minor		
Project contribution to greenhouse gas emissions (CO_2)	A	• Integration individual development component into a highly energy efficient production complex; • Power generation via gas fuelled co-generation plant will reduce emission by 50% compared with drawing energy from the existing provincial grid.	Represents increase of provincial emissions by 3%.	Global	operation phase	R	Greenhouse gasses already represent a significant impact due to large contributions by industrialized countries, and particularly the United States.	Minor		

* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 7
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 7
*** Only addressed for significant effects

9.7 NOISE IMPACTS

As with any major development project, noise from construction activities is an inevitable reality. The well-being and comfort of nearby residents, as well as indigenous wildlife, is a concern. As a matter of good practice, Keltic will develop a noise monitoring program (Section 13.2) that will include routine measurements during construction and operation.

In the absence of particular regulatory requirements, the Nova Scotia Government's "Guidelines for Environmental Noise Measurement and Assessments" will be used as the reference point for adhering to acceptable noise levels during construction activities at the Keltic Site. These Guidelines are noted in Table 9.7-1.

TABLE 9.7-1 Ambient Noise Guidelines

Local Time	Noise Level (dBA)
0700-1900 (day)	65
1900-2300 (evening)	60
2300-0700 (night)*	55

* Includes Sundays and Statutory Holidays

9.7.1 Construction Phase

The construction of Keltic's facility will span a period of some 33 months, and will involve site preparation (blasting, earthmoving, etc.), followed by the erection of major industrial components.

For comparison, a chainsaw at 1m is approximately 110 dB, a busy highway at roadside is 80 dB, conversational speech at 1m is 60 dB and a library is 40 dB.

Table 9.7.2 indicates some typical noise levels for construction equipment.

TABLE 9.7-2 Typical Construction Equipment Noise Levels at 50 Feet

Equipment	Typical Noise Range (dBA)
Loader	74-84
Bulldozer	82-95
Trucks	82-92
Pumps	68-72
Generators	72-80
Compressors	74-83

It is noted that the nearest occupied properties are some 300-500 m from the site boundary lines, and, accordingly, sound pressure levels (noise) will decrease from that point. The inverse square law states that the sound pressure level will decrease by 6 decibels for every doubling in distance from the source of noise. The following formula is used to determine the change in sound pressure levels over a distance:

$$\Delta D = 10 \log (d_1/d_2)^2$$

Where d_1 and d_2 are the two distances and ΔD is the change in sound pressure level in decibels (dB)

Given the above formula, the approximate sound pressure levels for a bulldozer at 300m from the property boundary would be 33-49 dBA. A level of 49 dBA is below the lowest recommended noise level in the NSEL Guidelines presented in Section 9.1. The attenuation formula does not take into account the effect of vegetation, topography, or climatic conditions, which would also affect the noise levels.

It is noted that when several pieces of equipment are operating in proximity to each other, sound levels (in dBA) are not additive. For example, two bulldozers, each with an operating sound level of 82 dBA would be the equivalent of a level of 85 dBA, since 3 dBA represents a doubling of the noise level, a difference that is considered to be barely perceivable to the human ear.

In conducting site construction operations, Keltic will:

1. Ensure that all equipment has appropriate noise-muffling equipment installed and in good working order.
2. Conduct routine noise monitoring at both the site boundaries and nearby occupied properties as appropriate.
3. Restrict intensive construction activities to the hours of 0700-1900 where practical.
4. Ensure that the public has contact numbers for appropriate construction and government personnel in the case of noise issues.
5. Ensure that the public is given adequate prior notice of any blasting activities scheduled to take place.
6. Maintain, where practical, treed buffers between the working site and the public.

There are also concerns as to the impacts from construction activities that generate noise emissions transmitted through the underwater environment.

Although there is not an extensive use of the nearshore waters by cetaceans and seals (Section 8.8.6), these species may be susceptible to damage from the underwater noises generated using conventional pile-driving techniques.

A recent study on bottlenose dolphins showed that pile driving has the potential to negatively affect dolphin populations at a distance of up to 40km. The potential impacts include interfering with communications, foraging, echolocation, and breeding. Possible mitigation includes working during low tide, working outside of sensitive periods, the use of ramped warning signals and masking the noise with bubble curtains (David, 2006).

Keltic also proposes to use alternative construction techniques such as vibratory pile-driving. Additionally, Keltic will confer with both representatives of both the recreational fishery and the commercial fishery in order to develop seasonal and daily activity schedules which will be the least likely to disrupt these activities.

9.7.2 Operation Phase

LNG Terminal

In order to determine potential noise levels during the operational phase of the LNG terminal, similar processes from the LionGas LNG terminal in Rotterdam were reviewed. While somewhat different from the proposed process for Goldboro, the projects are comparable. The noise levels for operation at the Rotterdam project ranged from 94 dB for a BOG cooling system to 145 dB for relief/blowdown valves. Sources like relief/blowdown valves are not continuous and would only be an incidental source. The sources with the highest noise levels were flaring operations and these are periodic or incidental operation. The continuous operations ranged from 94 to 110 with mitigative measures in place such are insulation or noise hoods.

As in the construction phase, noise levels generated from a particular point source would degenerate over distance. The noise levels at 300m from the property boundary generated from the continuous sources would be in the range of 45 dB to 61 dB. The noise levels generated by periodic or incidental sources such as flaring would be between 77 and 96 dB.

Noise impacts on marine mammals during operation is not expected to be significant as most noise generated (i.e. ship engines) would be of a lower frequency than pile driving and other marine construction practices.

Petrochemical Plant

During operation of the plant, the noise is more uniform in nature with most of the plant equipment being run continuously. As with the terminal operation, there will be some upsets (flaring, venting), which have the potential to produce significantly more noise. These are, by their nature, short duration events. Noise sources of the petrochemical plant include: air coolers; pumps; meters; air compressor packages; ground flares; boilers; process units, and; traffic movement.

Noise factors will be considered in the design and selection of equipment and piping by modeling predicted noise levels outside of the property boundaries.

To date, noise predictions at the site boundary are available for the following:

Steam/bfw/condensate sound power level	71
Air systems sound power level	53
Water systems sound power level	43
Storage/truck loading	63
Waste water treatment	60
Cooling systems	75
Common buildings	60

When the Keltic Facility becomes operational (2009), a fully developed noise monitoring program will be implemented to confirm that noise levels at the nearest occupied properties do not exceed the Canadian Mortgage and Housing Corporation (CMHC) recommended Leq (24-hour) of 55 dBA. Mitigative measures for noise impacts during construction and operation are discussed in Section 10.5.1.

9.7.3 Conclusion

Overall effects of noise during the Project's construction and operation phase are not expected to be significant (Table 9.7-3). Stormont Bay is not a significant area for marine mammals. The effects of construction noise on marine mammals therefore are expected to be minimal.

The nearest occupied residences are 300 to 500 m away from the Keltic site. Any project-related noise that reaches these properties will be significantly decreased. Effective noise abatement will be employed to reduce operation-related noise effects at the nearest residential receptors to levels within regulatory guidelines.

TABLE 9.7-3 Residual Environmental Effects Summary for Noise

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects: Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context	Significance**	Likelihood of Occurrence***	Level of Confidence***
Construction										
LNG Facility, Petrochemical Plant, Co-Gen Plant, Infrastructure (Meadow Lake Dam and Intake Structure)										
Disruption of residences around property by site preparation (blasting, earth moving) and construction of industrial components.	A	Ensure machinery has working noise muffling equipment Conduct routine noise monitoring Restrict intensive activity to hours between 700 and 1900 Supply public with contact numbers in case of noise issues Give public prior notice of blasting Maintain treed buffer between worksite and public	Low	Construction envelope (3.5km$^{2)}$ and adjacent lands	Construction Phase	R	Rural setting; sparsely populated; nearest residential receptors 300 to 500 m off site	Minimal		

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects: Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context	Significance**	Likelihood of Occurrence***	Level of Confidence***
Disturbance of marine life through noise emissions transmitted through the underwater environment (from activities such as conventional pile driving) (David, 2006)	A	Alternative techniques for will be used for pile driving such as vibratory pile-driving, adjusting the timing around sensitive periods and conducting driving during low tide. Recreational and commercial fishery representatives will be conferred with to develop seasonal and daily schedules to minimise disruption of fisheries.	Low	Isaac's Harbour/ Stormont Bay	Construction Phase	R	Stormont Bay is not an important marine mammal location	Minimal		
Operation										
LNG Facility, Petrochemical Plant, Co-Gen Plant, Infrastructure (Meadow Lake Dam and Intake Structure)										
Disturbance of nearby residents by noise from plant operations	A	A noise monitoring program will be implemented to confirm noise levels at nearest occupied properties do not exceed CMHC levels.	Low	Plant site ($3.5km^2$) and adjacent lands	Operation Phase	R	Rural setting; sparsely populated; nearest residential receptors 300 to 500 m off site	Minimal		

* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 7
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 7
*** Only addressed for significant effects

9.8 IMPACTS ON SURFACE WATER

The principal interactions between the Keltic Project activities and surface waters are associated with:

- land disturbance during and after construction and commissioning of the plant site facilities;
- wastewater and storm-water discharges during the construction and operation phases of the Project;
- water level changes in Meadow Lake and changes in the flow regime of the receiving Isaac's Harbour River.

The greatest potential for impact to surface waters is expected to be during plant site construction. The largest discharge component by volume is expected to be storm-water both during and after construction. The development of a water supply reservoir at Meadow Lake is also expected to result in changes the surface water regime of the Lake and the receiving Isaac's Harbour River.

9.8.1 Construction Phase

Roadway and plant-site construction, access to work areas, and the preparation of sites for the placement of buildings and other facilities will require:

- the clearing of vegetation and earthworks including grubbing and stripping topsoil and overburden; and
- the placement of excess material in temporary stockpiles which may be susceptible to erosion and result in sedimentation of watercourses adjacent to the site.

Guidelines published by the CCME (1999) recommended that, for the protection of aquatic life, the total suspended sediments (TSS) concentration in surface waters should not increase by more than 10 mg/L where background levels are up to 100 mg/L, and where background TSS concentrations are greater than 100 mg/L, TSS concentrations should not increase by more than 10%. Surface water quality will be monitored throughout both the construction and operation phases (Section 13.3).

Table 9.8-1 summarizes the three principal types of water discharge expected at the Keltic plant site during construction.

TABLE 9.8-1 Principal Types of Water Discharge Expected at the Keltic Plant Site (Construction Phase)

Project phase	Type of water discharge
Construction	Clean and possibly sediment-laden storm-water
	Construction waste water (hydrostatic test waters, concrete wash water, storm-water that has been in contact with uncured concrete)
	Sanitary waste water (worker sites and field offices)

The potential for adverse effects on and off-site water courses during construction are discussed below

9.8.1.1 On-Site Watercourses

The possible effects of run-off during plant site and Route 316 realignment construction have the highest potential to impact surface water, as construction will result in exposing soil to potential erosion. If unmanaged, erosion of site soils can lead to sedimentation of watercourses. Erosion control measures will be implemented as work progresses following the EPP and site grading plans.

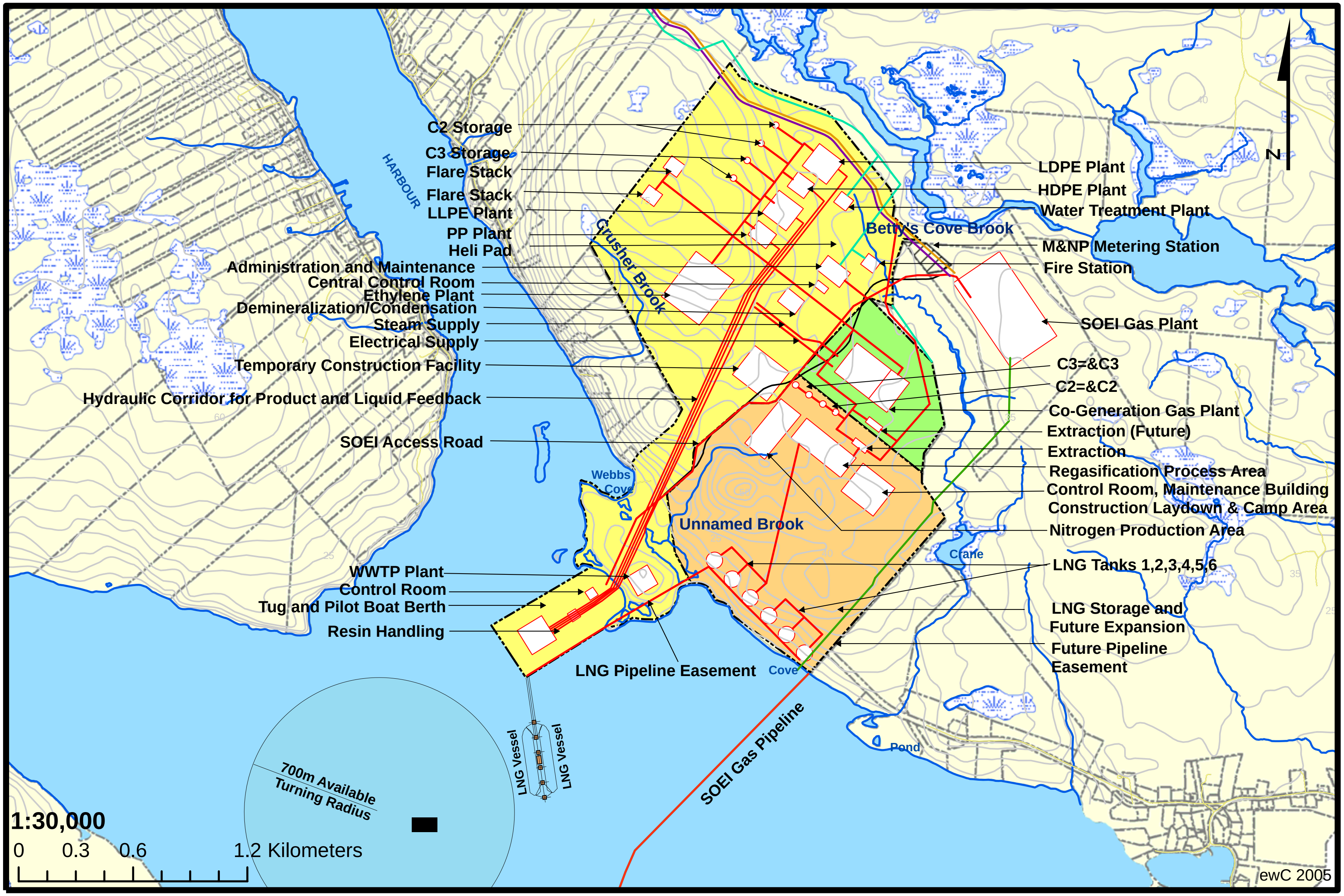
During construction, TSS concentrations in storm-water, residual hydrocarbons, and/or metals in hydrostatic test waters, or the concentration of lime in concrete production waste waters, could exceed the water quality guidelines for the protection of aquatic life published by the CCME (1999).

Mitigative measures (see Section 10.6) will be initiated to address these concerns. Sediment settling ponds will be put in place early during project construction, silt fences and berms will be used as required. Removed vegetation will be replaced, or more likely, process areas will be gravelled or paved and curbed, as soon as practical to minimize erosion and to direct runoff to a storm-water collection system and sediment control ponds. With implementation of these measures, it is expected that impacts to the aquatic environment from sediment-laden storm-water during construction will be minimized. Monitoring during storm events will be undertaken to confirm that the mitigative measures are functioning properly and to identify areas that need to be addressed.

To prevent the migration of construction chemicals into the aquatic environment, guidelines for the storage and disposal of chemicals, fuel and lubricants storage and concrete wash containment will be addressed in the EPP.

There are three tributaries within the Keltic Site – Crusher Brook, the headwater tributary of Betty's Cove Brook, and an unnamed tributary to Dung Cove (Figure 9.8-1).

FIGURE 9.8-1 Plant Facilities and On-Site Watercourses



Legend

- Petrochemical Facilities
- Co-Generation Power Plant
- LNG Facility

FIGURE No. 9.8-1

KELTIC PETROCHEMICALS INC.

PLANT FACILITIES AND ON-SITE WATERCOURSES

JULY 2006

Crusher Brook

A small drainage feature known as Crusher Brook flows from a small bog located near the northwest boundary of the Keltic Site. This first-order watercourse flows initially in a southeastward direction, through abandoned mine workings, and then turns southwesterly where it flows beneath a roadside dwelling before discharging to Isaac's Harbour. Crusher Brook appears to be perennial and is likely spring fed. No fish have been observed or captured in this watercourse throughout any of the surveys performed in 2001, 2004, and 2005.

The footprint of the Keltic plant facilities does not impinge on any part of Crusher Brook. Other than the original natural overland drainage, it is anticipated that the Project will have no discharges of any kind to this watercourse. As well, there will be a minimum 15 m setback (no disturbance zone) between the on-site reaches of this watercourse and any project-related infrastructure. In addition, this watercourse will be protected during construction by a comprehensive set of mitigation measures (See Sections 10.6, 10.11). As such, there are no anticipated effects of the Project on this watercourse.

Betty's Cove Brook

Depending on final site grading plans and construction staging, there may be periodic storm-water discharges to Betty's Cove Brook from one or more temporary sediment ponds during plant site construction (see Section 9.8.2). The storm-water ponds will be sized to accommodate flows from the exposed areas upstream of the ponds and allow for sufficient settling time for sediments. If necessary, flocculant may be added to the pond to enhance settlement prior to discharge. Effects on water quality in Betty's Cove Brook are expected to be minor given the mitigation measures described in Sections 10.6 and 10.11.

Unnamed Tributary to Dung Cove

A small first-order tributary is located within the LNG facility plant site, approximately 75 m east of the SOEI gas-plant road at the closest point. It appears to be spring fed and originates within a former mining and tailings disposal area, flows generally southward to where it crosses Highway 316 and discharges into Dung Cove. In summer, the tributary has been observed to be dry.

Due to its former mining legacy and the possibility of mobilizing contaminated sediments, the headwaters and all other parts of this drainage feature will be avoided. Similar measures described for Crusher Brook will be employed to protect this watercourse. Thus, the footprint of the LNG facility will not impinge on any part of this tributary, and other than original natural overland drainage, the Project will have no discharges of any kind to this watercourse. As with all site watercourses, it will be protected during construction by a comprehensive set of mitigation measures (See Sections 10.6, 10.11). As such, there are no anticipated effects of the Project on this watercourse.

9.8.1.2 Off-site Water Courses

Watercourses near the Project site include the Gold Brook Lake, Gold Brook, and Seal Harbour Lake system (Figure 8.6-1, coastal sub-watershed 1EQ-SD31). The potential for effects on these systems is briefly discussed below. The Isaac's Harbour River system, also in the vicinity of the site, is discussed in context of the Meadow Lake impoundment and associated effects (Section 9.8.2).

Gold Brook

The headwaters of the Gold Brook watershed originate at Oak Hill Lake, a small body of water situated almost midway between Ocean Lake and Meadow Lake. Gold Brook Lake, the largest lake in this system, has two main tributaries, both of which discharge to the lake along the north shore and one of which is the watercourse from Oak Hill Lake. Gold Brook Lake discharges to Gold Brook at Gold Brook Road, near the remains of a former gold mine. Gold Brook flows generally southeasterly to Seal Harbour Lake.

Gold Brook has been the historical receiving water for significant amounts of tailings discharges from the Boston Richardson gold mine. As a result, the sediments in the watercourse are highly contaminated, with levels of arsenic in the range of 1,740 to 59,500 mg/kg, mercury in the range of 2.9 to 5.8 mg/kg, and some elevated levels of lead, chromium, and nickel.

In light of the area's past mining history and the possibility of mobilizing contaminated sediments during periods of high flow, other than the current levels of natural overland flow, Keltic intends to avoid discharging storm-water into Gold Brook. Applying measures to avoid storm-water (controlled drainage) flow toward Gold Brook during and after construction is feasible considering natural site grades.

The footprint of the Project does not impinge on any part of Gold Brook and the Project will have no discharges of any kind to this watercourse. In addition, this watercourse will be protected during construction by a comprehensive set of mitigation measures (See Sections 10.6, 10.11). As such, there are no anticipated effects of the Project on the watercourse.

Seal Harbour Lake

Seal Harbour Lake, located over 300 m east of the closest Project, component, the realignment of Route 316 and receives most of its surface-water contribution from Gold Brook with some smaller tributaries discharging to the lake along its north shore. It is the second largest lake in the Gold Brook watershed and is quite shallow with a maximum depth of about 2 m. From Seal Harbour Lake, water flows by way of East Brook and West Brook to the Atlantic Ocean at Warrington’s Cove and Long Cove, respectively.

The Project will have no discharges of any kind to this water body. In addition, this lake and associated watercourses will be protected during construction by a comprehensive set of mitigation measures (See Sections 10.6, 10.11). As such, there are no anticipated effects of the Project on the water quality or quantity associated with this feature.

9.8.1.3 Construction of Meadow Lake Dam and Water-Intake

The dam proposed for use at Meadow Lake will have a footprint of about 170 m^2 located in existing aquatic habitat The structure leading to the water-intake will consist of approximately 1550 m^2 of rock-lined channel or berm. The entire berm will be situated below all operational water elevations in the new Meadow Lake. The screened intake will consist of three inlets leading to a pump house facility; two in service and one to allow for maintenance (See section 9.15 for a discussion of the effects on fish habitat).

The construction of the dam will require in-water works at the Lake and the receiving Isaac's Harbour River. To protect Meadow Lake and Isaac's Harbour River from being the receiving waters for potential construction-related effects, a range of mitigation measures will be implemented to ensure the protection of these surface-water features (See Sections 10.6 and 10.11). These include measures to control siltation and erosion, appropriate storage of fuel, appropriate operation of construction machinery, among others. With the effective implementation of these measures, there are no expected adverse effects on the water quality or quantity of Isaac's Harbour River or Meadow Lake during the construction phase of the dam and water-intake structures.

9.8.2 Operation Phase

9.8.2.1 Plant Site Discharges and Receiving Waters

Table 9.8-2 summarizes the three principal types of water discharge expected at the Keltic plant site during operation.

TABLE 9.8-2 Principal Types of Water Discharge Expected at the Keltic Plant Site (Operation Phase)

Project phase	Type of water discharge
Operation	Potentially oily storm-water from some process complexes (paved or hard surfaces), process water, cooling water blow down
	Clean storm-water from some process complexes and general areas, either paved (hard surface) and unpaved (soft surface)
	Domestic-type or sanitary waste water (some from process complexes and some from common-user utilities)

9.8.2.2 General Process Wastewater Management

As described in Section 2, the wastewater streams identified in Table 9.5-2 will be treated in a number of ways depending on the source and characteristics of the wastewater stream including: storm-water management ponds, CPI and induced air flotation units; biological treatment such as sequencing batch reactors; and carbon adsorption. Effluents from the demineralization plant, condensate polisher and incinerator QW will be discharged directly, with pH adjustment if necessary, to Isaac's Harbour as these effluents are relatively oil and organics free. At this stage of the project design the treated and untreated effluent quality and quantity have not been specifically determined for the petrochemical plant or the LNG facility. However based on existing operations or comparable projects in detailed design, the effluent quality from the treatment plant may be up to 50 mg/L biological oxygen demand. Keltic will investigate opportunities to optimize the plant to achieve the current Atlantic region standard of 30 mg\L. At maximum capacity (18 BCM/a) the LNG facility will discharge approximately 490,000 m^3/year consisting of purge water from SCVs and cooling water from the BOG compressor. This water consists of non-contact cooling water and normally requires no treatment prior to discharge to marine receiving waters.

9.8.2.3 Storm-water Management – Plant Site Operation

The largest discharge component by volume will be storm-water as much of the site will have gravel or impervious surfaces.

Process areas will be paved and curbed to direct runoff to one or more collectors equipped with a sump and oil and water separator to remove oil and grease from storm-water flows. A storm-water management plan envisages the use of large fire ponds as the primary means to control and treat sediment-laden runoff from the facility prior to being discharged to Betty's Cove Brook Isaac's Harbour. Based on the preliminary layout of the facilities it is expected that much of the storm-water will be directed to Isaac's Harbour.

Controlled drainage from a large land development such as this project may periodically generate large amounts of storm-water discharge to Betty's Cove Brook. Flushing of the watercourse may occur result of the more severe flows experienced during and immediately after storms although the wetland associated with Betty's Cove Brook will likely have an ameliorating effect on the flows. Reduced groundwater recharge in paved areas (thus, reduced stream base flow) may cause drier conditions and longer dry periods between flow events in streams. Although this impact is considered minor in relation to the large watershed of Betty's Cove Brook.

9.8.2.4 Receiving Waters

Following treatment, process and sanitary wastewater will be discharged to Isaac's Harbour using conventional gravity and, if required, forced main systems.

Should the proposed plan to direct the majority of the volume of storm-water to Isaac's Harbour require that storm drains be installed in deep trenches to accommodate site topography, the potential impact of the trenches (which can redirect groundwater flow) on base flows to Betty's Cove Brook will be further investigated. Groundwater and surface water investigations indicated that the groundwater flow is an important contributor to the flows and water quality of the watercourse.

The protection of Betty's Cove Brook was a component of the SOEP development plan for the gas plant indicating the importance the regulatory agencies placed on the watercourse. Therefore, Keltic will take steps to design the facilities to maintain the watercourse's existing water balance such as employing soft-surface practices where practical and proactive management of storm-water ponds to help attenuate storm surges.

Proposed mitigation measures are presented in Section 10.6

9.8.2.5 Operation of Meadow Lake Dam and Water-Intake

Source

Meadow Lake has been identified as the only suitable water body available as a source for process and cooling water for the Keltic Project. It is situated within the lower reaches of the Isaac's Harbour River watershed (Figure 8.6-1, 1EP-1).

The headwaters of the watershed originate in Mile Lake (Figure 8.6-1, 1EP-1E) and Garry Lake (Figure 8.6-1, 1EP-1D) roughly 15 km and 10 km northwest and north of Meadow Lake, respectively. Mile Lake discharges via many small lakes and tributaries located near the Forest Hill gold mining district, through Costley Lake and Costley River to Big Stillwater Lake. Garry Lake and other minor tributaries discharge to Big Stillwater via Garry River. Below Big Stillwater, discharge becomes Isaac's Harbour River, which flows to Meadow Lake. The only other major tributary to Meadow Lake is that from Little Beach Hill and Beach Hill lakes located about 2 km north of Meadow Lake. Meadow Lake discharges to the lower Isaac's Harbour River from where it flows generally southward to its discharge to Isaac's Harbour.

Effects of Flooding

It is expected that the Keltic Facility will require up to 1,200 m^3/hour of freshwater. Section 8.6 describes the capacity of the watershed and Meadow Lake to serve as water supply and maintain downstream flows. Given the anticipated rate of water withdrawal, it will be necessary to impound Meadow Lake to achieve the required storage capacity. This impoundment will raise the elevation of Meadow Lake by 2 m.

The impoundment and elevation of Meadow Lake is not expected to have any adverse effects on the quality of water in the lake. Meadow Lake is relatively shallow, with a maximum depth of about 2 m. With a post-impoundment maximum depth of about 4 m, the water temperature of the lake may be slightly cooler during the summer season. This is not considered a negative effect.

Impoundment of water may result in the increased methylation of mercury in the aquatic environment. The rate of methylation and the potential effects on aquatic biota and other constituents of the food chain (including humans) are known to be affected by factors including the level of organics in the flooded land, the residence time of water in the reservoir, the species present, etc. To minimize the potential for mercury methylation as an environmental or human-health issue, much of the surficial organic material in the flood zone will be removed before impoundment. In addition, the hydrology of the reservoir and the watershed are such that there will be a residence time of only about 6 days for water in the impoundment. In other words, the reservoir will be continually “flushed”, with the result that the risk of mercury accumulation in the Meadow Lake environment is extremity low.

The impoundment of Meadow Lake will also flood the lower reaches of the nine tributaries discharging to the lake. The length of each tributary affected by flooding is summarized in Table 9.8-3 and illustrated in Figure 9.8-2.

TABLE 9.8-3 Meadow Lake Tributaries and Incremental Length Flooded

Tributary (see Figure 9.5-1)	Incremental Length Flooded (m)
1	380
2	475
3	50
4	300
5	280
6	550
7	380
8	55
9	840
Total	3,310

9.8.2.6 Inter-Watershed Transfers

Water withdrawn from Meadow Lake (Figure 8.6-1, watershed 1EP-1) will be piped straight to the plant site and disposed of either as cooling vapour to the atmosphere, or within the treated wastewater stream directly to the ocean via forced and gravity mains. This is where the water from Meadow Lake would typically arrive if it were allowed to flow naturally via the Isaac's Harbour River so it does not constitute an inter-watershed transfer The proposed Keltic plant site partially overlies two separate watersheds (Figure 8.6-1, 1EP-SD1 to the southwest, and 1EQ-SD32 to the northeast) however, plant site grading may alter surface run-off direction and the watershed boundaries but it is not anticipated that these changes will constitute an inter-watershed transfer.

9.8.3 Conclusion

During construction and operation, impacts on surface water (freshwater) resources on and off-site are expected to be not significant as effective mitigation measures are available to minimize construction impacts that are related to erosion, sediment loading, and contamination resulting from accidental spills, fuel storage and handling.

Operation-related effects will be minimized through an on-site waste water treatment system. This system will ensure that discharges from any components of the development will be treated to applicable federal and provincial standards, guidelines, and objectives prior to discharge. Monitoring of effluent quality will be implemented to ensure effectiveness of the treatment process.

TABLE 9.8-4 Residual Environmental Effects Summary for Surface Water

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects: Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context	Significance**	Likelihood of Occurrence***	Level of Confidence***
Construction										
LNG Facility, Petrochemical Plant, Co-Gen Plant, Infrastructure (Meadow Lake Dam and Intake Structure)										
Effects on On-site Watercourses (erosion, sediment loading, storm-water discharges, spills)	A	Erosion and sediment control plan Buffer zone Storm-water management plan Spill prevention and response plan Designated fuelling and material storage site	Three on-site water courses	350 ha (Project site)	Construction Phase	R	Small, local drainage systems	Minimal		
Effects on off-site Watercourses through site (erosion, sediment loading, storm-water discharges, spills)	A	See above	Gold Brook and Seal Harbour Lake	Limited to brook and lake	Construction Phase	R	Part of small, local drainage systems	Minimal		

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects: Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context	Significance**	Likelihood of Occurrence***	Level of Confidence***
Effects on Meadow Lake and Isaac's Harbour River through in-water works and dam and onshore works for dam and intake structure (erosion, sediment loading, storm-water discharges, spills)	A	See above, plus Construction of cofferdam In-water works outside of spawning / fish migration season Use of silt curtains Rehabilitation of shoreline upon completion	Meadow Lake; Isaac's Harbour River	Limited to river and lake	Construction Phase	R	Small, local drainage systems	Minimal		
Operation										
LNG Facility, Petrochemical Plant, Co-Gen Plant, Infrastructure (Meadow Lake Dam and Intake Structure)										
Effects on - and off-site surface water quality as a result of discharges of Storm-water Process water Sanitary waste water	A	Implementation of storm-water management plan On-site waste water treatment plant to collect and treat all waste water streams Controlled discharge point(s) Monitoring of discharge quality	Low with management measures	Three on-site water courses;	Operation Phase	R	Some sediments contaminated due to historic mining activities	Minor		

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance**	Likelihood of Occurrence***	Level of Confidence***
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context			
Effects on Meadow Lake and Isaac's Harbour hydrology (water levels, fluctuations, flow) as a result of water withdrawal and impoundment of Meadow Lake	A	Maintain minimal flow conditions in Isaac's Harbour River	1,200m^3/hr freshwater withdrawal; 2m max water level increase following impoundment	Meadow Lake; Isaac's Harbour River	Operation Phase	R	No sensitive uses at Lake or along Isaac's Harbour River	Minor		
Inter-watershed water transfer (resulting potentially in changes in hydrology and water quality)	A	Discharge of collected storm-water within respective watershed Water withdrawn from Meadow Lake to be discharged to Isaac's Harbour / ocean (= ultimate receiver under baseline conditions)	1,200m^3/hr freshwater withdrawal; Storm-water quantities tbd.	350 ha (Project site); Isaac's Harbour	Operation Phase	R	Not identified as a concern in the area	Minimal		

* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 7
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 7
*** Only addressed for significant effects

9.9 IMPACTS ON GROUNDWATER

The issues regarding the quality and quantity of groundwater are the effects that the plant construction and operation may have on water supply wells, and the effects that changes to the groundwater regime may have on surface water bodies, streams, and wetlands adjacent to the Project.

Groundwater quality or quantity effects may often be of long duration. Unlike surface water, where sun, exposure to air, wind, and wave action may help to break down or disperse deleterious substances introduced to a stream or lake, the dark and cold conditions present in the subsurface are generally conducive to the long-term preservation of many substances. Thus, deleterious materials introduced into the subsurface aquatic environment may remain there for long periods of time, and once adsorbed to soil and rock, may serve as a long-term source of material to be dissolved into groundwater. These dissolved materials may in turn be introduced to surface waters via base flow and discharge to wetlands, thus possibly affecting those environments as well.

The field reconnaissance indicates that there are approximately 40 wells located within 1 km of the Keltic Site boundaries. There are also three streams within the site boundaries (Betty's Cove Brook, Crusher Brook and the unnamed tributary to Dung Cove) which may have groundwater supplies interrupted by excavation associated with site preparation and construction.

Based on the projected gravitational groundwater flow lines shown in Figure 8.7-3, possible surface water receptors could include Gold Brook, Betty's Cove Brook, Crusher Brook, associated wetlands, the unnamed tributary to Dung Cove, Dung Cove, and Isaac's Harbour. Possible receptor wells, depending upon the final site configuration, are likely to include wells west of the site within a zone that extends along Highway 316 for a distance of approximately 1 km north of the gas plant road; the degree and significance of which would depend on the exact locations and nature of the source, well type, nature of the surficial and bedrock geology present between the source and the well, and distance to the well. Depending upon facilities locations, other wells north of this zone could, to a lesser degree, also become receptors.

9.9.1 Construction

The main considerations with respect to impacts on water supply wells from the Project during construction include:

- blasting and vibration damages, with consequent temporary siltation (for dug and drilled wells) and possible permanent reduction in well yield (for drilled wells) during construction;
- trenching, site drainage and large cuts or changes in surface topography, could result in water level reductions during and after construction (dug well effects); and
- accidental release of fuel chemicals due to equipment failure during site preparation and construction.

The severity of the water supply well impacts are expected to be a function of well type (spring, dug well, drilled well), age of the well, well construction method, distance from the site boundaries, overburden thickness and the hydraulic properties of the soil and bedrock. The effect of deep trenches to nearby wells and streams may also be reduced by placing low-permeability plugs within the trenches to prevent large-scale groundwater flow and drainage within the gravel backfill placed in trenches.

With respect to groundwater quantity, the main concerns related to plant site construction are:

- potential loss of well yield or lowered water level in dug wells (this is not expected to be significant due to the relative distance and small number of wells involved);
- possible damage to, or loss of drilled wells during blasting operations; and
- possible reduction in base flow at on-site streams and reduced (or increased) discharge at wetlands.

With respect to groundwater quality, the main concerns related to plant site construction are:

- chemistry changes in down-gradient wells due to uncontrolled runoff;
- temporary siltation of dug wells during heavy equipment operations; and
- accidental release of hazardous materials up-gradient of wells or streams.

There are locations within the proposed plant site, which may, or are known to, sulphide mineralization, particularly along the lower part of the SOEI gas plant access road and in the southwest and northeast portions of the Keltic Site. Contamination of wells and/or on-site streams from acidic drainage due to the exposure of acid generating rock may be a concern in these areas, however, Keltic will be undertaking an assessment of the bedrock as part of the geotechnical site investigation.

The effects of groundwater on surface water bodies and streams adjacent to the Project include stream dewatering which may be caused by deep and/or large-scale site drainage, and possible leakage at the dam at Meadow Lake and ensuing rise of groundwater levels before the dam and its effect on shore-line vegetation. See Section 10.7 for a discussion of proposed groundwater mitigation and Section 13.4 for the groundwater monitoring program.

9.9.2 Operation

The main considerations with respect to impacts on water supply wells from the Project during operation include:

- salt contamination from on-site roadways; and
- accidental (acute) and chronic spills and release of chemicals, and possible releases due to fires, during plant operation.

As with the construction phase, the severity of the water supply well impacts will be a function of well type, age of the well, well construction method, distance from the plant site boundaries, overburden thickness and the hydraulic properties of the soil and bedrock. With regard to groundwater quantity, the main concern is potential loss of well yield or lowered water level in dug wells. With respect to groundwater quality, the main concerns related to the operation of the plant include:

- chemistry changes in down-gradient wells due to uncontrolled on-site road runoff; and
- chronic and acute accidental release of hazardous materials up-gradient of wells or streams.

The potential for well contamination from acidic drainage should be considered low so long as the rock, if present, is managed to prevent exposure to water or oxygen.

The effects of groundwater on surface water bodies and streams adjacent to and within the site boundaries, which include stream dewatering (caused by deep and/or large-scale site drainage during construction), and possible leakage at the dam at Meadow Lake, are not expected to change from conditions possibly arising from the construction phase.

9.9.3 Conclusion

The effects on groundwater quality, groundwater flow, and base flow conditions in the area caused by the construction and operation of the plant are not expected to be significant. Effects on well water supply and quality depend on the type, age, and construction method of the wells as well as the distance from the plant, the overburden thickness, and the hydraulic properties of the soil and bedrock the wells are in. Effective mitigation measures have been put in place to deal with potential problems and are summarized in Table 9.9-1 and Section 10.0.

TABLE 9.9-1 Residual Environmental Effects Summary for Groundwater

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects: Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context	Significance**	Likelihood of Occurrence***	Level of Confidence***
Construction										
LNG Facility, Petrochemical Plant, Co-Gen Plant, Infrastructure (Meadow Lake Dam and Intake Structure)										
Siltation of dug and drilled wells and possible permanent decrease in well yield of drilled wells from blasting and vibrations	A	• Avoid blasting to the extent possible within 500m of residential wells • Pre-blast well survey Remedial action as necessary to restore damaged wells and/or provide temporary potable water as needed	40 wells within 1 km of site	>350 ha (>Project site)	Temporary (dug and drilled wells) possibly permanent (drilled)	R/NR	Vacant Project site; sparsely populated area	Minimal		
Water level reductions in dug wells as a result of trenching, site drainage, and large cuts or changes in surface topography.	A	Monitoring and remedial action as necessary to restore damaged wells and/or provide temporary potable water as needed.	40 wells within 1 km of site	>350 ha (>Project site)	Construction Phase	NR	Vacant Project site; sparsely populated area	Minimal		

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance**	Likelihood of Occurrence***	Level of Confidence***
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context			
Water quality degradation from accidental release of fuel chemicals (equipment failure; handling accident)	A	• Proper fuel management Application of EPP Monitoring and local remedial action as necessary	Three on-site water courses; one downstream water course below Meadow Lake dam	On-site water courses and Isaac's Harbour River (downstream receiver of Meadow Lake)	Construction Phase	R	Water courses with little to no importance for local fisheries and water supply	Minimal		
Reduction of flow in streams and reduced discharge into wetlands during of Meadow Lake dam construction	A	Assess specific site hydro-geologic characteristics Dam construction method to provide for continuous minimal flow in Isaac's Harbour	Isaac's Harbour River	Isaac's Harbour River	Construction Phase	R	Isaac's Harbour River with little to no importance for local fisheries and water supply	Minimal		
Contamination of wells and/or onsite streams from acidic drainage in areas of known sulphide mineralization on site	A	Avoidance of mine tailings within the Project site	40 wells within 1 km of site; three on-site water course	>350 ha (>Project site)	Construction Phase	R	Vacant Project site; sparsely populated area; Acid generating mine tailings identified so far are off-site	Minimal		

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects: Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context	Significance**	Likelihood of Occurrence***	Level of Confidence***
Operation										
LNG Facility, Petrochemical Plant, Co-Gen Plant, Infrastructure (Meadow Lake Dam and Intake Structure)										
Degradation of surface and groundwater and well water quality due to accidental spills	A	• Proper management of fuel, product and material storage and handling Application of EPP Monitoring and local remedial action as necessary	Three on-site water courses; 40 wells within 1 km of site;	Three on-site water courses; for wells: >350 ha (>Project site)	Operation	R	Water courses with no importance for local fisheries and water supply; Project area sparsely populated	Minimal		
Contamination of wells and/or onsite streams from acidic drainage in areas of known sulphide mineralization on site	A	n/a; interaction unlikely as site construction site surfaces will be stabilized and rehabilitated	NA	NA	NA	NA	NA	NA		

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance**	Likelihood of Occurrence***	Level of Confidence***
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context			
Reduction of flow in Isaac's Harbour River and reduced discharge into wetlands as a result of Meadow Lake dam operation	A	Assess specific site hydro-geologic characteristics Dam operation to provide for continuous minimal flow in Isaac's Harbour River Operation to provide for alternative water supply source during extended dry weather periods	Isaac's Harbour River	Isaac's Harbour River	Operation Phase	R	Isaac's Harbour River with little to no importance for local fisheries and water supply	Minimal		

* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 7
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 7
*** Only addressed for significant effects

9.10 IMPACTS ON FLORA, FAUNA, AND TERRESTRIAL HABITAT

A discussion of potential impacts for the construction and operational phases of the plant site, terminal area is presented below. Recommended mitigation measures for these impacts are presented in Section 10.8. The proposed terrestrial habitat monitoring program is outlined in Section 13.5.

9.10.1 Construction Phase

Habitat Removal

Habitat removal will result effectively in a loss of up to approximately 380 ha of vegetation and associated wildlife habitat on the plant site. In spite of a great deal of disturbance (past and present clear-cutting and past mining activity), much wildlife habitat remains, including some wetlands. Effects on wetlands are discussed in detail in Section 9.12. While not all of the area may be involved, it and surrounding areas will be affected to some degree. Habitat removal during the breeding season for vertebrate wildlife forms, roughly April through July, can have deleterious effects on wildlife populations. Much of the approximately 47 ha of the terminal area and adjacent coastal strip will be similarly affected.

Vegetation

Vegetation loss is a large component of habitat loss as described above. Habitat disturbance from construction activities will undoubtedly encourage colonization of non-native plants, as has already occurred on the site to some degree (see Section 8.8, Tables 8.8-1 and 8.8-2). Also, clearing may expose the forest profile in adjacent areas, altering wind, temperature, and light regimes resulting in some die-off and reduced growth until edge vegetation matures.

Rare Plant Species

A single rare plant species – a horsetail (*Equisetum variegatum*) was found on the plant site near the junction of Sable Road and Highway 316. This site possibly could be disrupted during construction, but proposed plans suggest this is not likely. A large population of this species is at Goldbrook Lake, and it probably is in other neighbouring places as well.

Wildlife

Habitat removal will result in loss of associated wildlife. Those forms that can move easily may move to similar habitats elsewhere. Successful survival may depend on the number of individuals of the same or closely related species already in those habitats. Without question there will be some loss of all wildlife forms currently inhabiting the site areas.

Amphibians

Some loss of habitat is expected especially in the wetter areas such as Map Sites 4 and 5 (Figure 8.8-1) and Dung Cove Pond in the terminal area.

Reptiles

Loss of habitat will affect snakes throughout, and possibly turtle habitat in Dung Cove Pond in the terminal area.

Birds

Pipeline construction is planned to occur on the beach and dike at Betty's Cove. This is important habitat for migratory and resident shorebirds; greater yellowlegs breed here and at Map Site 2 (Figure 8.8-1) in 2005. The main impact on raptors would be removal of prey habitat on both sides of Highway 316, potentially up to 400 ha. The site also includes a small portion of short-eared owl habitat (short-eared owl is a COSEWIC species of special concern). Up to 400 ha of woodland and woodland edge bird habitat may be removed. Most of the site has been cleared recently (i.e. in the past 5-15 years).

There may be some minor effects on waterfowl that spend time along the marine shore in the terminal area due to blasting. Other construction activity may have some minor effect on waterfowl in the adjacent Gold Brook wetland at Map Site 11.

Sea birds nest on Goose, Harbour, and Country Islands offshore. Gulls, cormorants, and eiders nest on Goose and Harbour Islands. Of these, eiders represent some concern, but they are sufficiently distant from the site that no impacts are anticipated. The roseate tern colony on Country Island is of special concern (Leonard et al, 2004), but the distance of over 9.0 km is sufficiently great that no problem is anticipated.

Mammals – A number of furbearers are on-site. The aquatic furbearers, mink, muskrat, beaver, and otter are on the terminal area around Dung Cove Pond and associated wetland. Habitat removal and disturbance may result in some or all of these being extirpated from the area.

Impact on small mammals is mainly related to loss of habitat. There are no rare or otherwise unique species expected in the area.

The most concentrated winter deer activity observed was at the terminal area (See Figure 8.8-1). Clearing and construction activities are expected to have a major impact, in all likelihood reducing or eliminating winter use by deer.

Mainland moose (endangered) is not known to be in vicinity of site, so no impact is anticipated.

Dust

Dust will inevitably be generated during construction activities. The main impact is expected to be a slight contribution to sediment-loading which marginally may affect some amphibian habitat. Also, dust on leaf surfaces of nearby vegetation may have a temporary inhibiting effect on the processes of photosynthesis and transpiration (Farmer, 1993).

Noise Effects

Construction noise, in addition to being associated with habitat removal, may have some deleterious effect on animals in adjacent areas. Flushing of nesting birds may result in decreased productivity from such factors as increased nest predation and changes to less favourable nesting sites (Interior Waste Authority, 1994). The data regarding effective distance due to noise disturbance are relatively few and conflicting, with various field studies showing effects from edge of area of disturbance to 200 m. The distance of effect is of course related to noise volume and quality. The effects of noise on the site due to construction are expected to be short-term. Recommended mitigation measures for these construction impacts are presented in Section 10.8.1.

9.10.2 Operation Phase

9.10.2.1 Project Site

Vegetation

The greatest impact to vegetation during operations is thought to be the establishment of non-native plants resulting from soil disturbance during construction.

Amphibians

Amphibians are likely to be affected, other than by habitat removal, only if drainage patterns are changed and/or if there is a significant change in water quality from operational procedures.

Reptiles

During operation, no significant impact on reptiles are expected.

Birds

There is expected to be an increase in birds that are especially compatible with human activity; i.e. starlings, robins, grackles, cowbirds, rock doves, some of which are nest predators and may otherwise compete with woodland and edge birds.

There may be some concern about shipping activity and disturbances to the roseate tern colony on Country Island, but this is not likely a problem. There are shoals around Country Island that would be avoided by LNG tankers; recently, a shrimp boat was grounded near Country Island with no adverse affect on the roseate tern colony (A. Boyne, pers. comm.). No impacts are expected during standard operations.

Migratory Birds

These types of lights may impact upon migrating birds; however, the extent of the impact cannot be forecasted at this stage. The number of birds killed may vary from a large number per night in collision with high towers (Ornithological Council, 1999) to only a few striking household windows. Klein (1990) indicated that collision with household windows, in one instance, resulted in 26-33 birds being killed annually, and that greater than one-half of bird strikes at lighted windows were fatal. Johnston and Haines (1957) recorded thousands of bird-lighted-object deaths in Georgia; most if not all species they reported have been observed in the Keltic Study Area. Mortality is greatest with lighted towers (i.e. 70 m in height), and less with lights near ground level.

The LNG Terminal and the Marginal Wharf area will of necessity be well-lit with high intensity lighting at night, and although the lighting will be directed as narrowly as possible on the work areas (wharf and vessel), these lights will be visible to residents in the vicinity of Goldboro and Isaac's Harbour. In addition, during construction of these facilities, the potential for unavoidable light (direct or reflected) hitting the water exists, and may have some effect on fish activity in the immediate area, although the long-term effects should not be significant. These construction activities will be the focus of some consultation with both recreational and commercial fishery representatives in the area. Mitigative measures for noise impacts during construction and operation are discussed in Section 10.5.1.

Mammals

Increased human activity will have a depressing effect on most mammal populations that remain after construction. Also, increased human activity will encourage some forms such as raccoons and skunks. The furbearers and wintering deer populations on the terminal area may cease to exist; deer may winter elsewhere along the coast toward Drum Head and Seal Harbour. Recommended mitigation measures for operation phase impacts are presented in Section 10.8.2.

9.10.2.2 Meadow Lake

Approximately 295 ha of habitat/vegetation will be removed including coniferous stands (39%), wetlands (38%), brush/barrens (17%), raised bog (4%), and intolerant hardwood/conifer mixed stands (2%) (See Table 8.8-1, Section 8.8.3). The major loss to inundation will be terrestrial vegetation and associated wildlife. Nest sites of common loon, common merganser, and ring-necked duck will be displaced, but it is speculated that all three species will find new nesting sites on the lake shore.

The newly inundated area will provide a source of nutrients and habitat complexity that may result in increased populations of some fish, invertebrates, and amphibians, at least in the short-term. This has to be traded off against reduced dissolved oxygen, increased temperatures in shallow water and increases in toxicity. It is speculated that there will be an increase in prey communities in shallow water that will benefit some predators such as great blue heron and belted kingfisher (see Section 9.12.2).

The lake was dammed previously for logging (date not known) with little adverse affect detected over the long term.

Data on affects of dams generally demonstrate a decrease in aquatic biodiversity (McAllister et al., 2001). Effects on waterfowl are variable. Data regarding effects on terrestrial fauna seem generally to be lacking, but certainly there will be a considerable loss due to habitat removal.

Effects on wetlands are discussed in detail in Section 9.12. Recommended mitigation measures for the impoundment of Meadow Lake are presented in Section 10.8.3.

9.10.3 Conclusion

The impact of the Project on the terrestrial environment is not expected to be significant. Most adverse effects are associated with the construction phase when vegetation communities and habitats are removed and associated wildlife disrupted. The development will affect only vegetation communities and habitat that are frequent within the surrounding area, thus offering replacement habitat for wildlife currently present on-site. Through vegetation clearing outside of the bird breeding season, effects on migratory birds will be minimized. During the plant operation, lighting may cause adverse effects on migratory birds. The site location, however, is not considered to be of particular significance to migratory birds.

TABLE 9.10-1 Residual Environmental Effects Summary for Flora, Fauna, and Terrestrial Habitat

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance**	Likelihood of Occurrence***	Level of Confidence***
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context			
Construction										
LNG Facility, Petrochemical Plant, Co-Gen Plant, Infrastructure (Meadow Lake Dam and Intake Structure)										
Habitat Removal	A	Minimize construction envelope Rehabilitate all temporarily used sites	Medium	Project Site (350 ha)	Permanent	NR	No designated/protected lands involved	Medium		
Vegetation Disruption/destruction (?) of site of rare plant species (*Equistem variegatum*)	A	If site is affected, replanting should be considered	Low	Small portion of Project site	Permanent	NR	Not protected under SARA Schedule 1; Species frequent in near-by locations	Minimal		
Displacement / Loss of wildlife	A	-clearing of site outside of breeding season of migratory birds -Rehabilitate all temporarily used sites	Medium	Project Site (350 ha)	Permanent	NR	Species affected without protective status	Medium		
Dust impacts on vegetation	A	See mitigation for Air Quality	Low	Project Site (350 ha) and adjacent lands	Construction period	R	**Vegetation affected without protective status**	Minimal		

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects: Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context	Significance**	Likelihood of Occurrence***	Level of Confidence***
Noise effects on wildlife (including blasting)	A	See mitigation for Air Quality	Low	Project Site (350 ha) and adjacent lands	Construction period	R	Species affected without protective status	Minor		
Effects of dam at Meadow Lake on bird nesting sites	A	Clearing outside of bird nesting period.	Low	Approximately 140 ha	Construction and Operation phase	R	**Species protected by *Migratory Bird Convention Act* (MBCA)**	Minor		
Effects of clearing around and flooding of Meadow Lake on habitat/vegetation	A	- minimize area cleared around new shoreline - use "good housekeeping" procedures regarding disposal of slash, litter, etc.	Medium	Approximately 140 ha	Construction and Operation phase	R	**Vegetation affected without protective status**	Minor		
Operation										
LNG Facility, Petrochemical Plant, Co-Gen Plant, Infrastructure (Meadow Lake Dam and Intake Structure)										
Effects of air emissions on vegetation (deposition)	A	See Air Quality	Low	Immediate site vicinity	Operation phase	R	vegetation affected without protective status	Minimal		
Effects of water quality impairment effects on amphibians	A	Treatment of water to government standards prior to discharge Monitor of discharge quality	Low	On-site creeks	Operation phase	R	Species affected without protective status	Minimal		

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance**	Likelihood of Occurrence***	Level of Confidence***
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context			
Lighting effects on migratory birds	A	Minimize use of lighting	Medium	Project site	Operation Phase	R	Species affected without protective status other than MBCA; Project site not of particular importance to migratory birds	Minor		
Disruption of migration corridors of mammals	A	None available	Low	Project site	Operation Phase	R	Species affected without protective status; Project site not of particular importance as migration corridor	Minor		High
Meadow Lake (effects of dam operation on bird nesting sites)	A	None required	Nil	Approximately 140 ha	Permanent (facility operation)	R	Species affected without protective status other than MBCA;	Minimal		High
Meadow Lake (effects of dam on invertebrate and amphibian populations)	P	None required; habitat will adjust to new water levels	Low	Approximately 140 ha	Permanent (facility operation)	R	Species affected without protective status;	Minimal		High

* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 7
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 7
*** Only addressed for significant effects

9.11 IMPACTS ON FORESTRY

9.11.1 Construction Phase

Site clearing at the Project site will have minimal effects on forestry, since the site is considered to have no merchantable timber. Similarly, both the realignment of Route 316 and the development of the Meadow Lake dam and intake structure and the subsequent flooding of part of the Lake's shore line is expected to have minimal effects on forestry.

Of the six vegetation (stand) types identified around Meadow Lake (see Section 8.8) a significant portion has been assessed as either tree bog, brush and barren, fen marsh and raised bog. These stands have little or no commercial forestry value due to the low land capability, and poor drainage. The two remaining stand types are labeled as "Conifer Stand" and "Intolerant Hardwood/Conifer Mixed Stand", and the land supporting these stands is generally low or marginal from a forestry land capability perspective. These stands are comprised of slow growing small diameter balsam fir, with lesser amounts of the more desirable black spruce and white spruce. Poor quality, white birch and red maple are the main hardwood species. Merchantable volumes are relatively low over the majority of the area, averaging less than 10 cords per acre. Consequently, there is very little potential for commercial forestry in the stand types noted above.

9.11.2 Operation Phase

No interaction between the Project's operation and local forestry has been identified.

9.11.3 Conclusion

The Project is not expected to affect forestry resources during the construction and operation phase.

9.12 IMPACTS ON WETLANDS

9.12.1 Construction Phase

The functions and values of wetlands given in Section 8.10 are generally not compatible with construction activities. Spills of fuels, lubricants, and hydraulic fluids, erosion, sedimentation, and damage caused by heavy machinery can result in significant impacts.

Several wetlands may receive impacts from construction. These include Map Sites 3, 5-10 (see Figure 8.8-1) on the site proper, parts of Map Sites 3 and 11, and Map Site 4 on the marginal wharf area. Site construction may result in filling, excavating, and otherwise disturbing wetlands, which in addition to unique habitat loss may alter the hydrological integrity of the site.

A proposed hydro corridor crosses the wetland on the terminal area at Map Site 4 and comes close to the wetlands at Map Sites 5, 7, and 8 (See Figure 8.8-1). The LNG pipeline in the terminal area crosses a wetland area (Map Site 13) that flows southeasterly into Betty's Cove. Both the hydro line and pipeline pose potentially significant impacts.

The application of a "no net loss policy" will ameliorate the general impact to the wetlands.

9.12.2 Operation Phase

Impacts on small on-site wetlands may vary from virtually no impact to disruption with wetland foundation, depending on where facilities are placed.

Meadow Lake will be dammed to provide a source of water for industrial cooling. The characteristics of the Meadow Lake basin are discussed in Section 8.6.3.1. The basin as depicted in Section 8.6.3.1 is the area that will be inundated if the proposed dam becomes a reality.

Approximately 124 ha of wetland habitat will be removed including raised bog (8%). Nest sites of common loon, common merganser, and ring-necked duck will be displaced, but it is speculated that all three species will find new nesting sites on the lake shore.

The newly inundated area will provide a source of nutrients and habitat complexity that may result in increased populations of some fish, invertebrates and amphibians, at least in the short-term. This has to be traded off against reduced dissolved oxygen, increased temperatures in shallow water and increases in toxicity. It is speculated that there will be an increase in prey communities in shallow water that will benefit some predators such as great blue heron and belted kingfisher.

The lake was dammed previously for logging (date not known) with little adverse affect detected over the long term.

Dam construction typically causes a decrease in aquatic biodiversity (McAllister et al., 2001). Effects on waterfowl are variable. Data regarding effects on terrestrial fauna seem generally to be lacking, but certainly there will be a considerable loss due to habitat removal. Recommended mitigation measures for wetlands are presented in Section 10.9.

A freshwater fish and fish habitat monitoring program for each phase of the construction and operation of the Project is presented in Section 13.7.

9.12.3 Conclusion

The impact of the Project on the wetlands on and near the Project site is not expected to be significant. Most adverse effects are associated with the construction phase when wetlands may be filled as part of the site preparation and grading work. Wetlands are frequent features within the surrounding area, thus offering replacement habitat for plant and wildlife currently present on-site. During the plant operation, water discharges to the environment may cause adverse effects on wetlands. Waste water treatment prior to discharge, discharge controls and monitoring, as well as EMP provisions for spill prevention and clean up will ensure that operation –related effects will also be not significant.

TABLE 9.12-1 Residual Environmental Effects Summary for Wetlands

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance**	Likelihood of Occurrence***	Level of Confidence***
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context			
Construction										
LNG Facility, Petrochemical Plant, Co-Gen Plant, Infrastructure (Meadow Lake Dam and Intake Structure)										
Spills of fuels, lubricants, and hydraulic fluids	A	Implementation of EMP with spill prevention and cleanup procedures	Up to 8 wetlands	About 11 ha	Construction Phase	R	Site designated for industrial Uses; numerous wetlands in site vicinity	Minor		
Erosion, sedimentation, and damage caused by heavy machinery	A	Implementation of EMP with erosion and sediment control plan	Up to 8 wetlands	About 11 ha	Construction Phase term	NR	Site designated for industrial Uses; numerous wetlands in site vicinity	Minor		
Filling, excavation, and other disturbance of wetlands that may alter hydrological integrity of the site	A	Application of a "no net loss" policy	Up to 8 wetlands	About 11 ha	Permanent	NR	Site designated for industrial Uses; numerous wetlands in site vicinity	Minor		
Effects on the wetlands of spills, excavation, sedimentation, and erosion from the proposed hydro corridor and LNG pipeline.	A	Application of a "no net loss" policy	Up to 5 wetlands	About 5 ha	Permanent	R	Site designated for industrial Uses; numerous wetlands in site vicinity	Minor		

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance**	Likelihood of Occurrence***	Level of Confidence***
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context			
Operation										
LNG Facility, Petrochemical Plant, Co-Gen Plant, Infrastructure (Meadow Lake Dam and Intake Structure)										
Reduction of wetland water quality resulting from discharges/runoff from project	A	Implementation of on-site storm-water management plan; Controlled discharges to the environment and effluent monitoring Implementation of EMP with spill prevention and cleanup procedures;	Up to 8 wetlands	About 11 ha	Operation Phase	R	Site designated for industrial Uses; numerous wetlands in site vicinity	Minor		
Meadow Lake Impoundment (effect of water level fluctuation on nearby wetlands)	A	Application of a “no net loss” policy		124ha	Permanent	R	Numerous lake systems in site vicinity	Minor		

* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 7
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 7
*** Only addressed for significant effects

9.13 IMPACTS ON FISHERIES, AQUACULTURE, AND HARVESTING

Commercial fishing and aquaculture are two important economic activities that occur within the marine environment of Stormont Bay. Commercial fishing occurs almost entirely outside of the estuaries of Country Harbour and Isaac's Harbour and aquaculture occurs only within Country Harbour. Recreational fisheries in the area are small but diverse, and include both freshwater and estuarine components. Brook trout are the primary recreational species. They are fished both in many of the lakes, rivers and streams that flow into Stormont Bay and in the inner parts of the estuary. Smelt are often fished recreationally under the ice in the upper estuaries. Commercial lobster fishing is the only harvesting that occurs in close proximity to the Project.

Information on harvesting was obtained primarily through discussion with local residents. Background information was also provided by the Guysborough County Coastal Resources Mapping Project. Numerous consultation meetings with the commercial fishermen who fish within Stormont Bay were held by Keltic and project consultants.

9.13.1 Construction

9.13.1.1 Marine Environment

Local fishers have expressed concern about disruption to their traditional fishing activities from construction and operation of the Keltic facilities. Marine impacts of construction will be concentrated in the wharf and terminal areas, either as a result of construction or facilities equipment being transported to the site, or actual construction of the wharf and terminal.

The magnitude of construction impacts will be related to the seasonal timing of activities. Impacts will be greater if activities occur during the relevant fishing seasons, particularly the lobster fishing season, which runs from mid-April to late June. The marginal wharf is not a major fishing area, and most fishing tends to occur further out into the harbour, limiting the potential for disruption to traditional fishing patterns. In addition, little fishing activity takes place in the central deep water part of the bay where the larger LNG and cargo vessels will be transitting.

For a significant impact on fishing activity to occur, the earnings from the fishery would need to be affected as a result of decreased catch quantity and/or quality, or increased costs of fishing from longer travel times or similar issues. The overall productivity of the bay and the associated amount of lobster habitat are important factors determining the potential quantity and quality of the catch and thus monetary return to local fishers.

DFO will require replacement of three to five times the area of fish habitat lost with habitat of similar or higher type and quality. A potential compensation area in Fisherman's Harbour has been identified (see Appendix 14) where a habitat augmentation project could provide approximately one square kilometre of lobster habitat, similar in quality to that lost to construction. Theoretically, this would augment lobster production in the area by an amount equal to the area of additional productive habitat. This increased production should lead to increased catch by the fishermen, which should more than make up for any increased travel costs.

Aquaculture operations are located entirely within Country Harbour and no construction activities or transport of equipment will occur near these operations. Release of sediments or contaminants to the water column from construction is also anticipated to be minimal, and thus no impacts on aquaculture operations are expected.

9.13.1.2 Freshwater Environment

Betty's Cove Brook

A first-order headwater tributary of Betty's Cove Brook originates in the northwest corner of the Keltic Site. Although there is no indication that there is a fishery in the on-site reaches of this watercourse, the headwaters no doubt contribute to the fishery which exists further downstream, and which includes species such as brook trout and American eel. There is no existing commercial or Aboriginal fishery associated with Betty's Cover Brook so that no Project-related interactions with fishery resource uses are expected.

Crusher Brook

There have never been any fish found in this tributary and there is no known fishery of any kind associated with this watercourse. No Project-related interactions with fishery resource uses are expected.

Un-Named Tributary to Red Head Pond

A small first-order tributary is located a short distance east of the SOEI gas plant road. No fish have ever been collected or observed in this drainage feature during any Keltic survey. No Project-related interactions with fishery resource uses are expected.

Red Head Ponds 4 and 5

The construction of the marginal wharf on the Red Head peninsula will result in the filling in of Ponds 4 and 5 at that Project site (Figure 8.12-7). The fish community in these ponds includes threespine, stickleback, fourspine stickleback, ninespine stickleback, and banded killifish. There is no recreational, Aboriginal, or commercial fishery associated with these ponds. No Project-related interactions with fishery resource uses are expected.

Meadow Lake

This lake currently supports a relatively diverse fish population consisting of seven species: American eel, white sucker, brook trout, golden shiner, yellow perch, ninespine stickleback, and Atlantic salmon. In terms of proportion of catches, yellow perch and white sucker are the dominant species. The Lake provides a recreational fishery for local residents. It does not have any known commercial or Aboriginal fishery.

The activities associated with the construction of the dam and the intake structure will involve clearing of some of the shoreline vegetation. To minimize in-water works, cofferdams will be established at both the dam site and the intake location. This will permit working in the dry for contouring and foundation works and may involve blasting.

The increase in the area of Meadow Lake and the flooding of associated tributaries is not expected to induce any significant negative impacts on the recreational fishery which now exists in this watershed. The populations of fish species now targeted by anglers (brook trout, perch, eels) are not expected to decrease in size.

As discussed in Section 9.14, with the implementation of the proposed mitigation measures, potential effects on fish habitat and communities are not expected to be significant. Consequently, effects on the use of the fisheries resources at Meadow Lake are also expected to be not significant.

9.13.2 Operation

9.13.2.1 Marine Environment

Potential operational impacts are associated with Project-related vessels entering and leaving the bay, but may also be related to other marine traffic traveling around the proposed marginal wharf into and out of Isaac's Harbour.

The wharf extends into the entrance of Isaac's Harbour, occupying about 45 % of the width of the entrance between Red Head and Bear Trap Head. However, the entrance to Isaac's Harbour reduces to a similar width another 500 m further into Isaac's Harbour. Furthermore, the marginal wharf is located in an area of comparatively shallow water, leaving the deeper water portion of the entrance unaffected. The wharf itself will be equipped with navigation aids, such as lights and fog horns, as required by TC, mitigating navigation concerns (See Section 10.10.1). Few vessels routinely use Isaac's Harbour even though the community wharf in Goldboro was substantially upgraded by the SOEI for construction of the gas plant. The current marine traffic within the harbour is composed of the sporadic inshore fishery including a monthly passage of a shrimp trawler to the Stormont facility in Country Harbour and the occasional offshore supply vessel interfacing with the ExxonMobil SOEI facility. These vessel dimensions and displacements range respectively from: 5.5 m Length overall x 1.8 m beam with draft of 1 m, to 19 m Length overall x 6 m beam and draft of 3.3 m to 52 m Length overall x 11 m beam and draft of 5.5 m. An exact count and analysis of marine shipping activity within the harbour will be accomplished during the engineering FEED study. Overall, the reduction in channel width at the entrance should not have a significant impact on navigation.

Impacts associated with commercial fisheries other than lobster are expected to be minor. For example, fishermen may have to shift gillnets set for herring or mackerel in the central part of the bay, but Keltic will provide advance notice of ship arrivals and departures to ensure fishermen can manage their gear without damage. The potential effect on overall catch or the cost of fishing is anticipated to be insignificant, but will be addressed through consultation with the marine fisheries authorities and the local fishing community and the completion of a Potential Effects Analysis and review.

Fish may be attracted to the facilities or vessels because of lights at night, and may perceive noise at some distance from operations. These impacts are expected to be minimal and not result in any population impacts on any fish species frequenting the area. Monitoring programs for the marine habitat and inshore fishing activity are presented, respectively, in Sections 13.6 and 13.8.

Routine operations are not anticipated to have any impacts on aquaculture within Country Harbour, but hydrocarbons or other contaminants could be released in a major accident at the Keltic facilities or during shipping operations. The potential for such an accident is judged to be extremely low.

9.13.2.2 Freshwater Environment

As discussed in Section 9.13.1 Construction, an active use of freshwater fishery resources only occurs at Meadow Lake. As discussed in Section 9.14, with the implementation of the proposed mitigation measures, potential effects on fish habitat and communities during the operation phase are not expected to be significant. Consequently, effects on the use of the fisheries resources at Meadow Lake are also expected to be not significant.

9.13.3 Conclusion

Overall, works and activities associated with the construction and operation phases of the Project are not expected to have significant adverse effects on marine or freshwater fisheries, aqua culture or harvesting of fish resources (Table 9.13-1). The area for the planned wharf and marine terminal is not a major fishing area and represents only a very small portion of the lobster habitat in the Stormont Bay.

Project-related vessel movements will be infrequent and are not expected to cause significant interference with the navigation of local fishing vessels.

There is very little commercial or recreational use of freshwater fishery resources at and near the Project site. Given that the effects on freshwater fish habitat are also expected to be insignificant it is concluded that no significant effects on freshwater fisheries are to be expected.

TABLE 9.13-1 Residual Environmental Effects Summary for Fisheries, Aquaculture, and Harvesting

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance**	Likelihood of Occurrence***	Level of Confidence***
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context			
Construction										
LNG Facility (Marine Terminal), Petrochemical Plant (Marginal Wharf), Infrastructure (Meadow Lake Dam and Intake Structure)										
Disruption of marine fishing activities from equipment transported to site and actual construction of wharf and terminal.	A	NA The marginal wharf is not a major fishing area	Low	Wharf size: $0.123km^2$; representing 1.6% of lobster fishing area in Stormont Bay	Permanent	NR	The area of the wharf/marine terminal is not a major fishing area	Minimal		
Decrease in marine fishery-related earnings as a result of loss of fish habitat with construction of wharf and terminal	A	Implementation of habitat compensation in accordance with DFO requirements	Low	Wharf size: $0.123km^2$	Construction Phase; effect will terminate with successful completion of compensation plan	R	The area of the wharf/marine terminal is not a major fishing area	Minimal		

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance**	Likelihood of Occurrence***	Level of Confidence***
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context			
Disturbance of freshwater fisheries (recreational fishing) as a result of disturbance and habitat alteration on-site, at Meadow Lake, and in Isaac's Harbour Creek	A	Implementation of habitat compensation in accordance with DFO requirements	Low	Two on-site creeks; Meadow Lake; Isaac's Harbour River	Permanent	NR	The on-site creeks, Meadow Lake, and Isaac's Harbour River are not important resources for recreational fishing	Minimal		
Operation										
LNG Facility (Marine Terminal), Petrochemical Plant (Marginal Wharf), Infrastructure (Meadow Lake Dam and Intake Structure)										
Disruption of marine fishing activities from LNG and cargo vessels in the bay.	A	Fishermen will be notified of ship arrival so they can shift gill nets in the central part of the bay.	Low	Stormont Bay	Large LNG carrier about once a week, and as many as 3 traditional cargo vessels per week	R	The proposed shipping channel in Stormont Bay and approaches is not a major marine fishing area	Minor		
Impacts on navigation from the narrower entrance to Isaac's harbour created by the marginal wharf	A	NA The harbour narrows to a similar width 500m further into the harbour	Low	Entrance to Isaac's Harbour	Permanent	R	Isaac's harbour is not a major shipping destination/route	Minimal		

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance**	Likelihood of Occurrence***	Level of Confidence***
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context			
Marine fish may be attracted by facility lights at night and may perceive noises at a distance from the operation	A	Monitoring programs to be followed	Low	Isaac's Harbour	Operation Phase	R	The area of the wharf/marine terminal is not a major fishing area	Minimal		
Disturbance of freshwater fisheries (recreational fishing) as a result of the Meadow Lake Impoundment (water level fluctuations); low flow conditions in Isaac's Harbour River;	A	Operation of fish ladder at Meadow Lake dam; Operation of dam to provide for minimal flow in Isaac's Harbour River	Low	Meadow Lake; Isaac's Harbour River	Operation Phase	R	The Meadow Lake system and Isaac's Harbour River are not important resources for recreational fishing	Minimal		

* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 7
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 7
*** Only addressed for significant effects

9.14 IMPACTS ON FRESHWATER SPECIES AND HABITAT

This section discusses the potential effects of the Project on the freshwater aquatic environment, in particular freshwater species and habitat. For impact on the commercial use of this resource refer to Section 9.13.

Potential interactions between the Project and the aquatic environment are manifold and include for example destruction of fish habitat during site development and grading, or impairment of fish habitat as a result of waste water discharges during Project operation.

9.14.1 Construction Phase

9.14.1.1 Betty's Cove Brook

The footprint of the Keltic project does not impinge on any part of Betty's Cove Brook. There will be a minimum 15 m setback between the on-site reaches of this watercourse and any project-related infrastructure. In addition, this watercourse will be protected during construction and operation by a comprehensive set of mitigation measures (See Section 10.10).

There will be periodic storm-water discharges to Betty's Cove Brook from one or more ponds during plant site construction and operation (see Section 9.8). The storm-water ponds will be sized and managed to meet or exceed relevant provincial storm-water quality and quantity objectives. As such, the potential effects on fish and fish habitat in Betty's Cove Brook are expected to be minor. Proposed mitigation measures are described in Sections 10.6 and 10.11

9.14.1.2 Crusher Brook

This first-order watercourse originates on the Keltic site from where it flows initially in a southeastwardly direction, through abandoned mine workings, and then turns south westerly where it flows beneath a roadside dwelling and then discharges to Isaac's Harbour. There have never been any fish found in this tributary and there is no known fishery of any kind associated with this watercourse. There are also no aquatic "species of concern" associated with Crusher Brook.

The footprint of the Keltic project does not impinge on any part of Crusher Brook. The Project will have no discharge of any kind to this watercourse, and there will be a minimum 15 m setback between the on-site reaches of this watercourse and any project-related infrastructure. In addition, this watercourse will be protected during construction and operation by a comprehensive set of mitigation measures (See Section 10.10). As such, there are no anticipated effects of the Project on this aquatic feature.

9.14.1.3 Un-Named Tributary to Red Head Pond

A small first-order tributary is located a short distance east of the SOEI gas plant road. It appears to be spring fed, and from its origin, flows generally southward to where it crosses the existing highway and discharges to the largest pond on the Red Head peninsula. No fish have ever been collected or observed in this drainage feature during any Keltic survey, and no aquatic "species of concern" are associated with this tributary.

The footprint of the Keltic project does not impinge on any part of this tributary and the Project will have no discharge of any kind to this watercourse. In addition, this watercourse will be protected during construction and operation by a comprehensive set of mitigation measures (See Section 10.10). As such, the Keltic project will not have any effect on the aquatic biota or habitat in this tributary.

9.14.1.4 Red Head Ponds 4 and 5

The construction of the marginal wharf on the Red Head peninsula will result in the filling in of Ponds 4 and 5 at that site (Figure 8.12-7). These ponds both have brackish water and are less than 1 ha in total area. The fish community in these aquatic features includes threespine, stickleback, fourspine stickleback, ninespine stickleback, and banded killifish. There is no recreational, Aboriginal, or commercial fishery associated with these ponds, and no aquatic "species of concern" have been found during any survey at this site.

The Keltic project will not have any effect on any fishery, but the construction of the marginal wharf will result in the loss of the two ponds and associated habitat and fish community.

9.14.2 Operation Phase

9.14.2.1 On-site Water Courses

As discussed in Section 9.8.2 (Surface Water), at the Project site, all wastewater will be collected and treated to applicable government standards and objectives prior to discharge to the environment. The discharge quality will be monitored in order to verify the effectiveness of the treatment. Adverse effects on aquatic species and habitat during the operation phase are not expected to be significant.

9.14.2.2 Meadow Lake and Isaac's Harbour Watershed

Meadow Lake is the site of the proposed dam and water-intake structure for the Keltic project. This lake currently supports a relatively diverse fish population consisting of seven species: American eel, white sucker, brook trout, golden shiner, yellow perch, ninespine stickleback, and Atlantic salmon. In terms of proportion of catches, yellow perch and white sucker are the dominant species. Although Meadow Lake provides a recreational fishery for local residents, it does not have any known commercial or Aboriginal fishery. There is no known aquatic biota designated as a "Species at Risk" under the SARA.

Historically, this lake was impounded, presumably in support of resource-extraction activities. Meadow Lake has also historically supported an Atlantic salmon population which spawned in tributaries to Meadow Lake and perhaps in Isaac's Harbour River downstream of the lake. During multi-season surveys in this watershed, however, only one specimen of Atlantic salmon has been collected in the Meadow Lake watershed during the surveys of 2001, 2004, and 2005. No juvenile salmon have been found during any survey.

The likely explanation for the present dearth of salmon in the Meadow Lake - Isaac's Harbour watershed is the pH of the surface water in the system. In 2004, pH values measured in situ ranged from 3.4 to 4.9. These are pH levels at which salmon reproduction is not possible. In

2005, water samples collected in this watershed and which were analyzed in the laboratory had pH levels which ranged from 4.7 to 5.1 - also values which preclude salmon reproduction. These depressed pH levels are probably caused by acid precipitation resulting from fossil-fuel emissions. Acidification has been identified as the reason for the failure of salmon populations in numerous watersheds in Nova Scotia and elsewhere along the east coast of North America.

There are four main aspects of Meadow Lake, as a proposed impoundment, which have the potential to affect fisheries, fish habitat, and associated aquatic biota:

- changes in lake area and tributary lengths;
- water quality;
- the impoundment dam; and
- water withdrawal.

These are discussed below.

Lake Area and Tributary Lengths

When impounded, Meadow Lake will increase from an existing area of about 104 ha to approximately 244 ha and the lake will go from the current maximum depth of about 2 m to a maximum depth of 4 m. The increase in lake area will provide more habitat for fish and other aquatic biota. Although there is not necessarily a direct relationship between habitat quantity (area) and fish productivity, it is generally acknowledged that the in-filling or reduction of fish-habitat quantity typically results in a decrease in the productive capacity of that habitat. Conversely, increases in aquatic area tend to provide more fish-habitat opportunities and increases in productivity. The increased lake area of Meadow Lake and the expected increased fish productivity, therefore, are not considered a negative effect.

The new habitat will consist entirely of a shallow-water (i.e. < 2 m) euphotic area. Given the existing shallow bathymetry of the Meadow Lake, the entire area of the new lake is expected to be within the euphotic zone – typically the most productive stratum in terms of benthic invertebrates, aquatic macrophytes, and fish. Fish species expected to benefit from the larger lake area include forage fish such as golden shiner and stickleback as well as yellow perch and perhaps white sucker. This, too, is not considered a negative effect.

The flooding of adjacent lands, however, will also flood approximately 3,300 m of the downstream reaches of tributaries now contributing to Meadow Lake. This is not considered a loss of habitat, but will be an alteration of aquatic habitat from riverine to lacustrine. The following Table summarizes the lengths and the habitat characteristics associated with each affected watercourse:

TABLE 9.14-1 Fish and Aquatic Habitat in Meadow Lake Tributaries

Tributary #	Length Flooded (m)	Habitat Characteristics in Affected Reaches	Habitat Significance
1	380	- gravel and sand substrate - undercut banks	- salmonid migration route
2	475	- substrates of organic fines and sands - bankfull width ~2.9 m - bankfull depth ~0.35 m	-refuge for small/young fish -spawning habitat for forage fish
3	50	- sand substrates, with occasional cobbles and gravel - bankfull width ~0.4 m - bankfull depth ~0.25 m	
4	300	- sand and organic substrate - bankfull width ~0.5 m - bankfull depth ~0.3 m	
5	280	- sand, silt, and organic substrate - bankfull width ~0.4 m - bankfull depth ~0.25 m	
6	550	- sand and organic silt substrate - bankfull width ~2.5 m - bankfull depth ~0.6 m	-refuge for small/young fish
7	380	- sand and gravel substrate - bankfull width ~5.0 m - bankfull depth ~0.6 m	- brook trout collected, but no spawning habitat noted
8	55	- sand and organic silt substrate	
9	840	-organic silt and sand substrate	-refuge for small/young fish

The impoundment of Meadow Lake will flood approximately 380 m of the Isaac's Harbour River flowing into the lake. Although this tributary is a salmon migration route, the flooding of the downstream-most reaches is not expected to impair this habitat function of the watercourse. Salmon will still be able to move throughout the river, and no salmon-spawning habitat has been noted in that part of the river which will be flooded.

No brook trout spawning habitat was observed in the lower reaches of the remaining Meadow Lake tributaries. These watercourses no doubt provide refuge for young and small fish and some likely provide spawning habitat for forage species such as stickleback. None of the affected habitat, however, is considered particularly sensitive, significant, or limiting to any constituent of the fish community in Meadow Lake.

The increase in the area of Meadow Lake and the flooding of associated tributaries is not expected to induce any significant negative impacts on the recreational fishery which now exists in this watershed. The populations of fish species now targeted by anglers (brook trout, perch, eels) are not expected to decrease in size. No known spawning habitat for trout will be affected, and the spawning and nursery habitat for perch will increase. The potential effects on the fishery, in fact, may be positive because of the easier access and the higher productivity expected post-impoundment.

Water Quality

Although there is no expected change in overall water quality within the lake, it may be slightly cooler because of the increased depth. This is not considered a negative effect.

The proposed impoundment will not flood any existing historical mine workings or tailings-disposal areas. There are therefore no issues related to the potential effects of water contamination by As or Hg associated with previous mining activity near the lake.

Impoundment of water may result in the increased methylation of mercury in the aquatic environment. The rate of methylation and the potential effects on aquatic biota and other constituents of the food chain (including humans) are known to be affected by factors including the level of organics in the flooded land, the residence time of water in the reservoir, the species present, etc. To minimize the potential for mercury methylation as an environmental or human-health issue, much of the surficial organic material in the flood zone will be removed before impoundment. In addition, the hydrology of the reservoir and the watershed are such that there will be a residence time of only about 6 days for water in the impoundment. In other words, the reservoir will be continually "flushed" with the result that the risk of mercury accumulation in the Meadow Lake environment is extremely low.

The Impoundment Dam

The impoundment of Meadow Lake will require the construction of a dam to raise the water elevation of the lake by about 2 m. This dam will be a concrete structure, with a fishway, spillway, and associated water-level control systems.

The dam proposed for use at Meadow Lake will have a footprint of about 170 m^2 located in existing aquatic habitat. This is considered a "loss" of fish habitat. Given that the impoundment will result in the creation of 140 ha of additional fish habitat, however, the 170 m^2 loss associated with the dam structure may be insignificant. Notwithstanding, the relatively minor magnitude of this particular effect on fish habitat, Keltic is committed to implementing a Fish Habitat Compensation Plan to the satisfaction of DFO and to achieving a "no net loss" of fish habitat. This will be done by following DFOs hierarchy of compensation options.

In the absence of any mitigating measures, this dam would also be an obstacle to the up-stream movement of fish and would constitute a harmful alteration of fish habitat. The Keltic project, however, includes provision for a fishway which will allow fish passage either upstream or downstream. Although virtually any of the species now in Meadow Lake may move downstream from time to time, it is only Atlantic salmon and American eel which require such movement as part of their life-cycle processes. Salmon are not reproducing in this watershed at present, but the fishway is designed to accommodate this species to allow passage when water-quality conditions hopefully improve in the future. In addition, the fishway design will also provide for the passage of eels and brook trout.

Basic features of the fishway design include a one metre wide flow section for the fishway. A Denil type fishway is proposed with a single resting pool. Since all low flows and minor storm flow would go through the fishway, fish should have little difficulty finding and making entry into the fishway. The fishway is located just upstream of a pool in the river where resident or migratory fish would normally hold or stage.

A second one metre wide section next to the fishway is used to discharge frequent storm flows. This opening or sluiceway could be constructed such that the height is variable (i.e. use stop logs) and also functions as a step pool type fishway under higher flow conditions.

A total 24 m wide spillway at elevation 36.25 m provides relief for spring melt and likely larger summer storm flow events. The dimensions and elevations have been determined from a number of flow analyses for the observed flows.

9.14.3 Conclusion

Potential effects on freshwater species and habitat during the construction and operation phases are considered to be not significant (Table 9.14-2). No encroachment into local creek systems is anticipated. Only exception is the Isaac's Harbour River, which will be cut off by a dam from Meadow Lake, which will be designed with a fish passage. Implementation of EMP provisions including spill prevention and spill response policies as well as sediment and erosion control plans will minimize effects to insignificant levels.

During operation, water quality of the fish habitat will not be significantly affected due to waste water treatment, discharge controls, and effluent monitoring prior to any releases to the aquatic environment. The operation of the dam at Meadow Lake may result in beneficial effects on fish habitat and fish communities due to increased Lake size.

TABLE 9.14-2 Residual Environmental Effects Summary for Freshwater Species and Habitat

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects: Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context	Significance**	Likelihood of Occurrence***	Level of Confidence***
Construction										
LNG Facility (Marine Terminal), Petrochemical Plant (Marginal Wharf), Infrastructure (Meadow Lake Dam and Intake Structure)										
Potential for HADD through site development and grading	A	Application of a "no net loss" policy; Erosion and sediment control plan Maintain 15m buffer zone Storm-water management plan Spill prevention and response plan Designated fueling and material storage site	Max. 3 small local water courses	Project site	Construction and possibly Operation Phase	R	Small local water courses; some sediment and water quality impacts from historic mining activities	Minor		
Potential for HADD due to in-water works and dam construction at Meadow Lake	A	Application of a "no net loss" policy; Erosion and sediment control plan Site and shoreline rehabilitation	Low	$170m^2$ dam footprint	Construction Phase	R	Start of Isaac's Harbour River	Minor		

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance**	Likelihood of Occurrence***	Level of Confidence***
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context			
Operation										
LNG Facility (Marine Terminal), Petrochemical Plant (Marginal Wharf), Infrastructure (Meadow Lake Dam and Intake Structure)										
Potential for fish habitat impairment due to waste water discharges	A	See mitigation for Water Quality	Low	Project site		R	Small local water courses; some sediment and water quality impacts from historic mining activities	Minor		
Potential for fish habitat impairment due to dam operation; potential beneficial effects through lake expansion	A/P	Dam construction with fish passage	Medium (140 ha)	Meadow Lake	Operation Phase	R		Nil (adverse effects)/ Medium (positive effects)		

* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 7
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 7
*** Only addressed for significant effects

9.15 IMPACTS ON MARINE SPECIES AND HABITAT

The marine habitat of Stormont Bay supports a typical range of marine and estuarine species (i.e. fish, shellfish, marine mammals and coastal and seabirds), and provides a migratory path for some fish, such as Atlantic salmon and sea-run trout. Nearshore, shallower areas also support various marine plant species. Lobster is by far the most important species in terms of economic value within the Bay, and thus the emphasis in assessing impacts has been placed on this species.

The marginal wharf and LNG terminal will result in loss of fish habitat. A permitting process (HADD) through DFO is required to authorize this loss. Information on fish habitat was collected by ROV survey and submitted to DFO as part of this permitting process, along with an assessment of the role of this habitat to fish production, primarily lobster. Under the HADD process, compensation for loss of productive habitat is required, and information on a potential compensation project in Fisherman's Harbour was also submitted to DFO. These assessments indicated that it should be possible to augment fish habitat in the vicinity of Stormont Bay to more than replace any loss of habitat due to the facilities.

The marginal wharf has the potential to affect wave action and currents around the facilities, particularly the marginal wharf. A general assessment of these potential impacts was carried out and detailed oceanographic modelling may be conducted as part of the FEED to confirm the configuration of the wharf and jetty

9.15.1 Construction

9.15.1.1 Fish Habitat

The habitat in the vicinity of the proposed Keltic facilities comprises three basic types: rock and kelp; eelgrass and sand; and sand and mud. Based on video transects, the area to be occupied by the wharf is predominantly rock and kelp with patches of eelgrass and sand. Sand and mud bottom are primarily associated with deeper water (>12 m) where the proposed LNG terminal is to be located. This habitat is of most value to lobster and sea urchins, the two principal commercial species fished in the area.

Past surveys have shown that the area of fish habitat in the eastern part of Stormont Bay is relatively consistent between the proposed Keltic facilities and Harbour Island – a mix of rock, boulder, kelp, and patches of sand. In deeper areas, outside Country Harbour Head and past Harbour Island, habitat is patchier, related primarily to water depth and substrate.

Table 9.15-1 summarizes the amount of habitat potentially lost as a result of wharf construction (0.123 km^2) compared to that found within Stormont Bay. Approximately 60% of the wharf area is typical of lobster habitat, representing approximately 1.6% of the lobster habitat within Stormont Bay.

TABLE 9.15-1 Lobster Habitat Area within the Proposed Wharf Area and Stormont Bay

	Habitat Area (km^2)	% Bay Habitat	% Wharf area
Wharf Area	0.123	100	60
Bay Area	7.800	1.6	

If lobster habitat within the approaches to Stormont Bay is also considered, the percent lost to construction of the wharf drops to 0.45%.

Factors that most influence lobster productivity are habitat and food supply (Cobb et al., 1999). The type of fish habitat preferred by lobster, however, changes with age of the animal.

Post-larval lobsters live in burrows until they reach about 25 mm carapace length (CL). For lobsters between 25-50 mm CL a coarse substrate and a suitable amount of cover is necessary. Lobsters with a CL of >50 mm prefer areas with algae, stones, and large crevices. Some larger lobsters have been observed on compact sand or mud bottoms consolidated by eelgrass. All sizes of lobster have been observed co-existing in areas with large stone size and heavy algal cover. Sand covered in eelgrass had a low abundance of juveniles and adults, while on bare sand bottoms no resident lobsters were observed (National Oceanographic and Atmospheric Association, 1994).

Post-larval lobsters spend a few years “in self-dug tunnels or in the natural crevices under cobble” (Harding, 1992). Post-larvae, in their burrows, feed on plankton and may also prey on small benthic organisms. This habitat provides shelter from potential predators when the post-larval lobsters are still small and quite vulnerable. This part of the life cycle is critical to recruitment to the fishery, and the amount of post-larvae that settle in an area is directly proportional to the number of fishery recruits to that area (Miller, 1997). At the same time, the numbers of post-larvae that settle in an area is an overriding factor in determining an area’s productivity.

The small amount of fish habitat lost as a result of construction of marine facilities, between 0.45 and 1.6%, would not result in a significant impact on fish resources in the area. None of the habitat lost is in anyway unique to the Bay, nor does it provide a critical function to the ecosystem. The loss of production of lobster, and other fish species, would be dwarfed by local variations in environmental factors such as water temperature and larval drift into the area.

9.15.1.2 Fish Habitat and Sediment Contamination

Historic mining has resulted in elevated levels of heavy metals, particularly arsenic and mercury, in marine sediments in Isaac’s Harbour, and on land in the Goldboro area. However, two sampling programs found no areas of mine waste contamination within or near the proposed construction site.

Sampling was conducted to determine if contaminated sediments were present in the proposed marginal wharf or LNG terminal area. No indications of contamination were found, although elevated levels of arsenic and mercury exist within Isaac’s Harbour. Construction of the marginal wharf will begin by enclosing the future wharf area with concrete caissons or sheet piling, followed by filling the interior with aggregate to provide a structure capable of holding heavy large storage silos and other equipment. The construction procedure will prevent sediment escape from the interior of the wharf infill area.

The low probability of contaminants occurring in the marine construction area, coupled with the construction method, will ensure no heavy metal contamination results from the construction of the marginal wharf.

The potential for heavy metal contamination at the LNG facility is low because it is in deeper water of predominately fine sediment with no indications of contamination and sediment disturbance is minimal from the pile construction proposed.

9.15.1.3 Seabirds

No direct impacts on seabirds are anticipated as a result of construction of the Project, which is located well away from important nesting and rearing areas.

9.15.1.4 Mammals

Stormont Bay is not particularly important in relation to marine mammals. Seals may haul out on the shoreline and small whales may enter the area to feed, following schools of herring and mackerel, but no significant impacts from construction or operation of the Project are anticipated. The potential impacts to marine species and habitat will be monitored using the programs outlined in Sections 13.6 (Inshore Fishing Activity), 13.7 (Freshwater Fish and Fish Habitat) and 13.8 (Marine Fish Habitat).

Noise that can be heard by marine mammals can be generated from construction associated with the marginal wharf and the jetty, in particular, noise related to driving piles. Source levels have been shown to range from 131 - 135 dB re 1uPa up to one kilometre from the source (Richardson et al, 1995 in Hammond et al, 2005) however there are no available data on the effects of pile driving on marine mammals (Hammond et al, 2005). Stormont Bay is not particularly important in relation to marine mammals. Marine mammals appear to be transitory. Seals may haul out on the shoreline and small whales may enter the area to feed, following schools of herring and mackerel. Given the short duration of the operation and proposed option for vibratory drilling of piles, no significant impacts from construction or operation of the Project are anticipated. The potential impacts to marine species and habitat will be monitored using the programs outlined in Sections 13.0.

9.15.2 Operation

9.15.2.1 Fish Habitat

The operation of the Keltic facilities will involve arrival, loading or unloading of cargo, and departure of LNG carriers and cargo vessels carrying petrochemical products to market. Anticipated traffic is in the order of one large LNG carried per week and perhaps as many as three traditional cargo vessels. Booms and other spill prevention and clean-up equipment will be maintained at the wharf facilities to ensure minor spills do not impact the local environment, including fish habitat. The petrochemical facilities will be a closed-loop system with any discharge receiving appropriate treatment. Thus, no ongoing impacts on fish habitat are anticipated. Recommended mitigation measures for the marine environment are presented in Section 10.11.

9.15.2.2 Fish Habitat and Sediment Contamination

No sources of heavy metal contamination have been identified from operations of the Project (see also discussion in Section 9.15.1.2). However, propeller wash from vessels could potentially disturb sediments in and around the wharf and terminal.

Tugs will be used to manoeuvre and dock vessels, and these tugs will be berthed on the northwest (Isaac's' Harbour side) of the wharf nearest the areas of known sediment contamination. The shallow draft of the tugs will limit the potential for disturbance of bottom sediments and any contaminants present. As a result, no impact from sediment contamination is anticipated.

9.15.2.3 Seabirds

Two potential impacts on seabirds are associated with operation of the Project. Large ships passing close to Country Island could disturb nesting birds. Of particular concern are roseate terns, a SARA listed species. The low number of ships servicing the area, however, is unlikely to lead to a significant impact, as ships will not pass within the exclusion zone established for Country Island.

Some birds, particularly storm petrels, are known to be attracted to lights at night. Flares at the petrochemical facility could attract these birds, which nest on Country Island, particularly during their fall migration. The potential for significant injury or mortality is low, given that Country Island is 10 km from the petrochemical facility. Any impacts on storm petrels should be less than those associated with the flare at the Sable gas plant, which is closer to Country Island.

The proposed shipping lane for Keltic traffic will pass more than 5 km from Country Island. The shipping lane was placed as far as possible from the island given the various navigation constraints to minimize any potential impacts. While foraging of terns and other species may occur within the shipping lane, the relatively infrequent traffic and the large foraging area available will result in no more than minimal impacts.

9.15.2.4 Marine Mammals

Stormont Bay is not particularly important in relation to marine mammals (see discussion above under "Construction"). Seals may haul out on the shoreline and small whales may enter the area to feed, following schools of herring and mackerel, but no significant impacts from construction or operation of the Project are anticipated. The potential impacts to aquatic species and habitat will be monitored using the programs outlined in Sections 13.7 (Freshwater Fish and Fish Habitat), 13.8 (Marine Fish Habitat) and 13.6 (Inshore Fishing Activity).

9.15.3 Conclusions

Overall, the construction and operation of the marine terminal, the marginal wharf, and the LNG facility are not expected to have significant effects on marine species and habitat (Table 9.15-2).

None of the habitat lost is in anyway unique to the Bay, nor does it provide a critical function to the ecosystem. The loss of production of lobster, and other fish species, would be dwarfed by local variations in environmental factors such as water temperature and larval drift into the area. Water discharge qualities from the LNG facility will be within regulatory standards.

TABLE 9.15-2 Residual Environmental Effects Summary for Marine Species and Habitat

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance**	Likelihood of Occurrence***	Level of Confidence***
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context			
Construction										
LNG Facility (Marine Terminal), Petrochemical Plant (Marginal Wharf)										
Destruction of fish habitat as a result of construction of wharf and marine terminal	A	NA Loss of lobster habitat is only 1.6% of Stormont Bay	Low	Wharf/terminal: $0.123km^2$	Permanent	NR	Affected habitat type widely represented within Stormont Bay	Minimal		
Disturbance of seabird (Roseate tern) nesting habitat on Country Island from vessel movement and noise (i.e. blasting)	A	NA Establishment and adherence to exclusion zone	Low	Stormont Bay	Construction Phase	R	Species protected under SARA Schedule 1	Minimal		
Disturbance of marine mammals from Project-related marine traffic	A	NA Stormont Bay is not an important marine mammal location	Low	Stormont Bay	Construction Phase - Infrequent	R	Stormont Bay is not an important marine mammal location	Minimal		
Operation										
LNG Facility, Petrochemical Plant, Co-Gen Plant, Infrastructure (Meadow Lake Dam and Intake Structure)										
Disturbance of fish habitat from LNG and cargo vessels berthing at wharf and terminal; material handling, unloading.	A	• Environmental management plan • Spill response plan • Effluent discharges to marine environment to comply with regulatory standards • Effluent quality monitoring.	Low	Wharf/terminal: $0.123km^2$	Operation Phase	R	Affected habitat type widely represented within Stormont Bay	Minimal		

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance**	Likelihood of Occurrence***	Level of Confidence***
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context			
Marine habitat impairment as a result of re-suspension of contaminated sediments from propeller wash	A	NA • Large vessels to be berthed with support of tugs; • No sediment contamination identified;	Nil	Wharf/terminal: $0.123km^2$	Operation Phase	R	Affected habitat type widely represented within Stormont Bay	Minimal		
Marine habitat impairment as a result of wastewater discharges to Isaac's Harbour	A	• Discharges to be in accordance within regulatory standards; • Monitoring of effluent discharge quality;	Low	Wharf/terminal: $0.123km^2$	Operation Phase	R	Affected habitat type widely represented within Stormont Bay	Minimal		
Seabirds disturbed by large ships passing close to Country Island (Roseate terns)	A	Prescribed navigational route not to pass within the exclusion zone established for Country Island	Low	20 km radius exclusion zone	Operation Phase	R	Species protected under SARA Schedule 1	Minimal		
Seabirds (petrels) that nest on Country island could be attracted to flares at night	A	NA	Low	Stormont Bay	Operation Phase	R	No protective status under SARA Schedule 1	Minimal		
Disturbance of marine mammals through noise from Project-related marine traffic	A	NA Stormont Bay is not an important marine mammal location	Low	Stormont Bay	Operation Phase	R	Stormont Bay is not an important marine mammal location	Minimal		

* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 7
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 7
*** Only addressed for significant

9.16 IMPACTS ON AGRICULTURE

9.16.1 Construction Phase

No interaction between construction-related Project works and activities and agriculture have been identified. There are no agricultural uses within the proposed construction envelope or the zone of influence of the Project.

9.16.2 Operation Phase

No interaction between construction-related Project works and activities and agriculture have been identified. There are no agricultural uses within the proposed construction envelope or the zone of influence of the Project.

9.16.3 Conclusion

The Project is not expected to affect agriculture during the construction and operation phase.

9.17 GEOLOGICAL IMPACTS

There are two geologically related impacts in proximity to the Project area, all of which pre-exist the development of the Project namely:

- the abandoned mine workings that are located predominantly in the southwest portions of the proposed site; and
- the tailings areas on site, which remain as a legacy of past gold mining activities in the area.

There is a significant number of abandoned mine workings (around 100) on the proposed Project site, particularly in the southwest portions of the proposed site; including south and west of Route 316 generally coinciding with the proposed LNG facilities. Some of the abandoned mine workings are known to be quite extensive, some are several hundred metres long, and workings in the area are known to have gone to depths that exceed 70 m. Some workings are also believed to have moved upward from greater depth to surface either through the historic mining activity or through progressive collapsing of the underground workings. They are also known to be in direct contact with the ocean.

The exact location and character of these old workings are either poorly or undocumented. These workings are abundant in the southwestern part of the Keltic site, yet they are difficult to find because they have become overgrown and, in some instances, plugged at the surface with debris.

There are three tailings disposal areas within the Keltic Site, and one located just outside of the Site boundaries. Although the arsenic and mercury concentrations were lower in the soil samples collected at the shore of Dung Cove, because of possible exposure to storm surges, this tailings disposal area is perhaps of greater concern than the others. The floor of Dung Cove is believed to have been totally, or nearly totally, flooded with tailings.

Based on currently available information, with the exception of the local mine dumps and a few localized highly mineralized bedrock zones which have not yet been worked, there appears to be little risk of encountering large amounts of acid generating material within the boundaries of the proposed plant site, if any.

9.17.1 Construction

9.17.1.1 Mine Workings

The old mine workings are of concern primarily from a health and safety perspective during construction. The locations of the openings are difficult to see through the vegetation on site and workings close to the surface may pose a safety concern for heavy equipment operations. A detailed geotechnical investigation which includes an investigation for underground workings and mine openings will proceed any site construction activities.

9.17.1.2 Tailings

The tailings areas could become disturbed during plant site preparation or plant construction increasing the potential for arsenic- and mercury-bearing dust and sediment to be released by wind or via the watercourses that originate from or run through them. The airborne particles can be inhaled directly or migrate downwind to be deposited elsewhere. The mercury may also volatilize, to be introduced in downwind environments as mercury vapour. The tailings areas will be mapped and construction activities in the vicinity of the sites will be guided by protocols to be detailed in the EPP.

Further, there is concern with regards to the potential for off-site acid drainage generation at some locations north of the site including the Meadow Lake area. There may be abandoned mine tailings disposal areas on or near the Orex Exploration property located a short distance to the north of the proposed plant site. This area will need to be further evaluated once the plant site grading plans are finalized. It is anticipated that these areas can be avoided by careful project planning.

The tailings present at Dung Cove may become disturbed should there be a need to work in this body of water for the installation of piping or other structures. The installation of structures along the gravel and cobble barrier beach may cause the integrity of the beach to change, thus possibly subjecting the beach to greater erosion during severe storm events during site preparation and construction. Maintenance of the beach will be integral to the structural integrity of piping from the jetties to the LNG facility. As a result, the Proponent will include stabilization measures to minimize the loss of the barrier beach.

9.17.2 Operations

9.17.2.1 Mine Workings

The greatest concern regarding the mine workings relates to site operation and the possibility of accidental spills. The old mine workings may serve as rapid pathways, or “highways,” for spills or other groundwater contaminants from the Project toward neighbouring residential wells, watercourses and to Isaac’s Harbour.

9.17.2.2 Tailings

As during construction, should the tailings located on-site or at Dung Cove become disturbed during operation, arsenic- and mercury-bearing sediments and dust could be released via the wind or in streams, to be deposited elsewhere on and off site. The possible release of mercury vapours through volatilization could also pose a concern to plant site worker health.

With respect to acid drainage generation, the Project operation is considered to have minimal effects on the environment, since all surfaces affected by the construction will be stabilized and rehabilitated, where applicable. In addition, it is anticipated that with the implementation of an acid generating rock management plan, if required, there is not expected to be any on-going environmental concerns.

Possible breaches of the barrier beach at Dung Cove due to storm surges and the possible release of arsenic and mercury to the ocean will likely remain a concern throughout the lifespan of the plant site.

9.17.3 Conclusion

The effects on groundwater quality caused by the construction and operation of the plant are not expected to be significant (Table 9.17-1, see Section 10 for discussion of mitigation measures). The tailings areas will be mapped. If these areas cannot be avoided, construction activities in the vicinity of the sites will be guided by protocols to be detailing in the EPP. The tailings present at Dung Cove, maintenance of the beach will be ensured as part of the engineering of the piping from the jetties to the LNG facility. If required, specific beach stabilization measures will be included. During operation, effects will not be significant either, since all surfaces affected by the construction will be stabilized and rehabilitated, where applicable.

TABLE 9.17-1 Residual Environmental Effects Summary for Groundwater

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects: Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context	Significance**	Likelihood of Occurrence***	Level of Confidence***
Construction										
LNG Facility, Petrochemical Plant, Co-Gen Plant, Infrastructure (Meadow Lake Dam and Intake Structure)										
Mine workings could pose a risk for worker's health and safety	A	detailed geotechnical investigation and inventory of underground workings and mine openings	Low	Project site and vicinity	Construction Phase	NR	Known historic mining activities	Minor		
Disturbance of tailings could cause release to the environment of arsenic- and mercury-bearing dust and sediment	A	Mapping of tailings areas Implementation of EPP policies Stabilization of Barrier Beach (at Dung Cove) if required	Low	Project site and vicinity	Construction Phase	NR	Known historic mining activities and tailings	Minor		
Operation										
LNG Facility, Petrochemical Plant, Co-Gen Plant, Infrastructure (Meadow Lake Dam and Intake Structure)										
Mine workings could function as "highways" for spill related contaminants to enter groundwater health and safety	A	Implementation of EPP with spill prevention and response plan; Protections of mine openings against inflow of surface water run off	Low	Project site y	Operation Phase	NR	Known historic mining activities	Minor		

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance**	Likelihood of Occurrence***	Level of Confidence***
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R=reversible NR=Nor reversible	Ecological/Social-cultural and Economic Context			
Acid drainage generation from tailing sites	A	None required; all surfaces will be sealed and rehabilitated after construction phase; little to no potential for interaction identified	low	Project site	Operation	R	Known historic mining activities and tailings	Minimal		

* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 7
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 7
*** Only addressed for significant effects

9.18 IMPACTS ON ARCHAEOLOGICAL RESOURCES

9.18.1 Introduction

Archaeological resources are those tangible remains of past human activity, whether on or below the surface of land or water, which include portable and non portable objects including structures, features, and artifacts. An archaeological structure is a built standing object such as an abandoned house whereas an archaeological feature is defined as a fixed object such as a house foundation, cemetery, hearth, shipwreck, or mine shaft. Artifacts are those portable remnants of human activity such as stone tools, china, nails, and clothing. In Nova Scotia, archaeological resources are the property of the citizens of the province and are protected and curated by the Nova Scotia Museum under the *Special Places Protection Act* (R.S., c. 438, s.1.).

Previous archaeological investigations in the vicinity of the development area, such as the archaeological intervention at Red Head Cemetery in 2001-2002 and archaeological assessments for the M&NP and SOEI project, indicated that this area was of high potential for heritage resources. Several such resources were located within the development zone during the current archaeological assessment (refer to Section 8.14). Under the *Special Places Protection Act*, mitigation of those resources expected to be impacted by construction or related ground-disturbance activities is required.

A historical background study was conducted for the entire 324 ha of land in Goldboro. However, the archaeological survey and recommended mitigation measures were confined to those areas expected to be directly impacted by construction (i.e. the footprints of buildings and necessary infrastructure).

9.18.2 Construction Phase

Each archaeological resource within the Study Area has been evaluated according to its relative significance based on the cultural and physical integrity of each resource, existing documentation, and the expected impact on those resources (Table 9.18-1).

TABLE 9.18-1 Relative Significance of Sites within the LNG Plant Keltic Study Area

Archaeological Site or Resource	Archaeological Sensitivity	Cultural Sensitivity	Expected Impact (Yes/No)
Red Head Cemetery	Medium	High	Yes
Sculpin Cove 1	High	High	Unknown
Sculpin Cove 2	High	High	Unknown
Sculpin Cove 3	High	High	Unknown
Sculpin Cove 4	High	High	Unknown
Sculpin Cove 5	High	High	Unknown
Hurricane Island Mine	High	N/A	Unknown
McMillan Mine	Low	N/A	Yes
Dung Cove	High	High	Unknown
Giffin's Mill	High	N/A	No
Hattie's Belt	Medium	N/A	No
Giffin Lead	Medium	N/A	No
Skunk Den Mine Crusher	Medium	N/A	No
South Mulgrave Lead	Medium	N/A	Yes

9.18.2.1 LNG Facility and Marine Terminal

Construction of the LNG and Marginal Wharf may have effects on several archaeological features. However, due to previous excavation and removal of burials at Red Head in 2000 and 2001, complemented by subsurface testing in October 2004, there is confidence that no burials remain in the cemetery and, therefore, the site is no longer believed to be of high archaeological sensitivity. However, due to its association as the final resting place of the first Black Loyalists in Goldboro and Isaac's Harbour, it remains to be of cultural significance to the nearby Black community at Lincolnville. This site lies within the impact zone and is expected to be heavily disturbed.

The Sculpin Cove 1 to 5 sites produced no surface artefacts and shoreline erosion has not exposed any material culture. Although they are obviously of human construction, there is no evidence to indicate that they were occupied for extensive periods of time and their cultural, functional, and historical period affiliations are unknown. However, the possibility that they are related to late eighteenth century Black Loyalist settlement is present. Research into Black Loyalist settlement is just beginning in Nova Scotia and it is a current focal point of several projects in the province (Cottreau-Robins, MacLeod-Leslie, Niven, Whitehead). For these reasons, these features are believed be of high archaeological and cultural sensitivity. Although none of these five features are expected to be directly impacted by construction, the effect of ship wakes on these features as a result of product storage construction and ship berthing is of concern.

Hurricane Island Mine is a pristine example of late nineteenth-century mining in Nova Scotia. To the best of the archaeologists' knowledge, no research has been conducted to date on historic mining in the province during any period of the past. This site, then, is deemed of high archaeological sensitivity and community members have expressed concern regarding the fate of historic resources on the island. Hurricane Island is not expected to be impacted by construction.

The McMillan mine is of early to mid twentieth-century origin and, therefore, is believed to be of low archaeological sensitivity. This site is located directly in the impact zone and is expected to be heavily disturbed by construction of the product storage area and access road.

The Dung Cove site is located within close proximity to the impact zone and the possible level of impact needs to be further understood. Due to the obscurity of features by low tree cover, no structural remains were visible at the Dung Cove site. However, the site does exhibit landscape modification congruent with agricultural activity. Although no surface artefacts were present to indicate the age of the site or its cultural affiliation, the potential that it is related to late eighteenth century Black Loyalist settlement exits. Therefore, this area is believed to be of high archaeological sensitivity.

The physical integrity of features at Giffin's Mill and the possibility of recoverable material culture make this site one of high archaeological sensitivity. There has been little or no research conducted on early twentieth century mills in the province and this site and its contents would likely be of interest to the Museum of Industry. The mill site is not expected to be impacted by construction.

Although no definitive structural remains were found, Hattie's Belt includes several features associated with early mining in Goldboro including crusher piles, sluices, open-pit mines, prospecting pits, and a surface tunnel. As a whole, these features could lend valuable information regarding early gold mining activities in the province which could be of interest to the Museum of Industry. The Skunk Den Mine and the Giffin Lead exhibit similar valuable features. These sites are deemed to be of medium archaeological sensitivity. However, none of these three sites are expected to be impacted by construction.

9.18.2.2 CoGeneration Power Plant

The Skunk Den Mine and the Giffin Lead exhibit valuable features associated with early mining in Goldboro. These sites are deemed to be of medium archaeological sensitivity. However, none of these three sites are expected to be impacted by construction.

9.18.2.3 Petrochemical Facility

The Mulgrave lead was the first area mined in Goldboro and the south lead still exhibits structural remains of a mine shaft along with associated stone crusher piles. The east end of the site has been recently disturbed by levelling of the stone crusher piles and surrounding land, making the determination of associated settlement location difficult.

Features may still exist beneath the levelled crusher piles or may have been destroyed during the landscaping process. The west end of the site including the mine shaft is located outside the Keltic Study Area. The east end of the site, however, is located directly in the impact zone and will be disturbed further by construction. This site is believed to be of medium archaeological sensitivity.

Several areas of surface prospecting were noted during the survey and have been discussed in earlier sections of this report. Because they contain no structural remains and the chances of recovering associated in situ material culture are negligible, these areas are deemed to be of low archaeological and cultural sensitivity. This assignment extends to those areas of cultural activity noted in Section 8.14 which were not recorded. Recommended mitigation measures are presented in Section 10.14.

9.18.2.4 Infrastructure (Water Intake or Others)

The construction of the dam at Meadow Lake would result in water level increases that may submerge archaeological resources, if present, particularly First Nations resources. This area was not surveyed during the 2004 field assessment. However, First Nations sites have been recorded at Stormont as well as on the west shore of Isaac's Harbour.

9.18.3 Operation Phase

The only expected impacts to archaeological resources during the operation phase are associated with the continued rise in water levels at Sculpin Cove, Hurricane Island, and Meadow Lake. A rise in sea level and wakes created by ship berthing as a result of the operation of the marginal wharf may cause erosion to known archaeological sites at Sculpin

Cove and on Hurricane Island. Similarly, flooding of Meadow Lake and its associated reservoirs may also impact on archaeological sites, if present.

9.18.4 Conclusion

Significant impact to at least three sites of moderate archaeological sensitivity is expected during construction of the LNG facility and associated wharf. Archaeological mitigation is recommended for the Dung Cove, Hattie's Belt, and Skunk Den Mine sites prior to construction. The former cemetery at Red Head is an area of cultural sensitivity and should be monitored carefully during ground disturbance. Finally, the potential impact to sites along Sculpin Cove and on Hurricane Island is not clearly understood at this point and may require mitigation should operation and maintenance of the wharf and shipping in the harbour cause shoreline erosion. Specific recommendations for mitigation are outlined in Section 10.14 and a monitoring program is outlined in Section 13.9.

TABLE 9.18-2 Residual Environmental Effects Summary for Historic Resources (Archaeology)

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance**	Likelihood of Occurrence ***	Level of Confidence***
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Not reversible)	Ecological/ Social-cultural and Economic Context			
CONSTRUCTION										
LNG Terminal and Marginal Wharf										
Disturbance of land at the former Red Head Cemetery by marginal wharf and marine facility	A	Public consultation with Lincolnville Black community. Monitored backhoe excavation.	High	7,200 m^2	Permanent	NR	Historic black Loyalist	Medium (Cultural/ Spiritual)		
Erosion of sites at Sculpin Cove (1-5) by marginal wharf	A	None currently. Investigation if they are subject to erosion.	Unknown	Shoreline	Permanent	NR	Unknown	Minor		
Erosion of sites on Hurricane Island by marginal wharf	A	None currently. Investigation if they are subject to erosion.	Unknown	Shoreline	Permanent	NR	Unknown	Minor		
Impact on McMillan Mine by LNG storage and access road	A	Monitoring during disturbance.	High	Unknown	Permanent	NR	Euro-Canadian Industrial	Minor		
Impact on Dung Cove site by WWTP building	A	None currently. Investigation if it is subject to impact.	Unknown	Unknown	Permanent	-	Euro-Canadian settlement	Minor		
Impact on Hattie's Belt by LNG storage.	A	None currently. Investigation if it is subject to impact.	Unknown	Unknown	Permanent	-	Euro-Canadian Industrial	Minor		

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance**	Likelihood of Occurrence ***	Level of Confidence***
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Not reversible)	Ecological/ Social-cultural and Economic Context			
Petrochemical Plant										
Potential impact on South Mulgrave Lead	A	Monitoring during disturbance.	Unknown	Unknown	-	NR	Euro-Canadian industrial/ settlement	Minor		
Co-Gen Plant										
No interaction with the Project	n/a	n/a	-	-	-	-	-	-		
Infrastructure										
Potential impact to sites at Meadow Lake as a result of construction of dam and resulting submergence.	A	None currently. This area has not been surveyed. Archaeological survey prior to construction activities	Unknown	Unknown	Permanent	NR	Unknown	Unknown		
OPERATION										
LNG Terminal and Marginal Wharf										
Continued erosion of sites at Sculpin Cove (1-5) by potential rise in sea level and wakes.	A	None currently. Investigation if they are subject to erosion.	Unknown	Shoreline	Unknown	NR	Unknown	Unknown		
Continued erosion of sites on	A	None currently. Investigation if they are subject to erosion.	Unknown	Shoreline	Unknown	NR	Unknown	Unknown		

Project-Environment Interaction	Potential Positive (P) or Adverse (A) Effect	Mitigation	Significance Criteria for Environmental Effects					Significance**	Likelihood of Occurrence ***	Level of Confidence***
			Magnitude*	Geographic Extent	Duration/Frequency	Reversibility (R= reversible NR = Not reversible)	Ecological/ Social-cultural and Economic Context			
Hurricane Island by potential rise in sea level and wakes.										
Petrochemical Plant										
No interaction with the Project	n/a	n/a	-	-	-	-	-	-		
Co-Gen Plant										
No interaction with the Project	n/a	n/a	-	-	-	-	-	-		
Infrastructure										
Potential impact to sites at Meadow Lake by continued submergence.	A	None currently. This area has not been surveyed.	Unknown	Shoreline	Unknown	NR	Unknown	Unknown		

* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 7
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 7
*** Only addressed for significant effects

9.19 TRANSPORTATION IMPACTS

The transportation impacts of the Keltic project include transportation infrastructure impacts related to the construction and operation of the LNG facility; petrochemical facilities; and cogeneration plant

In considering the impact of the Project on the transportation infrastructure, safety, convenience, level of service or performance, and safety as indicated by collision experience were evaluated.

The primary concerns of the effects that the Project may have on transportation infrastructure include increased volumes and potential collisions on sections of Trunk 7, Routes 276 and 316, between Highway 104 near Antigonish and the Site as result of the following:

- construction workers and equipment travelling to/from the Site over a three year construction period;
- workers travelling to/from the Site over future years of operation of the LNG and petrochemical plants;
- maintenance equipment and production materials being transported to the Site; and
- heavy trucks transporting finished products from the petrochemical plants.

The existing highway infrastructure between Antigonish and the Keltic Site (see Section 8.16) is characterized by approximately 77 km of travel on roads with low posted speed limits and, a considerable length of road with inadequate all-weather strength for heavy trucks. The majority of the route is considered to be a two lane collector route (Route 276 and 316) with the segment between Route 276 and the Sable Gas Plant Road currently experiencing higher than average collision rates when compared to the provincial average for collector roads.

9.19.1 Construction Phase

Construction of the Keltic Site is projected to last three years and will involve about 1400 workers working six days per week for 48 weeks per year. If it is assumed that all of these workers travelled from, and returned to, the Antigonish area each day with 2.5 workers per vehicle, there will be an additional 1,120 two-way vehicle trips per work day on the existing access route using Trunk 7, Route 276 and Route 316. This traffic will be concentrated during times coinciding with shift changes at the site.

Shipment of construction materials is projected to include about 3,500 truck loads delivered over the three year construction period which will involve 7,000 additional truck trips on the existing access routes or an average of 8 additional truck trips per day (assuming a six day work week). This traffic will generally be spread out over the course of a day.

The combined impacts of construction worker traffic and transportation of construction materials will be an increase of about 900 vehicles per day in the AADT volume on Trunk 7, Route 276 and Route 316 which represents an estimated two-fold volume in traffic for Routes 276 and 316.

Using the total route length of 76.7 km (Table 8.16-1) and the combined collision rate of 59.7 collisions per hmvk (Table 8.16-4), the additional traffic may result in an estimated 15 additional vehicle collisions per year on the existing access route over the three year construction period.

Impacts of Access Route Weight Restrictions on Truck Operations

The existing road route most likely to be used to travel from Antigonish to Goldboro is Trunk 7 from Highway 104 to Route 276, Route 276 from Trunk 7 to Route 316, and Route 316 from Route 276 to Goldboro. The Trunk 7 section of the route is rated as a Maximum Weight – Spring Exempt road, meaning that trucks can carry maximum registered loads all year. While Routes 276 and 316 are designated as 'B-Train' routes, a considerable section of Route 316 from south of Route 276 to north of Goldboro is subject to 'Spring Weight Restrictions,' which means that gross allowable weights will be reduced considerably below registered weights for about six to eight weeks each spring.

The six to eight weeks of Spring Weight Restrictions on most of Route 316 between Route 276 and Goldboro will impact the transportation of construction materials during the construction phase of the Project, and production materials and finished products during the operation phase of the Project. For example, while a six-axle semi-trailer could be registered for a maximum weight of 47,500 kg, it would be restricted to a maximum weight of 30,000 kg during the Spring Weight Restriction period. This reduction in allowable weight may require increased numbers truck trips during the six to eight week period each spring throughout both the construction and operation phases.

Potential mitigation actions of the Spring Weight Restriction on Route 316 include:

1. Ship materials in smaller loads in accordance with the restricted weights;
2. Upgrade the road to allow maximum weight - spring exempt truck movements;
3. Stockpile construction and production materials on site before the start of the Spring Weight Restriction. Also, stockpile finished products on site for shipping after the Spring Weight Restriction.

9.19.2 Operation Phase

During the operation of the LNG and petrochemical plants, it has been estimated that there will be approximately 500 employees at the plants. If 25% of the workers are assumed to live near the plants, and 75% live near Antigonish, there would be about 500 two-way trips per work day on access routes between Antigonish and the plants if operation workers travelled with1.5 persons per vehicle. Also, it is estimated that there will be about 100 two-way truck trips per day for shipping of products, including butane, propane, and polymers. It is anticipated that the distribution of personal vehicle traffic through the day will be similar to the construction phase, however, truck traffic may be spread out through a 24 hour period.

If there are assumed to be about 320 work days per year, the combined impacts of operation worker traffic and transportation of finished products will be an increase of about 525 vehicles per day in the AADT volume on the existing access route using Trunk 7, Route 276 and Route 316. Using the total route length of 76.7 km (Table 8.16-1) and the combined collision rate of

59.7 collisions per hmvk (Table 8.16-4), the additional traffic may result in additional vehicle collisions on an annual basis.

Impacts of Access Route Weight Restrictions on Truck Operations

The discussion on access route weight restrictions on truck operation presented for the construction phase equally applies to the operation phase.

9.19.3 Conclusion

Transportation impacts are expected to be most noticeable during the operations phase, when the existing road system is used for the transport of products by plant workers. Upgrades to the existing road infrastructure will likely be required so that the overall level of effect will not be significant (Table 9.19-1).

TABLE 9.19-1 Residual Environmental Effects Summary for Transportation

Project-Environment Interaction	**Potential Positive (P) or Adverse (A) Effect**	**Mitigation**	**Significance Criteria for Environmental Effects**					**Significance****	**Likelihood of Occurrence*****	**Level of Confidence*****
			Magnitude*	**Geographic Extent**	**Duration/Frequency**	**Reversibility (R=reversible NR=Nor reversible**	**Ecological/Social-cultural and Economic Context**			
Construction										
LNG Facility, Petrochemical Plant, Co-Gen Plant, Infrastructure (Meadow Lake Dam and Intake Structure)										
Increase in collision rates due to construction-related vehicular traffic	A	Flagman at construction site entrance, if required; Along main transport route, adjustment of travel speed, signage, intersection controls, sight lines;	Medium (increase by about 15 vehicle collisions/ yr)	77 km road between Antigonish and Keltic Site	Construction Phase	R	Existing two lane road link consisting of one trunk and two collector road segments; no control of access, frequent driveway	Medium		
Operation										
LNG Facility, Petrochemical Plant, Co-Gen Plant, Infrastructure (Meadow Lake Dam and Intake Structure)										
Increase in collision rates due to operation-related vehicular traffic	A	Controlled site entrance, if required; Along main transport route, adjustment of travel speed, signage, intersection controls, sight lines;	Medium (increase in collision rates less than 15/yr)	77km road between Antigonish and Keltic Site	**Construction Phase**	R	Existing two lane road link consisting of one trunk and two collector road segments; no control of access, frequent driveway	Medium		

* For definition of levels of magnitude (high, medium, low, nil, unknown) refer to Section 7
** For definition of levels of significance (major, medium, minor, minimal) refer to Section 7
*** Only addressed for significant effects

9.20 IMPACTS ON HUMAN HEALTH AND SAFETY

Human health and safety are identified as a VEC in the Terms of Reference for the Keltic project. This VEC includes two facets of potential adverse effects, public health and safety and worker health and safety. It is evaluated primarily to address potential health and safety risks to the public and workers associated with routine plant emissions, accidents, malfunctions, and unplanned events. Section 9.21 addresses potential hazards associated with accidents, malfunctions, and unplanned events, in particular related to LNG. In part, this section considers potential impacts of the Project on other VECs that are also relevant to human health. These include: air quality, groundwater, geology (soil), and surface water. The potential effects on these other VECs will be evaluated in a cumulative way to evaluate whether there is a potential for effects on human health and safety.

In order to protect worker health and safety, Keltic will develop a comprehensive Health and Safety Program that will be implemented throughout the Project, including construction, operation, and decommissioning.

Spatial and Temporal Boundaries

The spatial boundary for the evaluation of human health and safety is the area that could be potentially affected by routine facility activities, as well as accidents, malfunctions, and unplanned events. This assessment considers members of the public that may be present, either intermittently or continuously, within the zone of influence of any such effect. This would include members of the general public that may live in or visit the area. This assessment also considers workers that are employees or contractors for the Project. It does not include workers at adjacent facilities or establishments, as they are considered as part of the general public.

The spatial boundaries for this VEC relative to public health and safety are determined by:

- the area impacted by air releases, as identified by potential for releases, or areas of impact identified (Section 9.6); and
- the area potentially affected as a result of the consequence analysis (Section 9.21).

The areas of other potential impacts are likely to be within the above areas. As a result of these analyses, the spatial boundaries (Figures 2.0-1A and B) have been defined in Section 7.1.2. The temporal boundaries for these impacts are largely during facility operation, although limited releases may occur during the construction and decommissioning phases.

For worker health and safety, the spatial boundaries have been established in the vicinity of the proposed pier, LNG processing and storage area, and the petrochemical complex located in Goldboro Industrial Park and along the northeast side of Isaac's Harbour and from the end of the shipping lane into Isaac's Harbour to the proposed pier. The temporal boundaries for these impacts are during the construction and operational phases.

The spatial boundaries for project-related marine accidents are the shipping lanes and Isaac's Harbour from the end of the shipping lanes to the pier. Temporal boundaries include the time traveling to the pier and docked at the facility. It is estimated that vessels will arrive approximately 3-4 days during the initial project phase and then every 3.5 to 1.8 days. Hoteling and unloading of LNG ships will typically require 24 hours.

Overall, the temporal EA boundaries were established by considering the time periods over which project-related impacts could occur and during which environmental impacts should be evaluated. These are activities and timeframes related to:

- Site preparation, construction and commissioning of the Project, including road construction, facility component construction, and marine facility construction. This phase is expected to occur in the beginning of the Project over a period of approximately 33 months.
- Operation of the Project facilities. For the purposes of this assessment, this time frame is assumed to be a period of at least 30 years.
- Decommissioning of the facility and site restoration. These activities are assumed to occur over a period of approximately 12 months.

Once decommissioning is complete, no impacts from the Project are expected.

Administrative and Technical Boundaries

Administrative boundaries are those boundaries that provide a regulatory framework for the evaluation of this VEC. Technical boundaries are any limitations to the scope or evaluation of this VEC.

A number of laws, regulations, and guidelines are relevant to the evaluation of human health and safety, as identified below:

- *Occupational Health and Safety Act of Nova Scotia* – describes the general guidelines under which worker health and safety will be protected.
- Air Quality Regulations of Nova Scotia – specifies maximum permissible ground level air concentrations.
- *CEPA* – establishes ambient air quality objectives for maximum desirable as well as maximum tolerable ground level air concentrations.
- Canadian Environmental Quality Guidelines – includes soil guidelines for the protection of human health and guidelines for Canadian drinking water quality.
- Atlantic PIRI Reference Document for Petroleum Impacted Sites in Atlantic Canada. Atlantic RBCA Version 2.0 – Provides Tier 1 soil and groundwater concentrations protective of human health from petroleum releases, as well as methods to develop site-specific target levels.

The technical boundaries of this assessment are primarily related to the fact that impacts to human health and safety are generally based on modeling. While the modeling approaches are somewhat standardized and accepted, the evaluation of potential impacts to health and safety is limited by the assumptions used and the scenarios modeled.

Residual Environmental Effects Evaluation Criteria

In order to evaluate whether any potential impacts on human health and safety are significant, criteria are established. In general, such impacts would be considered significant if they resulted in adverse health effects or serious injury. Criteria to protect public health have been established through the laws, regulations, and guidance documents identified above. These criteria will be used to evaluate whether anticipated impacts are likely to result in significant impacts to human health. Anticipated concentrations exceeding criteria shown in this Table will be considered a significant adverse effect. Table 9.20-1 summarizes the relevant criteria for chemicals that might be spilled or released during construction, operation, or decommissioning.

Criteria are not shown in Table 9.20-1 to address worker health and safety. A preventative health and safety program will be implemented for construction, operation, and decommissioning that ensures that the public and workers are not adversely affected during routine operations, and that contingency plans are in place to prevent impacts during accidents, malfunctions, and unplanned events.

Potential Interactions, Issues and Concerns

Humans that may be potentially affected by construction, routine facility activities, as well as accidents, malfunctions, and unplanned events are primarily those that live in the Study Area. The nearest communities to the Keltic facility are Goldboro and Seal Harbour. According to Industry Canada (2005), Goldboro has a population of about 450. The primary sensitive receptors in the area of the Project include the Goldboro Interpretive Centre, Isaac's Harbour Villa Senior Apartments, and Isaac's Harbour Medical Centre.

Residents in the area all use private wells, as described in Section 8.7. There are also approximately 1780 people within 30 km of Goldboro, although most of these are outside of the potential area of impact.

As discussed above, during the 33 month construction period, the facility is expected to employ up to 3000 people. Approximately 60% of the workforce is expected to be housed in temporary construction quarters at the facility. During operation, the facility is expected to employ approximately 600 workers.

The following sections describe potential impacts to health and safety during construction, operation, and decommissioning. These impacts, as well as mitigative measures, are summarized in Table 9.20-2.

TABLE 9.20-1 Residual Environmental Effects Criteria - Health and Safety

Chemical	Soil (mg/kg)											
	Canadian Environmental Quality Guidelines				Atlantic RCBA Version 2.0 Tier I Risk-Based Screening Level							
	Agri.[1]	Res./Park[2]	Comm.[3]	Industrial[4]	Residential				Commercial			
					Potable		Non-Potable		Potable		Non-Potable	
					Coarse-grained soil	Fine-Grained soil	Coarse-grained soil	Fine-grained soil	Coarse-grained soil	Fine-grained soil	Coarse-grained soil	Fine-grained soil
Petroleum Hydrocarbons												
Gasoline					39	140	39	330	450	520	450	10,000
Diesel/#2					140	220	140	4,400	7,400	840	7,400	7,700
#6 Oil					690	970	690	8,300	10,000	4,700	10,000	10,000
VOCs												
Benzene	0.05	0.5	5	5	0.03	0.01	0.16	1.5	0.03	0.01	1.8	11
Toluene	0.1	0.8	0.8	0.8	0.38	0.08	14	120	0.38	0.08	160	680
Ethyl Benzene	0.1	1.2	20	20	0.08	0.02	58	430	0.08	0.02	430	430
Xylenes	0.1	1	17	20	11	2.3	17	160	11	2.3	200	650
Metals												
Arsenic	12	12	12	12								
Chromium (hexavalent)	0.4	0.4	1.4	1.4								
lead	70	140	260	600								
Mercury	6.6	6.6	24	50								
Criteria Air Pollutants												
CO												
Hydrogen Sulphide												
NO_2												
Ozone												
SO_2												
TSS												

1. Agricultural Land Use
2. Residential/Parkland Uses
3. Commercial Land Use
4. Industrial Land Use

TABLE 9.20-2 Residual Environmental Effects Evaluation Assessment Matrix - Health and Safety

Project Activities and Physical Works	Potential Positive (P), Adverse (A), or No (N) effect on VEC	Potential Significance	Mitigation
Construction and Commissioning			
Site Preparation (clearing and grubbing, blasting, grading)	A - particulate generation, safety concerns regarding former mine workings	Unlikely to impact the public due to distances to receptors, more likely to impact workers; concern in mine tailings areas; structural concerns if construction occurs in former mine workings areas	Dust Control Program, Worker Health and Safety Program, Avoid mine workings and tailings areas to the extent possible
Temporary Construction Camp	N		
Construction of Pier (side casting, placement of rock and offshore structures, driving or drilling/grouting of berthing piles, placement of decking)	P - Potential covering or control of mine tailings	Pier construction may result in positive effect by limiting future migration of mine tailings	None
Vessel Transportation (delivery of construction materials and equipment)	A - air emissions	Unlikely to impact the public due to distances to receptors and duration of construction activities	None
Pier Deck-LNG unloading and transfer piping, fire protection)	N		
Installation of Process Components (tanks, piping, pumps, ancillary facilities, pipelines and power generation)	N		
Concrete Production	A - dust generation	Unlikely to impact the public due to distances to receptors, more likely to impact workers	Dust Control Program
Water Management, including waste water management	N		
Waste Management including site prep debris	A - potential for run-off	Run-off resulting in migration of mine tailings a concern	Erosion Control Program
Vehicular Traffic	A - air emissions	Unlikely to impact the public due to distances to receptors, dust may be an issue for workers	Dust Control Program, Worker Health and Safety Program
Equipment and Materials Storage	A - potential spills	Potentially significant if spills result in vapours or air impacts, or effects on groundwater resulting in impact on private wells	Spill control plan

Project Activities and Physical Works	Potential Positive (P), Adverse (A), or No (N) effect on VEC	Potential Significance	Mitigation
Watercourse Crossing (stream diversion, culvert installation, restoration temporary vehicle crossings)	N		
Installation of Water Supply Components	N		
Operation			
Marine Vessel Traffic, Unloading	A - air emissions	Unlikely to be significant due to distance to receptors	
Unloading LNG from Vessels to Tanks	A - air emissions	Unlikely to be significant based on modeling results	Spill control plan
Vaporization/regassification of LNG to Natural Gas	A - air emissions	Unlikely to be significant based on modeling results	
Chemicals Manufacturing (various)	A - air emissions, potential spills	Air emissions unlikely to be significant based on modeling results; Potentially significant if spills result in vapours or air impacts, or effects on groundwater resulting in impact on private wells	Spill control plan
Power Generation	A - Air emissions	Unlikely to be significant based on modeling results	
Water Management (process, potable)	N		
Waste Management	A - discharge	Unlikely to be significant due to limits to discharge proposed	
Vehicular Traffic	A - air emissions	Unlikely to impact the public due to distances to receptors	
Materials Transfer and Storage (other than LNG)	A - potential spills	Potentially significant if spills result in vapours or air impacts, or effects on groundwater resulting in impact on private wells	Spill control plan
Maintenance/Repairs	N		

Project Activities and Physical Works	Potential Positive (P), Adverse (A), or No (N) effect on VEC	Potential Significance	Mitigation
Decommissioning and Abandonment			
Decommissioning the waterfront facilities and pipelines	A - Potential uncovering of mine tailings	May result in releases of mine tailings	Decommissioning should retain cover for mine tailings
Decommissioning of Petrochemical facilities	A - Potential for air emissions, spills	Potentially significant if spills result in vapours or air impacts, or effects on groundwater resulting in impact on private wells	Dust Control Plan, Spill control plan
Demolition and Removal of Facilities	A - Potential for air emissions, spills	Potentially significant if spills result in vapours or air impacts, or effects on groundwater resulting in impact on private wells	Dust Control Plan, Spill control plan
Reclamation	A - particulate generation	Unlikely to impact the public due to distances to receptors, more likely to impact workers; concern in mine tailings areas	Dust Control Program, Worker Health and Safety Program, Avoid mine tailings areas to the extent possible
Vehicular Traffic	A - air emissions	Unlikely to impact the public due to distances to receptors	None

9.20.1 Construction Phase

During construction, there are several activities that could potentially impact human health and safety:

- dust generation during facility and roadway construction, in particular concerns with arsenic and mercury that are residuals of mining operations;
- safety concerns regarding former mine workings;
- air emissions from construction equipment and vessels transporting construction materials and equipment;
- water and waste management and control; and
- air emissions from vehicular traffic to the construction locations.

Dust generation during facility and roadway construction could occur, although potential impacts are expected to be localized. A Dust Control Plan to be implemented during construction will address this issue and provide specific monitoring requirements and controls to minimize dust. This is of particular concern in areas where mine tailings are found. As discussed in Section 8.13.4, sediment/tailing samples in Dung Harbour have been shown to have elevated concentrations of arsenic ranging from 14 mg/kg to 1700 mg/kg, well above the Canadian Environmental Quality Guideline for soil of 12 mg/kg, considering either residential or industrial land use, as shown in Table 9.18-1. Concentrations of mercury in this area slightly exceed the residential guideline of 6.6 mg/kg in only one sample. Since the tailings in this area are wet, particulate generation is unlikely. However, handling of this material by workers should be conducted with adequate Health and Safety Controls, and re-use at the ground surface in other locations should be prevented. Such use could result in transport as particulates, and potential exposure to the public.

Two other known tailings areas are found in locations potentially within the project area (see Figure 8.13-4). In addition, others may be identified during construction activities. Health and Safety controls should be used to protect workers involved in activities in these areas, and potential airborne transport should be minimized.

Air emissions from construction equipment and vessels transporting equipment and materials should be localized with limited transport, due to their sporadic nature and emissions close to ground surface. Air emissions of vehicular traffic to the construction site will also occur, however, many of the workers will be located at the site, and much of the equipment and materials will be transported to the site by sea. Therefore, traffic to the site during construction will be minimized.

Water and waste management should not pose a hazard to public health or worker safety during construction. The primary concern is preventing run-off or other transport of soils impacted by mining. Construction practices in such areas should include provisions to control run-off and potential migration of impacted soils.

Equipment and materials storage during construction is likely to consist of building materials, process components, and other items needed for construction. Spills could occur from construction equipment kept on-site during this period, or from stored fuels, or other liquid materials needed for equipment or construction. Such spills are likely to be of small volume and localized, as large quantity storage is not expected during the construction period. Nevertheless, uncontrolled spills could impact groundwater and potentially migrate to private supply wells. As discussed in Section 9.17.1.2, old mine workings could provide a preferential pathway for spills to impact private wells. Equipment and materials storage that could result in spills should be located away from areas with former mine workings. A Spill Control Plan will be implemented during construction to provide specific requirements for storage, prevention, and response to spills to minimize any potential impact.

Old mine workings also present a safety hazard for workers during construction activities due to their potential lack of structural integrity. Steps should be taken to assure their stability, or activities or structures should be located away from such areas.

9.20.2 Operation Phase

During facility operation, there are several activities that could potentially impact human health and safety:

- air emissions from marine vessel traffic and uploading;
- air emissions during vapourization/regassification of LNG to natural gas;
- air emissions during chemical manufacturing and power generation;
- facility wastewater discharges;
- air emissions from vehicular traffic; and
- potential spills during materials transfer and storage.

Air emissions from marine vessel traffic are unlikely to impact humans, since the shipping lane is quite distant from human receptors. However, during hoteling and unloading of LNG ships (approximately 24 hours), engines will be idling. Emissions are expected to occur over this period. These impacts are considered in the modeling of air emissions, as discussed below.

Section 9.6 estimated emissions from project components during operation and modeled air concentrations based on these emissions and those from the SOEP gas plant. The highest predicted pollutant air concentrations are compared to Nova Scotia Maximum Permissible Concentrations. This comparison (Table 9.6-3) shows that all regulatory standards are met. In addition, the highest predicted pollutant concentration is not likely to be where there are any receptors. Table 9.6-4 shows that maximum estimated concentrations at identified sensitive receptors are much lower than the highest predicted concentrations. These comparisons indicate that air emissions during facility operation are not likely to pose a health risk.

Spills could occur during chemical manufacturing and power generation, although most of the feedstocks and intermediate products are gases. Hexane and pentane will be stored on site for use in the polyethylene plant. The volatile nature of these compounds makes potential migration to groundwater and water supplies unlikely. A pyrolysis fuel oil product will be used as auxiliary/power boiler fuel, and a residue gas product will be produced in the ethylene plant and flow to the central fuel gas mix drum of the facility. Given the anticipated reuse of these products, spills are unlikely. Storage of other miscellaneous fuel oil products needed to operate vehicles and equipment may also occur, and could result in spills. As described above, storage of materials that could result in spills should be located away from areas with mine workings that could provide a preferential flow pathway to surface water or groundwater. A Spill Control Plan will be developed for facility operation. It will describe required monitoring, storage requirements, and response procedures should a spill occur. The implementation of this plan will minimize any potential impact to soils and groundwater that could result in potential impacts to human health. Many of the spill containment measures in terms of facility design and component siting are described in Section 2.3.

Expected wastewater discharges from the facility have been described in Section 2.3.2.5. Effluents from the facility will be treated to applicable quality standards and are not expected to present a hazard to health or safety.

Worker safety concerns are present at this facility, similar to any other industrial facility. A health and safety program will be developed and implemented for the facility that will address routine and non-routine activities and procedures to minimize potential chemical exposures and safety incidents. This program will provide the basis for compliance with all workplace standards and guidelines.

9.20.3 Conclusion

Most of the site activities that could affect human health and safety are related to dust generation. During construction and demolition activities, a particulate monitoring plan will be implemented to protect workers and nearby residents.

In order to assure that construction or operation activities have not impacted drinking water in the area, select private wells will be included in the groundwater monitoring program. These wells will be sampled and analyzed for metals, VOCs, and petroleum compounds, as well as coliforms. While no such impacts are expected, monitoring is planned due to the uncertainty regarding flow characteristics considering the mine workings in the area.

The Health and Safety Program for the Project may require additional monitoring and follow up to ensure the safety of the facility workers and the nearby public.

Follow-up may also be required as part of the Dust Control Plans and Spill Control Plans if certain conditions are observed that trigger monitoring.

9.21 MALFUNCTIONS AND ACCIDENTAL EVENTS

This Section provides a summary of the potential malfunction and accident scenarios that could occur at the Project facilities, the types of analysis conducted to predict the potential effect of these incidents, and mitigation measures that can be implemented as part of the Project design.

Another issue that is discussed in this section is the requirement to conduct a Quantitative Risk Assessment as part of the permitting process.

9.21.1 LNG Facility

9.21.1.1 LNG Properties and Behaviour

Release of cryogenic or low temperature hydrocarbon liquids due to spills, leaks, or intentional draining can expose facility personnel to several hazards. These hazards include oxygen deficiency, freezing injuries, fire hazards, and flammable air-gas mixtures. LNG spills do not pose an explosion risk unless the spill occurs in an uncontrolled confined space.

Natural gas has a characteristic relatively low reactivity and low burning speed. Because of its narrow flammability range (i.e. 5 – 15 volume % in air), unconfined clouds of natural gas generated by an outdoor leak or LNG spill present little danger of explosion. Natural gas is lighter than air and quickly dilutes into the surrounding air forming an air-gas mixture below its Lower Flammable Limit. If ignition from an external ignition source should occur, burning will take place only along the air/gas interface in which flammability requirements are met. Flame speeds in unconfined natural gas clouds (about 4 to 10 m/s) are far below those that would produce dangerous overpressure. A flash or detonation is very unlikely.

Natural gas presents the greatest safety risk when gas leaks or LNG spills occur in confined areas. Confinement, such as an enclosed compressor building, can allow flammable vapour to accumulate and increases the possibility of ignition and the risk of localized damage. Once ignited, pressure will build in the enclosed area, however, flame speeds decelerate rapidly beyond the boundaries of the confinement and limit the extent of potential damage and injuries. The risk of explosion in a confined space is minimized by providing good ventilation in structures that contain or possibly contain natural gas. Ventilation allows the naturally rising natural gas to escape and dilute below its flammability range. Additional gas-detection will enable direct control to prevent fires and explosions.

Cryogenic hydrocarbon liquids (i.e. LNG) in the facility boil when released liquids contact warmer surfaces such as concrete or soil. The rate of boiling is rapid initially but decreases as the surfaces in contact with the liquid cools.

The gas evolved mixes with the surrounding air to form three types of mixtures:

1. Near the surface of the liquid, the mixture of gas and air will be too rich in hydrocarbons to burn.
2. A distance away from the liquid surface, the mixture of gas and air will be too lean in hydrocarbons to burn.

3. Between these two non-flammable mixtures, there is a flammable air-gas mixture. The flammable range of natural gas in air is approximately 5 to 15% by volume. Ignition of this mixture will result in a flame, which travels to the source of the gas. Released gas is safe from ignition only after it has diluted to a concentration below its Lower Flammable Limit.

Atmospheric water vapour will condense to form a white cloud or fog as the air and cold gas mix. The flammable air-gas mixture can exist inside or outside of the visible cloud. Confined explosion, fire, and thermal radiation hazards will exist wherever a flammable air-gas mixture is found.

LNG vapours will be heavier than air at temperatures of -107°C or below and will tend to spread out laterally along the ground rather than rise vertically. As the cloud warms above -107°C, its density becomes less than air and the cloud will rise. The dispersion of the cloud depends on atmospheric and wind conditions as well as the rate at which the vapour is released or generated. Gas, at concentrations above its Lower Flammable Limit can exist for a considerable distance from its source.

Natural gas produced from LNG is odourless. The sense of smell should not be relied upon to detect the presence of natural gas. Odourizer is typically only added just inside battery limits of the regassification process on the natural gas send-out pipeline. For this reason, fixed and potable combustible gas detection equipment is provided within the natural gas and LNG process and handling areas.

9.21.1.2 General Regulatory Requirements

During the time that the design concepts for the Keltic LNG Project were being developed, the NSDE finalized the LNG Code of Practice (July 2005). This Project is therefore consistent with the requirements of The LNG Code of Practice which has been found to be based on the requirements of CSA Z276-01, "Liquefied Natural Gas (LNG)-Production, Storage and Handling" and on NFPA 59A "Standard for the Production, Storage and Handling of Liquefied Natural Gas (LNG)". Differences do exist between the CSA and NFPA Codes. However, there is an attempt currently underway to achieve a greater level of consistency between these two documents. It is expected that revisions will be made to both Codes and that new requirements will be included in the 2006 edition of CSA Z276, and the 2006 edition of NFPA 59A which has now been released. In general the revisions concern the design requirements of facilities and equipment contained in section 4 of CSA Z276-01 and the corresponding section of NFPA 59A. In particular, the pending Code revisions, affects the design of the following items:

- Configuration and capacity of impoundment systems;
- Required minimum separation distances of LNG storage tanks and equipment based on maximum allowed thermal radiation;
- New impoundment requirements for in-plant LNG transfer piping;
- Sizing of impoundment areas for vapourization, process or transfer areas are now to be based on a revised LNG release criteria.; and
- Revised criteria for calculating thermal radiation exclusion zones.

The conceptual design of the Keltic LNG Terminal is in compliance with the pending changes to the CSA Z276 Code requirements, to the extent that they are known at the time of preparation of this document and in compliance with the 2006 edition of NFPA 59A.

A consequence model was conducted as part of the overall Project planning to:

- determine if CSA Z276-01 requirements regarding thermal radiation protection distances and flammable vapour clouds could be met by the proposed facility design, at the proposed site; and
- provide hazard analysis results that might be of assistance to the general layout of the facility

The thermal radiation and vapour dispersion calculations have been prepared in strict compliance with the code requirements of CSA Z276-01 LNG - Production, Storage, and Handling, and referenced Codes, notably NFPA 59A. The code requires that the lower flammable limit and thermal flux levels be modeled. The lower flammable limit is the lower flammable limit at which natural gas will ignite and burn (approximately 5% by volume for natural gas in air) in the presence of an ignition source.) Ignition can occur at concentrations between 5% and 15% in natural gas and would result in a flame front that travels to the source of the gas. The code requires that the vapour dispersion be modeled for each scenario to the lower flammable limit , with the exception of Case 4 (rapid LNG storage tank failure into tank dyke) which only requires a thermal reflux calculation.

The thermal flux level is a measure of radiant heat. The code requires that thermal flux (i.e. radiant heat) be modeled to TFLs of 5 kW /m^2, 9 kW /m^2 and 30 kW /m^2. The characteristics of these various flux levels are:

- 5 kW /m^2 – a second degree burn can occur on exposed flesh after 30 to 60 seconds exposure;
- 9 kW /m^2 – wood will auto-ignite after prolonged exposure to radiant heat in this range, but equipment damage is unlikely; and
- 30 kW /m^2 – wood will auto-ignite quickly and damage will occur to equipment.

Using these characteristics, the code prescribes exclusions for land uses contained in Section 9.21.5 and Section 9.21.6

In addition to satisfying the mandatory LNG code requirements, the proximity of process equipment has also been considered. The effects of LNG spills both in the form of thermal radiation (or flux) and vapour dispersion have been calculated using software acceptable to the requirements of CSA Z276-01, (i.e. GRI 0176, “LNGFIRE3: A Thermal Radiation Model for LNG Fires” and GRI 0242, “LNG Vapour Dispersion Prediction with the DEGADIS Dense Gas Dispersion Model”).

The following cases have been considered:

Thermal Radiation

- LNG release from the ship to storage tank transfer piping, assuming a guillotine type failure. The assumption is that the transfer pumps will be shut down after 10 minute from commencement of the spill. Following pump shut down the LNG contained in the transfer piping will also spill out of the transfer pipe. All spilled LNG will be channelled into a sub impoundment sump where it will later ignite;
- Ten minute LNG release from the process piping within the storage tank area that could occur during tank filling, or tank to tank LNG transfer;
- Ten minute LNG release from the process piping within the storage tank area that could occur during operation of the high pressure pumps, condenser, etc.;
- Ten minute LNG release from high pressure send out transfer piping and equipment located outside of the storage tank area;
- Thermal radiation at the property line, as a result of an LNG storage tank fire; and
- Thermal radiation at adjacent tanks, and other equipment, as a result of an LNG storage tank fire.

Vapour Dispersion

- LNG release into the ship unloading transfer line impoundment, and sub-impoundment following a ten minute spill;
- Ten minute release into spillways and sub-impoundment resulting from the largest design spill within the storage tank area;
- Ten minute release into spillway and sub-impoundment resulting from the design spill from the high pressure send out outside of the storage tank area; and
- Vapour dispersion exclusion zone relative to the property line following the failure of the inner container within the LNG storage tank.

9.21.1.3 LNG Industry Safety Record

The LNG industry has a long and excellent safety record, due to strict industrial safety standards applied worldwide. Busy ports around the world have LNG facilities that have operated for up to 40 years without an incident impacting the public.

There have been approximately 35,000 LNG carrier voyages, covering more than 60 million miles, without a significant accident or safety problem, either in port or on the high seas. LNG carrier safety equipment includes sophisticated radar and positioning systems that alert the crew to other traffic and hazards around the ship. A number of distress systems and beacons will automatically send out signals if the ship is in difficulty. The cargo system safety features include an extensive instrumentation package that safely shuts down the system if it starts to operate out of predetermined parameters. Ships are also equipped with gas and fire detection systems.

LNG terminals have been operating for over 40 years without a serious public safety incident.

An incident resulting in loss of life occurred in Cleveland, Ohio in 1944. At this time, knowledge of storage of LNG, or of the low temperature performance of materials, was not as advanced as today. Improper materials used in a single unprotected containment system failed and resulted in spilled LNG. Current design of containment systems utilizes low temperature nickel steel and a secondary containment vessel.

Other incidents attributed to LNG are:

- A construction accident on Staten Island in 1973 where the construction crew was working inside an (empty, warm) LNG tank. Although often referred to as an LNG accident this was strictly speaking a construction accident.
- Failure of an electrical seal on an LNG pump in 1979 permitted gas (not LNG) to enter an enclosed electrical switchgear building. A spark caused the building to explode. As a result of this incident, the electrical code has been revised for the design of electrical seals used with all flammable fluids under pressure.
- The recent incident at Skikda in Algeria in 2004 is naturally causing some concern due to the loss of life. The cause of this incident was likely due to a steam boiler explosion. It should be noted that even the resulting fire did not damage storage tanks that are somewhat similar to those that would be utilized at the LNG facility. Furthermore, it should be noted that the Skikda facility is a liquefaction plant which is completely different compared to the LNG import terminal.

9.21.2 Petrochemical Facility

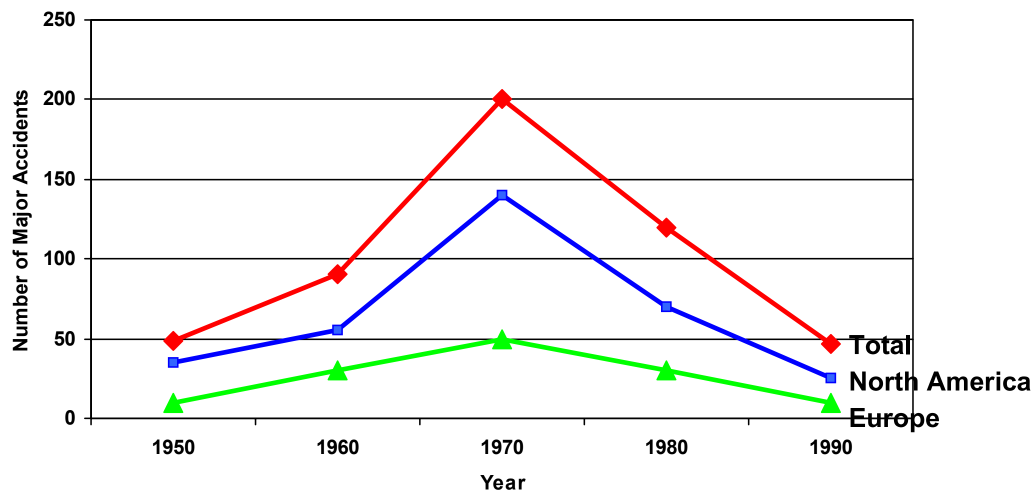
9.21.2.1 Background

To a large extent the EHSS performance of a chemical process plant is fixed during the early design stage of the capital project.

However, because of ever changing regulatory requirements and the resultant revisions to methods and standards for ensuring EHSS compliance there are inconsistencies in approaches taken.

Statistics in North America and Western Europe clearly indicate that major hazards have been reduced, especially in the period 1970-1990 (Figure 9.21-1).

FIGURE 9.21-1 Major Accidents in Europe and North America (Factory Mutual Research Corporation, June 1999).



9.21.2.2 Historical Perspective

The CPI covers petrochemical, biochemical, oil and gas, food processing, fertilizer, pharmaceutical, semiconductor, and so forth. Within each of these sectors, there are numerous processes that can be used to alter the chemical and physical structure of the materials. It would seem that a prescriptive approach to regulating and standardizing these industries was viewed as an insurmountable task by the CPI. Thus, it was not until major accidents occurred and public pressure was exerted that governments acted to legislate the CPI into action.

Increasing industrialization after the Second World War lead to a significant increase of accidents involving dangerous substances used or produced by the CPI.

Two major accidents occurred in the 1970s:

- Flixborough (UK) in June 1974 - an inexperienced site design team installed a temporary 20 inch bellows/bypass line was installed to circumvent one of six reactors used to oxidize cyclohexane. The bypass line failed immediately after placing it in operation.

  The underlying cause was human error. Forty (40) metric tonnes of inventory flashed into the plant environs, formed a vapour cloud, and exploded. The TNT equivalent was estimated to be 15 metric tonnes. The plant and nearby houses were completely destroyed. The control room collapsed. Twenty-eight (28) operators were killed and 89 operators and neighbours were injured.

- Seveso (Italy) in July 1976 - a valve failed at a chemical plant manufacturing pesticides and herbicides. Approximately 3000 kg of chemicals were released into the atmosphere from the reactor system. Among these chemicals was tetrachlorodibenzoparadioxin a poisonous and carcinogenic material made as a by product of uncontrolled exothermic reaction conditions. tetrachlorodibenzoparadioxin, also known generally as dioxin, is lethal to man even at microgram doses.

  The vapour cloud wafted 50 metres into the sky and, carried by a SE wind, enshrouded the municipality of Seveso with a contamination area of about

  25 km^2. More than 600 people had to be evacuated from their homes and as many as 2000 were treated for dioxin poisoning. Approximately 4% of local farm animals died and about 80,000 were killed to prevent contamination of the food chain.

These two major accidents prompted the European Community to legislate the CPI in the early 1980s.

In the mid to late 1980s the CPI added to its list of major accidents:

- Bhopal (India) 1984 – an accident initiated by human error and resulted in the release of methyl isocyanate into the surrounding community. 2500 people were killed. This had similarities with the Seveso accident and precipitated a look at international operations and technology licensing.

- Basel (Switzerland) 1984 - firewater contaminated with mercury and orthophosphate pesticides and other chemicals caused massive pollution of the River Rhine and the death of over half a million fish.

- Mexico City (1984) - termed the “Forgotten Disaster” and was started by a small release and explosion of a flammable mass of Liquefied Petroleum Gases. The initial explosion damaged piping and from thereon the event escalated into a major accident involving badly spaced Liquefied Petroleum Gases storage spheres and bullets. Again the surrounding community was impacted and 500 people were killed. Following this accident increased emphasis was put upon the layout and design of Liquefied Petroleum Gases storage facilities.

- Piper Alpha (UK) 1988 - as a result of a maintenance/human error a small flammable mass of material was released (45kg) on this North Sea oil production platform resulting in a localized explosion which caused extensive damage to the control room. From thereon the incident escalated into additional major explosions and fires. 167 people were killed. The speed at which the accident escalated and the impact on the means of evacuation, escape, and rescue prompted significant legislation of the offshore oil and gas industry in the UK. Note the similarities with the Mexico City Liquefied Petroleum Gases accident in that a small explosion led to an escalated incident.

- Pasedena (Texas) 1989 - a major accident initiated by human error and involved contractors who were performing a routine clean of the drop legs in a slurry loop polyethylene unit. A massive release of reactor inventory occurred and resulted in a confined vapour cloud explosion approximately one minute after the release. The explosion escalated to eventually destroy two polyethylene units and caused Boiling Liquid Expanding Vapour Explosion (BLEVE) of adjacent storage vessels. 23 people were killed. This incident prompted major legislation in the USA through Occupational Safety and Health Administration (OSHA) and EPA.

9.21.2.3 Legislation

A consequence of these major accidents legislation was enacted in the European Community and USA. Table 9.21-1 provides a summary of EHSS Legislative Milestones Affecting the CPI.

The European Community was the first to act with the Seveso I Directive issued in 1982. In 1984 the UK issued the Control Industrial Major Accidents Hazards regulation (CIMAH). This was a direct result of the Seveso I Directive.

The Bhopal and Mexico City incidents led to the amendment of the Seveso I Directive in 1987 and 1988. Both amendments aimed at broadening the directive and in particular included provisions on dangerous substances.

In 1996 the Seveso II Directive was issued and followed in the UK by the implementation of the Control of Major Accident Hazards (COMAH) regulation in April 1999. Seveso II replaced Seveso I and COMAH replaced CIMAH.

Both of these latest regulations are much broader in scope, and require a demonstration that measures have been, or will be, taken to reduce risk to persons affected by hazards (with the potential to cause a major accident) to the lowest level that is reasonably practicable, (i.e. ALARP or As Low As Reasonably Practicable).

In 1993, the USA OSHA issued its standard for Process Safety Management (PSM) to protect worker safety. In 1995 the EPA issued its Risk Management Planning to protect public safety and the environment.

These two documents were revolutionary because they introduced performance based regulations to the USA. The standards require individual corporations to evaluate their own operations and to ensure that there are no undue risks. However, for the most part neither OSHA nor the EPA set quantitative safety goals or define risk.

One of the main components of OSHAs PSM program and the EPA Risk Management Planning is the Process Hazard Analysis (PHA). The PHA is a thorough, orderly, and systematic evaluation of a facility that determines whether there is any design or operational issues that could lead to onsite (OSHA) or offsite (EPA) concerns.

TABLE 9.21-1 Summary of EHSS Legislative Milestones Affecting the CPI

1982	Seveso I	European Community, directive which was amended twice to broaden scope after Bhopal (1984) and Seveso(1986)
1984	CIMAH	UK, regulation Control of Industrial Major Accident Hazards
1990	API RP 750	USA, Management of Process Hazards
1992	OSHA 29 CFR 1910	USA, process safety management of highly hazardous chemicals
1995	EPA 40 CFR (68)	USA, management programs for chemical accidental release prevention
1996	ANSI/ISA S84.01	Safety Instrumentation Systems (SIS)/Safety Integrity Levels (SIL) and enforceable under OSHA 29 CFR 1910
	Seveso II	European Community, directive on control of major accident hazards with much broader scope and requires mitigation of consequence to man and the environment
1999	COMAH	UK, control of major accident hazard regulations which replaced CIMAH (1982)
	IEC 61508	SIS/SIL – from Seveso II
2005	IEC 61511	SIS/SIL which integrates IEC/ISA and has become an international all encompassing standard

OSHA PSM and the EPA Risk Management Planning mandate that all companies dealing with regulated chemicals of sufficient quantity must perform a PHA. The OSHA PSM also requires that companies revisit the PHA at least every 5 years of operation. Most companies have therefore already been through this exercise at least once.

In a number of countries the chemical industry itself responded to EHSS challenges with Responsible Care® initiatives. Responsible Care® was developed in the 1980s by the CCPA and was taken up in the USA by the Chemical Manufacturers' Association/American Chemistry Council, in 1989 and by the UK Chemical Industries Association (CIA) and elsewhere thereafter.

Keltic Petrochemicals will become a CCPA member and will apply the principles of Responsible Care® to the design, maintenance, and operation of the proposed petrochemical facility.

9.21.3 Qualitative Assessment of Safety Risks

Safety risks are defined here as acute risks having immediate impacts. For facilities processing large quantities of hydrocarbon materials these tend to be fires and explosions.

Low molecular weight hydrocarbons like those that will be processed are essentially non-toxic, but are highly hazardous from a fire and explosion perspective. Thus there is no long term health impact from exposure. The health threats from fires are (a) thermal radiation for someone near a fire, and (b) flame impingement for someone caught in the path of a flash fire. Fire combustion product plumes for low molecular weight paraffinic/olefinic hydrocarbons will consist of CO_2, CO, water vapour, and small quantities of soot. These will be hot, and are expected to rise and disperse to safe levels before touching down to the ground.

The process units cover a range of low temperature (cryogenic)/atmospheric pressure to high temperature/high pressure. Breaches in containment within cryogenic process produce spills to the ground which can rapidly evaporate. Breaches in containment within high temperature/pressure process tend to produce airborne flashing two phase clouds with liquid in mist form. These may pool if the releasing jet impacts a large object. The range of fires and explosions that can arise are discussed below.

Note also that there are a number of non-hydrocarbon chemicals that will be imported and used to support operations at the Keltic site – i.e. concentrated hydrogen peroxide. These materials will be used in small quantities and release events most likely can be attributed to handling accidents involving human error. Any acute effects involving them – i.e. toxic exposures, fires and explosions, will be localized. Significant impacts are not expected off site.

Potential fires can be characterized as follows:

Flash fire:	A flash fire may arise following the spillage of a cryogenic hydrocarbon (LNG, ethane, propane, ethylene or propylene), followed by evaporation, dispersion of the flammable vapours and ignition of a cloud downwind of the release point. A fire will burn back through the cloud towards the point of release. The flame front will travel very quickly and thus thermal radiation is not a concern. The hazard of concern is flame impingement – i.e. being caught in the flammable cloud when the flash fire burns through it. A flash fire can also arise following the release of high temperature and pressure hydrocarbons from a breach in containment in a pipe or vessel within the petrochemical facility that does not ignite near the point of

	release. This type of release will be a flashing liquid that produces a vapour/liquid mist cloud that entrains a lot of air. These clouds will be hot and are expected to rise, producing hazard distances that are significantly smaller than those from large cryogenic spills. Since the area around the proposed facility is heavily forested, there is a chance that a flash fire will cause a forest fire.
Pool fire:	Pool fire arises from the ignition of a liquid pool following the spillage of a hydrocarbon liquid. A pool fire can occur on land – i.e. in an impoundment bund or on water following, for example, an LNG spill from a ship-to-ship collision. The primary threat from a pool fire is thermal radiation. Pool fires within the Keltic complex will essentially be site hazards and only of concern to worker safety. The facility will be constructed with an extensive system of impoundments for critical tanks and pipeline and equipment will be adequately spaced such there will be little risk of domino effects. LNG spills in open waters, following for example ship-to-ship collisions can produce thermal radiation impact distances for skin burns in the hundreds of meters. The likelihood and thus the risk of these events is, however, small.
Jet fire:	Jet fire is a hazard that can arise when a hydrocarbon release from a high pressure source (i.e. pipe break, gasket failure) is ignited at the source. At the Keltic complex these will be on-site hazards. Jet fires can be important as they can be precursors to more severe events like BLEVEs (see definition below). However, it is expected that the final plant design will include adequate safeguards to protect against the domino effects of jet fires (i.e. fire protection, emergency depressurization), such that their risk impact will be small. It is also expected that in the final plant layout, process units will be adequately spaced such that there will be a negligible chance of jet fire-induced domino effects between process units (see Section 9.21.5 and 9.21.6)
Fireballs:	Fireballs are spherically-shaped short duration fires (~ < 1 minute) that typically result from catastrophic failures of large tanks. Fireball diameters can grow beyond 100 m producing significant thermal radiation levels for hundreds of meters. Catastrophic tank failure is usually preceded by a smaller external fire (jet fire or pool fire) which causes tank heat-up, and ultimate failure. Fireballs are usually associated with BLEVEs. These events can take time to develop, providing an opportunity for mitigation. The Keltic complex utilizes cryogenic storage for large inventories of low molecular

	weight hydrocarbons. This intrinsically safe design averts the possibility of large fireballs. The potential for fireballs/BLEVEs exists in, for example, butane storage for export located on the marginal wharf and with distillation columns operating at a high pressure/temperature – i.e. depropanizer/debutanizer in the ethylene plant. However, the marginal wharf and ethylene plant will be > 500 m from the public, resulting in a negligible public risk.

In summary, fires on land are expected to be on-site hazards posing negligible risk to the public. Large LNG spills on water, will have a greater impact, but their frequency of occurrence is expected to be low. A potential concern for the Keltic site is a secondary forest fire.

Explosions can occur via a number of mechanisms. These are described below.

Vapour Cloud Explosions:	Vapour cloud explosions (VCEs) arise when a flammable vapour cloud forms in or disperses to a congested area, mixes with air, and experiences delayed ignition. A congested area can be a process unit like the Keltic ethylene plant or a number of buildings or tanks in close proximity. Sources of vapour cloud explosions are plant units processing hydrocarbons at high pressure and temperature. Breaches in containment result in flashing two-phase releases which become airborne and readily mix with air. Cryogenic spills may be initiators if the spills occur over a large surface resulting in fast evaporation. At the Keltic complex, the principle candidates for vapour cloud explosions s are the ethylene plant and the LDPE unit, which operates at a very high pressure. Historical events indicate that the principle effects and loss of life from vapour cloud explosions s tend to be on site. Public impacts tend to be limited to superficial structural damage to dwellings and glass breakage.
BLEVEs:	These are BLEVEs. They are produced most frequently from steel vessels containing flammable gases liquefied under pressure that become involved in a fire. The pressure in the vessel is increased by the rising temperature and the wall of the vessel loses strength for the same reason. Prior to full disclosure and analysis, it seems that the probability of BLEVEs on the Keltic Site is very low. Storage of Hydrocarbons is planned to be at atmospheric pressure and the failure of gas pipelines may produce a jet fire that is unlikely to develop into a BLEVE.
Rapid Phase Transition Explosions:	Such an explosion can be produced by spillage of LNG on water. The mechanism is not well understood, but the cold fluid (LNG) is taken to the superheat limit by the warm fluid (water) where upon the LNG is

	violently transformed into the gas phase. Any spillage of LNG at or near the jetty could produce such an explosion. The anticipated overpressure generated is low, water is usually thrown up into droplets; any damaging effects will be small and localized.
Decomposition Explosion:	The polymerization within the LDPE unit is carried out at a very high pressure in excess of 3000 Bar. If there is a run-away in the reaction, the plant is designed to release ethylene through a water quench. Should this quench fail to function the ethylene will escape at high velocity; it will then form as an aerial cloud that results in a decomposition explosion. This produces a cloud of soot, loud noise, and overpressure that is experienced at ground level. While the probability of this event is low, effects might be felt outside the boundary fence given the present siting of the LLDPE Plant.
Confined Explosion:	Such explosions are produced from the ignition of a flammable gas/air mixture within confinement i.e. an empty hydrocarbon storage tank or in the ullage space of such a tank or in buildings into which flammable gas/vapour has ingressed. In the present situation such events would be on-site occurrences and the effects off-site would be of a minor nature with no off site impacts. There is a very low probability of NG drifting from a large spill of LNG from a ship accident, into dwellings in Goldboro, Isaac's Harbour, or Drum Head.
Steam Explosions:	It is assumed that there will be a sizeable steam drum under pressure in the Keltic co-generation plant. In the event of a steam drum failure, depending on the volume and pressure of operation, an overpressure wave would be experienced at the boundary fence; high levels of destruction would occur on-site. Effects off site would be limited to glass breakage. The event is one of low probability.
Dust Explosions:	Ignition of confined dispersions of combustible dusts leads to a rise in pressure and therefore explosion of the containing vessel unless it is very strong, is adequately relieved or the explosion is suppressed. The occurrence of a dust explosion in the silos or in the ship carrying product away depends on the ability of the polymer pellets to break up to form dust. The nature of the material renders this unlikely. Dust explosions of a magnitude where the effects of which could be felt off-site, is a low probability event.

In summary, there are a number of areas within the proposed Keltic complex where an explosion can arise. The Keltic site is quite large providing sufficient opportunities to adequately space process units to avoid domino effects. Impacts from explosions will largely be on site. Off-site effects will largely be limited to superficial effects such as broken windows/glass and minor structural damage to dwellings within about 1 km. Explosions are low probability events and the public risk from explosions will thus be low as well.

9.21.4 Introduction to Quantitative Risk Assessment

In addition to the facilities being engineered and constructed in strict accordance with regulatory requirements, A Quantitative Risk Assessment is a valuable tool for determining the risk of the use, handling, transport, and storage of dangerous substances. A Quantitative Risk Assessment is used to demonstrate the risk caused by the activity and to provide the competent authorities with relevant information to enable decisions on the acceptability of risk related to developments on site.

As outlined in subsequent sections (Section 9.21.5 and Section 9.21.6), there was predictative modelling and analysis conducted as part of the Project planning and conceptual design. This analysis provided necessary details associated with siting the facilities near surrounding land uses and the spacing of infrastructure within the facility.

In addition to this analysis, a Quantitative Risk Assessment is required as part of the review process associated with the Nova Scotia Utility and Public Review Board process and as part of the federal TERMPOL process under the direction of TC. This Quantitative Risk Assessment is being conducted in these parallel processes as part of the permitting process associated with the operations of the facilities, where the scope and methods of conducting the Quantitative Risk Assessment are currently being discussed with provincial and federal agencies.

Quantitative Risk Assessment has evolved into the state-of-art process for evaluating the safety of facilities having the potential for major hazards. A Quantitative Risk Assessment must first establish what the risk is (Risk Analysis), and then evaluate this risk by comparison to risk acceptability criteria. In risk management, the Quantitative Risk Assessment forms a basis for decision-making principally related to:

- Acceptability of a proposed new facility,
- Land – use planning for the region surrounding a facility, and
- Requirements for additional mitigation within a facility.

Quantitative Risk Assessments can consider risks to (i) the public near a facility, (ii) workers at a facility, and (iii) the operator of a facility – in terms of financial risk. These are the so-called risk receptors. The scope of a Quantitative Risk Assessment must identify which risk receptors are to be considered. This is of particular importance for the proposed facility since it is located in a remote location.

Risk assessments for public risk can consider risk to an individual and to society as a whole within the region near the proposed facility and near the transport routes. The Major Industrial Accident Council of Canada process, described below, although focusing on individual risk, considers both. This approach has been recommended to local regulatory agencies for this Project. However, in other jurisdictions, principally Europe, a more rigorous quantification of societal risk via so-called F-N curves is required. The Quantitative Risk Assessment will identify how risk is to be measured.

9.21.4.1 The Major Industrial Accident Council of Canada Process for Canada

The Major Industrial Accident Council of Canada risk-based approach was initially developed for land use planning in the vicinity of hazardous installations. It is equally applicable to the siting of proposed new hazardous installations. Although it is based on an individual risk calculation that produces a risk-separation distance curve, the interpretation for land-use planning has elements of societal risk.

A risk analysis combines these consequences with their likelihood, or frequency, of occurrence. Quite simply:

$$\text{Risk} = \text{Frequency} \times \text{Consequences}$$

In a risk analysis, a number of accident scenarios would be identified (i.e. release of a gas under stable atmospheric conditions and low wind speed). The frequency and consequences would be quantified separately and multiplied to determine the risk. This process would be undertaken for all accident scenarios that are identified, and the risks summed to obtain the total risk. The total risk is typically shown as iso-risk lines around the hazard source, with risk decreasing with increasing separation distance.

Figure 9.21-2 shows a generic risk curve and MIACCs risk acceptability criteria. These guidelines for acceptable levels of risk are as follows:

- From the risk source to the 1 in 10,000 (10^{-4}) annual chance of fatality risk contour the risk to the public is deemed unacceptable and no other land uses except the source facility.
- In the area between the 1 in 10,000 to 1 in 100,000 (10^{-4} to 10^{-5}) annual chance of fatality risk contours, land uses involving continuous access and the presence of limited numbers of people that can be readily evacuated, can be allowed. For example: open spaces (golf courses, parks), warehouses, manufacturing plants.
- In the area between the 1 in 100,000 to 1 in 1,000,000 (10^{-5} to 10^{-6}) annual chance of fatality risk contours, uses involving a slightly higher population density, but still having continuous access and easy evacuation, i.e. commercial uses, low-density residential areas, offices.
- Beyond the 1 in 1,000,000 (10^{-6}) annual chance of fatality risk contour the risk is deemed acceptable and there are no land use restrictions.

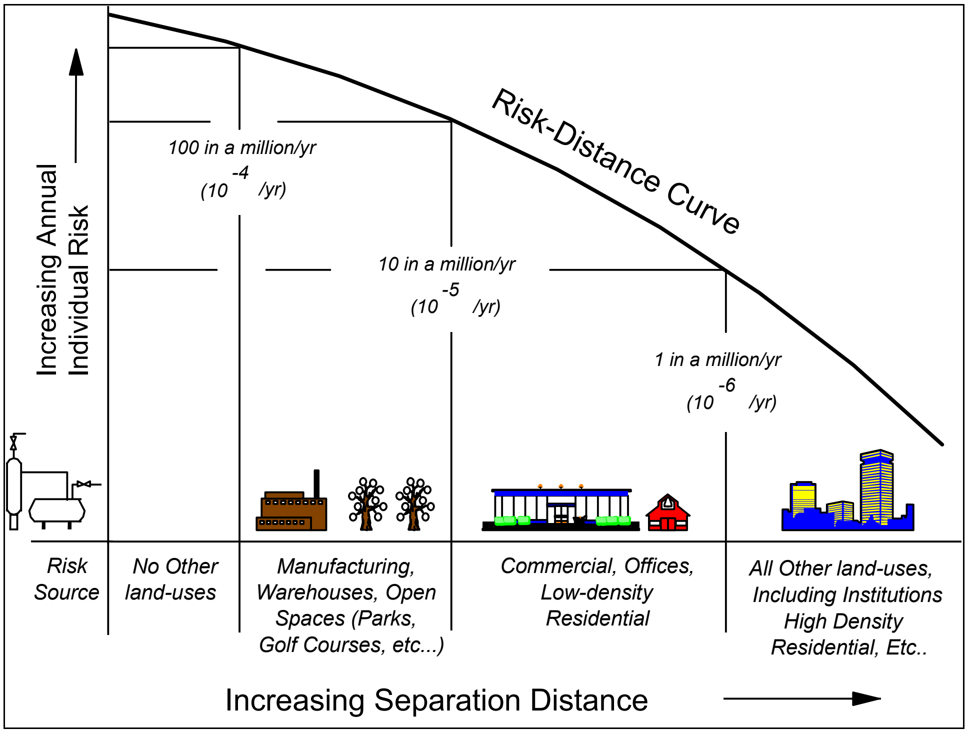
These criteria are similar to those used in other jurisdictions (i.e. Europe) for major hazard installations and in other industries (North American nuclear industry).

Major Industrial Accident Council of Canada never defined “low density residential” or “high density residential”. For the purposes of this risk assessment, these are assumed to be as follows:

Low Density Residential:	< 5 dwellings per hectare (rural region)
High Density Residential:	> 5 dwellings per hectare (small town; urban region)

Regulatory concurrence is required for the above definitions.

FIGURE 9.21-2 Major Industrial Accident Council of Canada Land-Use Risk Acceptability Criteria



9.21.5 Thermal Radiation Exclusion Zones

As previously outlined, modelling was conducted, as per the appropriate standards and guidelines, to establish thermal exclusion zones for siting the overall facility, as well as the infrastructure within the facility. The following sections outline the results of this analysis.

9.21.5.1 Regulatory Requirements for Property Lines and Occupancy

CSA Z276-01 requires that thermal radiation be predicted at several levels, for design spills that could be ignited, as follows:

- 5 kW/ m^2 (1,600 Btu/ft^2) at a property line that can be built upon for ignition of a design spill;
- 5 kW/ m^2 (1,600 Btu/ ft^2) at the nearest point located outside the owner's property line that, at the time of plant siting, is used for outdoor assembly by groups of 50 or more persons, for a fire in an impounding area;
- 9 kW/ m^2 (3,000 Btu/ ft^2) at the nearest point of a building or structure outside the owner's property line that is in existence at the time of plant siting and used for occupancies classified by NFPA Standard 101, for a fire in an impounding area; and
- 30 kW/ m^2 (10,000 Btu/ ft^2) at a property line that can be built upon for a fire over an impounding area.

A similar thermal radiation exclusion zone criteria is contained in NFPA 59A (2006 edition).

The current version of CSA Z 276-01 requires that atmospheric conditions of 0 (zero) wind speed, 21 deg C (70 deg F) temperature, and 50% relative humidity be used as the basis for calculating the values of thermal radiation levels at property lines as defined above. Thermal radiation exclusion distances shall be calculated using GRI Report 0176, available in the form of LNGFIRE III computer model. This is consistent with the requirements of NFPA 59A (2006 edition).

9.21.5.2 Regulatory Requirements Concerning Container Spacing

Significant new requirements for spacing between containers and equipment containing LNG, based on thermal radiation have been proposed for the pending 2006 edition of CSA Z276, and have already been incorporated into the published 2006 edition of NFPA 59A. In addition to the physical separation distances stated in the existing regulations, these new requirements impose a thermal radiation limitation which also dictates separation distances, as follows:

- 30 kW/ m^2 at the concrete outer surface of an adjacent storage tank; and
- 15 kW/ m^2 at the metal outer surface of an adjacent storage tank or the outer surfaces of process equipment

The 2006 edition of NFPA 59A requires that the ambient conditions for thermal radiation flux be based on the conditions of temperature, wind speed and relative humidity, within the range expected on site, calculated to produce the highest temperature at the secondary container.

9.21.5.3 Methodology Used to Determine Effects of Thermal Radiation

If a quantity of LNG is spilled in the presence of an ignition source, the resulting LNG pool fire will result in high levels of thermal radiation. The method required to predict the levels of thermal radiation are closely controlled through regulations. The calculated thermal exclusion distances affect both the basic layout of the facility and the design measures that are required to mitigate the effect of LNG spills that may be ignited. All calculations have been performed using LNGFIRE III: A Thermal Radiation Model for LNG Fires.

9.21.5.4 Results of Calculations

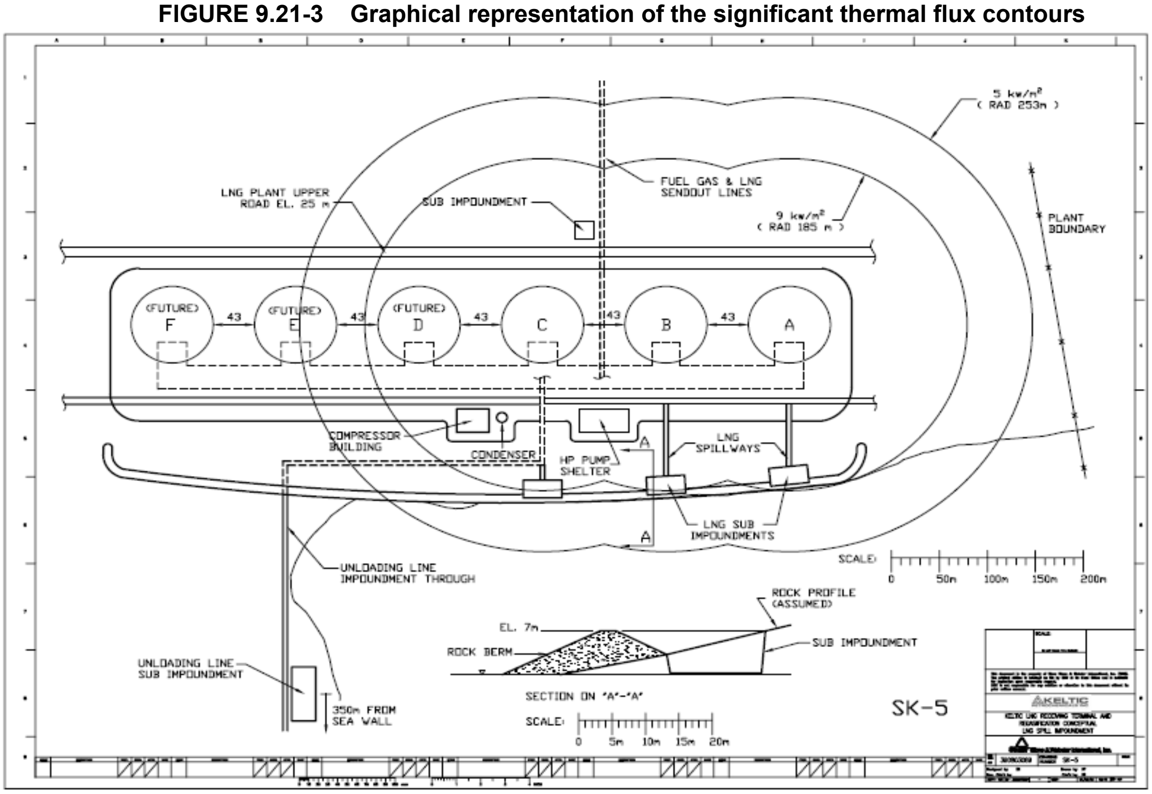
Storage Tanks

Assuming that Tank A lost the roof and the contents were ignited. The resulting thermal radiation at the nearest point on the property line, located to the SE at 230 m, at the specified atmospheric conditions is 4.14kW/ m^2. As there are no existing structures of any description in that area, the criterion in effect requires that the levels of thermal radiation shall be less than 30kW/ m^2. On this basis the property line requirements are satisfied. See Table 9.21.2 for the results and Figure 9.21-3 for the graphical representation of the significant thermal flux contours.

TABLE 9.21-2 LNG Model results 84 m diameter circular pool

Input			
Molecular Weight		17.00	
LNG Liquid Density (Kw/m3)		432.00	
Boiling Temperature (K)		112.00	
Flame Base Height (m)		51.00	
Target Height (m)		20.00	
Pool Diameter (m)		84.00	
Wind Speed (m/s)		0.00	
Ambient Temperature (C)		21.00	
Relative Humidity (%)		50.00	
Output			
Mass Burning Rate (Kw/m2 S)		0.11000	
Flame Length (m)		106.07	
Flame Tilt from Vertical (Deg)		0.00	
Flame Drag Ratio		1.00	
Eff. Emissive Power (Kw/m2)		190.00	
Thermal Flux to:			
Distance From Centre of Pool (m)	Horizontal Target (Kw/m^2)	Vertical Target (Kw/m^2)	Maximum Flux to Target (Kw/m^2)
272.00	1.31	3.92	4.14

FIGURE 9.21-3 Graphical representation of the significant thermal flux contours



The storage tanks have been located with a spacing of half of the diameter as required by the table of minimum distances contained in the LNG regulations. The thermal radiation on the upper wall of an adjacent tank was calculated for zero wind speed and the maximum annual wind speed that could occur while blowing in the direction of the adjacent tank. Meteorological data for a location close to the proposed LNG plant indicates that a combination of 19 m/s wind speed from the Southeast or Northwest, 5°C ambient temperature, and a relative humidity of 86% could occur simultaneously during the winter. Assuming that one of the tanks lost the roof and the contents were ignited, the resulting thermal radiation on the adjacent downwind tank is predicted to be 36.76kW/m^2 for the zero wind speed and 118kW/m^2 for the maximum wind speeds. See Tables 9.21-3 and 9.21-4.

TABLE 9.21-3 LNG Model Results 84 m Diameter Circular Pool

Input			
Molecular Weight	17.00		
LNG Liquid Density (Kw/m^3)	432.00		
Boiling Temperature (K)	112.00		
Flame Base Height (m)	35.00		
Target Height (m)	35.00		
Pool Diameter (m)	84.00		
Wind Speed (m/s)	0.00		
Ambient Temperature (C)	15.00		
Relative Humidity (%)	90.00		
Output			
Mass Burning Rate (Kw/m^2 S)	0.11000		
Flame Length (m)	104.74		
Flame Tilt from Vertical (Deg)	0.00		
Flame Drag Ratio	1.00		
Eff. Emissive Power (Kw/m^2)	190.00		
Thermal Flux to:			
Distance From Centre of Pool (m)	Horizontal Target (Kw/m^2)	Vertical Target (Kw/m^2)	Maximum Flux to Target (Kw/m^2)
85.00	18.12	31.98	36.76

TABLE 9.21-4 LNG Model Results 84 m Diameter Circular Pool

Input			
Molecular Weight	17.00		
LNG Liquid Density (Kw/m^3)	432.00		
Boiling Temperature (K)	112.00		
Flame Base Height (m)	35.00		
Target Height (m)	35.00		
Pool Diameter (m)	84.00		
Wind Speed (m/s)	19.00		
Ambient Temperature (C)	5.00		
Relative Humidity (%)	86.00		
Output			
Mass Burning Rate (Kw/m^2 S)	0.11000		
Flame Length (m)	102.51		
Flame Tilt from Vertical (Deg)	63.98		
Flame Drag Ratio	1.00		
Eff. Emissive Power (Kw/m^2)	190.00		
Thermal Flux to:			
Distance From Centre of Pool (m)	Horizontal Target (Kw/m^2)	Vertical Target (Kw/m^2)	Maximum Flux to Target (Kw/m^2)
85.00	101.75	58.40	118.05

To comply with a level of 30kW/ m^2 under such extreme wind speeds, the tank spacing would have to be increased from 43 m to (167-42) m, or125 m. See Table 9.21.5. Tank spacing such as this is not practical at this location. As permitted by the Code minimum physical separation distance of half of the diameter, the tank spacing will remain at 43 m, but in the event that one of the storage tanks is ignited, a water deluge system will be brought into operation to control the level of thermal radiation to a value below 30kW/ m^2, at the adjacent downwind tank.

The thermal radiation imposed on the compressor building and pump shelter from a tank fire has also been calculated. These structures are estimated to be 112 and 102 m respectively from the outer walls of the storage tanks. The calculated thermal radiation levels are 33.13 and 37.24 kW/ m^2. To comply with the regulations these structures will

need to be protected with a deluge system whether constructed using concrete, or steel, or be relocated further away from the storage tanks. See Table 9.21-6.

TABLE 9.21-5 LNG Model Results

Input			
Molecular Weight	17.00		
LNG Liquid Density (Kw/m^3)	432.00		
Boiling Temperature (K)	112.00		
Flame Base Height (m)	35.00		
Target Height (m)	35.00		
Pool Diameter (m)	84.00		
Wind Speed (m/s)	19.00		
Ambient Temperature (C)	5.00		
Relative Humidity (%)	86.00		
Output			
Mass Burning Rate (Kw/m^2 S)	0.11000		
Flame Length (m)	102.51		
Flame Tilt from Vertical (Deg)	63.98		
Flame Drag Ratio	1.00		
Eff. Emissive Power (Kw/m^2)	190.00		
Thermal Flux to:			
Distance From Centre of Pool (m)	Horizontal Target (Kw/m^2)	Vertical Target (Kw/m^2)	Maximum Flux to Target (Kw/m^2)
160.00	18.02	30.08	35.06
162.00	17.00	29.48	34.03
164.00	15.72	28.30	32.38
166.00	14.55	27.17	30.82
168.00	13.47	26.07	29.34
170.00	12.48	25.01	27.95
172.00	11.56	23.99	26.63
174.00	10.72	23.01	25.39
176.00	9.96	22.07	24.21
178.00	9.25	21.18	23.11

TABLE 9.21-6 LNG Model Results

Input			
Molecular Weight	17.00		
LNG Liquid Density (Kw/m^3)	432.00		
Boiling Temperature (K)	112.00		
Flame Base Height (m)	35.00		
Target Height (m)	10.00		
Pool Diameter (m)	84.00		
Wind Speed (m/s)	16.50		
Ambient Temperature (C)	10.00		
Relative Humidity (%)	86.00		
Output			
Mass Burning Rate (Kw/m^2 S)	0.11000		
Flame Length (m)	103.63		
Flame Tilt from Vertical (Deg)	61.92		
Flame Drag Ratio	1.00		
Eff. Emissive Power (Kw/m^2)	190.00		
Thermal Flux to:			
Distance From Centre of Pool (m)	Horizontal Target (Kw/m^2)	Vertical Target (Kw/m^2)	Maximum Flux to Target (Kw/m^2)
144.00	27.28	25.34	37.24
152.00	22.95	23.90	33.13

Storage Tank Area Sub Impoundments

The process piping spillways and sub impoundments are shown on Figure 9.21-3. Calculations for the largest design spill, from the process piping described above, has been performed on the assumption that the LNG collected in the sub impoundment was subsequently ignited. The spill from piping associated with Tank C was selected as this sub impoundment is the closest to piping and equipment. The thermal radiation that would result from a sub impoundment fire at the following locations are shown below and in Table 9.21-7:

- Pump shelter 17.04kW/ m^2;
- Condenser 12.73kW/ m^2;
- Compressor building 12.73kW/ m^2;
- Pipe Rack 5.71kW/ m^2; and
- Storage tank C 3.47kW/ m^2

TABLE 9.21-7 LNG Model Results (22 x 40 m Rectangular Pool)

Input		
Molecular Weight	17.00	
LNG Liquid Density (Kw/m^3)	432.00	
Boiling Temperature (K)	112.00	
Flame Base Height (m)	7.00	
Target Height (m)	16.00	
Pool Width (m)	22.00	
Pool Length (m)	40.00	
Wind Speed (m/s)	0.00	
Ambient Temperature (C)	21.00	
Relative Humidity (%)	50.00	
Output		
Mass Burning Rate (Kw/m^2 S)		0.11000
Flame Length (m)		41.80
Flame Tilt from Vertical (Deg)	(Front)	0.00
	(Side)	0.00
Flame Drag Ratio	(Front)	1.00
	(Side)	1.00
Eff. Emissive Power (Kw/m^2)	(Front)	189.74
	(Side)	190.00

Front View	**Thermal Flux to:**		
Distance From Centre of Pool (m)	Horizontal Target (Kw/m^2)	Vertical Target (Kw/m^2)	Maximum Flux to Target (Kw/m^2)
71.00	6.48	27.23	17.04
81.00	3.98	19.36	12.73
116.00	1.05	7.69	5.71
145.00	0.46	4.40	3.47
Side View			
70.00	6.63	24.19	13.55

Unloading Line Sub Impoundment

The unloading piping impoundment trough and proposed location of the sub impoundment are shown on Figure 9.21-3. A thermal radiation calculation for the largest predicted design spill has been performed, on the assumption that LNG is collected in the sub impoundment and later ignited. The closest structure is the water treatment plant located approximately 100 m to the north of the sub impoundment. At this distance the thermal radiation is estimated to be 12.17kW/ m^2. The calculation results are given in Table 9.21-8.

TABLE 9.21-8 LNG Model Results (24 x 78 m Rectangular Pool)

Input			
Molecular Weight	17.00		
LNG Liquid Density (Kw/m^3)	432.00		
Boiling Temperature (K)	112.00		
Flame Base Height (m)	5.00		
Target Height (m)	15.00		
Pool Width (m)	24.00		
Pool Length (m)	78.00		
Wind Speed (m/s)	0.00		
Ambient Temperature (C)	21.00		
Relative Humidity (%)	50.00		
Output			
Mass Burning Rate (Kw/m^2 S)		0.11000	
Flame Length (m)		44.41	
Flame Tilt from Vertical (Deg)	(Front)	0.00	
	(Side)	0.00	
Flame Drag Ratio	(Front)	1.00	
	(Side)	1.00	
Eff. Emissive Power (Kw/m^2)	(Front)	189.86	
	(Side)	190.00	
Front View	**Thermal Flux to:**		
Distance From Centre of Pool (m)	Horizontal Target (Kw/m^2)	Vertical Target (Kw/m^2)	Maximum Flux to Target (Kw/m^2)
112.00	2.33	15.90	12.17
Side View			
139.00	0.80	5.46	4.07

Send Out Line Sub Impoundment

The unloading piping impoundment trough and proposed location of the sub impoundment are shown on Figure 9.21-3. A thermal radiation calculation has been performed, on the assumption that the largest predicted design spill of LNG is collected in the sub impoundment and later ignited. The closest structure is storage tank C located approximately 60m from the edge of the sub impoundment. At this distance the thermal radiation is estimated to be 5.36kW/ m^2. The calculation results are given in Table 9.21-9.

9.21.6 Vapour Dispersion Exclusion Zones

As previously outlined, modelling was conducted, as per the appropriate guidance and regulations, to establish vapour exclusion zones for siting the overall facility, as well as the infrastructure within the facility. The following sections outline the results of this analysis.

9.21.6.1 Regulatory Requirements

The methods required to predict vapour dispersion are closely controlled through CSA Z276 and NFPA 59A regulations. The criteria for modeling contained in NFPA 59A (2006 edition) requires that in the event of a spill the average concentration of LNG vapour in air be at or below 50% of the lower flammable limit at the property line that can be built upon. The calculations shall be based upon either, 1) The combination of wind speed and atmospheric stability that can occur simultaneously and results in the longest predictable downwind dispersion distance that is exceeded less than 10% of the time, or 2) The Pasquill-Gifford atmospheric stability, Category F, with a 2 m/s wind speed. As the CSA Z276 pending requirements are not known at this time, the NFPA 59A, option 2) has been used in the preparation of the vapour dispersion predictions.

TABLE 9.21-9 LNG Model Results

Input			
Molecular Weight		17.00	
LNG Liquid Density (Kw/m^3)		432.00	
Boiling Temperature (K)		112.00	
Flame Base Height (m)		32.00	
Target Height (m)		32.00	
Pool Width (m)		16.00	
Pool Length (m)		16.00	
Wind Speed (m/s)		0.00	
Ambient Temperature (C)		21.00	
Relative Humidity (%)		50.00	
Output			
Mass Burning Rate (Kw/m^2 S)			0.11000
Flame Length (m)			33.50
Flame Tilt from Vertical (Deg)		(Front)	0.00
		(Side)	0.00
Flame Drag Ratio		(Front)	1.00
		(Side)	1.00
Eff. Emissive Power (Kw/m^2)		(Front)	188.44
		(Side)	188.44
Front View	**Thermal Flux to:**		
Distance From Centre of Pool (m)	Horizontal Target (Kw/m^2)	Vertical Target (Kw/m^2)	Maximum Flux to Target (Kw/m^2)
68.00	1.32	5.20	5.36
Side View			
68.00	1.32	5.20	5.36

The computed distances shall be based on the maximum vapour outflow rates from the vapour containment areas.

Methods of mitigating the rate of vapour production, through the use of surface insulation, use of water curtains, etc are subject to regulatory approval.

For the purposes of siting the outer wall of a full containment tank can be regarded as the impounding area.

9.21.6.2 Methodology Used to Determine Vapour Dispersion Exclusion Zones

If a quantity of LNG is spilled without being ignited, LNG vapour will be produced. The rate of vapourization depends on the area of the spill exposed to surfaces from which heat can be extracted, and the rate of heat transfer across those surfaces. The calculations were performed using a four part process, as follows:

- Part 1 calculates the quantity of LNG spilled;
- Part 2 considers the flow of LNG through troughs and spillways and subsequent collection in a sub impoundment;
- Part 3 predicts the rate of vapour production with time; and
- Part 4 estimates the LNG vapour/air ratio versus downwind distance.

Parts 1-3 of the calculations were performed using the methodology contained in the AGA report “Evaluation of LNG Vapour Control Methods.” Part 4 of the calculations was performed using the GRI report No 0242 “LNG Vapour Dispersion Prediction with the DEGADIS Dense Gas Dispersion Model.”

DEGADIS is configured to model the effects of a spill whose source is assumed to be a rectangular shaped pool. In the model this is equated to a circle of equivalent area. At Keltic most of the spills that could occur will be contained in long narrow spillways and troughs. For example, the Marine unloading transfer line impoundment will have a typical width of 4 m and an estimated length of 1,150 m from the unloading arms to the sub impoundment. The piping impoundment will have essentially a zero floor slope along its length, so a spill that occurs close to the unloading arms will have a significant residence time in the impoundment before flowing into the sub impoundment. The vapour will thus be produced from the piping impoundment over a very long and narrow area, which is very different from the idealized circular pool assumed by DEGADIS.

Given these circumstances it is recognized that the vapour exclusion distance will be significantly influenced by the wind direction. A wind blowing along the impoundment will result in exclusion distances far greater than a wind blowing across the impoundment. In addition to the base case which assumes a circular pool of LNG, other DEGADIS calculations were performed using modified input data. When the wind direction was along the length of the piping impoundment, the source strength was maintained, but the pool diameter was assumed to be the width of the piping impoundment plus the width of the sub impoundment. For conservatism the location of the source was considered to be at the down wind end of the piping impoundment, rather than being located in the centre. When the wind blows across the transfer piping, the impoundment length was divided into a number of segments. The source strength was divided by the same number of segments. Thus, the source strength per unit length of impoundment was derived. The results of the base case, down wind and cross wind predictions are presented in graphical form. The following data was assumed in the calculations:

- Reference height, 3m;
- Surface roughness length, 0.0002m;
- Monin-Obukhov length, 10.6m;

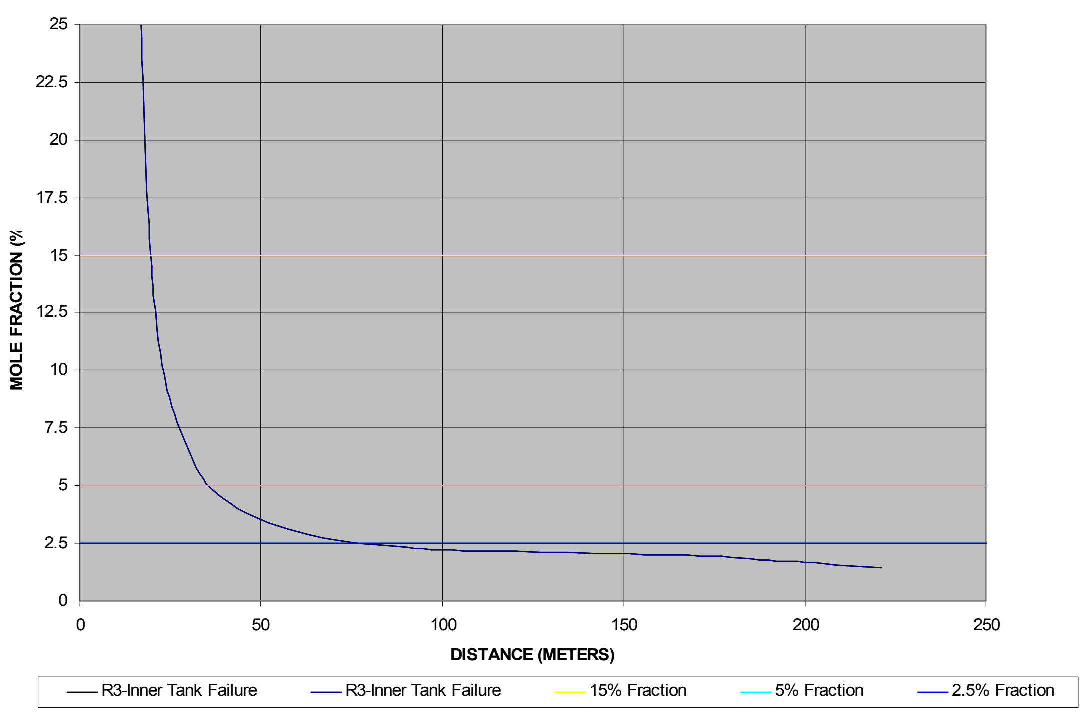
- Ambient temperature, 294 deg K;
- Surface temperature, 310 deg K; and
- Ambient relative humidity, 87%

9.21.6.3 Results of Vapour Dispersion Studies

LNG Storage Tank

The rate at which vapour would be released from a storage tank has been based upon a failure within the wall of the inner tank. If this occurred LNG would occupy the space between the inner and outer walls either displacing or intermingling with the pearlite insulation. It is assumed that the LNG would be in contact with the inner surface of the concrete outer wall. It is further assumed that the roof, suspended deck and roof insulation would remain intact. As such increased heat transfer into the tank would now occur through the un-insulated concrete wall. The rate of LNG boil off was calculated on this basis. It was assumed that the boil-off compressors were not available, and that all of the vapour produced would exit the tank through a combination of relief valves and discretionary vents. Assuming a point source in the centre of the tank roof the vapour exclusion distance to 50% lowest effect level is 75 m. See Figure 9.21-4. As the centre of tank A is at a distance of 273 m from the property line, the siting requirements are satisfied.

FIGURE 9.21-4 Keltic Petrochemicals LNG Vapour Dispersion Study Inner LNG Storage Tank Failure



Ship Unloading Transfer Line

As stated in the description of the unloading transfer line the impoundment will be divided into two sections of 1,150 m and 350 m long. The maximum amount of vapour produced will occur if the design spill occurs at the unloading arm end of the transfer line. Three DEGADIS calculations were performed, as described in the foregoing methodology. The results are shown graphically in Figure 9.21-5. The vapour source strength in this instance is very strong, 202 kg/s due to the large area that would be occupied by the spill. The DEGADIS base case, which is multi directional, indicates that the 50% lowest effect level is attained at a downwind distance of 350 m from the centroid of the impounding area. In the case of wind blowing along the impoundment, i.e. from south west to north east, the 50% lowest effect level exclusion distance is calculated to be 340 m downstream of the sub impoundment. In this direction it would just reach the sea wall. In the case of a wind blowing across the transfer piping impoundment, the 50% lowest effect level is calculated to occur at a distance of 100 m from the unloading line.

High Pressure Send Out Transfer Line and Vapourizer and Demethanizer Area

A design spill occurring in the vapourizer area will be channelled away from the equipment and into the impounding trough located beneath the transfer piping. A spill from the transfer piping will also collect in the trough. Spills occurring at any location will eventually flow to the sub impoundment. Three DEGADIS calculations were performed, as described in the foregoing methodology. The results are shown graphically in Figure 9.21-6. The vapour source in this instance is of medium strength at 56 kg/s. The DEGADIS base case, which is multi directional, indicates that the 50% lowest effect level is attained at a downwind distance of 220 m from the centroid of the impounding area. In the case of wind blowing along the impoundment trough, i.e. from south west to north east, and assuming a spill in the vapourizer/demethanizer area, the 50% lowest effect level exclusion distance is calculated to be 220 m downstream of the vapourizer/demethanizer area. In the case of a wind blowing across the transfer piping impoundment, the 50% lowest effect level is calculated to occur at a distance of 60 m from the transfer line.

9.22 ENVIRONMENTAL EFFECTS ON THE PROJECT

A significant effect of the environment on the Keltic project would be one that results in:

- a substantial loss of project schedule during construction;
- a long-term interruption in service, such as ship-to-shore product transfer at the LNG terminal or marginal wharf;
- damage to plant-site infrastructure such that public health and safety is at risk; or
- damage to plant-site infrastructure that would not be technically or economically feasible to repair.

FIGURE 9.21-5 Keltic Petrochemicals LNG Vapour Dispersion Study Ship Unloading Transfer Line

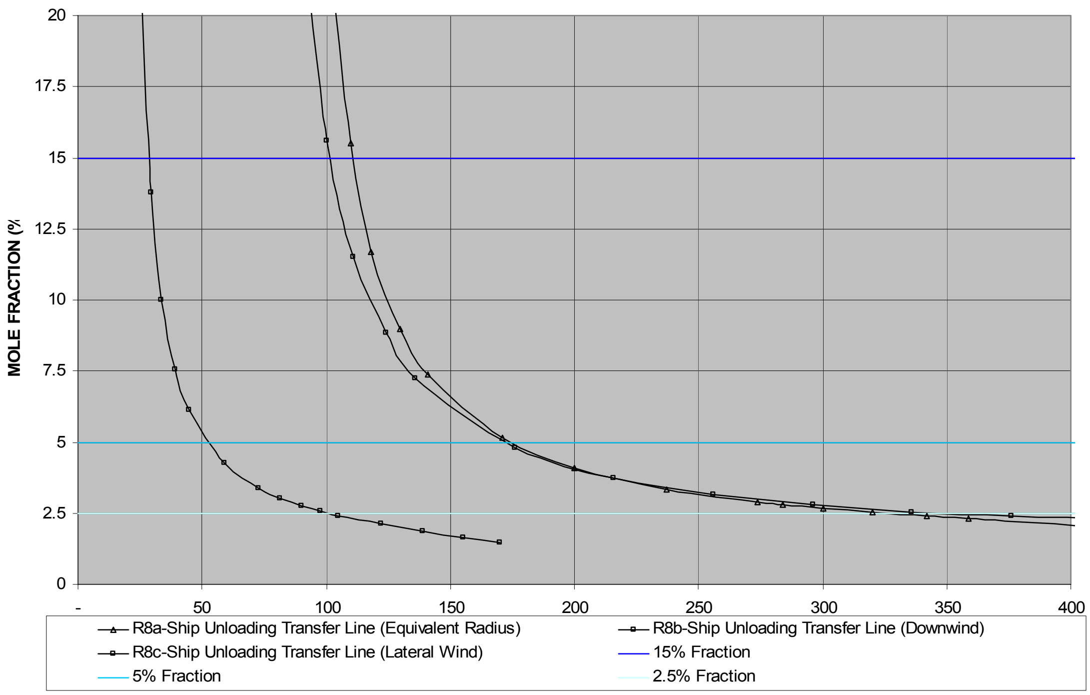
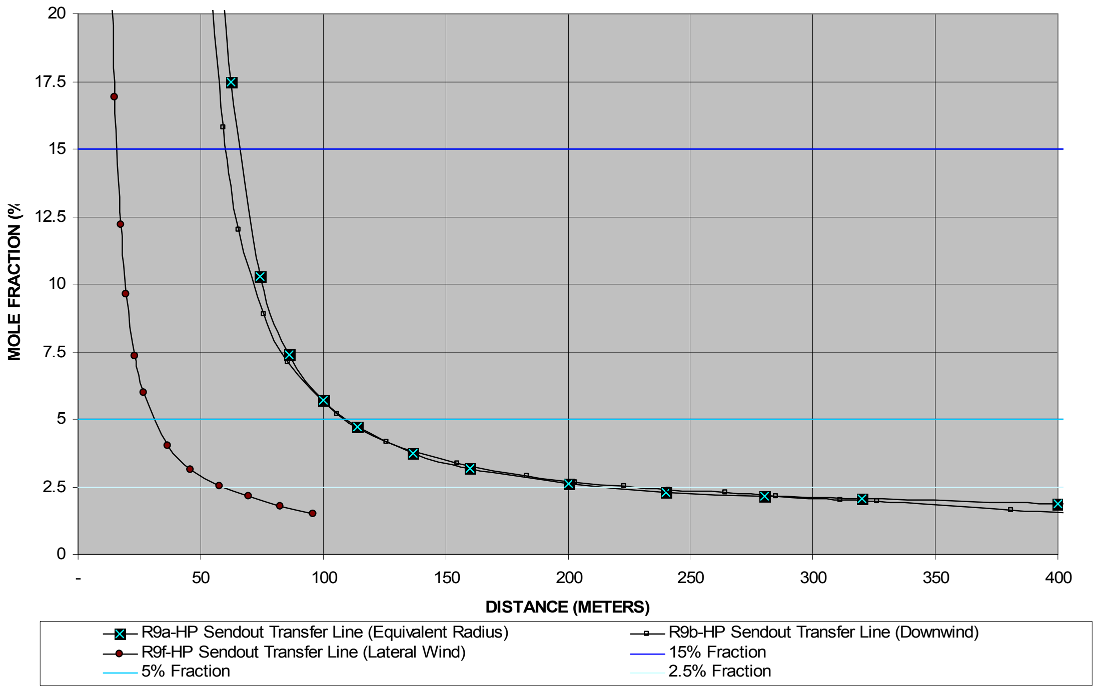


FIGURE 9.21-6 Keltic Petrochemicals LNG Vapour Dispersion Study High Pressure Sendout Transfer Line



Minor effects of the environment on the Keltic project would be ones that result in delayed construction schedules, frequent short-term disruptions in service, and increased operating or maintenance costs.

The types of natural environmental issues or events that could have an effect on the Keltic project during construction or operation of the plant-site components include the following:

- extreme weather;
- floods;
- ocean waves (storm induced);
- construction-site or shore-line erosion;
- sea spray, acid rain, acid fog;
- icing;
- seismic activity, tsunami;
- climate change;
- sea level rise; and
- forest fires.

Each of these is discussed in the sections that follow. Recommended mitigation measures are discussed in Section 10.18.

9.22.1 Extreme weather

Storms frequently pass close to the Atlantic coast of Nova Scotia, producing highly changeable and often stormy weather. Extreme weather events have the potential to delay construction of the plant-site petrochemical and LNG facilities in Goldboro, and to damage plant-site facilities and related vessels. Extreme weather events may include wind, heavy rainfall or snowfall, hail, lightning, and fog.

The ocean has a moderating effect on temperature along Nova Scotia's eastern shore, and while attention may have to be given to some materials (reduced ductility) during construction in cold weather, the plant-site facilities are not expected to be affected significantly by the extreme levels of cold or heat typically experienced in Nova Scotia.

9.22.1.1 Wind

Winds blow predominantly from the south or southwest during summer and from the northwest during winter, although severe storms, including summer hurricanes and winter “nor’easters” may generate strong winds from the northeast. High winds could have an effect on the transfer of product to/from ships. High winds can also increase structural loading on large or tall structures. Due consideration to wind must be given to components design.

9.22.1.2 Precipitation

The 1982 to 2002 mean annual total precipitation for the Keltic Study Area was 1438 mm. Although rain may occur in any month of the year, rainfall in the Keltic Study Area is generally highest during fall. Snow and freezing precipitation can occur between October and May, with the largest amounts falling between December and March. Storm precipitation events in the Keltic Study Area can be severe – the 100, 200 and 500 year 24 hour-duration events estimated to be 152 mm, 162 mm and 175 mm, respectively.

Extreme rain can result in stoppages of outdoor work, particularly during construction phases of the plant site. If unusual wet periods or excessive rain do occur, this can result in project delays and an associated delay in completion and could result in additional capital cost.

Extreme rainfall, especially when augmented by snow-melt during the spring, can result in excess amount of water collecting in the water supply reservoir at Meadow Lake. This should not negatively affect project schedules or costs to any serious degree, but may require more diligent monitoring of reservoir levels and more frequent flood gate management.

Extreme snowfall can affect winter construction or contribute to unusual flooding during snow-melt. It has the potential to increase structural loadings on facility and temporary buildings. Exceptional early snowfall could delay construction and result in additional work for snow clearing and removal. This could increase construction costs. Early snow cover can minimize or prevent ground freezing and this may also affect winter construction intended at improving work progress and accessibility.

Freezing rain, hail, ice and snow can interfere with the operation of vehicles on the highway, as it can cause slippery driving conditions and limit visibility. However, these effects should be no worse than on any other highway crossing Nova Scotia. .

9.22.1.3 Lightning

Severe weather events during which there is lightning are usually of short duration and so lightning is not considered to be a concern during construction or operation of the facilities at Goldboro.

9.22.1.4 Fog

Dense inland fog is more prevalent in late spring and early summer. Chilled air above southerly-flowing ocean currents mixing with warm, moisture-laden air moving from the Gulf Stream can generate bands of thick, cool fog off the coast. Dense fog originating inland may reduce visibility and can interfere with the operation of vehicles on the highway. With onshore winds, fog banks can move far inland and can interfere with the operation of vehicles near the coast and with shipping off shore.

9.22.2 Floods

Local flooding may occur at work sites during extreme precipitation events should storm-water retention ponds become filled.

9.22.3 Ocean Waves

Extreme wind can produce high waves, dense blowing sea foam, heavy tumbling of the sea, and poor visibility. Run-up waves can be produced from wind blowing over the surface of water. Maximum wave height is primarily a function of wind strength, wind duration, and length of exposed water (fetch). Substantial run-up waves can occur during extreme storm events such as during tropical storms, hurricanes, and "nor'easters."

Isaac's Harbour is open to the ocean and to easterly gales that can bring large waves ashore. However, the predominant winds are from the Northwest and Southwest, and easterly winds at sea generally shift to northeast, thus reducing wave force within Isaac's Harbour.

9.22.4 Construction Site and Shore-line Erosion

Heavy rainfall events may cause work-site erosion at the plant site. A potential exists for failure of erosion and sediment control structures due to such precipitation events. Such a failure could result in the release of a large quantity of sediment-laden runoff to receiving watercourses with potential adverse environmental effects on fish and fish habitat.

9.22.5 Sea Spray, Acid Rain, Acid Fog

High winds and heavy seas at reduced temperatures can cause freezing spray conditions. Freezing spray can occur between November and April, however the potential for moderate or greater vessel icing from freezing spray is greatest in February. Safe work aboard a vessel can be impeded by freezing spray, as could some work tasks at the marginal wharf and LNG terminal.

Sea spray carried as high winds causing waves to break over rocks can lead to long-term corrosion on exposed oxidizing metal surfaces and structures. Acid rain and acid fog may also lead to long-term corrosion on exposed oxidizing metal surfaces and structures.

9.22.6 Icing

Sea ice forms along Nova Scotia's Atlantic coast during January, February and March, peaking in late February and March. Sea ice formed in the Gulf of St. Lawrence can also drift through the Cabot Strait onto the Scotian Shelf and pile up along the coast when winds are from the north and east. Ice accumulations occur mainly between the second week of February and the second week of May.

In the coastal area around Country Harbour, the frequency of occurrence of ice could be up to 33% during the first week of March and between 1% and 15% in February and the rest of March. The 30-year median of the predominant ice type is new or grey-white ice (less than 30 cm thick) in February, grey ice (less than 15 cm thick) during the 1st week of March, and first year ice (up to 70 cm thick) for the rest of March (ExxonMobil, 2006).

When carried away to sea by winds and currents, the coastal ice cover melts and does not hinder navigation. The likelihood of Gulf of St. Lawrence ice occurring at the development sites is very low; less than 1%. However, the formation of ice in the shallow coastal waters must be taken into account when designing the Marginal Wharf and LNG terminal facilities.

Icebergs originate from glaciers in Greenland and drift with the Labrador Current and typically decay on the Grand Banks of Newfoundland. According to a few local residents, icebergs have never been seen in the Keltic Study Area. Only one iceberg has been reported in the Keltic Study Area in the last 60 years (ExxonMobil, 2006), and the probability of future iceberg occurrences is low.

9.22.7 Faults/Shear Zones, Seismic Events and Tsunamis

9.22.7.1 Faults and Shear Zones at the Proposed Dam at Meadow Lake

A less-obvious, but nevertheless significantly important matter of concern includes geological structures – faults and shear zones – as they may relate to the construction and operation of the proposed dam at Meadow Lake. The Isaac's Harbour River may have developed along a fault or shear zone, in which the river would have been able to more easily carve into bedrock which is already broken and thus, more easily eroded. These same geological structures are believed to be responsible for the surplus of water discharging at the Isaac's Harbour River relative to total precipitation. Faults may also allow water to flow beneath the dam, to be lost from the water supply reservoir. This may present a potential for concern for leakage throughout the lifespan of the proposed dam at Meadow Lake.

9.22.7.2 Seismic Considerations

Notwithstanding Nova Scotia's location within the stable continental part of the North American tectonic Plate, within Canada's eastern seismic region, large earthquakes have occurred in the past and will inevitably occur in the future. These are likely to have little effect, if any, on the proposed plant site only and may (or may not) occur at any time during its construction and/or operation. Tanks and other structures on site will be designed for the seismic rating in the region, as required under CSA Z276-01. In addition, all structures at the site will be built to meet or exceed the new design criteria as set out in the 2005 edition of the NBCC. Appropriate contingency planning will also address the possibility of structural failure which may result from such an event. With proper mitigation measures in place, the residual effects, although improbable are expected to be of major significance (see Table 11.0-1 in Section 11.0). Considerations for mitigation are presented in Section 10.

<u>Seismic Hazard</u>

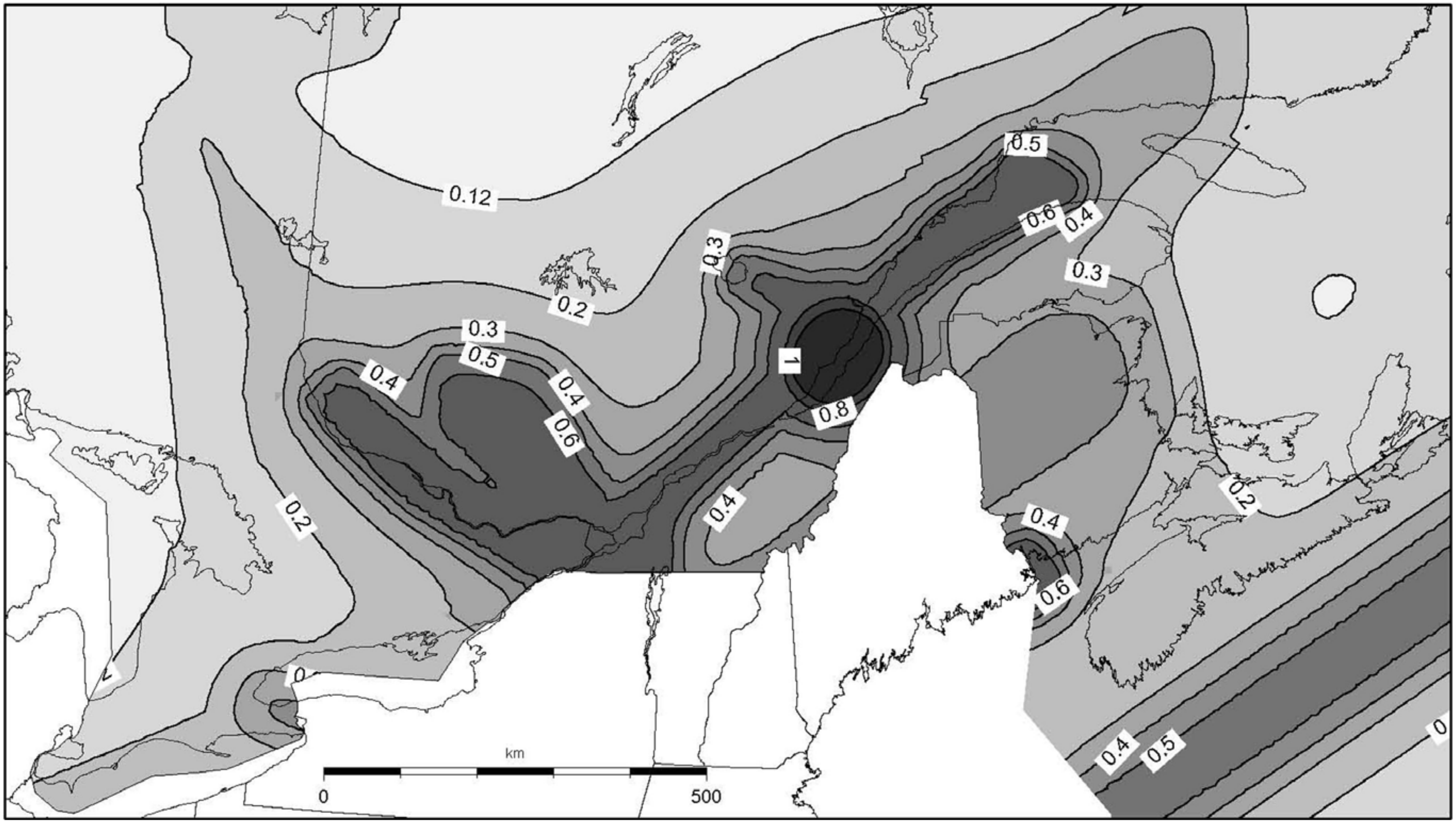
Figures 9.22-1 to 9.22-5 contain the new seismic hazard maps that will be used in the 2005 edition of the NBCC to replace the 1985 maps presently in use in the 1995 NBCC (Adams and Atkinson, 2003). The 2005 edition of the NBCC was adopted by Nova Scotia on May 1, 2006 (T. Ross, pers. comm., 2006).

The 2005 edition of the NBCC contains significant changes in the provisions for seismic loading and design (Heidebrecht, 2003). The 1995 NBCC employed seven "zones" (0 to 6) to describe peak ground velocity and acceleration, determined at a probability of 10% in 50 years. In the 2005 edition of the NBCC, the Geological Survey of Canada is now using a probability of exceedance of 2% in 50 years, and calculating hazard in the form of uniform hazard spectra, which provides a much better period-dependent representation of earthquake effects on structures. The implication is that the design forces in short-period structures relative to those in long-period structures would be much larger than is the case for structures designed in accordance with the 1995 NBCC provisions.

Table 9.22-1 presents the seismic hazard for various spectral acceleration time periods as given by Adams and Halchuk (2003) for site category C (very dense soil and soft rock, $360 < V30 \leq 760$ m per second (m/s)), and seismic hazard with appropriate ground motion amplification factors as defined by Liam Finn and Wightman (2003) applied for site categories B (rock, $760 < V30 \leq 1,500$ m/s) and A (hard rock, $V30 > 1,500$ m/s) for three localities along Nova Scotia's Eastern Shore, compared to three urban areas with low to high levels of seismic hazard, i.e. Toronto, Montreal, and Vancouver (Heidebrecht, 2003).

The seismic hazard at the proposed Keltic plant site would fall somewhere between that for Halifax and Canso, and since all important structures will have foundations built directly onto bedrock, it could be defined as a class A to B site. Even when taking into account the nearby magnitude 7.2 Grand Banks event of 1929, Figure 8.13-7 shows the seismic hazard for the Keltic plant site to be generally low; similar to or less than site class A to B criteria for Toronto for time periods of 0.2 and 0.5 seconds, and only slightly above that for Toronto and significantly less than for Montreal for 1.0 second period events. Recommended mitigation measures are described in Section 10.13.5.

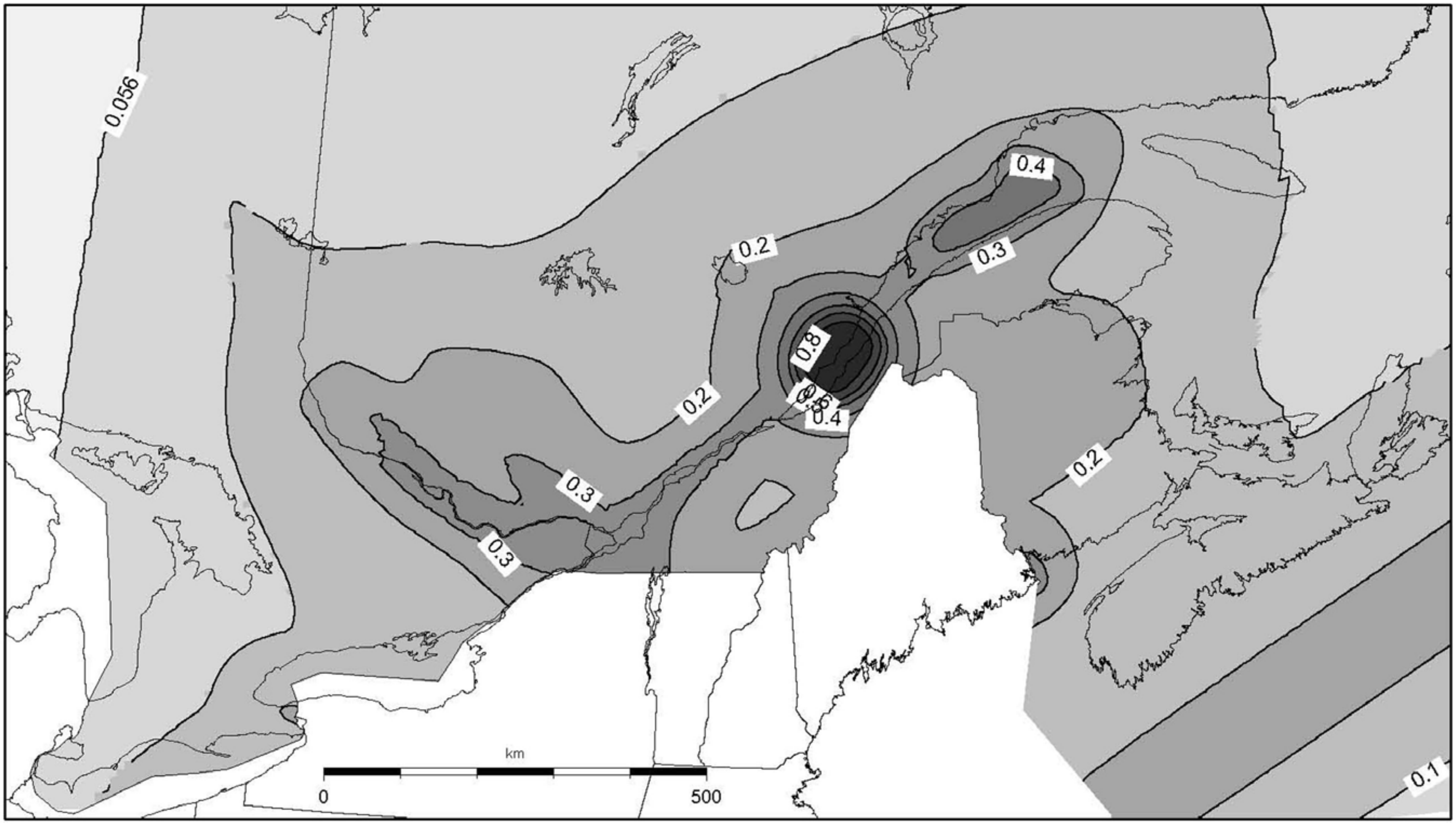
FIGURE 9.22-1 Spectral Acceleration (0.2) for Canada



National Building Code of Canada

FIGURE 9.22-1
KELTIC PETROCHEMICALS INC.
SPECTRAL ACCELERATION (0.2)
FOR CANADA
JULY 2006

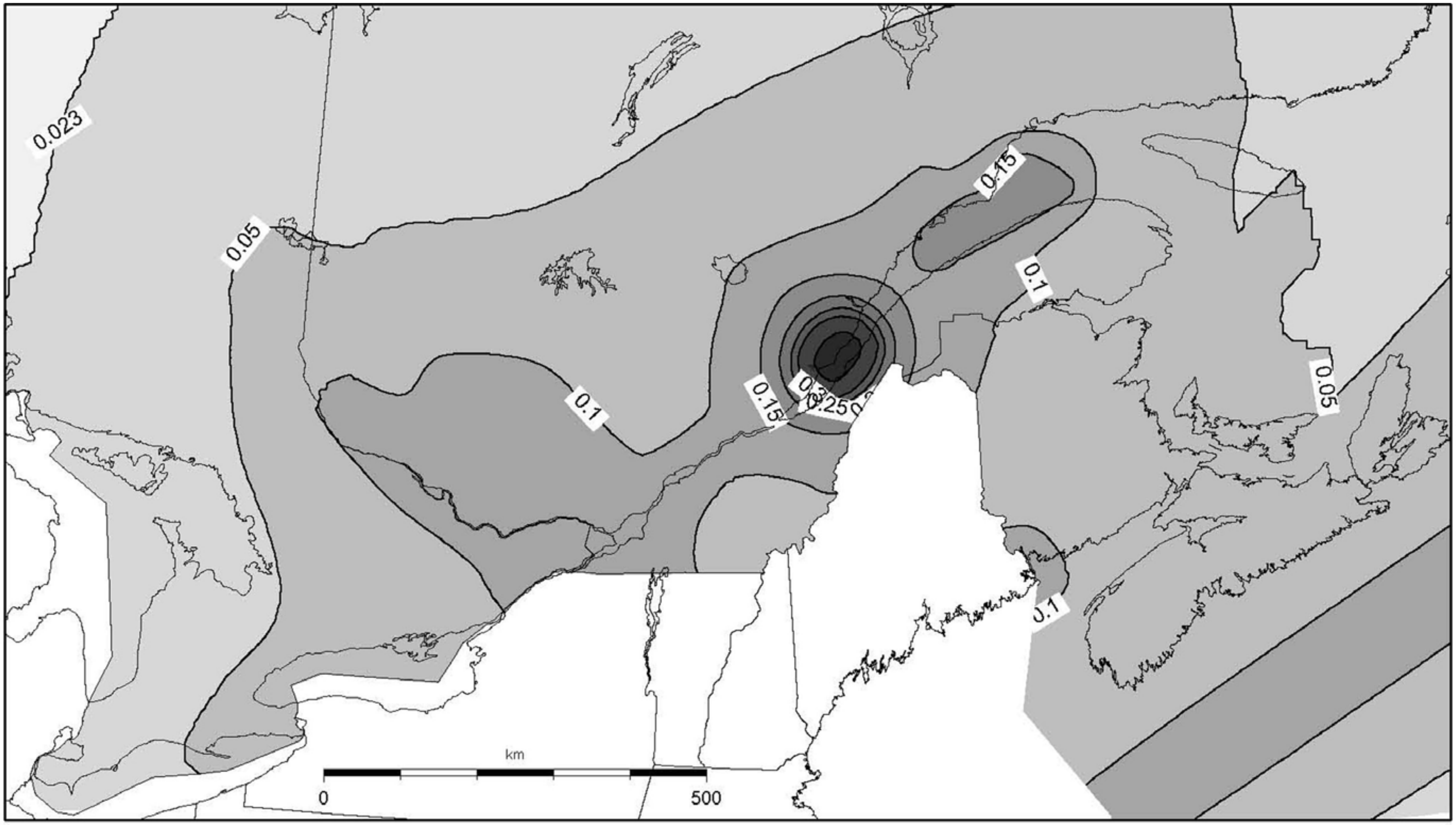
FIGURE 9.22-2 Spectral Acceleration (0.5) for Canada



National Building Code of Canada

FIGURE 9.22-2
KELTIC PETROCHEMICALS INC.
SPECTRAL ACCELERATION (0.5)
FOR CANADA
JULY 2006

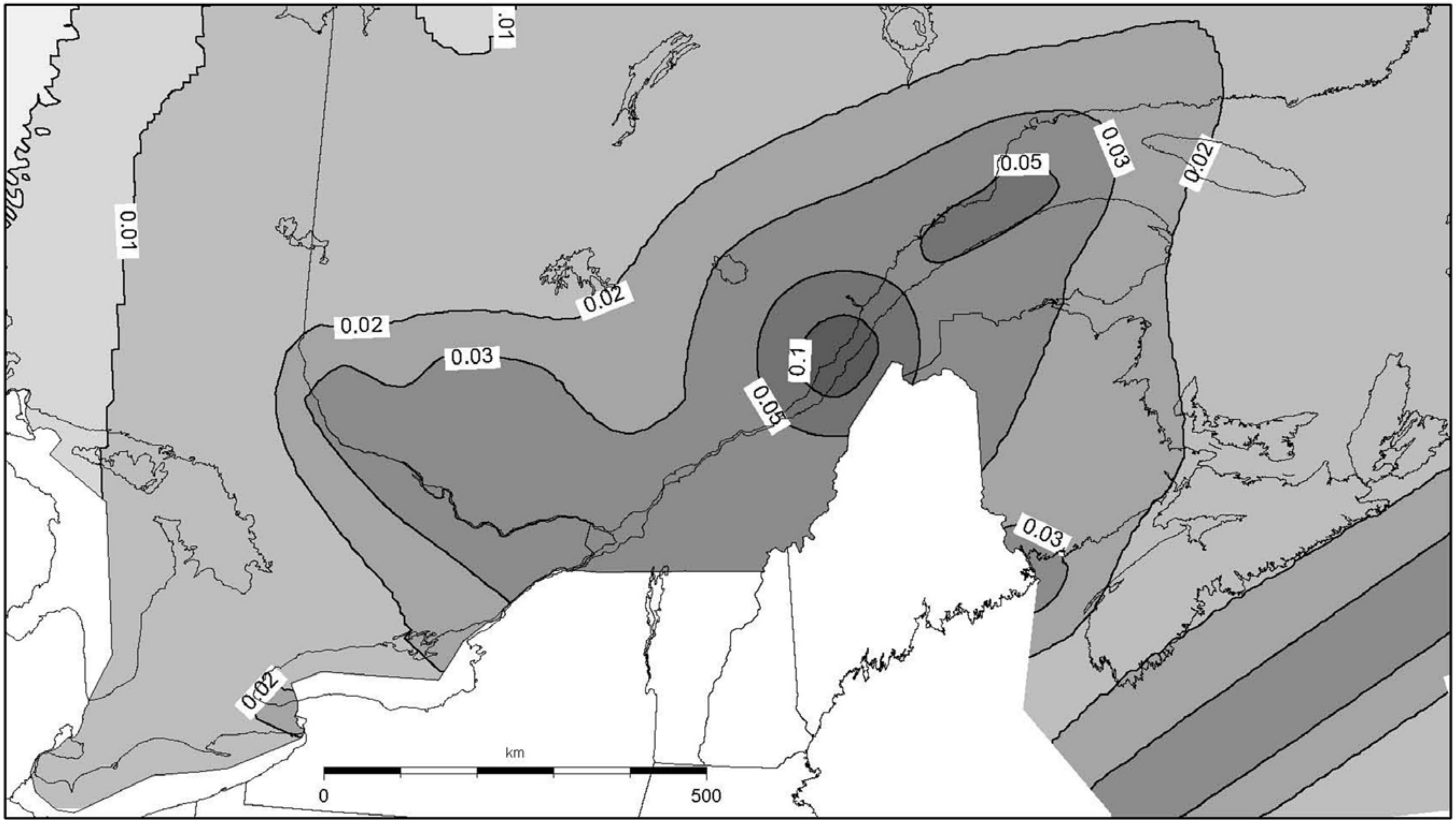
FIGURE 9.22-3 Spectral Acceleration (1.0) for Canada



National Building Code of Canada

FIGURE 9.22-3
KELTIC PETROCHEMICALS INC.
SPECTRAL ACCELERATION (1.0)
FOR CANADA
JULY 2006

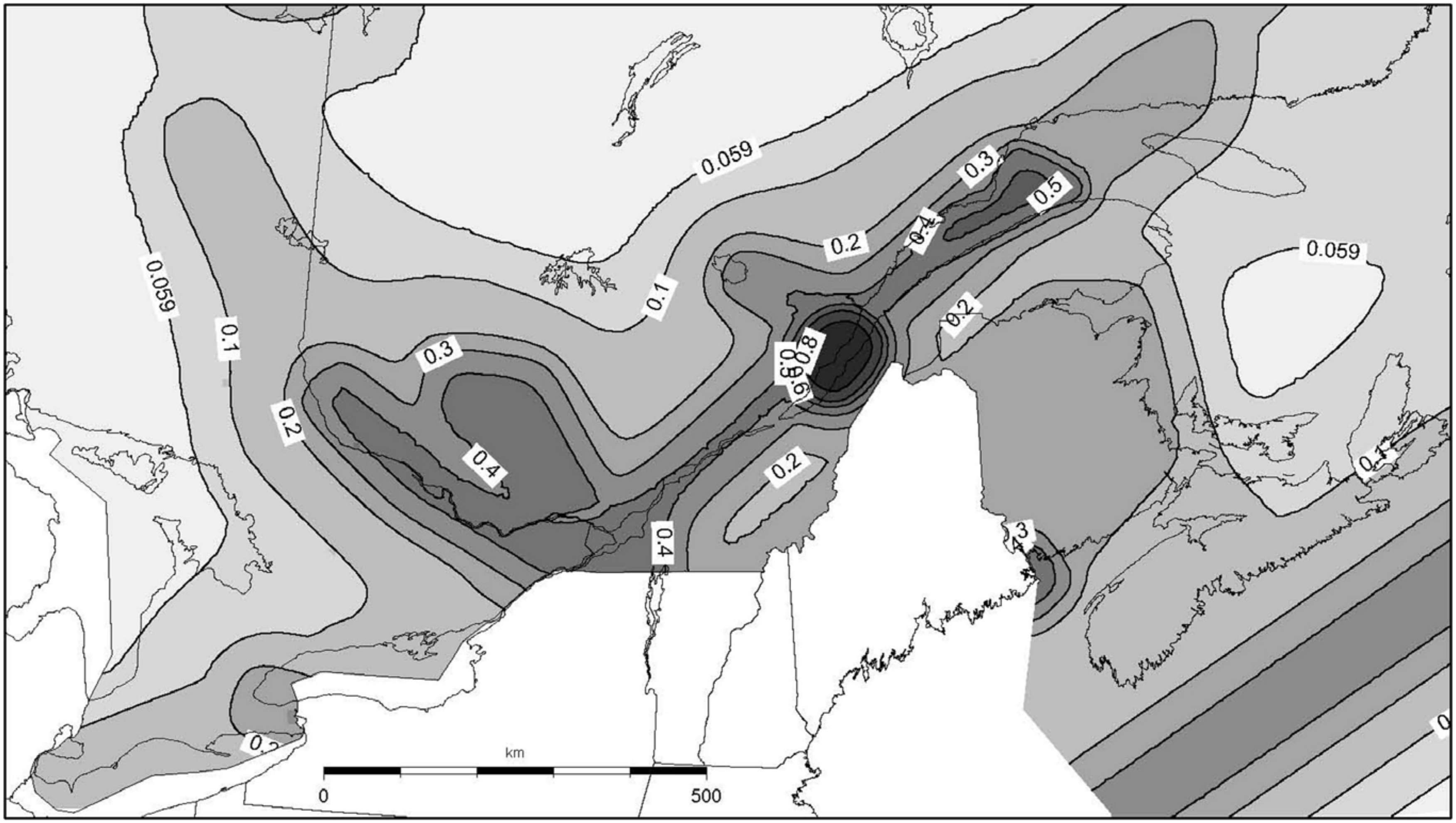
FIGURE 9.22-4 Spectral Acceleration (2.0) for Canada



National Building Code of Canada

FIGURE 9.22-4
KELTIC PETROCHEMICALS INC.
SPECTRAL ACCELERATION (2.0)
FOR CANADA
JULY 2006

FIGURE 9.22-5 Peak Ground Acceleration for Canada



National Building Code of Canada

FIGURE 9.22-5
KELTIC PETROCHEMICALS INC.
PEAK GROUND ACCELERATION
FOR CANADA
JULY 2006

TABLE 9.22-1 Seismic hazard – Spectral Acceleration (g) with Time Periods 0.2. 0.5, 1.0 and 2.0 sec., and Peak Ground Acceleration (g) for Normalized Site Class C and for Site Classes A, B (after Adams and Halchuk, 2003 and Heidebrecht, 2003)

Site class	Locality	Spectral Acceleration (0.2)	Spectral Acceleration (0.5)	Spectral Acceleration (1.0)	Spectral Acceleration (2.0)	Peak Ground Acceleration
C	Halifax	0.23	0.13	0.069	0.019	0.12
	Canso	0.24	0.14	0.071	0.020	0.13
	Louisburg	0.22	0.12	0.066	0.018	0.12
	Toronto	0.26	0.13	0.055	0.015	0.17
	Montreal	0.69	0.34	0.140	0.048	0.43
	Vancouver	0.94	0.64	0.330	0.170	0.46
A	Halifax	0.16	0.08	0.035	--	--
	Canso	0.17	0.08	0.036	--	--
	Louisburg	0.15	0.07	0.033	--	--
	Toronto	0.18	0.08	0.028	--	--
	Montreal	0.55	0.22	0.070	--	--
	Vancouver	0.75	0.42	0.165	--	--
B	Halifax	0.18	0.09	0.041	--	--
	Canso	0.19	0.1	0.043	--	--
	Louisburg	0.18	0.08	0.040	--	--
	Toronto	0.21	0.09	0.033	--	--
	Montreal	0.62	0.26	0.084	--	--
	Vancouver	0.94	0.54	0.231	--	--

9.22.7.3 Tsunami

A tsunami is possible at the site, although the severity of such an event is not known at this time; some predict the risk to be low, and work is currently underway by various agencies to define the risks for Nova Scotia and other parts of eastern Canada as part of a proposed tsunami warning system.

Public awareness of tsunami hazard and risk in Canada are generally low because destructive tsunamis along Canada's East Coast are thought to be rare events (Clague et al., 2003). However, the events of December 26, 2004, in the Indian Ocean have focused interest on the geologic and historical records and modeling of tsunamis in the Atlantic Ocean, which at present is no better protected than was the Indian Ocean when it comes to having a tsunami warning system.

Tsunami may be triggered by asteroids crashing into the ocean, or as is more commonly known from human history, by deep-seated earthquakes. A magnitude 6.0 earthquake off the east coast would likely not be strong enough to cause a tsunami by itself, but it could cause an underwater landslide that could cause a tsunami. Shallow energy sources able to trigger tsunami are also possible, and although clearly climate related (Campbell et al., 2003), it is uncertain whether the late-glacial failures noted in the geologic record were most influenced by ice-load induced seismicity, high marine sedimentation rates, or melting of gas hydrate.

At sea, tsunamis travel as a shallow water wave with a small height (generally less than 1 m) and usually go unnoticed. However, on reaching shallow water, speed diminishes but the energy in the wave remains constant, and so wave height must increase. Under optimum conditions, a wave height of perhaps a few metres could be experienced at Isaac's Harbour.

The frequency of tsunamis in Atlantic Canada is uncertain. Ruffman (in HNF, 2003) suggested that earthquakes of the magnitude that triggered the 1929 tsunami are 1 per 1000 years, but could be as low as 1 per 100 years for magnitude 6.0 earthquakes.

Campbell et al. (2003) note that common large failures occurred during the late glacial period between 20 and 10 kiloannum (ka) and appear to have a recurrence interval on the order of 2000 years. They also suggest that at present the risk of a local large tsunami appears to be low based on the occurrence of only two large failure events during the last 7 ka.

Researchers have only begun to model submarine slump-generated tsunami (Bornhold et al., 2004; Finea et al., 2005) and their possible effect on Atlantic Canada coastlines. As regards the tsunami that was triggered by the 1929 Grand Banks earthquake, models by Murty et al. (2005a, 2005b) have shown that quarter wave resonance amplification played a major role in amplifying the tsunami in some of the bays and gulfs on the south coast of Newfoundland. Their model suggested that tsunami energy could not propagate towards Nova Scotia, mainly because of extensive sand banks in between. However, one person was reported drowned in Cape Breton as a result of the 1929 tsunami (Geological Survey of Canada, 2005).

There are presently tsunami warning systems in the Pacific Ocean and in the Gulf Coast; but to date, none are located in the Atlantic Ocean. One is planned near Canadian shores, however, and this system will reportedly involve all Atlantic Provinces (Murty et al, 2005a).

If appropriate information is not available from the anticipated tsunami-warning system, modeling will be undertaken to estimate possible wave size and run-up in Isaac's Harbour and at the proposed Keltic plant site. The results of this modeling will be used, as appropriate, in the design of the wharf and plant facilities and in developing emergency response procedures.

The foundations for the Keltic LNG Tanks have been sited +15 m above sea level. Historical data dating back to 1774 shows tsunamis affecting Canada's Atlantic coast have been limited to no more than three occurrences which only impacted Newfoundland's coast with a maximum 15 m water height (National Geophysical Data Center). The sheltered on-shore facilities of the Keltic Complex are therefore, not expected to be vulnerable to a major LNG release caused by a tsunami. With the USA government's commitment to enhance the tsunami early warning and detection system by 2007, it is expected that sufficient advance warning will be communicated to marine vessels servicing the Keltic Complex to provide them adequate disengagement time to return to the safety of the open sea before a tsunami makes landfall.

9.22.8 Climate Change and Sea Level Rise

Global climate change has emerged as a long-term environmental challenge of global significance, in which emissions of greenhouse gases are ascribed to contribute to global warming in addition to the natural warming the earth has been subject to since its advance out of the pleistocene ice age starting about 10,000 years ago. In addition to general global temperature increases, climate change projections for the Project area include increased precipitation, sea level rise due to thermal expansion of the oceans and melting of polar ice, overall changes in the frequency and severity of storms due to changes in ocean salinity, thus global oceanic circulation and thus, oceanic temperature changes.

Table 9.22-2 summarizes the climate criteria changes provided by the Canadian Institute for Climate Studies (2006) scenario prediction model as a result of global warming through to the 2080s due to natural and anthropogenic causes. In addition, global warming within this time period is expected to result in:

- a reduction in northern hemisphere snow cover and extent of sea-ice;
- global sea level rise of up to 88 cm as a result of the above;
- global changes in the frequency and intensity of extreme climate events in the north Atlantic;
- more frequent heat waves and fewer cold waves and frost days;
- increased incidents of coastal sea flooding, accelerated coastal erosion and possible increased saltwater intrusion into freshwater resources (i.e. water level increase in the lower reaches of the Isaac's Harbour River).

TABLE 9.22-2 CICS Scenario Prediction Model Results for Nova Scotia through to the 2080s. (using default model CGCM2 A21 SRES)

Climate parameter	Units of change	Mean annual	winter	spring	summer	fall
temperature	ºC	+4	+5	+3.5	+4.3	+3
precipitation	%	+3	+5	-4	+7	+5
Max. temperature	ºC	+4	+3.5	+4	+4	+3.5
Min. temperature	ºC	+4.2	+6.2	+4	+3.2	+3
Solar radiation	Watts per m^2 (W/m^2)	0	+1	+1	-6	0
Wind speed	%	+5	0	+14	0	+3
evaporation	mm per day (mm/d)	+0.2	-0.2	+0.7	+0.25	+0.2
Soil moisture capacity fraction	%	0	0	0	0	-0.05
Mean sea level pressure	Hectopascal (hPa)	+0.4	0	+1.3	_1	-0.2
Snow water content	Kg/m^2	0	0	0	0	0
Sea ice	Kg/m^2	0	0	0	0	0
Derived vapour pressure	hPa	+3.4	+2.2	+2.2	+4	+3.5
Derived relative humidity	%	0	0	-1	+1.5	+0.5
Derived diurnal temp. change	ºC	-0.5	-2.5	0	-0.5	0
Surface temperature	ºC	+4	+5.2	+3.8	+4	+3.5

The effects of climate change on the Project are not considered to be particularly relevant during the construction phase due to the time frame associated with climate change relative to the proposed time frame for project construction. However, over time during project operation, the changes noted above are expected to have an effect on various (sensitive) components of the natural ecosystem. An increase in extreme marine-related events (including increased storm intensity, winds, ocean waves, storm surges) could result in an increased number of operation disruptions at the Marginal Wharf and LNG terminal facilities. It is possible that extreme events could increase the likelihood of accidents or malfunctions if structures were not designed to withstand frequent storms, which could lead to environmental impacts on marine fish, marine mammals, and birds. Structures must be properly designed, and appropriate mitigation measures in place to deal with the increased likelihood of such malfunctions or accidents.

9.22.8.1 Sea Level Rise

Sea level rise is an important consideration for coastal projects. For example, tidal records for the Halifax region show that the mean tide level has risen approximately 36 cm per century, or at least 40 m in the past 10,000 years (Shaw et al., 1993, Stea et al., 1994).

The Intergovernmental Panel on Climate Change projects that the global sea level rise will be between 9 cm and 88 cm by the year 2100, and that this rise will mostly be due to warming of the oceans and glacial cap melting. This would be in addition to the 36 cm per century already being experienced. This is not likely to have an effect on the Keltic project.

9.22.9 Forest Fires

During plant site construction and operation, forest fires could be caused by a fuel spill fire, vehicular accidents, careless travelers throwing cigarette butts from vehicles, other accident, or carelessness involving fire, or by natural causes such as a lightning strike. There is a large fuel load by way of slash and litter in the areas immediately surrounding the proposed plant site. Also, should there be a need to remove large amounts of soil or bedrock during plant site preparation, large grading cuts could cause groundwater levels to be lowered such that nearby forests could experience drought-like conditions, which could exasperate the risk of forest fire near the site. The immediate concern for a fire would be for human health and safety.

In the unlikely event of a forest fire, the importance of “good housekeeping” practices (see Section 10.17) is reinforced; i.e. keep the area clear of slash, litter, extraneous building materials, etc. Not only would this reduce potential tinder, but it would facilitate access for fire fighting.

9.23 CUMULATIVE EFFECTS

The effect of a project on the environment may not be fully reflected by the individual interactions of project components or activities with VECs. In many cases, individual projects and/or project components produce environmental effects that are not significant. However, when combined with the effects of other project components or other projects and activities, these small effects may become important. The basis for the consideration of the cumulative environmental effects are provided in the Responsible Authority’s Guide (The Agency, 1994), and supplemented by the Cumulative Effects Practitioners Guide (The Agency, 1999).

The Cumulative Effects Assessment Practitioners Guide (the Agency, 1999) defines cumulative effects as:

"changes to the environment that are caused by an action in combination with other past, present and future human actions."

The assessment has considered any potential cumulative effects that may result from Project construction or operation or in concert with any other projects known for the reasonably foreseeable future (five years). The assessment of cumulative effects is done between both the Project and other projects and activities and between Project components. Often the intra-Project assessment is done implicitly but where the Project activities are distinctly separated in time, as is the case with the proposed Project, it makes sense to address cumulative effects overtly. Thus the various major "Project components" will be addressed including:

- petrochemical plant;
- marine terminal;
- Meadow Lake reservoir; and
- co-generation facility.

9.23.1 Selection of Other Projects and Activities

This assessment must consider other planned or reasonably foreseeable oil and gas development activities in Nova Scotia or on the Scotian Shelf that might interact in a cumulative fashion with potential activities from the Keltics' development. Other projects and activities that were considered to potentially have cumulative effects with the Project are forestry, mining, and existing roads.

9.23.1.1 Regional Oil and Gas Development

In addition to the Keltic proposal, two other LNG projects are currently under consideration. LNG offloading facilities have been proposed for Bear Head in the Strait of Canso and in Saint John, New Brunswick.

In relation to cumulative impacts, it is important to assess the potential growth for these types of facilities in Atlantic Canada. Currently the M&NP pipeline is the only means of sending the natural gas to major markets in the northeastern USA, and it does not have the capacity for a large number of LNG offloading facilities. However, additional reservoirs of natural gas could be found in the offshore, leading to construction of additional pipeline capacity, as in the case of the proposed Blue Atlantic marine pipeline possibly located along the edge of the Scotian Shelf and connecting to markets around New York City.

Table 9.23-1 provides the number of EAs considered by the Canada Nova Scotia Offshore Petroleum Board in fiscal years 2001 to 2005, as an indication of overall oil and gas industry activity.

TABLE 9.23-1 Number of Environmental Assessments Considered by the CNSOPB, 2001-2005

Activity	Seismic Surveys	Other Geophysical Surveys	Drilling Programs	Totals[1]
2004-2005	2	3	1	7
2003-2004	13	4	10	29
2002-2003	7	4	8	21
2001-2002	8	7	2	18

1. Totals include a small number of Strategic Environmental Assessments and other studies

As Table 9.23-1 indicates, oil and gas exploration activity has dropped over the last year, and expectations are that it may remain at a lower level of activity for the foreseeable future. Most oil and gas exploration and production to date has occurred on Sable Island Bank, with some exploration along the Slope Edge and near the Gully. Promises of natural gas finds in deep water along the Slope Edge have not been fulfilled, and expectations for additional marine pipeline capacity have faded.

Development of the oil and gas industry in Nova Scotia is expected to continue, but at a slow pace. Thus, the context for cumulative impacts is one where the Keltic project is not anticipated to be a precursor to many other developments – cumulative impacts can be considered largely with respect to existing oil and gas projects.

9.23.1.2 Forestry

Commercial forestry operations occur throughout the project area. Many of these areas have been commercially harvested (clearcut) in the past, some very recently. As a result, there are few merchantable stands remaining and immature coniferous or deciduous forest types tend to predominate. Commercial forestry plantations and Christmas tree farms exist in some areas. Herbicide spraying programs occur in some plantations to reduce competition from deciduous species. Ongoing forestry activities may interact with Project VECs will include road use and local employment.

9.23.1.3 Mining

Gold mining has been a major resource extraction activity in Goldboro and the surrounding area. Abandoned mine sites exist around Goldboro and tailings are present in Isaac's Harbour. In recent years, the price of gold has risen to a level high enough to encourage more interest in active gold exploration and mining. Although most activity today is exploratory, there is a move to re-open the Orex site near Goldboro in 2006. Acadia Minerals is currently pursuing some exploratory activities near Forest Hill (limited activity), but is focusing most effort towards Goldenville and Sheet Harbour. A processing facility is currently set up in the Country Harbour Cultural Centre near Cross Roads on Highway 316 (B. Mitchell, pers. comm., 2006). Ongoing mining activities that may interact with Project VECs will include road use and local employment.

Gold mill tailings deposits remain as a legacy of the past mining activity in the area.
Stamp milling and mercury amalgamation were the primary methods used for gold extraction in Nova Scotia and in the Goldboro area, much of which was done on-site; although there are

reports that some sulphide mineral concentrate may have also been taken off site by boat to be processed elsewhere.

The stamp milling process involved crushing ore to sand or silt-size material, then washing the pulp over mercury-coated copper plates. Recent investigations by Parsons et al. (2004) just outside the proposed Keltic Site boundaries and at other sites in Nova Scotia have documented high concentrations of mercury (up to 350 mg/kg) and arsenic (up to 31% by weight) in mine wastes. The map in Figure 8.13-4 shows the location of tailings disposal areas identified within the proposed Keltic Site boundaries.

All of the tailings samples collected during the assessment field session for which results are shown in Table 8.13-1 exceed the CCME guideline values for mercury for sediments in fresh water and marine environments. All of the samples exceed the CCME guideline values for arsenic for sediments in all aquatic environments and for soil under all land uses (agricultural, residential/parkland, commercial and industrial).

Mining legacy issue that may interact with Project VECs include surface water quality (through acid mine drainage) and fish and marine habitat (through heavy metal contamination and marine deposit of mine tailings).

9.23.1.4 Existing Roads

The existing road routes include portions of Trunk 7, Route 276, and Route 316. The travel distance from Highway 104 to the Sable Gas Plant Road by the existing route is about 76.7 km. All are two lane paved roads with one lane for each direction of travel. The roads do not have any control of access and private driveways occur frequently, averaging up to about seven accesses per km. Existing traffic volumes vary along the access routes from 400 to 4510 vehicles per work day.

The Trunk 7 section of the route is rated as a Maximum Weight – Spring Exempt road, meaning that trucks can carry maximum registered loads all year. While Routes 276 and 316 are designated as 'B-Train' routes, a considerable section of Route 316 from south of Route 276 to north of Goldboro is subject to 'Spring Weight Restrictions,' which means that gross allowable weights will be reduced considerably below registered weights for about six to eight weeks each spring. Therefore, a significant road upgrade will be required to provide the necessary level of access to the Site.

9.23.2 Discussion of Potential Effects

The following sections discuss potential cumulative effects on each VEC. Potentially affected VECs include: fish habitat, air quality, socio-economic environment, and traffic infrastructure. Potential cumulative interactions between these projects and activities are identified in Table 9.23-2.

TABLE 9.23-2 Potentially Significant Cumulative Effects Interactions With Other Project Components/Projects/Activities

Other Projects/activities Considered	Fish & Marine Habitat	Air Quality	Socio-economic Environment	Traffic Infrastructure
Petrochemical Plant	X	√	√	√
Marine Terminal	√	X	√	X
Meadow Brook Reservoir	√	X	√	X
Co-generation Facility	X	√	√	√
Regional Oil and Gas development	√	√	√	√
Forestry	X	X	√	√
Mining	√	X	√	√
Existing roads	√	X	X	√

Notes: √ = Potentially significant cumulative effects likely.
X = Potentially significant cumulative effects not likely.

9.23.3 Fish & Marine Habitat

The most likely cumulative impacts on marine ecosystems from the Keltic project will result from concurrent commercial fishing activities and oil and gas exploration and production activities. The cumulative impact of these effects is most likely additive but likely insignificant in relation to the continued impact of the fishing mortality from commercial fisheries. Atlantic salmon is the only SARA species potentially impacted by the Project. In many parts of the East Coast, populations of salmon are at very low levels and there are concerns about losing genetic diversity as small wild runs disappear. Although similar effects may occur with other oil and gas developments, all activities resulting in impacts to marine resources are regulated by DFO and would require compensation for any loss of habitat, therefore, no cumulative effects on habitat will occur.

Commercial fishing operations have changed over the years and will continue to change. DFO has adopted a licensing policy that promotes fishing as a lucrative commercial enterprise rather than a fall-back subsistence occupation. Any impacts of the Project on local fisheries in the long term will likely be insignificant in relation to stock health and DFO management policies and administration.

Existing mine legacy issues continue to cause negative effects on surface water quality and heavy metal contamination in the marine environment. Measures have been taken to minimize Project effects on surface water quality and fish & marine habitat so that cumulative effects will not be significant.

9.23.4 Air Quality

9.23.4.1 Local Air Quality

Air quality related impacts associated with the construction of the facility will be comprised mainly of gaseous pollutant emissions from diesel-powered construction equipment and from marine vessels used to deliver equipment and materials to the site. There will also be pollutant emissions from private vehicles driven by the construction labour force (i.e. approximately 400 vehicles per day over the entire construction period).

Fugitive dust emissions will be generated as a result of excavation and earth moving activities as well as construction equipment traveling on paved and un-paved roads (i.e. dump trucks, cement trucks, watering trucks, bulldozers, graders, scrapers, compactors, front end loaders, and back hoes). A concrete batch plant will also be a source of fugitive dust emissions. These types of emissions will occur over a relatively brief period of time and will have only very localized impacts with the dust settling out generally within a few hundred metres of the activity.

Effective emission control measures will be employed at all identified emissions sources and will ensure that concentrations of air emissions remain within applicable government standards and guidelines. Cumulative effects may occur with emissions from the SOEP gas plant and metering station and local traffic; however, the site is fairly isolated from the public and cumulative effects of air emissions are expected to be not significant at off-site locations.

9.23.4.2 Greenhouse Gasses (GHG)

The cumulative effects related to greenhouse gasses are already significant due to very large contributions from the industrialized countries, particularly the US. Therefore, Keltic can only reduce their contribution to the extent possible. To this end, the Project has been designed to minimize greenhouse gas production through the use of natural gas generated energy instead of coal or oil. The 200 MW co-generation plant is expected to contribute up to 1,000,000 tonnes per year CO_2 as compared to the total annual emissions for Nova Scotia at 30,000,000 tonnes of CO_2 eq per year, representing a Provincial increase of 3%. However, this release of CO_2 is much less than would be expected when compared to the alternative of taking power off the NSPI grid. Typically, one would expect CO_2eq to be approximately 1,000,000 tonnes per year from the 200 MW cogeneration facility whereas the equivalent from a utility coal-fired plant would be at least 1,700,000 tonnes per year (not including allowances for transmission losses). This is due to both the inherent advantages of using natural gas as compared to coal and Bunker C, the avoidance of transmission losses, as well as the energy efficiencies gained from a combined cycle facility. In addition, the Proponent will implement energy-efficiency measures throughout its petrochemical processing facilities and take steps to promote energy savings by its employees on both an individual and collective basis, including the potential of car pooling for those commuting to the workplace. Further planning and measures related to climate change issues will take place as the Federal and Provincial Governments move forward with policy/legislative guidance.

9.23.5 Socio-economic Environment

Construction employment related to LNG receiving terminal construction, petrochemical plant construction, cogeneration plant construction, site preparation, site services and support services will total about 4,775 people who will be employed for varying lengths of time. Total employment at full operation will stand at about 624. The annual payroll of the facility will be about $37.4 million.

It is reasonable to expect that some employees at the plant will move into the Guysborough County area. In addition, spending in the local area during construction and operation will improve business prospects in Guysborough and Antigonish Counties and therefore should also improve employment prospects.

Capacity utilization of community infrastructure and retail and service operations are relatively low and therefore increased economic activity would first serve to absorb surplus capacity rather than immediately introducing the need for new costs of service provision. Given that household income in the County is well above the provincial level, the addition of well paid jobs will serve to boost retail and service sales across the board, but more so in the higher end and more discretionary lines of household spending. It is likely that taxes paid will decrease due to economies of scale in providing municipal services to a larger population. In addition, the Project, through the property tax revenue it will generate will support the enhancement and maintenance of infrastructure.

While other industries such as forestry, mining, and regional oil and gas developments will have a cumulative effect with the Project on the local and regional economy, these industries are currently in a state of relatively low growth. It is expected that the Project will represent a major increase in economic activity and will likely cause an increase in local population and spending, the available services are not near capacity and should accommodate any cumulative effects. Therefore, no significant (negative) cumulative effects on the socio-economic environment are anticipated.

9.23.5.1 Traffic Infrastructure

It has been estimated that plant employees will contribute up to 500 two-way trips per work day on access routes between Antigonish and the plants. Also, it is estimated that there will be about 100 two-way truck trips per day for shipping of products, including butane, propane, and polymers. It is anticipated that the distribution of personal vehicle traffic through the day will coincide with shift changes at the site, however, truck traffic may be spread out through a 24 hour period. This represents a significant cumulative increase in terms of demands on infrastructure and the additional traffic may result in more vehicle collisions on an annual basis. A traffic circulation study and a traffic infrastructure study will be undertaken as part of the Project design process. Cumulative effects would be considered implicitly in those assessments.

9.23.6 Conclusion

Recommended mitigation measures for cumulative effects are presented in Section 10.19.

Based on the review of potential effects and identification of available mitigation measures, it is unlikely that the construction and operation of Keltic petrochemical plant and associated infrastructure will result in significant adverse environmental or socio-economic impacts, including cumulative effects.

10.0 PROPOSED MITIGATION

10.1 REGULATORY COMPLIANCE

Keltic is committed to the effective management of all project activities that may potentially affect the Project's biophysical and socioeconomic environments. This commitment has been demonstrated during the project planning phase through numerous community consultations and the completion of this EA, and will result in a Project design that minimizes adverse effects and will continue through detailed design, construction and operations as Keltic is committed to effective implementation of the environmental design and mitigation measures specified in this document.

EPPs and the emergency response plan for the Project will be completed after EA approval, prior to construction and operation. These plans will be submitted to NSEL for approval, which will involve circulation to DFO, TC, and other regulatory agencies as required.

Section 3 summarized the relevant legislation and regulations that lead to the mitigation of environmental impacts. As well, the Proponent will apply the guidelines, policies, best management practices, and specifications that are noted throughout this document and are summarized below.

- It is Keltic's corporate commitment to provide an economical and sustainable complex in accordance to the highest level of environmental goals and principles. As the agreements between Keltic and the financial, licensors and petroleum firms are finalized; a detailed EMS will be developed for each component of the Project. Keltic and its various partners will jointly provide detailed EMSs in compliance to the EA and approvals granted.
- Nova Scotia LNG Code of Practice, CSA Z276-01and NFPA 59A will be followed during the design of the LNG facilities.
- Marine Terminal and LNG Transfer Lines - TERMPOL requirements will be followed for the marine facilities. A simulation study for the navigability of Isaac's Harbour has been undertaken and the Proponent is currently determining the Terms of Reference for the Quantitative Risk Assessment for the Project which will satisfy the needs of the federal and provincial regulators. The QRA will also be used in the TERMPOL process. The arrival and departure of both LNG and other vessels will be under the Atlantic Pilotage Authority Regulations and tugboats and a pilot boat will be available.
- Plant Water Supply - A screened intake will comply with DFO "Freshwater Intake End of Pipe Fish Screen Guidelines," (DFO, 1995) based on meeting the requirements for the anguilliform group of fish like eels. The water treatment plant will likely be of the dissolved air flotation design to treat water to "Canadian Drinking Water Quality Guidelines."
- DFO "Guidelines for the Use of Explosives in Canadian Fisheries Waters".
- Prior to construction of the marginal wharf, mooring dolphins and structures associated with the water supply (i.e. dam, impoundment and water intake), any permits required under the NWPA will be obtained.

- Sanitary Wastewater - All wastewater treatment facilities will be designed to meet Nova Scotia Guidelines for the Collection, Treatment, and Disposal of Sanitary Wastewater.
- Storm-water - All storm-water management will be in accordance to NSEL "Erosion and Sedimentation Control Handbook for Construction Sites."
- Nova Scotia Watercourse Alteration Guidelines.
- Nova Scotia Guideline for Environmental Noise Measurement and Assessment.
- Nova Scotia Contingency Plan Criteria for the Releases of Dangerous Goods or Waste Dangerous Goods.
- Nova Scotia Standards for Construction and Installation for Petroleum Storage Tank Systems.
- Construction Management and Standards - The EPP will include environmental protection measures for each major segment of the Project, i.e., marine facilities, water supply source, and process facilities.
- Decommissioning and Reclamation - Should any part of the Keltic Facility become obsolete, be decommissioned or taken out of service for whatever reason, decommissioning and reclamation of the site and facilities would be undertaken in accordance with the regulatory process at the time.

10.2 LAND USE

No mitigation required.

10.3 ABORIGINAL USE OF LAND AND RESOURCES

Following is a discussion of mitigation measures proposed for effects of the Project on Aboriginal use of land and resources. Table 10.3-1 summarizes this section and is located at the end of this section.

10.3.1 Mitigation Measures Related to Construction Phase

The historical review of the project area demonstrated that there are key areas within the Study Area that have at one time, seen significant Mi'kmaq occupation. This points to the probability that Mi'kmaq artefacts could be found during construction, and in such cases, construction workers should be made aware that this is a possibility. In the event that artefacts are found during construction activities, these must be reported to the Nova Scotia Museum immediately.

10.3.2 Mitigation Measures Related to Operation Phase

There are three sea urchin diving areas located at Betty's Cove and Red Cove that the proposed marginal wharf and LNG terminal will likely limit Mi'kmaq harvesting in this area. Sea urchins in all shallow water areas of Stormont Bay were largely decimated by a parasite in the late 1990's and have not made a significant recovery. No mitigation is suggested for these sites, as there are adjacent sea urchin areas documented by this study that should allow the continued harvesting of this resource by the Mi'kmaq.

The complete Mi'kmaq ecological knowledge study of the Keltic Study Area can be found in Appendix 2.

TABLE 10.3-1 Mitigation Measures for Land Use Effects

Potential Effect	Mitigation Measures	Project Application
• discovery of artefacts related to first nation use	• Cultural resource awareness training • contingency plant for discovery of resources	• pre-construction
• loss of sea urchin fishing grounds due to construction of marginal wharf and LNG terminal	• adjacent sea urchin fishing grounds should allow for the continued harvesting of this resource by the Mi'kmaq	• construction

10.4 SOCIO-ECONOMIC ENVIRONMENT

The majority of the socioeconomic impacts associated with the construction and operation of the Project will be beneficial to the counties of Antigonish and Guysborough and especially to the Goldboro community. Since the Goldboro area is likely to change as a result of increased economic activity associated with ongoing operation of the Keltic facilities, it makes sense to encourage development rather than minimize it.

Potential negative impacts can be readily mitigated. The following subsections describe mitigation activities to control negative effects and enhancement activities to improve the effect of positive impacts on the Goldboro area and the counties of Guysborough and Antigonish in general. Table 10.4-1 summarizes this section and is located at the end of this section.

10.4.1 Overriding Mitigation and Enhancement Recommendation

To improve the ability of Guysborough County and Antigonish County to benefit from economic activity created by the construction work the project Proponent needs to establish an "impacts and benefits coordination" function. The task of this function will be to communicate to the local economic development organizations, communities, and labour unions the forthcoming activities of the Project and the requirements of the Project for labour, materials, services, and equipment. As much advance notice as possible should be provided so the local economies and communities can organize themselves to take best advantage of the construction economic activity.

10.4.2 Mitigation related to Construction Phase

Construction of the facility will, relative to the size of the local economy, bring significant but manageable impacts to the Goldboro area.

10.4.2.1 Population Impacts

For a 27 month period there will be between 1,445 and 2,000 construction workers on-site. Significantly fewer workers will be on-site during the early and late stages of construction and commissioning. While many of these workers will commute to the work site from Guysborough County and Antigonish County a large number will also require accommodation at or near the construction site. Given the relatively small supply of rental accommodation the Project has made allowances for the operation of a construction camp. The camp will minimize impacts related to short-term accommodation requirements.

Impacts related to the influx of construction workers into the local community will also be reduced by the project's plan to have major components manufactured off-site and transported to the site for installation.

10.4.2.2 Labour Force Impacts

This is a large construction project with a relatively short duration. Trades unions should be contacted as soon as possible to advise them of the occupations and skill levels required so that they can prepare to supply the required labour force. With advance warning, should shortages be apparent and timing is appropriate, the unions will be able to implement or facilitate the implementation, of training programs.

10.4.2.3 Economic Structure Impacts

Services, materials and equipment suppliers, and local economic development agencies, in the Counties will benefit from early notice of the types, volume and timing of services and materials required during construction.

Purchasing and tendering policies of the Project should be examined, in consultation with local economic development agencies, to determine how they could best be organized to facilitate successful bidding by local businesses. In particular, where practical, tender packages could be broken into sizes that can be effectively bid on by local firms.

These activities will facilitate the capture of construction spending within the Guysborough and Antigonish Counties' economies.

10.4.3 Mitigation Related to Operation Phase

The impacts and benefits coordination function will facilitate the ability of the local economies to capture economic benefits from the operation of the Project.

10.4.3.1 Population Impacts

Workers associated with construction and operation phases may favour Antigonish for initial accommodations until more amenities are available in the Goldboro area. Over time a number of workers may choose to live in Goldboro and the surrounding area.

10.4.3.2 Economic Structure Impacts

Business services, materials and equipment suppliers, and local economic development agencies, in the Counties will benefit from early notice of the types, volume, and timing of services and materials required.

Purchasing and tendering policies of the Project should be examined, in consultation with local economic development agencies, to determine how they could best be organized to facilitate successful bidding by local businesses. In particular, where practical, tender packages could be broken into sizes that can be effectively bid on by local firms. This will help increase the capture of spending by the facility within the Guysborough and Antigonish County economies.

10.4.3.3 Labour Force Impacts

The higher paying jobs at the facility require special skills. To improve the chances of Guysborough County and Antigonish County residents to win these jobs, local economic development agencies need to be advised in advance of the occupations and skill levels required for the operation of the facility. These agencies need to work with the Proponent to identify labour force recruitment and available training programs that will allow the labour forces of Guysborough County and Antigonish County to take maximum advantage of the new employment opportunities.

10.4.3.4 Tourism Impacts

The establishment of an interpretive centre at the new facility would add to the tourism infrastructure of the Goldboro area and the Eastern Shore in general. The potential for the centre should be first discussed with the Eastern Shore Tourism Association and the Nova Scotia Department of Tourism Culture. Given the economic development nature of an interpretive centre local development agencies should be involved in the planning so that they could access financial assistance from economic development programs of the provincial and federal governments.

10.4.3.5 Municipal and Community Services

Information from the labour force recruitment and training programs should be shared with local governments so that they can be prepared for potential increases in the need for additional community services and infrastructure.

10.4.4 The Role of Local Economic Development Agencies

The overall potential for social and economic impacts complements the strategic economic development plans of Guysborough and Antigonish Counties. No further impact enhancement recommendations need to be made at this time beyond encouraging the local economic development agencies to aggressively implement the actions that stem from their long-term strategies.

With proper mitigation measures in place, the significance of residual effects are expected to be minor (see Table 11.0-1 in Section 11.0).

TABLE 10.4-1 Mitigation Measures for Socioeconomic Effects

Potential Effect	Mitigation Measures	Project Application
• limited local accommodation for construction workers	• provision of a temporary construction camp during the construction period • some components manufactured off-site to minimize influx of workers	• construction
• limited supply of skilled trades • potential need for skills upgrading	• advanced notice to agencies and trade unions regarding training and skill-level requirements	• pre-construction period
• limited ability for local businesses to participate	• advanced notice of required services, materials and equipment • tender packages sized and otherwise tailored to suit local enterprises where appropriate	• construction and operation
• failure to capitalize on public interest in project and tourism opportunities	• establishing an interpretive centre at the new facility may be discussed with appropriate agencies • interpretive centre would increase tourism potential and could act as a centre to keep the public informed on construction and future operation	• operation

10.5 RESIDENTIAL PROPERTY VALUE

Overall effects of the Project’s construction and operation phase on property values are expected to be beneficial.

10.6 RECREATIONAL OPPORTUNITIES AND AESTHETICS

The construction of the Keltic LNG plant, co-generation plant and petrochemical complex will inevitably change the visual landscape and character of the area. These impacts can be mitigated by ensuring good housekeeping around the site, such as the cleaning of the road at and near the site entrance when required. Other measures include maintaining a vegetation buffer along the site perimeter and Marine Drive as a visual screen and the design of a “jogged” road to prevent unobstructed views from the public road to the construction site. While most of the site will be hidden by a vegetative buffer the topmost structures, i.e. stacks and towers, will be visible. A colour scheme for these structures that supports blending in with the background will mitigate their visual impact.

Appropriate lighting is necessary to ensure safe and secure construction and operations. To minimize disturbances to humans and wildlife, shielded lighting will be used wherever possible. Lighting will also be angled or directed as closely as possible to work areas of concern (see Table 10.6-1).

With proper mitigation measures in place, the significance of residual effects are expected to be minor (see Table 11.0-1 in Section 11.0).

The opportunity exists for the population of Goldboro and the surrounding areas to grow in population, possibly surpassing the capacity current recreational facilities. Mitigative measures to combat this include providing information to government agencies regarding labour force in-migration, in-migrant family sizes, etc to identify government-servicing needs.

TABLE 10.6-1 Mitigation Measures for Recreational Opportunities and Aesthetics Effects

Potential Effect	Mitigation Measures	Project Application
• effects on the local visual landscape character	• ensure good housekeeping • leaning of road at and near site entrance when required • tree and shrub planting as visual screens along site perimeter and Marine Drive near the Project site • design "jogged" road to prevent unobstructed views from public road to construction site • use of color schemes for stacks and higher buildings that support blending in with background	• construction
• need for additional recreational community services and infrastructure	• provide information to government agencies re: labour force in-migration, in-migrant family sizes, etc to identify government-servicing needs	• pre-construction, construction, and operations
• impacts of light on the surrounding community	• no unnecessary lighting used • lighting to be shielded where possible • lighting to be angled or directed close to work area	• construction and operation

10.7 AIR QUALITY

Following is a discussion of mitigation measures proposed for potential air quality-related effects of the Project, with relevant information summarized in Table 10.7-1.

TABLE 10.7-1 Mitigation Measures for Air Quality Effects

Potential Effect	Mitigation Measures	Project Application
• excess dust in the air	• dust control techniques may include watering and/or chemical stabilization of potential dusty sources. • covering materials being hauled by truck and routine washing of trucks • cleaning the area around stored materials • reducing the working faces of material piles	• construction
• dust emission from anticipated batch concrete plant operations	• use of enclosures, hoods, shrouds and water sprays	• pre-construction and construction
• exceedance of air-quality objectives	• monitoring and maintenance of emission-quality systems • monitoring of VOCs prior to and during operation • low NO_x burners • application of low-NO_x burners for the LNG vaporizers	• operation of petrochemical complex and co-generation plant • operation of LNG facility
• production of greenhouse gasses	• maximize efficiency of co-generation plant • maximize energy efficiency of operations • promote car pooling and other demand side management measures • monitor development in Federal and Provincial climate change programs and implement measures as appropriate • maintaining vehicles and equipment in good working order • minimizing distance between transfer points • maintaining speed restrictions on roads	• operation of LNG and petrochemical facilities • integration between LNG facility, co-generation plant and petrochemical complex to maximize energy efficiency

10.7.1 Mitigation Related to Construction Phase

Construction air quality impacts will be mitigated to the extent that potential offsite nuisance conditions are prevented. Dust control techniques may include watering and/or chemical stabilization of potential dusty sources. Other techniques that will be used to control fugitive dust emissions include covering materials being hauled from the site by truck and by employing routine washing of trucks. Dust emissions from anticipated concrete batch plant operations will also be mitigated through the use of enclosures, hoods, shrouds, and water sprays. Gaseous emissions from construction equipment are mitigated by requiring regular maintenance of equipment.

10.7.2 Mitigation Related to Operation Phase

As noted in Section 9.6, it is anticipated that Project's air emissions from its operations, including all components (LNG delivery and natural gas send-out, cogeneration, petrochemical operations and feed/product shipping), will not result in exceedances of the provincial and CCME ambient air quality objectives/regulations. This will be confirmed through monitoring programs described in Section 13.1. As process design progresses, the Proponent will take all practical measures to further reduce the air emissions noted in Section 9.6, including both energy efficiency measures and improvement in emission-control technologies

The mitigation of greenhouse gas contributions noted in Section 9.6 will rely on both the efficiency of the co-generation plant and the LNG vaporizers as well as the energy-efficiency measures which the Proponent will implement throughout its petrochemical processing facilities. In addition, the Proponent will take steps to promote energy savings by its employees on both an individual and collective basis, including the potential of car pooling for those commuting to the workplace. Further planning and measures related to climate change issues will take place as the Federal and Provincial Governments move forward with policy/legislative guidance.

With proper mitigation measures in place, the significance of residual effects are expected to be minor (see Table 11.0 -1 in Section 11.0).

10.8 NOISE IMPACTS

The construction and operation of the Keltic facilities will inevitably result in noise effects, which will vary both in intensity and location. The major portion of the work will take place within the confines of the industrial park, meaning that both distance and the buffering effect of the landscape will serve to mitigate these impacts.

Work activities will be planned so as to create minimal disruption in the evening and night time hours, and construction activities at the wharf and marine terminal areas will be discussed with local fishermen so as to minimize potential impacts on the commercial fisheries. A summary of mitigative measures for noise impacts can be found in Table 10.8-1.

In conducting site construction operations, Keltic will:

1. Ensure that all equipment has appropriate noise-muffling equipment installed and in good working order.
2. Conduct routine noise monitoring at both the site boundaries and nearby occupied properties as appropriate.
3. Restrict intensive construction activities to the hours of 0700-1900 where practical.
4. Ensure that the public has contact numbers for appropriate construction and government personnel in the case of noise issues.
5. Ensure that the public is given adequate prior notice of any blasting activities scheduled to take place.
6. Maintain, where practical, treed buffers between the working site and the public.

A recent study on bottlenose dolphins showed that pile driving has the potential to negatively affect dolphin populations at a distance of up to 40km. The potential impacts include interfering with communications, foraging, echolocation, and breeding. Possible mitigation includes working during low tide, working outside of sensitive periods, the use of ramped warning signals and masking the noise with bubble curtains (David, 2006).

Keltic also proposes to use alternative construction techniques such as vibratory pile-driving. Additionally, Keltic will confer with both representatives of both the recreational fishery and the commercial fishery in order to develop seasonal and daily activity schedules which will be the least likely to disrupt these activities.

In addition, by modeling predicted noise levels at the property boundary at sensitive receptor locations, Keltic will be able to factor noise in the design of the facilities for example, modeling may indicate that addition insulation or baffling is required for certain pieces of equipment.

TABLE 10.8-1 Mitigation Measures for Noise Impacts

Potential Effect	Mitigation Measures	Project Application
• impacts of noise on surrounding community	• distance from source to receptor • use of a treed buffer between plant site and residences • use of silencers and baffles on equipment • conduct routine noise monitoring to ensure noise levels at nearest occupied properties do not exceed CMHC levels • supply public with contact numbers in case of noise issues • give public prior notice to blasting • minimize evening and night-time operations • use alternative techniques to pile driving such as vibratory pile-driving • work activities will be planned as to create minimal disruption in the evening and night time hours • discussions with local fishermen will take place to minimize potential effects on the commercial fisheries	• construction and operation
• impacts of noise on marine mammals from pile driving	• working at low tide • the use of ramped warning signals • the use of bubble curtains to mask the noise • use alternative techniques to pile driving such as vibratory pile-driving	• construction

10.9 SURFACE WATER

The guiding document regarding the mitigation of potential effects on surface water will be “Erosion and Sedimentation Control Handbook for Construction Sites” (Nova Scotia Department of the Environment, 1988). Following is a discussion of mitigation measures proposed for potential storm-water-related effects of the Project, with relevant information summarized in Table 10.9-1.

The locations of the plant-site facilities were selected, in part, to minimize interactions with watercourses.

Sanitary wastewater will be stored and hauled off site during early construction and then treated on-site using approved sanitary wastewater treatment methods. Wastewater generated from project operations will be treated to comply with NSEL and EC criteria prior to discharge as described in Section 2.3.4.2. A storm-water management plan will be developed to reduce the total amount of storm-water discharge generated and to prevent sediment-laden runoff from the site from entering surface waters during project operation. Routine air emissions from the facility are not expected to cause a degradation in surface water quality.

TABLE 10.9-1 Mitigation Measures for Surface Water Effects

Potential Effect	Mitigation Measures	Project Application
• siltation of surface waters	• location of plant-site facilities to minimize interactions with watercourses • erosion control measures • provision for spill control • restrict the removal of riparian vegetation from margins of surface waters i.e. 15 m setback • use of surface water settling/detention ponds • stabilization of disturbed soils	• construction and decommissioning
• contamination of surrounding surface waters via runoff, spills, and leaks	• all on-site fuels, oils and chemicals should also be stored at a designated fuelling and material storage site at least 150 m from any surface waters • re-vegetation of disturbed soils • management of storm-water quantity and quality to relevant provincial standards • treatment of wastewater to comply with regulatory requirements prior to discharge • use of surface water settling/detention ponds • discharge of collected wastewater within respective watershed	• excavation, construction, and operation

Potential Effect	Mitigation Measures	Project Application
• contamination of surrounding surface waters via runoff, spills, and leaks *(Continued)*	• all rock excavation will be tested for acidic conditions. If any is found it will be disposed of in a provincially approved manner • storm-water runoff from uncontaminated areas will be segregated from potentially contaminated areas	
• effects on Meadow Lake and Isaac's Harbour River	• construction of cofferdam • in-water works to take place outside of spawning/fish migration season • use of siltation curtains • rehabilitation of shoreline upon completion • surface water gauging stations and groundwater monitoring wells to help maintain the overall water balances above and below the dam	• construction and operation
• erosion of watercourses	• line ditches with granular materials • flow checks used in drainage ditches • use of surface water settling/detention ponds • develop an erosion and sediment control plan • retain as much vegetated and porous surface as possible to aid in groundwater recharge	• operation

10.9.1 Surface Water Quality

Mitigation measures for the protection of surface water quality are summarized below:

- Industrial Site Wastewater Management - Storm-water runoff from uncontaminated areas will be segregated from potentially contaminated areas and discharged through a storm-water outfall. These uncontaminated areas generally include roads, building roof drains, undeveloped areas, and uncontaminated areas in the utility and offsite units. The non contaminated runoff will generally flow through open site ditches with final disposal in Isaac's Harbour. Ditch checks, vegetation and siltation ponds will be utilized to treat the storm-water before discharge.

  A first flush approach will be utilized in handling potentially contaminated storm-water. Under this approach the initial 25 mm of rainfall is diverted to storm-water ponds. Rainfall in excess of 25 mm is considered to be clean and is diverted to the storm-water outfall. Water from the storm-water pond will be transferred at a controlled rate to the onsite wastewater treatment system.

  Oily water will be collected in the oily water system and pumped to the CPI separator, where initial separation of oil and water takes place. Water effluent from the CPI separator flows to the IAFU for further removal of any remaining free and/or emulsified oils. In the IAFU, oil, suspended solids, and grease adhere to bubbles and are floated to the surface. This froth then overflows to a collection point while the water from the IAFU is pumped to the equalization basin. In the equalization basin, the IAFU water combines with non oily wastes and potentially contaminated storm-water.

Recovered oil from both the CPI separator and the IAFU is collected and pumped to the recovered oil tank. This oil will be disposed of off site. Solids removed by the CPI separator will collect in the bottom of the separator and will be removed periodically via vacuum truck for disposal off site.

A biological treatment unit consisting of an extended aeration and activated sludge system will be utilized for further treatment of wastewater. Effluent from the equalization basin is sent to the bioreactor basin and is contacted with activated sludge. The activated sludge permits natural biological reactions to further treat the wastewater. The mixed biological slurry overflows to the secondary clarifier where the biological solids are removed and recycled back to the bioreactor. The effluent from the biological treatment unit will be of sufficient quality to be discharged to the environment.

- Construction of Petrochemical / LNG complex - All rock excavation will be tested for acidic conditions and any found to exceed regulatory levels will be disposed of in accordance with the Sulphide Bearing Materials Disposal Regulations (NSDE 1995) and Guidelines for Development on Slates in Nova Scotia (NSDE1995).
- Construction of Wharf - No dredging plus silt curtains and booms will be used during construction to minimize siltation in the marine environment.
- Construction Management and Standards - Due to the large areas that will be disturbed by construction, extreme effort will be undertaken to avoid release of dust and sediment into the environment. Storm-water management will be exercised during construction to address both dust control and erosion and sediment control. Sediment-laden storm-water runoff will be prevented from entering surface water bodies. Control features will include utilizing granular material, ditch checks, silt fences, vegetation and siltation ponds.
- Impacts on Surface Water - The locations of the plant-site facilities were selected to minimize interactions with sensitive environmental features such as watercourses.

  Wastewater generated from project operations will be treated to comply with regulatory requirements prior to discharge. Sanitary wastewater will be stored and hauled off site during early construction and then treated on-site using approved sanitary wastewater treatment methods. A storm-water management plan will be developed to reduce the total amount of storm-water discharge generated and to prevent sediment-laden runoff from the site from entering surface waters during project operation.
- Dam and Water Intake Construction - To protect Meadow Lake and Isaac's Harbour River from being the receiving waters for potential construction-related effects, measures to control siltation and erosion, appropriate storage of fuel, and appropriate operation of construction machinery will be employed.
- On-Site Watercourses, Crusher Brook - There will be a minimum 15 m setback between the on-site reaches of this watercourse and any project-related infrastructure. In

addition, this watercourse will be protected during construction and operation by a comprehensive set of mitigation measures.

- On-Site Watercourses, Betty's Cove Brook - There will be ongoing storm-water discharges to Betty's Cove Brook from one or more fire ponds during plant site construction and operation. Besides associated piping or open ditches, the footprint of the Keltic plant facilities does not impinge on any part of Betty's Cove Brook. There will be a minimum 15 m setback between the on-site reaches of this watercourse and any project-related infrastructure, and this watercourse will be protected during construction and operation by a comprehensive set of mitigation measures.
- On-Site Watercourses, Unnamed Tributary to Dung Cove - Due to its former mining legacy and the possibility of mobilizing contaminated sediments, the headwaters, and all other parts of this drainage feature will be avoided. Thus, the footprint of the Keltic plant facilities will not impinge on any part of this tributary, and other than original natural overland drainage, the Project will have no discharges of any kind to this watercourse. In addition, where it is present near the SOEI gas-plant road and at other places, this watercourse will be protected during construction and operation by a comprehensive set of mitigation measures.
- General Construction and Process Wastewater Management - Technologies are readily available (or specific technologies can be designed) to reduce and/or treat the waste waters that will be generated during construction, and the oily storm-water and sanitary waste water that will be generated during site operation. Examples include the use of storage for treatment off site, first flush approach to remove oily storm-water, oily water collection, and treatment by static and forced gravity separators with residuals treatment on or off site, and use of bioreactors, sequencing batch reactor systems.
- Storm-water Management / Plant Site Construction - Erosion control measures will be initiated essentially as work progresses. During construction, TSS concentrations in storm-water, residual hydrocarbons, and/or metals in used test waters, or the concentration of lime in concrete waste waters, could exceed the water quality guidelines for the protection of aquatic life published by the CCME (1999). Proper mitigative measures will be initiated to help address these concerns. Sediment settling ponds will be put in place early during project construction, silt curtains will be used as required, and a minimal number of areas will be stripped of vegetation and disturbed at any one time. Disturbed vegetation will be replaced, and/or process areas will be paved and curbed, as soon as possible to avoid excess erosion and to direct runoff to appropriate collector locations and treatment equipment.
- Storm-water Management (Plant Site Operation) - Process areas will be paved and curbed to direct runoff to one or more collectors equipped with a sump and oil and water separator to ensure that runoff not meeting regulatory criteria is treated or disposed in accordance with requirements. A storm-water management plan will be developed incorporating the use of large fire ponds to prevent sediment-laden runoff from the facility from entering streams or Isaac's Harbour.

10.9.2 Surface Water Quantity

Mitigation measures for the protection of surface water quantity are mentioned below:

- Plant Water Supply - The impoundment will require a concrete gravity dam to raise the water level. The concept will meet a variety of objectives and hydrologic conditions observed for 2002. Basic features include a 1 m wide flow section for a Denil type fishway with a single resting pool. The fishway would extend to 0.5 m above the existing normal water elevation and also function as the primary source for make up water to the river.
- Water System Operation - Keltic will install surface water gauging stations and groundwater monitoring wells above and below the dam to measure lake stage and river flows to help determine the overall water balances. Keltic will endeavour to protect the water supply by also implementing a watershed protection strategy.
- Storm-water Management - plant site operation - Reduced groundwater recharge in paved areas (thus, reduced stream base flow) can cause drier conditions and longer dry periods between flow events in streams. The net result can be an increase in stream erosion and channel straightening over time, accompanied by reduced water and aquatic habitat quality. To mitigate Keltic intends to retain as much vegetated (natural or replanted) and porous (unpaved parking areas and walkways) “soft surface” as possible and reduce the amount of paved or “hard surface” needing controlled drainage. This can help to maintain existing water balances and status-quo conditions regarding net overland flow and infiltration to groundwater recharge and base flow to receiving watercourses.
- Inter-Watershed Transfers - All storm-water collected within the plant site will be disposed of within each respective watershed. As such, there will be no inter-watershed transfers during the construction, operation, or decommissioning of the Keltic project.

10.9.3 Mitigation Related to Construction Phase

The main potential effect on surface water during construction is the possibility of silt-laden runoff into various surface waters. Mitigation measures during construction will include the use of existing vegetated surfaces, silt fences, granular stabilization materials, ditch checks, etc. for sedimentation and erosion control. Settling/detention ponds will also be used, as appropriate, to achieve acceptable storm-water-quality objectives.

Construction equipment fuelling stations and fuelling operations will also be kept away from any surface water body so as to minimize the risk of spillage into surface waters. As part of the EPP, spill kits will be on hand for possible use by all construction teams. Construction personnel will be trained in the use of these kits.

10.9.4 Mitigation Related to Operation Phase

A storm-water management system will be developed and implemented as part of the Keltic development. This system will include collection, detention, and discharge facilities designed to meet or exceed regulatory requirements. All storm-water will be intercepted before discharge into any watercourses. Storm-water ditches will be lined with granular material and will contain ditch checks to prevent and control erosion. Flow from the storm-water ditches will be directed to settling/detention ponds intended to capture the first 25 mm of each rainfall event. These storm-water ponds may also be used to augment on-site fire-fighting storage volumes.

10.9.5 Decommissioning

Some disturbance of soils will likely occur during decommissioning of the facility. As during the construction period, a range of mitigation measures will be used to control erosion and sedimentation and to minimize potential effects of storm-water discharges to surface waters. These will include the use of existing vegetated surfaces, silt fences, granular stabilization materials, ditch checks, etc.

With proper mitigation measures in place, the significance of residual effects are expected to be minor (see Table 11.0-1 in Section 11.0).

10.10 GROUND WATER

In the absence of effective mitigation, potential effects of the construction and operation of the petrochemical plant may include:

- lowering of groundwater levels, changes in groundwater quality and decreased groundwater quantity at nearby residential water supply wells due to blasting and excavation;
- changes in groundwater quality due to chronic and/or acute (malfunction) spills; and
- possible decrease in the supply and quality of base flow to streams.

Provided the proposed mitigative measures are implemented as suggested, no significant adverse residual environmental effects on groundwater resources are likely to occur.

Following is a discussion of mitigation measures proposed for potential groundwater-related effects of the Project, with relevant information summarized in Table 10.10-1.

TABLE 10.10.1 Mitigation Measures for Groundwater Quality and Quantity Effects

Potential Effect	Mitigation Measures	Project Application
• loss of well yield • temporary siltation of wells	• avoid blasting to the extent possible within 500 m of residential wells • use ripping techniques as an alternative to blasting where possible • pre-blast survey • remedial action as necessary to restore damaged wells and/or provide temporary potable water as needed	• blasting during plant site preparation
• water-level lowering • in shallow dug or • drilled wells	• monitoring and remedial action as necessary to restore damaged wells and/or provide temporary potable water as needed	• excavation during plant site preparation
• groundwater quality degradation from spills	• proper fuel management • application of EPP	• plant construction
• stream flow decreases, dry streams	• assess specific site hydrogeologic characteristics, design to minimize depth of cuts near streams	• excavation during plant site preparation
• groundwater and surface base flow quality degradation due to chronic spills	• apply impermeable aprons, secondary containment where necessary • double-wall vessels and piping subject to leakage • proper management, regular equipment inspections • develop/adhere to EPP • monitoring and local remedial action as necessary to restore damaged soil and groundwater	• plant operation
• degradation of groundwater, surface base flow and well-water quality due to accidental spills	• contingency planning (spill containment, recovery, etc.) • remedial action as necessary to restore damaged groundwater • remedial action as necessary to restore damaged wells and/or provide other sources of potable water as • needed	• plant operation
• contamination of wells and/or onsite streams from acidic drainage in areas of known sulphide mineralization on-site	• avoidance or stabilization of mine tailings within the Project site	• construction
• groundwater quality • degradation; siltation	• drainage and vibration controls • remedial action as necessary to restore damaged wells and/or provide temporary potable water as • needed	• road construction and repairs

10.10.1 Mitigation Related to Construction Phase

10.10.1.1 Blasting

Blasting has the potential to affect adjacent wells, with possible impacts ranging from minor temporary turbidity to damage to well crocks or casing and loss of water. Wells completed within 500 m of the plant site boundaries may be affected; with the severity of the effect being proportional to separation distance, physical and properties of the bedrock being excavated, age and construction method of the well, well yield, and blast magnitude. "Natural" mitigating factors include thick overburden and 'soft' bedrock.

Buildings and wells located within 1 km plant site have been identified. Based on the detailed design of the plant site grading plans, a detailed survey of those homes and wells located within 800 m of the blast areas will be undertaken following the NSEL guidelines for blasting at quarries. The pre-blast survey includes: an inspection of all buildings located with the boundaries of the pre-blast survey; inventory of wells including water sampling for general chemistry, metals and bacteria; and short-term pumping tests (where wells are accessible), to determine the capacity of individual wells and nearby aquifers.
In the south half of the Keltic Study Area (areas underlain by bedrock of the Meguma Group), overburden is expected to be relatively thin to non-existent. The bedrock is also hard and topographic relief is severe. These conditions suggest a higher need for blasting in this area. As a mitigation consideration, the project design will be modified where possible to reduce the need for such blasting.

In the more northern parts of the Keltic Study Area (non-Meguma terrain), overburden thickness is expected to be greater and therefore the probability of encountering bedrock will be less. Furthermore, the bedrock in this part of the Keltic Study Area is expected to be "softer" generally consisting of sandstone, mudstone, and limestone. This should require much less blasting during construction, and ripping techniques could possibly be used instead of blasting.

10.10.1.2 Water Level Lowering Due to Excavation

Major excavations though glacial tills and bedrock could potentially lead to a drop in groundwater table elevation in proximity to the excavation. This could possibly affect wells and streams.

The degree of water level lowering will be proportional to the depth of the excavation below natural water table level, the distance between the well or stream and the excavation, and the hydraulic properties of the earth materials. Dug wells in close proximity of an excavation, which in Nova Scotia are already susceptible to seasonal water-level fluctuations of 2 m to 4 m, may become dry. Drilled wells may experience similar water-level drops, although because of the larger water column of drilled wells, they are not likely to be adversely affected by average overburden or bedrock cuts.

Design and construction engineers and hydrogeologists will work closely to identify grading requirements and areas at the plant site where water levels in wells and streams may be vulnerable to grade changes. Monitoring and implementation of appropriate mitigation measures (i.e., deepening of drilled wells, replacement of dug wells with drilled ones, design change, etc.) will make it possible to minimize and likely avoid adverse potential effects on groundwater in the project area.

10.10.1.3 Changes in Groundwater Quality

The main potential adverse effects on groundwater quality during the construction of the plant are expected to be from accidental spills and siltation from vibration. The EPP will address the issues related to the containment and clean-up from spills. Wells located near the plant site which may be susceptible to siltation from vibration or erosion runoff during construction will be inspected and inventoried for possible future reference.

10.10.2 Mitigation Related to Operation Phase

Proper precautions such as secondary containment, leak detection systems, and monitoring alarms will be incorporated into the plant design and processes as appropriate. The potential effects of chronic and accidental spills of deleterious materials on groundwater will be reduced through vigilant monitoring and rapid cleanup response.

With proper mitigation measures in place, the significance of residual effects are expected to be minor (see Table 11.0-1 in Section 11.0).

10.11 FLORA FAUNA AND TERRESTRIAL HABITAT

Following is a discussion of mitigation measures proposed to address potential effects of the Project on terrestrial habitat. Much of this discussion is derived from New Mexico Department of Game and Fish (2003).

10.11.1 Mitigation Related to Construction Activities on Plant Site, Terminal, and Off-Shore Areas

The development of the proposed Keltic industrial site will involve the removal of much of the existing vegetation as well as the displacement of most of the associated wildlife. The mitigation measures proposed for this phase and location of the Project focus on minimizing the clearing area where possible, the use of effective erosion and sedimentation controls, and the stabilization and re-vegetation of disturbed areas on the site. There are several small wetlands on-site; and with consideration to the siting of facilities and the implementation of the suggested mitigation measures, it appears that encroachment and effects on the wetland can probably be avoided (see Table 10.11-1). With proper mitigation measures in place, the residual effects on the wetlands are expected to be of medium significance (see Table 11.0-1 in Section 11.0).

TABLE 10.11-1 Mitigation Measures for Flora, Fauna, and Habitat Relative to Construction Activities on Plant Site, Terminal, and Off-Shore Areas

Potential Effect	Recommended Mitigation Measures
• general habitat loss	• clear vegetation outside the April through July time frame of vertebrate animal reproduction • minimize area cleared where possible. • progressive removal of habitat, as required, vs. clearing the entire area at once • use “good housekeeping” procedures regarding building materials, slash, litter, etc • replant disturbed areas with native vegetation as soon as possible, where space allows • use the opportunity, where possible to do effective landscaping • employ effective erosion and sediment control techniques • try to preserve the most sensitive sites • boulders and tree trunks and rootwads harvested during construction should be retained for possible use in aquatic-habitat enhancement initiatives
• loss/disturbance re rare plant (i.e., *Equisetum variegatum*)	• flag relevant location(s) to keep construction activities away; otherwise transplant to a site with similar conditions. • minimize impacts on vegetative communities
• loss/disruption regarding wildlife (birds, amphibians, reptiles, mammals) due to habitat loss	• follow mitigation practices recommended for general habitat loss
• shorebird disturbance, (i.e., removal or disturbance of beach and dike at Betty’s Cove)	• avoid pipeline construction in this specific area if possible, otherwise reduce duration of construction activity here • avoid construction during vertebrate breeding period for the two greater yellowlegs breeding sites
• disturbance of short-eared owl feeding and breeding area near plant site	• no mitigation required, if proposed construction plans are followed
• potential loss of furbearer habitat in Dung Cove Pond area	• minimize disturbance to Dung Cove Pond
• loss of white-tailed deer habitat (i.e., winter-concentration area in and near terminal area)	• reduce area disturbed/lost as much as possible
• dust impacts during construction	• progressive construction periods would help; no mitigation anticipated.
• noise	• short term impact, no mitigation required

10.11.2 Mitigation Related to Operations on Plant Site, Terminal, and Off-Shore Areas

The mitigation measures proposed for use during the operations of the plant site, terminal, and offshore areas are primarily intended to address potential effects related to the new infrastructure and to human presence and activities. These include the possible increased presence of pest animals, birds which may out-compete specialist songbirds, and the inadvertent introduction of non-native plants. These potential effects can largely be addressed with the use of proper planting designs and procedures and by “good-housekeeping” practices (see Table 10.11-2).

TABLE 10.11-2 Mitigation Measures for Flora, Fauna, and Habitat Relative to Operation Activities on Plant Site, Terminal, and Off-Shore Areas

Potential Effect	Recommended Mitigation Measures
• introduction of non-native vegetation	• do not allow disturbed soil to be exposed for longer than necessary • store and return top soil to sites to be landscaped, before new planting • use native species as much as possible • in some cases, pioneer species may be needed for ground cover and erosion control, but these should be short-lived successional species that eventually give way to planting and natural seeding of native species
• potential increase in bird species compatible with human activity and which may out-compete specialist song-birds	• establish new vegetation as comprehensively and as soon as possible to restore habitat for specialist birds • construct new buildings without ledges to prevent rock dove nesting
• potential shipping-related disturbance to the roseate tern colony on Country Island	• ships are unlikely to venture near Country Island because of shoals, but shipping personnel should be instructed to stay away from the island
• human presence and activity may encourage the presence of pest mammals such as skunk, raccoon, and even black bear	• maintain good housekeeping everywhere on the plant site, and take extra measures to eliminate garbage.

10.11.3 Impoundment of Meadow Lake

The impoundment of Meadow Lake will flood approximately 140 ha of habitat, much of which is wetland. Prior to the impounding of water, it is proposed to remove as much of the vegetation as possible in the area to be inundated. Additional measures to mitigate potential effects on relevant wildlife include undertaking the clearing operations outside the period of vertebrate production, the use of “good housekeeping” practices, and the stabilization of disturbed terrain as soon as possible (see Table 10.11-3).

With proper mitigation measures in place, the significance of residual effects are expected to be minor (see Table 11.0-1 in Section 11.0).

TABLE 10.11-3 Flora, Fauna, and Habitat Mitigation Measures for Meadow Lake

Potential Effect	Recommended Mitigation Measures
• loss of approximately 140 ha of habitat/vegetation, including at least 122 ha of wetland	• clear vegetation outside the April through July time frame of vertebrate animal reproduction • minimize area cleared around new shoreline • use “good housekeeping” procedures regarding disposal of slash, litter, etc. • stabilize shoreline using accepted erosion and sediment control techniques

10.12 FORESTRY

The Project is not expected to affect forestry resources during the construction and operation phase therefore mitigation is not necessary.

10.13 WETLANDS

With proper mitigation measures in place, the residual effects are expected to be of medium significance (see Table 10.13-1 and Table 11.0-1 in Section 11.0).

TABLE 10.13-1 Mitigation Measures for Wetlands.

Potential Effect	Recommended Mitigation Measures
• disturbance/alteration to wetlands	• avoid construction of plant facilities on or near wetlands • minimize encroachment, by avoidance where ever possible • keep construction equipment out of wetland areas and away from wetland edges as much as possible • equipment to be inspected daily to detect leaks of fuels, etc • all on-site fuels, oils and chemicals should also be stored at least 150 m from any surface waters • take appropriate measures to reduce or avoid disruption of surface and ground water patterns • drainage control features should be implemented to prevent soil erosion and impacts to water quality • boulders and tree trunks and rootwads harvested during construction should be retained for possible use in aquatic habitat enhancements • wetland mitigation should adhere to a "no net loss" policy • a wetland mitigation plan should be drafted prior to construction for those wetlands where encroachment is unavoidable (as per Methow, 2005); principals include: • avoid the impact where possible; • minimize effects by limiting the magnitude of the action by using appropriate technology, taking steps to avoid where possible, and to reduce impacts; • rectify or eliminate impacts over time by preservation and maintenance operation during the life of the action; • compensate for the impact by replacing, enhancing, or providing substitute resources or environments; and • monitor the impact and take appropriate corrective measures • the pipeline in the terminal area should be buried or raised to avoid impeding wetland flow to Betty's Cove

10.14 IMPACTS ON FISHERIES, AQUACULTURE AND HARVESTING

10.14.1 Mitigation Related to Construction Phase

10.14.1.1 Marine Environment

Navigation

The marginal wharf may alter navigation into Isaac's Harbour; however, the wharf will be well lit and marked on all navigation charts for the area. The navigation lighting and other marking of the wharf will follow the recommendations of TC. The very low level of boating activity in Isaac's Harbour is not expected to result in any important navigation issues with respect to marine facilities.

Aquaculture

As with fish habitat, standard mitigating measures to control sediment and small spills will be implemented to ensure the aquaculture operations in Country Harbour are not adversely affected by construction activities.

Fisheries

Local fishers have expressed concern about disruption to their traditional fishing activities from construction and operation of the Keltic facilities. Marine impacts of construction will be concentrated in the wharf and terminal areas, either as a result of construction or facilities equipment being transported to the site, or actual construction of the wharf and terminal.

The magnitude of construction impacts will be related to the seasonal timing of activities. Impacts will be greater if activities occur during the relevant fishing seasons, particularly the lobster fishing season, which runs from mid-April to late June. The marginal wharf is not a major fishing area, and most fishing tends to occur further out into the harbour, limiting the potential for disruption to traditional fishing patterns. In addition, little fishing activity takes place in the central deep water part of the bay where the larger LNG and cargo vessels will be transitting. Refer to Section 10.11.1.1 for mitigation measures related to navigation.

For a significant impact on fishing activity to occur, the earnings from the fishery would need to be affected as a result of decreased catch quantity and/or quality, or increased costs of fishing from longer travel times or similar issues. The overall productivity of the bay and the associated amount of lobster habitat are important factors determining the potential quantity and quality of the catch and thus monetary return to local fishers.

DFO will require replacement of three to five times the area of fish habitat lost with habitat of similar or higher type and quality. A potential compensation area in Fisherman's Harbour has been identified (see Appendix 14) where a habitat augmentation project could provide approximately one square kilometre of lobster habitat, similar in quality to that lost to construction. Theoretically, this would augment lobster production in the area by an amount equal to the area of additional productive habitat. This increased production should lead to increased catch by the fishermen, which should more than make up for any increased travel costs.

10.14.1.2 Freshwater Environment

Fisheries

As discussed in Section 9.13.1.2, an active use of freshwater fishery resources only occurs at Meadow Lake. This lake currently supports a relatively diverse fish population consisting of seven species: American eel, white sucker, brook trout, golden shiner, yellow perch, ninespine stickleback, and Atlantic salmon. In terms of proportion of catches, yellow perch and white sucker are the dominant species. The Lake provides a recreational fishery for local residents. It does not have any known commercial or Aboriginal fishery.

The activities associated with the construction of the dam and the intake structure will involve clearing of some of the shoreline vegetation. To minimize in-water works, cofferdams will be established at both the dam site and the intake location. This will permit working in the dry for contouring and foundation works and may involve blasting.

The increase in the area of Meadow Lake and the flooding of associated tributaries is not expected to induce any significant negative impacts on the recreational fishery which now exists in this watershed. The populations of fish species now targeted by anglers (brook trout, perch, eels) are not expected to decrease in size.

As discussed above, with the implementation of the proposed mitigation measures, potential effects on fish habitat and communities during construction are not expected to be significant. Consequently, effects on the use of the fisheries resources at Meadow Lake are also expected to be not significant.

10.14.2 Mitigation Related to Operation Phase

10.14.2.1 Marine Environment

Navigation

Potential operational impacts are associated with shipping entering and leaving the bay, but may also be related to other marine traffic traveling around the proposed marginal wharf into and out of Isaac's Harbour. The wharf protrudes into the entrance of Isaac's Harbour, occupying about 45% of the width of the entrance between Red Head and Bear Trap Head. However, the entrance to Isaac's Harbour reduces to a similar width another 500 m further into Isaac's Harbour. Furthermore, the marginal wharf is located in an area of comparatively shallow water, leaving the deeper water portion of the entrance unaffected. The wharf itself will be equipped with navigation aids, such as lights and fog horns, as required by TC, mitigating other navigation concerns.

Impacts associated with other fisheries should be minor. For example, fishermen may have to shift gillnets set for herring or mackerel in the central part of the bay, but Keltic will provide advance notice of ship arrivals and departures to ensure fishermen can manage their gear without damage.

Aquaculture

Aquaculture operations could be significantly affected by a large spill. A compensation agreement will be worked out with the aquaculture operators to ensure adequate compensation is provided in the event a large spill affects operations.

Fisheries

Impacts associated with commercial fisheries other than lobster should be minor. For example, fishermen may have to shift gillnets set for herring or mackerel in the central part of the bay. To mitigate in such a situation, Keltic will provide advance notice of ship arrivals and departures to ensure fishermen can manage their gear without damage. The potential effect on overall catch or the cost of fishing is anticipated to be insignificant, but will be addressed through consultation with the marine fisheries authorities and the local fishing community.

10.14.2.2 Freshwater Environment

Fisheries

As discussed in Section 9.13.1.2 an active use of freshwater fishery resources only occurs at Meadow Lake. As discussed in Section 10.11.1.2, with the implementation of the proposed mitigation measures, potential effects on fish habitat and communities during the operation phase are not expected to be significant. Consequently, effects on the use of the fisheries resources at Meadow Lake are also expected to be not significant. Mitigation measures are summarized in Table 10.14-1.

TABLE 10.14-1 Mitigation Measures for Fisheries, Aquaculture and Harvesting

Potential Effect	Mitigation Measures	Project Application
• the marginal wharf will pose a potential hazard to navigation into Isaac's Harbour	• the wharf will be well lit and marked on all navigation charts for the area. • the navigation lighting and other marking of the wharf will follow the recommendations of TC	• construction of marginal wharf and LNG Terminal
• impacts on navigation from the narrower entrance to Isaac's Harbour created by the marginal wharf	• the harbour narrows to a similar width 500 m further into the harbour	• operation
• aquaculture operation could be significantly effected by a large spill	• standard mitigating measures to control sediment and small spills will be implemented • a compensation agreement will be worked out with operators to ensure adequate compensation is provided in the event a large spill affects operations	• construction and operation
• disruption of marine fishing activities from equipment transported to site and actual construction of wharf and terminal	• the marginal wharf is not a major fishing area • little fishing activity takes place in the central deep water part of the bay where the larger LNG and cargo vessels will be transitting	• construction
• decrease in marine fishery-related earning as a result of loss of fish habitat with construction of the wharf and terminal	• implementation of habitat compensation in accordance with DFO requirements	• construction

Potential Effect	Mitigation Measures	Project Application
• disturbance of freshwater fisheries (recreational fishing) as a result of disturbance and habitat alteration on-site, at Meadow Lake, and in Isaac's Harbour Creek	• use of cofferdams to minimize in-water works • implementation of habitat compensation in accordance with DFO requirements • operation of fish ladder at Meadow Lake dam • operation of dam to provide for minimal flow in Isaac's Harbour River	• construction and operation
• disruption of marine fishing activities from LNG and cargo vessels in the bay	• fisherman will be notified of ship arrival so they can shift gill nets in the central part of the bay	• operation
• marine fish may be attracted by facility lights at night and may perceive noises at a distance from the operation	• monitoring programs to be followed	• operation

10.15 IMPACTS ON FRESHWATER SPECIES AND HABITAT

Essentially all of the mitigative actions described in Section 10.9 (Surface Water) are also valid for the protection of freshwater species and their habitats, so the reader is referred to this section. In addition, readers should refer to the following two sections relating to impacts on freshwater species and habitat (more specifically the impacts of accidental spills on freshwater environments):

- Section 10.18.1.1 Mine Workings; and
- Section 10.22.8 Hazardous Material Spills.

10.15.1 Mitigation Related to Construction Phase

10.15.1.1 Marginal Wharf and LNG Terminal

Construction of the marginal wharf and LNG terminal on Red Head Peninsula will result in the loss of two brackish ponds and their associated habitat and fish community. These losses will be separately addressed in the Habitat Compensation Plan which will be submitted to DFO as part of Keltic's Application for Authorization. The Habitat Compensation Plan will be completed in accordance with DFOs hierarchy of compensation options and the "no net loss" of habitat objective. Although the substance of the proposed Compensation Plan is not yet fully developed, compensation options now under consideration include liming an acidified watercourse to facilitate salmon spawning, habitat enhancements at currently degraded sites, and the rehabilitation of existing habitat problems such as perched culverts and other such barriers to migration.

It is expected that all other potential effects of the Keltic project on freshwater fish and the aquatic environment can be mitigated with the implementation of the measures presented in Table 10.15-1.

TABLE 10.15-1 Freshwater Fish and Fish-Habitat Mitigation for Proposed Marginal Wharf and LNG Terminal during Construction, Operation, and Maintenance

Potential Effect	Mitigation Measures	Project Application
• modification and/or removal of aquatic habitat • displacement of plants and animals	• conduct in-water works during non-critical periods • restore substrates • implementation of an approved Fish Habitat Compensation Plan in accordance with DFOs hierarchy of compensation options and the "no net loss" of habitat policy	• construction of marginal wharf and LNG Terminal
• siltation of surface waters • smothering of aquatic plants and other biota through the deposition of silt • increased turbidity of surface waters	• use suitable backfill materials • implement effective erosion control measures	• storm-water outfalls • erodible soils and stockpiles • ditch construction • dewatering
• contamination of surrounding surface waters via runoff, spills, and leaks	• provision for spill control • all fuelling and maintenance of construction equipment will be completed away from water to minimize the possibility of water contamination • all on-site fuels, oils and chemicals should also be stored at least 50 m from any surface waters • spill prevention and clean-up equipment will be maintained at the wharf facilities	• construction, operation, and maintenance of LNG Terminal, pipeline, etc • contaminated surface runoff

10.15.1.2 Keltic Site

The petrochemical complex will not impose any negative effects on fish and fish habitat within Crusher Brook or the un-named tributary to Dung Cove on Red Head Peninsula because the footprint does not impinge on these on-site watercourses. Betty's Cove Brook will receive periodic storm-water discharge from pond(s) on the site, but the storm-water-management system will be designed and managed to meet or exceed relevant provincial requirements. As a result, potential effects on fish and fish habitat in Betty's Cove Brook are expected to be minor. Mitigation measures to preserve and/or enhance existing aquatic features include restrictions on the removal of riparian vegetation, the establishment of vegetated 15 m setbacks from watercourses, as well as the use of erosion and spill-control measures.

Mitigation measures will be used to prevent the spread of invasive and non-native species within freshwater environments. All storm-water collected within the plant site will be disposed of within each respective watershed. As such, there will be no inter-watershed transfers of invasive and non-native species during the construction, operation, or decommissioning of the Keltic project.

The detonation of explosives in the vicinity of fish habitat may cause fish mortality, and may potentially affect the physical characteristics of fish habitat. These effects can be mitigated by managing the timing, location, and technical specifications of blasting operations appropriately. The use of explosives may also result in the introduction of ammonia and other detonation by-products into the aquatic environment. These contaminants can be lethal to fish and other aquatic biota (Wright and Hopky, 1998). To mitigate/avoid the effects of such contaminants, explosives consisting of ammonium nitrate and fuel-oil mixtures will be avoided. Keltic will also follow the DFO Guidelines for the Use of Explosives in or Near Canadian Fishery Waters (Wright and Hopky, 1998).

Contingency and remediation in case of accidental (spill) events with potential to damage aquatic habitat:

- Construction Management and Standards - To avoid adverse environmental effects and to minimize unavoidable negative effects, an EPP will be prepared specifically for the construction phase of the Project. The EPP will prescribe all environmental management measures, mitigation measures, spill prevention protocols, contingency measures, responsibilities, supervision, and reporting measures necessary to ensure the least impact to the environment during construction.

Table 10.15-2 provides a summary of mitigation measures intended to protect the freshwater fish community and fish habitat associated with the Keltic plant site.

TABLE 10.15-2 Fishery Resources Mitigation for Petrochemical Complex Site during Construction, Operation, and Maintenance

Potential Effect	Mitigation Measures	Project Application
• fluctuations in thermal regime of adjacent watercourses • stream-bank erosion due to increased overland flow	• a 15 m vegetated buffer will be maintained along on-site watercourses and ditches • restrict the removal of riparian vegetation from margins of surface waters • on-site ditches will be lined with vegetation for erosion protection and sediment removal • management of storm-water quantity and quality to relevant provincial standards	• construction and operation of the petrochemical complex
• contamination of surrounding surface waters via runoff, spills, and leaks	• provision for spill control in facility design • an EPP will be prepared specifically for the construction phase of the Project which will prescribe all environmental management measures, mitigation measures, spill prevention protocols, contingency measures, responsibilities, supervision, and reporting measures • all fuelling and maintenance of construction equipment should be completed away from water to minimize the possibility of water contamination • all on-site fuels, oils and chemicals should also be stored at least 50 m from any surface waters	• construction, operation, and maintenance of petrochemical complex
• degradation of water quality of nearby watercourse(s)	• a 15 m buffer will be maintained along watercourses and ditches on-site • excess construction materials will not be deposited in the watercourse, or anywhere where they could be reintroduced into the aquatic environment • any storm-water discharged to watercourses will be treated in accordance with relevant provincial standards and objectives	• site preparation • operational and decommissioning phases
• spread of invasive and non-native species between watersheds	• all storm-water collected within the plant site will be disposed of within each respective watershed • as such, there will be no inter-watershed transfers of invasive and non-native species	• construction, operation, decommissioning

Potential Effect	Mitigation Measures	Project Application
• fish/animal mortality • loss or alteration of aquatic habitat	• blasting caps should be used in such a fashion to produce a series of small discrete time-delayed detonations • large charges should be subdivided into multiple small time delayed charges to produce explosions at > 25 milliseconds • implementation and compliance with appropriate setback distances from fish and spawning habitat according to substrate type	• construction of plant site
• disruption or loss of migratory or resident fish and mammal populations	• works to be completed during period of least biological activity/sensitivity • deployment of bubble/air curtains as appropriate to disrupt shock wave • deployment of noise generating device to deter fish from blasting site • removal or exclusion of fish from work area prior to blasting	• construction of plant site

10.15.1.3 Meadow Lake Water-Withdrawal Structure

The Keltic project includes provision for the proposed impoundment of Meadow Lake to facilitate its use as a source of cooling and process water for the petrochemical complex.

Water withdrawal from this system has the potential to affect fish and fish habitat within the reservoir through the alteration of lake levels and the entrainment of fish. Mitigation measures to be implemented to reduce negative effects on fish and fish habitat include a regulation of water-level fluctuation and withdrawal as well as the use of screened intake structures to limit fish entrainment (Table 10.15-3).

TABLE 10.15-3 Fishery Resources Mitigation Measures for the Meadow Lake Water-Withdrawal Structure during Construction, Operation, and Maintenance

Potential Effect	Mitigation Measures	Project Application
• shoreline erosion and sedimentation • changes in the composition of aquatic and riparian vegetation	• implementation of shoreline stabilization as appropriate • stabilize and re-vegetate shoreline areas with native vegetation	• impoundment of Meadow Lake
• modification of aquatic habitat • detrimental effects of spawning and breeding periods	• restore aquatic substrates to original state • sediment controls • clear vegetation in area to be flooded • in-water works should not be conducted during sensitive periods • a regulation of water-level fluctuation and withdrawal	• construction of Meadow Lake impoundment

Potential Effect	Mitigation Measures	Project Application
• fish impingement	• design screening to reduce intake velocities to allow escape of most susceptible fish species	• operation of water-withdrawal system

10.15.1.4 Meadow Lake Dam

The impoundment of Meadow Lake will require the construction of a dam approximately 2.0 m in height. This structure will have a footprint which will result in a "loss" or "alteration" of aquatic habitat which will require Authorization from the DFO. A Habitat-Compensation Plan is being prepared separately from this EA process and as part of Keltic's Application to DFO. The Habitat Compensation Plan will be completed in accordance with DFOs hierarchy of compensation options and the "no net loss" of habitat objective. Although the substance of the proposed Compensation Plan is not yet fully developed, compensation options now under consideration include liming acidified watercourses to facilitate salmon spawning, habitat enhancements at currently degraded sites, and the rehabilitation of existing habitat problems such as perched culverts and other such barriers to migration.

Other potential effects on fish and fish habitat include the potential for the dam to act as a barrier to fish movement and for there to be adverse alterations to the flow regime in Isaac's Harbour River downstream of the dam. To mitigate the issue of the dam as a barrier, a fishway will be constructed to allow fish passage, particularly for Atlantic salmon, brook trout, and eels. The Keltic project will withdraw less than 10% of the average annual flow in Isaac's Harbour River. As part of the mitigation program, the remaining 90% of the flow will be managed with the use of the "Range of Variability Approach", which has the objective of mimicking the existing natural flow regime in the river so that existing ecological functions (i.e. fish migration) can be maintained.

Compensation will be offered for HADD of fish habitat for the Plant Water Supply Development. To mitigate against loss of upstream access for resident or diadromous fish at the proposed Meadow lake impoundment, and thus a loss of migratory habitat, a fishway is proposed. The impoundment will require a concrete gravity dam to raise the water level. The concept will meet a variety of objectives and hydrologic conditions observed for 2002. Basic features include a 1 m wide flow section for a Denil type fishway with a single resting pool. The fishway would extend to 0.5 m above the existing normal water elevation and also function as the primary source for make up water to the river. Since all low flows and minor storm flow would go through the fishway, fish should have little difficulty finding and making entry into the fishway. The fishway is located on the south side of the dam that is just upstream of a pool in the river where resident or migratory fish would normally hold or stage. A preliminary concept of the Dam is shown in Figure 2.3-8.

Following is a summary of mitigation measures intended to address these and other potential effects associated with the impoundment of Meadow Lake (Table 10.15-4).

With proper mitigation measures in place, the residual effects are expected to be of medium significance (see Table 11.0-1 in Section 11.0).

TABLE 10.15-4 Fishery Resources Mitigation for the Meadow Lake Dam during Construction, Operation, and Maintenance

Potential Effect	Mitigation Measures	Project Application
• siltation of surface waters • smothering of aquatic plants and animals through the deposition of silt • increased turbidity of surface waters	• use suitable backfill materials • implement appropriate erosion-control measures • use silt curtains where appropriate	• watercourse diversions
• loss/alteration of fish habitat	• implementation of an approved Fish Habitat Compensation Plan in accordance with DFOs hierarchy of compensation options and the "no net loss" of fish habitat policy	• construction
• slumping of encroached soils • erosion and sedimentation	• avoid unstable slopes • use appropriate stabilization and erosion/sedimentation controls • re-vegetation as soon as possible after disturbance	• construction of the dam and water-intake structure
• the dam as a barrier to fish movement	• construction of an effective fish ladder at impoundment structure • discharge of water so as to achieve target minimum flows for fish passage • in-water works should not be conducted during sensitive periods	• construction and operation of impoundment structure
• adverse reduction in flows in Isaac's Harbour River	• maintain flow regime downstream of the Meadow Lake dam so as to achieve appropriate riverine functions, including fish passage	• operation of Meadow Lake impoundment
• contamination of surface waters via runoff, spills, and leaks	• provision for spill control • all fuelling and maintenance of construction equipment should be completed away from water to minimize the possibility of water contamination • all on-site fuels, oils and chemicals should also be stored at least 50 m from any surface waters	• construction, operation, and maintenance of impoundment structure • excavation

10.15.2 Mitigation Related to Operation Phase

10.15.2.1 Marginal Wharf and LNG Terminal

It is expected that all potential operation and maintenance effects of the Keltic project on freshwater fish and the aquatic environment can be mitigated with the implementation of the measures presented in Table 10.15-1, above.

Contingency and remediation measures will be in place in case accidental, spill events occur that have the potential to damage freshwater aquatic habitat. This includes measures applicable to the operational phase of the LNG Unloading Facilities. Spill prevention and clean-up equipment will be maintained at the wharf facilities to ensure minor spills do not impact the local environment, including fish habitat.

10.15.2.2 Keltic Site

Contingency and remediation measures will be in place in case accidental, spill events occur that have the potential to damage freshwater aquatic habitat. This includes measures applicable to the operational and decommissioning stages of the Keltic Plant. The Keltic facilities have been designed with spill containment and protective measures to prevent contamination of the site. The operations should therefore not result in long term effects that will preclude rehabilitation and re-use of the site. Refer to Table 10.15-2 for a summary of mitigation measures to be used at the Keltic Site during construction, operation, and maintenance

10.15.2.3 Meadow Lake Water-Withdrawal Structure

Water withdrawal from this system holds the potential to affect fish and fish habitat within the reservoir through the alteration of lake levels and the entrainment of fish. Mitigation measures to be implemented to reduce negative effects on fish and fish habitat include a regulation of water-level fluctuation and withdrawal as well as the use of screened intake structures to limit fish entrainment (see Table 10.15-3).

10.15.2.4 Meadow Lake Dam

The potential effects on fish and fish habitat include the potential for the dam to act as a barrier to fish movement and for there to be adverse alterations to the flow regime in Isaac's Harbour River downstream of the dam. A summary of mitigation measures intended to address these and other potential effects associated with the impoundment of Meadow Lake are provided in Table 10.15-3, above.

With proper mitigation measures in place, the significance of residual effects are expected to be minimal (see Table 11.0-1 in Section 11.0).

10.16 MARINE SPECIES AND HABITAT

The construction of the Keltic facility will undoubtedly result in some losses and alterations of fish and aquatic habitat which cannot be mitigated. In accordance with the requirements of the *Fisheries Act* and relevant policies of the DFO, Keltic will be required to compensate for these losses/alterations to the satisfaction of DFO so as to achieve "no net loss" of fish habitat. Proposed Habitat-Compensation Plans are being prepared separately from this EA process and as part of Keltic's Application to DFO for Authorization.

Essentially all of the mitigative actions described in Section 10.9 (Impacts on Surface Water) are also valid for the protection of marine species and their habitats, so the reader is referred to this section. In addition, readers should refer to Table 10.16-1 and the following two sections relating to impacts on marine species and habitat (more specifically the impacts of accidental spills on marine environments):

- Section 10.18.1.1 Mine Workings; and
- Section 10.22.8 Hazardous Material Spills.

10.16.1 Mitigation Related to Construction Phase

Following is a discussion of mitigation measures proposed for potential effects of the Project on the marine environment, including fish habitat, seabirds, and marine mammals with relevant information summarized in Table 10.16-1.

10.16.1.1 Fish Habitat

The construction of the marginal wharf and related works will result in some losses and alterations of fish and aquatic habitat which cannot be mitigated. The *Fisheries Act* and relevant policies of the DFO, require that Keltic compensate for these losses/alterations to the satisfaction of DFO and with the objective of achieving “no net loss” of fish habitat. Proposed Habitat-Compensation Plans are being prepared as part of an Application to DFO for Authorization. These are discussed in Appendix 14.

Existing habitat could be adversely affected by sediment from construction, disturbance of heavy metals in sediment, or accidental spills. Mitigation of these effects includes the use of construction techniques designed to minimize the disturbance of sediment in the marine environment. Sediments in the vicinity of the proposed wharf are also not significantly contaminated to be of concern. Mitigation related to sediment and spill control will include standard measures such as the use of a boom and silt curtain around the construction area to contain any accidental spills or minor sediment plumes.

Compensation will be offered for HADD of fish habitat for the construction of the Wharf and Unloading Facilities to compensate for loss of lobster habitat and for potential disruption of fishery. DFO will require replacement of three to five times the area of fish habitat lost with habitat of similar or higher type and quality. A potential compensation area in Fisherman's Harbour has been identified (see Appendix 14) where a habitat augmentation project could provide approximately one square kilometre of lobster habitat, similar to that lost to construction. Theoretically, this would augment lobster production in the area by an amount equal to the area of additional productive habitat.

The mitigative measures for blasting near fish or marine mammal habitat are discussed in Section 10.15.1.2 and Table 10.15.2.

10.16.1.2 Seabirds

Construction of Keltic facilities is far removed from any area important to seabirds and no mitigation is required.

10.16.1.3 Marine Mammals

No mitigation of construction activities is required with the exception of noise mentioned in Section 10.8.

10.16.2 Mitigation related to Operational Phase

10.16.2.1 Fish Habitat

The operation of the Keltic facilities will not result in routine emissions which will impact fish habitat. Equipment will be maintained on-site to handle small accidental spills, and a boom will be deployed around vessels actively loading or unloading hydrocarbons or other noxious material. Arrangements will be made with appropriate responder organizations to assist in the event of a large spill.

10.16.2.2 Seabirds

During operations of the Keltic facility, the movement of large ships close to Country Island is unlikely because of the presence of shoals. Shipping lanes will be established in consultation with TC and the CWS to keep ships a reasonable distance away from the island and its population of endangered roseate terns. Sufficient space exists to avoid significant impacts on seabirds given the relatively infrequent passage of ships through the area. Measures will also be implemented to restrict access by Keltic and shipping personnel to Country Island.

10.16.2.3 Marine Mammals

No mitigation of operational activities is required given the low level of marine mammal activity in the area.

10.16.2.4 Invasive and Non-Native Species

Mitigation measures will be used to prevent the spread of invasive and non-native species within the marine environment. LNG vessels will be brought in fully loaded and re-ballasted offshore. Ballast water issues (exotic species transfers) are not expected to arise under current navigational regulations.

TABLE 10.16-1 Mitigation Measures for Marine Environment Effects

Potential Effect	Mitigation Measures	Project Application
• degraded water quality via sediments, heavy metals, sediment, or accidental spills.	• containment booms will surround construction area • construction techniques designed to minimize the disturbance of sediment • the use of appropriate erosion and sediment-control measures	• construction and operation
• loss/alteration of fish habitat	• implementation of an approved Fish Habitat Compensation Plan	• construction

Potential Effect	Mitigation Measures	Project Application
• contamination of surface waters via accidental spills, and leaks	• equipment will be maintained on-site to handle small accidental spills • arrangements made with appropriate responder organizations to assist in the event of a large spill	• operation
• disturbance of nesting and foraging seabirds on Country Island	• establishment of shipping lanes in consultation with TC and the CWS • restriction of access by Keltic and shipping personnel	• operation
• marine habitat impairment as a result of re-suspension of contaminated sediments from propeller wash	• large vessels to be bearthed with support of tugs • no sediment contamination identified	
• contamination of surface waters via runoff, spills, and leaks	• erosion control measures • provisions for spill containment • prompt and accurate spill reporting • effluent discharges to marine environment to comply with regulatory standards • effluent quality monitoring	• construction and operation
• spread of invasive and non-native species	• LNG vessels will be brought in fully loaded and re-ballasted offshore • following current navigational regulations will prevent ballast water issues (exotic species transfers)	• operation

10.17 AGRICULTURE

The proposed facility site is not expected to have any interaction with agricultural land, therefore no mitigative measures are necessary.

10.18 GEOLOGICAL IMPACTS

Following is a discussion of mitigation measures proposed for potential geological-related effects of the Project, with relevant information summarized in Table 10.18-1 located at the end of this section.

10.18.1 Mitigation Related to Construction Phase

10.18.1.1 Mine Workings

Some mapping of the old mine workings in the Keltic Study Area has been completed, but additional surveys will be required to identify all former mine sites in areas of concern and to make the proposed petrochemical plant site safe to workers and/or structures. Additional surface mapping (GPS and surveyed locations) will be done prior to site development and during the site-preparation and re-grading operations. Those workings believed to be shallow will be pumped out for direct observation to confirm depth, and subsequently filled with stone from the site.

Contingency and remediation in case of accidental (spill) events with potential to damage aquatic habitat:

- Potential Effects Resulting from the Existence of Old Mine Workings - The greatest concern regarding the mine workings relate to site operation and the possibility of accidental spills. The old mine workings may serve as rapid pathways, or “highways,” for the large-scale and direct migration of spills or other groundwater contaminants from the proposed petrochemical plant toward neighbouring residential wells and into the ocean. Storage of materials that could result in spills should be located away from areas with mine workings that could provide a preferential flow pathway to surface water or groundwater. Many of the spill containment measures in terms of facility design and component siting are described in Section 2.4.

10.18.1.2 Tailings Disposal Areas

Tailings disposal areas will be fenced and avoided where feasible. In the event that this is not possible, tailings sites will be encapsulated to prevent the emanation of dust, sediment, surface water, or groundwater.

10.18.1.3 Acid Drainage Potential

Based on the results of the field surveys, the greatest potential for acid drainage is situated at the northern boundary of the proposed petrochemical plant site. Based on current conceptual plans, no excavation into Halifax Formation in that area is proposed.

The Project’s engineers and project geologist/hydrogeologists will work closely together to:

- more clearly define those areas which might become a concern for acid drainage based on preliminary grading design;
- test bedrock in those areas where there might be acid drainage potential and where excavation for grading is deemed necessary, or where new sources of borrow material are likely to be obtained on-site; and
- where acid drainage potential is confirmed based on the testing, change the grading design so as to minimize or avoid excavation of potentially acid generating rock.

In those areas where bedrock is to be tested, the testing work would consist of:

- grab samples of bedrock during preliminary and detailed geotechnical investigations on the site;
- advancing angled bore holes (as near perpendicular to bedrock dip as possible) where equipment allows (vertical bore holes where equipment does not allow), with continuous bedrock coring, to 1.5 m beyond grading design depth; and

- splitting of the core along its axis, with retention of half for future reference, the other half sent for laboratory determination of total sulphide content, acid generation, and acid consumption (net acid production) potential.

With proper mitigation measures in place, the significance of residual effects of acid drainage are expected to be minimal (see Table 11.0-1 in Section 11.0).

10.18.2 Mitigation Related to Operation Phase

10.18.2.1 Mine Workings

Former mine workings which are deep and/or extensive will be mapped using electric sounding techniques and/or shallow seismic methods so as to properly delineate them for structural reasons and for evaluation regarding potential influences on groundwater flow. Those which are deemed to pose a risk to the groundwater regime (quantity, quality, flow) will be sealed with the use of low-permeability grout where possible. Survey information will also be used to assist in the development of groundwater/spill contingency planning.

Contingency and remediation in case of accidental (spill) events with potential to damage aquatic habitat:

- Decommissioning - Old mine workings could provide a preferential pathway for spills to impact private wells. Equipment and materials storage that could result in spills should be located away from areas. The Spill Control Plan will remain in effect during facility decommissioning, specifying the monitoring and response requirements during this project phase.

TABLE 10.18-1 Mitigation Measures for Geological Impacts

Potential Effect	Mitigation Measures	Project Application
• structural/safety risks associated with former mine workings	• detailed surveys and mapping of project site • filling and stabilization as appropriate	• plant and LNG site preparation
• risks of former mine workings regarding groundwater regime	• detailed surveys and mapping of project site • grouting where appropriate • storage of hazardous material will avoid old mine working sites which can act as preferential pathways should spills occur	• plant construction, operation and decommissioning – accidental spills
• disturbance of tailings disposal sites	• avoidance where possible • encapsulation if avoidance is not feasible	• plant and LNG site grubbing and preparation

Potential Effect	Mitigation Measures	Project Application
• acid drainage	• avoid excavation of relevant bedrock • avoid changes to drainage and groundwater regime • testing for acid drainage potential	• plant site construction

10.19 ARCHAEOLOGICAL RESOURCES

Following is a discussion of mitigation measures proposed to address potential effects of the Project on existing archaeological resources, with relevant information summarized in Table 10.19-1. With proper mitigation measures in place, the significance of residual effects of acid drainage are expected to be minor (see Table 11.0-1 in Section 11.0).

10.19.1 Mitigation Related to Construction Phase

10.19.1.1 Plant Site

Red Head Cemetery

There is a high level of confidence that additional burials at the Red Head cemetery site are unlikely and that no further manual excavation is necessary. Due to the remaining cultural sensitivity of the site, however, it is recommended that excavation by a small backhoe be monitored by a qualified archaeologist during ground disturbance. It is also recommended that consultation with the Lincolnville Black community be initiated prior to any ground disturbance in order to address any possible cultural and political issues associated with the site.

Sculpin Cove

The Sculpin Cove sites 1 through 5 are not expected to be directly impacted by construction and, therefore, no recommendations for mitigation are considered necessary. Due to lack of information regarding their age, function, and cultural affiliation, however, they should be further investigated prior to disturbance in the event that construction or development plans are altered. The potential effect of changes in ship wakes as a result of construction in the vicinity of these sites is not known. If these sites become affected by shoreline erosion as a result of rising tide levels, it is recommended they be investigated by a qualified archaeologist.

Hurricane Island

Hurricane Island is also not expected to be directly affected by construction but may be affected by wakes from ships. Again, should this location become a target for construction activities, it is recommended that the mining site be investigated as it is considered to be of high archaeological significance.

McMillan Mine

The McMillan Mine is expected to be affected by construction of the product-storage area and wharf at Sand Cove as well as by the associated access road. It is considered to be of low archaeological sensitivity given its recent age, however, and no pre-construction investigation of the features is required. It is recommended that the site be monitored during ground disturbance to ensure that no earlier and archaeologically/culturally sensitive features exist which may be affected by construction.

Dung Cove

The Dung Cove location is believed to be of high archaeological and cultural sensitivity. The level of confidence concerning an understanding of the full extent of the site is low due to the obscurity of features by low tree cover. At this time, the site is not located within a direct impact zone (i.e., within the footprint of necessary infrastructure). If, however, development plans change so that the site would be directly impacted by construction, it is recommended that the site be investigated by a qualified archaeologist prior to any ground disturbance.

Giffin's Mill, Hattie's Belt, Skunk Den Mine, and the Giffin Lead

Giffin's Mill, Hattie's Belt, Skunk Den Mine, and the Giffin Lead are not expected to be affected by construction. Due to elevated levels of archaeological sensitivity, however, it is recommended that these sites be further investigated in the event that development plans change such that these sites become vulnerable to disturbance.

South Mulgrave Lead Site

The east portion of the South Mulgrave Lead site is expected to be heavily impacted by construction at the northwest extremity of the Keltic Study Area. It is evident, however, that this portion of the site has been recently disturbed by ground levelling for safety reasons. As a result, no intact features are visible on the surface and no pre-construction investigation of the site is therefore required at this time. It is recommended that ground disturbance be monitored by an archaeologist in order to better assess the archaeological integrity of the site as it is of high archaeological sensitivity.

Buckley's Farm

Although Buckley's Farm was not identified as an intact archaeological site since it was not located during the archaeological survey, it is recommended that the area be resurveyed by an archaeologist once the brush is cleared from the impact area as this location is slated for development.

Those areas of surface prospecting and random cultural activity which were noted throughout the Keltic Study Area during the archaeological survey are believed to be of no archaeological significance and, therefore, no recommended mitigation is necessary. However, if in situ artefacts are encountered in any of these features, it is recommended that they be recovered and reported to the NSMNH.

Each of these recommendations is made based on the current development plan and the expected effects on heritage features, as noted. If any portion of the development plans change so that impact zones shift, it is recommended that these areas be reinvestigated and re-assessed prior to ground disturbance.

TABLE 10.19-1 Mitigation Measures for Archaeological Resources

Potential Effect	Mitigation Measures	Project Application
• disturbance to additional burials at the Red Head cemetery site	• excavations to be completed with a small backhoe • excavations shall be monitored by qualified archaeological personnel • additional consultation with the Lincolnville Black community as appropriate	• construction of marginal wharf
• disturbances to archaeologically significant sites if development footprint changes	• reassessment of archaeological resources before construction at target sites	• modifications to existing development plan

10.20 TRANSPORTATION IMPACTS

Transportation impacts are expected to be most noticeable during the operations phase, when the existing road system is used for the transport of products by plant workers. Other impacts will be seen during the construction at the plant site from both increased traffic and spring weight restrictions. The applicable mitigation is summarized in Table 10.20-1.

TABLE 10.20-1 Mitigation Measures for Transportation Impacts

Potential Effect	Mitigation Measures	Project Application
• effects of spring weight restrictions on Route 316	• ship materials in smaller loads in accordance with spring weight restrictions • upgrade the road to allow for maximum weight – spring exempt truck movements • stockpile construction, production and finished product materials on site for delivery before and after the spring weight restrictions	• construction and operation
• increase in collision rates due to construction-related vehicular activity	• flagman at construction site entrance, if required • adjustment of travel speed, signage, intersection controls and sight lines along the main transport route	• construction

Potential Effect	Mitigation Measures	Project Application
• increase in collision rates due to operation-related vehicular activity	• controlled site entrance, if required • adjustment of travel speed, signage, intersection controls and sight lines along the main transport route	• operation

10.21 HUMAN HEALTH AND SAFETY

Following is a discussion of mitigation measures proposed to address potential effects of the Project on human health and safety, with relevant information summarized in Table 10.21-1.

Construction of the petrochemical complex may induce potential effects on VECs relevant to human health. These include air quality, groundwater, geology (soil), and surface water. In order to protect worker health and safety, Keltic will implement a comprehensive health and safety program. The program will ensure that the general public and workers are not adversely affected during routine operations, and that contingency plans are in place to prevent impacts during accidents, malfunctions, and unplanned events.

The mitigation measures proposed for use during the construction and operation of the petrochemical plant and LNG terminal are intended to minimize potential effects related to public health and safety and worker health and safety.

TABLE 10.21-1 Mitigation Measures for Human Health and Safety Effects

Potential Effect	Mitigation Measure	Project Activity
• particulate generation, safety concerns regarding former mine workings	• dust control program • worker health and safety program • avoidance of mine workings and tailings areas • provide proper personal protective equipment to workers during work around tailings	• site preparation (clearing and grubbing, blasting, grading)
• potential covering or control of mine tailings	• none	• construction of pier (side casting, placement of rock and offshore structures, driving or drilling/grouting of berthing piles, placement of decking)
• air emissions	• dust control program • worker health and safety program • spill control plan	• vessel transportation (delivery of construction materials and equipment) • vehicular traffic • marine vessel traffic, unloading • unloading LNG from vessels to tanks • vaporization/re-gassification of LNG to natural gas • power generation
• dust generation	• dust control program	• concrete production

Potential Effect	Mitigation Measure	Project Activity
• potential for run-off	• erosion control program	• waste management including site prep debris
• potential uncovering of mine tailings	• decommissioning should retain cover for mine tailings	• decommissioning the waterfront facilities and pipelines
• potential spills • air emissions	• dust control plan • spill control plan	• decommissioning of petrochemical facilities • demolition and Removal of Facilities • materials transfer and storage (other than LNG)
• particulate generation	• dust control program • worker health and safety program • avoidance of mine tailings areas	• reclamation

10.22 MALFUNCTIONS AND ACCIDENTAL EVENTS

10.22.1 LNG Facility

10.22.1.1 Introduction

The design of the LNG facility takes into account mitigative measures that would protect humans and the environment in the event of an accident or malfunction. Details about the mitigative features of the facility are provided in detail in Section 9.21 and outlined in Section 2. A brief overview of the mitigative measures is presented in this section. However it is remarked that during the design of the facility extensive safety studies, for instance Hazard and Operability Analysis (HAZOP) / What-If studies, will be performed to achieve a high safety level. Also the Emergency Shut Down system (ESD), fire fighting equipment, leak/fire detection systems and other preventive and repressive measures which will be installed to prevent any loss of containment, will be evaluated during the design of the terminal and safety studies. All preventive and repressive measures will be designed according the appropriate codes and standards.

10.22.1.2 Plant Layout

The overall plant layout takes into consideration mitigative measures related to accidents and malfunctions. Section 9.21 provides details on the plant layout.

10.22.1.3 LNG Storage Tank

The LNG Storage Tanks will be designed to take into consideration mitigative measures related to accidents and malfunctions. In the unlikely event that a failure occurs in the 9% nickel steel inner tank the outer concrete tank will be capable of containing the full tank contents. For more details on mitigative features of the LNG Storage Tanks see Section 9.21.

10.22.1.4 LNG Storage Tank Layout, Pipe Racks, Access Roads etc.

The following mitigative features associated with the layout design are described in more detail in Section 9.21:

- Tank A has been located such that the regulated levels of thermal radiation fall within the property boundary.
- The spacing between the outer walls of adjacent tanks is 43 m, which is in compliance with LNG code general spacing criteria.
- Site preparation for future tanks will occur now to avoid blasting at a future time in the vicinity of the storage tanks already in service.

10.22.1.5 Transfer Piping from LNG Carrier to Storage Tank Header

Mitigation of accidents and malfunctions is taken into consideration in the design of the components of transfer piping from LNG carriers to storage tank headers. Section 9.21 provides details on the proposed design of the following components of this system:

- LNG marine carrier unloading and transfer system design;
- transfer piping system; and
- marine unloading line design spill (occurring upstream of the tank area).

Mitigative features of the LNG Marine Carrier Unloading and Transfer System Design include the following:

- installation Powered Emergency Release Couplers (PERC) at the loading arms; and
- during unloading of the LNG carrier the ESD system of the LNG carrier and the LNG import terminal will be coupled;

10.22.1.6 LNG Storage Tank Manifold, Tank Fill, Send Out and Vapour Piping

<u>Storage Tank Area Impoundment Description</u>

The LNG tanks are of the “full containment” type and designed to fully contain any spills or leaks occurring at the inner tank.

Spills or leaks occurring at the piping system in the immediate vicinity of the tanks will be managed according the Piping Impoundment and Sub Impoundment Systems described below.

<u>Piping Impoundment and Sub Impoundment Systems</u>

The Piping Impoundment and Sub Impoundment Systems are described in detail in Section 9.21.5. The volume of LNG released as a result of 10 minutes operation would be equivalent to 1.3 x 2.0 BCM natural gas or 914 m^3 of LNG.

10.22.1.7 Thermal Radiation Exclusion Zones

If a quantity of LNG is spilled in the presence of an ignition source, the resulting LNG pool fire will result in high levels of thermal radiation. The methods required to predict the levels of thermal radiation are closely controlled through regulations. The calculated thermal exclusion distances affect both the basic layout of the facility and the design measures that are required to mitigate the effect of LNG spills that may be ignited. All calculations have been performed using LNGFIRE III: A Thermal Radiation Model for LNG Fires.

Results of Calculations

Storage Tanks

Assuming that Tank A lost the roof and the contents were ignited. The resulting thermal radiation at the nearest point on the property line, located to the southeast at 230 m, at the specified atmospheric conditions is 4.14 kW/m^2. As there are no existing structures of any description in that area, the criterion in effect requires that the levels of thermal radiation shall be less than 30 kW/m^2. On this basis the property line requirements are satisfied. See Tables 9.21-2 to 9.21-9 for the results and Figure 9.21-3 for the graphical representation of the significant thermal flux contours.

The storage tanks have been located with a spacing of half of the diameter as required by the table of minimum distances contained in the LNG regulations. The thermal radiation on the upper wall of an adjacent tank has been described in Section 9.21.1.

To comply with regulations, the tank spacing would have to be increased from 43 m to (167-42) m, or 125 m (See Table 9.21-5). Tank spacing such as this is not practical at this location. As permitted by the Code minimum physical separation distance of half of the diameter, the tank spacing will remain at 43 m, but in the event that one of the storage tanks is ignited, a water deluge system will be brought into operation to control the level of thermal radiation to a value below 30 kW/m^2, at the adjacent downwind tank.

The thermal radiation imposed on the compressor building and pump shelter from a tank fire has been described in Section 9.21.5. To comply with the regulations these structures will need to be protected with a deluge system whether constructed using concrete, or steel, or be relocated further away from the storage tanks (See Table 9.21-6).

10.22.1.8 Vapour Dispersion Exclusion Zones

If a quantity of LNG is spilled without being ignited, LNG vapour will be produced. The rate of vaporization depends on the area of the spill exposed to surfaces from which heat can be extracted, and the rate of heat transfer across those surfaces.

Given these circumstances it is recognized that the vapour exclusion distance will be significantly influenced by the wind direction. A wind blowing along the impoundment will result in exclusion distances far greater than a wind blowing across the impoundment.

Results of vapour dispersion studies have been presented in Section 9.21.6 for:

- LNG storage tank;
- ship unloading transfer line; and
- high pressure send out transfer line and vapourizer and demethanizer area.

The Project has been designed in recognition of environmental concerns related to vapour dispersion patterns. If deemed necessary, further mitigation of vapour formation rate and consequential reduction of vapour dispersion exclusion zones can be achieved through the use of a layer of polystyrene, or equivalent slab insulating material, under the floor of the impounding troughs.

10.22.2 Petrochemical Facility – Safety Design Approach

10.22.2.1 Regulatory Controls and Industry Standards

As a consequence of several major accidents legislation was enacted in the European Community and USA. Table 10.22-1 provides a summary of EHSS legislative milestones affecting the Chemical Process Industries, which are directly applicable to or have strong implications related to the Project.

TABLE 10.22-1 Summary of EHSS Legislative Milestones Affecting the CPI

1982	Seveso I	European Community, directive which was amended twice to broaden scope after Bhopal (1984) and Seveso(1986)
1984	CIMAH	UK, regulation Control of Industrial Major Accident Hazards
1990	American Petroleum Institute recommended practice 750	USA, Management of Process Hazards
1992	OSHA 29 Code of Federal Regulations 1910	USA, PSM of highly hazardous chemicals
1995	EPA 40 Code of Federal Regulations (68)	USA, management programs for chemical accidental release prevention
1996	American National Standards Institute /ISA S84.01	SIS/SIL and enforceable under OSHA 29 Code of Federal Regulations 1910
	Seveso II	European Community, directive on control of major accident hazards with much broader scope and requires mitigation of consequence to man and the environment
1999	COMAH	UK, COMAH regulations which replaced CIMAH (1982)
	International Electrotechnical Commission 61508	SIS/SIL – from Seveso II
2005	International Electrotechnical Commission 61511	SIS/SIL which integrates International Electrotechnical Commission /ISA and has become an international all encompassing standard

In a number of countries the chemical industry itself responded to EHSS challenges with Responsible Care® initiatives. Responsible Care® was developed in the 1980s by the CCPA and was taken up in the USA by the Chemical Manufacturers' Association/American Chemistry Council, in 1989 and by the UK Chemical Industries Association and elsewhere thereafter.

Keltic Petrochemicals will become a CCPA member and will apply the principles of Responsible Care® to the design, maintenance, and operation of the proposed petrochemical facility.

The safe design of the Keltic Petrochemicals facility will use approved methods and tools that are defined within the codes, standards, and guidelines that are approved by regulations and CCPA. As a minimum, USA regulatory requirements will be enacted.

To understand how these methods and tools will be applied in the safe design of the Keltic Petrochemicals facility it is necessary to define the design, construction, and operation concept. The design can begin in the Research and Development stage through the feasibility phase defined as FEL. The FEL methodology allows both business and project needs to be analyzed with key decisions being made based upon a techno-economic assessment of the opportunities. A critical aspect of design-making is EHSS compliance among other important considerations.

The OSHAs PSM standard, 29 Code of Federal Regulations 1910.119 and EPAs Risk Management Program rule, 40 Code of Federal Regulations Part 68 require that there is analysis of toxic, fire and explosion hazards resulting from specific chemicals (called major hazards) and their possible impacts on employees, the public, and the environment. The specific chemicals are defined in the regulations and are called hazardous chemicals by OSHA and regulated substances by EPA.

10.22.2.2 Project Design Approach

The most commonly used methods include safety reviews such as the HAZOP and the What-If and What-If/Checklist methodologies. Safety reviews are traditionally performed at predefined project milestones using progressively more detailed Project design information including:

- the process definition stage;
- prior to issue of the P&IDs for client approval; and
- once fully engineered P&IDs are available and/or prior to issue of the P&IDs for construction.

The final safety review is a full scope PHA and is conducted when a complete set of P&IDs, mechanical equipment data sheets, draft operating and maintenance manuals are available.

A line by line traditional HAZOP methodology is used. This is effectively a detailed safety review of the engineered design as all major safety requirements/issues should have been identified and addressed in prior safety reviews. This traditional HAZOP can also be used to address Reliability, SIS/SIL and HFE as described in 9.14.2.7.

Process plant layout is a creative task demanding significant engineering ingenuity and experience. An optimized layout will strike a balance between safety requirements, maintenance accessibility, and capital investment.

Three approaches currently used are described below:

1. Spacing guidelines from Insurance Underwriters. Alternatively, owner or Engineering, Procurement and Construction contractor standards can be used as these are usually consistent with Insurance Underwriters guidelines.
2. Dow Fire and Explosion Index or Mond Index. The Dow Fire and Explosion Index is a semi-quantitative technique that is used to rank specific types of hazards based upon types of materials being processed, the inventory of materials within the process and the operating conditions (pressure and temperature) at which the process is operating. Credit can be taken in the methodology for the active protection system installed. If

hazards cannot be significantly reduced then a more detailed hazard and risk assessment is usually carried out.

3. A more detailed hazard and risk assessment using consequences analysis, various vapour cloud modelling techniques (simplified and complex) and blast contouring to locate buildings and set spacing distances between process units and areas within the units to mitigate domino effects and assess the impact upon the offsite community.

10.22.2.3 Project Execution Safety Approach

The safety reviews described above are traditionally focused upon PHA methodologies (What-If, What-If/Checklists, HAZOP, etc.). For this Project, additional key safety related activities will also be incorporated into the traditional safety review process including:

- inherently safer design;
- HFE;
- reliability; and
- SIS/SIL.

Intuitively one would think that to improve overall safety and reliability is to:

- over-design;
- add redundancy, (i.e., more spares);
- install very reliable and possibly past experience equipment; and
- maximize continuous plant operation whenever possible

Rationalization of this approach leads to the concept of “Life Cycle Costs” which is defined as all costs associated with the acquisition and ownership of a system over its full life expectancy. Life Cycle Costs analysis is a tool used to rationalize the trade off between increased operating cost investments and to increase reliability and therefore improve plant on-stream time.

Obviously safety, reliability, and Life Cycle Costs must be balanced to achieve an optimum business solution. This is usually done using semi-quantitative risk assessment and quantitative reliability analysis. This has been achieved by incorporating reliability studies into the traditional HAZOP. This type of HAZOP has been termed a Hazards Reliability and Operability Analysis (HAZROP) by some companies (i.e., Rohm and Haas). The difference between HAZOP and HAZROP is that in a HAZROP additional people, information, and techniques are used.

The general trend in the industry is to move maintenance and inspection from a reactive to proactive approach. This is termed Risk Centred Maintenance. The Risk Centred Maintenance proactive approach is endorsed by the American Petroleum Institute for Risk Based Inspection (Risk Based Inspection per American Petroleum Institute 581) and fitness for service (American Petroleum Institute 579).

Safety Instrument Systems and Safety Integrity Levels (SIS/SIL)

For the Keltic Petrochemical project International Electrotechnical Commission 61511 and ISA S84.00.01 will be followed, as a matter of CCPA Responsible Care®.
The International Electrotechnical Commission safety standard International Electrotechnical Commission 61511 and the US version American National Standards Institute /ISA 84.00.01-2004 are now being applied to the design of SIS in the CPI. These standards require a semi-quantitative assessment of the SIS. This semi-quantitative assessment is difficult to implement using the traditional HAZOP method as the traditional HAZOP method is inductive and evaluates risk in a qualitative manner with nominal measures designed to the probability and consequences of events. This qualitative method is easily implemented by operating personnel and this is the principle reason for its popularity and usage.

International Electrotechnical Commission 61511 and ISA S84 on the other hand define the risk reduction to be achieved and is expressed as a SIL. In addition the standard introduces the concept of life cycle management to ensure that target risk reductions are made in all life cycle phases of the plant. It is worth noting that major refiners and petrochemical companies (i.e., Dow, Shell, DuPont, etc.) have long regarded compliance with the principles of International Electrotechnical Commission 61511 and ISA S84.00.01 (using older versions of ISA S84 and International Electrotechnical Commission 61508) as a matter of Responsible Care®. Such compliance was made as early as 1992 when preliminary drafts of ISA S84 existed and continues today whether or not local authorities require such compliance or not.

Human Factors Engineering (HFE)

Studies conducted by the Abnormal Situation Management consortium, American Institute of Chemical Engineers, the American Petroleum Institute, the American Chemical Society (ACS) and other organizations have concluded that 80% of major process hazards can be linked to human error.

The Institute of Petroleum (UK) have published Human Factor Briefing Notes which, together with Shell publications, will form the basis of the Keltic Petrochemicals HFE methodology. The HFE methodology will be traditional HAZOP based except that the analysis will be conducted using both P&IDs and the plant operating and maintenance procedures.

Other Safety Reviews

A list of additional safety and health analyses that may be performed on the Project is identified in Table 10.22-2 below.

TABLE 10.22-2 Additional Safety and Health Analyses that May be Applied

Accidental release modeling studies	Fire protection analyses	P&ID reviews
Concurrent operations reviews	HAZOP studies	Protection philosophy
Constructability hazard analyses	Hazard and risk analyses	Plot plan reviews (layout)
Control and safeguarding philosophy	Hazard register	Quantitative risk assessments
Emergency system survivability assessments	Hazardous area classification reviews	Reliability, availability, maintainability analyses (HAZROP)
Equipment sparing philosophy and optimization	Inherently safer design reviews	Safety design and integrity reviews
Ergonomics/Human Factor Analysis (HAZOP – Human Factors)	Layers of Protection Analysis	Safety case development/reviews;
Explosion over-pressure studies	Loss prevention studies/plans	Safety and operability on electric power systems
Evacuation, escape and rescue analyses and rationalization;	Management of change	Safety instrumented system reviews (SIS/SIL)
Event tree analysis	Materials of construction reviews	Safety specification development and review
Failure mode and effect analyses	Offsite consequence analysis	Scenario based layout reviews
Fault tree analysis	Occupied building siting studies	Smoke ingress assessments
Fire fighting and rescue plans	Operations philosophy	

10.22.3 Natural Gas-related Accidents, Malfunctions and Upset Conditions

Contingency planning, personnel training, procedures, and restrictions on smoking and burning, call-before-you-dig procedures, emergency response planning and other initiatives will minimize the possibility and magnitude of adverse effects of a natural gas-related accident, malfunction, or upset condition. Mitigative measures for malfunctions and accidents are presented below in Table 10.22-3.

If the natural gas pipeline ruptures or explodes, causing a fire, it would lead to localized, extensive disruptions of soil. Rehabilitation of the disturbed area may include:

- replacement of subsoil and topsoil with soil recovered at the site or with suitable fill from another area;
- addition of soil amendments as required to optimize and restore soil nutrient levels, organic matter and soil acidity, and to optimize physical properties of the topsoil; and
- re-grading and reseeding the disturbed area to minimize soil erosion.

10.22.4 Forest Fire

Forest fires could be caused by a liquid hydrocarbon spill fire, other accident involving fire or by natural causes such as a lightning strike. The immediate concern for a fire would be for human health and safety. Local air quality conditions associated with the fire as well as the flames have the potential to kill humans and wildlife in the area. The major emissions would be smoke (PM) and CO_2 but would also include CO, NO_x, SO_2, VOCs and polycyclic aromatic hydrocarbons. A large fire could create PM levels greater than the ambient air quality standard over distances greater than 10 km but such situations would be of short duration.

The central administration complex will have a fully equipped fire station. The operation of the fire station will be coordinated with the local community volunteer fire departments. Local fire fighting response will be available at each of the main process areas. For unanticipated large fires and/or fires in isolated areas assistance will be requested from appropriate government departments.

10.22.5 Vehicle Accidents

Within the Complex's battery limits all roads will be adequately spaced from the operating units and designed consistent with industrial occupancies allowing for emergency response vehicular movement. Traffic signage will be installed and enforced by plant security. Vehicular access within the operating units will be controlled by plant security and operating personnel. Any vehicular accidents, including near misses, will be treated similarly as plant incidents which require incident reporting with appropriate follow-up to help ensure that there is not a repeated occurrence.

Emergency Medical Facilities will be provided at the central administration complex with first aid stations at each of the main facilities and within the process areas and marine facilities as required.

10.22.6 Worker Accidents

The potential for accidents to workers exists for all phases of the Project. During the construction and decommissioning phases, workers may be exposed to noise, dust, and hazardous chemicals resulting directly from the construction activities themselves (i.e., dust and noise) or indirectly from the materials and equipment required for construction (i.e., cutting oils, lubricants, cleaning agents, etc.). Conventional construction accidents related to hoisting and rigging, working near heavy equipment, excavations, working at height, welding, and cutting may occur. Accidents may also occur as a result of increased marine vessel and vehicular traffic.

During the operations phase, accidents specifically related to the transport, handling and storage of LNG and the transport of natural gas by pipeline as well as the downstream liquid, gaseous and solid hydrocarbon production from the petrochemical plants may occur. This is in addition to conventional accidents related to operating and maintaining process equipment (i.e., working on energized systems, welding, and cutting, working at height). Accidents may also occur as a result of increased marine vessel and vehicular traffic required to transport LNG to the pier or petrochemical plant production from the pier.

Accidents, malfunctions, and unplanned events will be prevented and mitigated by taking a systematic approach to safeguarding worker health and safety and establishing a safety culture within the organization. This will be achieved by the development and implementation of a Keltic Worker Health and Safety Plan, the EHSS management system, the Emergency Response Plan, and the marine Terminal Manual.

As a future member of the CCPA, Keltic will be providing intensive training to its operating personnel related to the safe handling of all hazardous chemicals that employees may encounter during the performance of their job responsibilities. On those occasions where external contractors are required to perform specialized work within the plant boundaries, they will be trained about those specific hazards they may encounter within their restricted work sites. This will also include training pertaining to safe work permitting procedures as well as how to recognize and respond to a plant emergency.

Emergency Medical Facilities will be provided at the central administration complex with first aid stations at each of the main facilities and within the process areas and marine facilities as required.

10.22.7 Failure of Erosion Protection Measures

A potential exists for failure of erosion and sediment control structures due to precipitation events. Such a failure could result in the release of a large quantity of sediment-laden runoff to receiving watercourses with potential adverse environmental effects on fish and fish habitat. Erosion and sediment control measures will be implemented and maintained according to the EPP (Section 13.13) and will be monitored by an environmental inspector, particularly after a heavy precipitation event or snow melt. Remedial action will be taken as necessary.

10.22.8 Hazardous Material Spill

The potential for spills of hazardous materials exists for all phases of the Project. During the construction and commissioning phases, the potential for spills is limited to materials used in the site preparation, fabrication, and installation of the facilities and equipment required for handling, storing and processing hydrocarbons. For example, gasoline, diesel fuel, propane, grease, motor oil, and hydraulic fluids are all needed for heavy equipment needed for site preparation. Construction of the facilities will also require hazardous materials such as acetylene, oxygen and other compressed gases, form oil, paints, epoxies, concrete additives, glycol/methanol, cleaners and solvents.

The probability of spills will be reduced and the effects of any spills, in the event that they occur, will be reduced by the implementation of hazardous materials management processes and procedures. The handling of fuel and other hazardous materials will be in compliance with the *Transportation of Dangerous Goods Act*. All bulk storage of fuel products, concrete additives and other hazardous materials will be stored in aboveground, self-dyked tanks or drums with secondary containment. A complete inventory of all fuels and hazardous materials will be maintained and fuels and other hazardous materials will only handled by persons who will be trained and qualified in handling these materials. The Project will also implement WHMIS to ensure proper handling and storage is achieved.

During the operations phase, the potential for spills includes most of the materials identified for the construction phase and will be managed similarly. The hazardous material unique to the operations phase is LNG. LNG is essentially comprised of methane with fractional amounts of ethane and propane. It is odourless, colourless, non-corrosive, and non-toxic. Release of cryogenic LNG due to spills, leaks, or intentional draining can expose facility personnel to several hazards. These hazards include oxygen deficiency, freezing injuries, fire hazards, and air-gas mixtures.

Prevention and mitigation of LNG spills will be accomplished by the following means:

- inherent safe design;
- effective emergency planning and preparedness; and
- operational procedures and training.

Inherent safety features are designed into the Project. The equipment and facilities will be designed to strict design codes and standards and a quality assurance system will be implemented on the Project to ensure the final design meets these standards. Further hazard analysis of the design will provide for additional level of assurance that the potential for spills or unintentional releases of natural gas is minimized. In the unlikely event of a spill occurring, emergency response plans will be in place to ensure that the size of the spill and potential for effects of the spill are minimized. Operational procedures will be prepared to ensure the transport, handling and process systems are operated within the design parameters. All employees and contractors will be trained in operational procedures and environmental emergency response procedures to ensure safe operation of tanker unloading and facility operation.

Prevention and mitigation of all hydrocarbon spills will be accomplished by the adherence to the Safe Design Approach (Sec. 9.17.2). Emergency Medical Facilities will be provided at the central administration complex with first aid stations at each of the main facilities and within the process areas and marine facilities as required.

Contingency and remediation in case of accidental (spill) events with potential to damage aquatic habitat:

- Hazardous Material Spill - All bulk storage of fuel products, concrete additives and other hazardous materials will be stored in aboveground, self-dyked tanks or drums with secondary containment.

  In the unlikely event of a spill occurring, emergency response plans will be in place to ensure that the size of the spill and potential for effects of the spill are minimized.

10.22.9 Security

The Keltic Petrochemicals facility will have a perimeter chain link fence with access to the facility through a manned security gatehouse. Plant staff will gain access to the facility via an addressable card reader system.

The facility will feature a digital video monitoring and retrieval system. When operational, this system will permit the manned security services to monitor the facility on a continuous basis. This will be supplemented with an intrusion alarm connected to the gatehouse facility.

Plant-wide alarms and communication systems, both fixed and portable will be established.

Keltic is working closely with TC and US Customs and Boarder Protection on projects that will assist this facility in the maintenance of security. Recent requirements under the ISPS Code (July 2004) will be implemented as well as any future requirements.

10.22.10 Dam Failure

The supply of fresh water to the Keltic Complex will be provided via a newly constructed pipeline and dam. In the event of an uncontrolled dam failure, accumulated water contained in the dam reservoir (i.e., Meadow Lake) would flow to the most northwest inlet of the Isaac's Harbour by virtue of the surface topography of the region which would be routed via Isaac's Harbour River. As the harbour is approximately 1 km wide and the Keltic Complex Isaac's Harbour shoreline is more than 4 km from where the escaping water will be entering the harbour, no water or resulting damage is contemplated to impact the Keltic Complex given the harbour's inherent surge capacity and no additional mitigative measures are required.

TABLE 10.22-3 Mitigation Measures for Accidents and Malfunctions

Potential Effect	Mitigation Measures	Project Application
• accidents and malfunctions at the LNG facility	• plant layout that takes mitigative measures into account • spacing and construction of LNG storage tanks in compliance with LNG code criteria • proper design of transfer piping such as insulated lines, support piping that allows for warm-up and cool-down, non-return valves and a transfer piping impoundment system • comply with regulations concerning Thermal Radiation Exclusion Zones • design with recognition of environmental concerns related to vapour dispersion patterns	• construction and operation
• accidents and malfunctions at the petrochemical facility	• follow regulatory controls and industrial standards • a project design approach using methods such as HAZOP methodology • project execution safety approach • implement SIS and SIL • human factors engineering (HFE)	• construction and operation
• natural gas-related accidents, malfunctions and upset conditions	• contingency planning, personnel training, procedures and restrictions on smoking and burning • call-before-you-dig procedures, emergency response planning and other initiatives	• construction and operation

Potential Effect	Mitigation Measures	Project Application
• forest fire	• the central administration complex will have a fully equipped fire station that coordinates with local community volunteer fire departments • for unanticipated large fires and/or fires in isolated areas assistance will be requested from appropriate government departments	• construction and operation
• vehicle accidents	• roads will be adequately spaced from the operating units • traffic signage will be installed and enforced by plant security • control vehicular access	• construction and operation
• worker accidents	• development and implementation of a Keltic Worker Health and Safety Plan, EHSS management systems, Emergency Response Plan and Marine Terminal Manual • provide intensive training to operating personnel • train external contractors about specific hazards they may encounter within their restricted work sites • maintain emergency medical facilities on-site	• construction and operation
• failure of erosion protection measures	• erosion and sediment control measures will be implemented and maintained according to the EPP • monitoring by an environmental inspector, particularly after a heavy precipitation event or snow melt • take remedial action as necessary	• construction and operation
• hazardous material spill	• the handling of fuel and other hazardous materials will be in compliance with the *Transportation of Dangerous Goods Act* • all bulk storage of hazardous materials will be in aboveground, self-dyked tanks or drums with secondary containment • hazardous materials will be handled by persons trained and qualified in handling these materials • the accidental spill of LNG will be mitigated by following an inherent safe design, effective emergency planning and preparedness, and operational procedures and training	• pre-construction, construction and operation

10.23 ENVIRONMENTAL EFFECTS ON THE PROJECT

Following is a discussion of mitigation measures proposed to address potential effects of weather on the project components.

EPP measures will be employed during the design and construction of project facilities based on appropriate environmental-design criteria to ensure the safety and integrity of all facilities during severe environmental conditions, including high winds, extreme rainfall, and major marine storm surges.

Designs will incorporate an adequate factor of safety to deal with possible changes in weather severity during the lifetime of the Project, including storms and sea level rise associated with climate change. Monitoring and/or contingency planning (see Table 10.23-1) will also serve to minimize potential adverse effects. With the implementation of this mitigation plan, the environment is not expected to affect the Project to the extent that there is a long-term interruption in service, a substantial loss of project schedule, damage to infrastructure which puts public health and safety or the environment at risk, or that there is damage to infrastructure that would not be technically or economically feasible to repair.

TABLE 10.23-1 Mitigation Measures for the Effects of the Environment on the Project

Potential Affecting Agent	Mitigation Measures	Project Application
• high wind	• ships will not be allowed to dock or remain at the facility if sea conditions do not allow safe operation • in the event of an extreme weather event during a transfer, the activities will be postponed, and ships will be dispatched to harbour anchorage • all facilities will be fully weather proofed and designed for a full range of climatic conditions including severe rain, wind, etc	• extreme weather
• precipitation (rain)	• the EPP will include measures to ensure that environmental loads (i.e., sediment-laden water) are addressed appropriately and sedimentation events will be controlled appropriately	• extreme weather
• precipitation (snow)	• ice and snow are controlled through snowploughing, sand and salting of the roadways • loading environmental effects of snowfalls have been considered in the development of the NBCC and design specs of all project structures.	• extreme weather
• fog	• modern navigation aids and piloting service will assist with shipping operations.	• extreme weather

Potential Affecting Agent	Mitigation Measures	Project Application
• waves	• the LNG storage facility will be located and designed to appropriate wave run-up conditions. • the LNG terminal and marginal wharf will be design to withstand the design storm/wave/wind events • LNG ships are designed to be seaworthy in all types of weather • if waves exceed design criteria, ships will not dock and, if docked, will depart	• extreme weather
• shoreline	• additional sediment erosion and transport modeling will be carried out, with adjustments to the marginal wharf design details as required to reduce changes in the sediment transport regime.	• erosion
• sea spray	• appropriate measures will be employed by ships to avoid or control vessel icing from sea spray • all facilities on land will be fully weather proofed and designed for a full range of climatic conditions including severe sea spray	
• icebergs	• operational procedures will include a monitoring program for this rare possibility	
• faults and shear zones at dam site	• the groundwater monitoring stations proposed under Section 10.7 will be augmented by an Electromagnetic survey (EM16-VLF combination) of the greater dam site to identify the location and orientation of buried fractures, faults or shear zones	• dam construction and operation
• seismic events	• all structures at the plant site will be built to meet or exceed relevant building codes, including the new design criteria as set out in the 2005 edition of the NBCC • appropriate contingency planning will also address the possibility of structural failure which may result from ground vibration caused by a severe seismic event	• plant construction and operation

Potential Affecting Agent	Mitigation Measures	Project Application
• tsunami	• project components will be designed to withstand the forces of a tsunami resulting from seismic activity on the Laurentian Slope • a tsunami warning systems is planned for the Atlantic Ocean near Canadian shores, which will likely monitor interstellar as well as seismic causes for tsunami • if warning system is not available, modeling will be undertaken and used, as appropriate, in the design of the wharf and plant facilities and in developing emergency response procedures • in the event of a tsunami, ship-to-shore transfers would be postponed and ships would be dispatched to harbour anchorage or the open sea • foundations for the Keltic LNG Tanks have been sited +15 m above sea level, which is the maximum historical height for tsunamis in the region	• plant and LNG construction and operation
• extreme weather	• project components will be designed to withstand the forces of storms, storm surge, waves and associated sea spray.	
• sea level rise	• the LNG and plant site facilities will be sited and designed to be able to withstand possible rises in sea elevations which may result from climate warming	
• forest fires	• a cleared buffer will be maintained at the site for security reasons and to reduce the potential for fire to affect structures and facilities • mobile fire-fighting equipment will be provided by a central fire station as part of common user facilities • latest technology in fire/smoke sensing will be incorporated in the facility designs and will respond to appropriate fire-control centres as appropriate • all process and storage areas will be serviced by underground pipelines and hydrants as well as strategically place special fire-fighting equipment • operators at all process units will be located in individual control centres and will be trained as first responders for fire-fighting	

10.24 CUMULATIVE EFFECTS

No special mitigation for cumulative effects is required. It should be noted that some cumulative effects have been identified in Section 9.23 and mitigation for the Project effects on the affected VECs will also mitigate cumulative effects to some degree (such as reductions in emissions of greenhouse gasses); however, no significant cumulative effects have been identified for which special mitigation is necessary.

11.0 RESIDUAL ADVERSE EFFECTS AND ENVIRONMENTAL EFFECTS

Residual impacts refer to those environmental effects predicted to remain after the application of mitigation outlined in this EA. The predicted residual effects are considered for each Project phase (Construction, Operation, Decommissioning/post-decommissioning, and Unplanned Events). As per the criteria established in Section 7.0, the Significance of each residual adverse effect has been determined. For ease of reference, these criteria are repeated here:

Significant

- Major: Potential impact could jeopardize the long term sustainability of the resource, such that the impact is considered sufficient in magnitude, areal extent, duration and frequency, as well as being considered irreversible. Additional research, monitoring, and/or recovery initiatives should be considered.

Not Significant

- Medium: Potential impact could result in a decline of a resource in terms of quality/quantity, such that the impact is considered moderate in its combination of magnitude, areal extent, duration and frequency, but does not affect the long term sustainability (that is, it is considered reversible). Additional research, monitoring, and/or recovery initiatives may be considered.
- Minor: Potential impact may result in a localized or short-term decline in a resource during the life of the Project. Typically, no additional research, monitoring, and/or recovery initiatives are considered.
- Minimal: Potential impact may result in a small, localized decline in a resource during the construction phase of the Project, and should be negligible to the overall baseline status of the resource.

The results of the assessment have been developed and presented in Table 11.1-1. The Table describes the predicted effect on several indicator criteria representing each VEC and the identified mitigation or avoidance measure which could reduce or eliminate the predicted effect. Note that, for the purposes of this EA, a Fish Habitat Compensation Plan is considered to be a Mitigation measure. The same is assumed with respect to Wetland Compensation Plans. The Project Phase or phases to which the identified effect applies have been listed, followed by the type of impact (adverse or positive) and the significance of residual effects.

It is important to note that although a significant residual effect may be determined for one individual criterion within a VEC, that the overall significance of effects on the VEC as a whole may still be not significant when the relative values of the different criteria are balance against one another. Thus, when considering the VEC Recreational Opportunities and Aesthetics, even though the visual impact of the Project on the local visual landscape will be major (i.e., representing a major change in visual character) the effect on receptors and receptor locations will be medium and the over-all effects of visual intrusion will be medium. This is based on the small number of potentially affected residents and visitors (tourists).

The Table 11.0-1 illustrates that relatively few of the predicted residual effects on VEC criteria are Significant, with the following exceptions:

- Socio-economic effects – several significant benefits are expected in the local and regional economy. The over-all significance of predicted effects on the socio-economic environment will be major.
- Recreational Opportunities and Aesthetics – Project development will result in a significant change in the visual character of the site. However, as described above, the over-all significance of predicted effects on recreational opportunities and aesthetics will be medium.

Accidental events can occur, potentially causing damage to the biophysical environment, as well as to effects on human health and safety. The severity of effects from accidental events is dependent upon the magnitude of the event, location of the event, and the time of year. For the prediction of residual adverse environmental effects, it is acknowledged that, while the likelihood is low, the result can be Significant. Unplanned events are, by their nature difficult to predict, our approach has been to apply environmental management practice to prevention and preparedness training so as to reduce the likelihood of such events, but to be well prepared to implement an effective emergency response should an event occur. Our Emergency Preparedness planning will include the development and maintenance of a high degree of readiness through equipment purchase and maintenance, training exercises and simulations. As has been previously noted, Emergency Preparedness Planning has been integrated into all phases of Project design, planning, and execution. Our objective is to perform well above the industry average, and to improve on our record continuously.

Through careful design and planning, combined with prudent application of proven mitigation measures, Keltic has identified and addressed all potential adverse environmental effects, and reduced the predicted adverse impacts to a low level of significance. The Project will also have important economic benefits both locally and regionally.

TABLE 11.1-1 Summary: Effects, Mitigation, and Significance of Residual Effects

VEC	Mitigation	Construction Phase	Operation Phase	Type (A-adverse; B-beneficial)	Significance of Residual Effect
Land Use					
Land Use - lands taken up by the Project and its components will remove the potential for mineral extraction from those areas.	None	X	X	A	Minimal
Aboriginal Use of Land and Resources					
Potential for impacts on Mi'kmaq Land Use (Hunting, Fishing)	• None • Mi'kmaq sea urchin harvesting may be limited in the area of the LNG terminal and marginal wharf, but there are adjacent sea urchin areas that will allow continued harvesting. Sea urchin populations are currently severely depressed by disease.	X	X	A	Minimal
Potential for impacts on Mi'kmaq Land Resources (Fish, Wildlife, Vegetation)	• See mitigation for biophysical VECs	X	X	A	Minimal
Socio-economic Environment					
Potential effects on population size	• Operate construction camp • Major components to be manufactured off-site and transported to the site for installation	X		B (A)	Medium
Potential effects on Economic Structure (increased employment opportunities and tax revenues; spin-off effects)	• Purchasing and tendering policies to support local businesses	X		B	Major
Potential effects on Labour Force (increased demand, employment and training opportunities)	• Advise unions of the occupations and skill levels required • unions will implement, or facilitate the implementation, of training programs	X		B	Medium
Potential effects on Income (increased average income)	• Purchasing and tendering policies to support local businesses	X		B	Minor
Potential effects on Socio-Economic Planning (supportive of municipal strategic objectives)	• None required	X		B	Medium

VEC	Mitigation	Construction Phase	Operation Phase	Type (A-adverse; B-beneficial)	Significance of Residual Effect
Potential effects on Tourism (loss of natural landscape character may reduce outdoor oriented tourism in site vicinity)	• Use of dust suppressants if required • Regular road cleaning at /near the construction access when required • Establish information point/centre to inform on construction and future operation	X		A	Minor
Potential effects on population	• None required		X	B	Minor/Medium
Potential effects on Economic Structure (increased employment opportunities and tax revenues; spin-off effects)	• Purchasing and tendering policies examined to determine how to be organized to facilitate bidding by local businesses • Where practical, tender packages broken into sizes that can be bid on by local firms		X	B	Medium
Potential effects on Labour Force (increased demand, employment and training opportunities)	• Advise unions and local development agencies of the number, type of occupations and skill levels required • Work with unions and local development agencies to advertise employment opportunities and organise training programs		X	B	Medium
Potential effects on Income (increased average income)	• Purchasing and tendering policies to support local businesses		X	B	Medium/Major
Potential effects on Socio-Economic Planning (supportive of municipal strategic objectives)	• None required		X	B	Medium/Major
Potential effects on Tourism (loss of natural landscape character may reduce outdoor oriented tourism in site vicinity; improved income and tax base likely to benefit tourism infrastructure in region)	• Establish interpretative centre at site		X	A (local) B (region)	Minor (adverse effects) and Minor to Medium (beneficial effects)
Residential Property Values					
The presence of approximately 3.000 workers and the expectation of long-term economic development at and near the site can be expected to increase demand for residential property and therefore potentially increase in property prices, in particular rental rates	• Operate construction camp • Major components to be manufactured off-site and transported to the site for installation	X		A	Minor

VEC	Mitigation	Construction Phase	Operation Phase	Type (A-adverse; B-beneficial)	Significance of Residual Effect
Increase in the local population is expected to result in a greater demand for residential property in the area, which is likely to increase prices for residential property	• None		X	B	Medium
Recreational Opportunities and Aesthetics					
Effects on the local visual landscape character	• See Operation Phase • construction-specific mitigation • Ensure good housekeeping • Cleaning of road at and near site entrance when required • During initial site clearing, maintain and protect tree and shrub buffer along site perimeter as visual screen • Design “jogged” road access to prevent unobstructed views from public road into construction site	X		A	Minor
Effects on receptors and receptor locations (recreational opportunities)	• Tree and shrub plantings at receptor locations to screen views • Along Marine Drive, provision of interpretive opportunities with information on the facility and its operation	X	X	A	Minor
Effects on the local visual landscape character	• Tree and shrub planting along site perimeter as visual screen • Use of colour schemes for stacks and higher buildings that support blending in with background • Minimal night lighting • Location of flare stacks at back of site		X	A	Minor
Air Quality					
Emissions of gaseous pollutants from diesel powered construction equipment and marine vessels delivering equipment as well as from workers private vehicles.	• Maintaining vehicles and equipment in good working condition • Minimizing distance between transfer points. • Maintaining speed restrictions on roads • Promote car pooling	X		A	Minimal

VEC	Mitigation	Construction Phase	Operation Phase	Type (A-adverse; B-beneficial)	Significance of Residual Effect
Fugitive dust emissions from excavating and moving earth, construction equipment, and the concrete batch plant	• Cleaning the area around stored materials • Covering stored materials, if necessary • Vacuum sweeping or flushing roads • Applying dust suppressant • Reducing working faces of material piles	X		A	Minimal
Emissions from LNG tankers, gas vent stacks, SCV, and LNG extraction plant	• Monitoring and maintenance of emission control system • Monitoring of VOCs prior to and during operation • Maximize efficiency of operations		X	A	Minor
Emissions from the cogeneration facility simple cycle combustion turbine for power supply	• Monitoring and maintenance of emission control system • Maximize efficiency of cogeneration plant		X	A	Minor
Emissions from the Petrochemical facility (vents of plants for production of LLDPE, LDPE, and HDPE)	• Monitoring and maintenance of emission control system • Monitoring of VOCs prior to and during operation • Maximize efficiency of operations		X	A	Minor
Project contribution to greenhouse gas emissions (CO_2)	• Integration of individual development component into a highly energy efficient production complex • Power generation via gas fuelled co-generation plant		X	A	Minor
Noise Impacts					
Noise emissions from site preparation (moving earth, blasting) and from construction of industrial components	• Ensure machinery has working noise muffling equipment • Conduct routine noise monitoring • Restrict intensive activity to hours between 700 and 1900 • Supply public with contact numbers in case of noise issues • Give public prior notice of blasting • Maintain treed buffer between worksite and public	X		A	Minimal
Noise emissions from pile driving	• Alternative techniques will be used for pile driving such as vibratory pile-driving • Recreational and commercial fishery representatives will be contacted to develop seasonal and daily schedules to minimize disruption of fisheries.	X		A	Minimal

VEC	Mitigation	Construction Phase	Operation Phase	Type (A-adverse; B-beneficial)	Significance of Residual Effect
Noise emissions from plant operation	• A fully developed noise monitoring program will be implemented to ensure noise levels at nearest occupied properties do not exceed CMHC levels		X	A	Minimal
Surface Water					
Effects on On-site Watercourses (erosion, sediment loading, storm-water discharges, spills)	• Erosion and sediment control plan • Buffer zone • Storm-water management plan • Spill prevention and response plan • Designated fuelling and material storage site	X		A	Minimal
Effects on off-site Watercourses through site (erosion, sediment loading, storm-water discharges, spills)	• See above	X		A	Minimal
Effects on Meadow Lake and Isaac's Harbour River through in-water works and dam and onshore works for dam and intake structure	• See above, plus • Construction of cofferdam • In-water works outside of spawning / fish migration season • Use of silt curtains • Rehabilitation of shoreline upon completion	X		A	Minimal
Effects on on- and off-site surface water quality as a result of discharges of Storm-water, Process water, Sanitary waste water	• Implementation of storm-water management plan • On-site waste water treatment plant to collect and treat all waste water streams • Controlled discharge point(s) • Monitoring of discharge quality		X	A	Minor
Effects on Meadow Lake and Isaac's Harbour hydrology (water levels, fluctuations, flow) as a result of water withdrawal and impoundment of Meadow Lake	• Maintain minimal flow conditions in Isaac's Harbour River		X	A	Minor
Inter-watershed water transfer (resulting potentially in changes in hydrology and water quality)	• Discharge of collected storm-water within respective watershed • Water withdrawn from Meadow Lake to be discharged to Isaac's Harbour / ocean (= ultimate receiver under baseline conditions)		X	A	Minimal

VEC	Mitigation	Construction Phase	Operation Phase	Type (A-adverse; B-beneficial)	Significance of Residual Effect
Groundwater					
Siltation of dug and drilled wells and possible permanent decrease in well yield of drilled wells from blasting and vibrations	• Avoid blasting to the extent possible within 500m of residential wells • Pre-blast well survey • Remedial action as necessary to restore damaged wells and/or provide temporary potable water as needed	X		A	Minimal
Water level reductions in dug wells as a result of trenching, site drainage, and large cuts or changes in surface topography	• Monitoring and remedial action as necessary to restore damaged wells and/or provide temporary potable water as needed	X		A	Minimal
Water quality degradation from accidental release of fuel chemicals (equipment failure, handling accident)	• Proper fuel management • Application of EPP • Monitoring and local remedial action as necessary	X		A	Minimal
Reduction of flow in streams and reduced discharge into wetlands during Meadow Lake dam construction	• Assess specific site hydro-geologic characteristics • Dam construction method to provide for continuous minimal flow in Isaac's Harbour	X		A	Minimal
Contamination of wells and/or onsite streams from acidic drainage in areas of known sulphide mineralization on site	• Avoidance of mine tailings within the project site	X		A	Minimal
Degradation of groundwater and well water due to accidental spills	• Proper management of fuel, product and material storage and handling		X	A	Minimal
Contamination of wells from acidic drainage in areas of known sulphide	• N/A; interaction unlikely as site construction surfaces will be stabilized and rehabilitated		X	A	N/A
Reduction of flow in Isaac's Harbour River and reduced discharge into wetlands as a result of Meadow Lake dam operation	• Assess specific site hydro-geologic characteristics • Dam operation to provide for continuous flow in Isaac's Harbour River • Operation to provide for alternative water supply source during extended dry weather		X	A	Minimal
Flora, Fauna, and Terrestrial Habitat					
Habitat removal	• Minimize construction envelope • Rehabilitate all temporarily used sites	X		A	Medium

VEC	Mitigation	Construction Phase	Operation Phase	Type (A-adverse; B-beneficial)	Significance of Residual Effect
Displacement / Loss of wildlife	• Clearing of site outside of breeding season of migratory birds • Rehabilitate all temporarily used sites	X		A	Medium
Dust impacts on vegetation	• Minimize dust	X		A	Minimal
Noise effects on wildlife (including blasting)	• Minimize noise during sensitive breeding period	X		A	Minimal
Effects of dam at Meadow Lake on bird nesting sites	• Clearing outside of bird nesting period	X		A	Minor
Effects of clearing around and flooding of Meadow Lake on habitat/vegetation	• Minimize area cleared around new shoreline • Use “good housekeeping” procedures regarding disposal of slash, litter, etc.	X		A	Minor
Effects of air emissions on vegetation (deposition)	• Emission controls		X	A	Minimal
Effects of water quality impairment effects on amphibians	• Treatment of water to government standards prior to discharge • Monitor of discharge quality		X	A	Minimal
Lighting effects on migratory birds	• Use lightning that is known to not attract birds • Minimize overhead wires and other obstacles that may cause collisions		X	A	Minor
Disruption of migration corridors of mammals	• Mitigate temporary safe migration route if necessary		X	A	Minor
Meadow Lake (effects of dam on bird nesting sites)	• Mitigate alternate nesting area if necessary		X	A	Minor
Meadow Lake (effects of dam on invertebrate and amphibian populations)	• None		X	B	Minimal
Forestry					
Site clearing at the Project site will have minimal effects on forestry, since the site is considered to have no merchantable timber.	• None	X	X	N/A	None
Wetlands					
Spills of fuels, lubricants, and hydraulic fluids	• Implementation of EMP with spill prevention and cleanup procedures	X		A	Minor
Erosion, sedimentation, and damage caused by heavy machinery	• Implementation of EMP with erosion and sediment control plan	X		A	Minor

VEC	Mitigation	Construction Phase	Operation Phase	Type (A-adverse; B-beneficial)	Significance of Residual Effect
Filling, excavation, and other disturbance of wetlands that may alter hydrological integrity of the site	• Application of a "no net loss" policy	X		A	Minor
Effects on the wetlands of spills, excavation, sedimentation, and erosion from the proposed hydro corridor and LNG pipeline.	• Application of a "no net loss" policy	X		A	Minor
Reduction of wetland water quality resulting from discharges/runoff from project	• Implementation of on-site storm-water management plan; • Controlled discharges to the environment and effluent monitoring • Implementation of EMP with spill prevention and cleanup procedures; •		X	A	Minor
Meadow Lake Impoundment (effect of water level fluctuation on nearby wetlands)	• Application of a "no net loss" policy		X	A	Minor
Fisheries, Aquaculture, and Harvesting					
Disruption of marine fishing activities from equipment transported to site and actual construction of wharf and terminal	• N/A; the marginal wharf is not a major fishing area.	X		A	Minimal
Decrease of marine fishery-related earnings as a result of loss of fish habitat from construction of wharf and terminal	• Implementation of habitat compensation in accordance with DFO requirements	X		A	Minimal
Disturbance of freshwater fisheries (recreational fishing) as a result of disturbance and habitat alteration on-site, at Meadow Lake, and in Isaac's Harbour Creek	• Implementation of habitat compensation in accordance with DFO requirements	X		A	Minimal
Disturbance of fishing activities from LNG and cargo vessels in the bay	• Fishermen will be notified of ship arrival so they can shift gill nets in the central part of the bay		X	A	Minor
Impacts on navigation from the narrower entrance to Isaac's Harbour created by the marginal wharf	• N/A; the harbour narrows to a similar width 500m further into the harbour		X	A	Minimal

VEC	Mitigation	Construction Phase	Operation Phase	Type (A-adverse; B-beneficial)	Significance of Residual Effect
Marine fish may be attracted by facility lights at night and may perceive noises at a distance from the operation	• Monitoring programs to be followed		X	A	Minimal
Disturbance of freshwater fisheries (recreational fishing) as a result of the Meadow Lake Impoundment (water level fluctuations); low flow conditions in Isaac's Harbour River	• Operation of fish ladder at Meadow Lake dam • Operation of dam to provide for minimal flow in Isaac's Harbour River		X	A	Minimal
Freshwater Species and Habitat					
Potential for HADD through site development and grading	• Application of a "no net loss" policy; • Erosion and sediment control plan • Maintain 15m buffer zone • Storm-water management plan • Spill prevention and response plan • Designated fueling and material storage site	X		A	Minor
Potential for HADD due to in-water works and dam construction at Meadow Lake	• Application of a "no net loss" policy; • Erosion and sediment control plan • Site and shoreline rehabilitation • See mitigation for Water Quality	X		A	Minor
Potential for fish habitat impairment due to waste water discharges	See mitigation for Surface Water Quality	X		A	Minor
Potential for fish habitat impairment due to dam operation; potential beneficial effects through lake expansion	Dam construction with fish passage		X	B	Medium
Marine Species and Habitat					
Destruction of fish habitat as a result of construction of wharf and marine terminal	• N/A; loss of lobster habitat is only 1.6% of Stormont Bay	X		A	Minimal
Disturbance of seabird (Roseate tern) nesting habitat on Country Island from vessel movement and noise (blasting)	• N/A; Establishment and adherence to exclusion zone	X		A	Minor
Disturbance of marine mammals from Project-related marine traffic	• N/A; Stormont Bay is not an important marine location	X		A	Minimal
Disturbance of fish habitat from LNG and cargo vessels berthing at wharf and	• Environmental management plan • Spill response plan		X	A	Minimal

VEC	Mitigation	Construction Phase	Operation Phase	Type (A-adverse; B-beneficial)	Significance of Residual Effect
terminal; material handling, unloading	• Effluent discharges to marine Environment to comply with regulatory standards • Effluent quality monitoring				
Marine habitat impairment as a result of re-suspension of contaminated sediments from propeller water	• N/A; large vessels to be berthed with support of tugs • No sediment contamination identified		X	A	Minimal
Marine habitat impairment as a result of wastewater discharges to Isaac's Harbour	• Discharges to be in accordance with regulatory standards		X	A	Minimal
Seabirds disturbed by large ships passing close to Country Island (Roseate terns)	• Prescribed navigational route not to pass within the exclusion zone established for Country Island		X	A	Minimal
Seabirds (Petrels) that nest on Country Island could be attracted to flares at night	• N/A		X	A	Minimal
Disturbance of marine mammals through noise from project-related marine traffic	• N/A; Stormont Bay is not an important marine mammal location		X	A	Minimal
Agriculture					
There are no agricultural uses within the proposed construction envelope or the zone of influence of the Project.	• None	X	X	N/A	None
Geological Impacts					
Structural/safety risks associated with former mine workings	• Detailed surveys and mapping of project site • Filling and stabilization as appropriate	X		A	Minimal
Risks of former mine workings regarding groundwater regime	• Detailed surveys and mapping of project site • Grouting where appropriate • Storage of hazardous material will avoid old mine working sites which can act as preferential pathways should spills occur	X		A	Minimal
Disturbance of tailings disposal sites	• Avoidance where possible • Encapsulation if avoidance is not feasible	X		A	Minimal
Acid drainage	• Avoid excavation of relevant bedrock • Avoid changes to drainage and groundwater regime • Testing for acid drainage potential	X		A	Minimal

VEC	Mitigation	Construction Phase	Operation Phase	Type (A-adverse; B-beneficial)	Significance of Residual Effect
Archaeological Resources					
Disturbance of land at the former Red Head Cemetery by marginal wharf and marine facility	• Public consultation with Lincolnville Black community. Monitored backhoe excavation	X		A	Medium
Erosion of sites at Sculpin Cove (1-5) by marginal wharf	• None currently • Investigation if they are subject to erosion	X		A	Minor
Erosion of sites on Hurricane Island by marginal wharf	• None currently • Investigation if they are subject to erosion	X		A	Minor
Impact on McMillan Mine by LNG storage and access road	• Monitoring during disturbance	X		A	Minor
Impact on Dung Cove site by WWTP building	• None currently • Investigation if it is subject to impact	X		A	Minor
Impact on Hattie's Belt by LNG storage	• None currently • Investigation if it is subject to impact	X		A	Minor
Potential impact on South Mulgrave Lead	• Monitoring during disturbance	X		A	Minor
Potential impact to sites at Meadow Lake as a result of construction of dam and resulting submergence.	• None currently. • This area has not been surveyed	X		A	Unknown
Continued erosion of sites at Sculpin Cove (1-5) by potential rise in sea level and wakes.	• None currently. • Investigation if they are subject to erosion.		X	A	Unknown
Continued erosion of sites on Hurricane Island by potential rise in sea level and wakes.	• None currently. • Investigation if they are subject to erosion.		X	A	Unknown
Potential impact to sites at Meadow Lake by continued submergence.	• None currently. • This area has not been surveyed		X	A	Unknown
Transporation Impacts					
Increase in collision rates due to construction-related vehicular traffic	• Flagman at construction site entrance, if required • Along main transport route, adjustment of travel speed, signage, intersection controls, sight lines	X		A	Medium
Increase in collision rates due to operation-related vehicular traffic	• Controlled site entrance, if required • Along main transport route, adjustment of travel speed, signage, intersection controls, sight lines		X	A	Medium

VEC	Mitigation	Construction Phase	Operation Phase	Type (A-adverse; B-beneficial)	Significance of Residual Effect
Human Health and Safety					
Particulate generation may pose safety concerns regarding former mine workings	• Dust control program • Worker health and safety program • Avoid mine workings and tailings areas to the extent possible	X		A	Minor
Potential disturbance of mine tailings from construction of waterfront facilities and pipelines	• None	X		P	Minimal
Air emissions from vessel transportation (delivery of construction materials and equipment)	• None	X		A	Minimal
Dust generation from concrete production	• Dust control program	X		A	Minimal
Potential for runoff from site preparation debris (waste management)	• Erosion control program	X		A	Minimal
Air emissions from vehicular traffic	• Dust control program • worker health and safety program	X		A	Minor
Potential spills from equipment and materials storage	• Spill control plan	X		A	Minimal
Air emissions from marine vessel traffic unloading	• None		X	A	Minimal
Air emissions from unloading LNG vessels to tanks	• Spill control plan		X	A	Minimal
Air emissions from vaporization/regassification of LNG to natural gas	• None		X	A	Minimal
Air emissions and potential spills from chemical manufacturing	• Spill control plan		X	A	Minimal
Air emissions from power generation	• None		X	A	Minimal

VEC	Mitigation	Construction Phase	Operation Phase	Type (A-adverse; B-beneficial)	Significance of Residual Effect
Waste effluent discharges	• Ensure discharges are in compliance with all regulatory requirements		X	A	Minor
Air emissions from vehicular traffic	• Unlikely to impact the public due to distance to receptors		X	A	Minimal
Potential spills from material transfer and storage (other than LNG)	• Spill control plan		X	A	Minimal
Potential remobilization of mine tailings from decommissioning the waterfront facilities and pipelines	• Decommissioning should retain cover for mine tailings		X	A	Minimal
Potential for air emissions, spills from decommissioning of Petrochemical facilities	• Dust control plan • Spill control plan		X	A	Minimal
Particulate generation from reclamation	• Dust Control Program • Worker Health and Safety Program • Avoid mine tailings areas to the extent possible		X	A	Minor

12.0 EVALUATION OF THE ADVANTAGES AND DISADVANTAGES TO THE ENVIRONMENT

This section presents, in overview fashion, a commentary and evaluation by Project Phase of the characteristics of the Project, expressed as "Advantages" and "Disadvantages" to the Environment. As required in the Terms of Reference for the EA, a rationale is provided as justification for the identified disadvantages.

This overview reflects the Keltic commitments to regulatory compliance and to sound environmental management principles. The list of advantages and disadvantages assumes the successful implementation of the specific mitigation measures and monitoring programs as described in this EA and are reflective of an undertaking that is in full compliance with all applicable regulatory requirements, contemporary approaches to environmental management, and sustainability assurance.

Tables 12.0-1, 12.0-2, and 12.0-3 summarize the evaluation of the Project by Phases. For the most part, disadvantages of the Project are short-term and localized and associated with environmental effects that were not considered significant. The disadvantages are off set by mostly socio-economic benefits, which are expected to be long-term and far reaching, i.e., relevant to the local community, the region, and the province of Nova Scotia.

TABLE 12.0-1 Construction Phase Project Advantages and Disadvantages

VEC Scope	Construction Phase Characteristics	
	Advantages	**Disadvantages incl. Justification**
Socio-Economic Environment		
Land Use	Project is compatible with land use designation	NA
Aboriginal Use of Land and Resources	No interaction with land claims No significant adverse effects on natural environment resources (see summaries under Biophysical Environment)	NA
Socio-economic Environment (Economic Conditions, Population, Employment)	Will provide short term (Construction) employment through direct hires and economic benefits through multiplier effects. Will strengthen existing industrial capability. Will encourage and facilitate local population growth.	NA
Residential Property Values	Property values likely to increase	NA
Recreational Opportunities and Aesthetics	NA	Change of landscape character within some viewsheds from rural to industrial; some impairment of visual quality (loss of views; visual intrusion by lighting). Potential for limitations on recreational boating near the marine construction site; considered a trade off against significant economic benefits for the local community.
Air Quality	NA	Increased air emissions; construction-related emissions short-term and to remain within applicable regulatory standards;
Noise	NA	Increased noise levels; construction-related noise effects short-term and to remain within applicable regulatory standards;
Surface Water (Quality, sediment quality and transport)	NA	Potential for some impairment of surface water quality and flow; construction-related effects short-term and to remain within applicable regulatory standards and requirements; Potential for some impairment of marine water and sediment quality and sediment transport; effects considered not significant;
Groundwater (Quality and Quantity)	Regular monitoring of select local water supply wells	Some potential impairment to groundwater quality; possible alterations in flow and volume; construction-related effects short-term and to remain within applicable regulatory standards and requirements.
Flora, Fauna and Terrestrial Habitat (including species at risk)	Improved inventory of area habitat and species (for species at risk)	Some habitat incursion, controlled through Construction EPP. Avoidance of identified at risk plant species
Forestry	NA	NA

VEC Scope	Construction Phase Characteristics	
	Advantages	Disadvantages incl. Justification
Wetlands	NA	Impoundment of Meadow Lake will involve inundation of a wetland area; effect short-to medium term; remaining wetlands in region extensive; moderated through a habitat compensation program.
Fisheries, Aquaculture and Harvesting	NA	Marine traffic, water quality impairment, and near-shore construction activity could affect fish harvesting, aquaculture. Considered a trade off against significant economic benefits for the local community.
Freshwater Species and Habitat (including species at risk)	Improved inventory of area habitat and species (for species at risk)	Potential HADD; residual effects to be addressed through a FHCP
Marine Species and Habitat (including species at risk)	Improved inventory of area habitat and species (for species at risk)	Some habitat loss at the terminal site; offset by habitat creation.
Geological (soil quality)	NA	Some potential impairment to surface and groundwater resources from works and activities at contaminated sites; Project will identify extent and degree of site contamination within the Project site boundaries and provide for adequate site management (i.e., remediation)
Archaeological Resources	Improved inventory and knowledge of area resources	NA
Transportation	Improved access to Project Area through road upgrades	Increased traffic volumes and congestion; effects expected to be localized and temporary; road upgrades will ensure road safety; considered a trade off against significant economic benefits for the local community.
Human Health and Safety	Positive psycho-social effects through improved employment and economic opportunities	None identified; all emissions and discharges to remain within applicable regulatory standards

TABLE 12.0-2 Operations Phase- Project Advantages and Disadvantages

VEC Scope	Operations Phase Characteristics	
	Advantages	**Disadvantages incl. Justification**
Socio-Economic Environment		
Land Use	Project is compatible with land use designation	NA
Aboriginal Use of Land and Resources	No interaction with land claims No significant adverse effects on natural environment resources (see summaries under Biophysical Environment)	NA
Socio-economic Environment (Economic Conditions, Population, Employment)	Will provide long term (Operation phase) employment opportunities; Contribute to local and regional economy (multiplier effect) Increased municipal tax base; Strengthen existing industrial capability of region and Province	NA
Residential Property Values	Stability in property values	NA
Recreational Opportunities and Aesthetics	Visitor Centre will provide interpretive and learning opportunities Increased municipal tax base will allow for improvement and maintenance of recreation infrastructure	Loss of rural character and associated visual quality; potential for some limitations on recreational boating near wharf and LNG terminal; offset by improved economic base and development potential for new recreational infrastructure.
Air Quality	Increased use of natural gas will be major advantage to natural environment	Increase in emissions from local sources; levels to remain within regulatory standards.
Noise	NA	Potential for increase in noise levels; levels to remain within regulatory standards
Surface Water (Quality, sediment quality and transport)	Ambient water quality monitoring	Discharges of (treated) waste water; all discharges compliant with applicable water quality standards. Potential for some impairment of marine water and sediment quality and sediment transport; effects considered not significant; trade off for new wharf infrastructure providing opportunities for large scale naval transport to and from the area and associated economic benefits.
Groundwater (Quality and Quantity)	NA	NA
Flora, Fauna and Terrestrial Habitat (including species at risk)	NA	Migrating species movement pattern could be disrupted as a consequence of the presence of the new development. Effect not considered significant.
Forestry	NA	NA

VEC Scope	Operations Phase Characteristics	
	Advantages	Disadvantages incl. Justification
Wetlands	NA	NA
Fisheries, Aquaculture and Harvesting	NA	Some loss of access to vessels and harvesting activity proximate to marine facilities; trade off against improved employment opportunities.
Freshwater Species and Habitat (including species at risk)	NA	NA
Marine Species and Habitat (including species at risk)	NA	NA
Geological (soil quality)	NA	NA
Archaeological Resources	NA	NA
Transportation	Road infrastructure improvements through road upgrades.	Increased traffic volumes; effects expected to be localized; road upgrades will ensure road safety; considered a trade off against significant economic benefits for the local community.
Human Health and Safety	Positive psycho-social effects through improved employment and economic opportunities	None identified; all emissions and discharges to remain within applicable regulatory standards; working environments in compliance with regulatory requirements

TABLE 12.0-3 Decommissioning Phase - Project Advantages and Disadvantages

VEC Scope	Decommissioning Phase Characteristics	
	Advantages	**Disadvantages incl. Justification**
Socio-Economic Environment		
Land Use	NA	NA
Aboriginal Use of Land and Resources	No interaction with land claims	NA
Socio-economic Environment (Economic Conditions, Population, Employment)	Will provide short term (Construction) and long term (Operation and Decommissioning) employment	NA
Residential Property Values	NA	Potential for reduced demand for residential property following completion of the decommissioning; dependent on subsequent use of property and economic development in the region.
Recreational Opportunities and Aesthetics	Upon completions, capability for recreational use of some areas maybe re-established; Potential for rehabilitating rural landscape characteristics; Potential for elimination of navigational restrictions for recreational boating;	NA
Air Quality	Upon completions, elimination of operations-related discharges.	Dust emissions from decommissioning work; short-term and localized
Noise	Upon completions, elimination of sources.	Noise-effects associated with decommissioning work; short-term and localized
Surface Water (Quality, sediment quality and transport)	Potential for rehabilitation of natural shoreline and processes	Potential for impairment of marine water and sediment quality from dismantling of infrastructure; short-term and localized
Groundwater (Quality and Quantity)	NA	NA
Flora, Fauna and Terrestrial Habitat (including species at risk)	Potential for rehabilitation of terrestrial habitat. Potential for rehabilitation of critical habitat relevant for Species at Risk	NA
Forestry	NA	NA
Wetlands	Potential for rehabilitation of wetland habitat	NA
Fisheries, Aquaculture and Harvesting	Upon completions, access regained to some marine areas.	NA

VEC Scope	Decommissioning Phase Characteristics	
	Advantages	**Disadvantages incl. Justification**
Freshwater Species and Habitat (including species at risk)	Potential for rehabilitation of natural shoreline and processes Potential for rehabilitation of critical habitat relevant for Species at Risk	Potential for impairment of marine habitat (through water and sediment quality) from dismantling of wharf and terminal; short-term and localized
Marine Species and Habitat (including species at risk)	Potential for rehabilitation of marine habitat. Potential for rehabilitation of critical habitat relevant for Species at Risk	NA
Geological (soil quality)	Restoration of flows; elimination of water quality impairment.	NA
Archaeological Resources	NA	NA
Transportation	NA	NA
Human Health and Safety	Site rehabilitation; removal of infrastructure and materials with potential for contamination	Some psycho-social stress in case of economic uncertainty; off set by improved infrastructure which may help attracting new economic opportunities; decommissioning work places in compliance with regulatory requirements

13.0 PROPOSED COMPLIANCE AND EFFECTS MONITORING PROGRAMS

An Environmental Compliance Monitoring (ECM) program is undertaken for a project to ensure that appropriate regulations and company specifications are implemented during project development. Activities relevant to all phases of the project (i.e. construction, operation, and decommissioning and abandonment) are subject to the provisions of relevant regulations and guidelines.

Environmental Effects Monitoring (EEM) is used to assess the accuracy of any predictions made in the EA concerning potential effects.

Most of the monitoring activities and mitigative measures to be employed for both the construction and operation of the various project components will be guided by the regulatory/policy regimes of the Nova Scotia and Federal government requirements and the Conditions of Approval. When necessary, the Proponent will also address relevant concerns identified by the residents of the Goldboro area. A number of programs are proposed for the purpose of delineating the anticipated objectives and substance of a monitoring work-plan.

Anticipated compliance and monitoring follow-up requirements were evaluated for each VEC and Valued Socio-Economical Component as a function of their sensitivity to project-related environmental effects. The likelihood and importance of such effects, as well as the level of confidence associated with any adverse residual effects rating, were taken into consideration. A general description of proposed monitoring programs follows.

13.1 AIR QUALITY MONITORING

It is anticipated that air emissions from the Project (including site preparation, construction, LNG delivery, co-generation, petrochemical operations and feed/product shipping), will not exceed the ambient air quality objectives and/or regulations. To validate the modeling results and impact prediction the Proponent will undertake the following monitoring programs.

13.1.1 Construction

Typically, in rural settings, air emissions, in particular dust, are not monitored during construction. If concerns are expressed on site related to occupational health and safety, portable PM_{10} monitors may be used for real time measurements of PM by field inspectors. If concerns are expressed regarding dust levels off-site, the Project may elect to employ high-volume samplers to determine particulate levels at specific receptors.

13.1.2 Operations

The LNG facility is expected to operate with minimal emissions to the atmosphere and thus continuous monitoring for this facility is not deemed to be necessary. The co-generation facility will generate emissions predominantly consisting of CO_2, NO_x, and water vapour. These parameters are proposed to be monitored but can be measured and assessed based on natural gas consumption using industry standard emissions factors.

There will be two forms of air quality monitoring related to the petrochemical plant: in situ continuous emission stack monitors and real-time ambient air quality analysis. The first type of monitoring is that of in situ stack monitors, termed continuous emission monitors (CEM). These monitors are used to both ensure that emissions are held to levels which will not result in unforeseen impacts to the surrounding air quality, as well as to enable the plant operators to ensure that equipment is operating efficiently in accordance with design criteria. In particular, CEMs are likely to be used to monitor NO_x, SO_2, and particulates (opacity), in addition to related operational variables as appropriate. In addition to a quality assurance program for ensuring that the CEMs are properly calibrated, occasional stack-testing may be undertaken to further check on emission levels.

The second type of monitoring is that of real-time ambient air quality analysis, which serves as both a check on the ground-level concentrations of pollutants which have been modeled (Section 9.3), as well as an assurance that other activities are not unduly impacting upon local conditions. It is anticipated that any requirements for such monitoring (both in terms of parameters; number of monitoring sites; and duration) will form part of the Industrial Approval, and would likely focus on NO_x and SO_2, and PM and be conducted periodically during the year. Normally, monitoring sites are located (where practical) at locations indicated by modeling as the point of greatest impact, and/or sites involving sensitive receptors. Reporting of results of the ambient monitoring are made available to both the regulatory authorities and the public. Although real-time monitoring of VOCs is not contemplated, Keltic intends to commission VOC monitoring (essentially 24 hour ‘grab’ sampling) both prior to and during operations, in order to assess the quantity and makeup of any VOCs at a number of points which will be determined as the specific design phase is completed. In addition, should odours be detected off-site, VOC monitoring will be undertaken to determine the source(s), and allow for appropriated mitigation measures.

Efforts will be made to coordinate with SOEI regarding existing monitoring equipment utilization and data resources.

13.2 NOISE AND LIGHT MONITORING

13.2.1 Construction

Monitoring will be conducted if complaints arise as a result of construction activities or truck traffic through Goldboro and/or other communities during construction.

A traffic/vehicle management system may be implemented if noise threshold levels are exceeded.

13.2.2 Operations

The Proponent will initiate a monitoring program which will consist of sampling noise levels over a 24-hour following commissioning. Noise sampling will be conducted quarterly and the results evaluated on an annual basis. Should noise levels be consistent over the first year, noise sampling would subsequently be conducted on a complaint basis or following process or equipment changes. This will include monitoring of ship noise, vehicle movement, heavy equipment operations, emergency operations, and normal operating modes.

The Proponent will notify the public in advance of any potentially unusual noise-related events. The Proponent will provide a direct contact number for a responsible company official to residents and other interested stakeholders.

13.3 SURFACE WATER MONITORING

Surface water-quality monitoring programs will be established in consultation with regulatory agencies and as part of the permitting process through the Conditions of Approval. Notwithstanding this, a proposed water-quality monitoring plan is presented for the purpose of describing the objectives and substance of monitoring.

With the exception of Betty's Cove Brook, it is anticipated that there will be no discharges into on-site or off-site watercourses. As a result, monitoring is not proposed for Crusher Brook or the unnamed tributary to Dung Cove. As Betty's Cove Brook may receive periodic discharges from the site during construction it will be sampled at key stream locations for TSS during storm events and during sediment pond discharge or dewatering. It will also be monitored as part of the groundwater monitoring program on the plant site (see Section 13.9.2) because of the identified dynamic relationship between groundwater and surface water in the area.

As an additional tool for assessing the water-quality impacts resulting from possible spills or other unforeseen effects of the project operations, is to conduct benthic-invertebrate survey at relevant locations in the Keltic Study Area.

These and other proposed water-quality monitoring programs are presented in Table 13.3-1.

TABLE 13.3-1 Proposed Surface Water Monitoring Program Elements

Project		Proposed Monitoring Program Elements
Phase	**Component**	
Pre-Construction	Project Site	• Qualitative/quantitative sampling of the benthic-invertebrate community at one station on each; Betty's Cove Brook (upstream and downstream of site), Crusher Brook, and unnamed tributary to Dung Cove. • One measurement of turbidity and TSS within on-site watercourses under typical flow conditions. • Prepare a report on results and analyses of benthic invertebrate surveys (ephemeroptera/plecoptera/trichoptera index, taxon dominance, density, species diversity, Hilsenhoff biotic index, etc.).
	Meadow Lake Impoundment	• Measure turbidity and TSS in Meadow Lake and in Isaac's Harbour River downstream of proposed dam.
Construction	Project Site	• Inspect, monitor erosion/sediment control measures at on-site watercourses throughout construction. • Periodically measure turbidity and TSS in on-site watercourses. • Annual qualitative/quantitative sampling of the benthic-invertebrate community at one station on each; Betty's Cove Brook (upstream and downstream of site), Crusher Brook, and unnamed tributary to Dung Cove. • Prepare annual reports on results of erosion-control and benthic-invertebrate surveys (ephemeroptera/plecoptera/trichoptera index, taxon dominance, density, species diversity, Hilsenhoff biotic
	Meadow Lake Impoundment	• Inspect, monitor erosion/sediment control measures throughout construction. • Periodically assess turbidity and TSS in the vicinity of the dam, the water-intake structures and in Isaac's Harbour River downstream of proposed dam. • Maintain environmental inspection reports and results of water quality monitoring program, compare with previous years.
Operation and Maintenance	Project Site	• Annual qualitative/quantitative sampling of the benthic-invertebrate community at one station on each; Betty's Brook, Crusher Brook, unnamed tributary to Dung Cove during post construction years 1, 2, 3, and 5, and every 5 years thereafter. • Prepare annual reports on survey results (ephemeroptera/ plecoptera/trichoptera index, taxon dominance, density, species diversity, hilsenhoff biotic index, etc.), compare results with previous years.
	Meadow Lake Impoundment	• Collect raw water samples for general chemistry and metals' analysis on a schedule to be determined based on water supply treatment requirements. • No other post-construction water-quality monitoring programs are anticipated in Meadow Lake.

In addition to the above, permanent gauging stations will be established within Meadow Lake and below the proposed dam in Isaac's Harbour River to replace the temporary one installed at location ML1 during the assessment study. Data from these will be collected on an ongoing basis as part of the water supply management program.

13.4 GROUNDWATER AND WATER WELL SURVEY

The following three subsections describe the monitoring programs which are anticipated to be applied with respect to the water supply wells near the plant site, at the plant site, and at the proposed dam site at Meadow Lake.

13.4.1 Water Supply Wells

13.4.1.1 Plant Site Pre-construction, Construction, and Operation

An inventory and water sampling of many wells within 1km of the Project site have already been completed. Prior to construction, the Proponent will expand on this earlier work by attempting to:

- interview all wells owners not yet interviewed;
- review and document (including photos) well construction not yet inspected;
- collect water samples for general chemistry, metals and coliform analysis where sampling has not yet been done; and
- collect additional samples at wells previously sampled so as to identify possible seasonal or other temporal changes in water quality.

As construction work progresses on the plant site, follow-up well sampling will be done, as required, to adequately assess general groundwater and specific well water supply quality.

During plant operation, there will be regular monitoring of well water quality at key wells located near the plant site. The post construction report noted above will identify these wells (selected on the basis of possible exposure to detrimental effects, if any, from plant operations, and on the basis of providing optimum scientific information), other possible future monitoring needs, and protocol for modifying the proposed monitoring program so as to continually optimize scientific data quality and resource utilization. Sampling at these wells will include analysis for general chemistry, metals, coliform, petroleum hydrocarbons, VOCs, and others as deemed necessary based on plant site operations and monitoring results.

13.4.1.2 Contingency Monitoring and Resolution

The above will form part of an overall water supply well contingency monitoring and resolution program. The Proponent will deliver an arbitration and resolution document to all owners of water supply wells located within 1 km of the proposed plant site boundaries. The Proponent is prepared to provide temporary water supply during construction should existing supplies be disrupted. Additionally, in the event that wells are adversely or permanently affected by plant-site preparation, construction, or plant operation the Proponent will repair or replace any affected wells.

13.4.2 Groundwater at the Plant Site

Since petroleum hydrocarbons other than LNG (i.e. diesel fuel for back up generators) and other chemicals are to be stored on the site, a groundwater monitoring program for the particular chemical(s) of concern will implemented.

The exact nature and location of on-site storage have not yet been determined, and thus detailed groundwater monitoring requirements have not been finalized. Once the design of the plant site, facilities locations and storage criteria have been completed, a groundwater monitoring well system will be designed and installed to expand upon the existing seven monitoring wells stations installed on-site during spring 2005. Some of the wells will be installed before any site preparation or construction activities begin while others will be completed once the storage systems are in place.

The plant site groundwater monitoring system will be designed, constructed, and maintained in accordance with Conditions of Approvals, where applicable. The system will also be used to augment current baseline data, to monitor early site preparation and construction effects and assist the Proponent and the neighbouring community for the duration of plant operation. The intent is to incorporate data collected from groundwater monitoring stations, in conjunction with other data which may become available on the abandoned mine workings, into groundwater models so as to allow for a more comprehensive groundwater flow migration forecasting. This information would form part of the spill response and contingency plan.

The plant site monitoring system sampling schedule will include:

- a sufficient number of monitoring stations to provide full (both background or up-gradient and down gradient) on-site and nearby off-site coverage;
- multi-level multi-wells stations at key locations;
- proximal and distal monitoring capability for all fuel/chemical storage;
- timely response to any spill event; and
- Four-season and longer temporal coverage.

This will include installations inside and at plant-site boundaries, outside plant-site boundaries (particularly in the east and south between the plant and Betty's Cove Brook, west between the plant site and the ocean, and north and northwest between the plant site and the community of Goldboro). Infill monitoring stations will be installed as suggested by early monitoring results and data collected.

In addition to the on-site and site-perimeter monitoring stations, groundwater monitoring stations will be installed at select locations within the community of Goldboro so as to allow uninhibited and unbiased collection of groundwater quantity and quality data (i.e. to simulate water supply wells).

It is expected that key monitoring stations will be assessed regularly for vapours that are relevant to storage and plant operations, and for water levels (data loggers). At others, groundwater levels will be measured and water samples collected quarterly, semi-annually and yearly for general chemistry, metals, total petroleum hydrocarbons and VOCs analysis. A protocol will be established to enable the program to be modified to optimize the use of monitoring resources, scientific data quality, and knowledge of on site hydrogeological characteristics.

Where data suggests that there may be surface-water/groundwater interaction, select streams will be sampled for such parameters as general chemistry, metals, total petroleum hydrocarbons, VOC analysis, and mercury. This will serve to give a better insight on groundwater conditions and augment the surface water monitoring program described in Section 13.3.

13.4.3 Proposed Meadow Lake Dam

The Proponent will install groundwater monitoring stations upstream, within, and downstream of the proposed dam at Meadow Lake so as to:

- monitor the effect of raising the lake water level on groundwater levels and shore-line vegetation upstream of the dam;
- monitor for possible groundwater underflow (leakage) at the dam; and
- develop improved groundwater hydrographs for overall improved watershed water balance determinations and thus, better floodgate and water supply management.

13.5 FLORA, FAUNA, AND TERRESTRIAL HABITAT MONITORING

Keltic proposes to conduct terrestrial habitat monitoring upon completion of commissioning and during the first 3 to 5 years operation of the Project. The proposed Study Areas and detailed scope for each of the components will be developed prior to commissioning.

A terrestrial biological monitoring program will be established that includes the following principal components. The findings will be documented on an annual basis and the scope of the program will be evaluated annually.

13.5.1 Bird Census

A bird census will be carried out that monitors birds along the shoreline and Isaac’s Harbour, and in the on-site terrestrial habitats. Counts will be taken at least twice per year for all birds (late May-early June and late August-early September), and at least once more (first two weeks of November) for sea birds and waterfowl.

In addition, routine site monitoring will be done to maintain records of bird mortality noted on site to enable identification of potential issues related to lighting. Should it be determined that significant lighting related mortalities are occurring, then appropriate mitigative strategies will need to be identified.

13.5.2 Vegetation

A vegetation monitoring program will be established to check the success of replanting and habitat restoration programs, where applicable. These will be done at least twice per year in late May-early June and again in late August. Appropriate restorative plantings will be done shortly after these inspections.

13.5.3 Wildlife

A monitoring program to assess wildlife populations will be established, with surveys carried out at appropriate times of the year as shown in Table 13.5-1.

TABLE 13.5-1 Proposed Survey Times for Wildlife Monitoring Program

Wildlife Species	Survey Times, Notes
amphibians	early May
reptiles	June-August
small mammals	June-July (check especially meadow vole activity)
Fur bearers	Fall and Winter (check tracks and other sign, especially in Dung Cove Pond area)
deer	Winter (check tracks in areas of previously known concentration)

Evidence of wildlife presence and activity, and vegetation condition requiring attention, will be monitored during the surveys.

13.6 INSHORE FISHERIES MONITORING

Monitoring of inshore fishing activity is difficult because reporting of specific fishing locations is not required for most fisheries and individual catches are considered confidential by DFO. However, since lobster is the primary species caught in Stormont Bay, a monitoring catch-rate program will be implemented in conjunction with local fishermen. Such a program will be important as part of a compensation program to provide independent and objective assessment of potential impacts on the fishery. A monitoring program will document catch in different parts of Stormont Bay during the commercial fishing season. It will involve placing an observer on local fishing vessels at three different times during the fishing season, with specific criteria for consistent setting of traps. Details of such a program will need to be developed in consultation with local fishermen and DFO.

13.7 FRESHWATER SPECIES AND HABITAT MONITORING

It is expected that the programs for monitoring freshwater fish and fish habitat will be established in consultation with DFO and during the DFO permitting process for various works associated with the Project. Nevertheless, a number of programs are proposed in Table 13.7-1 for the purpose of delineating the anticipated objectives and substance of the monitoring work plan.

TABLE 13.7-1 Proposed Fish and Fish Habitat Monitoring

Project Phase	Project Component	Monitoring Program Elements
Pre-Construction	Project Site[1]	• Survey fish communities in all on-site watercourses (Betty's Cove Brook, Crusher Brook, unnamed tributary to Dung Cove) by electrofishing and by trap netting in Dung Cove.
	Meadow Lake Impoundment[1]	• Sample fish community in Meadow Lake by electrofishing and trap netting.
Construction	Project Site	• Inspect/monitor sediment/erosion control measures at each on-site watercourse. • Annual fish community surveys (electrofishing) in all on-site watercourses (Betty's Cove Brook, Crusher Brook, unnamed tributary to Dung Cove) and annual trap-net surveys in Dung Cove throughout construction period. • Annual description/photographs of aquatic and riparian habitat at established representative locations on all on-site watercourses and in Dung Cove. • Prepare annual reports to present results of the erosion-control monitoring and the annual fish surveys, compared results (species presence, composition, etc) with previous years.
	Meadow Lake Impoundment	• Inspect/monitor sediment/erosion-control measures at dam and water-intake sites. • Annual (September) fish community survey (electrofishing, trap-net) in Meadow Lake. • Prepare annual reports on results of the erosion-control monitoring and annual fish; compare results (species presence, composition, etc) to previous years.
Operation and Maintenance	Project Site	• Fish-community surveys in all on-site watercourses and the large Red Head pond for post-construction years 1, 2, 3 and 5, and every 5 years thereafter, if required. • Describe/photograph aquatic/riparian habitat at established representative locations on all on-site watercourses and in the large freshwater pond on Red Head for post-construction years 1, 2, 3 and 5, and every 5 years thereafter. • Prepare reports on results of the annual habitat and fish surveys, compare results (species presence, composition, etc) to previous years
	Meadow Lake Impoundment	• Annual (September) fish community survey (electrofishing, trap-net in Meadow Lake for post-construction years 1, 2, 3 and 5, and every 5 years thereafter. • Inspect/maintain fishway, at a frequency to be determined, to ensure structure's integrity and efficacy of operation. • Prepare reports on results of the fishway operation and fish surveys, compared results (species presence, composition, etc) with previous years.

Notes: 1 – Completed as part of the baseline studies for this report.
2 – Relevant watercourses should be re-surveyed if road alignment changes.

13.8 MARINE SPECIES AND HABITAT MONITORING

Minor changes in sediment type and quality near proposed shoreline facilities are anticipated as a result of wave and current action. Changes in wharf and terminal design, however, may be required as part of the federal permitting process. Once design has been finalized, modeling will be carried out in more detail to assess potential changes in substrate and a monitoring program will be developed if required.

Prior to implementation of a habitat compensation project, additional physical assessment of the area will be required to ensure that bottom conditions are appropriate. Assessment will focus on determining if the bottom will support rock clusters or other habitat improvements, and to ensure that sediment transport does not result in fines infilling the crevices in the habitat structures.

Monitoring of the habitat compensation program will be carried out to document the success of the Project in relation to lobster production. Monitoring will examine juvenile and adult densities over a period of three years. The program will be developed in consultation with DFO.

13.9 ARCHAEOLOGICAL RESOURCE MONITORING

Archaeological compliance and monitoring programs are regulated by the NSMNH's manager of Special Places and subject to approval. A number of recommendations have been made to minimize impact on significant archaeological resources and are summarized in Table 13.9-1.

TABLE 13.9-1 Proposed Archaeological Compliance and Monitoring Programs

Archaeological Site or Resource		Proposed Compliance and/or Monitoring
LNG and Plant Site	Red Head Cemetery	Community consultation and monitoring of ground disturbance.
	Sculpin Cove 1	Monitoring of shoreline erosion. Archaeological testing as follow-up if sites are threatened.
	Sculpin Cove 2	
	Sculpin Cove 3	
	Sculpin Cove 4	
	Sculpin Cove 5	
	Hurricane Island Mine	
	McMillan Mine	Monitoring of ground disturbance.
	Dung Cove	None currently.
	Giffin's Mill	
	Hattie's Belt	
	Giffin Lead	
	Skunk Den Mine Crusher	
	South Mulgrave Lead	Monitoring of ground disturbance.
	Buckley Farm	Follow-up investigation once brush is cleared.
	Random Mining Activity	None.

13.10 PRE-BLAST SURVEY

The locations of buildings and wells situated within 1 km of the project site have been identified. The design and grading details of the Project site are not yet available. However, upon defining these criteria, and thus blasting requirements, a pre-blast survey of all homes and all wells present within 800 m of the blast zone boundaries will be carried out following the NSEL guidelines for blasting at quarries. This type of survey will include:

- an inspection of all buildings located within the pre-blast survey areas by qualified persons; and
- a complete inventory and testing, as appropriate, of all wells to determine individual pre-blast well condition and nearby aquifer capacity.

Before any blasting begins, a copy of all pre-blast survey results along with complete description of the arbitration and resolution methods to be will be delivered to both building and well owners and NSEL.

Blasting programs will be reviewed by qualified engineers and/or geoscientists. Trained and qualified personnel using appropriate equipment will be deployed to the field to monitor air and ground vibrations during all blasting. Blasting programs will be modified according to monitoring results so as to avoid any impacts to nearby buildings and water supply wells. Copies of all monitoring results will be available for review by NSEL.

Should any nearby building or water supply well owner claim deleterious effects from blasting activities, then qualified individual follow-up assessments of buildings (cosmetic and structural inspections and comparison to pre-blast documentation) and wells (water quality testing and other hydrogeologic evaluations as needed) will be done. These assessments will evaluate damage and recommend mitigative and/or corrective measures.

13.11 COMMUNITY INVOLVEMENT

The Proponent has already established a liaison committee to help consult and inform communities in the area. The committee was elected at a public meeting on August 2, 2004, and is represented by individuals who have expressed an interest in the Project. There are 12 individuals on the committee who represent the seven communities of Goldboro, Isaac's Harbour, Drum Head, Coddles Harbour, Stormont, Country Harbour, and Seal Harbour. The Antigonish-Guysborough Black Development Association, the Municipality of the District of Guysborough, and the District of Saint Mary's are also represented.

The liaison committee meets regularly with the Proponent and will continue to be used as a sounding board for any issues (such as safety, environmental concerns, employment, etc.) that arise. The most recent meetings were held November 8, 2005, February 13, 2006 and March 27, 2006. In addition to the liaison committee, the Proponent will continue to liaise with the Guysborough County Regional Development Authority and the Guysborough Journal as a means of communicating any information. The Proponent will also liaise actively with local emergency service providers, such as the Royal Canadian Mounted Police, fire and emergency health response.

13.12 OTHER MONITORING PLANS

Other monitoring requirements may be identified as part of the terms of the EA approval and permitting processes.

13.13 ENVIRONMENTAL PROTECTION PLAN (EPP)

Environmental protection plans (EPP) and emergency response plans for the construction and operation phases of the Project will be completed after EA approval and prior to construction. These plans will be submitted to NSEL for approval, which will involve circulation also to EC, DFO and other regulatory agencies as required.

The EPP for the construction phase will require all contractors to work in compliance with the EPP. Key provisions of the EPP will include but will not necessarily be limited to such topics as:

- roles, responsibilities and accountabilities for EPP implementation;
- temporary storm-water management and dewatering;
- Erosion Control Plan;
- fuels and lubricant storage;
- material storage;
- spill prevention;
- emergency response (spill containment and clean up protocols and equipment);
- maintenance of machinery;
- housekeeping protocols;
- construction waste management;
- dust management;
- encounter of finds of potential archaeological interest;
- encounter of contaminated soils;
- site access and construction traffic routing;
- construction site security;
- tree protection;
- environmental supervision and inspection;
- health and Safety standards and protocols;
- community Action Plan; and
- reporting.

A response and follow up procedure will be developed should there be complaints.

Similar to the EPP for the construction phase, an EPP will be developed for plant operation. The overall objective of the EPP is to ensure the plant operates in compliance with regulatory standards, and permits issued by the Ministry of the Environment. Its content is briefly described here as it applies to most of the discussions of effects and mitigation measures.

The EPP will become an integral part of the plant operation manuals and protocols and will be subject to periodic reviews and updating. Plant personnel will be trained on the provisions of the EPP and will be responsible for its implementation. Key provisions will include but will not necessarily be limited to such topics as:

- responsibilities;
- environmental Procedures;
- emission control systems;
- water discharges;
- waste management;
- chemical management;
- shut down policies;
- inspections;
- spill prevention;
- monitoring and reporting;
- icing and fogging;
- equipment;
- preventative maintenance;
- corrective maintenance;
- health and Safety;
- policies;
- standards and protocols;
- requirements for contractors and suppliers;
- incident reporting;
- emergency Preparedness and Response Plan;
- responsibilities;
- spill containment and clean up procedures and equipment;
- notification, training, drills;
- management of Environmental Program;
- training;

- documentation and record keeping;
- reporting;
- continuous improvement;
- management review; and
- community liaison and complaint procedure.

The EPP will be periodically reviewed and updated.

The EPP is expected to contain general and specific mitigation measures for project construction and operation, including measures specified in this document and applicable approval conditions. For example, the EPP will combine generic protection measures applicable to general industrial site preparation and construction projects, and with environmental protection measures specific to this project (i.e., use and maintenance of silt curtains, fuel handling protocol, etc.). In particular, areas of special environmental consideration (i.e., surveys and testing where there may be acid drainage potential, other areas requiring additional information) will be identified with specific protection measures included as appropriate.

The EPP will also contain requirements for the contractor to complete a work progression schedule for approval by the Project Engineer. Monitoring requirements, including, but not limited to, those noted above, will also be included. As part of the EPP, the design of the road and structures which make up the site preparation and structures at the plant site will be carried out such that contractors have clear direction for environmental controls made available to them both on the contract drawings and in project specifications. These measures may include those described in the EA Report; conditions of release from the assessment process; and other regulatory requirements and best management practices.

13.14 WASTE MANAGEMENT PLAN

A Waste Management Plan will be designed to meet the objectives of the Proponent's purpose, vision, and values. It will provide the basis for sound waste management practices that will focus on reduction, reuse, and recycling. The plan will cover all aspects of waste generation, storage, and handling, shipping and reporting. The plan will apply to the construction and operation phases of the Project and to all subcontractors.

14.0 PUBLIC INFORMATION PROGRAM

14.1 PURPOSE

Public consultation is a key component of an EA. It provides a means to integrate citizens into the environmental decision-making process and to provide proponents and regulators with the information they need for good decision-making. Specific EA consultations focus on stakeholders and are meant to gather relevant information and opinions.

The consultation plan specifies the goals of the EA consultation process, describes the relevant communities, identifies which elements are to be carried out by whom, and how results are going to be integrated with the information provided by Keltic's public communications work. A liaison committee was established by Keltic to provide information to stakeholders and the public, and also to provide feedback from the local community about concerns and advice for consultations.

14.2 REGULATORY CONTEXT

Nova Scotia allows the proponent to decide if and how the public should be involved early in the project planning stage and before a registration document is submitted, as Keltic has chosen to do through its public communications program. Formal public participation in the provincial EA process can range from the submission of written documents to a presentation at a public hearing.

For Class 2 developments, members of the public can review and submit comments on the registration document and the proposed terms of reference which will be considered by the EA Branch when preparing the final terms of reference for the EA report. When the EA report is submitted, the public can again review the report and submit comments and may make a presentation if a public hearing is required. During this formal part of the process, the Department expects that a proponent will carry out public consultation but allows the proponent to determine what and how this will be done.

At the federal level, public participation in conducting EAs is one of the core purposes of the Canadian Environmental Assessment Agency. Proponents are expected to understand and address the range of public concerns about a project. The Canadian Environmental Assessment Agency emphasizes that the public is not a single entity but comprised of varied interests (i.e., local residents, environmental groups, business owners), and requires that proponents provide "a variety of opportunities for consulting with interested parties." Canadian Environmental Assessment Agency Responsible Authorities (i.e., DFO and TC) are also free to request specific consultations to satisfy their requirements under the Act.

These requirements are broad and do not stipulate precisely how consultation should proceed. However, some general themes have developed in terms of expectations for EA consultations. Participants should be involved at all stages of the EA process, from issues scoping onward.

The first stage of the federal public consultation is scoping. Scoping means the area covered by a given activity or subject (http://dictionary.reference.com). In the CEAA (1992), the RA must ensure "public consultation with respect to the proposed scope of the project for the purposes of the environmental assessment, the factors proposed to be considered in its assessment, the proposed scope of those factors and the ability of the comprehensive study to address issues relating to the project." This involves the preparation of a scoping document by the RA that was posted on the CEAA registry website on June 6, 2005 for review by the public. The second phase of consultation occurs during the preparation of the CSR report. This phase of public consultation has been implemented through the holding of public open houses. These results are described subsequently. During this phase, government agencies (representing the public) with expertise on the Project or its potential implications are requested to make the information or knowledge available. This information is incorporated into the CSR. The third stage of review occurs after receipt by the RA of the CSR report. The public is informed of when and where the report is available for their review, and by when their comments must be filed.

The public must have enough time to digest information and prepare comments, but the process must stay within a reasonable time frame. Different techniques should be used to encourage the widest possible range of stakeholder participation. The public consultation program must be well planned and documented.

Regulators must be satisfied that the consultants preparing the EA have made a good faith effort to incorporate stakeholder information and public concerns into issue scoping, technical analysis, and conclusions.

14.3 GOALS

Effective public consultation for EAs should:

- ensure that issues are correctly identified and defined, and that matters of interest to the affected communities are adequately covered in the studies. This scoping is critical to the efficient completion of the EA;
- assist in judging the intensity of project benefits or impacts;
- ensure that the opinions of key stakeholders have been elicited;
- provide the EA team with accurate local information or expert opinions (i.e., regarding property values) not available through published sources; and
- fulfill regulatory requirements.

14.4 DEFINING STAKEHOLDERS, COMMUNITIES, AND PUBLICS

No one 'public' exists that can be consulted. Rather, different organizations and individuals will have different approaches to the project, whether based on geography, economic interests, and environmental or community planning concerns. The consultation approach must be framed to capture as many publics as possible. Many of these publics will also furnish technical material to the EA.

14.4.1 Communities

Geographically, communities affected by the project broadly fall into those in the immediate vicinity of the proposed plant and wharf, and those further along the coasts to either side. More specifically, they include:

- the communities on the shores of Country Harbour and Stormont Bay, including Drum Head, Goldboro, Isaac's Harbour, and Country Harbour;
- the communities on either side of Stormont Bay from Port Hilford through Port Bickerton to the west, and Coddles Harbour to Tor Bay to the east (in the Municipality of the District of Guysborough);
- the area around Erinville and Salmon River Lake (in the Municipality of the District of Guysborough);
- the area around Fraser Mills and Lower Springfield (in the Municipality of the County of Antigonish); and

14.4.2 Economic and Development Interests

Economic interests include:

- Guysborough County Regional Development Authority;
- Goldboro-Isaac's Harbour Community Development Authority;
- Guysborough County Inshore Fishermen's Association;
- Eastern Shore Fishermen's Protective Association;
- individual fishers and aquaculture interests in the Keltic Study Area;
- The Antigonish Area Partnership;
- Antigonish Chamber of Commerce; and
- Antigonish Regional Development Authority.

14.4.3 Environmental and Community Planning Concerns

Groups with environmental and community concerns, not necessarily based in the immediate area of the Project, are likely to include:

- Goldboro and Area Marine Protection Society;
- Ecology Action Centre, particularly their Coastal Issues and Marine committees;
- Canadian Parks and Wilderness Society, Nova Scotia Chapter;
- Nova Scotia Bird Society;
- The Aquaculture Association of Nova Scotia;
- Eastern Mainland Field Naturalists (based in Antigonish);
- The Sierra Club, Nova Scotia Chapter;

- Coastal Communities Network (based in Pictou); and
- Nova Scotia Salmon Association.

14.5 PUBLIC CONSULTATIONS

Keltic is a major Project, which, if built, will have substantial effects on many communities. Consultations were therefore extensive and inclusive. To date, several consultations have occurred. These consultations were designed to provide information about the proposed Project, respond to questions and concerns the public might have, and gather technical information and input into impacts, mitigation, and monitoring that could be incorporated into the EA.

14.5.1 Approaches to Public Consultation

Numerous approaches and techniques can be used in public consultation, ranging from hearings or public meetings, open houses, advisory committees, and workshops, to telephone surveys, focus groups, mail-back brochures, and web-based interactive surveys. The choice of method depends on a variety of factors, including:

- local culture;
- public knowledge and experience;
- the type of feedback needed for the EA;
- convenience and accessibility for stakeholders; and
- the magnitude of the project.

For this consultation process, a combination of public meetings and open houses supported by presentation material, Project information pamphlets, and questionnaires were used. In addition to general advertising in local newspapers such as the Casket (Antigonish) and the Guysborough Journal, direct contacts were made by the consulting team during the preparation of the EA. Large public open houses were held in targeted venues for both the general public and stakeholders. Also, small focus group meetings were held with a number of interests including:

- members of the GCIFA;
- individual fishermen and aquaculture interests in the Keltic Study Area.

14.5.2 Community Liaison Committee (CLC)

Keltic established a Community Liaison Committee (CLC) in August of 2004. The committee was set up by Keltic, voluntarily, to involve and inform local communities in the Project and will be the primary vehicle used for future consultations. The CLC has a two-fold mandate:

- to provide a forum for the representatives of the residents of Goldboro and surrounding communities to offer their input on the Keltic Project; and
- to provide a forum for representatives from Keltic to update the community, through the committee, on the various aspects of the Project.

Keltic held a number of open houses and asked attendees if they would be interested in sitting on the committee as a representative. A public meeting chaired by Councillor Derek Hayne was used to select committee members. The committee is structured as follows:

- Goldboro - 2 members;
- Isaac's Harbour – 2 members;
- Drum Head - 1 member;
- Coddles Harbour - 1 member;
- New Harbour - 1 member;
- Stormont - 1 member;
- African Nova Scotian Community - 1 member;
- Municipal Councillor - 1 member; and
- Keltic – 2 members.

14.5.3 Scoping Backgrounder

A scoping or Project backgrounder (Appendix 16) was prepared for the consultation process and was handed out during the open houses. The backgrounder included:

- definition of EA;
- Provincial and Federal requirements;
- a summary of the Project description; and
- a summary of the major environmental issues regarding the proposed plant site and socio-economic conditions.

14.5.4 Public Meetings on Issue Scoping

Scoping consultations needed to reach out to broader geographic publics in locations that are convenient for people to attend. A number of meetings were held by Keltic at the New Harbour School, prior to its closing during the summer of 2005. Meetings were generally themed to provide information about particular aspects of the Project. A meeting focused on socio-economic concerns and the consultation process on February 21, 2005 drew a crowd of over 400 people. Other venues used following closure of the New Harbour School included the Erinville Fire Hall, Antigonish Greenway Inn, and the Port Bickerton Community Centre.

14.5.4.1 New Harbour

A community information session was held at New Harbour School on April 11, 2005. This meeting was an information session to provide an overview of the community consultation process and the economic and social impact analysis process associated with the preparation of the EA. Kevin Dunn of Keltic, John Jozsa of Jozsa Management and Economics, and Norval

Collins, Joanne Cook and Tom Wilson of Communication, Environmental, and Fisheries (CEF) Consultants were present. Approximately 100 people attended this session.

Joanne Cook reviewed the public consultation plan, noting that although NSEL had finalized its Terms of Reference for the EA, the Canadian Environmental Assessment Agency had not yet finished its internal federal department issue scoping at the time. Most of the formal public consultation process that followed occurred after the draft federal scope was released.

John Jozsa reviewed how the socio-economic assessment would proceed, and the kinds of data needed.

Following the overview presentations, people in attendance were asked to brainstorm what questions they wanted answered with respect to the Project. The questions were grouped according to three major headings: Community (including infrastructure), Economic, and Environment. Most participants focused on local economic issues. The majority supported the Project, as long as there would be clear benefits for local communities. Only a handful of speakers raised negative concerns. The list of questions follows in Table 14.5-1. They are divided into two categories: questions more specific to community issues and questions directed at economic implications of the Project.

TABLE 14.5-1 Summary of Questions Asked at New Harbour Public Meeting

Category	Concern
Community	Will Highway 316 be fixed up? Will there be repairs before construction starts?
	What kind of consultation will there be with homeowners in the immediate area of the plant construction? Would consultation be one-on-one or with groups?
	Can you be more specific on the community benefits? For example, might we be able to keep the school open, or at least have Keltic use it so that the building is not destroyed?
	During plant operation what will the community health and safety issues be? What danger is there from explosions? What are the other dangers? What plans will there be to mitigate these dangers?
	Where will the off-ramp locations be on Highway 316?
	Will the workforce come from the local area or will they be brought in from the outside?
	What can be done to use the Project as a way to give people who have moved away the opportunity to move home?
	Will some people living in the area now choose to leave because of the plant?
	Does Keltic have a "community corporate citizenship" plan or policy?
Economic	What benefits will there be for people who live along Highway 316? Will people simply commute in from Antigonish?
	Are there any plans to rent or buy buildings and houses that are now for sale or vacant for use on the Project?
	Can you be more specific on the potential benefits for the community?
	Will there be a local hiring policy, one that gives preferential treatment to people from the immediate community?
	How much time will be available for training before construction starts?
	Will it be a unionized construction job-site?
	What will be the operating life of the plant? Are there expansion plans beyond initial construction?
	When will operations start and what will the employment levels be?
	How will people know what jobs will be available at the plant? How will they know what skills and education are required?
	How long will the jobs last?
	Will the plant be a union facility?

Category	Concern
Economic *(Continued)*	What will the impact be on the lobster fishery?
	What will be the impact on local retail and service businesses?
	Will there be impacts on land values? Will they lead to tax increases?
	Who will take the lead in training? Will it be Keltic, the Nova Scotia Community College, the unions, or will individuals be expected to figure it out themselves?
	What kind of spin off jobs will there be?

14.5.4.2 Erinville

A major requirement of the EA is to involve the public in order to address their concerns regarding the proposed Project and the scope of the EA, including identification of Environmental Components of Concern. These include aspects of the physical, biological, and social environment. The open house held in the Erinville Fire hall on Tuesday October 4, 2005, provided background information on the environmental setting (including the marine, terrestrial, and socio-economic components) and allowed attendees an opportunity to respond to a short survey.

Erinville was chosen due to its central location between Goldboro and Antigonish. 34 people attended this open house. Table 14.5-2 summarizes the main concerns highlighted during the open house and responses from Keltic. Survey results are summarized in Appendix 17.

Overall sentiment at this open house was supportive of the Project. However, people stated that they were getting tired of hearing the same things in meetings, and still not knowing how firm the prospects for development and employment opportunities were.

TABLE 14.5-2 Summary of the Major Concerns Raised at the Erinville Open House and the Responses to these Concerns from Keltic

Category	Concern	Response
Employment	What employment opportunities will be offered to local workers?	Local workers will be eligible to fill all positions for which they are qualified.
	Will locals be given notice as to what jobs will be available in order to train for them?	A full list of which jobs will be available has already been supplied to the community.
General	Will there be noise-pollution restrictions, such as prohibiting air braking in residential areas?	All provincial regulations will be followed.
	When will it be known if the Project is going to go ahead or not?	An LNG supplier is still being negotiated, and the EA process is still ongoing, but Keltic is committed to the completion of the Project.

14.5.4.3 Antigonish

This open house, held at the Antigonish Green Way Claymore Inn on Wednesday October 5, 2005, was a companion to the Erinville open house and provided background information on the environment and allowed attendees an opportunity to respond to a short survey.

Antigonish was chosen due to its prominence as a major population and service centre in the region. 16 people attended this open house. Table 14.5-3 summarizes the main concerns highlighted during the open house. Survey results are summarized in Appendix 17.

Overall sentiment at this open house was supportive of the Project, although again more definite answers about if and when construction will commence were sought. The questions and concerns focused primarily around the proposed road, employment, and safety.

TABLE 14.5-3 Summary of the Major Concerns Raised at the Antigonish Open House and the Responses to these Concerns from Keltic

Category	Concern	Response
Employment	How many post-construction jobs will there be?	There will be approximately 600 direct post-construction jobs.
	How can locals get these jobs? Will local workers be hired preferentially?	Qualified locals may apply for all jobs. Keltic is partnering with other companies for the operations of the plants, and will urge that qualified locals be given preferential treatment.
Safety	Will Goldboro be in danger in the event of an explosion?	Although a large amount of energy is stored in LNG, it cannot be released rapidly enough to cause the overpressures associated with an explosion.
General	Will the Bear Head LNG affect the chances of this Project being completed?	The Bear Head project does not affect the Keltic Project, as the US energy marketplace can accommodate large volumes of gas.
	What are the main reasons for the delays on the Project?	The EA must be approved, and a supply for the LNG must be secured.

14.5.4.4 Port Bickerton

This open house, held at the Port Bickerton Community Centre on Thursday, October 27, 2005, focused on the proposed Habitat Compensation Plan being presented by Keltic. Fisherman's Harbour has been proposed as a suitable compensation site for habitat lost due to construction of the Marginal Wharf in Goldboro. The intent of this session was to review the proposed Habitat Compensation Plan with fishers, answer questions, and gather input that could be used to refine the proposal. Port Bickerton was chosen due to its proximity to the Goldboro area and because it is a fishing community. Six people attended this open house, several of which actively fish in Stormont Bay. Table 14.5-4 summarizes the main concerns highlighted during this session.

Previous meetings that had been held with fishers who fished specifically within Stormont Bay focused on financial compensation in the event of accidents or disruption to traditional fishing practices within the bay. Concerns had focused on interference from large vessel traffic, loss of access to the marginal wharf area, and potential environmental damage from an accidental spill of hydrocarbons.

TABLE 14.5-4 Summary of Questions and Responses from Port Bickerton Open House on Proposed Keltic Habitat Compensation Project

Category	Concern	Response
Habitat Compensation	What do you do to improve habitat?	Rock is placed on the seafloor, creating crevices and encouraging algal growth. These conditions approximate natural lobster habitat.
	Have similar habitat compensation projects been done before?	Similar projects have been completed elsewhere in the Maritimes, but no studies have yet been completed to evaluate their effectiveness
	Have there been studies to support these types of compensation projects?	Studies are ongoing in several locations to evaluate similar projects, but none have as yet been completed.
	Why go ahead with this type of compensation when there are no study results supporting their effectiveness?	DFO requires habitat compensation, generally in the vicinity of the project. This project is seen as a viable opportunity to enhance lobster habitat in the area.
	Is the proposed Project area important for lobster at different times of the year?	The chosen site is not considered to be important for lobster productivity in its current state, but is seen as an ideal candidate site for enhancement.
	Should studies be undertaken to investigate year-round habitat use of proposed Project site?	Surveys of the site have occurred inside and outside of the lobster fishing season.
	Is the proposed compensation site the only location that was considered for this Project?	The proposed site is considered the most ideal location for habitat enhancement. Other sites, determined by input from fishers, may be considered.

14.5.5 Consultations Summary

Comments and questions received during the consultation process generally reflected regional economic concerns. For example, most issues raised at the Erinville consultation related to the proposed road alignment and job creation. The Antigonish open house focused more on the regional economic implications of the Project. At the Port Bickerton open house, the focus was the commercial lobster fishery and other marine related issues. The New Harbour open house attracted the most people, and therefore captured a greater variety of issues.

Input from the consultations was used to identify and refine VECs identified within the EA. Table 14.5-5 is a summary of the VECs (described in Section 7.2) that were captured during the public consultation process.

TABLE 14.5-5 Valued Ecosystem Components Identified during Public Consultation Process

Consultation Group	VECs Identified	
CLC	All VECs	
Antigonish	Quality of life Transportation Existing and planned land uses	Human health and safety Community resources
Erinville	Quality of life Existing and planned land uses Human health and safety	Transportation Acoustic environment Community resources
New Harbour	Human health and safety Existing and planned land uses Community resources Fish and fish habitat (marine)	Quality of life Transportation Commercial fisheries
Port Bickerton	Fish and fish habitat (marine) Commercial fisheries Human health and safety	Marine safety and security Navigation Quality of life
Mining Industry	Transportation (Orex requested that the road alignment be shifted to avoid possible land use conflicts)	

14.6 CONTINUED CONSULTATION

The CLC meets regularly with Keltic and will continue to be used as a sounding board for any issues (such as safety, environmental concerns, employment, etc.) that arise. In addition to the liaison committee, Keltic will continue to liaise with the Guysborough County Regional Development Authority and the Guysborough Journal as a means of communicating any information. Keltic will also liaise actively with local emergency service providers, such as RCMP, fire and emergency health response.

15.0 ASSESSMENT SUMMARY AND CONCLUSION

15.1 INTRODUCTION

Keltic proposes to construct and operate a Petrochemical and LNG Facility in Goldboro, Nova Scotia (the Project). The Project components, as described in Section 2.0, include a LNG regasification facility, a petrochemical complex, a marginal wharf, a marine LNG terminal, LNG storage and an electric co-generation facility; which, in total, will require approximately 300 hectares (ha) of land.

The marine terminal will allow the delivery of LNG and export of product. The co-generation plant will be fuelled by spent LNG with any remaining spent LNG injected into the existing M&NP pipeline in Goldboro. A freshwater supply system is required for the Project. This includes the construction of a reservoir at Meadow Lake, a wastewater collection and treatment system as well as other site infrastructure and maintenance facilities.

The purpose of the Project is to increase petrochemical production in North America. This will help to meet rising demand for polyethylene and polypropylene pellets and provide additional sources of natural gas to the Canadian and Northeastern US markets in an effort to meet the growing demands for natural gas. The petrochemical complex will convert liquids extracted from the SOEP at Goldboro combined with the liquids extracted from imported LNG to produce ethylene and propylene in order to manufacture polyethylene and polypropylene pellets. These pellets will be used to manufacture plastic products elsewhere in Canada and the US.

15.2 REGULATORY REQUIREMENTS

The Project is subject to a Class II EA under the EA Regulations made pursuant to the *Environment Act*, S.N.S. 1994-95, c.1 and Comprehensive Studies under the CEAA, S.C. 1992, c.37.

For this Project with respect to CEAA, two federal departments, TC and DFO have been designated as Responsible Authorities (RA) under CEAA as each department will need to issue an authorization for components of the Project.

EC, Natural Resources Canada (NRCan), and Health Canada have declared they can provide specialist or expert information and knowledge to support the comprehensive study process. In this role, the departments are working together with the Agency and the RAs to coordinate the federal response to the EA.

In addition, it is anticipated that the proposed dam to be constructed at Meadow Lake will also require approval under the NWPA Section 5 (1)(a). However, this component of the Project will be subject to a separate screening under the CEAA using the information provided in this EA.

As the Project is subject to both provincial and federal EAs, the province and the federal government have agreed to coordinate the processes to the extent possible by their respective legislations and processes. While the processes will be coordinated, the Proponent will receive an independent decision from the federal Minister of Environment and provincial Minister of

Environment and Labour as per each of their legislative mandates. Section 3.4 contains a list of the legislation relevant to the Project and notes where permits and approvals may be required.

15.3 IMPACT ASSESSMENT

The EA Report has been compiled in accordance with the Nova Scotia EA Regulations, the Project TOR, and Scoping Document (Appendix 1). In the context of Part IV of the *Nova Scotia Environment Act* and EA Regulations, the EA has described the effects of the Project on the environment whether positive or negative, on:

- air, water, and land;
- the layers of the atmosphere;
- organic and inorganic matter and living organisms;
- interacting systems that include components described above;
- socio-economic conditions, environmental health, physical and cultural heritage sites and related structures; and
- any change to the undertaking that may be caused by the environment.

The EA has also identified mitigative measures for these effects and predicted the significance of the remaining residual environmental effects. Residual impacts refer to those environmental effects predicted to remain after the application of mitigation outlined in this EA. The predicted residual effects have been considered for each Project phase (Construction, Operation, Decommissioning/post-decommissioning, and Unplanned Events). As per the criteria established in Section 7, the Significance of each residual adverse effect has been determined. The existing environment has been described in Section 8 and a detailed assessment of potential impacts is presented in Section 9.

15.4 MITIGATION

Mitigation for expected effects is detailed in Section 10 and summarized in Section 11.

15.5 RESIDUAL EFFECTS SUMMARY

Section 11 summarizes all residual effects, both positive and negative. It is important to note that although a significant residual effect may be determined for one individual criterion within a VEC, that the overall significance of effects on the VEC as a whole may still be not significant when the relative values of the different criteria are balanced against one another. Section 12 gives an overview of the relative value (benefits) of the Project versus the predicted impacts. The EA has determined that relatively few of the predicted residual effects on VEC criteria are Significant, with the following exceptions:

- Socio-economic effects – several significant benefits are expected in the local and regional economy. The over-all significance of predicted effects on the socio-economic environment will be major.

- Recreational Opportunities and Aesthetics – Project development will result in a significant change in the visual character of the site. However, due mainly to the small number of potential receptors, the over-all significance of predicted effects on recreational opportunities and aesthetics will be medium.

Accidental events can occur, potentially causing damage to the biophysical environment, as well as to effects on human health and safety. For the prediction of residual adverse environmental effects, it is acknowledged that, while the likelihood is low, the result can be Significant. As has been previously noted, Emergency Preparedness Planning has been integrated into all phases of Project design, planning, and execution. The objective is to perform well above the industry average, and to attain continuous improvement.

15.6 COMPLIANCE AND EFFECTS MONITORING

An Environmental Compliance Monitoring (ECM) program is undertaken for a project to ensure that appropriate regulations and company specifications are implemented during project development. Environmental Effects Monitoring (EEM) is used to assess the accuracy of any predictions made in the EA concerning potential effects. Most of the monitoring activities and mitigative measures to be employed for both the construction and operation of the various project components will be guided by the regulatory/policy regimes of the Nova Scotia and Federal government requirements and the Conditions of Approval. Anticipated compliance and monitoring follow-up requirements were evaluated for each VEC and Valued Socio-Economical Component as a function of their sensitivity to project-related environmental effects. The likelihood and importance of such effects, as well as the level of confidence associated with any adverse residual effects rating, were taken into consideration.

Compliance and monitoring initiatives are outlined in Section 13 including:

- Air Quality;
- Noise and Light;
- Surface Water;
- Groundwater and Water Well survey;
- Flora, Fauna, and Terrestrial Habitat;
- Inshore Fisheries;
- Freshwater Species and Habitat;
- Marine Species and Habitat;
- Archaeological Resources;
- Pre-blast Survey;
- Community Involvement;
- EPP; and
- Waste Management Plan.

Other monitoring requirements may be identified as part of the terms of the EA approval and permitting processes.

15.7 PUBLIC INVOLVMENT

Public consultation is a key component of an EA. It provides a means to integrate citizens into the environmental decision-making process and to provide proponents and regulators with the information they need for good decision-making. A liaison committee was established by Keltic early in the process to provide information to stakeholders and the public, and also to provide feedback from the local community about concerns and advice for consultations.

Section 14 describes the public information program for the Project. Numerous public information sessions were held in the local and regional area and a large amount of direct consultation has taken place with all levels of government and local interest groups.
Public stakeholders included local communities, economic and development interests, and Groups with environmental and community concerns, not necessarily based in the immediate area of the Project. Comments and questions received during the consultation process generally reflected regional economic concerns. For example, most issues raised at the Erinville consultation related to the proposed road alignment and job creation. The Antigonish open house focused more on the regional economic implications of the Project. At the Port Bickerton open house, the focus was the commercial lobster fishery and other marine related issues. The New Harbour open house attracted the most people, and therefore captured a greater variety of issues.

Keltic established a CLC in August of 2004. The committee was set up by Keltic, voluntarily, to involve and inform local communities in the Project and will be the primary vehicle used for future consultations. The CLC meets regularly with Keltic and will continue to be used as a sounding board for any issues (such as safety, environmental concerns, employment, etc.) that arise. In addition to the liaison committee, Keltic will continue to liaise with the Guysborough County Regional Development Authority and the Guysborough Journal as a means of communicating any information. Keltic will also liaise actively with local emergency service providers, such as RCMP, fire and emergency health response.

15.8 CONCLUSION

Through careful design and planning, combined with prudent application of proven mitigation measures, Keltic has identified and addressed all potential adverse environmental effects, and reduced the predicted adverse impacts to a low level of significance. The Project will also have important economic benefits both locally and regionally.

REFERENCES

Adams, J., and Atkinson, G. 2003. Development of seismic hazard maps for the proposed 2005 edition of the National Building Code of Canada; Can. J. Civ. Eng., v.30, p. 255-271.

Adams, J., and Halchuk, S. 2003. Fourth generation seismic hazard maps of Canada: Values for over 650 Canadian localities intended for the 2005 National Building Code of Canada, Geological Survey of Canada, Open File 4459, 155 p. (includes corrections made March 5, 2004 and May 15, 2003).

ANEI (Access Northeast Energy Inc.). 2004. Bear Head Liquefied Natural Gas Terminal Environmental Assessment.

Atlantic Canada Conservation Data Centre (ACCDC), 2004. Species location data – Public level.

Barrett, A.M., 1981. Isaac's Harbour Placers; NS Department of Natural Resources, Mines Branch Assessment Report ME-11F04D021-G-22(06).

Beanlands, G.E., and P. N. Duinker, 1983. An Ecological Framework for Environmental Impact Assessment in Canada. Published by: Institute for Resource and Environmental Studies, Dalhousie University and Federal Environmental Assessment Review Office, Hull, P.Q. p.7-2

Benson, D.G., 1970. Geology, Antigonish and Cape George (west halves); GSC Geo. Map 3-1970, from GSC Paper 70-8, scale 1:50,000.

Bent, A.L., 1995. A Complex Double-Couple Source Mechanism for the MS 7.2 1929 Grand Banks Earthquake; Bulletin of the Seismological Society of America, Vol. 85, No. 4, pp. 1003-1020, August 1995 .Boehner, R.C. and Giles P.S., 1982: Geological Map of the Antigonish Basin, Nova Scotia; NS Dept. of Mines and Energy Map 82-2, scale 1:50,000.

Bornhold, B., Rabinovich, A.B., Skvortsov, A., Fine, I.V., Kulikov, E.A., and Thomson, R.E., 2004. Landslide-generated tsunamis and their risk in coastal areas; Geo-Engineering for the Society and its Environment., 57th Canadian Geotechnical Conference and the 5th joint CGS-IAH Conference, Hilton Quebec Hotel, Old Quebec, October 24-27, 2004.

Boudreau, V., and Social Research for Sustainable Fisheries (SRSF), 2001. Fishing for a living: a profile of the Guysborough County inshore fisheries. Canso, NS. Internet publication: http://www.gcifa.ns.ca/Docs/fishing.doc.

Broders, H.G., G.M. Quinn, and G.J. Forbes. 2003. Species status, and the spatial and temporal patterns of activity of bats in southwest Nova Scotia, Canada. Northeast Naturalist 10 (4): 383-398.

Brodie, P.F., 1995. The Bay of Fundy/Gulf of Maine harbour porpoise (*Phocoena phocoena*): some consideration regarding species interactions, energetics, density dependence and bycatch. In Biology of phocoenids. Edited by A. Bjørge and G.P. Donovan. Rep. Int. Whaling Comm. Spec. Issue, 16: 181–187.

Cameron, R. 2004. A Second Location for the Rare Boreal Felt Lichen in Nova Scotia. Evansia 21(1): 40-42.

Campbell, D.C., Jenner, K.A., Piper, D.J.W., and Mosher, D.C., 2003. Risk of Large, Tsunami-Inducing Failures on the Scotian Margin; in Geological Society of America symposium, Geological Impacts of Extreme Events on Land and Sea (Storms, Floods, Climate Variability, Tsunamis), 1st Joint Meeting, Northeastern Section, GSA, and Atlantic Geoscience Society. Westin Hotel, Halifax, Nova Scotia, Canada. March 27-29, 2003.

Canadian Council of Ministers of the Environment, 1999. Canadian water quality guidelines for the protection of aquatic life: Dissolved oxygen (marine). In: Canadian environment quality guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg. Canadian Environmental Assessment Act, 1992. c. 37. Source: http://laws.justice.gc.ca/en/C-15.2/text.html

Canadian Environmental Assessment Agency (the Agency). 1994. Responsible Authorities Guide.

Canadian Environmental Assessment Agency (the Agency). 1996. A Guide on Biodiversity and Environmental Assessment. Minister of Supply and Services, Canada.

Canadian Environmental Assessment Agency, 1999. Cumulative Effects Assessment Practitioners Guide. Prepared by Canadian Environmental Assessment Working Group and AXYS Environmental Consulting Ltd.

Canadian Environmental Assessment Agency, 2006. Reference Guide: Determining Whether A Project is Likely to Cause Significant Adverse Environmental Effects. Federal Environmental Assessment Review Office. November 1994. http://www.ceaa-acee.gc.ca/013/0001/0008/Adverse-Environmental-Effects_e.pdf, Accessed January 27, 2006.

Canadian Environmental Assessment Agency. 1997. Guide to the Preparation of a Comprehensive Study: for Proponents and Responsible Authorities, Hull, Quebec.

Canadian Institute for Climate Studies, 2006. Canadian Climate Impacts and Scenarios project, Canadian Institute for Climate Studies, University of Victoria, http://www.cics.uvic.ca/scenarios/.Canadian Mortgage and Housing Corporation, 1981: “Road and Rail Noise: Effects on Housing”

Canmac Economics, 2004. Economic Sector Strategy for Colchester County.

Cann, D.B., and Hilchey, J.D., 1954. Soil survey of Antigonish County, Nova Scotia; Report 6, NS Soil Survey, Truro, NS, 54p. plus map, scale 1:63,360.

Church, Ambrose F., 1876. Topographical Township Map of Guysborough County, Nova Scotia.

Church, Ambrose F., 1879. Map of Antigonish. A.F. Church and Compnay, Halifax, NS

Clague, J.J., Munro, A., and Murty, T., 2003. Tsunami hazard and risk in Canada; Natural Hazards, 28 (2-3), p. 435-463.

Cobb, J.S., M. Clancy, and R.A. Wahle. 1999. Habitat-based assessment of lobster abundance: a case study of an oil spill. In: L.R. Benaka (ed.) Fish habitat: Essential fish habitat and rehabilitation - Proceedings of the Sea Grant symposium on fish habitat, Hartford, CT 26-27 Aug. 1998. Am. Fish. Soc. Symp. 22: 285-298.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC), 2003. COSEWIC assessment and update status report on the harbour porpoise, Phocoena phocoena, (Northwest Atlantic population) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa: 30p. http://www.sararegistry.gc.ca/status/status_e.cfm. Last accessed January, 2006.

Conservation and Recovery of Nova Scotia's Species at Risk, Municipal and Community Stewardship (C & RNSSR). Undated. Species at Risk in Nova Scotia, Boreal Felt Lichen (Erioderma pedicullatum). Web site:http://www.speciesatrisk.ca/municipalities/sar_borealflt.htm.

Cook, Findlay, 1976. History and Stories of Isaac's Harbour and Goldboro. Formac Limited, Antigonish.

Cooperative Institute for Marine and Atmospheric Studies (CIMAS), 2006. Introduction to Ocean Gyres. Website: http://oceancurrents.rsmas.miami.edu/ocean-gyres.html

Corey, M.C., 1992. Mineralogical investigations along the Upper Seal Harbour Anticline, Goldboro, Nova Scotia: NS Dept. of Natural Resources Mines Branch Open File Report 92-009.

COSEWIC, 2005. Web Site. COSEWIC Species Database.

David, J.A., 2006. Likely Sensitivity of bottlenose dolphins to pile driving noise. Water and Environment Journal. Volume 20, March 2006. ISSN 1747-6585

Davis, A., Kellman, L., Ruseski, G., Williams, J., Cameron, C., Mitchell, S., Edwards, C., and Spencer, D., 2000. St. Georges Bay Ecosystem Project (GBEP): Research Report I. Document prepared by the Interdisciplinary Studies in Aquatic Resources, St. Francis

Xavier University, Antigonish, Nova Scotia for Fisheries and Oceans Canada, Can. Manuscr. Rep. Fish Aquat. Sci. 2511, iv + 293p + Appendices.

Department of Fisheries and Oceans (DFO), 1995. Freshwater Intake End-of-Pipe Fish Screen Guideline. DFO / 5080, Cataloque No. Fs23-270 / 2004E-HTML.

DFO, 2000. Nova Scotia Green Sea Urchin. DFO Science Stock Status Report C3-48. 2000.

DFO, 2001. Catch and Effort Database 1994-2000, Commercial Data Division. Department of Fisheries and Oceans, Maritime Region.

DFO, 2004. Eastern Shore Lobster (LFAs 31A, 31B, 32). DFO Science Stock Status Report 2004/033.

DFO, 2005. Catch and Effort Database 2000-2003, Commercial Data Division.

EC, 2005c. Species at Risk Act (SARA) website: http://www.speciesatrisk.gc.ca/map/default_e.cfm

EC, Atlantic Climate Centre, 2005a. Climate of Nova Scotia.

EC, Atlantic Climate Centre, 2005b. Canadian Climate Normals or Averages 1971 -2000.

Energy Information Administration. 2006. Official Energy Statistics from the U.S. Government. Report #:DOE/EIA-0484(2006). http://www.eia.doe.gov/oiaf/ieo/nat_gas.html .

Environment Canada (EC), 2003. National Pollutant Release Inventory (NPRI). Website: http://www.ec.gc.ca/pdb/npri/

Erskine, A. J., 1992. Atlas of Breeding Birds of the Maritime Provinces. Numbus Publishing Limited and the Nova Scotia Museum, Halifax, N.S.

ExxonMobil, 2006. http://www.soep.com/cgi-bin/getpage?pageid=1/5/0&dpa=1/6/0/2.

Fancy, W.F., 1911. Cross-Section of the Hurricane Point Mine, Isaac's Harbour Gold District, Guysborough, Nova Scotia; NS Department of Natural Resources Mines Branch Open File Illustration ME 1911-3.

Faribault, E.R., 1899. Plan and section, Upper Seal Harbour, Guysborough Co., Nova Scotia; GSC Map 656, scale 1:6,000.

Faribault, E.R., 1904. Plan and sections, Isaacs Harbour Gold District, Guysborough Co., Nova Scotia; GSC Map 832, scale 1:6,000.

Farmer, A. M., 1993. The Effects of Dust on Vegetation – A Review. Environ-poll. 79:63-75.

Ferris, R., 1979. Effects of interstate 95 on breeding birds in northern Maine. J. Wildl Manage. 43(2): 421-427.

Finea, I.V., Rabinovich, A.B., Bornhold, B.D., Thomson, R.E., and Kulikov, E.A., 2005. The Grand Banks landslide-generated tsunami of November 18, 1929: preliminary analysis and numerical modeling; Marine Geology, 215(1-2), p. 45-57.

Fletcher, H., and Faribault, E.R., 1891. Province of Nova Scotia: Map Sheet No 11 SW (Part of Guysborough County Sheet); GSC Map 378, scale 1:253,440.

Fletcher, H., and Faribault, E.R., 1893a. Province of Nova Scotia, Guysborough County: Map sheet No. 25 (New Harbour Sheet); GSC Map 379, scale 1:63,360.

Fletcher, H., and Faribault, E.R., 1893b. Province of Nova Scotia, Guysborough County: Map sheet No. 27 (Isaac's Harbour Sheet); GSC Map 381, scale 1:63,360.

Fletcher, H., and Faribault, E.R., 1893c. Province of Nova Scotia, Guysborough County: Map sheet No. 29 (Sherbrooke Sheet); GSC Map 383, scale 1:63,360.

Fletcher, H., and Faribault, E.R., 1893d. Province of Nova Scotia, Guysborough County: Map sheet No. 30 (Country Harbour Sheet); GSC Map 384, scale 1:63,360.

Freeze, R.A. and Cherry, J.A., 1979. Groundwater; Prentice Hall Inc., 604p.

Gaskin, D. E., 1992. Status of the Harbour Porpoise, Phocoena phocoena, in Canada. Can. Field-Nat. 106(1): 36–54.

GCIFA. 2005. Core Fishers by Port. Internet publication: http://www.gcifa.ns.ca/.Haitjema, H.M. And Mitchell_Bruker, S., 2005: Are Water Tables a Subdued Replica of the Topography; Ground Water, Vol. 43, No. 6, p. 781-786.

Geological Survey of Canada (GSC), 1904. Plan and Sections: Isaac's Harbour Gold District,Guysborough County, Nova Scotia.

Gibb, J.E. and McMullin, K.A., 1980. Regional water resources, Pictou County, Nova Scotia; NS Dept. of Environment, 81p.

Gilhen,John, 1974. The Fishes of Nova Scotia's Lakes and Streams Halifax, Nova Scotia,1974. 49pp. Card covers. Numerous Illustrations by Donald Pentz.

Greater Halifax Partnership, 2003. http://www.greaterhalifax.com/en/home/default.aspx

GSC, 1985. Aeromagnetic Total Field and Vertical Gradient Maps, Country Harbour, Nova Scotia; Geological Survey of Canada published maps C20357G and C40098G, scale 1:50,000.

GSC, 2003. Earthquakes in Southeastern Canada; Geologic Survey of Canada web page http://www.seismo.nrcan.gc.ca/historic_eq/eastcan_e.php, last modified 2003-02-06.

GSC, 2005. The Magnitude 7.2 1929 Grand Banks earthquake and tsunami: Geologic Survey of Canada web page http://www.seismo.nrcan.gc.ca/damage/1929/1929_e.php, last modified 2005-01-10.

Guysborough County Inshore Fisherman's Association, (GCIFA), 2001. History. Internet publication: http://www.gcifa.ns.ca/historypage.htm

Halifax-Moncton Growth Corridor, 2003. Halifax-Moncton Growth Corridor Asset Mapping - Baseline Research Project.

Hammer, D. A., 1997. Creating Freshwater Wetlands, Second Edition. CRC Press, Boca Raton, Florida.

Hanson, A.R., and Calkins, L., 1996. Wetlands of the Maritime Provinces: Revised Documentation for the Wetlands Inventory, Technical Report NO. 267. Canadian Wildlife Service, Atlantic Region,

Harding, G.C., 1992. American Lobster (*Homarus americanus* Milne Edwards): a discussion paper on their environmental requirements and the known anthropogenic effects on their populations. Can J. Fish. Aquatic. Sci.,1887.

Hart, H. C., 1975. History of the County of Guysborough, Nova Scotia. Mika Publishing Company, Ontario.

Heidebrecht, A.C., 2003. Overview of seismic provisions for the proposed 2005 edition of the National Building Code of Canada; Can. J. Civ. Eng., v. 30, p. 241-254.

Hilchey, J.D., Cann, D.B., and MacDougall, J.I., 1969. Soil Survey of Guysborough County, Nova Scotia; Canada Dept. of Agriculture and Nova Scotia Dept. of Agriculture and Marketing, Nova Scotia Soil Survey Report No. 14, 55 p.

Hill, J.D., 1991. Petrology, Tectonic Setting, and Economic Potential of Devonian Peraluminous Granitoid Plutons in the Canso and Forest Hill Areas, Eastern Meguma Terrain, Nova Scotia; GSC Bulletin 383, map scale 1:50,000.

HNF, 2003. Newfoundland and Labrador Heritage, Memorial University of Newfoundland; http://www.heritage.nf.ca/environment/c_flooding.html#plate9

Hooker, S. K., Whitehead, H., and Gowans, S., 1999. Marine protected area design and the spatial and temporal distribution of cetaceans in a submarine canyon. Conservation Biology 13(3):592–602.

Hopper, D.B., Bonner, F.J., Fisher, B.E. And Murphy, A.N., 2000a. Mineral Resource Land-use Map of the Country Harbour Area (11F/4); NS Dept of Natural Resources, Mineral Resources Branch Open File Map ME 2000-4 (11F/4), version 2, scale 1:50,000.

Hopper, D.B., Bonner, F.J., Fisher, B.E. And Murphy, A.N., 2000b. Mineral Resource Land-use Map of the Guysborough Area (11F/5); NS Dept of Natural Resources, Mineral Resources Branch Open File Map ME 2000-4 (11F/5), version 2, scale 1:50,000.

Hopper, D.B., Bonner, F.J., Fisher, B.E. And Murphy, A.N., 2000c. Mineral Resource Land-use Map of the Antigonish Area (11F/12); NS Dept of Natural Resources, Mineral Resources Branch Open File Map ME 2000-4 (11F/12), version 2, scale 1:50,000.

Hunt, Thomas Skerry, 1868. The Gold Region of Nova Scotia. Hunter, Rose and Company, Ottawa.

Industry Canada, 2005. Community Demographics, Goldboro Nova Scotia. Online at http://broadband.gc.ca/demographic_servlet/community_demographics/1633.

Institute of Petroleum, 2003a. Human Factors no2 Briefing Notes – Alarm Handling

Institute of Petroleum, 2003b. Human Factors no4 Briefing Notes – Maintenance Error

Institute of Petroleum, 2003c. Human Factors no8 Briefing Notes – Ergonomics

Interior Waste Authority, 1994: Metropolitan Toronto/York Region Landfill Site Search, Detailed Assessment of the Proposed Site V4A, Appendix B, Biology Discipline.

Irving, E., 1980. Continental Drift Since the Devonian; unpublished charts, Earth Physics Branch, Dept. of Energy, Mines and Resources, Ottawa, Canada

Johnston, D.W. and Haines, T.P., 1957. Analysis of mass bird mortality in October 1954. Ank, 74: 447 – 458.

Jost, A.C., no date. Guysborough Sketches and Essays. Kentville Publishing Company, Kentville.

Kellman, D.A.L., Ruseski, G., Williams, J., Cameron, C., Mitchell, S., Edwards, C., and Spencer, D., 2000. St. Georges Bay Ecosystem Project (GBEP): Research Report I. Document Prepared by the Interdisciplinary Studies in Aquatic Resources, St. Francis Xavier University, Antigonish, Nova Scotia for Fisheries and Oceans Canada, can. Manuscr. Rep. Fish Aquatic Sci. 2511, iv + 293 p + Appendices.

Keltic Petrochemicals Inc., 2002. Environmental Impact Assessment, Proposed Petrochemical Facility at Goldboro, Guysboro County, Nova Scotia; Interim Report, February 2002.

Kenney, R. D., 1994. Appendix 2: Distribution Charts of Marine Mammals on the Scotian Shelf, 1966 through 1992. In: Reeves, R.R., and Brown, M.W. 1994. Marine mammals and the Canadian patrol frigate shock trials: A literature review and recommendations for mitigating impacts. East Coast Ecosystems Research Organization. Prepared for National Defence Headquarters, Ottawa. pp. 45–46 and passim.

Keppie, J.D., 1976. Structural Model for the Saddle Reef and Associated Gold Veins in the Meguma Group, Nova Scotia; Nova Scotia Dept. of Mines Paper 76-1, 34 p.

Keppie, J.D., 1977. Tectonics of Southern Nova Scotia; Nova Scotia Dept. of Mines Paper 77-1, 34 p.

Keppie, J.D., 1979. Geological Map of the Province of Nova Scotia; Dept. of Mines and Energy, scale 1:500,000.

Keppie, J.D., 2000. Geological Map of the Province of Nova Scotia; NS Dept. of Natural Resources, Minerals and Energy Branch Map ME 2000-1, scale 1:500,000.

Klein, D. Jr., 1990. Collisions between birds and windows: mortality and prevention. J. Field Ornithology 61 (1): 120 – 128.

Labour Force Historical Review, 2002. Publication #71F0004XCB.

Layers of Protection Analysis, 2001. AIChE, publication 2001

Leonard, M., Boyne, A., and Boates, S., 2004. Status and Management of Roseate Terns (Sterna dougallii) in Nova Scotia, 42 (2): 253-262.

Liam Finn, W.D., and Wightman, A., 2003. Ground motion amplification factors for the proposed 2005 edition of the National Building Code of Canada; Can. J. Civ. Eng., v. 30, p. 272-278.

Loucks, O. L., 1960. A forest classification for the Maritime Provinces. Proc. Nova Scotia Inst. Sci. 25: 85-167.

Lucas, Z., and Hooker, S., 2000. Cetacean Strandings on Sable Island, Nova Scotia, 1970-1998. Can. Field-Nat. 114: 45-61.

MacArthur, R.H. and J.W. MacArthur. 1961. On bird species diversity. Ecology 47:1074

MacArthur, R.H. and Wilson, E.D., 1967. The Theory of Island Biogeography. Princeton University Press, Princeton, NJ

MacGillivray, C. J., 1935. Timothy Hierlihy and His Times: The Story of the Founder of Antigonish, N. S. A paper read before the Nova Scotia Historical Society, November 12, 1935.

MacLaren Plansearch, 1996. Environment Impact Statement, Sable Offshore Energy Project (SOEP).

Mak, J., 2004. Power and LPG Production with LNG Import” 2nd Annual Atlantic Canada Power Summit, November 2004, Saint John, New Brunswick Canada.

Mak, J., 2005. “Mixed Fluid Power Rankine Cycle using LNG as Heat Sink with LPG Extraction, AIChE 2005 Spring Meeting, LNG I – Plant & Operation, April 10-14.

Malcolm, W., 1912. Gold Fields of Nova Scotia. Geological Survey of Canada. Queen’s Printer, Ottawa.

McAllister, D. E., Craig, J., Davidson, R., Delany, N., and Sneddon, M., 2001. Biodiversity Impacts of Large Dams, Background paperNo. 1, Prepared for IUCN/UNEP/WCD.

Meteorological Service of Canada, 2000. Canadian Climate Normals (1951-1980). Internet Publication: http://www.msc-smc.ec.gc.ca/weather/contents_e.html.

Methow, 2005. Methow Transmission Project, Mitigation. DEIS

Miller, R.J. 1997. Spatial differences in the productivity of American lobster in Nova Scotia. Can. J. Fish. Aquat. Sci./J. can. sci. halieut. aquat. 54(7): 1613-1618 (1997)

Murty, T.S., Nirupama, N., Nistor, I. and Rao, A.D., 2005a. Conceptual Differences Between the Pacific, Atlantic and Arctic Tsunami Warning Systems for Canada; Science of Tsunami Hazards, Vol. 23, No. 3, page 39.

Murty, T.S., Nistor, I., Hamdi, S. and Nurupama, N., 2005b. Numerical modelling for the tsunami warning system for Atlantic Canada; Proceedings of the 12th Canadian Coastal Conference, Dartmouth, Nova Scotia, November 6-9, 2005.

National Energy Board, 2005. Short-term Outlook for Natural Gas and Natural Gas Liquids to 2006, October 2005

National Geophysical Data Center. (http://www.ngdc.noaa.gov/seg/hazard/tsevsrch_idb.shtml)

National Oceanographic and Atmospheric Association, 1994. Review of American lobster (*Homarus americanus*) habitat requirements and responses to contaminant exposures: 1-52

National Petroleum Council (United States), 2003. Balancing Natural Gas Policy – Fueling the Demands of a Growing Economy, September 2003

New Mexico Department of Game and Fish, Conservation Services Division, 2003. Bridge and Road Construction Guidelines for Wetland and Riparian Areas.

Newbury, M.C., 1974. Report on the Property of the Nova Scotia Syndicate, Guysborough County, Nova Scotia; NS Dept. of Natural Resources Mines Branch Assessment Report 11F04D-21-G 54(07).

Nexant Chem Systems, 2004. Outlook for Polyolefins May 2004

Niven, L., Brown, N., and Richardson, A., 2001. Redhead Archaeology.

Nova Scotia Department of Agriculture and Fisheries (NSDAF), 2001a. Angling Regulations. Internet publication: http;//www.gov.ns.ca/nsaf/sportfishing/angling/.

Nova Scotia Department of Energy (NSDE), 2001. Nova Scotia's Energy Strategy Report Volume 1: Seizing the Opportunity;

Nova Scotia Department of Finance (NSDF), 2004. Overview of the Nova Scotia Economy: 1991 – 2003, October, 2004."

Nova Scotia Department of Natural Resources, Nova Scotia, 1999. Wetlands Database Specifications (DRAFT)

Nova Scotia Department of the Environment, 1980. Nova Scotia Watershed Areas; NS Dept. of Environment Watershed Map sheets 11F/4 & 11C/13, 11F/5 and 11F/12, scale 1:50,000.

Nova Scotia Department of the Environment, 1988. Erosion and Sedimentation Control Handbook for Construction Sites. Halifax, NS.

Nova Scotia Department of the Environment, 1991. "Guideline for Environmental Noise Measurement and Assessment."

Nova Scotia Department of the Environment, 1995. Environment Act. 1994-95, c. 1, s. 1 An Act to Reform the Environmental Laws of the Province and to Encourage and Promote the Protection, Enhancement and Prudent Use of the Environment.

Nova Scotia Department of the Environment, 1995. Guidelines for Development on Slates in Nova Scotia.

Nova Scotia Department of the Environment, 1995. Sulphide Bearing Materials Disposal Regulations.

Nova Scotia Department of the Environment, 1997. Nova Scotia Watercourse Alteration Specifications.

Nova Scotia Department of Transportation and Public Works (NSTPW), Undated. Unpublished traffic data.

Nova Scotia Museum of Natural History (NSMNH), 1996a. The Natural History of Nova Scotia, Vol. 1, Topics And Habitats. Davis, D.S and S. Brown (editors). Nimbus/Government of Nova Scotia, Halifax, N.S.

NSDAF, 2001b. Aquaculture site mapping for the Nova Scotia Department of Agriculture and Fisheries – Aquaculture Division. Internet publication: http;//www.nsgc.gov.ns.ca/fishaqua/provinceAllSpecies.htm

NSDAF, 2001c. Inland Fish Division. Statistical Summaries, Nova Scotia and Guysborough County. Pictou, NS.

Nova Scotia Department of Energy (NSDE), 2005. NSDOE LNG Code of Practice for Liquefied Natural Gas Facilities. Version 1, July 13, 2005.

NSDF, 2006. "Community Counts" http://www.gov.ns.ca/finance/communitycounts/

NSDNR, 2002. Forest Cover Type Mapping.

NSDNR, 2004. General Status Ranks of Wild Species in Nova Scotia.

NSDNR, 2005. Web site. Natural Resources – Significant Habitats of Nova Scotia. http://www.gov.ns.ca/natr/wildlife/Thp/disclaim.htm

NSDTPW, Undated. Unpublished data for Average 2005 Counter Group Factors

NSEL, 2005. Terms of Reference, As Required by the Environment Act For Preparation of an Environmental Assessment Report. Proponent: Keltic Petrochemical Inc.; Project: Petrochemical Plant and LNG Facilities, Goldboro, NS.

NSMNH, 1996b. The Natural History of Nova Scotia, Vol. 2, Theme Regions. Davis, D.S. and S. Brown (editors). Nimbus/Government of Nova Scotia, Halifax, N.S.

NSMNH, 2001. Excavations at the Webb Family Cemetery, Goldboro, Guysborough County, Nova Scotia. MS on file.

NSTPW. 1998. Upgrading Requirements of the Highway Infrastructure Directly Impacted by the Offshore Gas Industry, The Needs and Programs Group, Nova Scotia Department of Transportation and Public Works, April 1998 (Table 2).

Ornithological Council, 1999. Deadly Spires in the Night: the impact of communication towers on migratory birds. Bird Issues Brief, Vol. 1, No. 8, pp. 1-5.

Parsons, M.B. and Percival, J.B. 2005. A Brief History of Mercury and its Environmental Impact; in Mercury: Sources, Measurements, Cycles and Effects, Mineralogical Association of Canada Short Course Series Vol. 34, p 1-20.

Parsons, M.G., Smith, P.K., Goodwin, T.A., Hall, G.E.M., Sangster, A.L., and Percival, J.B., 2004. Distribution, Cycling, and Fate of Mercury and Associated Elements at Historical Lode Gold Mines in Nova Scotia, Canada. In Proceedings of the 7th International Conference on Mercury as a Global Pollutant (M. Horvat, N. Ogrinc, J. Faganeli, and J. Kotnic, eds.) RMZ – Materials and the geoenrironment 51, 185-189 (Abstr.).

Porter, R.J. 1982. Regional Water Resources, Southwestern Nova Scotia; NS Dept. of Environment, 87p.

Pronych, G. and Wilson, A.A. 1993. Rare Plants of Nova Scotia. 2 vols. Nova Scotia Museum. Halifax. 331 pp.

Public Archives of Nova Scotia (PANS), Undated. MG 100 Vol. 168. Notes on the History of Isaac's Harbour.

Rankin, Rev. D. J. 1929. A History of the County of Antigonish, Nova Scotia. The MacMillan Company of Canada Limited, Toronto.

Richardson, W.J., Greene Jr. C.R., Malme, C.I., Thompson, D.H. 1995. Marine Mammals and Noise. Academic Press, San Diego.

Roland, A.E. 1982. Geological Background and Physiography of Nova Scotia; The Nova Scotian Institute of Science; Ford Publishing Co., Halifax, N.S., 311 p.

Rowe, J. S. 1972. Forest Regions of Canada. Department of Environment, Canadian Forestry Service, Publication 1300, Information Canada, Ottawa.

Rudloff, Willy 1981. World Climates with Tables of Climatic Data and Practical Suggestions. Books of the Journal Naturwissenschaftiche Rundschau, Edited by Prof. Wolfgang Holl, Munchen, Wissenschftliche Verslagsgelellschaft mbH, Stuttgart.

Ruffman, A. 1991. A Compilation of Eastern Canadian Historic Tsunamis; Atlantic Geology, Issue 27(2), p. 161-162.

Ruffman, A. 1995. Earthquakes and Tsunamis of Eastern Canada: Cause for Concern?; Atlantic Geology, 31 (1), p. 58.

Ruffman, A. and Tuttle, M.P., 2005. Tsunamis of Eastern Canada and New England: the primary historical record; Proceedings of the 12th Canadian Coastal Conference, Dartmouth, Nova Scotia, November 6-9, 2005.Salt Institute, 2004: Highway Salt and our Environment. Alexandria, Virginia.

Ruffman, A., 1994. The November 18, 1929 Tidal Wave': Canada's Most Tragic Earthquake; Atlantic Geology, 30 (2), p, 157-158.

Ruffman, A., 2001. The November 18, 1929 offshore earthquake, slump and tsunami: Canada's most tragic historic seismic event; Geological Association of Canada - Mineralogical Association of Canada 2001 Joint Annual Meeting, Memorial University, St. John's, Newfoundland, May 27-30 2001.

Sable Gas Projects. 1997. The Joint Public Review Panel Review. Canadian Environmental Assessment Agency, Nova Scotia Department of Environment, National Energy Board, Natural Resources Canada, Nova Scotia Department of Natural Resources, Canada-Nova Scotia Offshore Petroleum Board.

Salt Institute, 2004. Highway Salt and our Environment. Alexandria, Virginia.

Scanlon, P. F., 1987. Heavy metals in roadside environments: implication for food chains. Science Total Environ. 59: 317-323.

Schiller, E, 1961. Geology, Guysborough, Nova Scotia; GSC Preliminary Map 27-1961, scale 1:63,360.

Scott and Stewart, Forestry Consultants Ltd, 2003. Letter to B. Mattie re: timber evaluation on Keltic Site, April 8, 2003.

Scott, W.B., and Crossman, E.J., 1973. Freshwater Fishes of Canada. Fisheries Research Board of Canada, Environment Canada, Ottawa.

Scott, W.B., and Scott, M.G., 1988. Atlantic fishes of Canada. University of Toronto Press. 731

Seabright Resources Inc., 1984. Gold tailings, 1984, Volume 1; NS Dept. of Natural Resources Mines Branch Assessment Report 85-031.

Shaw, J., Taylor, R.B. and Forbes, D.L., 1993. Impact of the Holocene transgression on the Atlantic coastline of Nova Scotia. Geographie physique et Quaternaire, 47, p221-238.

Statistics Canada website. 2001. Community Profiles (for Antigonish and Goldboro Counties), http://www40.statcan.ca/l01/cst01/, site accessed July 28, 2006

Statistics Canada, 2003. Provincial Gross Domestic Product by Industry 1984 to 2002, Publication #15-203.

Statutes of Nova Scotia, 1898. Chapter 97.

Stea, R.R., and Fowler, J.H., 1979a. Pleistocene Geology, Eastern Shore Region, Nova Scotia; N.S. Dept. of Mines Paper 79-4, accompanied by Map Sheet 1, scale 1:100,000.

Stea, R.R., and Fowler, J.H., 1979b. Pleistocene Geology, Eastern Shore Region, Nova Scotia; N.S. Dept. of Mines Paper 79-4, accompanied by Map Sheet 2, scale 1:100,000.

Stea, R.R., Boyd, R., Fader, G.B.J., Courtney, R.C., Scott, D.B., and Pecore.S.S., 1994. Morphology and seismic stratigraphy of the inner continental shelf off Nova Scotia, Canada: evidence for a -65 m lowstand between 11,650 and 11,250 C14 yr BP. Marine Geol. 117, p.135-154.

Stea, R.R., Conley, H., and Brown, Y., 1992. Surficial Geology of the Province of Nova Scotia, Nova Scotia Dept. of Natural Resources, Mines and Energy Branches Map 92-3, scale 1:500,000.

Stevenson, I.M., 1959. Geology, Chedabucto Bay, Guysborough and Richmond Counties, Nova Scotia; GSC Preliminary Map 3-1959, scale 1:63,360.

Stevenson, I.M., 1964. Geology, Chedabucto Bay, Nova Scotia; GSC Map 1156A, scale 1:63,360.

Stewart, D. T., Perry, N. D., and L. Fumagalli, 2002. The Maritime Shrew, Sorex maritimensis (Insectivora: soricidae): A Newly Recognized Canadian Endemic. Can. J. Zod. 80: 94-99.

Sutcliffe, W., and Brodie, P., 1977. Whale Distribution in Nova Scotia Waters. Fish. Mar. Serv. Tech. Rep. 722: 83p.

Taylor, F.C., and Schiller, F.A., 1966. Metamorphism of the Meguma Group of Nova Scotia; Canadian Journal of Earth Sciences, v. 3, p. 959-974.

Tilsley, J.E., 1988. Lotus Resources Ltd., Isaac's Harbour Property, Goldboro, Guysborough County, Nova Scotia; NS Dept. of Natural Resources Mines Branch Assessment Report 89-090.

Tilsley, J.E., 1996a. Isaac's Harbour Properties, Isaac's Harbour, Guysborough County, Nova Scotia; report prepared 20 February 1996 for Groundstar Resources Ltd., NS Dept. of Natural Resources Mines Branch Assessment Report 96-109, 16p. plus illustrations and appendix.

Tilsley, J.E., 1996b. Exploration of Isaac's Harbour Properties, Isaac's Harbour, Guysborough County, Nova Scotia; Report Prepared 17 July 1996 for Groundstar Resources Ltd., NS Dept. of Natural Resources Mines Branch Assessment Report 96-110, 34 p. plus illustrations and appendix.

Transport Canada and Fisheries and Oceans Canada. 2005. *Canadian Environmental Assessment Act* - Scoping Document for the Petrochemical and Liquefied Natural Gas Facilities at Gldboro, Nova Scotia. May 2005.

Transportation Association of Canada, 1998. Manual of Uniform Traffic Control Devices for Canada.

Transportation Association of Canada, 1999. Geometric Design Guide for Canadian Roads.

United States Environmental Protection Agency (USEPA), 1985. "Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations) (Revised)." EPA Publication No. EPA-450/4-80-023R, 1985.

US Department of Energy. 2006. Annual Energy Outlook 2006 with Projections to 2030. Report Number: DOE/EIA-0383(2006). February 2006

USEPA, 2002. User's Guide for the AMS/EPA Regulatory Model – AERMOD. Office of Air Quality Planning and Standards, Emissions, Monitoring, and Analysis Division, Research Triangle Park, North Carolina, August 2002.

USEPA, 2004. "Guideline on Air Quality Models," Appendix W to Part 51, Title 42 of the Code of Federal Regulations (42CFR51), December 29, 2004.

USEPA, 2005. "Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources," 5th Edition, AP-42, 2005.

Vaughan, J.G. and Somers, G.H., 1980. Regional Water Resources, Cumberland County, Nova Scotia; NS Dept. of Environment, 81p.

Walsh, Dr. Patrick F, 1989. The History of Antigonish. Scotia Design Publications, Antigonish.

Warner, B.G., and Rubec, C.D.A., (editors), 1997. The Canadian Wetland Classification System, Second Edition, Wetlands Research Centre, University of Waterloo, Waterloo, Ontario

Wright, D.G., and Hopky, G.E., 1998. Guidelines for the use of explosives in or near Canadian Fisheries Waters. Can. Tech. Rep. Fish. Aquat. Sci. 2107: iv + 34p.

Zinck, M. C., 1998. Flora of Nova Scotia, Volumes 1 and 2. Nova Scotia Museum, Halifax, N.S.

PERSONNEL COMMUNICATIONS

Contact Name	Organization	Date Contacted
Avery, Kim	Guysborough County Heritage Association.	2006
Boyne, Andrew	Canadian Wildlife Service	
Cleary, Gary	Municipality of the County of Guysborough	2006
Eagles, Michael	Fisheries and Oceans Canada:	2001
Forbes, Dr. Graham	University of New Brunswick	
Hayne, Derek	Municipality of the District of Guysborough.	2006
Hayne, Lynn, 2006..	Guysborough County Heritage Association.	2006
Mitchell, Bruce	Mercator Geological Services Ltd.	2006
O'Neil,		2005
Parsons		2005
Ross, Theodore	NSDEL, Public Safety. Program Administration Officer	2006
Seymour, N.	St. Francis Xavier University	
Smith, Paul		2001
Smith,		2005
Torrey, D	Municipality of the County of Guysborough	2006
	NSDNR	