4.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

4.1 DESCRIPTION OF THE BIOPHYSICAL ENVIRONMENT

Information provided in this section was derived from the broader biophysical description provided in Keltic's provincial EA (NSEL Environmental Assessment Branch website (http://www.gov.ns.ca/enla/ea/kelticpetro.asp) and studies conducted for other developments within the proposed project site (i.e., SOEP, and Deep Panuke Offshore Gas Development Project). Figure 4.1-1 depicts the interrelation of the Deep Panuke Study Area and this Project's Study Area.

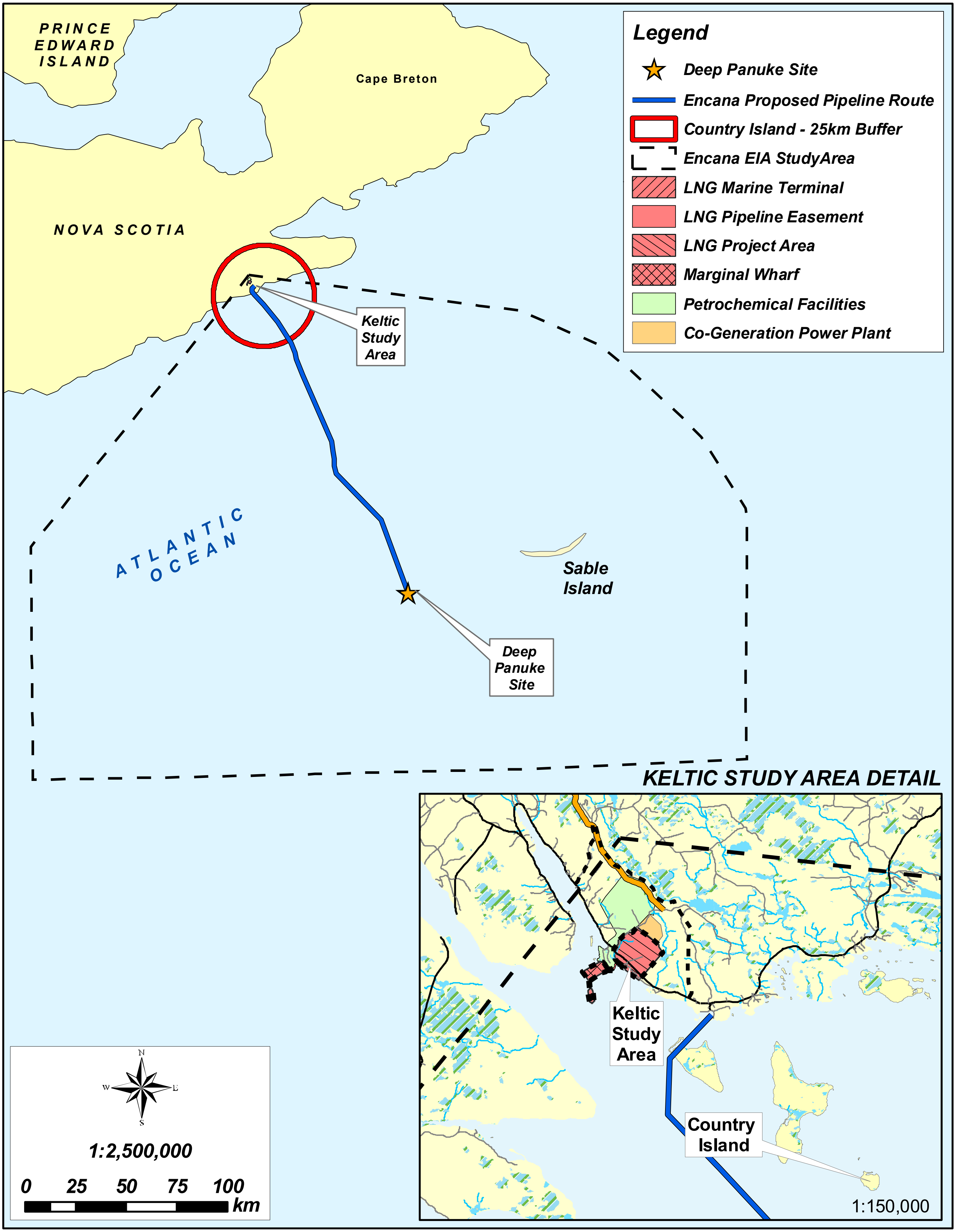
This section focuses, to the extent possible, on the elements of the Project within the scope of this CSR namely the LNG Facilities; the marginal wharf; and marine environment within 25 km of Country Island. Some of the data is more sub-regional in scope and applies to the complete Project including the LNG facilities and marginal wharf. Where this is the case it is noted accordingly. Information in this section is a synthesis of the results of approximately two years of field data collection; observations; and research with special attention being paid to the possible presence of rare or otherwise unique species, populations, and assemblages. Data collection and research was conducted by discipline specialists, who in addition to their own knowledge of their respective fields, also relied on others with specific expertise and local knowledge. These experts included:

- Mark Pulsifer, Regional Biologist, NSDNR, Antigonish;
- Randy Lauff, Dr. Barry Taylor, and Dr. Norman Seymour, St. Francis Xavier University, Antigonish;
- Dr. Graham Forbes, University of New Brunswick;
- Andrew Boyne, Canadian Wildlife Service (CWS), Dartmouth;
- Dr. Hugh Broders, St. Mary's University;
- Dr. Alan Hanson, CWS, Sackville, New Brunswick;
- Andrew Hebda, Alex Wilson, and John Gilhen, Nova Scotia Museum of Natural History (NSMNH), Halifax;
- Richard Hatch and Fulton Lavender, knowledgeable birders and naturalists in general, Halifax;
- Richard Morash, NSDNR Resources, Truro; and
- Frank Manthorne, Joey Manthorne, and Brian Fanning, knowledgeable and observant local residents of Seal Harbour and Drum Head.

Specific citations have been made at appropriate places in the following text.

4.1.1 Hydrology

The proposed Keltic Project will require approximately 1,200 m^3/hr of water to operate the plants. This water will be supplied from surrounding three main watersheds and associated sub-watersheds.



amec

June 2007
Drawn by S. Turner
Projection: NAD83 CSRS UTM Zone 20N
Job No.: TV61029

Figure 4.1-1
KELTIC PETROCHEMICALS INC.
Keltic Study Area in Relation to the Deep Panuke Study Area
JUNE 2007

Hydrological studies were originally conducted for the purpose of the Provincial EA Report (AMEC, 2006) and included all Project components as well as the petrochemical and co-generation facilities. Therefore the information presented below provides some reference to all watersheds when applicable to the entire KDP but attempts to focus on the coastal watershed (1EP-SD1 and 1EQ-SD32) as it pertains to the LNG Facility (Figure 4.1-2).

Table 4.1-1 presents a summary of basic known and assumed water uses for these waterbodies. In addition to the natural waterbodies listed in Table 4.1-1, within the marginal wharf area, the second pond south of the lane way to the existing home on the peninsula is a dug pond that was once utilized by cattle.

TABLE 4.1-1 Known, Assumed, and Possible Water Uses of Waterbodies in the Project Area

Water Body	Past Uses						Current Uses					
	Commercial Fishing	Recreational Fishing	Other Recreation	Mining	Drinking Supply	Industrial (Other)	Commercial Fishing	Recreational Fishing	Other Recreation	Mining	Drinking Supply	Industrial (Other)
Dung Cove		x		x				x				
Red Head Ponds												
Betty's Cove Brook		x						x				
Unnamed tributary to Dung Cove				x		x						

Note: Industrial (other) implies use for logging or as energy to run small mills.

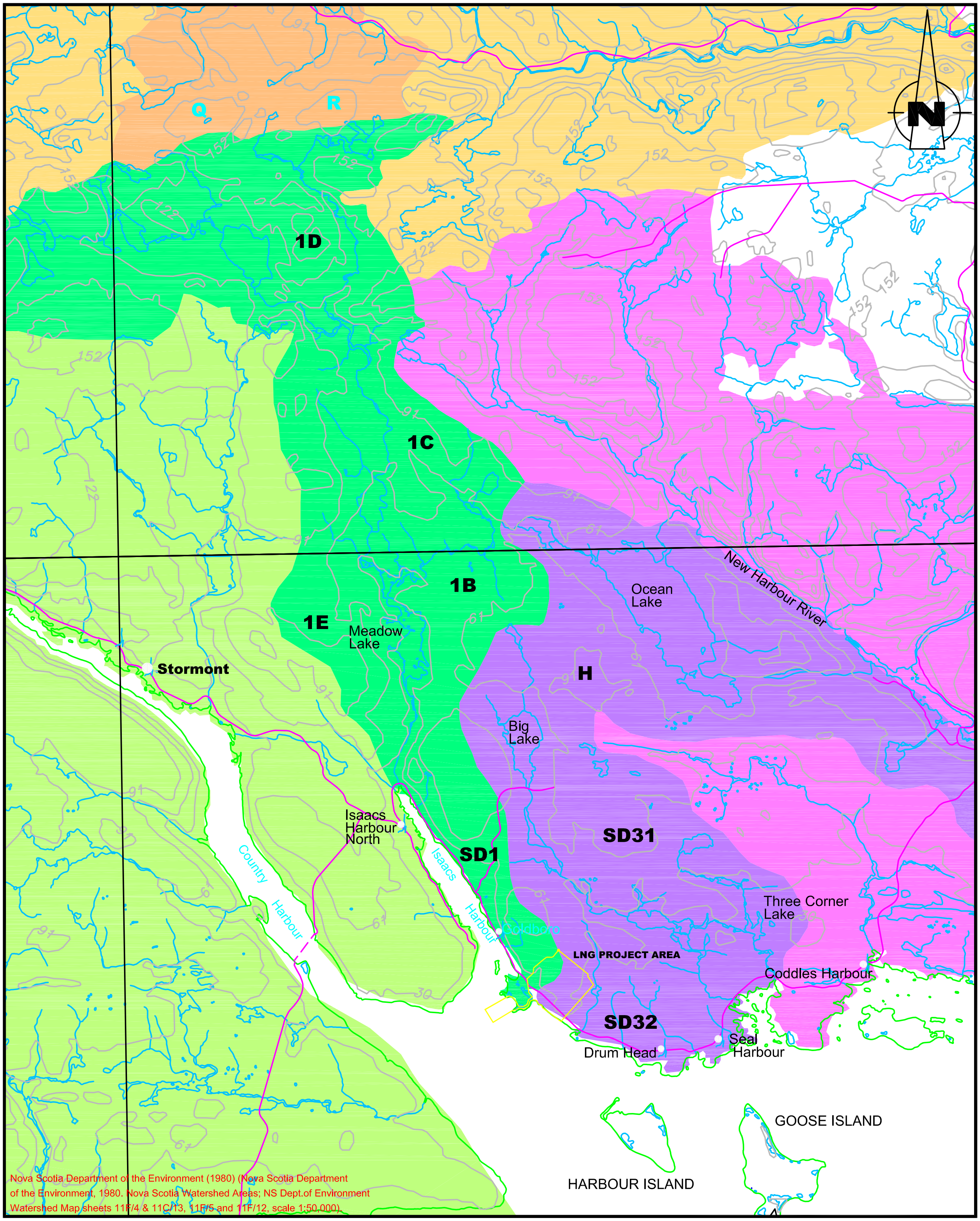
4.1.1.1 Stream Flow Data

The nearest two established hydrological stations on the Eastern Shore are on Little Sackville River in Middle Sackville, and on St. Mary's River at Stillwater. Rain gauges were installed in Goldboro and at Salmon River Lake and four hydrometric stations (GB1, GB2, GB3, and ML1) were installed at the locations shown in Figure 4.1-3. Data was collected for a period of 20 months from October 1, 2001 to May 23, 2003. A description of the data, corrections applied, station calibration and other details of the hydrologic assessments of the Gold Brook sub-watershed are provided in Appendix 3 of the Provincial EA Report (AMEC, 2006).

Stream-flow data collected from the study-area hydrometric stations is presented in Tables 4.1-2 to 4.1-6.

TABLE 4.1-2 Statistics of 2002 Flows (m^3/hr) for ML1, GB1, and GB2

Station	Total Outflow	Mean	Mode	Minimum	25^{th} Percentile	Median	75^{th} Percentile	Maximum
ML1	118,752,483	13,895	11,033	156	3,262	10,286	20,176	79,755
GB1	3,712,699	424	196	37	187	279	490	10,445
GB2	23,098,767	2,637	1,139	216	1,177	2,136	3,258	10,850



LEGEND

Road	1EP
River/Streams	1EQ–4
Contours	LNG Project Area
1EQ–1	

FIGURE No. 4.1-2

KELTIC PETROCHEMICALS INC.

KELTIC STUDY AREA WATERSHEDS

JUNE 2007

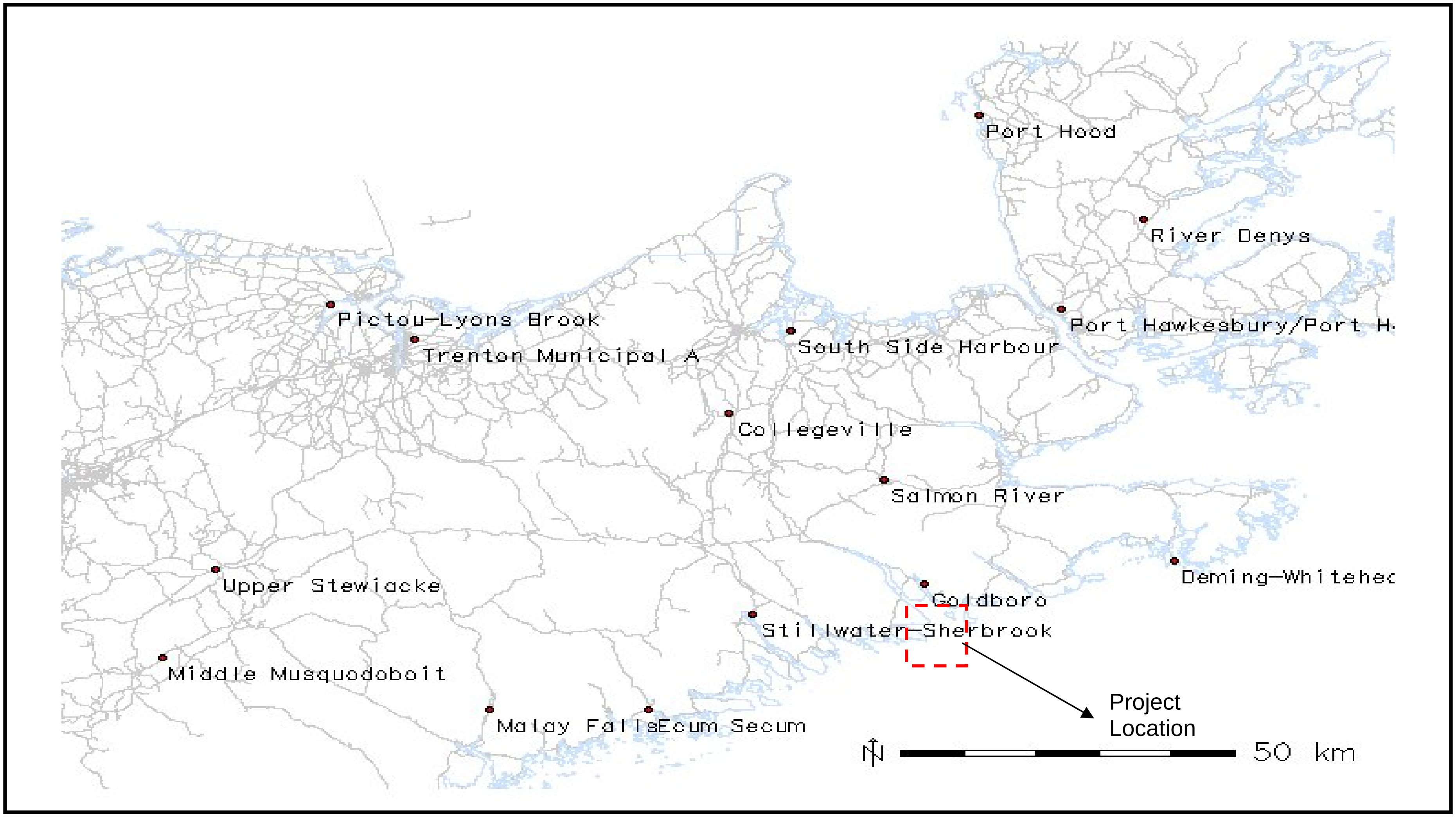


FIGURE 4.1-3
KELTIC PETROCHEMICALS INC.
LOCATION OF THE STUDY RAIN GAUGES AND ENVIRONMENT CANADA CLIMATE STATIONS
JUNE 2007
Source: ewC (2005)

TABLE 4.1-3 Monthly Summary Statistics of Flow Values for ML1, October 2001 to May 2003 (m^3/hr)

Month	Mean	Mode	Minimum	Median	Maximum
October 2001	2,038	295	233	1,285	12,075
November 2001	4,274	917	698	3,508	13,961
December 2001	11,445	10,189	1,597	10,078	34,043
January 2002	14,117	16,291	2,475	12,907	45,360
February 2002	16,550	3,679	2,651	18,455	54,126
March 2002	32,783	18,123	9,167	34,171	79,755
April 2002	27,282	20,736	8,401	23,348	64,959
May 2002	13,473	11,406	3,174	12,152	30,812
June 2002	1,353	552	156	1,027	4,582
July 2002	3,905	2,533	1,225	2,683	12,899
August 2002	5,297	1,027	705	1,601	34,357
September 2002	3,560	3,537	323	2,840	13,272
October 2002	11,588	5,575	2,461	9,540	36,783
November 2002	26,021	11,033	6,724	19,430	61,414
December 2002	16,572	7,868	5,443	15,511	37,529
January 2003	6,699	6,129	2,320	4,817	25,401
February 2003	20,274	5,575	4,817	17,004	56,562
March 2003	15,708	12,899	3,632	12,152	78,394
April 2003	20,746	5,575	3,352	10,846	65,705
May 2003	11,186	12,152	1,357	12,339	27,640

TABLE 4.1-4 Monthly Summary Statistics of Flow Values (m^3/hr) for GB1 (October 2001 to May 2003)

Month	Mean	Mode	Minimum	Median	Maximum
October 2001	278	235	132	235	1,195
November 2001	383	302	246	315	913
December 2001	452	235	215	368	1,531
January 2002	528	235	215	441	2,238
February 2002	836	279	246	490	10,445
March 2002	638	279	37	382	5,887
April 2002	607	659	179	474	4,710
May 2002	362	215	187	302	790
June 2002	253	162	126	215	701
July 2002	261	196	106	225	618
August 2002	173	126	50	119	1,164
September 2002	179	50	43	126	723
October 2002	330	154	119	225	2,192
November 2002	640	279	162	382	4,867
December 2002	320	196	154	235	1,019
January 2003	239	179	95	162	1,226
February 2003	578	279	132	327	3,637
March 2003	560	196	89	246	6,839
April 2003	149	79	46	119	1,047
May 2003	111	65	22	106	279

TABLE 4.1-5 Monthly Summary Statistics of Flow Values (m^3/hr) for GB2 (October 2001 to May 2003)

Month	Mean	Mode	Minimum	Median	Maximum
October 2001	704	283	260	604	1,745
November 2001	1,009	566	530	943	1,769
December 2001	1,752	2,164	656	1,672	4,113
January 2002	2,168	2,000	740	1,895	5,427
February 2002	2,345	994	784	2,404	6,610
March 2002	5,161	6,873	1,488	5,033	10,324
April 2002	4,119	2,667	1,139	3,456	10,225
May 2002	2,119	1,625	617	1,895	4,770
June 2002	948	1,065	441	960	2,601
July 2002	2,167	2,277	861	2,164	3,488
August 2002	1,642	579	316	994	6,150
September 2002	1,261	316	216	1,083	3,423
October 2002	2,625	2,000	1,139	2,306	5,657
November 2002	4,609	1,973	1,555	3,390	10,850
December 2002	2,464	1,158	1,065	2,404	4,836
January 2003	1,128	1,236	484	994	3,225
February 2003	3,251	960	799	2,601	9,272
March 2003	2,004	894	670	1,745	11,507
April 2003	4,981	2,930	1,870	3,439	11,934
May 2003	3,283	3,488	815	3,521	5,789

TABLE 4.1-6 Monthly Summary Statistics of Flow Values (m^3/hr) for GB3 (October 2001 to March 2002)

Month	Mean	Mode	Minimum	Median	Maximum
October 2001	1,190	849	481	1,068	3,375
November 2001	1,331	810	771	1,192	2,735
December 2001	2,061	2,185	810	2,033	4,620
January 2002	2,589	2,970	870	2,690	5,385
February 2002	3,785	1,324	1,117	3,875	16,206
March 2002*	5,147	4,053	2,345	4,753	9,339

4.1.1.2 Stream-Flow Amounts Greater than Total Precipitation Catchment

Total monthly precipitation for the period October 2001 to May 2003 for the nearest three EC climate stations located at Collegeville, Deming, and Sherbrooke, and the two study rainfall gauges at Goldboro and Salmon River Lake, are presented in Table 4.1-7.

TABLE 4.1-7 Total Monthly Precipitation (millimetre (mm)) for October 2001 to May 2003

Date	Deming	Sherbrooke	Goldboro	Collegeville	Salmon River
Oct-01	99	53	36	69	-
Nov-01	124	84	89	80	99
Dec-01	118	90	122	64	101
Jan-02	131	102	174	106	94
Feb-02	158	146	148	75	108
Mar-02	179	87	247	78	60
Apr-02	191	62	230	52	-
May-02	100	89	117	55	-
Jun-02	100	71	104	92	14
Jul-02	129	103	-	81	25
Aug-02	104	61	-	44	34

Date	Deming	Sherbrooke	Goldboro	Collegeville	Salmon River
Sep-02	119	123	-	107	5
Oct-02	178	155	67*	127	77*
Nov-02	235	254*	305	150	-
Dec-02	98	101*	93	98	-
Jan-03	144	128	83	40	-
Feb-03	131	206	135	52	40*
Mar-03	88	92	110	131	142
Apr-03	206	127	197	104	102
May-03	96	98	105	79	65

* indicates a month for which the full month of data is not available.

4.1.1.3 Drought and Flood Frequency Forecasting

Drought frequency analyses were performed on total summer (June, July, plus August) precipitation values for the three nearest EC stations (Collegeville, Deming-Whitehead, and Stillwater-Sherbrooke) to determine the limiting factor to the proposed water withdrawal. Results are summarized in Table 4.1-8. Storm frequency analysis for 100, 200, and 500 year storms was done for 24, 48, and 72 hour precipitation events for the EC climate stations at Collegeville, Deming-Whitehead, and Stillwater-Sherbrooke. The EC data used for the Tables in question include, Collegeville: 01 June 1916 to 31 May 2003, Deming-Whitehead: 01 December 1883 to 31 May 2003 and Stillwater-Sherbrooke: 01 December 1915 to 31 May 2003. The data for Deming-Whitehead represents the entire period of record available for the two individual climate stations located at Deming and at Whitehead, the data for these two stations was combined to expand the period of record for the general area of the stations. EC ceased to collect data at one climate station and at roughly the same time began to collect data at the other, with a bit of overlap in the data collection periods between the two stations. Where there was overlap in the data, a simple mean of the data from both stations was employed. This new, greater period of data was used in calculations (R. Gagne pers.comm.., May 2007). The results are summarized in Tables 4.1-9 to 4.1-11. The typical precipitation event to hydrograph peak delays (i.e., storm response times) for the Gold Brook system is shown in Table 4.1-12.

TABLE 4.1-8 Summer (June, July, August) Drought Estimates (mm)

Station Name	50-year	100-year	200-year	500-year
Collegeville	110-115	85-95	65-77	25-55
Deming-Whitehead	100	70-75	37-50	0-15
Stillwater-Sherbrooke	120	85-92	53-70	15-28

TABLE 4.1-9 100-year Storm Events (mm)

Station Name	24-hour Event	48-hour Event	72-hour Event
Collegeville	150-204	176-240	180-250
Deming-Whitehead	135	170	185-188
Stillwater-Sherbrooke	145-150	185-192	208-213

TABLE 4.1-10 200- year Storm Events (mm)

Station Name	24-hour Event	48-hour Event	72-hour Event
Collegeville	164-212	186-258	196-270
Deming-Whitehead	138-142	179-185	194-202
Stillwater-Sherbrooke	155-162	200-210	222-230

TABLE 4.1-11 500-year Storm Events (mm)

Station Name	24-hour Event	48-hour Event	72-hour Event
Collegeville	184-220	204-280	210-300
Deming-Whitehead	144-153	191-204	208-220
Stillwater-Sherbrooke	171-179	220-230	242-251

TABLE 4.1-12 Typical Event-to-Peak Delay (time in hours) between Precipitation Events and Stream-flow Peak on Hydrographs

Station Name	Fall	Winter	Spring	Summer
GB1	6 – 18	24 - 48	6 – 12	6
GB2	48	48 – 72	24 - 36	36 – 48
GB3	18 - 42	24 - 48	24	-

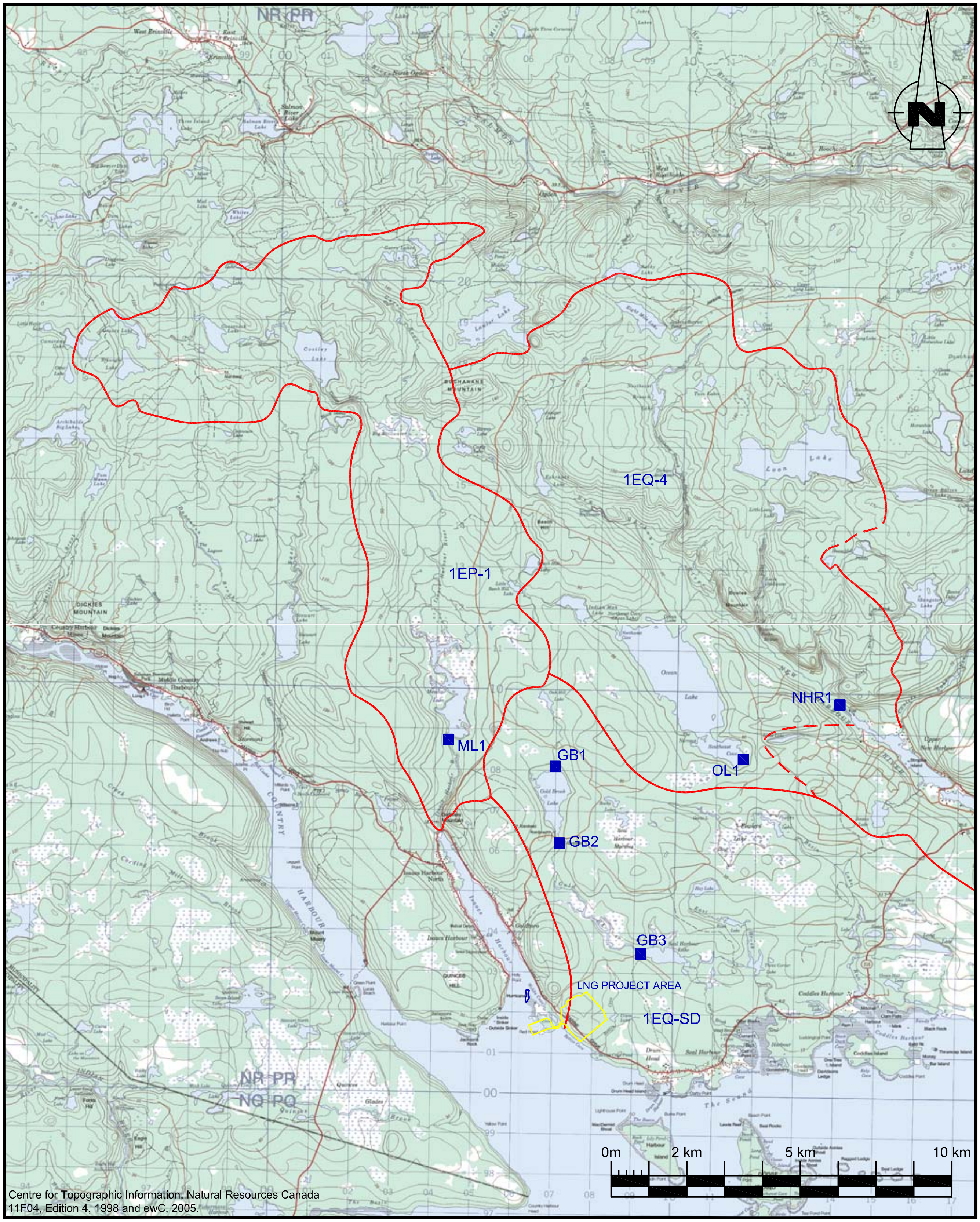
4.1.2 Freshwater Quality

As part of the aquatic-biology surveys completed in the Keltic Project Study Area during 2001, 2004, and 2005, evaluation of selected water quality parameters were undertaken (Figure 4.1-4). In 2005, key aquatic features were again surveyed. Basic water quality parameters measured during these surveys included temperature, dissolved oxygen (DO), pH, conductivity, and salinity where applicable.

Lab analyses included general chemistry, dissolved metals, and, for some samples, mercury. All parameters were determined with the use of a Yellow Springs Instrument 650 Multi Parameter Display System that was calibrated daily with the use of standard and accepted methods. Lab analyses used the following protocol:

- General chemistry samples collected in 200 millilitre (ml) polyethylene bottles with no preservatives.
- Dissolved metals samples field filtered to 0.45 micrometre (µm) using millipore Luer-Lok filters attached to a new (sterile) 60 ml syringe for each water sample. Raw water was used to rinse the syringe twice before attaching the filter. Filtered samples were placed into 50 ml polyethylene bottles, to which nitric acid was added for sample preservation.
- Mercury samples were collected by syringe and then transferred into 100 ml amber glass bottles with Teflon-lined cap; potassium dichromate in nitric acid was added as a preservative before sample collection. Each bottle was filled to zero head space but not allowed to overflow so as to not lose preservative.

Samples were immediately stored in coolers with ice packs until delivery to Maxxam Analytics Inc. in Bedford, Nova Scotia. Maximum sample storage time was seven days. Samples were analyzed using the lab protocol summarized in Table 4.1-13.



LEGEND

Project Location

GB1 Hydrometric Station Locations

FIGURE No. 4.1-4

KELTIC PETROCHEMICALS INC.

WATERSHEDS STUDIED

JUNE 2007

TABLE 4.1-13 Lab Analytical Protocol Used for Surface and Groundwater Sample Analyses

Analysis	Maxxam Laboratory Method	Method Reference
Alkalinity	2015-1-2	Based on EPA* 310.2
Chloride	2045-1-2	Based on SM4500-Cl-
Colour	2156-1-1	Based on EPA 110.2
Conductance – water	1013-1-2	Based on SM2510B
TEH in Water (Atlantic Partnership in Risk-based Corrective Action (RBCA) implementation (PIRI))	9025-1-5	Based on Atl. PIRI
Mercury (Total)	3425-1-2	C V A A
Metals in water ICP-OES	3120-2-1	Based on EPA 200.7
Elements by ICPMS - dissolved (FIAS)	3013-1-1	Based on EPA 6020A
Nitrogen Ammonia - water	2105-1-2	Based on USEPA 350.1
Nitrogen - Nitrate + Nitrite	2115-1-2	Based on EPA 353.1
Nitrogen – Nitrite	2125-1-1	Based on USEPA 354.1
Nitrogen - Nitrate (as N)	SOP 2130-1-1	Based on ASTMD3867
pH	1007-1-1/1011-1-2	Based on USEPA150.1
Phosphorus – ortho	2165-1-1	Based on USEPA 365.1
VPH in Water (PIRI)	9120-1-5	Based on Atlantic PIRI
Reactive Silica	2185-1-1	Based on USEPA 366.0
Sulphate	4065-1-2	Based on USEPA 375.4
Organic Carbon – Total	2020-1-3	Based on SM 5310C
Mod Total Petroleum Hydrocarbons (T1) Calc. for Water	--	Based on Atlantic PIRI
Turbidity	1040-2-4	based on USEPA 180.1
VOCs in Water	9615-1-3	Based on USEPA624

Note: *EPA – Environmental Protection Agency

A summary of water quality results collected during the on-site water sampling surveys is presented in Table 4.1-14. A summary of the lab analytical results is presented in the Provincial EA Report (AMEC 2006).

TABLE 4.1-14 Water Chemistry in Red Head Ponds

Location	Survey Dates	Temperature (°C)	Conductivity µS/cm[1]	Dissolved Oxygen (mg/L[2])	pH	Salinity (ppt[3])
Pond 1	Spring, 2005 0606793 E 5002155 N	19.69	85.0	9.44	6.35	0.04
Pond 2	Spring, 2005 0606799 E 5002068 N	19.32	27.0	8.65	6.14	0.01
Pond 3	Spring, 2005 0606618 E 5001904 N	22.41	2326.0	9.05	7.50	1.20
Pond 4	Spring, 2005 0606814 E 5001577 N	16.59	38880.0	10.03	8.46	24.83
Pond 5	Spring, 2005 0606952 E 5001553 N	18.75	25120.0	9.34	7.43	15.32
Pond 6	Spring, 2005 0606932 E 5001957 N	14.93	75.0	8.36	6.49	0.03

Notes:
1. µS/cm – microseimen per centimetre.
2. mg/L - milligrams per litre.
3. ppt – parts per thousand.

4.1.2.1 Red Head Ponds

Ponds 1, 2, and 6 are fresh-water; Pond 3 is slightly brackish; and Ponds 4 and 5 are saline (Table 4.1-14; Figure 4.1-5). Pond 6 is the only one which has input from a freshwater stream. All parameters in all ponds are within ranges considered normal although pH levels were higher than in other Keltic Study Area waters and were generally close to neutral. All ponds support at least one species of fish.

4.1.2.2 Betty's Cove Brook and Other Surface Samples

All parameters in Betty's Cove Brook and other surface samples were within normal ranges for the area with low values for pH and elevated levels of colour and aluminum.

It should be noted that Betty's Cove Brook originates within a wet forested area north of the proposed Project boundaries. Although the other "surface water" samples summarized in Table 4.1-15 are not "true" spring or stream samples, they are representative of these wet area sources – with general chemistries similar to that from Betty's Cove Brook.

4.1.3 Groundwater Quality/Quantity

Groundwater has a dynamic relationship with surface water, and provides a potable water supply to all of the un-serviced residences adjacent to the proposed Keltic Project Site. Obtaining a proper understanding of groundwater also requires having a clear understanding of the soil and bedrock through which it flows. Soil and sediment quality is discussed in Section 4.1.5 of this report.

A description of the hydrogeology within the LNG Facility Site was documented by conducting:

- a review of all available published maps and reports;
- reconnaissance-level and detailed geologic assessments of the hydrogeologic areas;
- monitoring well installations, slug hydraulic testing and groundwater sampling to help characterize the hydrogeology and to provide baseline groundwater quality data;
- a reconnaissance-level survey of all homes and wells present within 1 km of the proposed Keltic Project Site; and
- a door-to-door well survey with water sampling within 1 km of the proposed Keltic Project Site boundaries to further assess the hydrogeology of the area and to provide baseline information.

Reconnaissance-level geologic assessments of the greater Keltic Project Site were also done by a geoscientist during the periods May 31 to June 6, 2004 and June 24-25, 2004. Due to the industrial nature of the site, more detailed field mapping of specific areas, monitoring well installations, hydraulic testing at those wells, and groundwater sampling were carried out during the period from April 4 to May 3, 2005.

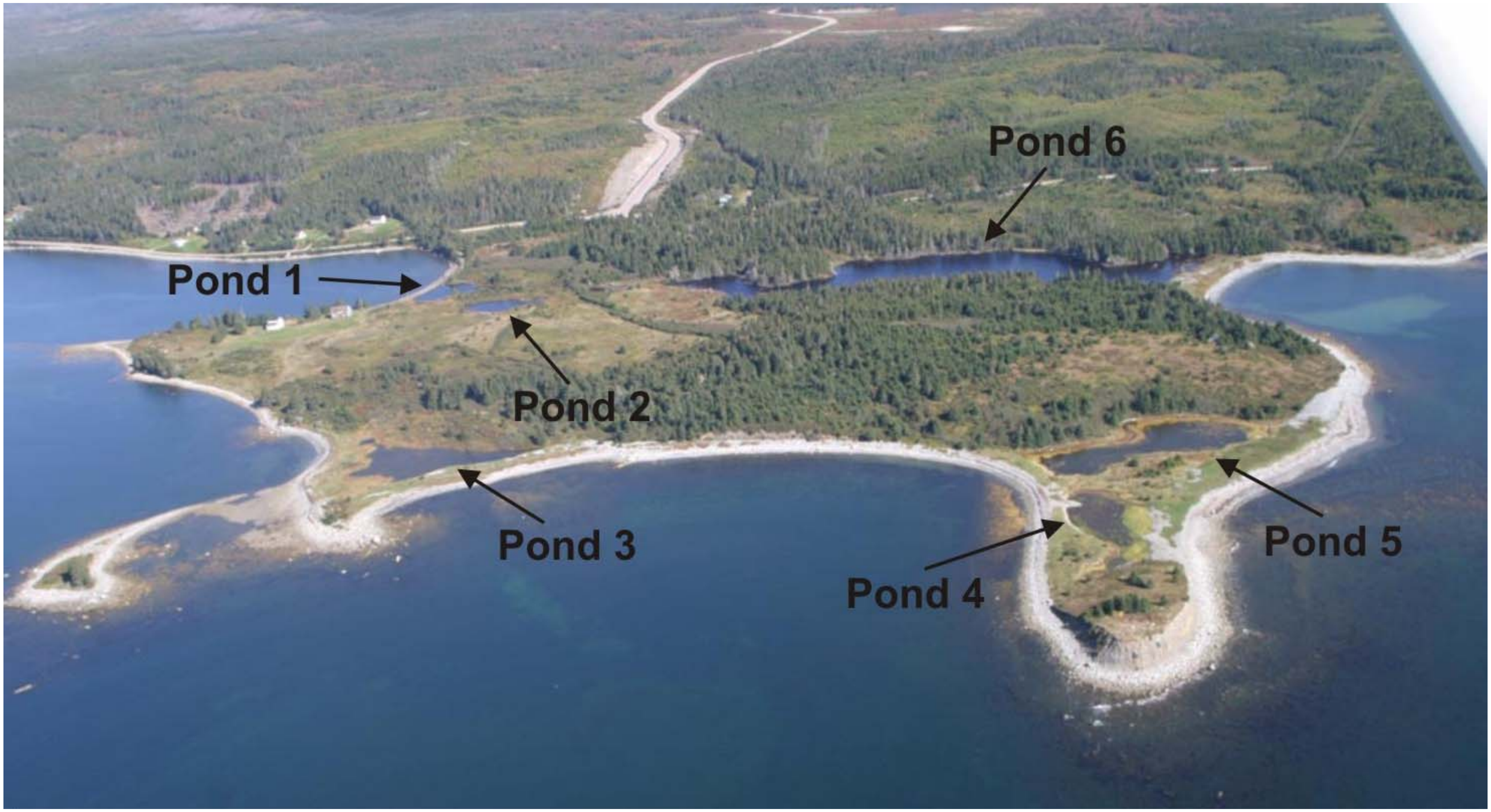


FIGURE 4.1-5
KELTIC PETROCHEMICALS INC.
RED HEAD PENINSULA STUDY AREA
JUNE 2007

TABLE 4.1-15 Monitoring Well Construction and Development Details

Well I.D.	Depth (m)		Elevation (m)		Well Development	
	To Bedrock	Well Total	Ground Surface	Top of Piezometre	Volume Removed (L)	Number of Casing Volumes
MW05-1a	2.29	17.68	74.73	75.28	1000	31.5
MW05-1b		8.54	74.66	75.18	828	62.5
MW05-2a	17.45	24.31	56.47	56.91	1449	32.0
MW05-2b		11.59	56.46	56.96	1536	79.0
MW05-3a	2.44	17.38	37.44	38.16	1207	38.7
MW05-3b		8.23	37.49	38.21	1173	92.9
MW05-4a	5.49	19.21	35.19	35.66	1035	29.7
MW05-4b		10.08	35.17	35.72	844	51.5
MW05-5a	0	17.68	34.86	35.41	1035	32.6
MW05-5b		8.54	33.30	33.82	862	65.0
MW05-6a	5.49	20.73	16.83	17.43	780 (dry 1x)	20.6
MW05-6b		7.01	16.79	17.25	186 (dry 2x)	18.3
MW05-7a	4.57	20.73	9.37	10.03	138 (dry 2x)	3.6
MW05-7b		11.59	9.24	9.78	855 (dry 2x)	44.0

Well Construction	3 m of 50 mm schedule 40 threaded poly vinyl chloride (PVC) 0.020 slot screen (pointed cap) at the bottom by schedule 40 threaded PVC casing to surface.
Annular Packing Material	No. 2 silica sand to about 1m above the top of screen, followed by 1m of betonies chips, then more sand to surface.
Water used for Drilling	Snow-melt from pools at root-ball of fallen trees, ditches, steams.
Well Protection	100 x 100 mm x 1.24 m lockable steel protectors with brass locks.
Sampling Apparatus	Dedicated 13 mm diametre high-density polyethylene Waterra® tubing with Delrin® foot valves.
Well Development	Soloinst Hydrolift® pump powered by 1 Kilowatt (kW) generator (kept a minimum 10 m downwind) to actuate the Waterra tubing. MW05-7a may have been underdeveloped as only 3.6 casing volumes were recoverable.

4.1.3.1 General Hydrogeology

The physical and general chemical hydrogeology of the various hydrostratigraphic units underlying and within 1 km of the Keltic Project Site in Goldboro are presented below. Reference is made to the NSEL well log database during this review to give insight on typical well depth and yield for each of the hydrostratigraphic units described.

Meguma Group (Halifax and Goldenville Formations)

Due to the lithologic composition and degree of metamorphism, the Goldenville Formation, Halifax Formation, and granitic plutons of the Meguma Group contain no primary permeability so well production from these bedrock units is nearly entirely dependent on fracture flow. Wells drilled into Meguma Group bedrock may be expected to yield anywhere from less than 1 litre per minute (L/min) to as much as 400 L/min, depending on location and fracture frequency, aperture size and interconnectedness. However, well yields in the order of 4 to 18 L/min are more the norm. A search of the NSEL well log database returned the data presented below in Table 4.1-16.

TABLE 4.1-16 Average Well Data (NSEL Well Log Database, Goldenville, and Halifax Formations)

Community	No. of Wells	Average Depth (m)	Average Yield Well (L/min)	Extreme Yields (L/min)	
				Low	High
Country Harbour	31	63	21	1.1	68
Isaac's Harbour	10	57	16.5	2.3	55
Goldboro	8	73	10.5	2.3	23
Drum Head	4	55	3	2.3	4.5

The data returned for the community of Country Harbour included the hamlets of Country Harbour, Middle Country Harbour, Country Harbour Mines, and Cross Roads Country Harbour. Within the Goldenville and Halifax Formations, calcium bicarbonate type waters appear to be most common, but calcium sulphate, calcium chloride and sodium chloride waters are also common. Waters from the Goldenville and Halifax Formations are typically only slightly hard to moderately hard with low to moderate concentrations of total dissolved solids, neutral to slightly acidic pH and low alkalinity. Iron and manganese concentrations often exceed their respective guidelines, arsenic concentrations can at places be elevated, and elevated values for uranium have also been reported.

The granites generally produce calcium bicarbonate type waters, although sodium chloride type waters can be found. The granites generally yield waters that are very soft to only slightly hard, with low pH, low alkalinity and low total dissolved solids. Iron, manganese, and uranium concentrations often exceed their respective guidelines, as can radon.

4.1.3.2 Groundwater Flow Direction

Local and intermediary groundwater flow direction may be controlled by a number of factors, including piezometric or water table hydraulic gradient, hydraulic conductivity, and fracture orientation where there is fracture flow through bedrock or fractured soils. Some often attempt to predict (while assuming a fair degree of accuracy) local groundwater flow direction on the belief that the water table in unconfined aquifers is a subdued replica of the local topography, but that may not always be the case (Haitjema and Mitchell-Bruker, 2005) and so defining groundwater flow direction solely based on surface topography may not be accurate. However, groundwater is expected to follow general relief on a regional or macro-scale.

Notwithstanding the generalities noted above, subsurface assessments were possible on the proposed Project Site and immediate surrounding areas, and the local groundwater flow direction details are understood in that part of the Keltic Project Area. That information is presented in Section 4.1.3.4 of this report.

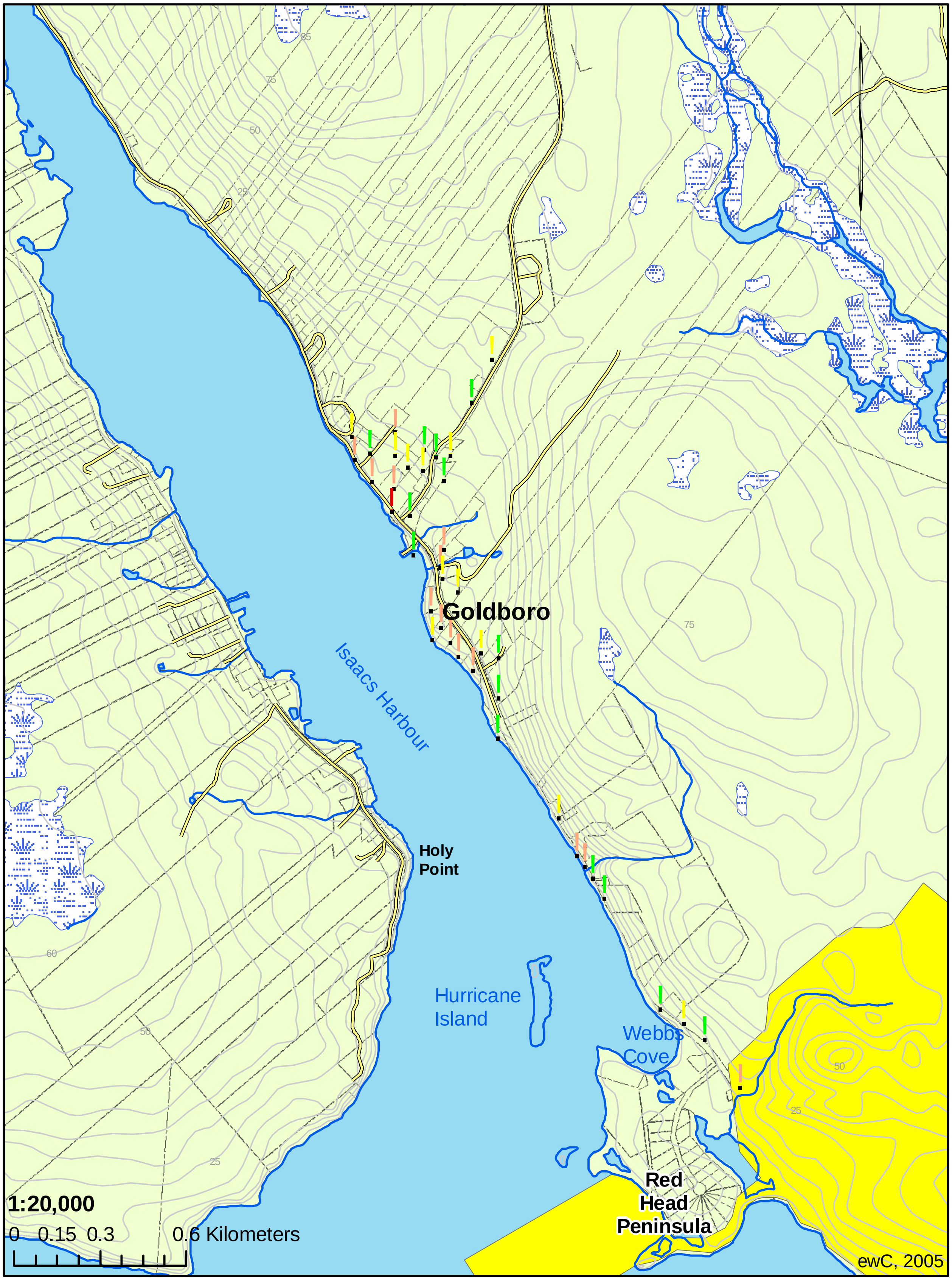
4.1.3.3 Local Well Survey

A door-to-door survey of the water supply wells located within 1 km of the proposed Keltic Project Site boundaries was carried out. Up to 40 wells were identified in the community of Goldboro (Figure 4.1-6), most of which are dug wells. There are only about eight drilled wells in the community.

Fourteen of the approximately 40 wells identified in the survey area were sampled for general chemistry, total metals, and coliform analysis. One homeowner refused to allow their well to be sampled. Twelve others whose homes appeared to be occupied (outside lights were on, outside plantings maintained) could not be contacted during the three-day survey or during subsequent visits to the site. Thirteen other homes and/or businesses appeared to be abandoned and/or used only seasonally. A newly drilled well located off-site was also sampled to serve as a groundwater quality benchmark.

Well owners agreed to participate in the sampling program on condition that identities would not be revealed. Thus the Table does not give sample locations. Well owners have been advised where results showed possible health concerns. Lab certificates of analysis are provided in Appendix 5 of the Provincial EA Report (AMEC, 2006). The following protocol was used to sample the water supply wells:

- Samples collected for general chemistry and total metals were taken directly from most commonly used faucet if no treatment was present or from the boiler valve on pressure tank upstream of any treatment, after purging the well and plumbing system for a minimum five minutes.
- Samples were collected in 200 ml polyethylene bottles directly from source for both general chemistry and total metals, without preservatives added.
- Samples collected for coliform analysis were taken directly from most often used faucet (aerators removed) into sterile (sealed) 100 ml bottles after purging wells and plumbing system for a minimum of five minutes. Sodium thiosulphate (to neutralize chlorine) was used as sample preservative.
- All samples were stored on ice in coolers immediately after collection until return to field office daily, then (except for coliform analysis) refrigerated until returned to coolers with ice packs for delivery to the lab. The maximum sample storage time was seven days.
- Samples collected for coliform analysis were delivered to the lab daily.
- All samples collected for general chemistry, total metals and some of the coliform analysis were analyzed at Maxxam Analytics inc. in Bedford, Nova Scotia, except for coliform samples 102F01-5-1 through 102F01-5-11, 102F01-5-13 and 102F01-5-15, which were analyzed daily at St. Martha's Hospital in Antigonish, Nova Scotia.
- Analytical results for the survey and benchmark well samples are provided in the Provincial EA Report (AMEC 2006).
- The lab analytical protocol used for general chemistry and metals is the same as for surface water and is shown in Table 4.1-13 above. Samples collected for coliform were analyzed using the Colilert (presence/absence) method.



Legend

- Homes Occupied, Owner not Contacted
- Home Refused to be Sampled
- Home Samples
- Seasonal Home
- LNG Project Area

FIGURE No. 4.1-6

KELTIC PETROCHEMICALS INC.

DUG AND DRILLED DOMESTIC WELLS WITHIN 1km SITE BOUNDARIES

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The dug wells generally produce water classed as soft, sodium-chloride type waters with low total dissolved solids, low alkalinity and low pH. The relative proportions of sodium and chloride appear to increase with increased total dissolved solids concentration, suggesting a possible road salt (less likely) and/or sea spray (more likely) influence on these wells. The values for pH and aluminum are generally outside of acceptable guideline limits. Nearly all of the dug wells showed positive for total coliform. This is likely a function of well construction in many cases: most wells are old, some consisting of nothing more than a cover placed over surface springs, others had holes and water pooling near them, and nearly all had poor fitting covers and vents with no screens. Many wells showed signs of containing insects.

Drilled wells sampled inside the survey area generally produce soft to only slightly hard, calcium-bicarbonate type waters with low total dissolved solids, low alkalinity, and neutral to just below neutral pH. Aluminum, iron, and manganese concentrations were found to be outside of acceptable guideline limits. Only one well indicated the presence of coliform. The chemistry for water from drilled wells inside the survey area was in general very similar to that of the off-site benchmark well.

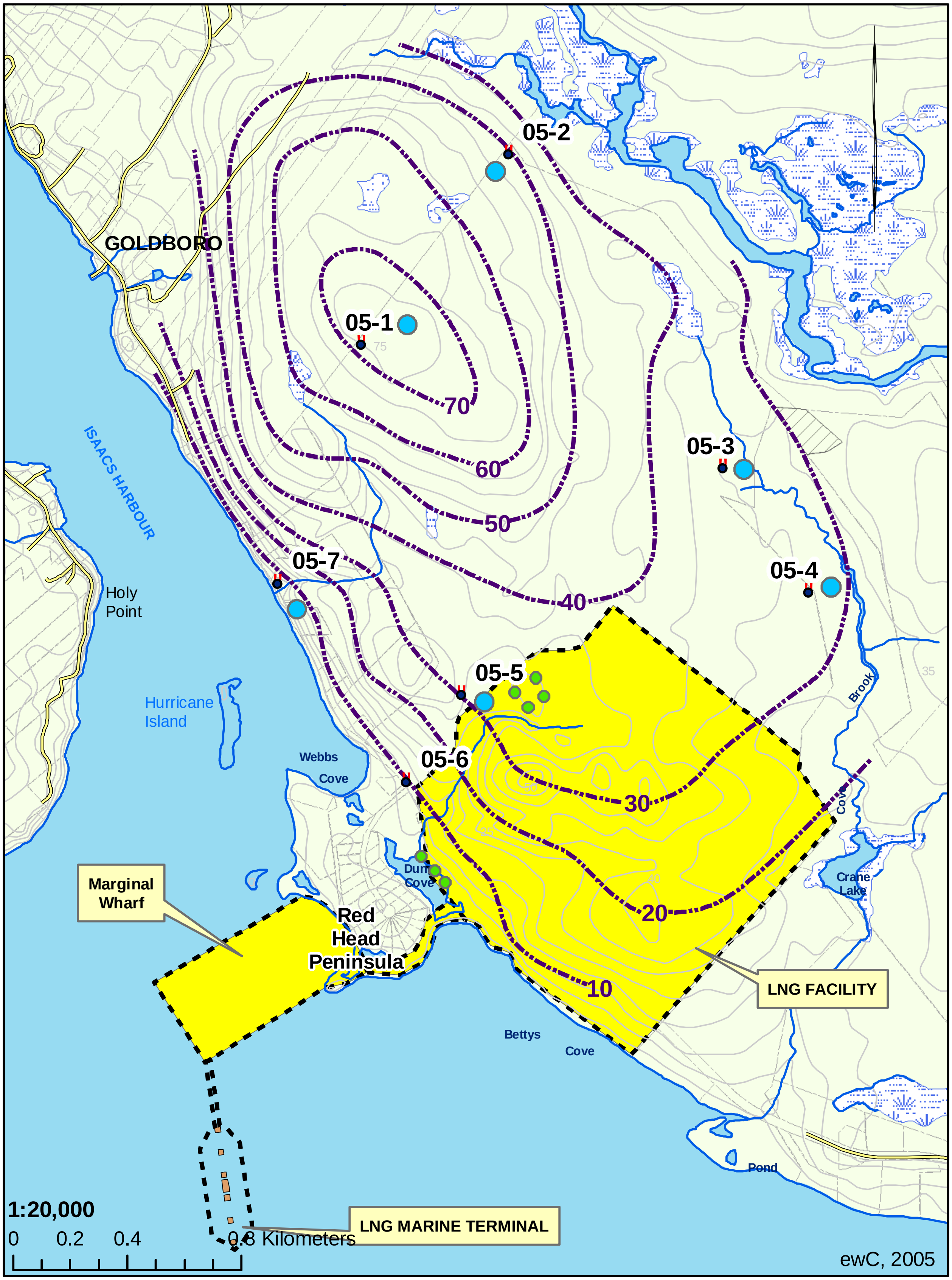
Mercury was not included in the residential wells sample for the following reasons:

- The Project does not involve mercury, and the Proponent does not plan to disturb any former mill tailings areas which may contain mercury. As such, mercury was not a concern for the purpose of the initial well survey as might relate to background conditions versus possible accidental spills or releases at the plant during construction or operation.
- Not all well were available to be sampled at the time of this initial sampling. More detailed follow-up surveys and sampling with a more comprehensive suite of parameters will be undertaken to provide a complete baseline once plant design details are known and before construction begins.
- Keltic intends to drill dedicated and secure groundwater monitoring stations within the community from which to obtain a better control over the data on local physical and chemical hydrogeology. For example, to avoid any possible bias induced by well owners who may have added liquid bleach (sodium hypochlorite) to their wells. Some domestic bleaches are manufactured using the mercury cell method, therefore may contain trace amounts of mercury. Some of these will be sampled for mercury.

4.1.3.4 Hydrogeology at the Proposed Keltic Project Site

The hydrogeology of the proposed Keltic Site, including the LNG Facility Area, was evaluated via the construction of 14 monitoring wells, installed as piezometre pairs at seven locations. Six piezometre pairs are located inside the proposed Keltic Site boundaries (two of which are located on the western edge of the LNG Facility), and one was installed outside the boundaries between the site and Isaac's Harbour (Figure 4.1-7).

The predominance of secondary permeability within the bedrock of the Goldenville Formation, and the large number of shear zones known and thought to be present at the site (especially those in the southwest part of the site) in conjunction with the large number of possibly extensive abandoned underground workings, can be expected to have a significant influence on groundwater flow pathways and on overall groundwater flow velocity within and beyond the site.



Legend

Monitoring Well Locations
Piezometric Contours
LNG Project Area
Soil Sample Location
Surface Water Sample Location

FIGURE No. 4.1-7
KELTIC PETROCHEMICALS INC.
MONITORING WELL LOCATIONS AND PIEZOMETRIC CONTOURS
June 2007

Therefore, the monitoring wells were located where they might best explain these underground phenomena and provide broad coverage and even distribution in areas where process infrastructure and thus, possible material spills might occur at some time in the future. The intent of the monitoring well program was to help characterize the site through definition of its baseline physical and chemical hydrogeology. As such, the hope is that these wells will not be disturbed during construction, so they may continue to serve as long-term groundwater monitoring stations.

Monitoring Well Design, Construction and Development

The monitoring wells were installed employing the services of Lantec Drilling from Dieppe, New Brunswick. The boreholes were advanced using augers and split spoon samplers where possible, advancing into bedrock with HQ-size diamond equipment. Due to the great depth to bedrock, monitoring well MW05-2b was screened in soil just above bedrock. All other monitoring wells were screened in bedrock. Details are provided in Table 4.1-15.

Hydraulic Conductivity (Slug) Testing

Hydraulic conductivity (slug) testing was carried out on each monitoring well after allowing at least 24 hours for water levels to recover following well development and groundwater sampling. The exception to this was MW05-1a and MW05-1b where due to the long distance in from the road and the need to carry well development and testing equipment in on foot, hydraulic testing was done prior to, and on the same day as, well development and sampling.

Slug testing was done using a 1 L aluminum slug on a rope, an electronic data logger, and electronic water level tape. At least two drawdown and recovery tests were carried out on each monitoring well. Presence or absence of response in the neighbouring well-pair was noted during each test. The field data was interpreted using the Hvorslev Method. Results are summarized in Table 4.1-17. Details of the analysis are provided in Appendix 6 of the Provincial EA Report (AMEC, 2006).

Groundwater Sampling

Groundwater samples were collected from the monitoring wells for analysis for general chemistry, dissolved metals, mercury, total petroleum hydrocarbons, and VOC. The water samples were collected directly from the end of the Waterra tubing installed at each well. Table 4.1-18 summarizes the protocol used for sample collection.

All groundwater sample collection was done in fair weather conditions. The generator used to power the Hydrolift pump was kept at least 10 m downwind of the monitoring wells during sample collection. The sampling QA/QC program included the following:

- sample and analyze all water sources used to drill during monitoring well construction;
- carry a field blank to all sampling locations;

TABLE 4.1-17 Hydraulic Conductivity Results at Monitoring Wells (cm/sec[1])

Location	Test 1		Test 2		Test 3		Mean	Standard Deviation
	Falling	Rising	Falling	Rising	Falling	Rising		
MW05-1a	$2.98x10^{-3}$	$2.63x10^{-3}$	$4.47x10^{-3}$	$3.73x10^{-3}$	$3.44x10^{-3}$	$3.73x10^{-3}$	$3.50x10^{-3}$	$6.44x10^{-4}$
MW05-1b	$3.31x10^{-3}$	$4.06x10^{-3}$	$3.73x10^{-3}$	$4.06x10^{-3}$	$3.89x10^{-3}$	$4.26x10^{-3}$	$3.89x10^{-3}$	$3.34x10^{-4}$
MW05-2a	$8.60x10^{-4}$	$9.94x10^{-4}$	$8.60x10^{-4}$	$8.94x10^{-4}$	--	--	$9.02x10^{-4}$	$6.33x10^{-5}$
MW05-2b	$7.45x10^{-4}$	$1.28x10^{-3}$	$7.45x10^{-4}$	$8.28x10^{-4}$	--	--	$8.99x10^{-4}$	$2.55x10^{-4}$
MW05-3a	$3.58x10^{-3}$	$5.26x10^{-3}$	$4.97x10^{-3}$	$5.96x10^{-3}$	$4.26x10^{-3}$	$5.96x10^{-3}$	$5.00x10^{-3}$	$9.48x10^{-4}$
MW05-3b	$8.94x10^{-3}$	$6.88x10^{-3}$	$9.94x10^{-3}$	$8.94x10^{-3}$	$2.63x10^{-2}$	$5.96x10^{-3}$	$1.12x10^{-2}$	$7.56x10^{-3}$
MW05-4a	$5.73x10^{-3}$	$4.86x10^{-3}$	$5.59x10^{-3}$	$6.12x10^{-3}$	$6.58x10^{-3}$	$6.39x10^{-3}$	$5.88x10^{-3}$	$6.24x10^{-4}$
MW05-4b	$1.02x10^{-2}$	$1.24x10^{-2}$	$1.12x10^{-2}$	--	--	--	$1.13x10^{-2}$	$1.13x10^{-3}$
MW05-5a	$4.97x10^{-4}$	$4.97x10^{-4}$	$3.99x10^{-4}$	$5.26x10^{-4}$	--	--	$4.80x10^{-4}$	$5.54x10^{-5}$
MW05-5b	$5.96x10^{-4}$	$1.28x10^{-3}$	$6.77x10^{-4}$	--	--	--	$8.50x10^{-4}$	$3.72x10^{-4}$
MW05-6a	$3.44x10^{-4}$	$4.06x10^{-4}$	--	--	--	--	$3.75x10^{-4}$	$4.42x10^{-5}$
MW05-6b	$3.89x10^{-5}$	$2.37x10^{-5}$	--	--	--	--	$3.13x10^{-5}$	$1.08x10^{-5}$
MW05-7a	$8.94x10^{-4}$	$2.03x10^{-3}$	--	--	--	--	$1.46x10^{-3}$	$8.05x10^{-4}$
MW05-7b	$5.81x10^{-4}$	$3.58x10^{-4}$	--	--	--	--	$4.69x10^{-4}$	$1.58x10^{-4}$

1. cm/sec – centimetres per second

TABLE 4.1-18 Summary of Protocol Used for Sample Collection

Sample	Bottle Type	Sample Filtered	Preservative	Additional Comments
General Chemistry	200 ml polyethylene	No	No	None
Dissolved Metals	50 ml polyethylene	Yes Millipore Luer-Lok filters to 0.45 μm with sterile syringe (new) for each sample	Nitric acid	None
Mercury	100 ml amber glass with Teflon lined cap	No	Potassium dichromate in nitric acid	Preservative added prior to sample collection. Bottle filled to zero headspace without overflow.
Total Petroleum Hydrocarbon	2 – 250 ml clear glass with Teflon lined cap	No	No	None
	3 – 40 ml amber glass with Teflon lined septum caps	No	Copper sulphate	Preservative added prior to sample collection. Bottle filled to zero headspace without overflow
VOC	3 – 40 ml clear glass with Teflon lined caps	No	Sodium bi-sulphate	Collected directly from open end of Waterra tubing. Preservative added prior to collection. Bottle filled to zero headspace without overflow.

- collect one full suite of duplicate samples at MW05-6a;
- do an air-transfer blank at MW05-7a while maintaining a 5 centimetre (cm) gap between lab-prepared distilled water bottle and sample collection bottles (handled as per Table 4.1.18), for VOC analysis;
- sample (directly from the grease tube) and analyze the lubricant used on drilling equipment;
- all samples were immediately stored in coolers with ice packs after collection until return to the field office daily, where they were kept refrigerated until return to coolers with ice pack for delivery to Maxxam Analytics Inc. in Bedford, Nova Scotia. Maximum sample storage time was seven days; and
- samples were analyzed using the lab protocol summarized in Table 4.1-13 above.

Physical Site Hydrogeology

With the exception of MW05-1a and MW05-1b, static groundwater depths were measured at the monitoring wells on two occasions during the field program – once just before commencing well development and a second time at the start of the hydraulic testing. The measurement dates and calculated groundwater elevations are summarized in Table 4.1-19 below.

TABLE 4.1-19 Groundwater Elevation at Monitoring Wells (elevations reference mean sea level)

Location	Measurement Event 1			Measurement Event 2		
	Date	Elevation (m)	Δh* (m)	Date	Elevation (m)	Δh* (m)
MW05-1a	16/04/05	73.27	+0.05	na	na	na
MW05-1b		73.21			na	
MW05-2a	10/04/05	54.19	-1.2	14/04/05	54.36	-0.81
MW05-2b		55.39			55.17	
MW05-3a	11/04/05	37.01	+0.07	14/04/05	36.90	+0.08
MW05-3b		36.94			36.82	
MW05-4a	13/04/05	34.97	-0.05	14/04/05	35.00	0
MW05-4b		35.02			35.00	
MW05-5a	17/04/05	33.88	+0.95	18/04/05	33.85	+0.95
MW05-5b		32.93			32.90	
MW05-6a	18/04/05	na	na	19/04/05	14.54	+0.53
MW05-6b		14.47		19/04/05	14.01	
MW05-7a	21/04/05	6.17	+0.05	03/05/05	6.65	+0.09
MW05-7b		6.12		03/05/05	6.56	

Note: * (+) and (-) values designate groundwater recharge and discharge conditions, respectively.

Measurements were taken only once at MW05-1a and MW05-1b because well development and hydraulic testing there were done the same day. Measurements were taken at MW05-6a on two separate occasions. However, it was found that bentonite had fallen into the monitoring well during construction and water was used to wash it out. Due to a slow water level recovery time, an accurate measurement was not possible before commencing well development. It was not possible to measure groundwater levels at all wells on the same day due to field schedules and long distances between stations.

Groundwater level fluctuations were found to range from about 3 cm at most wells, to 48 cm at MW05-7a. Water level fluctuations in the order of 2 m to 3 m might be expected seasonally, with the greatest fluctuations occurring at station MW05-7 based on currently available information.

Based on .h values (difference in water elevation between shallow and deep well pair) in Table 4.1-19, most areas of the proposed Keltic Site would be considered to be groundwater recharge zones (groundwater recharge conditions are considered present when piezometric levels for shallow horizons are higher than for deeper horizons). Hydraulic communication was found to exist between many of the monitoring well pairs during hydraulic testing (suggesting both vertical and lateral bedrock fracturing), and so the relative differences in magnitude for .h values from one monitoring well station to the other are likely as much a function of the communication that exists between well pairs, as it is to the relative degree of recharge or discharge at any location.

Figure 4.1-8 is a piezometric contour map of the site drawn using the second set of groundwater level measurements for the “a” (deeper) well series. The piezometric contours for the “b” (shallow) well series would be similar. From this, groundwater would be expected to flow in a radial direction (dark blue curved arrows) from around the northwest boundary of the site toward Gold Brook and Betty’s Cove Brook to the east, southeast and south, the hamlet of Goldboro to the north and northwest, and the ocean to the west and southwest. However, there are also possible groundwater flow paths of potential least resistance that must be taken into consideration, as indicated from the current knowledge of faults, shear zones, and abandoned underground workings on the proposed Keltic Project Site. These are expected to have a significant influence on the actual routes groundwater would flow underground – some components of flow could parallel the shore of Isaac's Harbour, while others are deflected east and west just above the proposed marginal wharf area. However, some faults are also known in other places to not allow groundwater to migrate along or across them. Additional monitoring wells are needed to help better characterize this situation.

The results of the hydraulic (slug) conductivity testing are summarized in Table 4.1-17. The overall average value obtained for hydraulic conductivity at the proposed Keltic Site is $3.30 \times 10^{-3} \pm 3.83 \times 10^{-3}$ cm/sec, with the lowest of 3.13×10^{-5} cm/sec being at MW05-6b, and the highest value of 1.13×10^{-2} cm/sec at MW05-4b. The norms for fractured and un-fractured metamorphic rock are in the order of 7×10^{-7} to 5×10^{-2} cm/sec, and $< 1 \times 10^{-12}$ to 1×10^{-8} cm/sec, respectively (Freeze and Cherry, 1979). The hydraulic conductivity values obtained at the Keltic Project Site are within the upper end of the generally recognized spectrum for fractured metamorphic bedrock.

There was a response at the shallow monitoring wells when testing the deeper ones, and vice-versa at nearly all of the monitoring well pairs. These usually rapid water fluctuation responses ranged from 1 cm at the monitoring well pairs where the hydraulic conductivity values were generally lower, to 8 cm at other well pairs – a significant water level change considering the relatively small (maximum 49 cm) displacement actually created by dropping a 1 L slug into the well being tested.

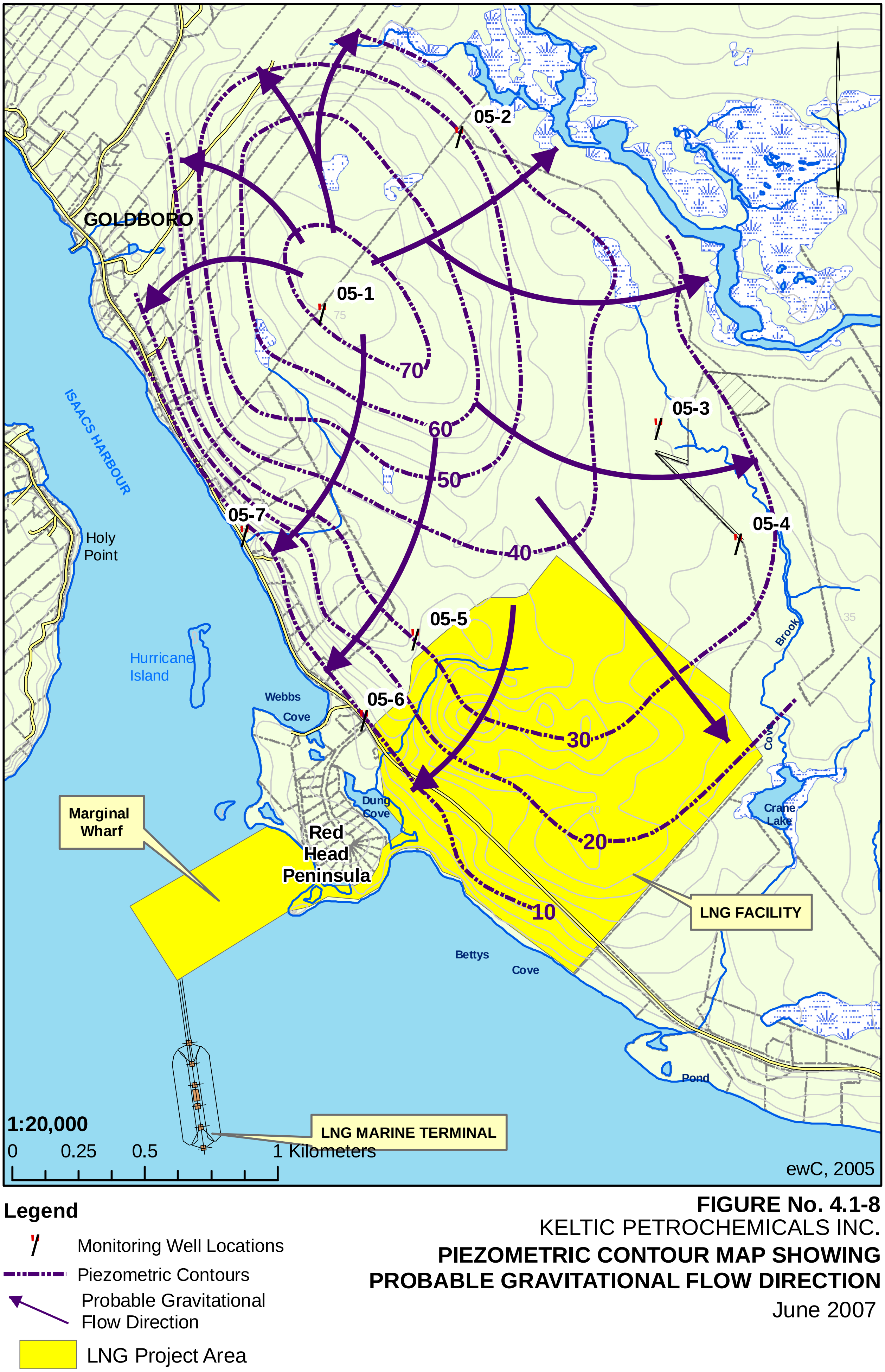


FIGURE No. 4.1-8

KELTIC PETROCHEMICALS INC.

PIEZOMETRIC CONTOUR MAP SHOWING PROBABLE GRAVITATIONAL FLOW DIRECTION

June 2007

The distribution of values throughout the proposed Keltic Site suggests that hydraulic conductivity in the vicinity of MW05-3 and MW05-4 are highest. This is consistent with the understanding that the lineaments defined by Betty's Cove Brook may represent bedrock faults which no one has yet been able to otherwise map.

The hydraulic conductivity values obtained at the deep and shallow piezometres at each monitoring well pair are for the most part quite similar. The hydraulic conductivity values obtained for the shallower wells are general slightly higher than those for the neighbouring deeper well. This is likely a function of the greater degree of bedrock weathering expected at the shallower depths. The reverse appears to be the case at MW05-6 and MW05-7 where hydraulic conductivity for the deeper bedrock horizon was found to be greater than in the shallower horizons. The overall hydraulic conductivity at these wells was lower than in other places. This reverse relationship may suggest a greater relative degree of bedrock fracturing at depths below the wells at those locations.

Table 4.1-20 lists average values (shallow and deep wells for two monitoring well locations) for hydraulic conductivity, and estimated average groundwater flow velocities between various monitoring stations using hydraulic gradients from Figure 4.1-5.

With few exceptions, the glacial till appears to be relatively thin throughout the proposed Keltic Project Site and as such, the low permeability till is expected to influence only very local groundwater flows at the site. The more intermediary to regional groundwater flows present within bedrock should be considered as the more significant flow components at this site.

TABLE 4.1-20 Groundwater Flow Velocity Estimates at the Proposed Keltic Project Site

From – To		Average K (cm/sec)	Average Groundwater Flow Velocity (m/yr)
MW05-1	MW05-2	2.30×10^{-3}	21.0
MW05-1	MW05-7	2.33×10^{-3}	51.7
MW05-1	MW05-3	5.90×10^{-3}	53.0
MW05-3	MW05-4	8.35×10^{-3}	9.5
MW05-1	MW05-4	6.14×10^{-3}	43.6
MW05-1	MW05-5	2.18×10^{-3}	22.6
MW05-5	MW05-6	4.34×10^{-4}	6.0
MW05-1	MW05-6	1.95×10^{-3}	24.6
MW05-5	MW05-7	8.15×10^{-4}	9.1

Chemical Hydrogeology

The analytical results for the samples of surface water used to drill and for the groundwater samples collected from the monitoring wells installed during the 2005 field season are summarized in the Provincial EA Report (AMEC 2006).

The Piper diagram in Figure 4.1-9 shows the relative distribution of major ions in water and gives a comparison of the groundwater samples collected from the monitoring wells to other groundwater samples collected from dug and drilled water supply wells located within 1 km of the proposed Keltic Site, and surface water samples taken from local streams (Gold Brook, Isaac's Harbour River) and on- or near-site surface water used for drilling (from local ditches, snow melt and Betty's Cove Brook, which originates within the Keltic Site boundaries).

The major ion chemistry is similar for most of the monitoring well samples as well as for all of the drilled water supply wells sampled, being mostly calcium bicarbonate type waters. There are generally no significant differences in major ion concentration among the deeper and shallower monitoring wells. Two notable exceptions, however, are at the north edge of the Keltic Site at MW05-1a, MW05-1b, MW05-2a, and MW05-2b, where samples from the deeper wells contained sodium bicarbonate type waters and samples from the shallow wells contain sodium chloride- type waters. The sample from MW05-6b is a sodium-bicarbonate type water, and that from MW05-7b is borderline between calcium-bicarbonate and sodium-chloride type water. These are likely showing a certain degree of surface water influence (recharging waters with lower residence times). The dug water supply wells in Goldboro are similar to these, but exhibit a greater range in relative amount of chloride versus bicarbonate.

The surface waters are distinct from groundwater in that they are predominantly sodium sulphate type waters from Gold Brook and Isaac's Harbour River (waters from off the Keltic Project Site), and sodium chloride type waters used for drilling (waters originating at the Keltic Project Site). The Gold Brook and Isaac's Harbour River waters also contain a slightly higher proportion of magnesium than the other surface waters (those used for drilling), whereas the relative proportion of magnesium is roughly the same for all water supply wells and monitoring well waters.

The monitoring wells generally produce soft to only slightly hard waters with low total dissolved solids, low alkalinity, and generally near neutral pH. The Langelier Index calculations for waters from the monitoring wells are all slightly negative – these are all under saturated with respect to calcium carbonate. A few monitoring wells have elevated aluminum concentrations, several have iron and manganese concentrations that exceed guideline values, and arsenic concentrations were elevated at MW05-5a, MW05-5b, MW05-6a and MW05-6b, all of which are located within or near highly mineralized areas.

As relates to the organic parameters, all concentrations are generally below the lab's detection levels, except chloroform, which is above the fresh water aquatic guideline value at MW05-1a, MW05-1b, MW05-2b, and present (but below the guideline value) at MW05-7a, as well as in the air transfer blank. This suggests either analytical problems (unlikely based on the lab's QA/QC data), or airborne contributions during sampling (sampling at these locations was done near/under conifers).

4.1.4 Marine Water Quality

The chemical composition of seawater is complex; nevertheless the relative concentrations of the major ions are generally constant throughout the oceans (Culkin, 1965). Some differences in water quality occur as deeper more nutrient rich waters mix with surface waters, which are in turn influenced by major outflows, such as the St. Lawrence River and the Nova Scotia Current.

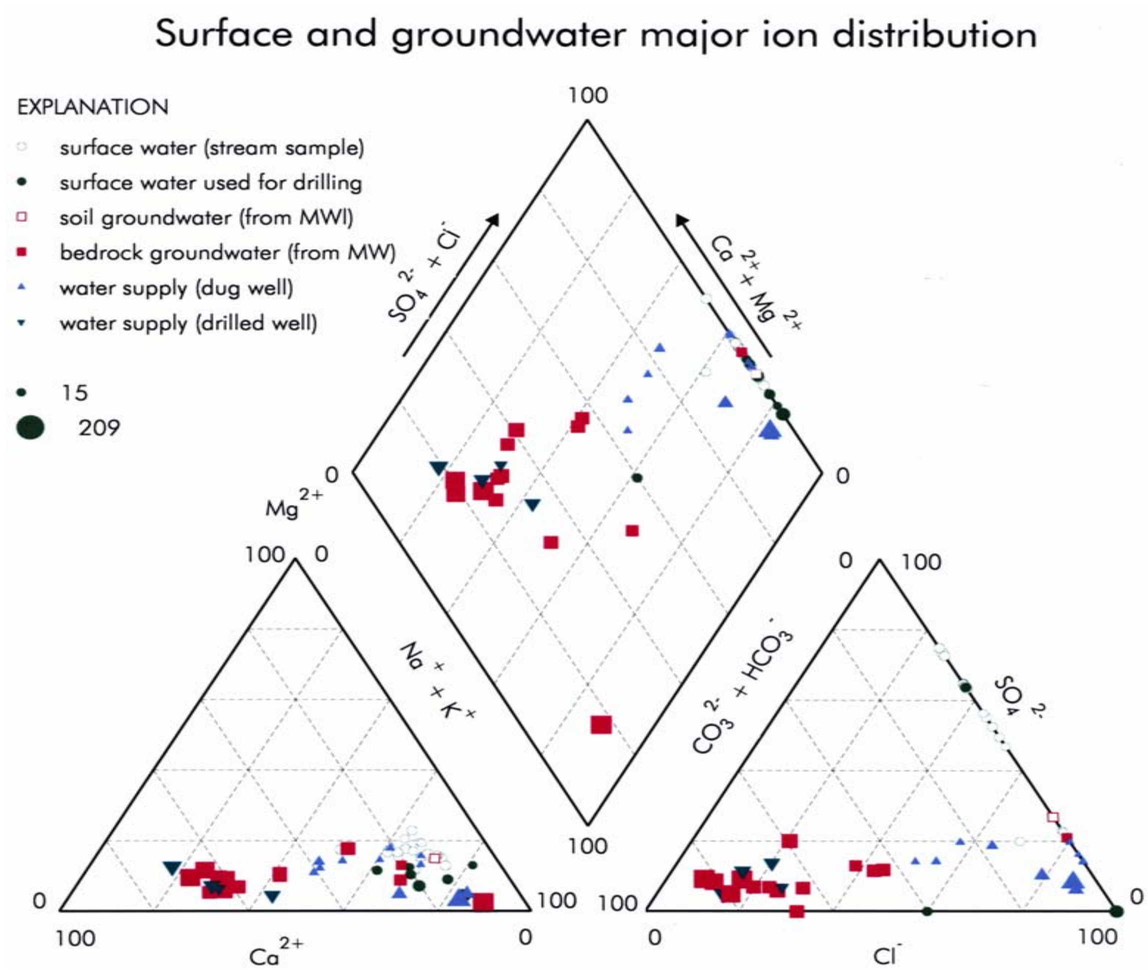


FIGURE 4.1-9
KELTIC PETROCHEMICALS INC.
PIPER DIAGRAM FOR THE WATER SAMPLES IN THIS STUDY
JUNE 2007
ewC, 2005

Approximately 86% of the total salt content of seawater is due to sodium and chloride ions, with magnesium and sulphate ions contributing an additional 11%. Other ions are present in much lower concentrations.

Seawater also has a high buffering capacity of acids and bases. During periods of high phytoplankton production, the uptake of carbon dioxide (CO_2) can cause localized changes in ionic balance. The water quality near the Keltic Project Site is also influenced by freshwater discharge, primarily from the Isaac's Harbour and Country Harbour Rivers. During the low flow summer months, this influence is minor.

The pH of seawater is relatively constant throughout the oceans with values ranging from 7.5 to 8.4 (mean = 7.8) (Wilson, 1975). Measured values for pH in surface waters in the region of the Keltic Project range from 8.05 to 8.11. DO is essential for the respiration of aquatic life. The solubility of oxygen in seawater is a function of salinity, temperature, and pressure. The major sources of DO in seawater are attributed to exchange with the atmosphere and production by marine plants. Although the waters in the Keltic Project Area are thermally stratified from May to October, the depths are shallow (Petrie et al. 1996). Consequently DO concentrations are likely to be at or near saturation with values in the order of 8 to 10 mg/L.

There are limited published suspended particulate matter (SPM) values for the Sable Bank area. Data collected from Emerald Bank in 1970 indicated a variation of 5.5 mg/L at the surface, increasing to 10.1 mg/L at 20 m and then decreasing to 4.0 mg/L below this depth. The data reflect the strong influence of biological activity during and after spring bloom. However, observations suggest that concentrations of SPM on Sable Bank are much lower than those measured on Emerald Bank (SOEP, 1996).

Regional data are available for nutrient concentration as a result of the Scotian Shelf Icthyloplankton Project and other programs (O'Boyle et al., 1982; Petrie et al., 1996). Concentrations of nitrite (as NO_2-N/L) in the euphoric zone have been observed to range from 5.0 to 10.0 milligrams (mg) in the early spring, dropping and remaining low at 0.5 to 1.5 mg during the summer, before rising slowly through the autumn from 0.5 to 10.0 mg. Phosphate concentrations (as PO_4-P/L) ranged from 0.6 to 0.9 mg in the early spring, dropping through the summer to 0.1 to 0.2 mg range and remaining at or about this level through the fall.

Trace metal inputs to the area are a function of the natural and human inputs from Nova Scotia, the Gulf of Saint Lawrence, and, to a limited extent, from atmospheric transport from central and eastern North America. Predicted trace metal concentrations from the SOEP area range from 0.002 Fg/L (mercury) to 25 Fg/L (barium).

Like temperature, salinity is an important parameter of marine water quality. Data provided in Petrie et al. (1996) shows that the average surface salinity ranges from a low of 31.30 microseimens (µS) in December to a high of 32.34 µS in April. At 10 m depth average salinity is lowest in November (30.96 µS) and peaks in April at (32.30 µS). In deeper waters of about 50 m the average salinity is least in February (31.69 µS) and greatest again in April at (32.65 µS) (Petrie et al., 1996).

Hydrocarbons arising from both recent biogenic processes and petrogenic sources are ever present in the marine environment. It is reasonable to assume that concentrations in the water column will be at the threshold of detection because of the large distance from any highly populated and heavily industrialized centres. However, infrequent detectable amounts may be found due to illegal discharge of bilge water by vessels within the region.

Temperature affects almost every property of seawater, as well as many chemical and biological processes. The annual sea temperature in the vicinity of the Keltic Project ranges from a low of 1.55°C in February to a high of 16.36°C in September at a depth of 10 m (Petrie et al., 1996).

Although the presence of polychlorinated biphenyls (PCBs) and various organohalogen pesticides (particularly DDT (Dichlorodiphenyltrichlorethane)) has been widely studied, there are no data on these compounds available for the waters of the area offshore of the planned Keltic Project. Nevertheless, there is no reason to expect significant concentrations of these related compounds in the region.

4.1.5 Soil/Sediment Quality

4.1.5.1 Terrestrial

Most of the immediate area around Goldboro is underlain by stony, silty sand till of the Quartzite Till sheet. The thickness of this ground moraine lodgement till typically averages 3 m, but may reach over 20 m. The shoreline from Webbs Cove to Drum Head is pebble-cobble beach with a short section (200 m) of boulder beach occurring just prior to Drum Head (EnCana Corporation, 2002). Beyond Drum Head the shoreline consists mostly of bedrock and human made-structures (wood and stone) (EnCana Corporation, 2002). The lower intertidal zone in the area consists of mixed coarse (no sand) beach material and bedrock resistant platforms with a wharf and breakwater in Drum Head Harbour (EnCana Corporation, 2002).

Three major soil series occur within the Study Area, Halifax; Aspotogan; and Organic. Halifax soils are associated with the gently undulating to hilly topography of the Project Area. These soils are well drained and support fair to good stands of mixed forest (Hilchey et al., 1969). Aspotogan soils are shallow, poorly drained soils located in lower areas of the Project Area landscape. They are derived from a sandy to gravelly sand quartzite till, which is often exceedingly stony.

Organic soils occur in very poorly drained areas of the Study Area either adjacent to water or in depressions in the landscape. Profiles consist of brown semi-decomposed fibrous material consisting mainly of sphagnum moss. Depth of the organic material may be as great as 2 m (EnCana Corporation, 2002).

The soils of the Keltic Project Site and surrounding regions were mapped by Cann and Hilchey (1954), Hilchey et al (1969), Stea and Fowler (1979) and Stea et al (1992).

<u>A and B Soil Horizons</u>

In Guysborough County, variably distributed Riverport, Thom, Halifax, Danesville, and Aspotogan series soils, and peat are present throughout the Keltic Project Site and in large portions of the watersheds studied. Figure 4.1-10 shows the distribution of these soil types.

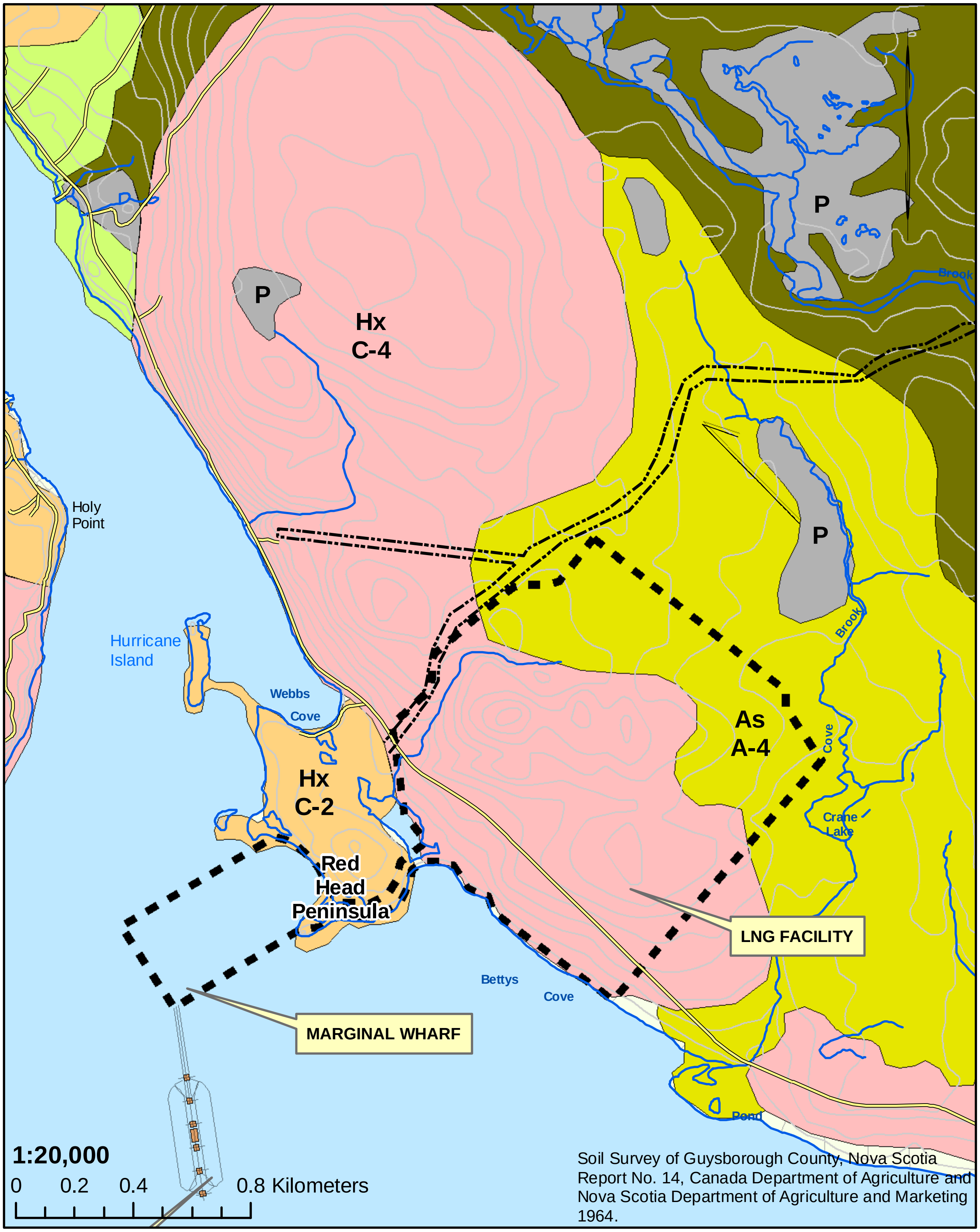


FIGURE No. 4.1-10

KELTIC PETROCHEMICALS INC.

SOIL TYPE DISTRUBUTION (A AND B HORIZONS)

June 2007

Legend

- ! Mine or Open Cut
- Other Roads
- LNG Project Area
- Peat
- Hebert
- Springhill
- Dansville
- Halifax
- Aspotogan

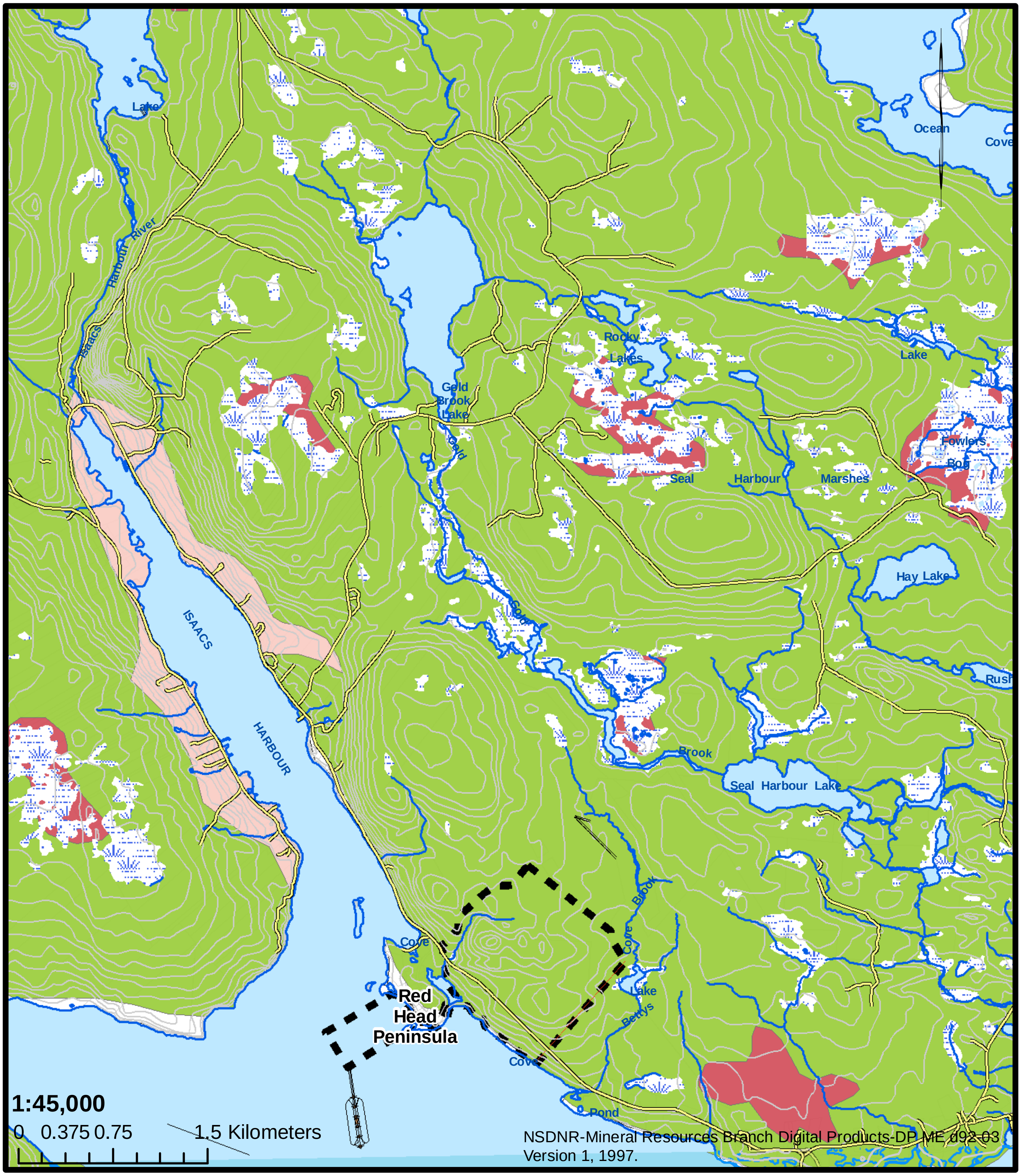
Description of the different soils is as follows:

- Queens Series: light brown clay loam over reddish-brown clay loam.
- Millbrook Series: light brown loam over reddish-brown gravely clay loam.
- Stewiacke Series: reddish-brown silty clay loam over reddish-brown silt loam.
- Woodborne Series: reddish-brown gravely loam to sandy loam over dark reddish-brown gravely clay loam.
- Kirkhill Series: light brown loam over yellowish brown shaley sandy loam.
- Riverport Series: brown shaley loam over grayish brown shaley loam.
- Thom Series: dark, reddish brown, friable sandy loam over dark, reddish-brown gravely sandy loam.
- Danesville Series: dark reddish brown mottled gravely sandy loam over dark-brown mottled gravely sandy loam.
- Aspotogan Series: mottled dark-brown sandy loam over olive-gray strongly mottled gravely sandy loam.
- Halifax Series: dark reddish brown friable sandy loam over strong-brown friable sandy loam.
- Most are generally well-drained soils, for which parent materials are generally the bedrock that underlies them, and are fairly well suited for various types of agriculture, although the relative shallowness of the Kirkhill Series soils makes it less suitable for agriculture than the others. The Riverport Series has imperfect drainage and is limited for agricultural use due to the stoniness, drainage, and shallowness and the Thom Series has rapid drainage and is unsuitable for agriculture but suitable for forestry (Cann and Hilchey, 1954). The Danesville and the Aspotogan Series have imperfect and poor drainage, respectively. Both soils are derived principally from quartzite glacial till parent material. The Halifax Series is rapid draining and is derived principally from gravely sandy quartzite glacial till.

C Soil Horizon

Beneath the A and B soil horizons, the C horizon materials or "mineral soil" consists generally of quartzite till and/or stony till plain deposits in Guysborough County. Glacial-age kame fields and esker systems, and post-glaciation alluvial deposits, are present at various locations throughout the Keltic Project Site (Figure 4.1-11).

The ground moraine till material is comprised of a mixture of gravel, sand, and mud of direct glacial origin, which was released from the top or within, stagnant ice masses by melting. It is variable in thickness from 2 m to 25 m and forms local ridges, depressions or pits (kettles). The stony till unit consists of material released at the base of ice sheets and is described by Steam (1979) as a bluish-greenish-grey, loose, cobbly, silt-sand till that will grade into a sandier, coarser till, sometimes with red clay inclusions. This till is generally thin (less than 10 m), and in general, the matrix is made up of 80% sand, 15% silt, and 5% clay derived of locally eroded quartzite and slate bedrock.



Legend

LNG Project Area

- Bedrock
- Glaciofluvial
- Stony Till
- Orangic Deposits

FIGURE No. 4.1-11

KELTIC PETROCHEMICALS INC.

SURFICIAL GEOLOGY

June 2007

Quartzite till is shown by Stea (1979) and Stea et al (1992) to extend northward along the eastern half of the Isaac's Harbour River watershed. Granite ablation till, or silty till plain deposits, are present along the western periphery in the upper reaches of the Isaac's watershed. These deposits are described by Stea (1979) as yellow-grey, bouldery sand till. A drumlin field is shown present south of the Antigonish-Guysborough County border. Locally at and around the Keltic Project Site, topographic features suggest that there may be a few low-lying drumlins. However, maps by Stea (1979), and Stea et al (1992) do not show any drumlins at the LNG Facility Site.

4.1.5.2 Past Mining

The greater Goldboro area has been the subject of gold mining activities during the late 1800's and early 1900's. Mines were established within the proposed Project Site boundaries including the McMillan Mine, west of Dung Cove, and the Mulgrave and Giffin Mines (also known as the Hattie Belt, Skunk Den Mine, or the Malloy, Eureka, Economy or Bluenose properties) (Figure 4.1-12).

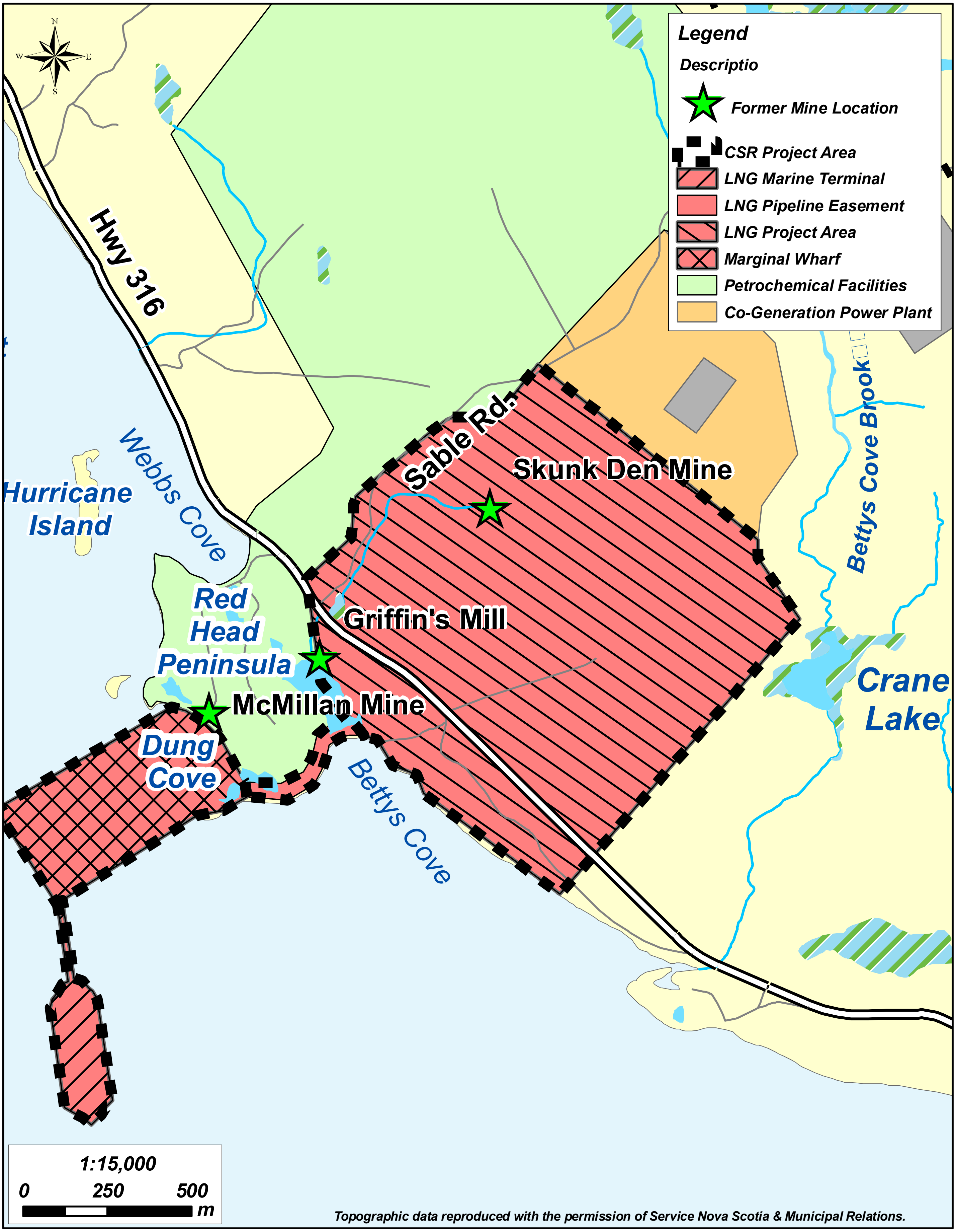
Very little information exists in the way of maps or cross sections of underground mine workings, of the actual quantities of ore removed from the underground, and gold recovered. Prior to about 1930, production statistics for Isaac's Harbour Gold District were recorded collectively with those from other nearby gold producing areas under the general heading "Stormont Gold District" (Tilsley, 1988). Included, in addition to Isaac's Harbour, were Forest Hill, Upper Seal Harbour, Lower Seal Harbour and Country Harbour areas. In addition, there is a general suspicion by geoscientists familiar with the area that as much as 50 percent of the total gold recovered from the region may have been removed by interveners – production which would not have made it to the records.

<u>Old Mine Workings</u>

Figure 4.1-13 is a map of the proposed Project Site that shows the location of former mine and associated workings inside the proposed Project boundaries as identified from an NSDNR Mines Branch database of mine workings and from direct observations in the field.

There is very little information on the underground workings in the area, although it is expected that workings inside the proposed Keltic Site boundaries may be up to 30 m or 45 m deep. Some of the old shafts and trenches are extremely dangerous, and some are known to be in direct hydraulic communication with the ocean (P. Smith, pers. comm., 2001).

In addition to digging into rock for gold, it is known that placers were explored, to a limited extent at least, off the shore of Red Head (Barrett, 1981), where some gold values and sulphide minerals were identified, albeit perhaps not in economic quantities.



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Projection: NAD83 CSRS UTM Zone 20N
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Figure 4.1-12
KELTIC PETROCHEMICALS INC.
Location of the McMillan, Mulgrave and Griffin Mines
JUNE 2007

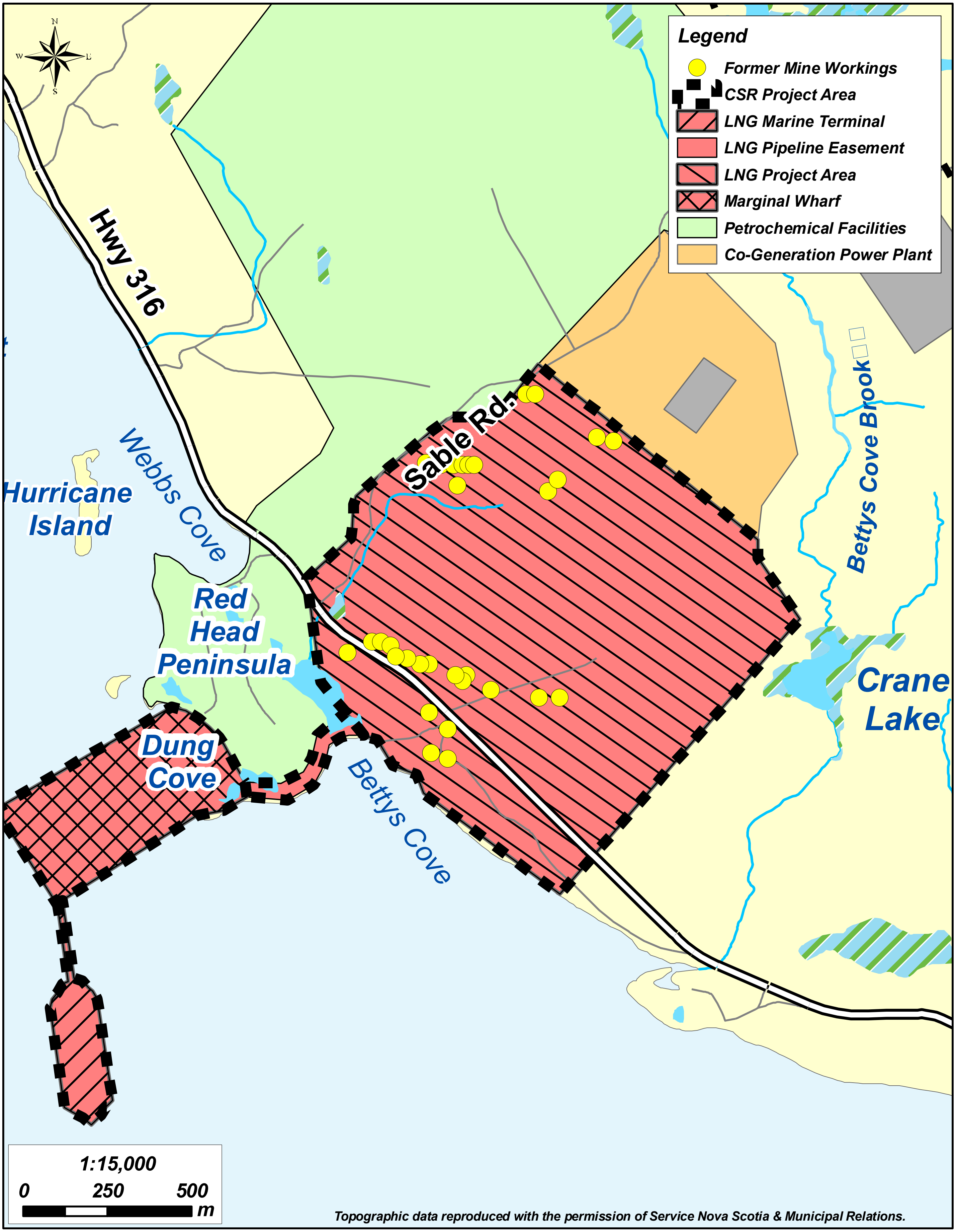

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Figure 4.1-13
KELTIC PETROCHEMICALS INC.
Location of Former Mine Works in the Project Site
JUNE 2007

Ore Mineralogy

The geology and mineralogy of the area was described in detail by Corey (1992). Gold in the area is commonly found in nugget form, as flakes of visible gold, or as gold associated with arsenopyrite and to a lesser degree, pyrite. Locally, arsenopyrite is the predominant metallic mineral, usually making 65% to 75% of the total. Pyrite accounts for most of the remainder. Galena, sphalerite, and chalcopyrite may, together, be 2% of the total sulphides (Tilsley, 1996a).

Inactive Tailings Disposal Sites

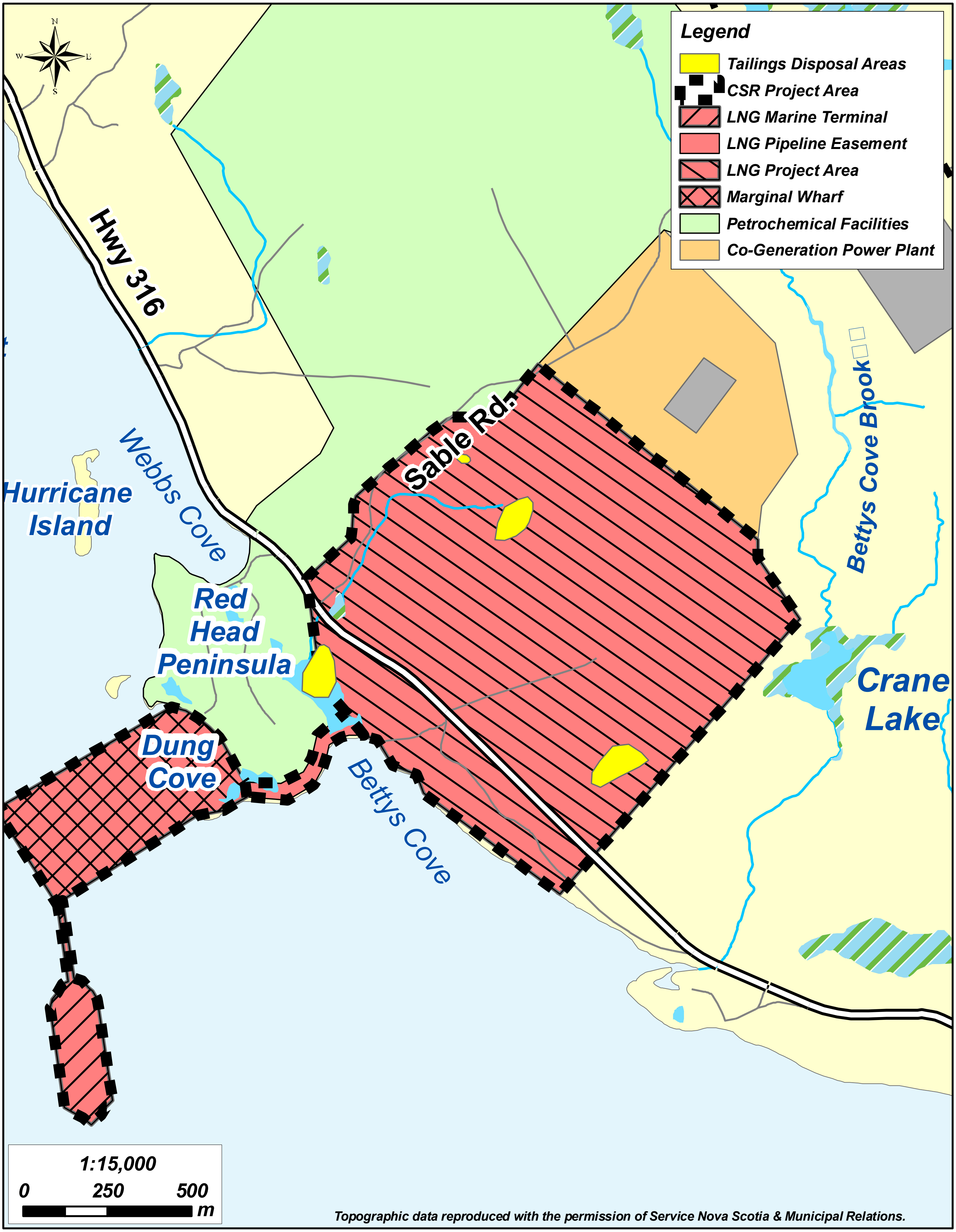
Gold mill tailings deposits remain as a legacy of the past mining activity in the area. Stamp milling and mercury amalgamation were the primary methods used for gold extraction in Nova Scotia and in the Goldboro area, much of which was done on-site; although there are reports that some sulphide mineral 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. Some of the free gold would combine with the mercury to form an amalgam, which was periodically scraped off the plates and heated in a retort to recover the gold. As a general rule of thumb, one ounce (oz) of mercury was used for each ounce of gold in the ore to obtain satisfactory recovery rates. At most stamp mills, 10-25% of the mercury used in the process was lost to the environment by loss with tailings, by evaporation during heating to recover gold, or by direct spillage (Smith, pers. comm. 2005; Parsons and Percival, 2005). Historical records of mercury loss from several gold districts range from 0.07 - 0.177 oz (5.5 grams) of mercury per tonne of ore crushed.

Recent investigations by Parsons et al. (2004) just outside the proposed KDP boundaries and at other sites in Nova Scotia have documented high concentrations of mercury (up to 350 milligram per kilogram (mg/kg)) and arsenic (up to 31% by weight) in mine wastes. The map in Figure 4.1-14 shows the location of tailings disposal areas identified by a geoscientist in the field within the proposed Keltic Site boundaries.

The remains of three former gold mills and three (possibly four) tailings disposal areas were found within the proposed Project boundaries during the field work. All that remains of the two steam-operated and one water-operated stamp mills today are the stone and concrete foundations.

One mill was located at Universal Transverse Mercator (UTM) 5001788N/606744E on the peninsula (proposed marginal wharf area) west of Dung Cove a short distance north of Red Head. The foundation remains suggest that this mill was small. It appears that tailings from it were disposed of directly into the ocean as no traces of any tailings could be found on land.



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June 2007
Drawn by S. Turner
Projection: NAD83 CSRS UTM Zone 20N
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Figure 4.1-14
KELTIC PETROCHEMICALS INC.
Location of Tailings Disposal Areas within the Project Area
JUNE 2007

Another mill foundation was located at UTM 5001948N/607073E, about mid-way between Route 316 and Dung Cove. The remains suggest that it may have been a small-to medium-size, water-powered mill. Tailings from it were disposed of directly into Dung Cove, and are easy to identify along a 50 m to 75 m stretch of the north shore of the cove, extending what appears to be some distance under water. Four samples were taken of these tailings for mercury and arsenic analysis as part of this EA; the results are presented in Table 4.1-21.

The third mill, a part of the Giffin Mine, was found at UTM 5002393N/607577E a short distance southeast of the SOEI gas plant road. Based on the foundation and boiler remains, this appears to have been the largest of the three mills. Tailings from it were disposed of in a 50 m by 30m area located a short distance down gradient and northwest of the mill (UTM 5002529/607507). This former tailings disposal area was assessed for possible gold reserves by Newbury (1974), and again about ten years later by Seabright Resources Inc. (1984). Seabright identified it as having an area of 1,584 metres squared (m^2), a tailings thickness of 0.70 m, and a volume of 1,113 m^3, containing 1,570 tonnes of tailings grading 0.70 grams per tonne (g/t) gold. Nine samples were taken of the tailings for this assessment for mercury and arsenic analysis – the results are in Table 4.1-21.

TABLE 4.1-21 Tailings Sample Results from Giffin Mine and Dung Cove Areas

Sample ID	Mercury		Arsenic		Location (UTM)	
	mg/kg	Detection Limit	mg/kg	Detection Limit	Easting	Northing
102F01-GMA1	24	1	1600	2	607496	5002544
102F01-GMA2	30	2	6700	2	607500	5002527
102F01-GMA2 Dup			6100	2		
102F01-GMA3	13	0.4	8000	2	607503	5002510
102F01-GMA4	11	0.2	2600	2	607516	5002513
102F01-GMA5	9.9	0.2	1100	2	607528	5002515
102F01-GMA6	19	1	2200	2	607525	5002527
102F01-GMA7	21	1	1600	2	607523	5002539
102F01-GMA8	26	1	1300	2	607510	5002541
102F01-GMA9	31	1	3400	2	607512	5002529
102F01-T1	4.7	0.1	1700	2		
102F01-T2	3.1	0.1	150	2	607056	5001928
102F01-T2 Dup			160	2		
102F01-T3	8.1	0.1	14	2	607069	5001912
102F01-T4	6.4	0.1	1100	2	607046	5001941
CCME*						
soil – agricultural	6.6		12			
soil – residential/parkland	6.6		12			
soil – commercial	24		12			
soil – industrial	50		12			
sediment – fresh water (ISQC)	0.170		5.900			
sediment – fresh water (PEL)	0.486		17.000			
sediment – marine (ISQC)	0.130		7.240			
sediment – marine (PEL)	0.700		41.600			

* December 2003. ISQC = interim sediment quality guidelines. PEL = probable effect level.

A fourth (possible) former tailings disposal area is present a short distance southeast of the third area. Based on Newbury (1974), and on the presence of healthier-looking vegetation than at the other sites, this was thought to be a water supply pond built for the mill described above, and thus no samples were collected. However, it was discovered after the field session that Seabright Resources Inc. (1984) had sampled this 65 m by 15 m pond and found gold to be present in it, thus suggesting that it was a tailings disposal pond and that it is likely to contain mercury and arsenic. Seabright identified this tailings pond as having an area of 1,026 m^2, thickness of 0.43 m and volume of 438 m^3 containing 617 tonnes of tailings grading 2.00 g/t gold.

All of the tailings samples collected during the assessment field session for which results are shown in Table 4.1-21 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).

4.1.5.3 Marine

Information regarding the marine environment was also derived from the CSR submitted by the EnCana Corporation in 2002 for the Deep Panuke Offshore Gas Development Project. The EnCana sub-sea pipeline crosses the Keltic Project Study Area to deliver market-ready gas to the M&NP main transmission line through Goldboro, Nova Scotia (Figure 4.1-1) and contains extensive environmental studies for this area.

According to the EnCana Corporation, 2002 Deep Panuke Offshore Gas Development Plan Application document, the bottom substrate of the nearshore region is composed mostly of rocks ranging from gravel to boulders interspersed with bands of sandy substrate (EnCana Corporation, 2002). Carbon concentrations are consistent throughout the area. The trace metals in the nearshore area with the highest concentrations are aluminum, barium, chromium, strontium, vanadium, zinc, and manganese (EnCana Corporation, 2002). Biogenic and petrogenic sources contribute to hydrocarbons in marine sediments (EnCana Corporation, 2002). With the exception of one sample, the petroleum hydrocarbon concentrations in the nearshore area are under the laboratory detection limit (Jacques Whitford Environmental Limited, 2002).

In May and August 2004, NRCan and DFO carried out a collaborative field program to determine impacts of historical mine tailings disposal on marine sediments and water in the Isaac's and Seal Harbour areas. Although these findings have yet to be published, consultation with NRCan has revealed some sampling sites in Isaac's Harbour show sediments containing elevated levels of arsenic and mercury that are in excess of the CCME Interim Marine Sediment Quality Guidelines (EnCana Corporation, 2006). These guidelines stipulate that concentrations of arsenic and mercury in sediments should not exceed 7.24 parts per million (ppm) and 130 parts per billion (ppb), respectively (CCME, 2005).

4.1.6 Description of Existing Ambient Air Quality

In general, the offshore areas of Nova Scotia have excellent air quality. Except for isolated sources, such as engine emissions from vessels transiting the area and a few exploration rigs and production platforms, there are no local sources of air pollution. The low-level air pollutants observed in the Study Area can be attributed to long-distance transport from cities along the Atlantic coast and in the northeast United States (EnCana Corporation, 2002).

It is likely that air quality in the Study Area falls within the desirable objectives of the federal classification and well within provincial limits, as evidenced by the results of the SOEI Onshore EEM air monitoring program at the gas plant in Goldboro (SOEI, 2001). These results show some detectable, and some non-detectable NO_x concentrations when the wind direction was from the gas plant toward the monitoring station. The magnitude of these concentrations was generally similar to the magnitude of NO_x from other wind directions; that is, very low, and likely due to vehicular traffic on the local road.

The specific air contaminants that are of most interest relative to the impact of the Keltic Facility operations, including the LNG Facilities, consist of the following:

- sulphur dioxide (SO_2), formed when fuel containing sulphur, such as coal and oil, is burned, and when gasoline is extracted from oil, or metals are extracted from ore;
- 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;
- total suspended particulates (TSP), PM with aerodynamic diametre less than a nominal 10 micrometres (PM_{10}) and less than 2.5 micrometres ($PM_{2.5}$), terms for particles found in the air, including dust, dirt, soot, smoke, and liquid droplets; and
- VOCs.

According to a 2003 emissions inventory reported by EC, the only other significant source of air contaminants emissions within 25 km of the Keltic Project Site is the adjacent SOEP gas plant and metering station. As a result of the lack of industry in the Project Area, the only available background air quality data consist of short-term monitoring data collected by ExxonMobil at their Goldboro Gas Plant as that facility is the primary contributor to ambient concentrations of most air contaminants in the area. Background ozone concentrations are primarily the result of long range transport of ozone and its precursors (i.e., NO_x and VOC) from upwind regions, primarily from the south and west.

Continuous monitoring for nitrogen dioxide (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 micrograms per metre cubed ($\mu g/m^3$) and the highest $PM_{2.5}$ value was 4.0 $\mu g/ m^3$.

4.1.7 Climatic Conditions

Nova Scotia has a “temperate continental” climate (Rudloff, 1981) marked by relatively large daily and day-to-day ranges of temperature, especially during the spring and fall, and moderate rainfall. This area lies in the "prevailing westerlies" that are characteristic of mid-latitudes in the northern hemisphere. Within this general circulation are embedded air masses originating at higher or lower latitudes that interact to produce storm systems. Nova Scotia experiences a relatively large number of storm systems that contribute to a roughly twice-weekly shift between fair and cloudy and stormy weather.

The continental climate is modified by Nova Scotia's surrounding waters (EC, 2005a). The Atlantic and Bay of Fundy waters are relatively cold (8-12^{o}C) which helps to keep the air temperature over southwestern Nova Scotia on the cool side in spring and summer. In January, when water temperatures are between 0 and 4^{o}C, winter temperatures become moderate. Farther offshore to the east, southeast, and south are the comparatively warm 16^{o}C waters of the Gulf Stream that are credited with prolonging warm weather well into October. Ice conditions in the Gulf of St. Lawrence retard the arrival of spring. Cool summer seas also help stabilize overriding air masses, thus suppressing local storm development. In addition, the merging of contrasting ocean currents (i.e., warm Gulf Stream and the cold Labrador Current) produces a great deal of sea fog that often moves far inland.

4.1.7.1 Temperatures

Winter temperatures are moderate along the coast. Yarmouth's average January temperature of -2.7^{o}C is the highest of any mainland station in the Maritimes. Inland, January means are between -4^{o}C and -6^{o}C. The most significant aspect of winter is the marked day-to-day variation caused by the alternation of Arctic and maritime air (EC, 2005b).

Summers are relatively cool in Nova Scotia. Afternoon summer temperatures reach 25^{o}C in the interior, but along the coast are frequently 4^{o}C to 6^{o}C cooler. At night the ocean remains a cooling source, keeping minimum temperatures along the coast about 2^{o}C to 3^{o}C below those inland. Halifax has a July mean temperature of 17.4^{o}C, while Yarmouth's mean July temperature is 16.3^{o}C.

4.1.7.2 Winds

Winds blow predominantly from the south or southwest in the summer with an average speed of about 10 to 15 kilometres per hour (km/hr). In the coldest months, the predominant direction is from the west and northwest with an average speed of 22 km/hr (EC, 2005b).

The wind at any given location is often quite different from the wind conditions which prevail even a short distance away. The variations that occur in both wind direction and speed results from the characteristics of natural and man-made obstructions, topography, and surface cover. Along the coast, an onshore sea breeze circulation often sets up, particularly during a warm, sunny afternoon in the spring or early summer (EC, 2005b).

Wind statistics taken between 1988 and 1999 from Beaver Island at the mouth of Country Harbour showed average monthly nearshore wind speeds between 19 and 31 km/hr. Extreme average hourly wind speeds ranged between 65 and 98 km/hr. Westerly winds predominated, with stronger winds more from the northwest (November to January) than the southeast (Meteorological Service of Canada, 2000).

4.1.7.3 Precipitation

Nova Scotia is wettest over the highlands of Cape Breton Island, where over 1600 mm of precipitation fall in an average year. The southern coast experiences almost as much, with totals of 1500 mm. By contrast, the north shore along the Northumberland Strait has less than 1000 mm a year (EC, 2005b).

Precipitation is slightly greater in the late fall and early winter because of the more frequent and intense storm activity. In most years there is a good supply of rain during the growing period. However, drought is not unknown in Nova Scotia.

On average, only about 15% of Nova Scotia's total annual precipitation originates as snow. Snowfall is relatively light near the warm Atlantic shore and near the entrance to the Bay of Fundy, where less than 150 cm may fall in one winter. Here, copious rain and freezing rain make up for the scanty snowfalls. Inland, the yearly snowfall increases to 250 cm. As a rule, elevated areas receive the greatest snowfall and have the longest snow cover season (EC, 2005b). The snow-cover season, that is, the period when there is at least 2.5 cm of snow on the ground, varies considerably. Usually its duration extends from about 110 days a year along the southern coast to 140 days inland and in areas adjacent to the frozen seas. In coastal areas the snow-cover may come and go.

4.1.7.4 Fog

Each year there is an average of 101 days with fog at Shearwater, although on most days fog persists for less than 12 hours. The period from mid-spring to early summer is the foggiest time. Bands of thick, cool fog lie off the coast, produced where the chilled air above the Labrador Current mixes with warm, moisture-laden air moving onshore from the Gulf Stream. With onshore winds these banks of fog move far inland. Sea fog often affects the headlands by day, moving inland and up the bays and inlets at night. At other times of the year fog is much more transient and local in nature (EC, 2005b).

Due to the extensive fogs, as well as mists, low cloud, and smog, sunshine amounts throughout the province are usually less than half the total possible. Sunshine totals range from 1700 to 1969 hours a year. July is the sunniest month inland, and August is the sunniest along the coast. Sunless days (days with less than 5 minutes of bright sunshine) amount to between 75 and 90 a year, with a marked seasonal high from November to February. Sunny days, on which less than 70% of the sky is covered with cloud in the early afternoon, amount to between 130 to 160, with a peak from July through October (EC, 2005b).

4.1.7.5 Severe Weather

Storms frequently pass close to the Atlantic coast of Nova Scotia and cross the southern part of Newfoundland, producing highly changeable and generally stormy weather. This region has more storms over the year than any other region of Canada. With a variety of weather conditions from hurricane-force winds to heavy precipitation, they can pass rapidly through or stall and batter the region for several days. Other conditions associated with these storms include freezing spray, reduced visibility in snow, rain, or fog, and numbing wind chills, especially in the storm's wake.

In late summer and fall the remnants of a hurricane or tropical storm are felt at least once a year in Nova Scotia. For example, on August 15-16, 1971, Hurricane Beth brought 296 mm of rain to Halifax, enough to wash away several bridges, damage buildings, and flood farmland (EC, 2005b).

Nova Scotia is not known for frequent thunderstorms but this type of weather condition occurs about 10 days of the year, about half the number that occur in northern and central New Brunswick. Tornadoes have been recorded but are rare. Reports of waterspouts over near-shore waters are received yearly (EC, 2005b).

Other severe weather phenomena include ice storms and blizzards. Each year one or two 25 cm snowfalls occur in Nova Scotia. When combined with strong winds, they can cause property damage and loss of life.

4.1.7.6 Normals and Extremes

The climate of the Keltic Project Site is best characterized by long-term meteorological data collected by EC at Stillwater-Sherbrooke (Table 4.1-22) and at Halifax-Shearwater station (Table 4.1-23). Stillwater-Sherbrooke is located approximately 25 km west of the Keltic Project Site. The Halifax-Shearwater station is located approximately 160 km southwest of the Keltic Project Site and is included for its wind speed and direction data and other parameters that are not available from Stillwater- Sherbrooke. These distances from the site support the spatial representation since they place them in the same general synoptic flow regime as well as most mesoscale systems. The Stillwater-Sherbrooke and Halifax-Shearwater stations are also located in a similar geographic setting as the Keltic Project Site and provide the commonly observed meteorological parameters.

Normal monthly precipitation is fairly uniform throughout the year at both stations with the larger amounts generally occurring in the fall and early winter months (90-148 mm per month) and the least amounts in the summer (97-112 mm per month). The annual average rainfall amount at Stillwater-Sherbrooke is 1,517 mm per year while at Halifax-Shearwater, it is 1,421 mm per year. Record 24-hour rainfall amounts of 142.6 mm and 184.9 mm have been recorded at Stillwater-Sherbrooke and Halifax-Shearwater, respectively. The average annual snowfall amounts at Stillwater-Sherbrooke and Halifax-Shearwater are 172.1 cm and 176.4 cm per year, respectively. Specific precipitation data for the Goldboro Region itself is explored in more detail in Section 4.1.1, where some 20 months of monthly precipitation is documented for Sherbrooke, Deming, Collegeville, Goldboro, and Salmon River, during the period from October 2001 through May 2003. Further details are provided in Figure 4.1-2 (Section 4.1.1), which indicates the location of study rain gauges and EC Climate Stations.

TABLE 4.1-22 Stillwater-Sherbrooke Climate Normals (1971-2000) and Extremes (1967-2001)

Temperature	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daily Average (°C)	-6	-5.7	-1.2	4	9.2	14.4	18.3	18.4	14.3	8.8	3.8	-2.2
Daily Maximum (°C)	-0.9	-0.5	3.6	8.4	14.6	20.3	24	23.9	19.8	13.9	7.8	2.2
Daily Minimum (°C)	-11	-10.8	-6	-0.5	3.8	8.5	12.7	12.9	8.7	3.7	-0.3	-6.5
Extreme Maximum (°C)	17.5	14.5	25.5	23.3	32	35	34	32.5	32.2	26.7	18.5	15.5
Date (yyyy/dd)	1995/16	1981/23	1998/31	1973/18	1992/22	1976/24	1999/18	1991/14	1969/01	1968/02	1983/05	1998/01
Extreme Minimum (°C)	-31	-39	-29	-12.5	-6.1	-2.2	3.5	1.7	-3	-7	-15.5	-32.5
Date (yyyy/dd)	1993/31	1985/07	1985/07	1986/05	1972/14	1969/01	1993/18	1968/20	2000/30	1993/11	1989/25	1989/29
Precipitation												
Rainfall (mm)	94.5	72.9	97.9	102.1	126.1	112.5	97.1	109.9	122.9	141.5	149	118.9
Snowfall (cm)	42.6	41.8	29.2	14.2	0.5	0	0	0	0	0	9.1	34.7
Precipitation (mm)	137	114.7	127.1	116.2	126.6	112.5	97.1	109.9	122.9	141.5	158.1	153.6
Extreme Daily Precipitation (mm)	96	71.2	80	85	105.9	78.7	75	134.8	142.6	81.3	89.6	114.3
Date (yyyy/dd)	1990/26	1988/16	1972/23	1982/28	1972/16	1970/27	1983/22	1990/01	1996/14	1967/10	1983/16	1975/10
Days with												
Maximum Temperature > 0 °C	14	14.3	24.5	29.5	31	30	31	31	30	31	28.8	20.9
Measurable Rainfall	6.2	5.4	7.2	9.4	11	9.9	8.5	8	9	10.9	11.4	8.4
Measurable Snowfall	7.3	6.7	4.3	2.3	0.15	0	0	0	0	0.08	2.2	5.7
Measurable Precipitation	11.6	10.5	10.2	10.9	11	9.9	8.5	8	9	10.9	12.4	12.4

EC, 2005b.

TABLE 4.1-23 Halifax-Shearwater Climate Normals (1971-2000) and Extremes (1944-2001)

Temperature	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Daily Average (°C)	-4.7	-4.5	-0.8	4.2	9.2	14.2	17.8	18.2	14.7	9.1	4.2	-1.6	6.7
Daily Maximum (°C)	-0.2	-0.2	3.2	8.1	13.6	18.7	22.1	22.4	18.9	13.1	7.8	2.6	10.9
Daily Minimum (°C)	-9.2	-8.8	-4.8	0.2	4.7	9.6	13.5	14	10.4	5.1	0.5	-5.7	2.5
Extreme Maximum (°C)	14.3	16.2	21.8	27.8	32	33	33.3	32.4	33.3	27.8	22.2	15.6	
Date (yyyy/dd)	1995/16	1994/20	1998/31	1945/11	1977/23+	1983/23	1963/26	1995/01	1945/08	1946/06	1956/01	1957/10	
Extreme Minimum (°C)	-26.5	-25.7	-22.2	-12.2	-3.3	2	6.7	5.6	-0.5	-5.6	-11.4	-23.5	
Date (yyyy/dd)	1994/26	1993/07	1948/06	1946/01	1945/03	1982/12	1946/04	1965/31	1980/29	1974/22	1978/27	1989/29	
Precipitation													
Rainfall (mm)	95.5	69.3	97.2	97.9	110.8	107.8	107.4	96.9	100.1	124.9	129	117.6	1254.3
Snowfall (cm)	43	40.3	30.9	15.6	2.3	0	0	0	0	1.6	9	33.6	176.4
Precipitation (mm)	134.7	107.4	127.3	114.3	113.5	107.8	107.4	96.9	100.1	126.6	137.1	148.3	1421.4
Extreme Daily Precipitation (mm)	78.2	87.9	70.4	96.9	91.4	80	131.6	184.9	90.8	78.2	70	111.3	
Date (yyyy/dd)	1958/16	1958/08	1972/23	1982/28	1947/01	1944/21	1954/20	1971/15	1996/02	1967/10	1991/11	1946/21	1254.3
Wind Speed													
Speed (km/hr)	18.1	17.7	17.8	16.9	14	12.8	11.3	11.1	12.8	14.8	16.5	17.7	15.1
Most Frequent Direction	W	NW	NW	N	S	S	S	SW	SW	W	NW	W	W
Maximum Hourly Speed	83	97	78	85	72	77	87	60	97	80	89	89	
Date (yyyy/dd)	1990/30	1963/20	1986/07	1962/13	1961/20	1964/12	1975/28	1956/08	1954/11+	1962/07	1958/29	1956/30+	
Maximum Gust Speed	127	146	148	122	106	111	114	93	126	132	121	150	
Date (yyyy/dd)	1960/03	1976/02	1976/17	1962/13	1961/03	1964/12	1975/28	1986/09	1958/29	1963/29	1963/08	1956/30	
Direction of Maximum Gust	S	S	SW	NE	W	NW	S	SW	N	S	NE	SW	SW
Days with													
Maximum Temperature > 0 °C	15.9	14	24.2	29.7	31	30	31	31	30	31	28.7	22.1	318.5

Temperature	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Measurable Rainfall	9.2	7	10	12.7	14.5	13.1	12.2	10.8	11.8	12.6	13.3	11.5	138.6
Measurable Snowfall	11.3	9.7	8.1	4.5	0.5	0	0	0	0	0.3	2.7	8.8	45.9
Measurable Precipitation	16.7	13.4	14.7	14.5	14.7	13.1	12.2	10.8	11.8	12.6	14.7	16.5	165.7
Other													
Sunshine Hours	111.7	127.5	143.1	155.4	195.9	221	227.8	229.6	181.9	157.2	113.3	100	1964.6
Daytime Relative Humidity (%)	76.3	73.4	72.7	69.3	69.8	69.5	71.2	69.5	66.8	67.7	72.3	76.6	71.2

The range of temperatures at the site is rather large from winter to summer. Summers are relatively cool, for example, the warmest average daily maximum temperature recorded at either station from June to August was 24^{o}C. The record high temperature at Stillwater-Sherbrooke is 35^{o}C in the month of June and is 33.3^{o}C at Halifax-Shearwater occurring in July and September. The average daily maximum temperature at Stillwater-Sherbrooke for July and at Halifax-Shearwater for August is 24^{o}C and 22.4^{o}C, respectively. Winters are cold with average daily minimum temperatures in January at Stillwater-Sherbrooke and Halifax-Shearwater of -11.0^{o}C and -9.2^{o}C, respectively. The lowest recorded temperature at Stillwater-Sherbrooke is -39^{o}C and at Halifax-Shearwater, it is -26.5^{o}C.

Winds at Halifax-Shearwater are fairly light with the highest speeds occurring in the winter with an average of 17.8 km/hr for those months. A peak gust of 150 km/hr was recorded in December 1956. The lightest winds occur in summer with a monthly average wind speed of 11.1 km/hr in August. The mean wind speed for the year is 15.1 km/hr. The prevailing wind direction at Halifax-Shearwater is from the south or southwest from May through September and from the west or northwest from October through April. There are no wind data available from Stillwater- Sherbrooke.

4.1.8 Marine Biophysical Environment

The Project (LNG facility including the marginal wharf and marine LNG Terminal area) is located near the coastal waters of Stormont Bay, Country Harbour, and Isaac's Harbour (Figure 1.0-1). This area is located within the Guysborough Harbours Unit, a coastal ecological zone characterized by long, narrow inlets with steep valley sides. The coastline is submerged, with parallel inlets and estuaries separated by headlands typically composed of greywacke or granitic bedrock covered with a thin layer of quartzite till. Glaciofluvial deposits of coarse sand and gravel are found in many of the river valleys, while the coastline is generally rockier with few sand beaches (NSMNH, 1996a).

Stormont Bay is predominantly covered with fine sand and silt with scattered rock shoals. The subtidal zone, generally extending to depths of about 15 m below mean low water, has a predominantly sand and gravel bottom (NSMNH, 1996a). The near-shore marine habitat at Red Head has a substrate of boulders, cobbles, and pebbles, with finer materials such as sand and gravel in more protected bays.

The Goldboro area was historically a site of active gold mining. Evidence of this activity can still be seen in the form of abandoned mine sites and tailings dumps. Gold mine tailings tend to be high in arsenic and mercury as a result of the gold extraction process. Several tailings sites have been identified near the main Keltic Project Site both on land and in the harbour. Sediment samples taken from the proposed wharf site do not show elevated mercury or arsenic levels and the terrestrial sites appear to be well contained.

A recent joint study by NRCan and DFO examined mercury and arsenic contamination levels in Isaac's Harbour and found that while there is a layer within the near surface sediment with an elevated metal content, the concentrations are within acceptable limits (Parsons, pers. comm., 2005). The sampling site nearest to Red Head shows almost no change in arsenic levels throughout the sediment column with a slight elevation of mercury near the surface of the sea bottom.

4.1.8.1 Wave Climate

Stormont Bay and the estuarial heads of Country Harbour and Isaac's Harbour are relatively open to the ocean and are therefore exposed to significant wave action. Although inner landmasses (such as Harbour Island) offer some protection from wave action, most shoreline in Stormont Bay is exposed and unsheltered. The predominance of large, cobbled beaches is indicative of this high-energy wave environment. Finer substrates, including silts, sands, and smaller pebbles, have been eroded or washed away. Coastline in the vicinity of the proposed Keltic wharf follows this pattern with rocky, coarse substrates dominating the shoreline.

There is little fetch and hence limited opportunity for coastal wind driven current to develop except in storms. Offshore wave statistics (AES40) show that most wave energy comes from the southern quadrant with the largest storms and waves occurring during winter months. Wave energy near the Project Site will be attenuated by the protection afforded by Country Harbour Head, other local protuberances, and by the effects of shoaling. However, it is expected that annual storm conditions may occasionally result in seas of 1-2 m in the deeper water near the face of the wharf and the LNG Terminal.

4.1.8.2 Currents

Ocean currents transport water from one region to another region, generally within an organized geographical flow (pathway) over a period of time. Currents are influenced by large global phenomenon (such as the Coriolis Effect), wind, tidal action, and also differences in pressure or density gradient caused by salinity, temperature, and water pressure. Tidal flow is the most dominant component affecting currents along inshore coastal regions (Cooperative Institute for Marine Atmospheric Studies, 2006).

Major currents on the Scotian Shelf are the Labrador Current and the Cape Breton current (which is the outflow of the Gulf of St. Lawrence). Mixing of these currents with more saline water from offshore creates the Nova Scotia Current, a southwesterly flow that predominates in Nova Scotia's nearshore areas year round. In more localized coastal areas such as Stormont Bay, tidal currents are forced back and forth parallel to the shoreline. In addition, freshwater inflows from Country Harbour River and Isaac's Harbour River contribute to increased circulation of water within the marine environment.

Current energy in this area is dominated by tidal flows. Some 'freshet' flow, primarily from Isaac's Harbour and Country Harbour Rivers, may have an influence in the spring. Relatively strong tidal streams of the order 10 cm/sec are predicted for near the proposed marginal wharf by simple models (i.e., based on the tidal prism) in response to the need for water to be transported upstream into Isaac's Harbour.

4.2 DESCRIPTION OF THE BIOLOGICAL ENVIRONMENT

An environmental evaluation was completed for the entire site of the KDP to document biological conditions including vegetation, fish and fish habitat, terrestrial wildlife and habitat, migratory birds, wetlands, and species at risk (Figure 4.2-1). This information is provided in Section 8.0 of the Provincial EA Report (AMEC, 2006). The description of the biological environment contained in this CSR is applicable to the Project as defined by the scope of the CSR, i.e., the LNG Facility, the LNG marine terminal the marginal wharf, and the marine environment potentially affected by the Project-related marine transport within a 25 km radius around Country Island.

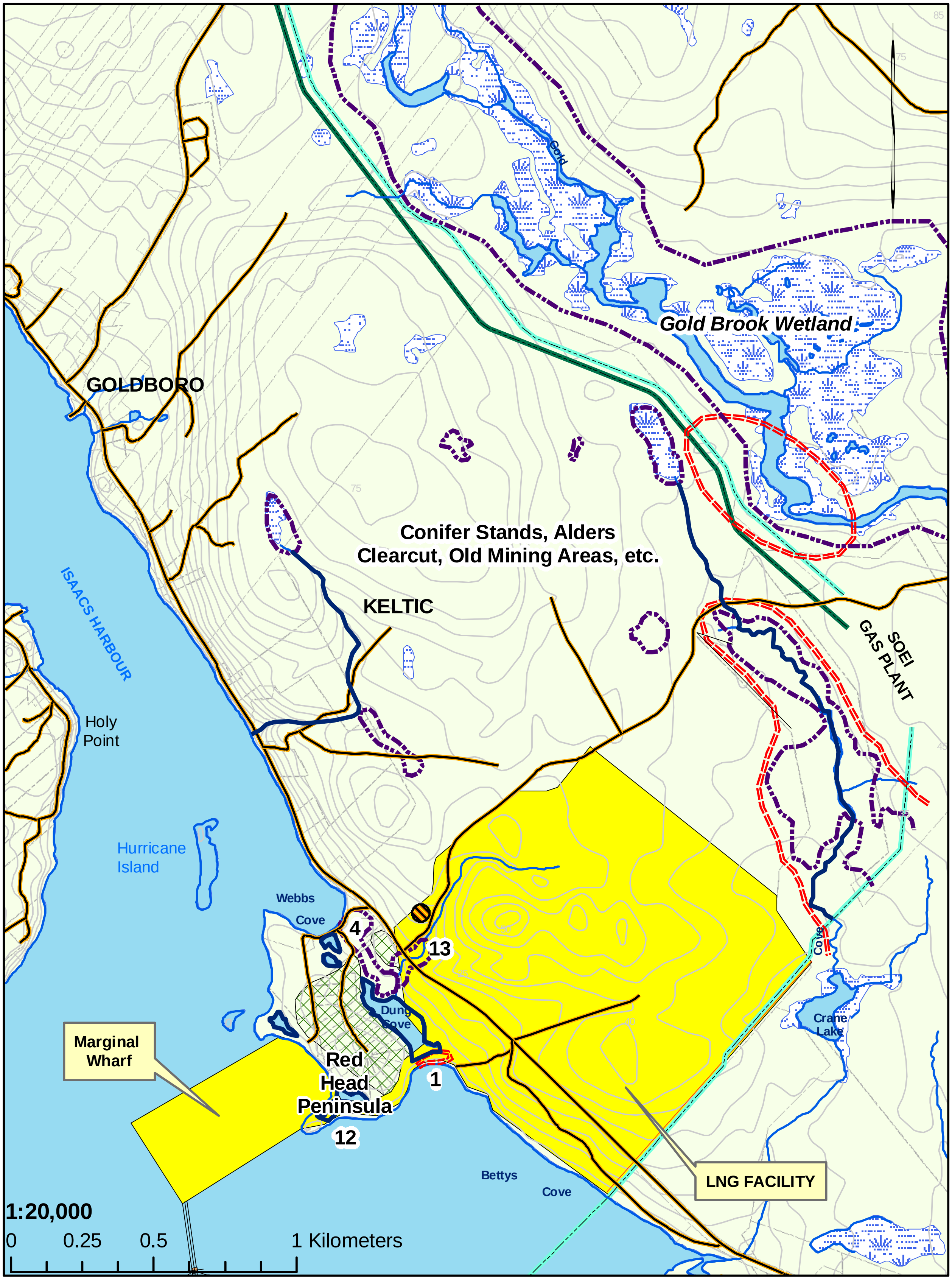
4.2.1 Vegetation

4.2.1.1 Terrestrial

The proposed LNG Facility Site lies within the East Atlantic Shore Section of the Acadian Forest Region (Rowe, 1972) which is essentially the Atlantic Coast Terrestrial Theme Region described in The Natural History of Nova Scotia, Vol. 2, Theme Regions (NSMNH, 1996a). This region is characterized by stands of black spruce (*Picea mariana*), balsam fir (*Abies balsamea*), white spruce (*Picea glauca*), and larch (*Larix laricina*) in the wetter areas. Immediately north and parallel to the coast line is the Atlantic Uplands Region (Rowe, 1972), which effectively is also the Atlantic Interior Terrestrial Theme Region (NSMNH, 1996a). Different authors (i.e., Rowe, 1972; Loucks, 1962; and NSMNH, 1996a) ascribe different terminology and locations to the vegetation between the Atlantic Uplands and the area of Antigonish. Nonetheless, the basic pattern is that on the higher, better drained areas to the north, deciduous species become more common, especially red and sugar maples (*Acer rubrum and Acer saccharum*), white and yellow birches (*Betula papyrifera and Betula alleghaniensis*), and beech (*Fagus grandifolia*).

The LNG Terminal area is located on a peninsula (approximately 35 ha). Much of the peninsular area reflects past farming activity as indicated by the presence of old-field. The southern half of the peninsula contains a mosaic of white spruce that has colonized the previously open old-field. Also, heath vegetation and alder (*Alnus sp.*) are dominant in much of this area. The southwestern tip of the peninsula is an exposed promontory known as Red Head. The three-toothed cinquefoil (*Potentilla simplex*), was found in one area; a species common to exposed sites. A portion of the terminal area from the base of the peninsula southeast to the site boundary is forested by mosaics of black spruce, balsam fir, and some white spruce. Much of this area has been clear cut. The vegetation assembly present in the area is identified in Figure 4.2-2.

Field studies on vascular plants were carried out in June, August, and early September, 2004, with a focus on the lake basins, New Harbour River, and the Keltic Project Site area. Additional field studies in June, July, and August, and early September, 2005, were carried out to complete the full season evaluations of vascular plants in all relevant areas, and to complete the evaluation of the Keltic Project Site proper.



Legend

Roads
Wetland Areas
Sensitive Areas-Birds
LNG Project Area
Deer Wintering Areas
Ponds/Streams
Rare Plant Lcoation

Note: See Text for Numbered Map Site Designations

FIGURE No. 4.2-1
KELTIC PETROCHEMICALS INC.
KELTIC PLANT SITE AND TERMINAL
June 2007

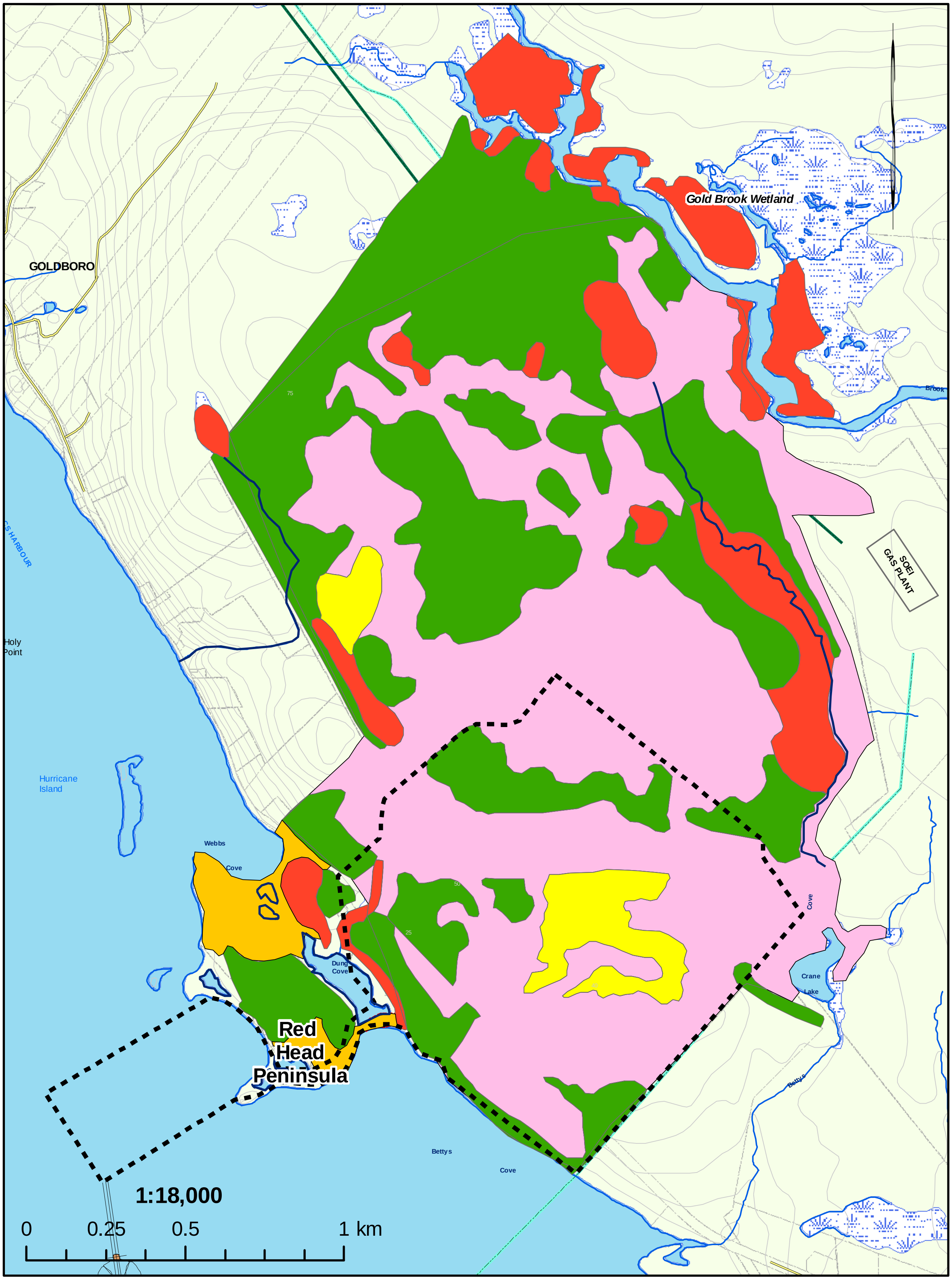


FIGURE No. 4.2-2

KELTIC PETROCHEMICALS INC.

VEGETATION TYPES

June 2007

Legend

LNG Project Area

Vegetation Type

- Clearcut, Brush, Barrens, and unclassified species
- Conifer Stand
- Intolerant HW/ Mixed Conifer
- Old Agricultural Fields
- Wetland, Fens and Treed Bogs

The complete list of vascular plants noted for all sites is provided, for comparison and to contribute to the regional context, in Appendix 7 of the Provincial EA Report (AMEC, 2006). A total of 305 vascular plants were noted in all sites combined of which 259 (85%) are native plants (AMEC, 2006). The number of species found at Gold Brook Lake and on the Keltic Project Site proper, including the LNG Facility Area, is shown in Table 4.2-1.

TABLE 4.2-1 Number of Vascular Plant Species

Study Site	# Native (%)	# Introduced (%)	Total Number
Keltic Site Proper	189 (80)	46(20)	235

*These values are greater than the total number in the overall Study Area as some will occur in more than one study site.

Not surprisingly the largest number of introduced species occurs in the Keltic Project Site/ LNG Terminal area. These are the areas that have been exposed to the greatest amount of human activity which introduces non-native species into an area, often inadvertently, and creates disturbances such as farming activity and road building where introduced species are at a competitive advantage. The Keltic Project Site is the most diverse, due especially to the LNG Terminal area with its marine influence and the greater number of introduced species.

No plant species observed is reported nationally rare or at risk, but one species, a horsetail (*Equisetum variegatum*), rare in Nova Scotia, (Zinck, 1998; Pronych and Wilson, 1993) was found on the LNG Site proper. The on-site location is shown in Figure 4.2-1.

Additional information regarding riparian vegetation is provided in Section 4.2.4 (Wetlands).

There are no terrestrial plant species of special status within the LNG Facility Area.

4.2.1.2 Aquatic (Vascular)

During the field surveys conducted in 2004 and 2005 fourteen aquatic vascular plants were identified. Aquatic vascular plants are defined as plants which reside within shallow to deep waters. Six species were found on the Keltic Project Site proper and are indicated in Table 4.2-2.

TABLE 4.2-2 Aquatic Vascular Plant Species at the Keltic Project Site

Family Scientific Name	Common Name	Habitat Requirements*
APIACEAE *Sium suave*	Water-parsnip	Wet meadows, shores, swamps, and shallow water.
HIPPURIDACEAE *Hippurus vulgaris*	Mare's-tail	Along damp shores and in shallow waters.
LENTIBULARIACEAE *Utricularia cornuta*	Horned Bladderwort	Acid peat bogs and on boggy shores.
HYDROCHARITACEAE *Vallisneria americana*	Water Celery	Shallow calm waters.
ACORACEAE *Acorus americanus*	Sweetflag	Marshes and shallow water.
SPARGANIACEAE *Sparganium angustifolium*	Bur-reed	Acid waters.

*Source: Zinck, 1998

Additional information regarding aquatic vegetation is provided in Section 4.2.2.2 (Freshwater Fish and Fish Habitat).

There are no vascular vegetative species of special status within the LNG Facility Area.

4.2.1.3 Plankton and Marine Plants

Plankton includes two groups of generally free-floating, microscopic plants (phytoplankton) and animals (zooplankton). These species are an integral component of the ocean food chain as they are the major food source for many larger animals. Therefore, plankton is a major factor influencing overall ecological productivity of marine habitats.

Marine plants, including algal and flowering species and phytoplankton are the primary producers in the ocean. In addition to being a major source of food energy in the ocean, marine plants also provide shelter and habitat for a variety of other marine animals. Major algal groups include encrusted algae and seaweeds, such as kelp. Marine algae generally require hard substrates to which to attach. Due to their requirement for sunlight, most marine algae are restricted to depths to which light can penetrate. Flowering plants include eelgrasses and coastal marsh grasses and are generally restricted to habitats with finer substrates, often within protected bays and inlets.

A shoreline survey conducted in November 2004 observed the presence of typical coastal intertidal communities dominated by rockweed (*Ascophyllum nodosum*) and bladder wrack (*Fucus sp.*). Kelp and other seaweeds are generally abundant in all nearshore areas of Stormont Bay. The marginal wharf is located on a peninsula (approximately 35 ha) where there are several small scattered ponds (Map Site 12, Figure 4.2-1), mostly near the shore line, and most of which are brackish to some degree. The shoreline vegetation is outlined in Table 4.2-3 and is typical of marine shores in this area of Nova Scotia.

TABLE 4.2-3 Marine Shoreline Plant Species Identified in the Peninsular Area

FAMILY Scientific Name	**Common Name**	**Habitat Requirements***
RANUNCULACEAE *Ranunculus cymbalaria*	Seashore Buttercup	Scattered along the coast in marshes, shores, and inland to salt springs.
CHENOPODIACEAE *Atriplex cf. patula*	Spreading Orach	Uppermost beach margins and on fallen soil bank.
CHENOPODIACEAE *Sueda maritima*	Sea-blite	Coastal sandy shores and in salt marshes.
BRASSICACEAE *Cakile edentula*	Sea Rocket	Coastal beaches.
FABACEAE *Lathyrus maritimus*	Beach Pea	Coastal areas on sandy or gravely beaches.
BORAGINACEAE *Mertensia maritima*	Sea Lungwort	Sandy or gravely sea beaches.
CHENOPODIACEAE *Salicornia europea*	Glasswort	Salt marshes and near inland salt springs.
CHENOPODIACEAE *Chenopodium album*	Lamb's Quarters	Cultivated and disturbed ground.
PLUMBAGINACEAE *Limonium carolinianum*	Sea Lavender	Coastal salt marshes and upper areas of sea beaches.
PRIMULACEAE	Seal Milkwort	Coastal salt marsh.

FAMILY Scientific Name	**Common Name**	**Habitat Requirements***
Glaux maritima		
APIACEAE *Ligusticum scothicum*	Scotch Lovage	Coastal headlands, margins of salt marshes and ledges.
PLANTAGINACEAE *Plantago maritima*	Seashore Plantain	Coastal areas in salt marshes, sands and ledges.
POACEAE *Elymus mollis*	American Dune Grass	Sea beaches and sands.
POACEAE *Elymus virginicus*	Wild Rye Grass	Open wet woods and on gravel strands.

*Source: Zinck, 1998

Significant seasonal fluctuations in biomass and productivity of nutrients, phytoplankton, zooplankton, and fish occur within the nearshore and estuarine habitats of Stormont Bay. Studies conducted for the SOEP showed a temporal relationship between primary and secondary producers and predator species, as phytoplankton concentrations are controlled by zooplankton predation in the spring and fall, and zooplankton populations are controlled by fish predation. This results in productivity pulses and population peaks, including a fall phytoplankton bloom.

Many of these ecological dynamics are emulated in Stormont Bay and the estuarial environments of Country Harbour and Isaac's Harbour. Higher levels of phytoplankton exist in the mouth of Country Harbour compared to Stormont Bay, which coincides with higher nutrient levels found in estuarial habitats (SOEI, 2000). Zooplankton concentrations show three seasonal peaks in St. Georges Bay- in early summer, for fish eggs, in mid-summer for copepods, and in late summer for larger copepods. Larger-bodied zooplankton is more prevalent in colder months, and smaller-bodied in warmer months (Davis et al., 2000). Kelp beds are known to provide important lobster (*Homarus americanus*) habitat and are a source of food for sea urchin (*Strongylocentrotus droebachiensis)*. Seaweed density in the Red Head area is variable. To the east, seaweed abundance is moderate and is restricted to lower intertidal and upper subtidal zones. Productivity northwest of Red Head was significantly lower (Envirosphere Consultants Limited, 2004). Other vegetated habitats, such as eelgrass beds, are also important and have a much higher abundance and diversity of species than adjacent non-vegetated areas.

There is no plankton or marine plants species of special status within the LNG Facility Area.

4.2.2 Fish and Fish Habitat

4.2.2.1 Marine Fish and Fish Habitat

In response to proposed and constructed industrial projects in recent years, several EAs and other studies have been completed over the past decade in order to assess the habitat of the area. These studies have led to an increased knowledge of the marine environment and a better understanding of fisheries capability. Results from these studies, in addition to other relevant marine and ecological research from elsewhere in the province, support general observations of the biophysical environment of Stormont Bay and surrounding areas.

Information has been compiled in order to help assess the habitat and biological productivity of Stormont Bay and surrounding areas, particularly in terms of its relevance to the proposed Keltic Facility. The types of studies carried out for each of these Projects are described below.

Previous Studies and Methodology

Habitat Surveys

Between 1995 and 1997, the Guysborough County Coastal Resources Mapping Project mapped the fish habitat of coastal Guysborough County (including Stormont Bay, the Keltic wharf area, and adjacent areas) based on traditional knowledge of fishers and other local residents and boaters. Areas of important fish habitat, including fishing areas for scallop (*Placopecten magellanicus*), lobster, and sea urchin were identified.

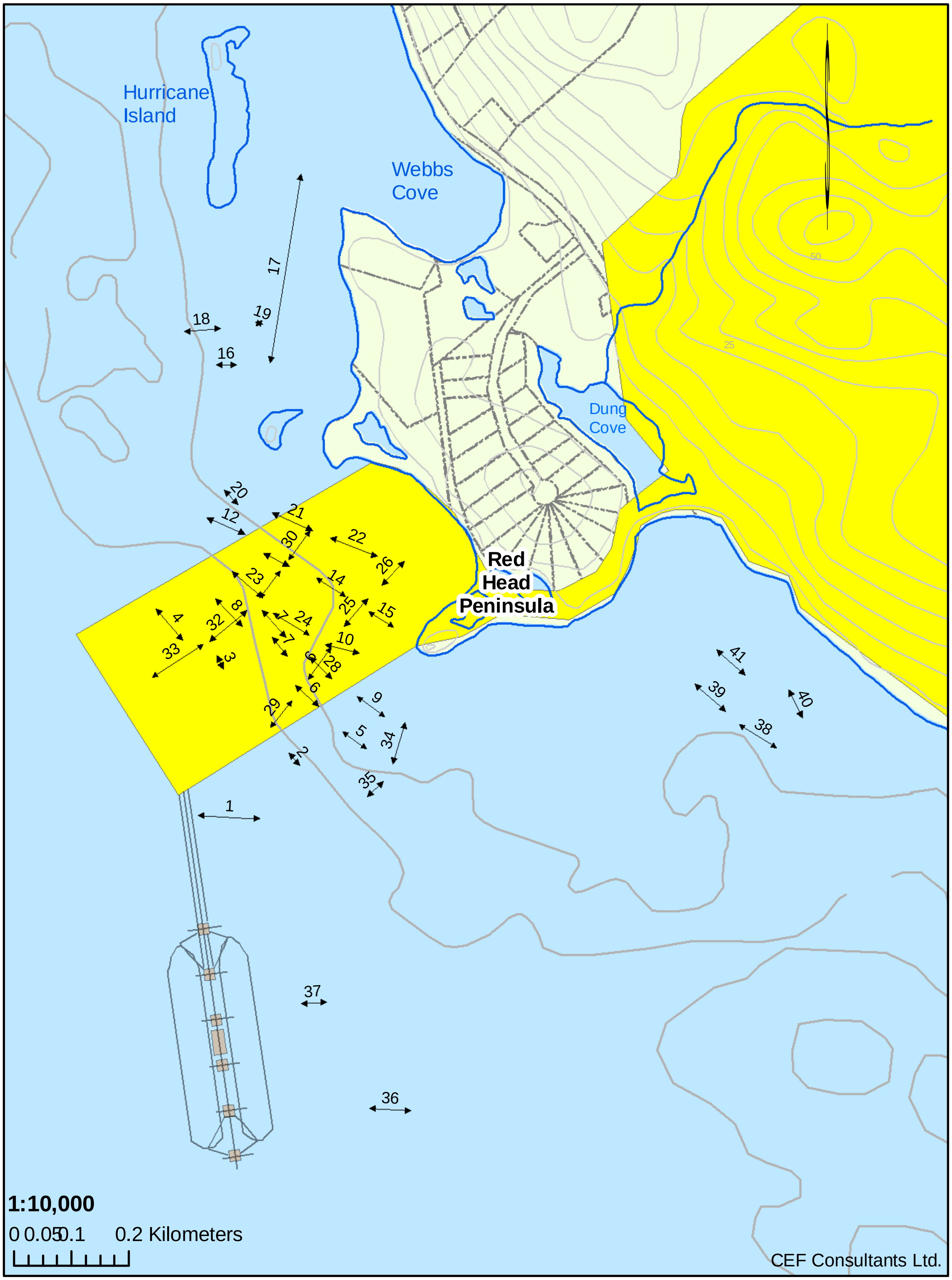
Between 1996 and 2000, studies were carried out during the planning, design, and construction phases of the SOEP, which was constructed to bring offshore gas into Goldboro near the proposed Keltic Facility. Biophysical studies included plankton surveys, sediment transport studies, and habitat assessments for species such as lobster and urchin.

EnCana Corporation’s Deep Panuke Project also proposed bringing offshore natural gas to shore in a marine pipeline near Goldboro. Fieldwork for an environmental impact assessment was conducted in 2001, and updated in 2005, and included an offshore benthic habitat and community survey.

Between 1996 and 2000, Canadian Seabed Research collected bathymetric and geological data within Country Harbour and Stormont Bay using sonar and seismic sounding equipment.

In 2004, Keltic initiated studies on the proposed marginal wharf and LNG Terminal site. These studies included a Remote Operated Vehicle (ROV) video survey (Figure 4.2-3) of marine habitat in the proposed site, a detailed intertidal habitat study of the surrounding shore, and a benchmark quadrat survey of selected sites in the vicinity.

Sampling and analysis of ocean floor sediments in Isaac’s Harbour was conducted by the Geological Survey of Canada (in association with the DFO) in May and August 2004. Work was performed to measure contaminant levels of mercury and arsenic in sediments associated with gold mine tailings. Due to the location of sampling sites, the work will not provide much information to characterize sediments in the area where Keltic is proposing to construct a marginal wharf. However, the collected information can be used to support broader inferences of ocean floor contaminants within the larger estuarial and bay ecosystems based upon biophysical factors such as sediment type and ocean currents.



Legend

LNG Project Area

ROV Transects

FIGURE No. 4.2-3
KELTIC PETROCHEMICALS INC.
REMOTE OPERATED VEHICLE TRANSECT LOCATIONS
June 2007

St. Georges Bay

The St. Georges Bay Ecosystem Project (GBEP) (Kellman et al, 2000) is a DFO supported initiative to gather existing information related to various biophysical and human use components of the estuarial and coastal zones in the St. Georges Bay area. The research was designed to improve overall understanding of abiotic and biotic ecological functions of the St. Georges Bay Ecosystem. This knowledge can be used to complement research in other marine environments in Nova Scotia, such as the estuarial and bay habitats in the area of the proposed Keltic Facility.

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.

According to the St. George's Bay Ecosystem Project website, "The GBEP is a collaborative partnership between the Interdisciplinary Studies in Aquatic Resources programme (ISAR), the following marine harvesters organizations in the Gulf of St. Lawrence: Gulf Bona Fide Fishermen's Association, Maritime Fishermen's Union (MFU), the Inverness South Fishermen's Association (ISFA), the Mi'kmaq Fish and Wildlife Commission (MFWC), and the Maritimes Region Fisheries Science Branch of the Department of Fisheries and Oceans (DFO). The GBEP is focused on St. Georges Bay, located in the Gulf Region of Northeast Nova Scotia, Canada. The intent of the project is to document and conduct applied analyses of the marine and human ecology of St. Georges Bay."

This project intends to bring government scientists, resource harvesters, and university-based researchers together in a long-term cooperative, collaborative, and interdisciplinary research project that emphasizes the development of working relationships and capacity. This interdisciplinary and inter-agency project will provide the foundation for new understandings respecting marine resources, the management of harvesting activities, and the development of sustainable marine resource harvesting livelihoods. It is also hoped that the Project will foster debate, education, and discussion with regards to public policy initiatives focused on the fisheries. ISAR and St. Francis Xavier University, through GBEP, will act as facilitator for this process. Keltic can gain a large amount of insight and information from the research that has been done and is currently on-going within St. George's Bay Ecosystem Project.

Nova Scotia Museum of Natural History (NSMNH)

The NSMNH issued a two-volume publication in 1996 entitled, "The Natural History of Nova Scotia". Volume I describe general habitat types found within Nova Scotia, including typical coastal and benthic habitats that occur along the Guysborough coastline. Volume II contains more detailed information specific to the region surrounding the proposed Keltic Facility that can provide a more complete picture of the region's ecology, including oceanography, climate, landforms, coastal regimes, geology, plants, and animals.

Marine Habitat

There is a diversity of marine habitats in Stormont Bay and surrounding area that includes freshwater, estuarial, nearshore, and deepwater environments. These habitats are defined by vegetation, type, and variability of ocean substrate, and shoreline and bottom topography. Habitat type is influenced by a number of factors including nutrient input, water temperature and salinity, depth and stability of the water column, tidal action, and wave action caused by wind and currents.

Freshwater inflow to Stormont Bay from the Country Harbour and Isaac's Harbour watersheds gives the harbours estuarial characteristics. The entrance to these harbours is unimpeded by the thick, glaciofluvial deposits (sills) found in many other inlets in the area, so water flow and mixing is less restricted (NSMNH, 1996a). This results in greater circulation of water and nutrients between Stormont Bay and the estuarine heads of the Harbours. The estuarine environment also receives greater saltwater inflow due to its openness to Stormont Bay. Country Harbour River and Isaac's Harbour River watersheds, in addition to smaller tributaries along the coastline, supply most of the freshwater to Stormont Bay. Freshwater inflow is highest in spring and winter, with peak flows occurring in April. In estuarial headwaters, freshwater will layer overtop of the deeper saltwater column beneath. The degree of mixing and circulation that occurs depends upon a number of factors including tidal influences, freshwater inflows, storm conditions, and saltwater inflow characteristics. Therefore, circulation patterns can vary seasonally and annually. The complex interaction between freshwater, tides, and geology creates a number of different estuarine habitat types, resulting in a greater diversity of species and higher productivity in this environment.

The Guysborough County Coastal Resources Mapping Project (GCIFA, 2001) mapped habitat types that support specific benthic invertebrates (such as lobster and scallop) in Stormont Bay and surrounding areas. Significant variation in the marine habitat occurs at water depths of less than 20 m and up to one kilometre from shore. The near-shore marine habitat at Red Head, the site of the proposed marginal wharf, has a substrate of boulders, cobbles, and pebbles, with finer materials such as sand and gravel prevalent in more protected bays. A narrow band of coarser sediment with relatively sparse macro algae cover stretches from the shoreline seaward for approximately 50 m. Marine plants such as kelp are associated with rockier areas, while eelgrass beds occur on sandy substrates (Figure 4.2-4). These habitat variations are similar to what predominates in nearshore coastal areas elsewhere in Stormont Bay.

Stormont Bay is open to the ocean and is not as influenced by fresh water inflows as Country and Isaac's Harbours; however, it is more susceptible to wave and ice action along its coastline (NSMNH, 1996a). Stormont Bay is predominantly covered with fine sand and silt with scattered rock shoals. The subtidal zone, generally extending to depths of about 15 m below mean low water, has a predominantly sand and gravel bottom (NSMNH, 1996a). Water depth is significantly greater towards the central part of the bay, and the ocean floor here is covered in soft, silty mud. This area is not considered significant lobster habitat but it does support a herring (*Clupea harengus harengus*) and mackerel (*Scomber scombrus*) fishery. Shallow, sandier shoals occur on either side of the entrance to Stormont Bay, the largest of these occurring near Harbour and Goose Islands and in the vicinity of Country Harbour Head see (Figure 4.2-5).

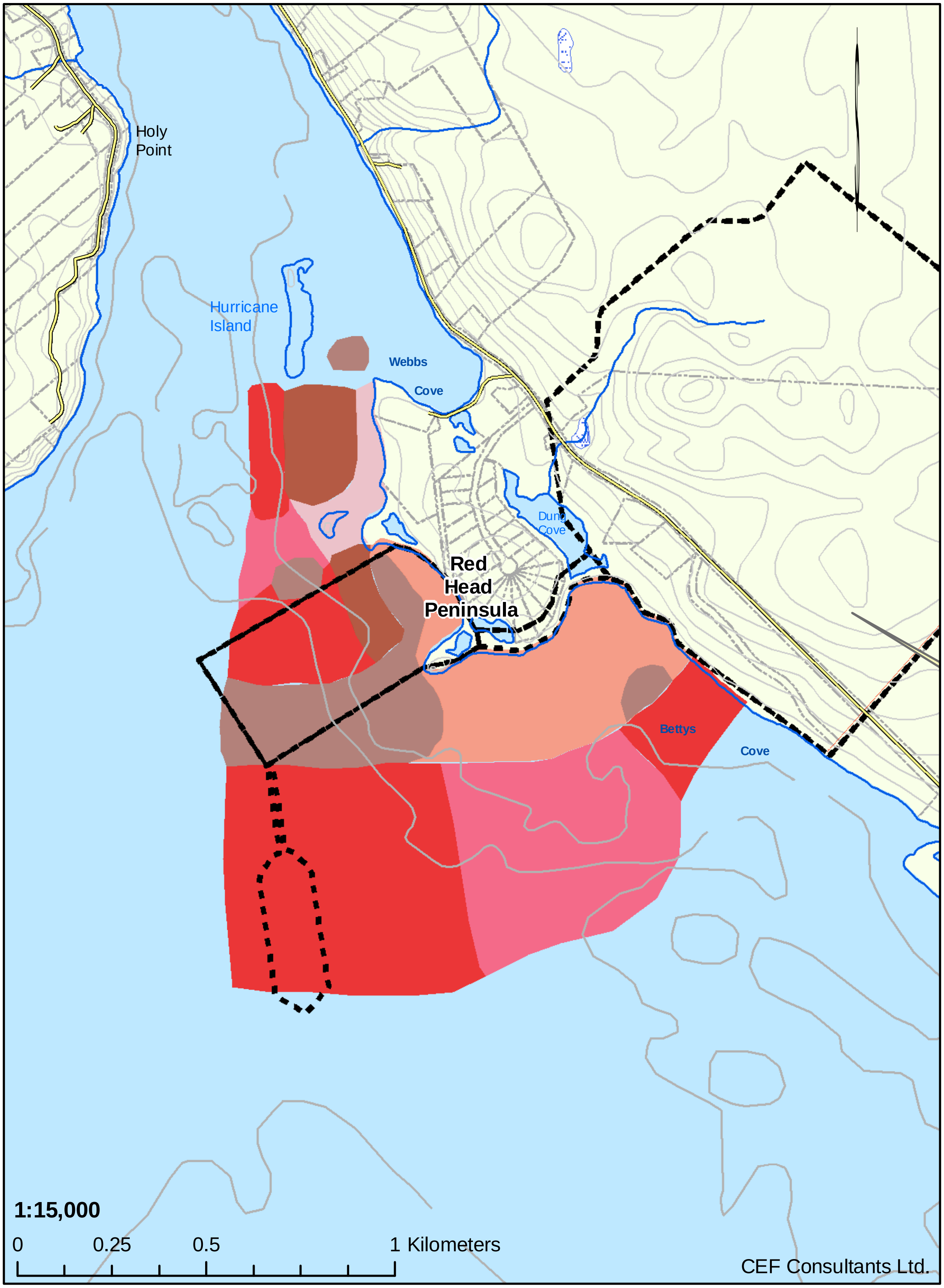


FIGURE No. 4.2-4

KELTIC PETROCHEMICALS INC.

FISH HABITAT IN THE VICINITY OF KELTIC FACILITIES

June 2007

Legend

- LNG Project Area
- Approximate Rock and Kelp Area
- Approximate Sand and Silt Area
- Inferred Sand and Silt Area
- Approximate Eelgrass and Sand Area
- Inferred Eelgrass and Sand Area
- Inferred Rock and Kelp Area

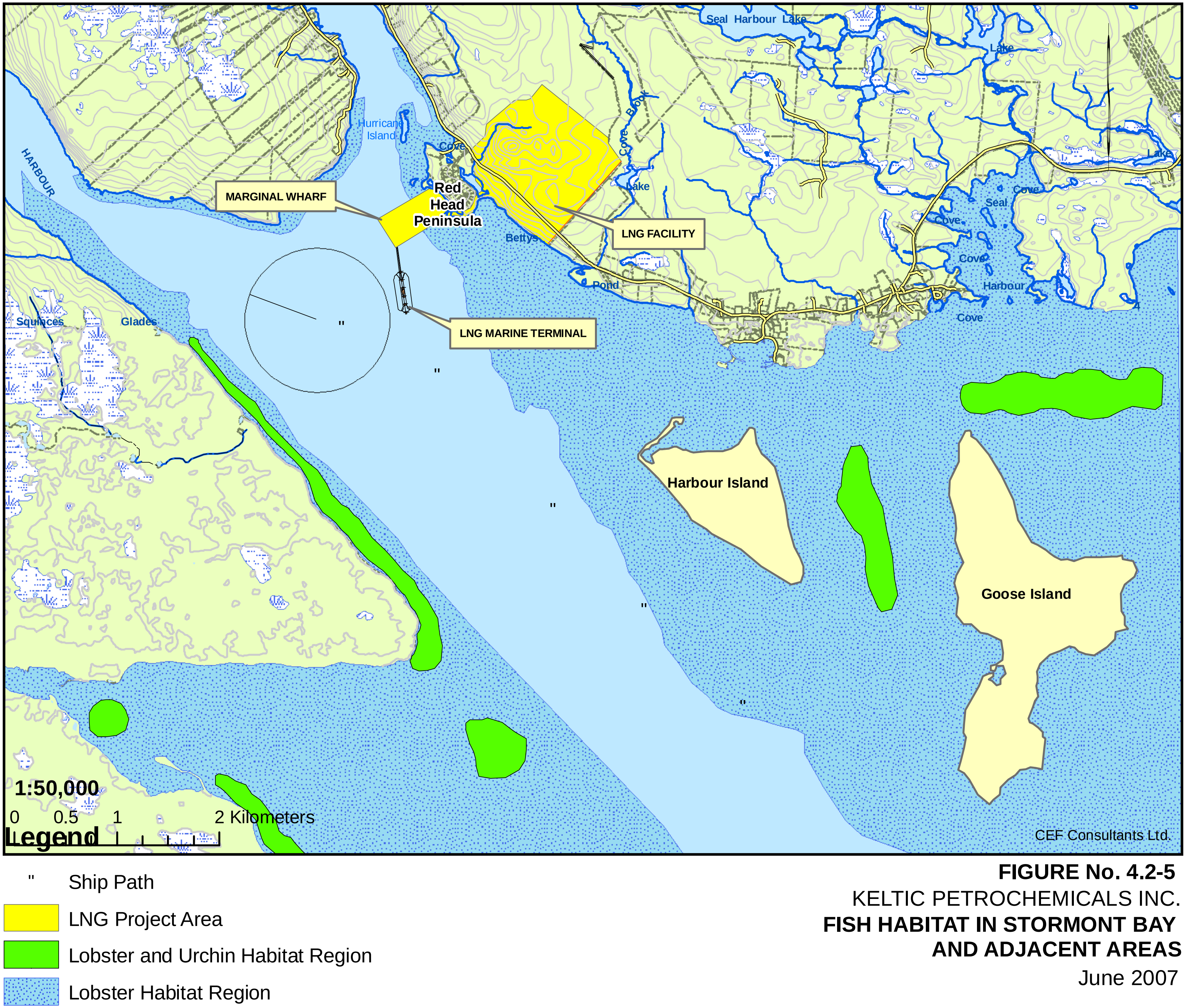


FIGURE No. 4.2-5
KELTIC PETROCHEMICALS INC.
FISH HABITAT IN STORMONT BAY AND ADJACENT AREAS
June 2007

The nearshore marine habitats of Stormont Bay and the estuarial habitats of Country Harbour and Isaac's Harbour (Figure 1.0-1) support a variety of marine organisms. Species include algae, phytoplankton, zooplankton, marine invertebrates, and estuarial, freshwater, and pelagic fish (Tables 4.2-4 and 4.2-5). Although overall species diversity is limited by the cold water, the variety of seabed habitats in the nearshore and estuarial environments somewhat offsets this limitation. Additional nutrient inputs from coastal salt marshes, eel grass beds, and freshwater tributaries increases the area's biological production, abundance, and diversity (NSMNH, 1996a).

TABLE 4.2-4 Marine Plant and Benthic Invertebrate Habitat

Group	Species	Habitat
Marine Plants	Irish Moss (*Chrondrus crispus*)	Sublittoral zone; rocky shores and tide pools, estuaries
	Sea kelp (*Laminaria longicruris)*	Below low tide mark; shallow sub-tidal to deep water; source of food for sea urchin
	Eelgrass (*Zostera marina*)	Sandy substrate; denser growth in shallow, clear water; location and abundance change over time
Benthic Invertebrates	Blue Mussel (*Mytilus edulis*)	Attach to rocks, wooden structures below low tide line; brackish, shallow estuaries and bays with elevated nutrient levels and increased phytoplankton levels
	Lobster (*Homarus americanus*)	Inhabit shallow to deep water with rocky bottoms; usually associated with kelp beds
	Rock crab (*Cancer irroratus*)	Inhabit shallow water with sandy bottom
	Sea urchin (*Strongylocentrotus droebachiensis*)	Prefers shallow (0-10 m), cooler water with high salinity, with hard to rocky substrates; associated with algae (especially kelp) as preferred food source
	Softshell Clams (*Mya arenaria*)	Settle in sandy or mud bottom substrate of bays and inlets; highest densities in shallow water
	Sea Scallop (*Placopectuun magellanicus*)	Found in sand or gravel substrate; water depths to 20 m

TABLE 4.2-5 Fish Habitat

Species	Habitat
Blueback Herring (*Alosa aestivalis*)	Anadromous (i.e., enters fresh water to spawn)
Mackerel (*Scomber scombrus*)	Juveniles in Stormont Bay throughout year, adults only spring/summer
Pollock (*Pollachius virens*)	Young (0-1 years old) move inshore during summer;
American Eel (*Anguilla rostrata*)	Catadromous (i.e., spawn at sea), lives most of life in freshwater as juveniles until spawning
Gaspereau (*Alosa pseudoharengus*)	Anadromous, enters fresh water to spawn in spring and leaves afterwards; inhabits bays, estuaries, and fresh water
Salmon (*Salmo salar*)	Anadromous; inhabits fresh water for first 2 or 3 years; prefers large, cool rivers with gravel bottom headwaters; present in Stormont Bay throughout summer
Cunner (*Tautogolabrus adspersus*)	Nearshore inhabitant; bottom /near bottom; shallow coastal waters; often around wharves, eelgrass, submerged seaweed; avoids brackish water
Tomcod (*Microgadus tomcod*)	Nearshore, shallow water; brackish or fresh water in estuaries and rivers
Winter flounder (*Pseudopleuronectes americanus*)	Nearshore inhabitant; shallow water, mud or sand; with or without vegetation; will feed in estuaries
Smelt (*Osmerus mordax*)	Anadromous; enters estuaries in fall and winter; present in Stormont Bay year round; spawns in freshwater in spring

EnCana conducted benthic sampling in 2002 within the Keltic Study Area, to characterize the benthic habitat along the nearshore sections of the Deep Panuke pipeline route to shore. There data is extremely relevant to the environmental effects of pipeline on nearshore environment.

They identified several macrobenthos species including: *Fucus vesiculosis*, *Laminaria* sp., blue mussels, *Corallina officinalis*, barnacles (*Balanus sp.*), amphipods, isopods, periwinkles (*Littorina littorea*) and, sea stars (*Asterias forbesi*). Rocky substrate in the nearshore is important for seaweed habitat, which is dominated by barnacles, whelks, hermit crabs, sea urchins, lobsters, rock crabs (*Cancer irroratus*), blue and hore mussels, small crustaceans, polychaetes, bryozoans, sponges, tunicates and other invertebrates. Marine algae are limited to relatively shallow depths by light availability. These are all species pervasive to the coastal rocky intertidal zone. In-depth surveys along the nearshore environment of the pipeline corridor determined that the most common macrofauna were sea stars and bivalves (EnCana Corporation, 2002).

Some species of marine fish found within proximity of the Project Area have special status and are discussed further Section 4.2.5.

<u>Marine Fish</u>

Fish are the most abundant and diverse group of vertebrates in the ocean, with 538 species recorded in the Canadian Atlantic Region alone. Three main groups of fishes are represented in Nova Scotia waters: jawless; cartilaginous; and bony fishes (NSMNH, 1996a, and b).

The familiar commercial species of marine fish in Nova Scotia make up only a small proportion of the total number of species. Numerous lesser-known, but in some cases abundant, species inhabit the different marine and estuarine habitats. Changes in the species assemblages have resulted in the following trends over the last two decades (EnCana Corporation, 2002):

- groundfish resources have declined precipitously;
- invertebrate stocks have increased; and
- overall shifting to harvesting the lower trophic levels (i.e., invertebrates).

<u>Habitat and Occurrence</u>

The marine fish likely to be found in the waters off Nova Scotia may be divided into five groups:

- estuarial and coastal species;
- groundfish (demerasal);
- pelagic species;
- mesopelagic (intermediate depth) species; and
- exotic warm-water and eastern-arctic species.

Shallow-water environments offer more opportunities for specialization and therefore have high species diversity. Further offshore, species diversity is lower but the biomass is high (NSMNH, 1996a and b).

Estuarine and Coastal Species

Up to twenty fish species are commonly found in estuaries around the coast of Nova Scotia. They include species that remain in estuaries for their entire life cycle or migrate into fresh water for short periods to spawn. Anadromous fish that pass through estuaries on their way to spawning grounds in freshwater include gaspereau (*Alosa pseudoharengus*), Atlantic salmon (*Salmo salar*), Atlantic smelt (*Osmerus mordax*), and American shad (*Alosa sapidissima*). Species, such as brown trout (*Salmo trutta*), brook trout (*Salvelinus fontinalis*), and four species of stickleback (*Gasterosteus sp.*), which typically live in fresh water, often feed in coastal estuaries during parts of the year because of the abundance of food and favourable temperatures. The juveniles of many demersal (bottom) and pelagic fishes (open ocean), such as cod (*Gadus morhua*), pollock (*Pollachius virens*), and herring, also feed in coastal environments (NSMNH, 1996a and b).

Groundfish (Demersal) Species

Groundfish occur both offshore and in coastal inlets and estuaries. They live close to the bottom for much of their adult life. The shallow waters close to Sable Island are an important nursery area for many juvenile fish. Sand lance and juvenile groundfish also provide food for seals and seabirds.

Studies on the Scotian Slope have placed fish within various assemblages. In the shallow slope waters (>200 m), redfish (*Sebastes sp*.) predominate. White (*Urophycis tenuis*), red (*Urophycis chuss*), and silver hake (*Merluccius bilinearis*), American plaice (*Hippoglossoides platessoides*), witch flounder (*Glyptocephalus cynoglossus*), and Atlantic argentine (*Argentina silus*) also occur in these waters. Fish, more characteristic of slope waters, occur deeper than 800 m (Markle et al., 1988).

Pelagic Species

Pelagic fish travel mostly in large schools, feeding primarily in surface waters or middle depths. Key commercial species on the Scotian Shelf include Atlantic herring, Atlantic mackerel (*Scomber scombrus*), tuna, swordfish (*Xiphias gladius*), and porbeagle shark (*Lamna nasus*). Other pelagic species include capelin (*Mallotus villosos*), which appear to have increased in abundance during the recent period of declining water temperature, as have many coastal and estuarine species.

Mesopelagic Species

Mesopelagic species, including lanternfish (myctophids), live on the Continental Slope and are unlikely to be seen in inshore waters. Many of these deepwater species migrate vertically towards the surface at night and toward the bottom by day.

Data on mesopelagic species in the Study Area were compiled from surveys along the Scotian Slope from 1984 to 1989 by Halliday et al. (1995). More than 200 species of mesopelagic fish were found. Many have a predominately southern distribution, with a large number of expatriates from tropical waters. Lanternfish dominated; other predominant species included lightfish (Gonostomatidae), viperfish (Chauliodontidae), silver hatchetfish (Sternoptychidae), scaled dragonfish (Stomiidae), sawpalate (Serrivomeridae), snipe eel (Nemichthyidae), dogfish shark (Squalidae), longneck eel (Derichthyidae), and gulper (Eurypharyngidae).

Exotic and Transient Species

The diversity of the coastal fish fauna off Nova Scotia is increased by a number of exotic visitors brought in by warm water currents from the continental slope. Studies in St. Margaret's Bay and Prospect Bay yielded 31 species from warmer waters, including flying fish, seahorses (*Hyppocampus sp.*), Priacanthids, and mullet (*Mugilidae sp.*). Several species of shark are also found in the warm waters of the Gulf Stream. In addition, several species of eastern origin, such as Greenland cod (*Gadus ogac*), mailed sculpin (*Triglops murrayii*), and Arctic eelpout (*Lycodes reticulatus*), have been recorded from cold-water areas on the banks and eastern shore.

Transient species, typically with a southern distribution, that migrate seasonally to or through the Study Area include species such as bluefin tuna (*Thunnus thynnus*), swordfish, sunfish (*Mola mola*), and basking sharks (*Cetorhinus maximus*). There are occasional inshore species, such as salmon, sturgeon (*Acipenser sp.*), and species from deep water such as grenadiers (Macrouridae). These occasional visitors are not of local commercial importance.

Seasonal Occurrence

The following discussion on movements of major fish species within the Study Area has been largely adapted from the EnCana Corporation reports (2002 and 2006), and from SOEP (1996).

Major seasonal movements of fish include the shift of many groundfish species, including cod and haddock, from deeper warmer waters around the edges of the banks in winter, to the surface of the banks in the summer. Herring and mackerel also show major spring and fall movements, with major concentrations of herring overwintering in Chedabucto Bay. Shark also move onto the Scotian Shelf as waters warm in the spring, returning south in the fall. Large pelagics, tuna, and swordfish, show migration patterns also related to water temperature, with fish following the Gulf Stream in spring and then moving towards the Shelf Slope in summer. The distribution of the fisheries can provide a good indication of areas where fish may be found at different times of the year.

During winter, most groundfish species move off the tops of the banks to deeper, warmer waters along the bank edges and in the adjoining basins (Scott and Scott, 1988). These include cod, haddock, silver hake, mackerel, American plaice, redfish, wolffish (*Anarhichas lupus*), and argentine. Other species more tolerant of colder temperatures, including yellowtail and most skate species, remain on the banks during the winter. Of particular note is the presence of winter flounder on Sable Island Bank. Witch flounder, wolffish, and monkfish (*Lophius americanus*) appear to remain in the same general location throughout the year (Kulka and Stobo, 1981). Reports from the winter herring fishery indicate that fish have shifted from the traditional wintering grounds in Chedabucto Bay to an area off Halifax (Stephenson et al., 1995). The winter months are peak spawning periods for several species including American sand lance and pollock. Migratory species such as tuna and swordfish are not found in the Study Area in winter.

As surface waters warm in the spring, groundfish such as Atlantic cod, haddock, silver hake, and American plaice move into shallower water on the banks. Deeper water species, such as Atlantic argentine, white hake, and redfish, remain in the deeper areas along the Shelf edge. In the spring, many species migrate over the Scotian Shelf on the way to summer feeding or spawning grounds. Spring is a peak spawning period for species such as herring, haddock, American plaice, argentine, and redfish. In recent years, the traditionally significant spring spawning of Atlantic cod has all but disappeared.

In summer, most groundfish species are dispersed over the tops of the banks. Species found on the banks include: Atlantic cod, haddock, silver hake, winter flounder, American plaice, thorny skate, and wolffish, yellowtail, halibut, winter skate, barndoor skate (*Dipturus laevis*), sand lance, mackerel, and squid.

In early fall, migratory species present on the Scotian Shelf move offshore, to the south. Atlantic mackerel migrate south through the area to wintering areas along the Shelf off Sable Island Bank, beginning in October. Tuna, swordfish, and shark leave the Shelf by November. Squid move offshore toward the Gulf Stream in October and November. In late fall, as the surface temperature drops, adults of most groundfish species move into deeper waters along the bank edges and the basins. Atlantic cod move to the Sable Island/Western Bank area for spawning. Haddock range over the Middle, Western, and Sable Island Banks. Redfish move to the southern edges of Sable Island Bank. Juvenile fish (i.e., silver hake, haddock) move to deeper waters. Winter flounder remain in the shallow areas of Sable Island and Western Banks.

Some species of marine fish found within proximity of the Project Area have special status and are discussed further in Section 4.2.5.

Benthic Invertebrates

Benthic organisms are the main food source for commercial fish species and are extremely diverse. The settlement and survival of marine benthic community assemblages in the Project Area are largely dictated by the nature of the substrate types that occur there, as well as additional factors such as currents, sediment type, temperature, salinity, and quality and quantity of the food supply. The success of settlement is dependent upon physical factors, such as temperature, level of biological productivity in overlying waters, bottom current, wave energy, and seabed stability. In the nearshore subtidal environments, diverse marine algae and associate fauna can occur, for example, sea urchins, mussels, gastropods, starfish (*Asterias sp.*), and barnacles.

Off the Nova Scotia coast, the rocky subtidal zone typically extends to about 15 m below the mean low water mark and grades into sand/gravel sedimentary bottom. Coastal marine habitat in Stormont Bay can be divided into intertidal (littoral) and subtidal (sublittoral) zones. The littoral zone, which exists between high and low tide, contains habitat for invertebrates adapted to growing on rocky surfaces that are able to withstand tidal and/or wave action. These include a variety of species from microscopic zooplankton, grazers such as chitons and limpets, filter feeders like barnacles (*Semibalanus balanoides*) and blue mussels, and larger crustaceans, such as rock crabs. Rockier areas within the sublittoral zone, which exists beneath mean low tide, support mussels, rock crab, lobster, sea urchin, and sea stars (McLaren, 1996). Other marine organisms typical of these areas include periwinkles (*Littorina littorea*, *L. saxatilis*, and *L. obtusatus*) and amphipods such as *Hyale nilssoni* and *Gammarus* species (Envirosphere Consultants Limited, 2004).

There are no benthic invertebrates of special status within the marginal wharf and LNG Terminal area.

Marine Mammals

Whales and seals are found throughout the Scotian Shelf, with fewer species in inshore waters. NSMNH (1996a) listed 21 species of whales, dolphins and porpoises in Nova Scotian waters, and 6 species of seals (NSMNH, 1996a and b).

Stormont Bay/Country Harbour is not an important area for cetaceans (NSMNH, 1996a). Whales or seals may enter the area following schools of herring or mackerel from spring to fall and seals frequently haul out on the shoreline (NSMNH, 1996a).

Whales

The general distribution of whales on the Scotian Shelf defines important areas of marine production, areas that are often associated with the edges of banks, the slope of the Shelf, and inlets or canyons (Sutcliffe and Brodie, 1977). The ocean dynamics associated with these bottom features result in higher levels of biological production. Filter-feeding baleen whales are attracted to areas with high densities of large copepods and euphausiids that can be efficiently harvested (Brodie et al., 1978). The larger copepods (McLaren et al., 2001) and euphausiids (Herman et al., 1981) are known to become concentrated in deeper waters of the Scotian Shelf basins and off the Shelf break through advection and vertical (including seasonal) migration.

Most baleen whales that occur in the northern hemisphere feed in higher latitudes in summer, exploiting biologically productive areas in the northwest Atlantic and the Gulf of St. Lawrence and moving south for the winter; mating and calving usually take place on the winter grounds (NSMNH, 1996b). Nonetheless, some individuals could be found throughout the year, albeit in lower numbers in winter than in summer. The Scotian Shelf has is a region of high diversity of prey items, and baleen whales have adapted their seasonal feeding strategies, as well as fat storage, accordingly (Brodie, 1975). Small toothed whales, dolphins and porpoise, occur on the Scotian Shelf year round. In general, most species appear to frequent the Shelf during summer and early fall, moving to the southwest as winter approaches (Kenney, 1994). This probably coincides with seasonal distributions of favoured prey.

The larger toothed whales (sperm and northern bottlenose) are associated with deeper waters, inlets, and canyons, where they feed on deepwater squid and fish. The association of the bottlenose whale with the Gully (a large submarine canyon located near Sable Island) is well known, although recent work (Gowans, 1999) indicates that only about one-third of the population of 130 is present in the Gully at any given time; presumably others are dispersing north and south along the Shelf slope. Sperm whales (*Physeter macrocephalus*) are more likely to venture out of the deep water than bottlenose, sometimes moving onto the banks of the Scotian Shelf (Sutcliffe and Brodie, 1977). The pilot whale (*Globicephala melaena*), a medium-sized toothed whale, feeds over a wide range of the Scotian Shelf, as evidenced by their status as the most abundant whale in Sable Island strandings (Lucas and Hooker, 2000). During spring and summer, this species feeds on squid and fish along the shelf break, but are often found over banks, and may move across the Shelf to the nearshore by late summer (Kenney, 1994). Pilot whales are observed in large numbers on both coasts of Cape Breton Island, following shoals of mackerel, and occasionally stranding in groups (EnCana Corporation, 2002).

Dolphins can range throughout the Scotian Shelf, over deep water on the Shelf break, and into coastal inlets and harbours. Groups of Atlantic white-sided dolphins (*Lagenorhynchus acutus*) occasionally enter Bedford Basin during the summer, feeding for several weeks (EnCana Corporation, 2002).

Reasonably reliable whale catch and sighting data are available from Sutcliffe and Brodie (1977) based on the former commercial whaling operation out of Blandford, Nova Scotia. Whaling data are biased by effort, and are limited by poor spatial and temporal coverage. Few records exist for the eastern portions of the Scotian Shelf and Slope, or in the winter. These data were re-plotted by Kenney (1994) with additional data.

Intensive surveys for whales occurred during the Department of National Defence frigate shock trials at latitude 42^{o} 05’ N, longitude 61^{o} 20’ W in November 1994 and provide additional information to Kenney (1994). The Department of National Defence survey location was chosen for low overall marine productivity (i.e., to reduce the chance of impacts), in areas not known to be attractive to marine mammals (i.e., 4100 m deep water and low bottom relief).

Atlantic harbour porpoise (*Phocoena phocoena*) are widely distributed in cold-temperate coastal waters of the Northern Hemisphere. They are nearly always found in relatively shallow water, less than 125 m deep on the continental shelf (Gaskin, 1992). They often come close to shore and into estuaries or harbours in the summer in pursuit of their favoured prey of herring, as well as mackerel, capelin, hake, pollock, and squid (Brodie, 1995). The harbour porpoise is at risk throughout its range, primarily as a result of bycatches in fisheries. The species was downlisted by Committee on the status of Endangered Wildlife in Canada (COSEWIC) from Threatened to Special Concern (COSEWIC, 2003). The long-finned pilot whale (*Globicephala melaena*), often traveling in herds of several hundred, is the whale most likely to occur in numbers on the Scotian Shelf throughout the year (Lucas and Hooker, 2000).

The minke whale (*Balaenoptera acuterostrata*) is the smallest baleen whale on the Scotian Shelf. It is widespread and seasonally abundant in the Northwest Atlantic. It has been identified in late spring and the summer months across the Shelf, with a preference for water less than 200 m deep (Hooker et al, 1999a).

Some species of whales found within proximity of the Keltic Project Site/LNG Terminal Area have special status and are discussed further in Section 4.2.5.

Seals

The grey seal (*Halichoerus grypus*) and harbour seal (*Phoca vitulina*) are routinely present on the Scotian Shelf. Grey seals disperse widely after breeding on Sable Island in December and January. Harbour seals tend to remain in the vicinity of Sable Island year round, although young may disperse more widely.

The total population of grey seals in Atlantic Canada is about 174,000 individuals (Hammill and Stenson, 2000). Approximately 25,000 pups were produced on Sable Island in 1997 (Bowen et al., 1999), and possibly 30,000-35,000 in 2000, compared with approximately 500 pups in the early 1960s (EnCana Corporation, 2002). The size of the harbour seal population in Atlantic Canada is much less certain, but is estimated to have increased from about 13,000 individuals in the early 1970s to about 32,000 in 1996 (Hammill and Stenson, 2000). The population breeding on Sable Island, however, has declined recently from a level of pup production of approximately 600 in 1989 to approximately 40 in 1997.

There are no seal species of special status within the marginal wharf and LNG Terminal area.

Habitat Use and Productivity

The various habitat types of Stormont Bay and the surrounding areas support a diversity of organisms from phytoplankton to smaller benthic invertebrates to large commercial fish species. Seasonal fluctuations in habitat quality and use also occur resulting in highly variable diversity and abundance of species at certain times of the year. Fish species, depending upon their lifecycle and activities, often require a diversity of habitat types to provide food, cover, and other requirements.

Stormont Bay supports several local fisheries, one of the most important of which is the commercial lobster fishery. The value of these fisheries is linked to the productivity of the area which is influenced by the habitat quality of the marine environment that supports primary producers, prey, and predatory species. Changes to the marine environment, particularly within the vicinity of the proposed wharf, will have adverse effects upon habitat and productivity. Although the productivity of the Lobster Fishing Area that encompasses the proposed marginal wharf and LNG Terminal is relatively low compared to other areas in Nova Scotia, lobster is the dominant species of concern.

In general, the coastal plant and animal communities were more productive in rockier areas than in beach areas that had finer substrates. Along the coastline near Red Head, the most productive intertidal habitats were generally the mid to low intertidal and upper subtidal zones on partially exposed rocky shoreline (Envirosphere Consultants Limited, 2004).

Invertebrate Production

Studies completed in the area have identified important lobster habitat. In the shallower waters of eastern Stormont Bay, between Red Head (the site of the proposed wharf) and Harbour Island, there is a consistent mix of rock, boulder, kelp, and sand. In the outer, deeper areas (outside Country Harbour Head and past Harbour Island) lobster habitat is patchier. The Black Ledges area, a shoal on the western entrance to Stormont Bay (shown as a large stippled blue patch off country Harbour Head in Figure 4.2-5) is considered good lobster habitat/urchin habitat with shoals surrounded by large sandy mud areas.

Habitat requirements for lobster, changes according to its various life stages. Lobster productivity depends upon a number of density independent factors such as temperature, time of hatching, predation, wind direction, and food supply. These factors have the greatest effect on larval survival and consequently lobster populations and area productivity. Optimal habitat for lobster changes as they grow. Smaller postlarval lobsters prefer to live in tunnels or in natural crevices and then, as they grow larger, move to habitats with coarser substrates and a suitable amount of cover. Juvenile lobsters 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).

Lobster production is influenced by local factors more so than external ones and is therefore area specific depending upon the local habitat and conditions. The amount of postlarvae that settle in an area is the overriding factor in determining an area's productivity. Postlarvae in their burrows feed on plankton and may also prey on small benthic organisms. Density independent factors such as starvation, predation, and offshore winds transporting larvae out to sea and away from suitable habitat can play a large role in larval mortality (Miller, 1997).

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 the 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.

Rock crabs inhabit intertidal zone to depths of up to 40 m. Rock crabs often spend winters in shallower waters on softer sand and mud substrates and then migrate to deeper waters during the spring and summer. Larvae float freely in the water column between mid-June to and mid-September until they settle on the ocean floor.

Sea urchins rely upon seaweed as their primary food source with the highest concentrations of urchins located near kelp beds. In Stormont Bay, kelp has increased in areas where urchins have formerly grazed. Management measures have recently been instituted to manage this fishery in Guysborough County.

Fish

Most of the year fish inhabit offshore waters, migrating to inshore areas in spring to spawn. Mackerel are a highly migratory, pelagic fish species and are present in Stormont Bay year round with juveniles present throughout the year and adults in spring and summer. In winter, adult mackerel generally move to feed grounds on the Scotian Shelf southwest of Sable Island (Scott and Scott, 1988).

Several anadromous fish species migrate upriver at different times of the year. Gaspereau (alewives) begin their migration in early spring and are followed by smelt, eel, trout, and Atlantic salmon. Salmon and gaspereau begin to migrate up Country Harbour and Isaac's Harbour Rivers by April. Elvers migrate upstream in May and June (Miller, 1997) while sea-run brook trout migrate during July and August. Gaspereau and smelt leave freshwater after spawning in early spring.

Salmon and brook trout spawn in freshwater burying their eggs in gravel to cobble-size material. Atlantic salmon spawn between late October and mid-November. Atlantic salmon generally hatch in the spring and emerge from the gravel by early June. Atlantic salmon smolts migrate to the sea from mid-May to mid-June (Scott and Crossman, 1973). Adult salmon downstream migration is also variable. In some river systems, populations remain over winter; while in others; downstream migration takes place directly after spawning. Brook trout begin spawning by mid-to-late September and generally hatch and emerge from the gravel in late March or early April.

Blueback herring is an anadromous fish entering freshwater inlets and estuaries to eventually spawn in lakes, ponds, and rivers above the tide head. After spawning, adults return to sea where they spend most of their adult life. In Stormont Bay and surrounding areas, herring are thought to be present between June and October. Blueback herring is similar to alewife and the two are often fished together sometimes being referred to collectively as gaspereau (Scott and Scott, 1988).

4.2.2.2 Freshwater Fish and Fish Habitat

Studies for freshwater fish species and fish habitat applicable to the LNG Facility pertains only to the Red Head Peninsula Ponds, located on the peninsula area where the marginal wharf and LNG Terminal site has been proposed, and Betty's Cove Brook. Additional studies of freshwater fish species and fish habitat were conducted for the purpose of the Provincial EA Report (AMEC, 2006) for lakes that were identified as candidates for sources of cooling or process water or as potential receiving waters for the plant discharge, and are not covered in this document. This information is available in the Provincial EA Report (AMEC, 2006).

Red Head Peninsula Ponds

As mentioned above, there are several ponds on the peninsula area where the marginal wharf and LNG Terminal is located, near the entrance to Isaac's Harbour. (Figure 4.1-5). Some are fresh water and some are brackish, and all ponds had fish - ranging from one to five species.

The largest pond, not brackish, is Dung Cove Pond which provides breeding habitat for waterfowl species such as black duck (*Anas rubripes*) and for semi-aquatic mammals such as muskrat (*Ondatra zibethica*), otter (*Lutra canadensis*), and beaver (*Castor canadensis*). The southeast end of Dung Cove Pond is separated from the marine waters of Betty's Cove by a cobble dike and beach (Map Site 1, Figure 4.2-1) on the Betty's Cove side. This dike, and especially the beach, is important habitat for migrating shore birds.

Pond 1

Pond 1 is located on the northwest side of Red Head (Figure 4.1-5). Aquatic substrates are dominated by organic silt. Stumps, woody debris, and overhanging vegetation provide some structural habitat for aquatic biota. Vegetation associated with this pond includes tapegrass (*Vallisneria Americana*), Richardson's pondweed (*Potamogeton richardsonii*), sweetflag (*Acorus americanus*), broad-leaved arrowhead (*Sagittaria latifolia*), rushes (*Juncus* sp.), grasses, cinnamon fern (*Osmunda cinnamomea*), caraway (*Carum carvi*), cow vetch (*Vicia cracca*), lily of the valley (*Maianthemum canadense*), wild strawberry (*Fragaria virginiana*), wild red raspberry (*Rubus idaeus*), sweet gale (*Myrica gale*), marsh cinquefoil (*Potentilla palustris*), Canada thistle (*Cirsium arvense*), Canada goldenrod (*Solidago canadensis*), tall meadow rue (*Thalictrum pubescens*), mountain holly (*Nemopanthus mucronata*), rhodora (*Rhododendron canadense*), leatherleaf (*Chamaedaphne calyculata*), speckled alder (*Alnus incana*), common juniper (*Juniperus communis*), tamarack, and white spruce. No aquatic species of concern have been found during any survey at this site.

A total of five fish species were collected in this pond during the fall of 2004 and spring of 2005; American eel, banded killifish (*Fundulus diaphanous*), brook trout, mummichog (*Fundulus heteroclitus*), and ninespine stickleback.

Pond 2

Pond 2 is situated immediately south of Pond 1 on the northwest side of Red Head (Figure 4.1-5). Pond substrates are predominantly organic silt with cobble patches along the margins. Aquatic and riparian vegetation consists of tapegrass, yellow pond lily (*Nuphar variegate*), sweetflag, grasses, cinnamon fern, cow vetch, wild red raspberry, wild strawberry, sweet gale, Canada goldenrod, rhodora, speckled alder, smooth serviceberry (*Amelanchier cf. laevis*), and white spruce. American eel was the only species found in this pond. No aquatic species of concern have been found during any survey at this site.

Pond 3

Pond 3 is located on the western side of Red Head (Figure 4.1-5). Substrates in the pond consist of organic silt with small areas of cobble and gravel at places around the pond shoreline. Aquatic and riparian vegetation within the pond include wild rice (*Zizania aquatica*), grasses, beach pea, sea lungwort, common dandelion (*Taraxacum officinale*), grass leaved stitchwort (*Stellaria graminea*), cow vetch, garden lupin (*Lupinus polyphyllus*), greater arrowgrass (*Triglochin maritima*), wild strawberry, cinnamon fern, Canada goldenrod, sweet gale, leather leaf, speckled alder, and white spruce.

Three fish species were collected in this pond during the spring 2005 surveys; ninespine stickleback, threespine stickleback, and banded killifish. No aquatic species of concern have been found during any survey at this site.

Pond 4

Pond 4 is located southwest of Pond 5, and is the southernmost pond on Red Head (Figure 4.1-5). Pond substrates are dominated by cobble and gravel overlain by organic silt. A thick mat of filamentous algae were noted throughout the pond. Aquatic and riparian vegetation in the vicinity of the pond includes slender naiad (*Najas flexilis*), grasses, wild raspberry, sea lavender, lovage, common dandelion, thistle, beach pea, speckled alder, smooth serviceberry, and white spruce.

A total of three fish species were collected from this brackish pond in 2004 and 2005; threespine stickleback, fourspine stickleback, and ninespine stickleback. No aquatic species of concern have been found during any survey at this site.

Pond 5

Pond 5 is situated immediately to the north of Pond 4 (Figure 4.1-5). Substrates in this pond are dominated by cobble and gravel overlain by organic silt. The margins of the pond have cobble and boulder with occasional woody debris. Thick stands of filamentous algae were noted during the 2004 and 2005 surveys. Aquatic and riparian vegetation in the vicinity of the pond consists of fucus, slender naiad, grasses, wild raspberry, sea lavender, lovage, common dandelion, thistle, beach pea, speckled alder, smooth serviceberry, and white spruce. No aquatic species of concern have been found during any survey at this site.

Three fish species were found in this brackish pond; threespine stickleback, fourspine stickleback, and ninespine stickleback.

Pond 6 (Dung Cove)

Pond 6 is located on the northeast side of Red Head near its junction with the mainland (Figure 4.1-5). Aquatic substrates are dominated by organic silt with scattered boulders around the perimeter of the pond. The shoreline is dominated by woody debris and grasses, with the exception of the eastern shore which is dominated by gravel, cobble, and boulder. Aquatic and riparian vegetation consist of common mare's tail (*Hippurus vulgaris*), tapegrass, yellow pond lily, common cattail (*Typha latifolia*), sweetflag, grasses, marsh cinquefoil, cinnamon fern, sheep laurel *(Kalmia angustifolia*), smooth serviceberry, speckled alder, tamarack, white spruce, and black spruce.

This is a freshwater tea-coloured pond. A total of five fish species were collected here during the fall 2004 and spring 2005 fisheries surveys; American eel, ninespine stickleback, banded killifish, mummichog, and juvenile and adult brook trout.

Betty's Cove Brook

A first-order headwater tributary of Betty's Cove Brook originates in the northeast corner of the Keltic Project Site. This drainage feature flows in a southeasterly, then off-site in a southerly direction to Crane Lake, which discharges to the Atlantic Ocean at Betty's Cove Pond.

This tributary supports a fish community consisting of brook trout, American eel, and nine spine stickleback. Brook trout and nine spine stickleback likely spawn in this watercourse. It also provides feeding and migratory habitat for American eel.

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. The eel is listed as 'special concern' by COSEWIC.

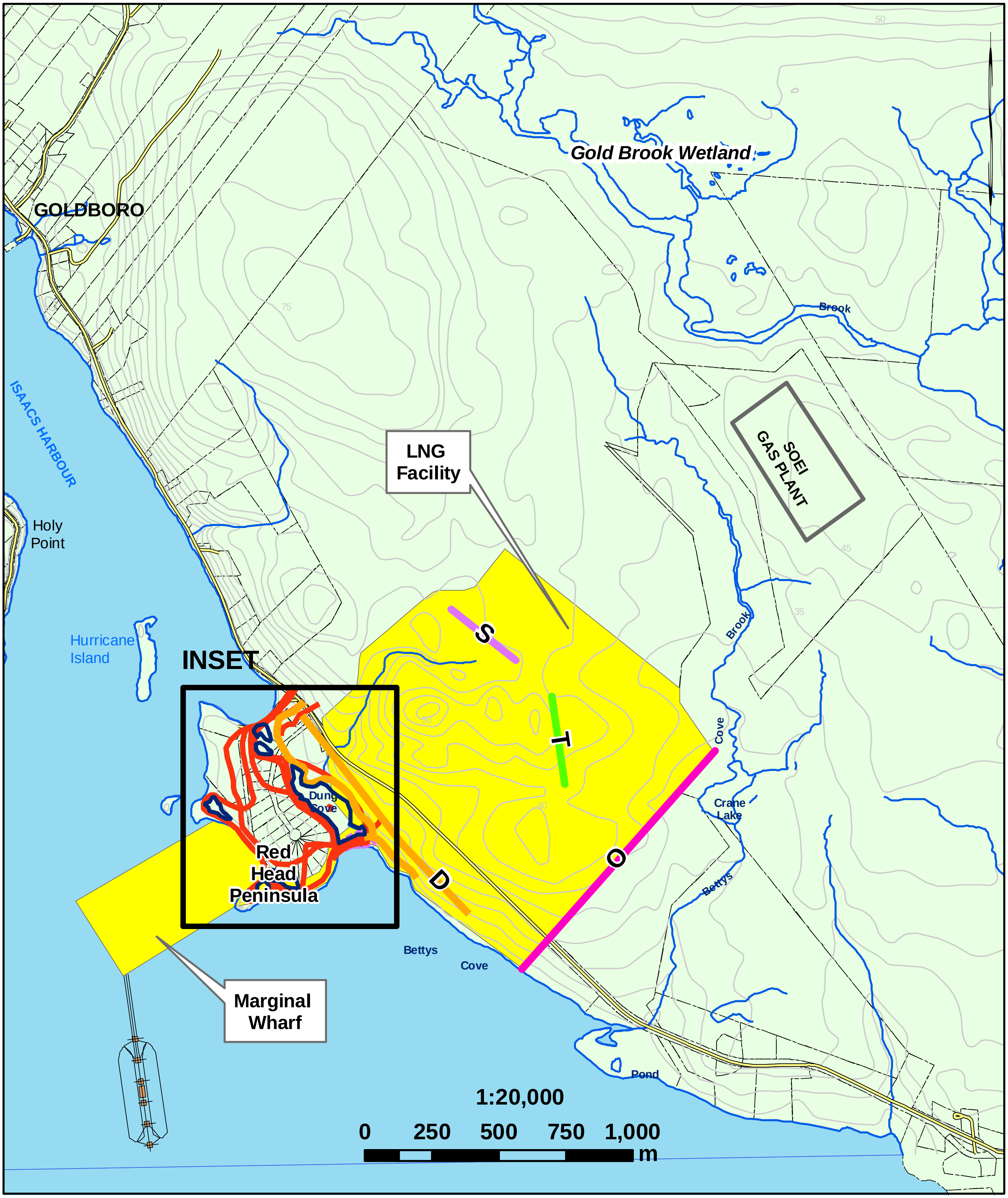
4.2.3 Terrestrial Wildlife and Wildlife Habitat

Field studies on terrestrial wildlife and habitat were carried out in June, August, and early September, 2004. A winter study directed primarily toward mammalian activity, especially white-tailed deer, took place in February 2005 by fixed wing airplane and on the ground. Additional field studies in June, July, and August, and early September, 2005, were carried out to complete the full season evaluations of wildlife in all relevant areas, and to complete the evaluation of the Project Site (Figure 4.2-6 and 4.2-7).

The complete list of common and scientific names of vertebrate wildlife species observed for the four terrestrial vertebrate groups at all sites are presented, for comparison and to contribute to the regional context, in Appendix 8 of the Provincial EA Report (AMEC, 2006). Wildlife in the general region is abundant and diverse. Species designated red (thought to be at risk) or yellow (sensitive to human activities) by NSDNR (2002), and/or having an S-rank of S3 or less (Atlantic Canada Conservation Data Centre (ACCDC), 2004) or other special status will be so indicated in the following text. See also Section 4.2.5 for further information.

4.2.3.1 Amphibians

American toad (*Bufo americanus*), green frog (*Rana clamitans*), pickerel frog (*Rana palustris*), mink frog (*Rana septentrionalis*), and wood frog (*Rana sylvatica*) were observed directly. Green frogs were especially abundant in all permanently wet habitats. The spring peeper (*Pseudacris crucifer*), leopard frog (*Rana pipiens*), and bull frog (*Rana catesbiana*) were not observed, but have ranges that may encompass the LNG Facility Area. No salamanders were observed, including the four-toed salamander (*Hemidactylium scutatum*) listed as yellow by NSDNR and S3 by ACCDC. It should be noted that the Nova Scotia Museum and NSDNR have indicated that the four-toed salamander is more abundant and widespread than previously thought and status re-assessment will likely result in it being assigned a status of "green" (not believed to be sensitive or at risk). COSEWIC (2002) has designated the four-toed salamander as "not at risk"



Legend

- Bird Sensitive Habitat
- Wetland
- LNG Project Area
- Bird Observation Transects
- See Figure 4.2-8
- C - Sept. 2004
- D - Sept. 2004
- O - June 2005
- S - June 2005
- T - June 2005

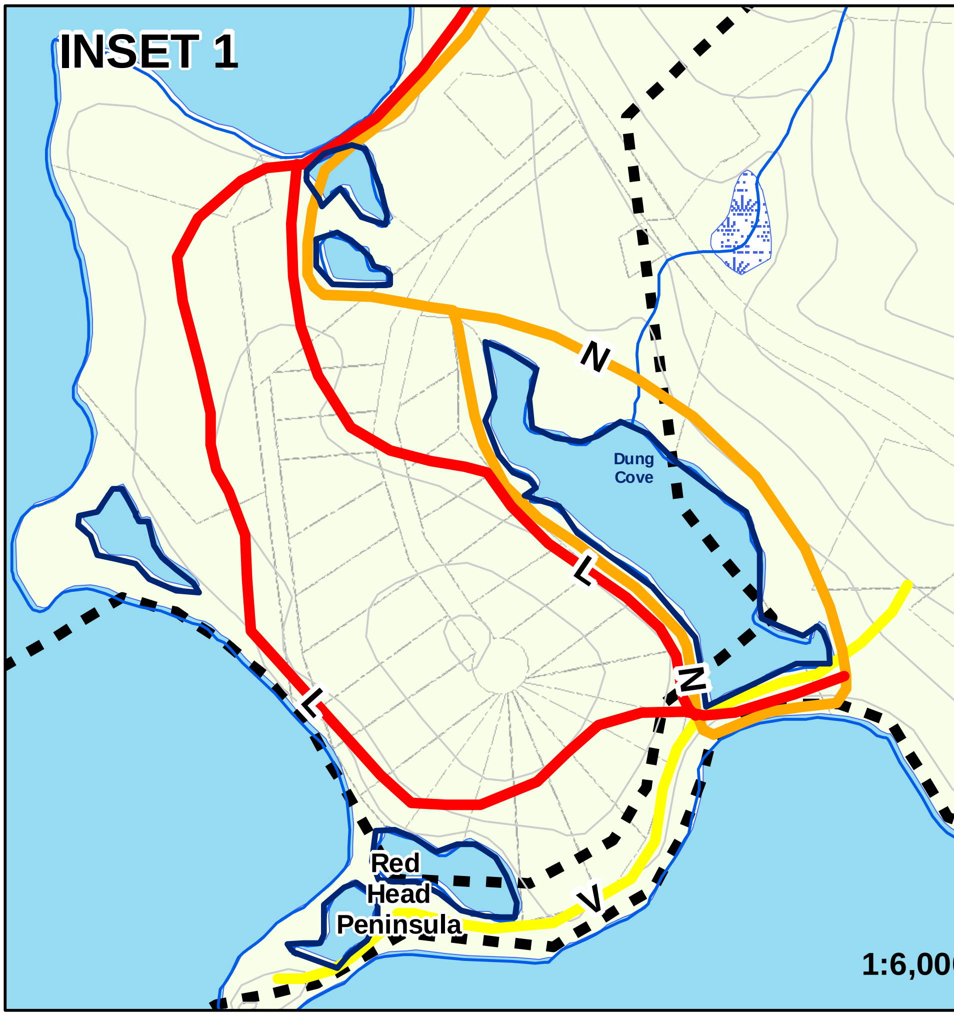
Figure 4.2-6
KELTIC PETROCHEMICALS INC.
Bird Observation Sites (2004 & 2005)
LNG Facility
June 2007

Figure 4.2-7

KELTIC PETROCHEMICALS INC.

Bird Observation Sites (2004 & 2005) LNG Facility

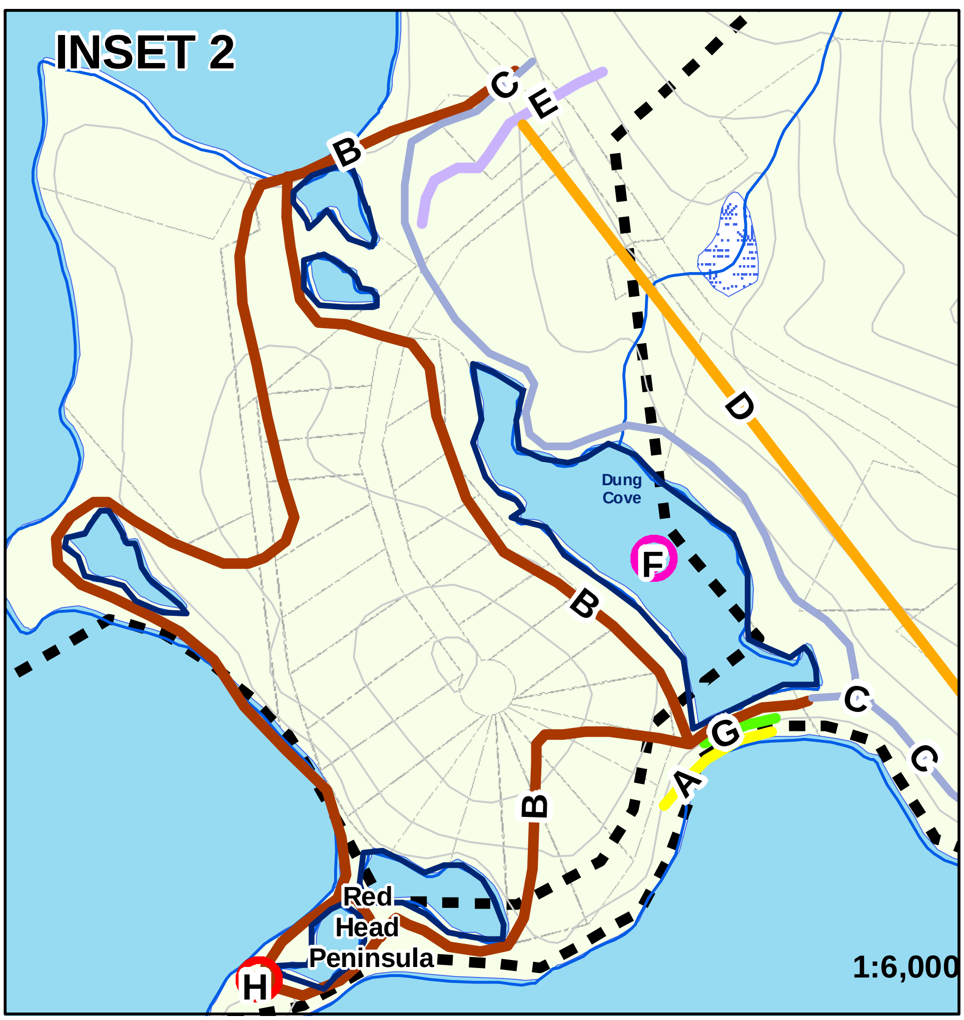
June 2007



Legend

Bird Observation Transects

- L - June 2005
- N - June 2005
- V - June 2005
- LNG Project Area



0 50 100 150 200 m

Legend

Bird Observation Transects

- A - September 2004
- B - September 2004
- C - September 2004
- D - September 2004
- E - September & November 2004
- F - September 2004
- G - September 2004
- H - September & November 2004
- LNG Project Area

in Nova Scotia. In addition to the four-toed salamander, eastern newt (*Notophthalmus viridescens*), spotted salamander (*Ambystoma maculatum*), redback salamander (*Plethodon cinereus*) and blue spotted salamander (*Ambystoma laterale*) and/or its hybrid with Jefferson salamander (*Ambystoma lateralejeffersonianum*) are expected to be in parts of the larger Study Area.

4.2.3.2 Reptiles

Two species of snakes were observed on the Keltic Site; i.e., eastern garter snake (*Thamnophis strialis strialis*) and red-bellied snake (*Storeria occipitomaculata*). Ring-necked snake (*Diadophis punctatus*), though not observed is probably present. Three turtle species that were not observed may also be in the Study Areas. Snapping turtle (*Chelydra serpentina*) is expected in all lakes and permanent streams and may also be in Dung Cove Pond in the LNG Terminal area. Similarly, painted turtle (*Chrysemys picta*) would be expected in bodies of permanent water where they often bask on old logs, rocks, and open shores. Wood turtle (*Clemmys insculpta*) (yellow; S3), the most terrestrial of the three species, is also possibly present. Surveys for wood turtles were conducted coincident with other wildlife surveys.

4.2.3.3 Birds

Within the 149 ha of the Project Site there are numerous locations for various types of bird habitat and, consequently, various types of bird species. Bird surveys were conducted with the following objectives:

1. to determine which bird species were on or adjacent to the Study Sites; and
2. to characterize the avian communities with respect to breeding activity, seasonality, location, and habitat use.

A series of bird surveys were conducted in the field by one individual over the course of six months (from June, partly August, September, October, November) in 2004. Data acquired included bird species, estimated abundance, breeding status, and habitat for each species. In 2005, in order to complete full season evaluations, field work was carried out in June, July, August and early September with most observations made in June and several in July and September. Due to poor weather conditions, field surveying was completed during the day, not necessarily during optimal early morning time windows for certain species. It is doubtful that species were missed, but numbers may be disproportionate. An attempt was made to cover all habitat types throughout the surveys. Land uses have undergone considerable changes over time, and remain continuous. The most recent clear cutting activities at the site have resulted in a collection of changing mosaical habitats; i.e., the site was manifestly different in 2005 than in 2004. It was felt that by varying the location and duration of observation over time that the objectives would better be met.

Identification of bird species were concluded by song for up to an estimated 100 m from the site boundary, and visually to an estimated 500 m. As well distance from transects or point locations is estimated at 100 m. Birds were identified to species, numbers estimated up to a distance of approximately 100 m, with no distance limit on visual identification. In some cases, only presence was documented, but these were few and did not alter any conclusions.

Observations were made from continuous transects and/or from point locations where more intense observation was deemed to yield more information. There was no set duration of observation at either type of location. Transects were walked slowly with occasional stopping, moving on when it seemed no additional significant information was forthcoming. Transects and point locations for the surveys completed on the Keltic Site, including the LNG Facility Area, are shown in Figures 4.2-6 and 4.2-7, respectively. As well, point locations were used as were selected continuous transects.

Migratory birds and habitat were assessed during field visits that were made in October and November, respectively, to assess the fall migration of waterfowl and marine birds.

A rough count indicated that ± 104 species (using the Atlas of Breeding Birds of the Maritime Provinces, Erskine, 1992) were likely to breed in the general area. A total of 95 (91%) of these, were observed along with three breeding species not designated as breeding in the area, plus 18 non-breeding migrants.

A total of 116 bird species was observed in all sites combined. Total bird observations for each study site are presented in Appendices 8 and 10 along with spring and fall presence (note that these values are averages for all observations at a given study site) of the Provincial EA Report (AMEC, 2006). The number noted at Gold Brook Lake, offshore sites, and the Keltic Project Site proper, including the LNG Facility Area, and the number confirmed/probably and possibly breeding are shown in Table 4.2-6.

Overall, 62 (53%) of the 116 species were deemed at least possibly breeding (AMEC, 2006). Birds were considered breeding on the basis of the number and temporal pattern of observations, type of habitat, courtship, and nesting behaviour, and/or the presence of young. Habitat types identified were based mainly on structural criteria (i.e., tall shrub vs. low shrub) and species composition. Except in the obvious cases (i.e., BF = Open Bog/fen) wetland characteristics are not used because of the wide variation of wet substrates in almost every habitat category.

TABLE 4.2-6 Number of Bird Species Observed

Study Site	Observed[1]	Breeding or Possibly Breeding (%)[2]	Migrants[3]
LNG Area	73	26(36)	7
Offshore	17	7(41)	4

1. These values exceed the total number in the overall Study Area as some species will occur in more than one study site.
2. These percentages are relevant to each study site total, not to the overall area total observed.
3. Migrants are those species that do not breed in the maritime provinces, Nova Scotia (water pipet), mainland Nova Scotia (i.e., golden-eye) or probably not locally (i.e., hooded merganser) (Erskine, 1992).

Breeding estimates are probably low partly because there are 18 migrant species that <u>by definition</u> do not breed in any of the Study Areas. Also, a subjectively conservative application of breeding criteria played a role in the low estimates and some events may simply not have been observed. Nonetheless, species diversity appears to be high and populations robust.

For purposes of discussion birds have been divided into four groups including: Woodland/ Shrubland and Woodland/Edge Birds, Shorebirds, Raptors, and Seabirds and Waterfowl. These are discussed separately below for the Keltic Site Proper, including the LNG Facility site, and offshore areas "Wetland" was not included as a category because most wetlands have a woodland/shrubland/edge component to them. Waterfowl by definition may be in the open water wetlands and/or nest in wetland areas, and certainly raptors forage in wetlands. Strictly wetland birds such as bitterns (*Botaurus lentiginasus*) were not observed, with the exception of great blue heron (*Ardea herodias*).

Woodland, Shrubland, and Woodland Edge Birds

Warblers and related birds were abundant in all woodland and woodland edge habitats at all sites. Thirteen species of warblers, two vireos, two kinglets, and two chickadees were noted and deemed breeding in most woodland areas. These are shown in Table 4.2-7.

TABLE 4.2-7 Warblers and Related Birds

Species Scientific Name	Species Common Name
Regulus satrapa	Golden-crowned Kinglet
Regulus calendula	Ruby-crowned Kinglet
Vireo solitarius	Solitary Vireo
Vireo olivaceus	Red-eyed Vireo
Parus atricapillus	Black-capped Chickadee
Parus hudsonicus	Boreal Chickadee
Vermivora ruficapilla	Nashville Warbler
Dendroica petechia	Yellow Warbler
Dendroica pensylvanica	Chestnut-sided Warbler
Dendroica magnolia	Magnolia Warbler
Dendroica castanea	Bay-breasted Warbler
Dendroica coronata	Yellow-rumped Warbler
Dendroica virens	Black-throated Green Warbler
Dendroica fusca	Blackburnian Warbler
Dendroica palmarum	Palm Warbler
Dendroica tigrina	Cape May Warbler
Mniotilta varia	Black-and-white Warbler
Setophaga ruticilla	American Redstart
Geothlypis trichas	Common Yellowthroat
Wilsonia canadensis	Canada Warbler

Other woodland/shrubland species present include ruffed and spruce grouse (*Bonasa umbellus* and *Dedragapus canadensis*), thrushes (veery (*Catharus fuscescens*), Swainson's (*Catharus ustulatus*), hermit (*Catharus guttatus*) and American robin (*Turdus migratorius*)), downy and hairy woodpeckers (*Picoides pubescens* and *Picoides villosus*), winter wren (*Troglodytes troglodytes*), flycatchers (yellow-bellied (*Empidonax flaviventris*), alder (*Empidonax alnorum*), and least (*Empidonax minimus*)), sparrows (savannah (*Passerculus sandwichensis*), song (*Melospiza melodia*), swamp (*Melospiza Georgiana*), white-throated (*Zonotrichia albicollis*)), red and white-winged crossbills (*Loxia curvirostra* and *Loxia leucoptera*), purple finch (*Carpodacus purpureus*), American goldfinch (*Carduelis tristis*), and pine siskin (*Carduelis pinus*).

A comparison (refer to Appendix 8 of the Provincial EA Report (AMEC, 2006)) of June and post-August presence results in some not unexpected patterns. In 2004, insectivorous birds such as flycatchers, swallows, and most warblers were absent. Common yellowthroat, palm, and yellow-rumped warbler were exceptions. A number of types are resident the year-round, including corvids (jays, crows, and ravens), chickadees, and woodpeckers. Woodland/shrubland birds were observed most often in mature and immature mixed forest. Table 4.2-8 shows the distribution within the six most used wooded habitats. The mixed forest habitats were used by both the greatest number of species and the greatest number of birds. Though not evaluated quantitatively, it is reasonable to assume that mixed forests have the greatest number of plant species and the greatest foliage-height-diversity. MacArthur and MacArthur (1961) demonstrated that bird diversity in deciduous forests correlated positively with these two parameters.

TABLE 4.2-8 Comparison of Habitat Use by Woodland/Shrubland Birds at the Keltic Site

Habitats	Keltic Site			
	No. species	Rank[2]	No. Birds[1]	Rank
Mature Coniferous Forest	6	6	29	6
Immature Coniferous Forest	12	3	72	3
Mature Mixes Forest	22	1	155	1
Immature Mixed Forest	17	2	98	2
Tall Shrub	11	4	60	4
Low Shrub	8	5	34	5

1. The sum of the maximum number of birds per species at any one habitat type at any one time.
2. Rank within the six habitat types.

Shorebirds

Shorebirds, both resident and migrating, were observed frequently in the LNG Terminal area. The cobble dike and beach area on the Betty's Cove side of the LNG Terminal area is important habitat for migrating and other shore birds. Birds that use this area are shown in Table 4.2-9.

TABLE 4.2-9 Shorebirds Observed in Dike/Beach Areas at Betty's Cove

Species Scientific Name	Species Common Name
Charadrius semipalmatus	Semipalmated Plover
Catoptrophorus semipalmatus	Willet
Calidris minutilla	Least Sandpiper
Tringa melanoleuca	Greater Yellowlegs
Calidris alba	Sanderling
Anthus spinoletta	Water Pipit (technically not a shore bird)
Plectrophenax nivalis	Snow Bunting (technically not a shore bird)
Numenius phaeopus	Whimbrel

These species with the exception of willet and greater yellowlegs were observed in the fall only, obviously during fall migration. Spring migration had likely occurred prior to June. Greater yellowlegs (S2B: rare provincially) (ACCDC, 2004) was observed exhibiting breeding behaviour at the edge of the cobble beach at Map Site 1, Figure 4.2-1.

The willet was a common breeder near Betty's Cove and along the shore southeast of the LNG Terminal area and the semipalmated plover was observed on the shores of the LNG Terminal area. Spotted sandpiper (*Actitis macularia*) was observed during the spring on the marine shore of the Keltic Site, and was observed breeding on the shores of fresh water streams in the area.

Raptors

Birds of prey observed are shown in Table 4.2-10.

TABLE 4.2-10 Raptors Observed in the Study Area at the Keltic Site

Species Scientific Name	Species Common Name
Pandion haliaetus	Osprey
Haliaeetus leucocephalus	Bald Eagle
Circus cyaneus	Northern Harrier
Accipiter striatus	Sharp-shinned Hawk
Buteo platypterus	Broad Winged Hawk
Buteo jamaicensis	Red-tailed Hawk
Falco sparverius	American Kestrel
Flaco columbarius	Merlin
Asio flammeus	Short-eared Owl

Osprey was observed near the LNG Terminal area. No nests were observed on or adjacent to either site, but one is near Highway 316 northwest of Stormont Bay. Bald eagles were seen several times at the Keltic site, but no nests were located. Local sources indicate that bald eagle is commonly seen on Harbour Island, but no nests have been found.

Red-tailed, broad-winged, sharp-shinned hawks and merlins were seen occasionally. One kestrel and one broad-winged hawk were observed near the heliport on the Keltic Site, and over the peninsular area, respectively. Northern harrier was noted on several occasions over the Keltic Site. Northern goshawk (*Accipiter gentilis*) (yellow, S3B) is known in the general area, but was not observed in this study.

At least one pair of short-eared owls and a northern harrier foraged in the wetlands along Betty's Cove Brook and down to Drum Head. Short-eared owl is designated a "species of special concern" by COSEWIC (2005), and is protected under SARA (2005). Other owls were not observed but great horned owl (*Bubo virginianus*) and northern saw-whet owl (*Aegolius acadicus*) are in the general area (Erskine, 1992).

Migratory Birds and Migratory Bird Habitat

The Atlantic coast line near the proposed Keltic Site and proposed LNG Terminal Site provides feeding and breeding habitat for a number of migratory waterfowl, shorebirds, and sea birds.

Seabirds, Waterfowl, and Shorebirds

Birds that nest and forage along the coastal shore, of which the LNG Terminal area is part, and on the off-shore islands (i.e., Country, Harbour and Goose), as well as waterfowl that breed inland but usually spend some time along the marine shore are considered in this category. Also included are migratory birds that stage in Stormont Bay.

Seabirds

Over 25 species of seabirds have been observed on the Scotian Shelf, their distribution depending on availability and distribution of preferred prey and the breeding status of the species (EnCana Corporation, 2006). Some, like cormorants and gulls, are largely found in inshore waters, however most species in offshore waters are truly pelagic, spending no time ashore. The Study Area includes both offshore and coastal marine habitats inhabited by a wide range of migratory and resident bird species. The offshore Study Area is dominated in the summer by non-breeding seabirds from the northern and southern hemisphere, and in the winter by seabirds that breed in the eastern Canadian Arctic and West Greenland (Lock et al., 1994).

Common eider (*Somateria mollissima*) and great black-backed (*Larus marinus*) and herring gulls (*Larus argentatus*) are common along the shore. Double-crested cormorants (*Phalacrocorax auritus*) were very common in Stormont Bay. Three species (all considered yellow by NSDNR, 2005) of terns, common (*Sterna hirundo*), arctic (*Sterna paradisaea*), and roseate (*Sterna dougallii*), forage along the coast. Only one roseate tern was observed. Arctic and common terns are designated S3B (uncommon breeder) and roseate S4B (extremely rare breeder) (ACCDC, 2004).

Country Island is of special interest because of the presence of a roseate tern colony. Roseate terns are at low numbers in Canada, with 95% restricted to a few coastal islands in Nova Scotia (Leonard et al., 2004). In 2003, only one other location in Nova Scotia had more roseate terns than Country Island. CWS carries out a program of non-lethal control of predators on Country Island in a successful effort to maintain tern numbers. Common and arctic terns and Leach's storm-petrel (*Oceanodromo leucorhoa*) nest here as well. See also Section 4.2.5.

A radio-tracking study (Rock, 2005) revealed that the roseate tern was not foraging in any section of the Keltic foot print (Figure 4.2-8). The closest foraging site was Harbour Island. Within the potential LNG shipping route, the bird was not tracked in any of the shallow ledges Local sources report that herring and great black-backed gulls and cormorant nest on Goose Island.

A number of migrants were observed and reported to occur in Stormont Bay and off-shore around the islands. Those observed are red-necked grebe (*Podiceps grisegena*), white-winged scoter (*Melanitta fusca*), surf scoter (*Melanitta perspicillata*), common scoter (*Melanitta nigra*), oldsquaw (*Clangula hyemalis*), and black guillemot (*Cepphus grylle*). Local residents reported dovekie (*Alle alle*), king eider (*Somateria spectabilis*), murres (*Uria sp.*), and northern gannet (*Morus bassanus*) as migrants.

The offshore seabird community of the Scotian Shelf consists primarily of shearwaters and storm-petrels during the summer months, and, in winter, kittiwakes, fulmars, and alcids such as: dovekie (*Alle alle*), common (*Uria aalge*) and thick-billed murres (*Uria lomvia*), razorbill (*Alca torda*), Atlantic puffin (*Fratercula arctica*) and, least commonly far offshore, the black guillemot (Lock et al., 1994). Large numbers of Leach's storm- petrels arrive in Canadian waters in May, breeding on coastal islands and remaining abundant there until migrating south in autumn.

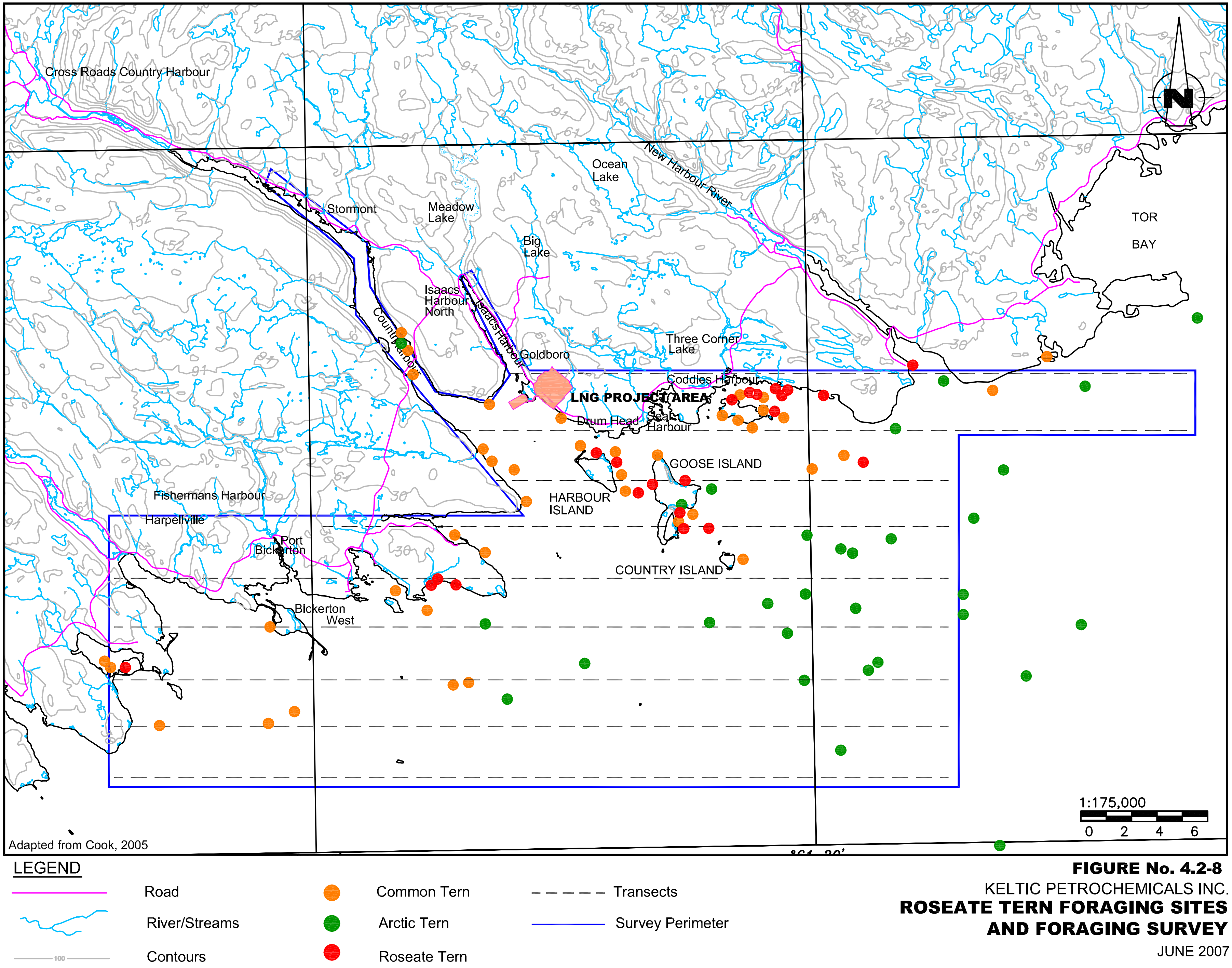


FIGURE No. 4.2-8

KELTIC PETROCHEMICALS INC.

ROSEATE TERN FORAGING SITES AND FORAGING SURVEY

JUNE 2007

Large numbers of these birds nest on Country Island and other small islands in the vicinity, and a few have recently nested on Sable Island (EnCana Corporation, 2006). The more abundant Wilson's storm-petrel breeds in the southern hemisphere on Antarctica and adjacent islands, spending the austral winter in the northern hemisphere.

Great black-backed gulls and herring gulls are the most abundant breeding seabirds in the Project Area. These species are present year-round, but are most abundant from April to September when they are present at breeding colonies on Sable Island (EnCana Corporation, 2002). Black-legged kittiwakes (*Rissa tridactyla*) are common in the area from October through April, but are scarce from May to September when they move to breeding colonies north of the Study Area (EnCana Corporation, 2006). Common and Arctic terns breed widely along the coast of Nova Scotia, including Country Island and Sable Island and are present in the Study Area during the breeding season from May through August, after which their young fledge and begin to migrate out of the Study Area.

Waterfowl and Shorebirds

The inland lakes are not very productive for waterfowl (Seymour, pers. comm.), a point that is reinforced by the observations in this study. Ring-necked duck (*Aythya collaris*), loon (yellow) (*Gavia adamsii*), and common merganser (*Mergus merganser*) were noted in small numbers. American black duck and green-winged teal (*Anas crecca*) breed in wetland areas such as the Gold Brook wetland immediately north of the LNG Facility site. An adult red-breasted merganser (*Mergus serrator*) and young were seen once at Dung Cove Pond and Canada goose was observed occasionally at the LNG Terminal area. Common loon (*Gavia immer*) is on all lakes in the original Keltic Study Area, with a nest observed directly in Gold Brook Lake. It is not known whether the young hatched or otherwise survived. Common loon was noted in small numbers along the marine shore of the Keltic Site in both spring and early fall, with a flock of about twenty individual's off-shore on November 7, 2004.

Whereas most shorebirds in the Study Area are autumn transients, the killdeer (*Charadrius vociferus*), willet, and spotted sandpiper breed along the mainland coast; least and spotted sandpipers breed on Sable Island. Transient shorebirds may migrate up to 12,000 km from breeding to wintering grounds, intensively foraging at traditional stopover sites to meet their high-energy requirements. Most migrant shorebirds in coastal Nova Scotia frequent salt marshes and mudflats. Sanderlings are more common on sandy beaches. Purple sandpipers (*Calidris maritima*) commonly occur in winter along rocky, exposed shorelines, and massive flocks of red phalaropes (*Phalaropus fulicaria*) have been seen off Sable Island in spring (McLaren, 1981a and b).

Great blue heron, though neither seabird nor waterfowl, was seen frequently on the LNG Terminal area and the shoreline to the south and were frequently observed feeding in all ponds. A heronry was reported to be near the northwest shore of Gold Brook Lake (NSDNR, pers. comm.), but both aerial and ground level searches failed to locate it.

4.2.3.4 Mammals

A total of 21 mammalian species were observed directly or by signs (i.e. tracks, scat etc.) in all areas combined. Mammal observations for each Study Area are presented in Appendix 8 in the Provincial EA Report (AMEC, 2006). The species noted are shown in Table 4.2-11.

TABLE 4.2-11 Mammals Observed in the Study Area at the Keltic Site

Species Scientific Name	Species Common Names
Canis latrans	Coyote
Vulpes fulva	Red Fox
Ursus americanus	American Black Bear
Procyon lotor	Raccoon
Mustela erminea	Short-tailed Weasel (Ermine)
Mustela vison	American Mink
Mephitis mephitis	Striped Skunk
Lutra canadensis	River Otter
Lynx rufus	Bobcat
Halichoerus grypus	Grey Seal (See Appendix 8*)
Phoca vitulina	Harbour Seal (See Appendix 8*)
Odocoileus virginianus	White-tailed Deer
Tamias striatus	Eastern Chipmunk
Marmota monax	Woodchuck
Tamiascuirus hudsonicus	Red Squirrel
Castor canadensis	Beaver
Ondatra zibethica	Muskrat
Microtus pennsylvanicus	Meadow Vole
Clethrionomys gapperi	Red-backed Vole
Erethizon dorsatum	Porcupine
Lepus americanus	Snowshoe Hare

* - Appendix 8 from the Provincial EA Report (AMEC, 2006)

Compatible habitat at various places in the Study Sites is present for a range of Nova Scotia mammals not observed directly or by sign. These include:

- Masked Shrew (*Sorex cinereus*);
- Smokey Shrew (*Sorex fumeus*);
- Arctic Shrew (*Sorex arcticus*) aka Maritime Shrew (*Sorex maritimensis*) (Stewart et al., 2002);
- Water Shrew (*Sorex palustris*);
- Pigmy Shrew (*Sorex hoyi*);
- Short-tailed Shrew (*Blarina brevicauda*);
- Hoary Bat (*Lasiurus cinereus*);
- Red Bat (*Lasiurus borealis*);
- Northern Long-eared Bat (*Myotis septentrionalis*);
- Little Brown Bat (*Myotis lucifugus*);
- Northern Flying Squirrel (*Glaucomys sabrinus*);

- Deer Mouse (*Peromyscus maniculatus*);
- Southern Bog Lemming (*Synaptomys cooperi*);
- Meadow Jumping Mouse (*Zapus hudsonius*); and
- Woodland Jumping Mouse (*Napaeozapus insignis*).

Two other species of shrew, the Gaspé shrew (*Sorex gaspensis*) and long-tailed shrew (*Sorex dispar*) both COSEWIC (2005) "Species of Concern" are in Nova Scotia, but have been found only on Cape Breton Island and the Cobequid Mountains, respectively (Dr. G. Forbes, pers. comm.).

No bats were observed but seven species are known from Nova Scotia, all of which are considered sensitive (yellow) by NSDNR (2004). These are:

- Little Brown Bat (*Myotis lucifugus*);
- Northern Long-eared Bat (*Myotis septentrionalis*);
- Eastern Pipistrelle (*Pipistrellus subflavus*);
- Silver-haired Bat (*Lasionycteris noctivagans*);
- Red Bat (*Lasiurus borealis*);
- Hoary Bat (*Lasiurus cinereus*); and
- Big Brown Bat (*Eptesicus fuscus*).

Broders et al (2003) suggest that significant populations of only little brown bat, long-eared bat, and eastern pipistrelle occur in the province. Red, hoary, and silver-haired bats are migratory species represented by only a small amount of records, but red and hoary bats may be widespread in spite of seemingly low numbers. Big brown bat has been tentatively identified as being in the province, but it is unlikely to be in the area of and of the Study Sites. Most records of the eastern pipistrelle are from western and central mainland Nova Scotia (Scott and Helda, circa, 2005). Broders (pers. comm.) is of the opinion that most of the bats in the general area of the Keltic Site are little brown and long-eared with little brown bats being most numerous. Little brown bats were most active over water, with long-eared bat being more of a forest interior species (Broders et al 2003).

Furbearer data were not gathered in 2004-2005 but the harvest numbers from 1994 (MacLaren Plansearch, 1996) are assumed to be a general reflection of the present circumstance. These are shown in Table 4.2-12. The presence of these furbearers, except striped skunk, was noted on the LNG Terminal area at some time during the course of the field studies. The four aquatic species were observed in association with Dung Cove Pond.

TABLE 4.2-12 Furbearer Harvest in Guysborough County in 1994

Species Common Names	Number Harvested
Aquatic Furbearers	
Muskrat	323
Beaver	237
Otter	83
Mink	127
Terrestrial Furbearers	
Short-tailed Weasel	139
Bobcat	58
Red Fox	10
Raccoon	85
Skunk	5
Red Squirrel	187
Coyote	87
Snowshoe Hare	13,992

Snowshoe hare populations fluctuate dramatically, usually over an approximately 10-year period, with 2005 being a very high year providing an abundance of prey for coyotes, bobcats, and raptors. A raptor kill and a bobcat kill, respectively, were observed on the LNG Terminal area. Coyote populations appeared to be high throughout the Keltic Study Area, perhaps in response to the abundance of snowshoe hares.

Meadow vole populations also fluctuate with a roughly 3-5 year periodicity. High population densities evidenced by numerous freshly used runways were noted in both 2004 and 2005. Meadow vole is the primary prey for short-tailed weasels and many raptors including shorteared owl, northern harrier, and red-tailed hawk.

The range of Canada lynx (*Lynx canadensis*) (COSEWIC, 2002, status “Endangered”) is restricted to Cape Breton Island (NSDNR, pers. comm.). Eastern cougar (*Felis concolor*) (COSEWIC, 2005; status “Data Deficient”) has been reported in Nova Scotia, but with little substantial evidence corroborating its presence.

White-tailed deer were sighted frequently in all Study Sites during the summer. A deer herd estimated by local sources to be about 50 in number is between the LNG Terminal area and Drum Head. During the February 2005 winter survey, at least 35 deer were counted in this area. Nova Scotia Natural Resources (NSDNR, 2005) indicates deer wintering areas near Drum Head. The greatest area of winter concentration noted in February 2005 was at the LNG Terminal site (Figure 4.2-1). This was corroborated by local residents, but the NSDNR (2005) website data do not indicate this.

Moose (*Alces alces*) in mainland Nova Scotia has been designated as “Endangered” (COSEWIC, 2005). It is reported to concentrate in the bogs just south of Ocean Lake (NSDNR, pers. comm.). This area was examined from the air during summer and winter and at ground level during summer, with no sign of moose, tracks, or droppings. No moose sign was noted anywhere at any time during field studies. One moose was reported by a local resident to have been seen near the mouth of New Harbour River during the late fall of 2004.

4.2.4 Wetlands

Wetlands are common in both the Atlantic Coast Terrestrial Theme Region and the Atlantic Interior Terrestrial Theme Region, and include marshes, bogs, and fens of various sizes and floristic composition. Barrens and areas of shrub species such as speckled alder, withered (*Viburnum nudum*), and various woody heath plants (Family Ericaceae) are relatively common. These heaths include rhodora, sheep laurel, lowbush blueberry (*Vaccinium angustifolium*), huckleberry (*Gaylussacia baccata*), mountain cranberry (*Vaccinium vitis-idaea*), and checkerberry (*Gaultheria procumbens*).

The major types of wetlands, according to the Canadian Wetland Classification System (1997) that are encountered on or functionally associated with the site of the KDP are:

- Bogs – peatlands with water from precipitation and not influenced by groundwater, peatmoss (*Sphagnum sp.*) is dominant vegetation.
- Fens – peatlands influenced by groundwater relatively rich in nutrients with vegetation dominated by graminoid species.
- Swamps – dominated by woody plants and may occur on peatland or mineral substrate; in the latter case free surface water may persist for considerable periods.
- Marshes – periodic or persistent standing water, usually dominated by graminoids and/or emergent forbs.
- Shallow water wetlands – free surface water up to 2 m deep at less than 25% cover by standing emergent or woody plants.

The wetlands identified to occur within the footprint of Project Site (the LNG Facility and Marginal Wharf), are presented in Table 4.2-13. Information for this Table was derived from several sources including:

- Canadian Wetland Classification System, Second Edition (Warner and Rubec, 1997);
- CWS Wetland Mapping (Hanson and Calkin, 1996);
- Wetlands Data Base Specification Draft (NSDNR, 1999);
- Nova Scotia Forest Cover Type Mapping (NSDNR, 2002);
- vertical black and white aerial photography;
- oblique colour photography;
- aerial reconnaissance; and
- ground level field work.

TABLE 4.2-13 Wetland Types and Area (ha) for the Project Site

Wetland Number[1]	Wetland Type[2]	Area (ha)
1	Coastal (Saline) Pond – vegetated (Pv)	2.4
12	Coastal (Saline) Ponds - vegetated (Po)	0.8
13	Swamp/marsh	2.0

1. Wetland Number: Keltic Site, see Figure 4.2-1.
2. Wetland type (see text).

It should be noted that there is some variability in the wetland surveys; i.e., not all were surveyed at ground level. This variability is explained further in the following sections pertaining to individual wetlands.

As of March 1, 2006, wetlands are protected in Nova Scotia by the Wetlands Designation Policy, which replaces the Wetlands Directive from 1995. Alteration of a wetland may remove or interrupt the ability of the wetland to continue to support the same level of pre-development functions.

There is some difference in terminology between Hanson and Calkins (1996), Warner and Rubec (1997), NSDNR (1999), and NSDNR 2002; i.e., only NSDNR (2002) uses the term "treed bog," and Hanson and Calkins (1996) CWS wetland mapping, revised 1988, do not use the term "fen." The wetland types presented in Table 4.2-13 do not follow any particular nomenclatural method, but rather are often descriptive modifications of the basic Canadian Wetland Classification System; i.e., "treed bog" instead of simply "bog." CWS terminology where available is also included, as described below:

- Coastal Saline Ponds – P;
- Po – pond open bottom undetermined; and
- Pv – pond vegetated.

Specific vegetation characteristics are presented here for each wetland. As noted above most have a significant component of heath shrubs; i.e., eriaceous (Family Ericaceae). Rather than identify these each time for each wetland, their presence may be noted as "heath shrubs" including the following species: Labrador tea, rhodora, sheep laurel, bog laurel (*Kalmia polifolia*), bog-rosemary (*Andromeda glaucophylla*), leather-leaf, lowbush blueberry, mountain cranberry, small cranberry (*Vaccinium oxycoccus*), large cranberry (*Vaccinium macrocarpon*), huckleberry, and bog huckleberry (*Gaylussacia dumosa*). Other shrubs not in the Family Ericaceae but often associated with heath shrub vegetation include sweet gale, black crowberry, black chokeberry (*Aronia melanocarpa*), bunchberry (*Cornus canadensis*), false holly (*Nemopanthus mucronata*), and witherod.

No rare plant or animal species was found in any wetland on the Project Site. Within the envelope of the overall KDP four-toed salamander (yellow; NSDNR, 2005) is probably in some wetlands, but none was observed within the Project Site. Meadow vole and common shrew are likely common inhabitants of most open wetlands within the envelope of the overall KDP and likely inhabitants of the wetlands within the Project Site. The sporadically occurring southern bog lemming (*Synaptomys cooperi*) may occur in bog/fen wetlands within the site of the KDP. The wetlands within the Project Site however, do not fall within this category. Evidence of use by white-tailed deer and snowshoe hare are nearly always present.

A wetland area (Map Site 4, Figure 4.2-1) is at the base of the peninsula between the entry road and Dung Cove Pond. This is mostly a marsh dominated by several sedge (*Carex sp.*) and rush (*Juncus sp.*) species. Local residents constructed a now un-used hockey rink several years ago in the midst of this marsh area. A wetland area that is in the Project Site (Map Site 13, Figure 4.2-1) is associated with a drainage that runs southwest to Dung Cove Pond with an extension into Betty's Cove.

Of the 3 wetlands identified within the footprint of the Project Site (Figure 4.2-1), No. 13 is primarily swamp, and the No. 1 and 12 are designated Coastal Saline Ponds by CWS mapping (Hanson and Calkins, 1996). The area of the Coastal Saline Ponds on the Project Site totals only 3.2 ha. These specific wetlands have been discussed below.

4.2.4.1 Wetland No.1

This is Dung Cove Pond, which CWS mapping refers to as (Pv), Vegetated Coastal Saline Pond, at 2.4 ha in area. This is Pond 6, discussed further in Section 4.2.2.2, Red Head Ponds. It is not saline.

The pond is relatively narrow with the long axis oriented Northwest-Southeast. The southeast end is contained by a cobble dike and beach and the northwest end grades into swamp/marsh/fen habitat. The pond appears to be fed by a stream associated by other off-site wetlands. Some of the shoreline vegetation and aquatic vegetation has been described (Pond 6) in Section 4.2.2.2. Additional shoreline plants include marsh St. John's wort (*Triadenum fraseri*), turtle head (*Chelone glabra*), blue flag (*Iris versicolor*), soft rush (*Juncus effusus*), small bedstraw (*Galium tinctorium*), blue-joint (*Calamagrostis canadensis*), and other rushes and sedges. Plants on the dike and beach include lamb's quarters, hemp-nettle (*Galeopsis tetrahit*), American dune grass, common ragweed (*Ambrosia artemidiifolia*), wild-rye grass, witch grass (*Elymus repens*), and swamp rose (*Rosea nitida*).

Red squirrel inhabits the coniferous forest along the edges of the pond, and meadow vole runways were observed near the northwest end. Muskrat, mink, and beaver were observed along the shore or swimming in the pond. River otter tracks were abundant during winter of 2005. White-tailed deer winter activity was considerable in the coniferous edges on both sides of the pond. Red-breasted merganser, green-winged teal, black duck, herring gull, and great black-backed gull were seen on the surface of the pond, with black duck and red-breasted merganser possibly breeding here. Great blue heron was observed feeding here and kingfisher (*Ceryle alcyon*) is present.

Northern harrier foraged near the northwest end where old-field is in proximity of the pond. Spotted sandpiper was observed along the shore. The dike and beach at the southeast end is an important migratory stopover for several shorebirds including semi-palmated plover, semi-palmated sandpiper, least sandpiper, whimbrel, and sanderling, as well as snow bunting and water pipet. Willet is here as well and breeds on the shoreline of Betty's Cove to the southeast. Greater yellowlegs probably breeds here, as it was observed exhibiting distress behaviour at the south end of the cobble dike.

Most woodland birds listed for the site at large were associated with the shoreline vegetation.

No reptiles were observed in this wetland, although some turtles may be here. Green frog and wood frog were the only amphibians recorded.

Fish species are reported in Section 4.2.2.2, Red Head Peninsular Ponds.

No evidence of contemporary commercial or recreational use of this wetland was noted.

4.2.4.2 Wetland No. 12

Wetland No. 12 is a complex of small coastal ponds that CWS mapping refers to collectively as Pv, Vegetated Coastal Saline Ponds, 0.8 ha in total area. These are Ponds 1-5, discussed in Section 4.2.2.2, on Red Head Peninsular Ponds (for locations refer to Figure 4.1-5). Ponds 1 and 2 are not saline, Pond 3 is slightly brackish, and Ponds 4and 5 are saline. Ponds 1 and 2 are located to the west, with Pond No. 2 the smaller of the two. This pond is a manmade pond dug to provide water for cattle when much of the peninsula was under agricultural land use. The aquatic and shoreline vegetation has been described in Section 4.2.2.2.

Additional shoreline plants for Pond 2 include leather-leaf, soft rush and lowbush blueberry and blackberry (*Rubus allegheniensis*) on the slopes west of the pond. Plants associated with Pond 1, in addition to those listed in Section 4.2.2.2, include meadow rue and common, seashore and narrow-leaved plantains (*Plantago major, Plantago maritima, and Plantago lanceolata*). While Pond 1 is not saline, there is some evidence of marine influence. The Pond empties through a culvert under the lane way into Webbs Cove. Sometimes, after strong winds, seaweed (*Fucus sp*.) can be found in the pond. Also, arrow-grass and seashore plantain are on the north shore of the pond close to the laneway.

Ponds 4 and 5 are at the base of, and northeast of, the Red Head promontory. Pond 5 is the more northeasterly of the two. The pond edge vegetation includes a number of marine shore species in addition to those mentioned in Section 4.2.2.2 (see Table 4.2-3, Marine Shoreline Plant Species Identified in Peninsular Area).

Pond 3, approximately 300 m north of Pond 5 is similar to Ponds 4 and 5 with respect to vegetation, but with a greater abundance of graminoids on the shoreline. These include spike rush (*Eleocharis palustris*), sedges (*Carex canescens* and *C. hormathodes*) and rushes (*Juncus effuses*, *J. arcticus*, and *J. canadensis*).

Great blue heron was observed feeding in these ponds. Gulls, crow, and raven were observed occasionally.

Fish species are reported in all ponds in Section 4.2.2.2, Red Head Peninsular Ponds.

No evidence of current commercial use of the wetland was noted, but as indicated above Pond 2 was used to provide water for cattle in the past. In early September 2004, a number of local people picked blackberries and blueberries on the slopes west of Pond 2.

4.2.4.3 Wetland No.13

Wetland No. 13 contains a drainage that begins on the northeast side of Highway 316 and flows into Dung Cove Pond. Spatially associated with this is a low linear area that runs parallel to the northeast shore of Dung Cove pond, but separated from it by a forested ridge. The area is best designated as a swamp, but there are marsh elements at both ends, respectively. This swamp/marsh is 2.0 ha in area. This portion of the wetland drains into Betty's Cove south of the Keltic Site footprint.

Tree species associated with the wetland include black and white spruce, white birch, American mountain ash, and trembling aspen. Shrub species include mostly speckled alder along with pussy, Bebb's, and bog willows (*Salix discolour, Salix bebbiana, and Salix pedicellaris*), and dwarf raspberry (*Rubus pubescens*). The southern more marsh-like portion contains scattered broad-leaved cattail, blue-joint, creeping bent grass (*Agrostis stolonifera*), and fowl meadow grass (*Poa palustris*). Other herbaceous plants include turtlehead, cinnamon fern, sensitive fern (*Oncolea sensibilis*), bog willow-herb (*Epilobium leptophyllum*), sedge (*Carex exilis*), soft rush, and field horsetail (*Equisetum arvense*).

Green frog was the only amphibian observed. No reptiles were noted. Deer tracks, snowshoe hare scat, and muskrat and meadow vole runways were in evidence. Coyote scat was seen, and during February 2005 a snowshoe hare kill by a bobcat occurred on the edge of the wetland.

On June 8, 2005, the following bird species were noted in or adjacent to the wetland: purple finch, American goldfinch, yellow-rumped warbler, white-throated sparrow, dark-eyed junco (*Junco hyemalis*), American robin, pine grosbeak (*Pinicola enucleator*), magnolia warbler, Swainson's and hermit thrushes, black capped and boreal chickadees, black-throated green, black and white, and yellow warblers, downy woodpecker, golden and ruby-crowned kinglets, ruffed grouse, yellow-bellied fly-catcher, and herring gull and tree sparrow (*Spizella arborea*) as fly-overs.

This is an area where there was a lot of mining activity and presently clear-cutting is occurring close to the edge of the wetland. A path from Highway 316 crosses the wetland on to the dike at the end of Dung Cove Pond. Fishers and hunters may use the path, but none were seen during the course of field work in this area.

4.2.5 Species at Risk

Species at risk are defined as: "native wildlife species that are—or have become—most sensitive to human activity due to their rare occurrence, restricted range in Canada, dependence on specialized habitats or declining population or distribution" (CWS, 2004). These may include federal listed species (SARA, COSEWIC) and/or provincial listed species (NSDNR, *Nova Scotia Endangered Species Act*).

Information on "Species-at-Risk" and "Rare" species was obtained from:

- NSDNR, Wildlife Division;
- the ACCDC;

- EC;
- NSMNH;
- COSEWIC; and
- Atlas of Breeding Birds in the Maritime Provinces (Erskine, 1992).

The EC SARA website (EC, 2005c) lists plants and animals designated "at risk" by virtue of being "Extinct, Extirpated, Endangered, Threatened, or of Special Concern." COSEWIC determines whether a species is at risk, following which the federal Cabinet will determine whether the species in question will be protected under SARA. It then becomes illegal to kill, harass, capture, or harm individuals of the species; their critical habitats are also protected from destruction.

Other organizations apply their own criteria to species thought possibly to be threatened by human activity. These include species designated "red" by NSDNR (NSDNR, 2002) that are "known to be or thought to be at risk." Those designated "yellow" are "sensitive to human activities or natural events." Those designated "green" are "not believed to be sensitive or at risk." ACCDC (2004) designates "S-Ranks" as follows:

- S1 = extremely rare;
- S2 = rare;
- S3 = uncommon;
- B = if breeding;
- S4 = usually widespread; and
- S5 = demonstrably widespread, abundant.

Over 350 species at risk were identified by ACCDC (2006) to occur within 100 km from the site of the Project Site, with the majority located greater than 5 km from the site. Table 4.2-14 summarizes those ACCDC listed species of special status known to occur within 5 km of the Project Site as well as species at risk observed during site field surveys. These species have designations under SARA, COSEWIC, NSDNR status, and/or the *Nova Scotia Endangered Species Act*. Although similar, each ranking applies specific criteria to species potentially threatened by human activity. It is important to note that four of the twenty species in the table are considered "at risk" under SARA criteria. Information and status listing for specific species is discussed in the following sections.

4.2.5.1 Terrestrial Species

In the area of the Project Site there are four terrestrial species possibly affected by the Project and classified "at risk" under SARA. These include: roseate tern (endangered), piping plover (*Charadrius melodus*) (endangered), mainland moose (endangered), and wood turtle (special concern). A Newfoundland sub-species of red crossbill is also listed as "endangered," but the Nova Scotia sub-species is not. There was no plant species reported as rare or at risk but reference to one provincially rare and/or possibly rare species is discussed further in Section 4.2.5.3.

TABLE 4.2-14 Summary of Species of Special Status for the Project Site

Species	Required Habitat	Habitat Present in Project Site	
		Yes	**No**
Fish			
Atlantic salmon (*Salmo salar*)	Nearshore and offshore while at sea	Anadromous: nearshore and offshore while at sea.	
American eel (*Anguilla rostrata*)	Freshwater streams and lakes, offshore while at sea	Catadromous (i.e., spawn at sea), lives most of life in freshwater as juveniles until spawning	
Birds			
Boreal chickadee (*Parus hudsonicus*)	Conifer forests	Yes-uncommon breeder, usually widespread	
Red crossbill (*Loxia curvirostra*)	Coniferous forests (pine, fir, spruce and tamarack) and urban parks.	Yes-as a winter resident, uncommon breeder, usually widespread, observed on main Keltic Site.	
Black guillemot (*Cepphus grylle*)	Rocky seacoasts, open sea, margins of landfast ice; seldom far from shore	Yes-uncommon, off shore migrant	
Common loon (*Gamia immer*)	Wooded lakes, tundra ponds, coastal waters	Yes- widespread as a breeder, frequents shore at LNG Terminal area	
Red-breasted merganser (*Mergus serrator*)	Estuaries, sheltered bays, less frequent on large inland bodies of water	Yes-rare as a breeder, seen with young at Dung Cove Pond terminal area	
Merlin (*Falco columbarius*)	Marshes, deserts, seacoasts, near coastal lakes and lagoons, open woodlands, fields	Yes-uncommon, widespread breeder, observed several times in flight	
Short-eared owl (*Asio flammeus*)	Prairies, marshes (fresh and salt), dunes, tundra	Yes-rare, one pair was observed summer 2005 foraging in a large wetland that extends from the Keltic site to Drum Head	
Semipalmated plover (*Charadrius semipalmatus*)	Shores, tidal flats	Yes-rare as a breeder, migratory non-breeder, observed on both marine and freshwater shorelines as a migrant	
Least sandpiper (*Calidris minutilla*)	Wet meadows, mudflats, flooded fields, shores of pools and lakes, narrow channels, edges of salt marshes, river sandbars, sometimes sandy beaches	Yes-extremely rare breeder, widespread migrant, shoreline migrant	
Solitary sandpiper (*Tringa solitaria*)	Streamsides, wooded swamps and ponds, fresh marshes	Yes- extremely rare breeder, probable migrant observed along fresh water streams	
Arctic tern (*Sterna paradisaea*)	Open oceans, rocky coasts, islands, tundra lakes (summer)	Yes-uncommon breeder, breeds on off-shore islands, but forages mainly away from shore	
Common tern (*Sterna hirundo*)	Lakes, ocean, bays, beaches, nests, colonially on sandy beaches and small islands	Yes-uncommon breeder, breeds on off-shore islands, may forage in LNG Terminal area	

Species	Required Habitat	Habitat Present in Project Site	
		Yes	**No**
Roseate tern (*Sterna dougallii*)	Coastal islands and nearshore	Yes-extremely rare, a colony exists on Country Island about 9 km from the proposed LNG site and one roseate tern was observed flying near the shore south of the area. Foraging occurs along the mainland and island shores, predominantly on sand lance (A. Boyne, CWS, pers. comm.; Rock, 2005). No foraging site is known to be in or directly adjacent to the LNG site area. The closest site is on the shore of Harbour Island about 3 km from the proposed LNG Terminal area (Figure 4.2-6).	
Greater yellowlegs (*Tringa melanoleuca*)	Open marshes, mud flats, streams, ponds; in summer, wooded muskegs, spruce bogs	Yes-rare as a breeder, otherwise widespread as a migrant, observed exhibiting breeding behavior at three sites	
Red phalarope (*Phalaropus fulicaria*)	Migratory in Nova Scotia found at lakes and large wetlands; breeds in arctic but congregates at Bay of Fundy upwellings in early spring/summer and late summer/early fall, common to abundant at sea in early spring, and early July to November.	Yes-but unlikely and only during migration if individuals come close to shore.	
Nelson's sharp-tailed sparrow (*Ammodramus nelsoni*) (Subspecies *subvirgatus*)	Uncommon to locally common summer breeder in Nova Scotia in coastal sedge and salt marshes; rare in winter and as a migrant in early spring and fall in marshlands with tall, emergent vegetation, shorelines, coastal salt marshes and dunes.	Yes-but only during summer breeding	
Fea's petrel (*Pterodroma feae*)	Globally threatened species (no COSEWIC or provincial designation), migrant	Yes-but highly unlikely, may be present in the Study Area (one record for the Gully) (Hooker and Baird, 1999).	
Flora			
Slender cotton-grass (*Eriophorum gracile*)	Peat bogs, fens, boggy ditches	Yes-several wetlands, have been identified on the Keltic site including the LNG Terminal area, many are peatland systems, with a combination of bog or fen	
Northern burreed (*Sparganium hyperboreum*)	Peaty pools		No- species is located 1 km from site, habitat unlikely to be present

Species	Required Habitat	Habitat Present in Project Site	
		Yes	No
Fauna			
Four-toed salamander (*Hemidactylium scutatum*)	Bogs, forested wetland, riparian areas, scrub-shrub wetlands, abundant sphagnum moss, sedgy pools for larval habitat.	Yes-major types of wetlands encountered in the Study Area, bogs, fens, swamps, marshes and shallow water wetlands	
Moose (*Alces alces americana*)	Second-growth forest, openings, swamps, lakes, wetlands. Requires water bodies for foraging and hardwood-conifer forests for winter cover.	Yes-extremely rare, though no evidence of moose presence was encountered, it has been reported in the general vicinity	
Wood turtle (*Clemmys insculpta*)	Streams, roam widely overland, terrestrial habitats, adjacent to streams, deciduous woods, cultivated fields, and woodland bogs, marshy pastures.	Yes-uncommon, potentially associated with the Dung Cove Pond, in summer may be found well away from the rivers and streams where hibernation takes place in winter, no report of wood turtles are known from the vicinity of the study site	

The Roseate tern, designated as “Threatened” under SARA; red; S1; extremely rare is located within 25 km of the proposed Project. The proposed Recovery Strategy for the roseate tern identifies “critical habitat” as defined in SARA and recommends that critical habitat be identified as:

- sites that currently support more than 15 pairs of roseate terns (The Brothers, Nova Scotia and Country Island, Nova Scotia); and
- tern colonies in areas that have supported small but persistent numbers of nesting roseate terns for over 30 years (Sable Island, Magdalen Islands, Chenal Island).

This designation includes the entire terrestrial habitat of all islands as well as aquatic habitat out 200 m seaward from the mean high tide line of each island.

Roseate Tern forage in areas within 25km of Country Island colony where shallow water (<5 m deep) occurs and where sand lance are found. The location of the proposed marginal wharf and marine terminal is within this defined area of foraging habitat and within the area described in the Recovery Strategy as requiring study (Environment Canada, 2006).

The other two terrestrial species considered “at risk,” but not observed at the Project Site are:

- Moose – Endangered (SARA, 2005; COSEWIC, 2005); red; S1; extremely rare.
- Wood turtle – Special concern (COSEWIC, 2005); yellow; uncommon.

The following species should also be noted:

- Piping plover (considered endangered under SARA) formerly nested on Sable Island (McLaren, 1981a), however there are no published reports of transients in the mainland Study Area in the regional journal for Nova Scotia Birds. Burrows (2002) notes that piping plovers utilize the shoreline area near the LNG Facility for summer breeding purposes on sandy beaches backed by dunes and close to shallow tidal flats.
- Harlequin duck (*Histrionicus histrionicus*), which are designated as a species of special concern (COSEWIC, 2005), were not detected near Country Harbour during a 1997 winter waterfowl survey conducted by NSDNR (EnCana Corporation, 2002). However, Harlequin ducks undoubtedly migrate through the area in small numbers, as there are wintering and staging areas on the outer coast (Burrows, 2002).
- Ivory gull (Atlantic population) (*Pagophila eburnean*) has been designated as endangered by COSEWIC (2005) but remains as special concern under SARA. No traditional nesting grounds have been identified in the Study Area and the presence of this species in the Study Area is expected to be incidental as individuals may arrive on ice flows; therefore limited interaction with LNG Facility activities is predicted (EC, 2006a).
- Barrow’s goldeneye (Eastern population) (*Bucephala islandica*) is considered by both SARA and COSEWIC as a species of special concern. This species is a diving duck that breeds and winters in Canada (Burrows, 2002). Small numbers of this population (about 400) winter in the Maritime Provinces and along the northern Atlantic coastline in the United States (Burrows, 2002). Migratory routes pass within the LNG Facility Study Area, however, limited interaction with Facility activities is predicted.

Other species observed in the area of the Project Site that are not protected by SARA, but designated to be sensitive in some respect by NSDNR (2002) or ACCDC (2004), include:

- Northern goshawk (*Accipiter gentillis*) – yellow; S3B – uncommon breeder – not observed; most other raptors were observed.
- Boreal owl (*Aegolius funereus*)– S1B – rare breeder; not observed but reported for New Harbour River system.
- Eastern phoebe (*Sayornis phoebe*) – S2S3B – rare to uncommon breeder; not observed; not likely present.
- Vesper sparrow (*Pooecetes gramineus*) – yellow; S2S34 – rare to uncommon breeder; not observed; not likely present; very little habitat available in the Study Area.
- Bobolink (*Dolichonyx oryzivorus*) – yellow; S3B – uncommon breeder; observed near Antigonish but not on site; little available habitat.
- Rusty blackbird (*Euphagus carolinus*) – S3S4B – uncommon, widespread breeder; not observed, in spite of high probability it is in or near the Study Area.
- Baltimore oriole (*Icterus galbula*) – S3B – uncommon breeder; observed near Antigonish, but not on site.

Other coastal birds in the Study Area that are sensitive to human disturbance include Great blue heron, osprey, and belted kingfisher. All of these species normally migrate south for the winter. Loons, grebes (*Podiceps sp.*), cormorants and bald eagles are resident year round.

4.2.5.2 Aquatic

Marine Fish

There are only two marine fish species found in the general area of the Scotian Shelf are currently listed by COSEWIC. These are Atlantic cod, categorized as a species of special concern, and Atlantic whitefish (*Coregonus huntsmani*), listed as endangered (COSEWIC, 2002).

Atlantic whitefish is an anadromous fish occupying estuarine and freshwater areas of the Tusket River drainage in southwestern Nova Scotia. There is no evidence that this species migrates to, or through, the marginal wharf and LNG Terminal area (Atlantic Whitefish Recovery Team, 2006).

Sea Turtles

Three species of sea turtle are known to occur off the Atlantic Canadian coast, including the leatherback (*Dermochelys coriacea*), Atlantic loggerhead (*Caretta caretta*), and Kemp's ridley (*Lepidochelys kempii*). A fourth species, the green turtle (*Chelonia mydas*) is a wide-ranging species and may be an occasional visitor to the area, but has yet to be positively identified.

The Kemp's ridley turtle, and, to a lesser extent, the loggerhead turtle, are generally confined to more southern waters and are not found on the Scotian Shelf as frequently as the leatherback turtle, due to the fact that Kemp's ridley and loggerhead turtles largely lack the counter-current biophysical flow mechanism that allows active leatherback turtles to keep warm in very cold water. The average northern occurrence of loggerheads was thought to be much further south (38E 20'N), than for leatherbacks (40E 05'N) (Shoop and Kenney, 1992). However, recent accidental catch rates by pelagic longline operations in Atlantic Canadian waters indicate that loggerheads are, at least in some years, more common than previously thought (Smith, 2001; cited in Breeze et al., 2002). The American longline fleet reported catching 3,000 loggerheads off of Newfoundland from 1992 to 1995 (McAlpine, 2001; cited in Breeze et al., 2002).

Being land-nesters, sea turtles are particularly vulnerable to disturbance by human activities. Along with natural predation, the nesting success of sea turtles has been diminished by various anthropogenic factors, including egg collection, loss of nesting beaches to commercial development, illumination of nesting beaches, shoreline pollution, ingestion of plastic and other debris, illegal hunting, and entanglement in fishing gear. Turtles, particularly sea turtles, mature slowly and exhibit moderate reproductive effort. Considerable natural mortality occurs on eggs and small juveniles. Any loss of breeding adults, above that caused through natural predation and disease, can lead to profound declines in population sizes, and possibly extirpation and/or extinction.

In Nova Scotian waters, adult and larger juvenile turtles feeding in the area may be affected by entanglement in and ingestion of debris. Entanglements in fishing line, lobster pot lines, nets, and other fishing gear have been reported. Sea turtles are caught with some regularity on longlines targeting tuna, swordfish, or other large pelagics. Often these turtles have mistakenly swallowed the bait, as opposed to being foul hooked, and although are cut loose while still alive, the rate of survival after being caught and released is unknown (Breeze et al. 2002).

Leatherback Turtles

The leatherback turtle is listed as endangered by COSEWIC (2002). The United States National Marine Fisheries Service and United States Fish and Wildlife Service list the leatherback and Kemp's ridley turtles as endangered and the loggerhead turtle as threatened (National Marine Fisheries Service and United States Fish and Wildlife Service, 1991; United States Fish and Wildlife Service and National Marine Fisheries Service, 1992). In 2006, a proposed recovery strategy for leatherback sea turtle was proposed that provided an outline of the basic biology, recovery goals, objectives, and performance indicators, identifies knowledge gaps, discusses permitted activities, and anticipated challenges for recovery of this species (Atlantic Leatherback Turtle Recovery Team, 2006).

The recovery strategy acknowledges that the population likely exceeds several hundred thousand individuals and model results suggest that the population can sustain human induced mortality up to about 1%. A review by DFO concluded that there was scope for human-induced mortality without jeopardizing survival or recovery of the species (Atlantic Leatherback Turtle Recovery Team, 2006).

The primary threat to leatherback turtles in Canadian waters is entanglement in fishing gear. There is little risk for entanglement with subsurface infrastructure associated with the Keltic Project as the structures are placed far enough apart such that there are few, if any spaces for head or flipper entanglement.

Peak leatherback occurrences in Canadian waters are during August-September but there are records for leatherbacks in Canadian waters for most months of the year primarily for feeding purposes (McAlpine et al., 2004; cited in Atlantic Leatherback Turtle Recovery Team, 2006). James et al. (2006) reveals a broad distribution of leatherbacks on the Scotian Shelf throughout the foraging seasons with most reported sightings occurring inshore from the continental shelf break. This recent study suggests that coastal and slope waters of the western Atlantic should be considered critical foraging habitat for adults of the species.

Whales

There are three endangered marine mammal species that could potentially be present in the Study Area: blue whale (*Balaenoptera musculus*), North Atlantic right whale (*Eubalaena glacialis*), and northern bottlenose whale (*Hyperoodon ampullatus*).

There is no reliable population estimate for the blue whale population in the western North Atlantic, however, it is thought to be in the low hundreds. The biggest factor responsible for low numbers of blue whales is the historical take in commercial whaling. Threats since the end of commercial whaling include ship strikes, disturbance from increasing whale watch activity, entanglement in fishing gear, and pollution. They may also be vulnerable to long-term changes in climate change as a result of change in abundance of prey (i.e., zooplankton) (Sears and Calambokidis, 2002).

The North Atlantic right whale also suffered high mortality due to whaling. The total population is currently estimated to be about 322 individuals and continues to experience high mortality from ship strikes and entanglement in fishing gear. It has been estimated that the population could become extinct in about 200 years (COSEWIC, 2003).

The COSEWIC Assessment Summary for Northern bottlenose whale (Scotian Shelf Population) (COSEWIC, 2002) states the reason for elevating this population to endangered status is primarily due to the threat of oil and gas development in and around the prime habitat (i.e., the Gully). It does, however, acknowledge there is little information as to how this species is, or is not, affected by oil and gas development activities. The COSEWIC assessment states that noise, chemical pollution and other disturbance of oil/gas exploration and production activities might lead the whales to abandon the Gully, potentially endangering the population.

The Atlantic populations of the fin whale (*Balaenoptera physalus*) and Sowerby's Beaked whale (*Mesoplodon bidens*) are designated as species of special concern by COSEWIC (2005).

4.2.5.3 Vegetation

No plant species observed is reported nationally rare or at risk, but one species, a horsetail (*Equisetum variegatum*), rare in Nova Scotia, (Zinck, 1998; Pronych and Wilson, 1993) was found in two places; i.e., near the shore of Gold Brook Lake (Keltic, 2002) and on the Keltic Site proper. The on-site location is shown in Figure 4.2-1.

A concerted effort was made to find rare and otherwise significant species; i.e., at risk (red), and sensitive to human activities or natural events (yellow) (NSDNR, 2004). Northern commandra (*Geocaulon lividum*) considered rare in Nova Scotia (Pronych and Wilson, 1993) is purported to be in the general area, but it was not observed in this study.

It has been suggested by the Protected Areas Branch of the Nova Scotia Government that the Endangered (COSEWIC, 2005) boreal felt lichen (*Eriodermea pedicellatum*) may be in the Keltic Study Area, and therefore the LNG Facility Area, as the area lies within the historical range of this small lichen. At present it has been known only from a single site in Halifax Regional Municipality (Conversation and Recovery of Nova Scotia Species at Risk, Municipal, and Community Stewardship, undated). Recently a second location in Nova Scotia has been reported (Cameron, 2004). The likelihood of this lichen being in the Study Area would seem remote. It is known from only two small areas in the province, and it is thought to be threatened by forestry activities, of which there has been considerable in the two Study Sites, especially the Keltic Site proper.

Plants are designated “rare” because it is presumed there are not very many of them. An extensive and intensive survey was carried out in this study, as evidenced by the finding of 305 species over a relatively comprehensive taxonomic range. Species known to be rare and the habitats in which they were likely to be found were given special attention. It is, of course, possible that there are other rare species in the LNG Facility Area that were not detected. The Bear Head LNG Terminal EA (Access Northeast Energy Inc., 2004) was carried out in roughly similar terrain and vegetation. Only two “rare” species were found; i.e., Northern commandra and Southern twayblade (*Listera australis*), but not *Equisetum variegatum*. This would seem to reinforce the point that “rare species” may indeed be rare.

4.2.5.4 Special Places

<u>Country Island</u>

Country Island is a 19 ha island located approximately 8 km offshore from Drum Head, Nova Scotia. The Island hosts a sizeable breeding colony of Common and Arctic terns. In addition, it is one of the few remaining Canadian breeding sites for the roseate tern. The use of Country Island by this species is discussed in Section 4.2.5.

There are currently no formal restrictions on travel to Country Island. The Country Island complex has been designated internationally as an Important Bird Area (IBA) and a proposal to designate Country Island as a Migratory Bird Sanctuary under the *Migratory Bird Convention Act* has been prepared. As mentioned above and in Section 4.2.5 the island is considered critical habitat for the roseate tern

4.2.6 Atmospheric Acoustic Environment

The general locale of the proposed facility is semi-rural in nature. However, its actual location is in an industrial park which is currently the site of the SOEI Gas Plant (Figure 1.0-1).

In September 2004, noise monitoring was conducted in the vicinity the SOEI gas plant at four locations (northeast, southeast, southwest, and northwest corners) within the property bounds.

The monitoring was conducted over a period of 24 hours (Sept.15-16, 2004), with measurements being taken once per minute in decibals (dBA). Given the limited noise sources in the area, this sample can be considered representative of typical noise levels in the area of the Project. The results are reported as equivalent sound level (Leq). Leq is the level of a constant sound which, in a given situation and time period, has the same sound energy as does a time-varying sound. Technically, Leq is the level of the time-weighted, mean square, A-weighted sound pressure. Typical noise guidelines are usually related to time of day, since noise impacts are generally perceived as being of the nuisance variety in terms of human activity, which also varies by time of day. The results of this monitoring are summarized in Table 4.2.15 below.

TABLE 4.2.15 Hourly Leq Range (dBA) SOE Gas Plant, Sept. 15-16, 2004

Time Period	Leq Range	Guideline Value*
14:00-18:00	45.5-63.7	65
18:00-23:00	38.6-54.8	60
23:00-07:00	38.5-52.7	55
07:00-14:00	39.1-61.4	65

The ‘Guideline Values’ are the criteria established by the Nova Scotia Department of the Environment in 1991, and are intended to reflect the effect that noise has on man. The Guideline states that “Noise legislation should be designed primarily to protect public health and within reasonable economic restraints provide a quiet and restful environment in which to live, work and play.”

The context for noise assessment may be assisted by an understanding of typical noise levels for a variety of scenarios/activities. These are exemplified in Table 4.2-16 below.

TABLE 4.2.16 Typical Noise Values (dBA)

Sound Level (dBA)	Descriptor
0-25	Threshold for Normal Hearing
10	Normal Breathing
40 (generally lower limit of ambient sound)	Quiet Office, Quiet Residential Street
50	Rainfall
50-60	Typical Office
60-95	Typical Household Appliances
80-120	Typical Construction Equipment
110	Jet Takeoff

4.3 DESCRIPTION OF THE SOCIO-ECONOMIC AND CULTURAL ENVIRONMENT

Prior to the Keltic Project, the Municipality of Guysborough County was instituting an industrial strategy for the region. Construction of the SOEP gas plant in the Goldboro Industrial Park has spurred expansion of the current industrial site to include land for the proposed Keltic development.

The proposed Marginal Wharf is located on Red Head and is a marine facility. Although other aspects of the Project Area covered under the District 7 Planning Strategy and Land Use Bylaws the proposed Keltic Site was previously zoned M- 2 (Industrial Resource) and Residential R-1. The M-2 zoning permitted uses, such as quarry development, that were not deemed suitable for extension to shoreline properties. Zoning has been amended to an M-3 designation that targets the marine aspect of the Keltic development.

This designation encompasses an area between 2833 and 3238 ha, of which approximately 460 has been allocated to Keltic. The area includes the shoreline of Red Head to Betty's Cove, including the existing pipeline, and NSPI line corridors. The adjoining Sable gas complex has a footprint between 40.5 and 48.6 ha, of which 20.2 ha has been fenced (G. Cleary, pers. comm., 2005).

4.3.1 Current Use of Lands and Resources for Traditional Purposes by Aboriginal Persons

A MEK Study was developed by Membertou Geomatics Consultants for Keltic. The purpose of the study was to identify Mi'kmaq land and resource use activities that have been or continue to be pursued by Mi'kmaq in the geographical areas being considered for development.

The MEK study consisted of a historical review of Mi'kmaq occupation and use of the area, Mi'kmaq traditional land and resource use activities, and a Mi'kmaq significant species analysis. The MEK study was completed by conducting interviews, reviewing archival information, and site visits. Numerous interviews with Mi'kmaq individuals from Paq'tnkek, Pictou Landing, and Millbrook were conducted by using maps of the Study Area and asking questions about the Mi'kmaq use activities. Archival documents and published works including Census Records and Nova Scotia Legislative Council records were reviewed for information on Mi'kmaq occupation of the Study Area. Site visits were taken to the Study Area with the Ecological Knowledge holder from Paq'tnkek. The site visits helped to familiarize the ecological knowledge holder with the areas of planned development and to further identify traditional Mi'kmaq plant resources that may be in the Study Area. The area studied for the MEK report encompassed the lands of the KDP including the inshore area proposed for the marginal wharf and LNG marine terminal, and surrounding lands within a 10 km radius. The full report is provided in Appendix 2 of the Provincial EA Report (AMEC, 2006).

The Mi'kmaq people have occupied various lands located throughout Antigonish and Guysborough counties since contact. The area surrounding Antigonish Harbour and the present town site was an important site for fishing, hunting, gathering of medicinal plants, as well as encampment. One of the most significant historical Mi'kmaq communities appeared to be at St. Mary's, which for the purpose of this study, is outside of the Keltic Study Area, and located about 30 km southeast of Goldboro. However, it is clearly an important historical area, as there are reported to be Mi'kmaq burial sites here, and the St. Anne's Chapel was constructed here in the early 19th century.

The Town of Guysborough was also found to be a significant historical area to the Mi'kmaq, with various archival references to Mi'kmaq petitions and grants during the 19th century. As well, the study also found various references to a burial ground at Isaac's Harbour and Upper Country Harbour.

Data collected from interviews with Mi'kmaq hunters, fishers, and plant gatherers is mapped in the full MEK report is provided in Appendix 2 of the Provincial EA Report (AMEC, 2006).

Results identified various hunting areas for small game, deer, and areas where these animals have been harvested previously. Medicinal plant gathering sites and areas were also identified. The most significant data appeared to be fishing activities that are pursued on many of the key rivers and waterways which are found throughout the counties. This included many species, such as trout, eels, salmon, tuna, and urchins.

The study found that Mi'kmaq continue to undertake traditional activities throughout the Keltic Study Area. Some of the reported hunting and fishing areas occur within the site of the KDP, including the area of the LNG Facility, marginal wharf, and marine terminal. However, most of the potentially affected hunting areas are relatively small compared to the other hunting areas which cover extensive tracks of land and are located at a significant distance from the Project Site (Schedule C in Appendix 2 of Provincial EA Report - AMEC, 2006). Similarly, traditional fishing areas are located at and nearby the Project Site. They too represent a very small portion of extensive fishing areas located away from the Project Site (Schedule B in Appendix 2 of Provincial EA Report - AMEC, 2006). No medicinal plant gathering sites were identified within the area of the Project evaluated in the CSR.

Davis Archaeological Consultants Ltd. identified the South River, Isaac's Harbour and Isaac's Harbour River, Gold Brook, and the Salmon River/Erinville areas as key resource and land use sites using a predictive model (Appendix 13 of the Provincial EA Report - AMEC, 2006). The MEK Study and archaeological predictive modelling provided similar results and were performed independently of one another.

4.3.2 Physical and Cultural Heritage

Historical research was conducted at Nova Scotia Archives and Records Management (Halifax), NSDNR, the NSMNH Heritage Division, and local libraries. Historic maps, manuscripts, land grants and deeds, archaeological reports, and published sources were consulted. This background study revealed a long settlement history pre-dating the arrival of Europeans to the province.

Before the arrival of European settlers to Goldboro in the nineteenth century, the area was home to at least two Mi'kmaq encampments, at Schoolhouse Brook and at the head of the harbour on Isaac's Harbour River. Local residents have also indicated the possibility of a third encampment at Webb's Cove. The district was known to the Mi'kmaq as "Eskegawagik" meaning "skin-drying place" (Cook, 1976). In the seventeenth and eighteenth centuries, this area was visited by the French and English although there is no documented European settlement in Isaac's Harbour prior to 1817.

In about 1817, a Black Loyalist settler, Isaac Webb, moved his family from County Harbour to the east side of Isaac's Harbour (then known as Port Hinchingbrook) which was unsettled save for the few Aboriginal encampments. Webb built a large white farmhouse there (Hart, 1975). In 1831 some fishers from the western end of the province settled on the west side of the harbour and the community became known as Isaac's Harbour after the pioneer the settlers found there. Several families of Black Loyalists settled around what is now known as Webb's Cove. Most of these early Black Loyalists were fishers (Cook, in Public Archives of Nova Scotia, undated).

The Black Loyalist settlers were buried in a cemetery at Red Head on the east side of the harbour. No burial records for the cemetery at Red Head have been located and only one headstone was ever known in the cemetery, although an archaeological excavation in 2001 (NSMNH, 2001) resulted in the discovery and removal of 24 burials. The single carved headstone in the cemetery was that of Henry Webb who died in 1935 and was the last surviving descendent of the original settlers remaining in Isaac's Harbour East (Niven et. al., 2001).

On March 11, 1898, Isaac's Harbour East was renamed "Goldboro" by an act of Legislature, due to the discovery of gold there in the mid-nineteenth century (Statutes of Nova Scotia, 1898).

Historic maps reveal little about the settlement history of the Keltic Study Area. Land was not granted by the province until the late nineteenth century. The 1776 Atlantic Neptune does not show any settlement on Isaac's Harbour (Port Hinchingbrook), nor does the 1834 Great Map of Nova Scotia, although the main road along the shore is shown. Ambrose F. Church's map of Isaac's Harbour, published in 1876, shows several wharves and stores along the shore, along with a lobster factory and an "old crusher" just north of Webb's Cove. A cookhouse, blacksmith shop, "old mines" and a few residences are situated within the Keltic Study Area on the east side of the main road (Church, 1876).

Gold was first discovered on the west side of Isaac's Harbour on September 14, 1861. It was discovered a short time later on the east side of the harbour by two Aboriginal persons, on what became known as the Mulgrave lead. By 1862, several leads had been discovered and were in operation throughout the district including the Mulgrave and Victoria leads in Goldboro. The Mulgrave lead continued to be mined at varying rates and under various management firms well into the twentieth century (Malcolm, 1912).

In 1887, a quartz vein was discovered on Hurricane Island and three shafts were sunk and worked by the Island Mining Company. A gold lead was discovered in the Skunk Den in 1890 and was being mined by 1892 (Hunt, 1868). Mining in Goldboro halted for the last time in 1943 (Hunt, in Malcolm, 1912).

4.3.2.1 Recreational Opportunities and Aesthetics

The proposed location of the Keltic Site offers a variety of non-formal recreational opportunities such as hiking, boating, fishing, camping, scuba diving, etc. However, in terms of formal recreation the area has limited parks and campgrounds, such as the picnic area at the Goldboro community centre.

4.3.2.2 Tourism

The Guysborough County Heritage Association works to promote tourism, heritage, and culture in the region. The Association is currently developing a marketing strategy which includes a website, brochures, and signage, to increase the profile of the region and highlight its heritage resources.

The Guysborough County Heritage Association has several active members and community groups in Guysborough County, including the Goldboro/Isaac's Harbour Development Association, the United Empire Loyalists' Association of Canada, Port Bickerton and Area

Planning Committee, Lincolnville Community Development Society and the Tor Bay Acadian Society. These groups seek to preserve particular aspects of the region's heritage through promotion and/or interpretive services.

Most cultural and heritage activity appears to be associated with coastal communities. Interior communities (such as Erinville) do not currently have any active membership promoting local cultural or heritage resources (K. Avery, pers. comm., 2006). Cultural and heritage resources include the Goldboro Interpretive Centre, Port Bickerton Lighthouse Interpretive Centre, and Country Harbour Cultural Centre. Community halls exist in Goshen, Port Bickerton, and Erinville (firehall).

Specific heritage projects include the exhumation and relocation of a former black settlement cemetery on Redhead, which was within one kilometre of the proposed Keltic site. The Lincolnville Community Development Society was instrumental in this Project, and the gravesites have now been moved to another cemetery on Gold Brook Road (L. Hayne, pers. comm., 2006). Another project is the United Empire Loyalists' Municipal Park, which is a small seaside park (approximately 1 ha) in Country Harbour. First opened in 1983 and neglected for years, the park was recently reopened in 2006. This park can be accessed via a 2.2 km walking trail leased from the NSDNR off of Highway 316, just north of the intersection with Highway 211. There is a memorial cairn and planned interpretive signs that will describe the cultural and natural history of the area (D. Hayne, pers. comm., 2006).

Guysborough County's natural heritage is also protected in numerous provincial parks and natural areas. In the Goldboro area, Salsman Provincial Park is located off Highway 316, eight km north of Isaac's Harbour, on a peninsula on the east side of Country Harbour. The park is open during the summer months (June to September) and has campground facilities. The Fraser Mills fish hatchery is located on Route 7, west of Erinville. This hatchery raises approximately 500 000 fish annually, including four different salmonid species. The facility also includes an interpretive centre.

Antigonish is the major cultural centre in the County of Antigonish. The Heritage Association of Antigonish operates the Antigonish Historical Museum as the main vehicle to promote and preserve the region's cultural and historical heritage.

4.3.3 Structures/Sites of Archaeological, Paleontological or Architectural Significance

An archaeological resource impact assessment of the Study Area for the KDP, was conducted under Heritage Research Permit A2004NS76. An assessment including a historical background study and field survey were conducted that resulted in the discovery of twelve previously unrecorded archaeological sites, at least three of which are expected to be impacted by construction of the Project assessed in this CSR (i.e., the LNG facility and the marginal wharf). A copy of the impact assessment is provided in Appendix 13 of the Provincial EA Report (AMEC, 2006).

4.3.3.1 Archaeological Field Survey and Reconnaissance

Prior to the field survey of the proposed Project Site, two archaeological sites were recorded during previous archaeological assessments. Archaeologist Laird Niven recorded the remains of the late nineteenth century Skunk Den Mine located on the south side of Sable Road within the Keltic Study Area. The site includes the remains of several stone crusher piles and irregularly-shaped depressions likely associated with open-pit mining.

In response to concern by citizens of the Lincolnville community, in 2000 and 2001, a crew of archaeologists and community members, lead by archaeologist Laird Niven, conducted an excavation of the cemetery at Red Head. The purpose of the excavation was to identify and remove burials which were being impacted by severe erosion of the table land on which the cemetery was located. Twenty-four burials were encountered over the two seasons and the skeletal remains were moved to a laboratory where forensic analysis and identification (gender, age, and pathology) was conducted before the remains were reburied at the Goldboro Baptist Cemetery.

No additional burials were encountered at Red Head during subsurface testing for the proposed Keltic Facility. Twelve archaeological sites were encountered during the survey of the remainder of the Project Site including eight sites on the peninsula, one on Hurricane Island, and the remaining three within the Industrial Park (Figure 4.3-1).

Five unidentified features were discovered and recorded at Sculpin Cove north of Red Head. All five features are comprised of irregularly-shaped depressions with no structural elements or associated artifacts visible on the surface. The age and function of these features is not known.

On Hurricane Island, at the mouth of Isaac’s Harbour, archaeologists discovered and recorded the remains of a late nineteenth century gold mining operation. The site is very extensive and includes numerous mine-related features spread out over the island including several irregularly shaped depressions associated with air shafts or surface prospecting. There are also several large deep rectangular depressions which may be related to open-pit mining, a possible powder magazine, a stone-lined well, and numerous other unidentified features.

The site is associated with the Hurricane Island Mine which was opened in 1887 by the Island Mining Company. The McMillan Mine is located north of Red Head and appears to be relatively modern (early twentieth century) as the main feature is comprised of a square footing of stone and concrete construction with wooden block supports inside. To the south of the main feature is a mine shaft adjacent to the shoreline.

Above Dung Cove, archaeologists discovered a site likely associated with settlement which includes a rectangular stone-lined feature. The feature is obscured by low tree cover and is surrounded by three stone piles resulting from field clearing. The land appears to have been cultivated at some point. The age of this site is not known but given its proximity to Webb’s Cove, it may be associated with Black Loyalist settlement.

The Giffin’s Mill site is located above Dung Cove on the north side of an old roadway that runs south-westward from Highway #316. The site is comprised of a shallow rectangular depression which is bounded on the east by a wooden structure of vertical posts and on the north and south by a mortared stone wall. A sluice runs parallel to the old roadway from the highway and leads to the feature. This area is marked on historic maps as “Giffin’s Mill” (Geological Survey of Canada, 1904).

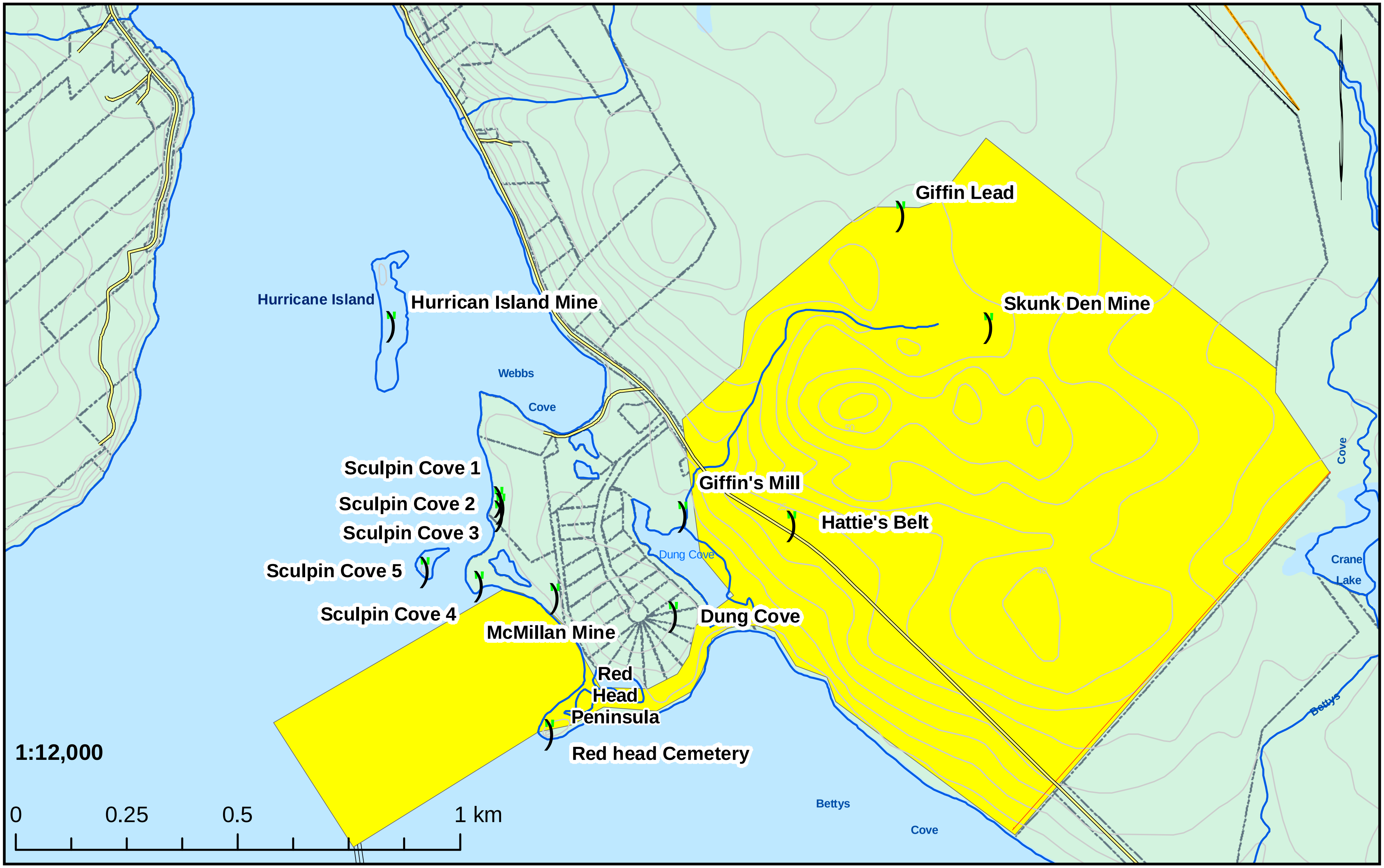


FIGURE No. 4.3-1

KELTICPETROCHEMICALS INC.

LOCATION OF HERITAGE RESOURCES

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The Hattie's Belt site is located adjacent to Highway #316 on the east side, south of Sable Road. The site encompasses an area approximately 50 m by 50 m and includes several stone crusher piles, air shafts, and/or open pits associated with gold mining. At the west end of the site immediately adjacent the highway is a surface tunnel which is marked on the 1904 gold district map for Isaac's Harbour (Geological Survey of Canada, 1904).

The Giffin Lead is located on the south side of Sable Road which consisted of more than a dozen water-filled depressions possibly related to open-pit mining. Several stone crusher piles were also observed in the surrounding area. This site stretched a radius of approximately 50 m. The South Mulgrave lead is located on the north side of Sable Road adjacent to an old roadway that runs northwest from Sable Road out to Highway #316. This site stretches for approximately 100 m along the old roadway and consists of several stone crusher piles, those on the east end of the site having been recently levelled. On the west side of the site are a stone crusher pile and open mine shaft with wooden structural remains. This site is likely the "old crusher" indicated on Church's 1876 map.

In addition to those archaeological sites that were recorded, several areas of cultural activity were noted. At the head of Betty's Cove, mining activity likely associated with surface prospecting was encountered. Several depressions were noted but no open mine shafts or structural remains were found.

On the north side of Sable Road approximately 350 m east of the South Mulgrave lead site, seven air shafts were discovered which are likely associated with the Mulgrave lead. Additional air shafts were discovered at the west end of the industrial park approximately 100 m east of the highway and 50 m north of Sable Road.

On the north side of Sable Road, west of the old roadway leading to the South Mulgrave lead, a linear stone alignment was discovered oriented north-northeast by south – southwest adjacent to a NSDNR Survey marker (#4447). No other heritage features were found in the surrounding area.

Two areas of recent dumping were encountered near the east end of the Keltic Study Area on the north side of Sable Road along a recently abandoned roadway opposite the Sable Offshore helipad. Midden materials included a wood stove, tires, a chemical storage drum, vinyl miniblinds, tar paper, mechanical parts, plastic containers, and plastic buckets. Newspapers dated March 1995 were also found among the refuse.

Finally, an early- to mid- twentieth century midden was found approximately 30 m south of Sable Road behind a standing abandoned house on Highway #316. The house is built on a fieldstone foundation which has been mortared in spots to repair it, and later boarded over. The house is likely of late nineteenth-century vintage. Across the highway opposite the house is a poor-grade concrete foundation with cast iron pipe running through it. Behind the foundation is a 1930s truck and scattered remains of other early automobiles, suggesting this may have been a commercial garage or a garage associated with the house across the street. Fifteen metres northeast of this feature is a mine air shaft.

4.3.4 Shipping and Navigation

The current marine activity within the Isaac's Harbour and Country harbour are basically those activities supporting the inshore fishery as discussed further in Section 4.3.8.2.

Current marine traffic also includes a monthly passage of a shrimp trawler to the Stormont facility in Country Harbour (a wharf located approximately 10 km north of the Project Site in Country Harbour. An approximation of the current harbour traffic scheme is provided in Figure 4.3-2.

4.3.4.1 Current Shipping Routes

Atlantic shipping routes cross north to south into the Chebucto Bay and Halifax Harbour from the seaward traffic lanes well outside the proposed entrance to Country Harbour. Marine traffic traveling along the Nova Scotia coastline generally chart a strait line route port to port at a distance of roughly 16 km+ off the coast to avoid coastal land extensions and small ships traffic.

4.3.4.2 Regulatory Environment

The *Canada Shipping Act* and Regulations, the *Oceans Act*, and the *Canadian Marine Act* all govern the movement of vessels in Canadian waters. Movements and routing of vessels in Canadian waters is monitored by the Marine Communications and Traffic Services. Marine Communications and Traffic Services provides the Eastern Vessel Traffic System, assisted by Pilots and as permitted by Customs and Port Authorities. The local fisheries activities are managed under the guidance of DFO with regulations pertaining to specific species pursued.

4.3.5 Lighting

The Project Site currently has virtually no artificial lighting sources. The surrounding community has artificial lighting sources consistent with those found in sparsely populated rural communities but in general the night sky is typically dark.

Existing ambient light levels were not monitored; however, as with noise levels, they would be typical of a semi-rural environment, with some slight impacts from the flare stack at the SOEI Gas Plant.

4.3.6 Marine Safety and Security

Ocean-going tanker transportation of LNG has a long record of safe operation. Few accidents have occurred since the first converted freighter delivered a Lake Charles, Louisiana cargo of LNG to the United Kingdom (UK) in January 1959, none involving a fatality or major release of LNG. The outstanding LNG shipping safety record is attributable to continuously improving tanker technology, tanker safety equipment, comprehensive safety procedures, training, equipment maintenance, and effective government regulation and oversight.

LNG ships are well-built, robust vessels with a double-hull design built to withstand the low-energy impacts common during harbour and docking operations.

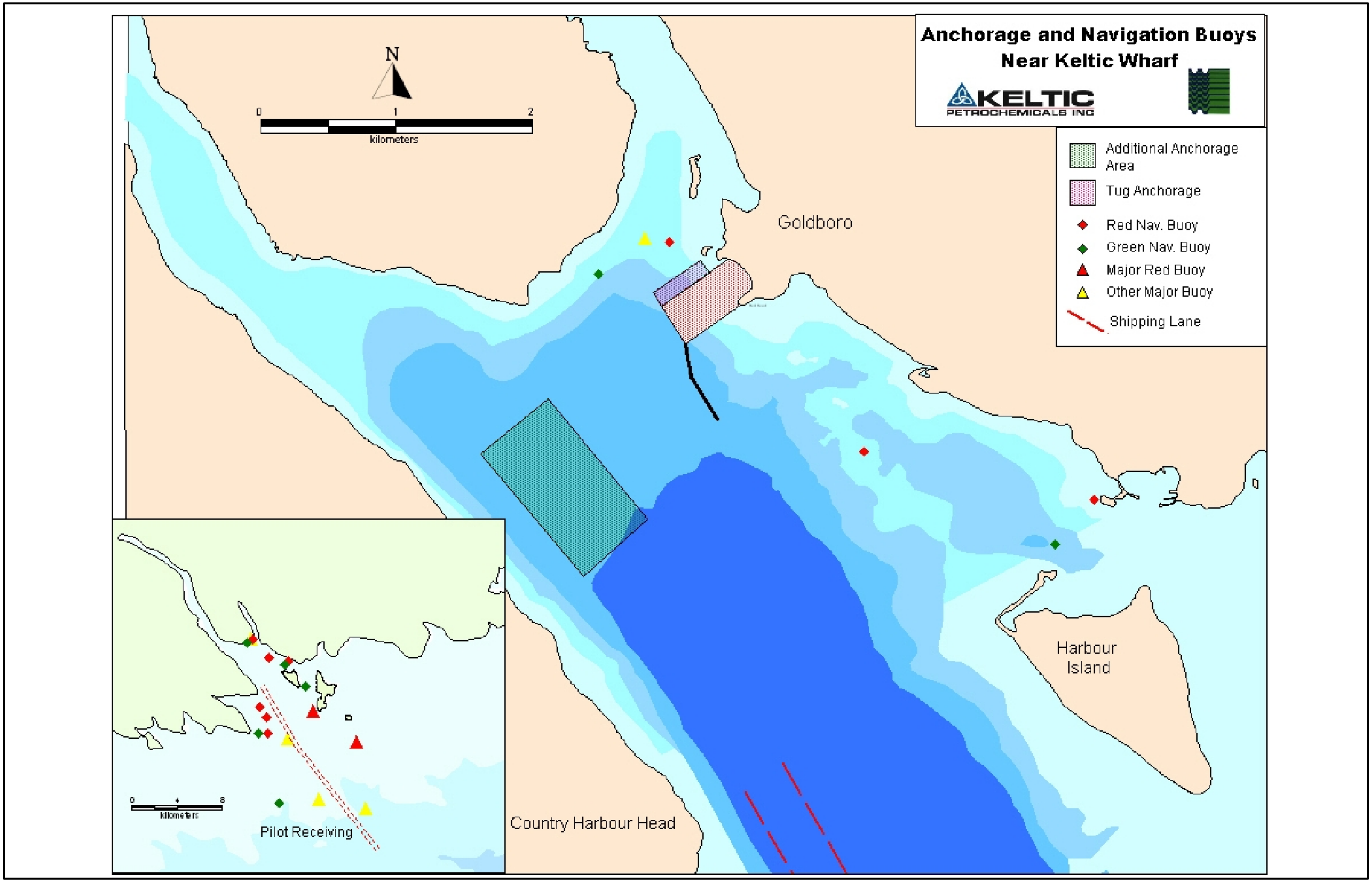

Figure No. 4.3-2
KELTIC PETROCHEMICALS INC.
Shipping and Navigation
June 2007

Currently, the only wharf in the vicinity of the LNG Facility is the single wharf structure utilized by the SOEI project. A port structure with formal marine security and safety policies and regulations is not available.

4.3.7 Human Health and Safety

No assessment of existing human health and safety was undertaken to record baseline conditions. Human health and safety will be addressed based on anticipated Project-related effects and a QRA.

4.3.7.1 Seismic Considerations

Eastern Canada is located within a stable continental part of the North American tectonic Plate and as such has a relatively low rate of earthquake activity. Nevertheless, within Canada's eastern seismic region, large earthquakes have occurred in the past and will inevitably occur in the future. The Eastern Seismic Region of Canada includes Northeastern Ontario, Southern Great Lakes, Western Quebec, Charlevoix-Kamouraska, Lower St. Lawrence, Northern Appalachians, and the Laurentian Slope (see web site of NRCan Earth Science Sector: http://earthquakescanada.nrcan.gc.ca/zones/eastcan_e.php).

Each year, approximately 300 earthquakes occur in the eastern seismic region, of which perhaps four will exceed magnitude 4, thirty will exceed magnitude 3, and about fifteen will be reported felt (Geological Survey of Canada, 2003). A decade will, on average, include three events greater than magnitude 5 (generally the threshold of damage).

The known earthquake seismic source zones of most concern to the populated areas of eastern Canada are the Charlevoix, Passamaquoddy and offshore Laurentian Slope seismic zones where major earthquakes of magnitudes 7.0, 5.7 and 7.2 occurred in 1925, 1869 and 1929, respectively. The Passamaquoddy area experienced a 5.9 event in 1904 and the Charlevoix area a 6.0 event in 1988 with the Laurentian Slope having had about nine events 5.0 or greater since 1929 up to 1977 (Ruffman, 1995). In 1929 a magnitude 7.2 earthquake on the Laurentian Slope (known also as the Grand Banks earthquake of 1929) triggered a large submarine slump, which ruptured 12 transatlantic cables and generated a tsunami that was recorded along the eastern seaboard as far south as South Carolina and across the Atlantic Ocean in Portugal, and caused the loss of 28 lives on the Burin Peninsula in Newfoundland. This represents Canada's largest documented loss of life directly related to an earthquake.

The causes of earthquakes in eastern Canada are not well understood: unlike at plate boundary regions where the rate and size of seismic activity is directly correlated with plate interaction, seismic activity seems to be related to the regional stress fields (Ruffman, 1994), with the earthquakes concentrated in regions of crustal weakness (Bent, 1995) at depths varying from surface to 30 km (Geological Survey of Canada, 2003).

4.3.7.2 Tsunamis

Ruffman and Tuttle (2005) have noted that written history of tsunami by European settlers on the western side of the Atlantic Ocean is relatively short and little oral history from first nations peoples or Viking visitors survives. The following is summarized from their work:

- The first known historic local tsunami is that caused by the November 1, 1755, Lisbon offshore earthquake.
- Tele-tsunami is known on September 24, 1848, from Fishing Ships Harbour, southern Labrador, to St. John's.
- A local tsunami was noted on June 27, 1864, at St. Shotts on the southwest extremity of the Avalon Peninsula, Newfoundland.
- On November 17, 1872, tide gauges on the Fox Islands in Penobscot Bay and in North Haven, Maine registered a train of tsunami-like waves for about six hours.
- On August 10, 1884, a magnitude 5.6 earthquake in southern New York State created a tsunami that was observed in Philadelphia, along the coast at Trenton and Highlands, New Jersey, and through to New York Harbour.
- On October 4, 1884, three trans-Atlantic cables south of the Tail of the Banks broke at the same time over a down-slope distance of 10 nautical miles suggesting a slump; a possible tsunami may have resulted, however no tsunami reports are presently known.
- On January 9, 1926, an apparent tsunami was seen at Bernard, in Bass Harbour on Mount Desert Island, and at Corea in Maine.
- On November 18, 1929, the magnitude 7.2 "Grand Banks" earthquake (epicentre of 44.5°N, 56.3°W) triggered a large submarine slump that generated the tsunami described in Section 4.3.7.2.
- In 1940, a small tsunami-like event observed on the Island of Saint-Pierre may have been associated with the Laurentian Slope Seismic zone.

Other tsunami which preceded these is known from studies of the offshore geologic record (Campbell et. al., 2003; Bornhold et. al., 2004; Finea et. al., 2005).

The tsunami that is most relevant to the proposed Keltic plant site is that of 18 November 1929, in which a magnitude 7.2 earthquake occurred along the southern edge of the Grand Banks (epicenter of 44.5°N, 56.3°W) that was felt as far away as New York and Montreal (Geological Survey of Canada, 2005). On land, damage due to earthquake vibrations was limited to Cape Breton Island, where chimneys were overthrown or cracked, and where some highways were blocked by minor landslides. However, the earthquake triggered a large submarine slump that generated a tsunami that was seen in Cape Breton Island, where it did minor damage; it was physically seen as far southwest as Lunenburg, Nova Scotia, and in Bermuda. It was recorded on tide gauges as far south as Charleston in the US, in the Azores, and across the Atlantic Ocean in Portugal (Ruffman, 2001).

The tsunami traveled at speeds up to about 500 km/hr through deep water, and over the continental shelf at about 205 km/hr toward Halifax and 140 km/hr toward Newfoundland, where two-and-a-half hours after the event, three main pulses arrived along the coast of the Burin Peninsula with amplitudes of 3 to 8 m (Finea et. al., 2005) and a run-up that rose 13 m (Ruffman, 2001) above sea level and perhaps as much as 27 m (Geological Survey of Canada, 2005) above sea level in narrow bays. It claimed a total of 28 lives in Newfoundland, one life in Cape Breton, Nova Scotia, and caused more than $1 million (1929 dollars) damage (estimated as nearly $20 million 2004 dollars).

The proposed Keltic plant site was shown by the Geological Survey of Canada (2005) to be just at the edge of the "minor damage" zone for the 1929 tsunami.

4.3.8 Fisheries

4.3.8.1 Freshwater

Nova Scotia is divided into six Recreational Fishing Areas; Guysborough County is located within Recreational Fishing Area 2, along with Antigonish and Pictou Counties. There were 1,632 fishing licenses sold in the County in 2000. Of these, 87 were non-resident and the rest resident. Overall, 2.5% of the 64,078 provincial licenses sold in 2000 were in Guysborough County (NSDAF, 2001a). Approximately 2000 licenses were sold in 2005 (O'Neil, pers. comm., 2005).

Seventy-five logbooks were returned from Guysborough County license-holders in 2000. The logbooks showed that the primary fish species targeted was brook trout, making up 98% of the reported catch. Catch per unit effort (fish caught versus hours spent fishing) was 0.77 in the County, compared to the provincial average of slightly over one fish per hour. Within the Keltic Study Area, anglers reported fishing on various parts of the watersheds of the St. Mary's, Country Harbour, and Isaac's Harbour rivers. All catch was brook trout, with an average length of 24 cm and a catch per unit effort of 0.58. Many rivers in Guysborough County support sea-run trout; however a license is not required if caught in salt water (NSDAF 2001a).

Atlantic salmon (*Salmo salar*) are managed on a river-specific basis within nine management areas in the Maritimes. The Keltic Study Area is in Salmon Fishing Area 20. Watersheds and rivers within the Keltic Study Area that supported salmon runs in the past decade include:

- Country Harbour River;
- Gaspereau Brook;
- Guysborough River;
- Isaac's Harbour River;
- New Harbour River; and
- St. Marys River.

Since 1996, the rivers have been open to catch and release only, and were closed altogether in 2000. In 1999, only six grilse and one adult salmon were caught on the St. Marys River. No salmon were caught on other rivers. In general, salmon returns to all rivers along the Atlantic Coast of mainland Nova Scotia were insufficient to meet conservation requirements in 2000, including those receiving hatchery stocking. Currently there is a hook-and-release salmon fishery on only the St. Marys River.

4.3.8.2 Marine

Stormont Bay (Figure 1.0-1) and adjacent areas (including Country Harbour, Isaac's Harbour, and Red Head) support a diverse local fishery. Aquaculture, commercial and recreational shellfish harvesting and inshore fishing activities occur in the area.

Non-Commercial Species

Stormont Bay and the surrounding areas including Country Harbour and Isaac's Harbour support a diversity of fish species, some of which contribute to an active recreational fishery. Common fish species in Stormont Bay include demersal fish (groundfish that tend to be associated with the seabed) such as tomcod, cunner, wolffish, and sculpins, as well as pelagic species (fish usually found inhabiting the water column), such as herring and mackerel (Scott and Scott, 1988; Gilhen, 1974; SOEI, 1999).

Estuarine habitats of Country Harbour support a variety of estuarial, freshwater, and pelagic fish species during their various life stages. These include Atlantic salmon, winter flounder, American eel, gaspereau (alewife), smelt, and trout in addition to juvenile cod, pollock, and herring (Scott and Scott, 1988; Gilhen, 1974; SOEI, 1999).

Salmon are likely present in Stormont Bay throughout summer, while smelt are found in coastal and estuarine waters in the area throughout the year. In addition, six other species of fish are reported to be common in the estuarial habitats and the lower reaches of rivers. These species include Atlantic silverside, backspotted stickleback, northern pipefish, windowpane, smooth flounder, and winter flounder (Gilhen, 1974).

Several species of non-migratory fish are expected to be in the area including creek chub, white sucker and various species of dace and stickleback (Gilhen, 1974). While not considered commercial species, they can, however, provide important sources of food for larger fish.

Commercial Species

A 1995 study done for the SOEP on the winter distribution of selected species of adult fish in the vicinity of Stormont Bay showed congregations of cod and herring. Summer surveys showed the presence of adult cod. Inshore areas around and including Stormont Bay support small commercial herring and mackerel fisheries.

Lobster and rock crab are currently fished in Stormont Bay and surrounding areas. Lobster in this area is managed under Lobster Fishery Area 31B, one of three Lobster Fishery Areas covering the Eastern Shore. Stormont Bay supports a small rock crab fishery with a limited number of licensees. Generally, rock crab is managed as a by-catch associated with lobster. Until recently, the green sea urchin (*Strongylocentrotus droebachiensis*) was also a major commercial species on the Eastern Shore of Nova Scotia; however, the Guysborough fishery has been traditionally underdeveloped in comparison. A significant decrease in sea urchin abundance occurred throughout most of the Eastern Shore of Nova Scotia, including Stormont Bay, in 1999, due to spread of Sea Urchin Disease (*Paramoeba invadens*) (DFO, 2000). Few, if any, urchins are now located within Stormont Bay or in the vicinity of the proposed Marginal wharf and LNG Terminal.

Inshore Fishery

Information about inshore fisheries and aquaculture in the Keltic Study Area is available from the GCIFA website, http://www.gcifa.ns.ca. GCIFA has partnered with St. Francis Xavier University, the Gulf Nova Scotia Bonafide Fishers Association (Lakevale), the MFWC, and the

ISAR (Antigonish) in a cross-Nova Scotia collaborative effort to build participatory research capacity related to coastal communities and sustainable fisheries. As part of this effort, a profile of the Guysborough County Inshore Fisheries was prepared in 2001 (Boudreau and Social Research for Sustainable Fisheries, 2001). Much of the following information in this section is drawn from that comprehensive report, however, catch and effort statistics have been updated with more recent information from DFO.

Most of the relevant available fisheries data is aggregated for Guysborough County as a whole, or the DFO statistical districts (SD) that border the county. The inshore fisheries Study Area was selected to include the region that could potentially be affected by Project activities, such as accidental releases from an LNG carrier or cargo vessel. Modeling carried out for the Deep Panuke Environmental Impact Assessment indicated that a slick dispersed to a concentration of 0.1 ppm would extend approximately 20 km from the point outside the approaches to Country Harbour in winter and 19.5 km in summer. Based upon this analysis, the coastal Study Area for the Keltic Project was delineated to extend approximately 30 km on either side of the proposed Project Site in Goldboro, i.e., from Berry Head to the St. Mary's River estuary. This Study Area is within DFO SDs 16 and 17.

Official data on catch and effort are based on two systems: reports of catches made by vessels and reports of purchases by buyers. Small vessels, common in inshore fisheries, are not required to supply log-books of catch or effort, so information is only available on sales made at a port of landing. Information on catches made by individual fishers is confidential, so data are usually pooled by port of landing or by SD.

Fishing effort in the lobster fishery is regulated by limiting the number of traps allowed per vessel, the type of license (full or part-time), and length of season. Other inshore fisheries, such as that for herring, are regulated by gear type, license, season, and quotas. The sea urchin fishery is different in that licensed fishermen are allocated a specific area to which they have exclusive fishing rights, coupled with an obligation to manage the urchin resource within their fishing area. SDs, lobster fishing areas, and sea urchin lease areas are shown on Figure 4.3-3.

<u>Home Ports, Numbers of Fishers and Vessels</u>

In 1999, Guysborough County had 257 registered fishing vessels ranging from 18 to 64.9 feet; twenty-five of these vessels were in the 35-44.9 foot class, and five were in the 45–64.9 foot class. All other boats were smaller, measuring less than 34.9 feet in length. The fishery directly employed 598 people of whom 345 were full-time and 253 part-time (Boudreau and Social Research for Sustainable Fisheries, 2001; DFO, 2001).

Under the *Fisheries Organizations Support Act* of Nova Scotia, core fishers, holding licenses for limited-entry fisheries such as lobster, groundfish, and scallops, can vote for an accredited organization of choice to which they agree to pay annual dues. In 1998, the GCIFA was accredited by the province to represent Region 3, the Eastern Shore (from Canso Causeway to Halifax Harbour) (GCIFA, 2001). Table 4.3-1 provides the number of core and non-core fishers for Guysborough County from 2000 to 2002.

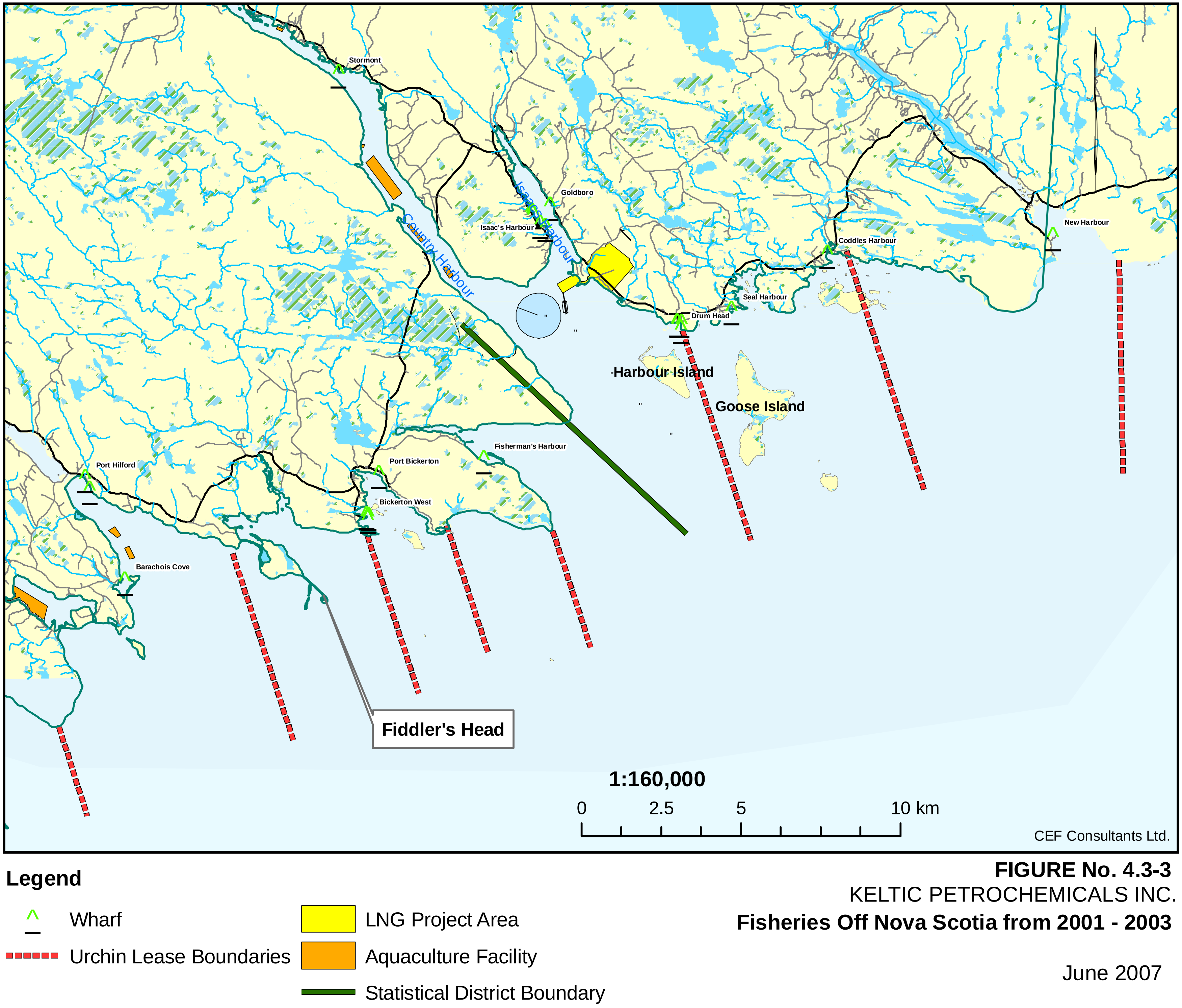

FIGURE No. 4.3-3
KELTIC PETROCHEMICALS INC.
Fisheries Off Nova Scotia from 2001 - 2003

June 2007

TABLE 4.3-1 Number of Inshore Fishers, Guysborough County

	2000			2001			2002		
	Core	Non-Core	Fishers Total	Core	Non-Core	Fishers Total	Core	Non-Core	Fishers Total
District 16	13	43	56	13	37	50	13	41	54
District 17	56	119	175	56	128	184	56	123	179

Source: GCIFA, 2001

Table 4.3-2 lists ports in the Study Area in 1999, with the number of registered vessels, and full-time, part-time, and core fishers in each. Responsibility for port and wharf management has devolved from the federal government to local Harbour Authorities. In the Keltic Study Area, these include:

- Harbour Authority of Port Bickerton;
- Harbour Authority of Drum Head; and
- Harbour Authority of New Harbour.

TABLE 4.3-2 Numbers of Fishers by Port (1999)

Port	Vessels (<34.9 feet, unless otherwise noted)	Full-time	Part-time	Core
Bickerton West	2	3	1	1
Coddles Harbour	3	5	2	2
Country Harbour	2 (<34.9 ft), 1 (45-64.9 ft.)	17	2	1
Drum Head	5	8	1	3
Fisherman's Harbour	3	5	5	3
Isaac's Harbour	3	3	1	1
New Harbour	5 (<34.9 ft), 1 (35-44.9 ft)	9	5	
Port Bickerton	5 (<34.9 ft), 2 (35-44.9 ft)	16	11	9
Port Hilford	2	3	0	2
Seal Cove		2	1	
Sonora	9	11	29	6
Stormont		3	0	
Wine Harbour	3 (<34.9 ft), 1 (35-44.9 ft)	3	2	3
Total	**49**	**88**	**60**	

(Source: DFO, 2001; Boudreau and Social Research for Sustainable Fisheries, 2001)

Landings and Values

The coastal waters of Guysborough County support fisheries for groundfish, small pelagic species, and invertebrates. Groundfish were historically important, but the stock collapses of the late 1980s and early 1990s, and the resulting moratoria, have largely eliminated those fisheries. However, with the collapse of the ground fishery, the inshore fleet shifted primarily into invertebrate fisheries like lobster and sea urchin (Boudreau and Social Research for Sustainable Fisheries, 2001).

The most recent data on the value of landings in the Keltic Study Area are available by SD (Table 4.3-3). Species include lobster, shrimp, and snow crab. Sea urchins are not included at present due to the recent collapse of this fishery. It is of note that a gradual recovery of urchins in the nearshore area around the Project Site could occur over time; however, urchins in the area were seeded by an urchin harvester a few years prior to the first survey of the area in 1996. The urchin distribution observed during frequent surveys for the Sable Gas project suggested that the urchin spread gradually from the seed location and were not otherwise in commercial numbers in the area. It is likely that urchin are not normally present in these shallow shoreline areas because water temperatures too often reach conditions favourable for spread of the parasite that kills them. Urchins in other areas more outside Stormont Bay were not affected by the recent die off. While the shoreline area near the Project Site is suitable for the growth of sea urchin, it is not likely a natural sea urchin area and repopulation in commercial quantities may not occur without seeding.

Landings of shrimp are from the offshore fleet, which are generally caught near Greenland and landed in Country Harbour.

Without groundfish, the total landed weight in the fishery dropped dramatically. However, the overall value of the Guysborough County commercial fishery is worth much more than it was in 1990 because of the high value per kilogram fetched for most invertebrates (Boudreau and Social Research for Sustainable Fisheries, 2001).

TABLE 4.3-3 2000-2003 Value of Landings by Statistical District (SD) in Thousands of Dollars

Species or Group	2000		2001		2002		2003	
	SD 16	SD 17	SD 16	SD 17	SD 16	SD 17	SD 16	SD 17
Halibut	0	35	8	83	1	70	1	75
Other Groundfish	120	29	61	31	1	14	149	5
Total Groundfish	**120**	**64**	**68**	**114**	**2**	**84**	**150**	**80**
Alewives	0	1	0	1	0	1	0	1
Mackerel	0	1	0	0	0	1	0	0
Eels	7	21	16	17	15	82	2	35
Smelts	1	4	1	6	1	4	1	0
Tuna, bluefin	52	0	120	11	16	0	54	0
Total Pelagic/Estuarial	**59**	**27**	**137**	**35**	**31**	**87**	**57**	**37**
Lobster	570	1792	709	1888	823	1813	943	2478
Shrimp	15516	0	14307	0	14192	0	17775	0
Crabs, Snow	0	6219	102	3579	0	5275	0	3075
Other Shellfish	9	24	5	13	5	4	2	60
Total Shellfish	**16180**	**8147**	**15122**	**5481**	**15020**	**7092**	**18720**	**5613**
District Total	**16359**	**8240**	**15327**	**5630**	**15052**	**7263**	**18928**	**5729**

<u>Lobster</u>

The inshore lobster fishery has been a limited entry fishery since 1968 and is the most consistent of the Guysborough County fisheries. The majority of licenses are Class A with a 250 trap limit, but there are some Class B licenses with a limit of 75 traps. Class B licenses cannot be sold or transferred.

Lobster season opens April 19th and closes on June 20th in the Keltic Study Area. Although landings have decreased by more than 50% over the past decade, the total landed value in SDs 16 and 17 increased to almost $3.5 million in 2003, and lobster landings in Lobster Fishing Area

31B has increased six times from 1997-2006. Lobster fishers in Guysborough County have actively participated in resource conservation focused on increasing egg production in Eastern Nova Scotia.

Sea Urchin

The sea urchin fishery developed in response to demand from the Japanese market. Shoreline areas are divided into leases assigned to individual operators who hire urchin divers and have a responsibility to adequately manage the resource. Management can include seeding urchins in new areas within their lease. Sea urchins are harvested for their roe.

Harvesting is not restricted by season, but generally occurs from October to March. The legal minimum size limit for harvest is 50 mm. In the 1999-2000 season, there were 10 active and 5 inactive licenses in Guysborough County. Lease areas within the Keltic Study Area are illustrated in Figure 4.3-3.

The 1994 to 2000 landings for eastern Nova Scotia (from Halifax east to Guysborough) are shown in Table 4.3-4.

TABLE 4.3-4 Sea Urchin Landings (t) for Eastern Nova Scotia from 1994 to 2000

Area	**Year**					
	94-95	**95-96**	**96-97**	**97-98**	**98-99**	**99-00[1]**
Eastern Nova Scotia	709	658	915	700	605	324

[1]Preliminary (Source: DFO, 2000)

Sea urchins are susceptible to parasitic amoebal infection. This infection spreads when waters remain unusually warm for a couple of weeks. Therefore, deeper water areas are less prone to infection and catch can be maintained (at least initially) by shifting the areas of harvest. Depopulated areas can also be reseeded from areas less affected. In the fall of 1999, large numbers of urchins died from parasitic amoebal infection and total landings fell 30% from the previous year. By 2000, the sea urchin fishery had collapsed and has not yet recovered.

Snow (Queen) Crab

Snow crab is a deep water, cold temperature species. They are fished on muddy or sand-mud bottoms at temperatures ranging from –1.0 to 6.0 °C and at depths ranging from 60 m to 300 m. Typical fishing depths off eastern Nova Scotia are 130 m to 250 m (DFO, 2005). The 2003 value of snow crab landings allocated to the inshore was $3,075,000 in SD 17. No landings were recorded in District 16.

Finfish

Swordfish and shark licence holders are based in Guysborough County. The majority of these catches occur in the Country Harbour and Ecum Secum areas. Other finfish such as mackerel, alewives, and herring are fished opportunistically along the coast, primarily for bait.

Other Species

Other invertebrate fisheries now exist for species traditionally considered a nuisance (such as rock crab), or for species that were once supplements to the traditional fishers' family diet. Additional fisheries have developed following exploration for underutilized species. Species such as crab, shrimp, scallop, and soft-shell clams have all contributed to an increase in the value of the invertebrate fishery.

Seasonality

Most inshore fisheries in the Keltic Study Area operate between April and October. The coast of the Keltic Study Area falls within Lobster Fishing Districts 31b and 32. The season opens April 19 for Districts 32 and 31b. Both close on June 20 (DFO, 2004). The rock crab season usually opens the week after lobster season closes and ends one week before it begins.

Historically, the inshore fleet's season began on July 1. Since a quota system is in place, most boats finish well before the formal end of the season. In 2001, for example, 80% of the quota for the temporary inshore associations off Guysborough County had been caught by early September (M. Eagles, pers. comm., 2001).

The inshore herring and mackerel fisheries are open throughout the year. A commercial herring roe fishery occurs in the fall on the Eastern Shore. Its location is dependent on where herring spawn. A review of landed values from 1996 onward showed almost no commercial landings in either District 16 or 17. Effort in the bait fishery for herring and mackerel is highest in the month before lobster season opens. Mackerel migrate out of the area in June, into the Gulf of St. Lawrence, and return in the fall on their way further south. Mackerel migration routes can change which can result in large variations in catch between years.

The inland waters sport-fishing season for speckled (brook) trout, brown trout, rainbow trout, landlocked salmon, chain pickerel, white perch, and yellow perch generally runs from April 1 to September 30 in the Keltic Study Area. The tidal waters season is from April 15 to September 30, to protect sea-run speckled trout, brown trout, and Atlantic salmon populations (NSDAF 2001b).

Revenues and Earnings

Inshore Fishery

Revenues from the Guysborough County inshore fisheries were $30 million in 1999, compared to $12 million from the offshore fleet. These proportions were roughly equivalent to the split between the inshore ($418 million) and offshore ($175 million) fisheries throughout the Scotia Fundy management region of that year (Boudreau and Social Research for Sustainable Fisheries, 2001).

Table 4.3-5 presents inshore landings in kilograms at the larger ports in the Keltic Study Area for 1999 and 2000. Data from adjacent communities was aggregated to preserve confidentiality. The Table highlights the near-absence of groundfish in the area compared to the high landings of lobster and sea urchin (prior to this fishery's collapse).

TABLE 4.3-5 Inshore Fish Landings (kilograms) by Community in the Study Area (1999 and 2000)

Community	Year	Groundfish	Lobster	Sea Urchin	Pelagic Species	Other Invertebrates
Drumhead, Isaac's Harbour, Stormont	2000	–	17,612	19,303	–	4,886
	1999	–	8,291	82,690	–	2,855
Coddle Harbour, New Harbour, Seal Cove	2000	–	19,702	28,284	1,216 (bluefin tuna)	5,795 (scallop)
	1999	–	14,644	30,481	828 (bluefin tuna)	13,521 (scallop)
Country Harbour	2000	–	1,744	–	–	–
	1999	–	1,230	–	–	–
Port Bickerton, Bickerton West, Fisherman's Harbour	2000	6,186	38,680	24,768	–	–
	1999	1,952	24,244	26,926	771 (mackerel)	24,622 (queen crab)
Port Hilford, Wine Harbour, Sonora	2000	676	13,995	23,762	–	6,422
	1999	1,377	7,100	74,516	–	1,722

(Source: DFO, 2001)

<u>First Nations Fisheries</u>

First Nations peoples have historically harvested fish and wildlife resources in the Keltic Study Area. Recently, however, little Aboriginal use of fish resources has been documented. The Millbrook First Nation has two commercial urchin leases in the vicinity of Country Harbour. One is located east of Port Bickerton, south of Cape Macodome, and the other to the west of Port Bickerton, south of Fiddlers Head (Figure 4.3-3). The Afton First Nation has a lease near Indian Harbour/Wine Harbour. Licenses that once belonged to a recently retired Country Harbour fisherman have been reissued to a First Nations band. These licenses are applicable in the area from Ecum Secum to White Head.

4.3.9 Aquaculture

Locally, there are five aquaculture sites in Country Harbour and two in Indian Harbour. The two in Indian Harbour are the furthest from the proposed Keltic site at a distance of 17 km. The Country Harbour aquaculture leases are all held by Atlantic Aqua Sea Farms (registered as 2382144 Nova Scotia Limited or Country Harbour Sea Farms Limited) of Prince Edward Island and range in distance from the Keltic site from 4.3 km to 12 km (Figure 4.3-3). The licensed species are blue mussel and sea scallops, but only mussels are cultivated currently. Licenses for other species, including sea scallop salmon and trout, have been issued historically within Stormont Bay, but no continued aquaculture for these species has occurred in the local area. The aquaculture industry generally relies on harvesting of seed spat (larvae) from Country Harbour and Stormont Bay in the summer.

4.3.9.1 Revenues and Earnings

The GCRDA has targeted aquaculture as a key factor in regional economic development. A Regional Aquaculture Development Advisory Committee was established to review applications for coastal resources and resolve potential conflicts among resource users. Active growers produce blue mussels and blue mussel spat for sale to other growers. Scallops, and steelhead salmon are also farmed, but not within Stormont Bay (Boudreau and Social Research for Sustainable Fisheries, 2001). Table 4.3-6 shows aquaculture production and employment for Guysborough County and Nova Scotia as a whole in 2000. Aquaculture sites within County Harbour are shown on Figure 4.3-3.

TABLE 4.3-6 2000 County and Provincial Production Statistics for Aquaculture Tourism

Area	Weight (kg)	Value	Full-time jobs	Part-time Jobs (< 6 Months Duration)	Part-time Jobs (> 6 Months Duration)
Guysborough	325,842	$351,209	31	21	12
Nova Scotia	11,618,948	$50,469,494	361	504	194

(Source: NSDAF, 2001b)

Cultivation of blue mussels is the most successful form of aquaculture in Guysborough County. Most shellfish farming in Guysborough County is done by suspension cultivation from longlines, as is the case with Country Harbour Sea Farms operating in Country Harbour. Cultures are hung at intervals along a longline, which is anchored at each end. Buoys and concrete blocks are tied along the line to provide mooring and regulate the overall height of the longline in the water. Growers sometimes sink the longlines at least one metre below the ice cover for the duration of the winter to avoid contact with surface ice (Boudreau and Social Research for Sustainable Fisheries, 2001). Most large-scale operations use a boat with a power-operated winch to lift, tend, and harvest the lines. SCUBA divers are also used, especially when the longlines are below the ice (Boudreau and Social Research for Sustainable Fisheries, 2001). Aquaculture operations in Country Harbour are relatively small scale; employment varies seasonally, with a small core staff of less than five people. Cultivation of finfish and scallops has been considered and attempted in some areas, but none of these species are currently produced within Stormont Bay.