APPENDIX A

Minister’s Letter and Notes from DFO Working Session

Nova Scotia

Department of Environment & Labour

PO Box 697
Halifax, Nova Scotia
B3J 2T8

Our File Number:
40100-30-128

Office of the Minister

JUL 3 1 2007

Mr. Scott G. McDonald, Project Manager
Alton Natural Gas Storage LP
PO Box 36052
Halifax, NS B3J 3S9

Dear Mr. McDonald:

Re: Environmental Assessment - Alton Underground Natural Gas Storage Facility

The environmental assessment of the proposed Alton Underground Natural Gas Storage Facility has been completed.

This letter is to advise that, pursuant to Section 13 (1)(a) of the *Environmental Assessment Regulations*, I have determined the registration information is insufficient to allow me to make a decision, and that I require additional information.

Fisheries and Oceans Canada (DFO) and other interested stakeholders, raised concerns that the report failed to provide adequate information to support the prediction that effects to fish and fish habitat, which includes a species at risk (Inner Bay of Fundy Atlantic Salmon), are insignificant. Concerns include the effects of the withdrawal of water from the Shubenacadie River into both the water intake and the pre-mixing pond; the brine being discharged into the Shubenacadie River; and the discharge of sediments into the Shubenacadie River. DFO has determined that, based on the information provided to date, there is uncertainty in regards to the potential for certain works or undertakings associated with this project to contravene provisions of the Habitat Protection Provisions of the *Fisheries Act*, and the *Species at Risk Act*.

- Alton Natural Gas LP. shall provide additional information to demonstrate that the prediction that project related effects to fish and fish habitat from the development, operation, and maintenance of the Alton Underground Natural Gas Storage Facility are insignificant. This information shall be prepared in consultation with Fisheries and Oceans Canada.

Concerns have also been raised regarding potential impacts of the project on First Nations. Additional information is required to demonstrate how First Nation concerns would be considered in the development and operation of the undertaking. Specifically this should include:

- Details of discussions with First Nations regarding potential environmental effects of the project, and issues identified through these discussions. Plans for addressing identified First Nations' concerns including procedures to deal with project-related issues that may arise, and ensuring issues are recorded and resolved in a timely manner.

Please note, other issues were raised during the review process and the comments are attached for your information.

The requested additional information shall be submitted by Alton Natural Gas LP. at your convenience, as an addendum to the original registration information. Pursuant to Section 13(1) of the *Environmental Assessment Regulations* decision options available to me are: additional information is required; approval with conditions; focus report is required; environmental assessment report required; or, rejection. Upon submission of the information I will have 25 days to make my decision.

Alton Natural Gas LP. shall not commence the undertaking or any part thereof until the undertaking has been approved under Part IV of the *Environment Act*.

Sincerely,

Mark Parent

Mark Parent
Minister

cc mailed to: Landis Energy Corporation
Suite 2320, 444-5th Avenue SW
Calgary, AB
T2P 2T8

Agenda -Alton Project Working Session

Wednesday September 19, 2007

Marriott Harbourfront Hotel, Halifax, NS

Meeting Purpose:	To provide additional information to the Alton EA Registration as requested by the Minister of Environment and Labour on July 31, 2007.
Objectives:	To provide additional Project information to NSEL/DFO on effects on fish and fish habitat.
	To discuss NSEL/DFO issues and concerns expressed in comments on the EA Registration.
	To develop a path forward and actionable items leading to Project approval by the Minister of Environment and Labour.

8:30-9:00 a.m.	Refreshments
9:00-9:15 a.m.	Welcome and Introductions
9:15-9:30 a.m.	Project History/Overview (Mr. David Birkett, Alton)
9:30-9:45 a.m.	Overview of cavern development as it pertains to brine flow rates and brine salinity levels (Mr. Bob Ramsay, SolTech Projects Inc.)
9:45-10:00 a.m.	Discussion on presentation
10:00-10:15 a.m.	Overview and update on river monitoring data collected May-September 2007 (Dr. Jim Warner, Martec Limited)
10:15-10:30 a.m.	Refreshments
10:30-11:15 a.m.	Detailed presentation on water intake, mixing channel and brine discharge designs (Mr. Wim Veldman, Matrix Solutions Inc.)
11:15-12:15 p.m.	Discussion on presentations
12:15-1:00 p.m.	Lunch provided
1:15-3:00 p.m.	Discussion pertaining to satisfying the Minister's request for additional information
3:00-3:15 p.m.	Refreshments
3:15-3:45 p.m.	Summary of action steps (Mr. Robert Federico and Mr. Bob Rutherford)
3:45-4:00 p.m.	Wrap-up (Ms. Kim West)

Alton Gas Working Session
September 19, 2007
Marriott Harbourfront

Melanie MacLean	DFO
Tim Milligan	DFO
Tana Worcester	DFO
Peter Amiro	DFO
Rob Bradford	DFO
Gary Bugden	DFO
Vanessa Margueratt	NSEL
David Birkett	Alton Natural Gas Storage LP
Scott McDonald	Alton Natural Gas Storage LP
Robert Federico	Jacques Whitford
Kelley Fraser	Jacques Whitford
Paul MacLean	Landis Energy Corporation
Jim Warner	Martec Limited
Wim Veldman	Matrix Solutions Inc.
Kim West	MT& L
Bob Ramsey	Soltech Projects Inc.
Bob Rutherford	Thaumas Environmental Consultants Ltd.

Question/Comment	Answer
David Birkett's Presentation	
Gary Budgen's question about other projects that discharge brine.	Bob Rutherford/Scott McDonald discussed the Potash Project that discharges into the St. John River Estuary/Bay of Fundy. Permit conditions subsequently provided to DFO/NSEL.
Bob Ramsay's Presentation	
Tana Worchester's question about monitoring.	Will be 24 hrs/day computer management system.
	Staffed 5 days/week, 7 hours per day.
	Automatic shutdowns if required.
Tana's question about controlling discharge of return brine.	Manually monitored to look and see that no excess sediment is leaving caverns with the brine.
	Also, automated sensors to monitor the brine components.
Tim Milligan's question about varying salinity due to tides – how	Sensors used and flow rate of pumping will be adjusted accordingly.

Question/Comment	Answer
does this affect brining process?	
Rob Bradford’s question about number of caverns developed and when.	4 caverns, starting 6 weeks apart, max, 10,000 m^3/day flow rate is 4 caverns being operated simultaneously, so it is the “ultimate” scenario.
Jim Warner’s Presentation	
Tim Milligan’s question about sediment concentration	TSS = 340 mg/L for Bay of Fundy grab sample (pg 5l in EA)
Peter Amiro’s question about location of monitoring – highly dynamic area. Animals have adapted to this highly dynamic area – need to provide more information because a complexity of area.	Wim/Jim – site tested and data is representative of where the mixing channel is proposed.
Rod’s question about turbidity – was this a snapshot? Need more info for spring tides.	Yes. Info on turbidity presented in EA was only a snapshot.
Tim’s question about sediment loading concentration. Tim’s concern about sediment dynamics over the tidal cycle and that they have not been characterized well enough. Fine sediments <20 micron size influence the hydro dynamics of the river. (TSS -total suspended sediments- becoming the fine bed load sediments).	Bob Ramsay’s answer – Coarser fraction sediment will be screened out upon intake. Finer fraction sediment will settle out in caverns and not affect cavern operation greatly. Pumps can handle high sediment load.
Tana’s question about the winter conditions (Jan – June).	Jim Warner– took measurements in December and had to pull equipment out of the river due to ice, so could not monitor.
	David- Alton would continue operation of cavern/intakes as long as there was no ice blockup. Then operations would have to shut down.
Rob Bradford – once river has ice, would salinity/temp levels increase above 25 ppt tidal cycles decrease? There has been no salinity monitoring in the river in the winter.	Bob Ramsay answered. It is agreed that data are sparse for winter habitat.
Wim Veldman’s Presentation – 1st Part Conceptual Design	
Tana’s question, channel design.	Bob said channel can be made to dilute the brine to within the tolerance of the fishes including juvenile stages. Current would quickly carry eggs and larvae past areas of elevated brine.
Peter Amiro’s question about significance of impacts. (*e.g.,* need to look at bad news scenarios (such as pumps shutting down etc.). Need to look at environmental risk potential to fish and animals and why is this design better than other design?	Wim said that there are operational design features that can be adjusted if issues arise, e.g., pumps can be shut off in response to any upset conditions or other malfunctions in caverns. Alternatives for brine transport are presented in Section 2.7 and appendices of the EA Registration.

Question/Comment	Answer
Peter is asking for a full year picture of process.	
In addendum, would like to see all options discussed and why they were not chosen.	Refer to Section 2.7 in the EA Registration. The supplemental report will provide a rationale for the post-EA design updates (e.g., water intake).
Tim Milligan's question/comments – mitigate fine grain sediment.	Channel will have similar or slightly less flows to main river channel and will be designed and maintained to keep channel clear of sediment. This is primarily an operational issue.
Will need a constant flow though the channel or the channel will completing fill up with the mud (because of intertidal period when the flow rate is very slow)	
The channel design for settling can be mitigated but can't just use hydro dynamic models to design the channel.	
Peter Amiro – watch that the channel does not become a lethal trap for the fish and animals. Look at local knowledge and the erosion potential.	Salinities in the channel will not surpass toxic levels for species. Water temperature will be very close to ambient when released.
Wim Veldman's Presentation 2nd Part - Modelling Discharge Scenarios	
Tim Milligan's comment about salinity mixing.	Have to maintain the high flow rate. Bob Rutherford – eggs and larvae become more tolerant as they get bigger. The turbulence keeps them in water column and moving as long as there is a constant flow.
Tana/Rod pointed out that the addendum will have to show distance modeling (down stream) e.g., temperature profiling if there is a thermal spike.	See below.
Rod asked about exclusion of fish (attracts fish in the winter) and the temperature coming out of the discharge.	The team will provide additional information about temperature.
Peter Amiro's comment that you can't just look at one species. Do we think the river changes will have a significant impact on species?	The EA Registration focused on listed species due to sensitivity and regulatory protection. Data on presence of other non-listed species may be sparse. In general, species have adapted to wide ranges of salinity in the river. Salinities from project discharges will be within the natural range of salinities.
Design that follows natural variation is the best regime (mimic nature).	The team agrees and presented several discharge scenarios that mimic salinities

Question/Comment	Answer
Tana pointed out that today's forum is for DFO science to learn and point out relative risk of the different options and then DFO management will determine the risk and make the decisions.	Comment noted.
Wim Veldman's Presentation 3rd Part	
Tim Milligan's comment about silt buildup in intake structure	This is operational issue but it will be continuously flowing.
Rod Bradford – need to know about minimum flow, how do you know?	The team will provide additional information about flow.
Peter Amiro said that design where zero impact is not reasonable so looking at max/min variables is the right thing to do. To be extracting at low discharge/low tide is not a good idea. Need to look at different velocity going through the interstitial spaces of the rock media filter.	Several designs are under consideration for the intake filter media. The team feels confident that the design can minimize impingement/entrainment of fish eggs and larvae. In any case, currents moving past the intake will be sufficient to overcome the velocities associated with the intake. Therefore, most of the eggs and larvae will be carried past the intake.
Rod's comment – even newest design will have entrainment of eggs.	Velocities in the channel will carry eggs past the intake. Any eggs that are entrained may be flushed out by the tides.
Rod said they will become impinged on the wall of structures and will not be able to get back out.	David said that monitoring will be done to determine the presence of eggs and larvae. The tides should dislodge any impinged eggs.
Peter said application must show model that proves that eggs will not be intake and will flow through the channel and out. Peter feels that this intake has not been designed from environmental reasons (silt up, eggs intake, velocity)	Answer similar to above.
Key Issues Summary	
1. Water Withdrawal.	
Tana asked about discussing alternatives.	Alternatives provided in Section 2.7 of the EA Registration.
Rod said interested in knowing why this location was chosen and have this discussed in the application.	David explained why this location was chosen over other locations due to a variety of technical/economically/environmental reasons.
Rod said the issue of winter habitat is a large unknown, therefore the design of the channel for winter dynamics is a large unknown.	Bob Ramsay answered. It is agreed that data are sparse for winter habitat.
Rod said that at this location, the "bar" is automatically raised for	Comment noted.

Question/Comment	Answer
project approval because there are 4 species of concern that use this river (IBOF Salmon, striped bass, sturgeon, American eel).	
2. Water withdrawal / Brine discharge	
Need high resolution, 3-D site model, indicating brine discharge and entrainment scenarios.	The team will provide additional information.
3. Sediment Discharge	
Need more data on sediment concentration in the river, e.g., interaction of flow patterns (change of river dynamics).	This is an operational issue that will be refined.
Four seasons of data	As discussed above, available data may be sparse.
Tana's comment about decommissioning of the intake/mixing channel.	David said would keep the intake/channel operational as long as the facility is operational in case more caverns are developed in the future.
Rod's comment – how will we show what the flow rates are in the mixing channel to prove no silt build up.	Wim said we will design and submit this information with the report.
Wrap-up	
Rod Bradford's comment to compile a table list of the species and their use of the habitat by each species to evaluate the impact of the project components.	Additional species information will be provided if available.
Melanie asked for electronic copies of the EA.	Vanessa will send it out and it also available on the NSEL website.
Tana asked for questions to go through science branch (*i.e.,* Tana) not to individual scientists. The science branch consults with Melanie's management department.	Comment noted.

APPENDIX B

Water Intake and Discharge Facilities

Jacques
Whitford

ALTON NATURAL GAS STORAGE LP

INTAKE AND DISCHARGE FACILITIES SHUBENACADIE RIVER, N.S. SUPPLEMENTAL INFORMATION

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

November, 2007
Matrix File: 6639

ALTON NATURAL GAS STORAGE
WATER INTAKE AND DISCHARGE FACILITIES
SHUBENACADIE RIVER, NOVA SCOTIA
FOLLOW-UP SUBMISSION

Report Prepared for:

ALTON NATURAL GAS STORAGE LTD.

Prepared by:

MATRIX SOLUTIONS INC.

Wim M. Veldman, M.Sc., FEIC, P.Eng.
Vice President

reviewed by
Don Ramsey, M.Sc., P.Eng.
Senior Engineer

November 21, 2007
Calgary, Alberta

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1.0 INTRODUCTION

On July 31, 2007, the Minister of Environment and Labour requested additional information from Alton Natural Gas Storage L.P. On September 19, 2007, a working session was held in Halifax with representatives from the Nova Scotia government (NSEL) and Fisheries and Oceans Canada (DFO). A number of questions and issues arose that warranted the submission of Supplemental Information to the July 2007 Environmental Registration (EAR) report for the Alton Natural Gas Storage Project.

With respect to the proposed water intake and discharge facilities at the Shubenacadie River, the Supplemental Information focuses on:

- providing more detailed preliminary design details and criteria of the mixing channel and associated outlet and intake works;
- presenting a summary of the discharge scenarios discussed at the meeting;
- outlining potential “what if” conditions in the operations phase, their impact on operations and/or the environment; and
- the need for mitigative measures, if necessary.

The proposed facilities on the Shubenacadie River are unique from a design and environmental viewpoint. A degree of uncertainty is associated with any unique project, whether its uniqueness is due to its design, availability of data, environmental considerations or river characteristics. With a sound design, construction, operation and maintenance strategy, it is believed that the uncertainties will be well within the projected impacts of the project and that mitigative measures can be undertaken, if necessary, in a timely manner.

2.0 MIXING CHANNEL DESIGN

2.1 Rationale for Selecting the Mixing Pond/Channel Design

Appendix B of the June 2007 ER report presented three options to withdraw and discharge flow from and into the Shubenacadie River, namely:

- Option 1 – Multi-Port Diffuser. With this option, water withdrawal would be by means of a structure located on the right bank (as looking downstream towards the Minas Basin), while the discharge from the salt caverns would be via multi-ports located in the main channel of the river.

- Option 2 – Single Port River Outlet. The water withdrawal would be the same as for Option 1, while the total discharge into the river would be via a single pipe or outlet structure located on the right bank.

- Option 3 – Intake/Outlet Structure and Pre-mixing Pond Channel. The water withdrawal in this option would be the same as in Options 1 and 2. With this option the discharge would be into a pre-mixing pond or channel constructed adjacent and parallel to the right bank of the river.

After consideration of the following:

- impact of construction regarding sediment concentrations in the Shubenacadie River;
- impact of the operation of the proposed works on water quality, namely salinity;
- extent of instream works with respect to design, construction and operation/maintenance issues;
- regulatory challenges, particularly Transport Canada and Fisheries and Oceans Canada with respect to the construction, operations and maintenance of midstream or near bank structures;

the pre-mixing pond/channel was selected. It avoids the need for significant instream construction (Option 1) – the diurnal tidal velocities and water level changes would require large instream cofferdam structures. The scope of instream works would have been significantly reduced with Option 2, but this technique would have discharged the total flow from the caverns into the river via a single point discharge, a potential salinity concern. With the pre-mixing pond/channel Option 3, the scope of instream works are minimized, and the mixing of the return flow from the salt caverns occurs in a side pond or channel excavated parallel to the Shubenacadie River.

From operational and environmental viewpoints, the advantages of Option 3 are significant, since maintenance or mitigative measures can be undertaken or constructed, if necessary, with minimal instream construction in the main channel of the river. For example, modification of the water withdrawal or outlet structures could be achieved by simply isolating those facilities within the confines of the mixing channel.

2.2 Mixing Pond versus Mixing Channel

As a result of modelling the salinity concentrations of the discharge from the salt caverns into the pre-mixing pond or channel (Section 3.2), the channel is more favourable from an environmental viewpoint, as it:

- Maximizes the flow-through and, thus, the mixing achieved.

- Provides a uniform cross-section; the channel reduces the likelihood of “dead flow areas” that would exist in a pond. Sediment deposition and high salinity concentrations would occur in the dead and low velocity areas common in a pond.

- Maintenance or cleanout of the water withdrawal or discharge facilities or the channel itself, would be, compared to a pond, greatly facilitated by a narrow channel cross-section that can be more easily accessed by conventional construction equipment.

2.3 Suitability of the Project’s Location in the Shubenacadie River

The performance of the mixing channel, from a hydraulic and thus salinity viewpoint is dependent on the magnitude of flow into the channel. River changes, such as the formation of bars at the channel’s inlet or outlet, could significantly decrease the magnitude of flow into the mixing channel.

The stability of the Shubenacadie River was evaluated via a comparison of 1974, 1985, 1994 and 2004 aerial photographs (Figure 1). The comparative photographs, selected to illustrate low tidal conditions when side or mid-channel bars are visible (except for the 2004 photograph), illustrate that at the proposed location of the mixing channel, the main channel has been located along the right bank for more than 30 years. The river’s pattern approaching the project’s location is governed by several sharp bends, upstream to the confluence with the Stewiacke River, which are stable. Thus, in the foreseeable future, the main channel of the Shubenacadie River, at and next to the proposed mixing channel, is not expected to change.

2.4 Flow and Velocity in the Channel

The layout of the mixing channel, relative to that of the Shubenacadie River, is illustrated on the 2004 air photograph (Figure 2). The mixing channel can best be compared to a natural side or sub-channel. Martec's May 2007 field data was utilized as follows to compute the flow and velocity in the mixing channel:

- The average water level profile or slope in the mixing channel is equal to that in the river, as the inlet and outlet water levels are governed by the river's water levels at those locations.

- The velocity in the mixing channel was assumed to be 66% of that in the main channel. The hydraulic conditions in the narrower mixing channel versus that in the main channel will result in somewhat lower velocities. The actual velocities in the channel, due to its uniform cross-section, will likely be higher, which will increase the flow and mixing compared to the calculated values.

- A trapezoidal channel with three horizontal to one vertical side slopes (3H:IV) and a bottom elevation 1.0 m below the lowest recorded water level was utilized. In Jacques Whitford's October 4, 2007 report entitled "Site Characterization – Proposed Saltwater Dilution Pond Site, Stewiacke, N.S." it is noted that "…based on preliminary assessments, the berm slopes would need to be constructed at a minimum of 3 horizontal to 1 vertical incline to maintain stability…".

- The velocity range in the river, as measured by Martec, is about -3.0 m/s (tidal bore travelling upstream) to about 2.0 m/s (river flow and ebb tide travelling downstream), which is equal to an estimated velocity of -2.0 m/s and 1.3 m/s, respectively, in the mixing channel. At non-tidal flow periods, the velocity in the mixing channel will be in the order of 0.3 m/s to 0.4 m/s.

- The resultant peak flow in the mixing channel, for a 6 m-wide channel bottom, will be about 150 m^3/s for the upstream travelling tidal bore and about 50 m^3/s for the river flow and ebb tide travelling downstream. The average “fresh” river flow is about 65 m^3/s. The outfall flow will therefore be 0.01% to 0.15% of the river flow, respectively. A graphic comparison of the magnitude of flow in the mixing channel to that in the river and from the salt caverns is presented on Figure 2.

2.5 Armouring

The variable and relatively high velocities in the channel will require armouring or protection of the channel’s cross-section. The impact of tidal-induced river ice movement and spring breakup ice floes are also factors in the design of the armouring.

Armouring the entire channel will ensure non-erodibility of the mixing channel and uniform velocities which will reduce the potential for the deposition of suspended sediments in the channel. The armouring details (size and thickness of the armouring, need for and type of filter layer, etc.) for the channel and the water intake and brine outlet facilities will be developed in the detailed design phase.

2.6 Channel Depth

The water quality modelling (Section 3.2) was undertaken for a mixing channel bottom elevation set below the low river water level at Elevation 2.0. For the final design phase, this elevation could be lowered somewhat depending on final river surveys in the river at the inlet and outlet of the mixing channel. Lowering will increase flow and thus the mixing that will occur in the channel. However, excessive levering is expected to have little water quality benefit as it would probably result in a higher potential for sediment deposition in the over-excavated channel.

2.7 Layout of the Channel

Figure 3 is the preliminary layout of the mixing channel superimposed on a 2007 survey of the river’s edge, dykes and adjoining agricultural land. The alignment:

- Provides for smooth transitions from the river into and out of the channel, essential to maximize the flow into the mixing channel, and to minimize the potential for sediment deposition at the inlet or outlet.

- Minimizes, as much as possible, the disturbance to the existing flood protection dyke during the construction phase of the dyke – a new continuous dyke will be constructed landward of the channel; thus, the remaining portion of the existing dyke will no longer be needed to provide primary flood protection.

3.0 MIXING CHANNEL PERFORMANCE

3.1 Criteria

The modelling of the cavern outflow into the mixing channel was based on the following:

- Martec's May 2007 field data.

- A 6 m-wide channel bottom, which, from a sensitivity analysis by Matrix, was determined to be the optimum width considering the mixing of the outflow from the caverns with the flow in the mixing channel.

- A daily salt cavern outflow volume of 9,000 m^3 at a salinity of 260 parts per thousand (ppt). This is the maximum design outflow volume and salinity concentration. (SolTech's write up discusses the variability in discharge and salinity versus the life of the project).

- The outfall design as discussed in Section 3.3.

3.2 Modelling Results – Using Maximum Outflow/Discharge Rates

The brine discharge scenarios modelled were as follows:

- Option 1 – Low River Flow[1] – continuous and uniform brine discharge. With a brine discharge volume of 9,000 m^3/day, the brine discharge would be 0.104 m^3/second.

- Option 2 – Low River Flow – continuous and variable brine discharge to produce a uniform percentage increase in salinity compared to the natural salinity in the river. The brine discharge rate would be lowest when the natural salinity in the river is low, and it would be highest when the natural salinity is high.

- Option 3 – Low River Flow – a three-hour shutdown in the brine discharge when the natural salinity in the river is at its lowest, preceding the arrival of the tidal bore. For the remainder of the tidal cycle, a variable brine discharge would be utilized.

- Option 4 – High River Flow – continuous and uniform brine discharge at the same rate as for Option 1.

The results of the four discharge scenarios are illustrated on Figure 5. Comments on these scenarios are:

- The magnitude of “fresh” river flow from upstream is the determining factor in establishing the natural salinity levels in the Shubenacadie River at this location. At low fresh river flows, the tidal influence is strongest, and thus the salinity levels in the river at the Alton project are the highest. Conversely, at high fresh river flows, the tidal influence is significantly dampened by the river’s flow and consequently the resultant natural salinity levels in the river are lower.

- The operation and storage characteristics associated with the brine facility permits a variable discharge rate into the mixing channel. A variable discharge rate, established in accordance with the natural salinity concentrations in the mixing channel or in accordance

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*[1] With a low to moderate river flow, the salinity of the river at the project is the highest. With a high river flow, the salinity concentrations at the project’s location are the lowest.

with the tidal clock, can be achieved in a computerized operation. Thus, the release of flow from the salt caverns is flexible.

- In the four scenarios presented, the resultant salinity values in the mixing channel will be less than the maximum natural salinity concentrations in the river, plus about 10%.

The salinity values for all options in the Shubenacadie River will be lower than those in the mixing channel.

The modelling results discussed above are predicated on full mixing of the brine discharge into the mixing channel – the brine is denser than the river flow. Thus, the design of the outfall must ensure full and total mixing in the mixing channel's flow depth and width. The proposed design of the outfall structure is shown on Figure 6 and discussed in Section 3.3.

3.3 Outfall Design

The conceptual design of the outfall is illustrated on Figure 6; it will consist of the following:

- Twin perforated lines across the bottom width of the mixing channel.

- Select cobbles/armouring placed around the lines to:

  - Protect the lines from ice floes.
  - Eliminate the direct discharge of the outflow into the water column. With the rock covering the outflow will percolate into the flow in the mixing channel.
  - High pressure air lines attached to the perforated lines to enhance the mixing of the outflow into the full flow depth in the mixing channel. The air lines, like the outflow line, would have numerous openings across the 6 m width of the mixing channel to ensure the brine discharge is uniformly distributed across the base width of the mixing channel.

At low flow depths in the mixing channel, the influence of the air lines and the rock will almost immediately disperse the outflow from the 6 m long perforated outfall across the full width of the channel. At higher flow depths, the influence of the rock on top of the lines combined with the flow patterns in the channel are expected to deflect and disperse the outflow across the full width of the channel within 20-30 m of the outfall.

3.4 Intake Design

The conceptual design of the intake is illustrated on Figure 6; the details are as follows:

- Its location will be on the outside, higher velocity, side of the mixing channel. This location, its projection into the channel and the vertical gabion face on the inlet will:
  - Increase velocities along the vertical face of the structure, and hence will reduce the potential for fish eggs to be attracted into the intake works. The intake velocity, generated by the flow percolating through the gabions, will be significantly less than in the channel along its face; therefore, it is considered unlikely that the eggs would move into the intake.
  - Reduce the potential for sediment deposition in the inlet.

- Twin, screened 15 m-long intake lines surrounded by select 100 mm to 200 mm crushed or rounded rock. The intake lines will feed into a 1.5 m diameter perforated corrugated wet well. A single line will then run from the wet well to the pumphouse. The ends of the intake lines will be setback from the face of the intake and will be closed off. The attracting velocity into the intake will thus correspond to the velocities through the gabion cobbles and the cobbles around the intake lines, as discussed in the paragraph below.

- The velocity into the intake, via the cobbles in the gabions and surrounding the intake lines, will range from 0.02 m/s (4 m depth of flow and 10% void ratio in the cobbles) to 0.07 m/s (2 m depth of flow and 5% void ratio in the cobbles).

The 1.5 m diameter perforated wet well will serve multiple purposes, namely to:

- Provide, in addition to the twin intake lines, an additional means of delivering water through the select rock to the pumphouse.

- Enable, by comparing water levels in the well to those in the mixing channel, a determination of the hydraulic effectiveness of the intake. If the levels are nearly the same, it would be an indication of little or no "clogging" of the 100 mm to 200 mm rock in the gabions and above the intake lines.

- Allow backflushing of the intake if clogging of the select rock has occurred. At low water levels in the mixing channel, the wet well could be filled or surcharged via temporary pumping of river flow to flush out any fine sediment deposition that may have occurred in the intake system.

- Enable cleanout of sediments, if necessary, prior to their entry to the pumphouse.

- Enable a visual inspection to determine whether any fish eggs have entered into the intake system.

4.0 "WHAT IF" OPERATIONAL SCENARIOS

Recognizing the uniqueness of this project, the nature of the Shubenacadie River and the importance of its aquatic resources, an assessment of "what if" scenarios and their potential associated operational or maintenance responses is provided in Table 1.

With adequate monitoring, particularly in the early years of the project, operational adjustments as needed with respect to the timing of release from the brine facilities and maintenance of the mixing channel and its associated facilities if necessary, it is believed that the proposed facilities on the Shubenacadie River will be able to fully operate within the parameters as determined herein.

The detailed design phase following project approval will refine the design of the works. As in the environmental application phase, the detailed design will be done in a multi-disciplinary manner to ensure all environmental, technical and operational issues are fully considered and addressed.

TABLE 1. OPERATIONAL RESPONSES TO VARIOUS “WHAT IF” SCENARIOS

WHAT IF	HOW DETERMINED	IMPACT ON OPERATION	IMPACT ON THE ENVIRONMENT	POTENTIAL MITIGATIVE MEASURES – IF NECESSARY
1. Silt or sand deposits in the Mixing Channel	From surveys and visual observations, the latter best done in non-tidal and low river flow periods.	Could reduce flow in the mixing channel – a bar would have a minimal impact on the flow. However, deposition across the full width of the channel could reduce flow during low flow conditions. This is expected to have little or no impact on the available flow for water withdrawal or the performance of the outfall.	A significantly reduced flow would increase salinity concentrations in the channel. Depending on the natural salinity in the river, the resultant salinity in the channel would still be expected to be well below the maximum natural salinity values in the river.	Remove the deposited material using a backhoe or small portable dredge. Undertake the work in the least sensitive period (from an aquatic viewpoint).
2. Scour of the bottom or erosion of the banks develops in the Mixing Channel	From surveys and visual observations – best done in non-tidal and low river flow periods.	Expected to have little impact on the magnitude of flow in the mixing channel and thus the operation of the intake and outfall.	Expected to have little impact if the scour and bank erosion is limited. Significant bank erosion could alter velocity patterns which could lead to non-uniform mixing of the flow in the channel.	Place more and/or larger armour material on the bed and banks of the mixing channel.
3. Mixing of the Brine Water with the flow in the Mixing Channel is not as modelled	Salinity measurements in the channel upstream and downstream of the outfall are higher than predicted herein.	None, except in the instance where the outfall flow affects the salinity of the water withdrawal from the channel. This could reduce the efficiency of the brining process.	Depending on the magnitude and spatial extent of the variance – actual versus modeled results – there could be a minor to moderate environmental impact.	Modify the outfall structure or add additional air lines to ensure full mixing of the brine and mixing channel flow. In an extreme nonconformance case, that can not be remediated by modifying the outfall structure, the magnitude of outflow might need to be reduced at certain times.

WHAT IF	HOW DETERMINED	IMPACT ON OPERATION	IMPACT ON THE ENVIRONMENT	POTENTIAL MITIGATIVE MEASURES – IF NECESSARY
4. Ice jams significantly reduce flows in the Mixing Channel	Visual observations during the ice formation period and during spring breakup – in the middle of winter the ice in the river is essentially stationary and less likely to jam.	A significant ice jam could reduce the water available for withdrawal from the channel. Since flow into the channel is from both directions, it would require jams at several locations to block the flow to the intake – with an upstream jam only, for example, the water would enter the mixing channel from its downstream end, resulting in minimal negative impact on the operation of the water withdrawal.	A significant ice jam could increase the salinity levels in the mixing channel if adequate flow is not occurring in the channel.	Remove the ice jam by mechanical means such as a backhoe or dragline. Reduce the brining rate during the period of reduced channel flow. If ice jamming, as per several years of observations appears to be a significant concern, mitigative measures such as piling at both ends of the mixing channel could be considered to reduce the potential for ice movement into the channel.
5. Eggs are detected in the mixing channel	Visual inspection	No impact on operation	No impact unless the eggs enter into the intake.	Not required, unless the eggs enter into the intake (see next scenario below)
6. Eggs are detected in the wet well in the intake	Visual inspection in the wet well.	No impact on operation.	Potential impact on the aquatic resources of the Shubenacadie River.	From detailed surveys in the river and mixing channel, determine when eggs are present and, reduce, or if necessary, cease water withdrawals during those periods. Another option would be to modify the design of the intake.

August 11, 1974

July 14, 1985

July 4, 1994

August 10, 2004

Scale
1:20,000 200 0 200 400 Metres

Notes:

1.0 The Shubenacadie River is an incised single channel whose pattern is governed by the nature and orientation of its banks and by the silt/sand bedload it transports.

2.0 At the proposed location, the Shubenacadie River is in the transition zone between its wide river mouth, heavily influenced by the tides, and the primarily river - dominated characteristics upstream from the (see right side of 1994 photo) Stewiacke River.

3.0 The main channel flow has been consistently next to the right bank at the proposed location of the Alton facilities ③ as a result of stable river bends at locations ① and ② upstream. This is not expected to change in the foreseeable future assuming no significant instream structures or works are constructed upstream in the Shubenacadie River.

4.0 In the wide tidal-influenced lower section of the River, see ④ in the 1994 photo, the higher mobility of the main channel is apparent - the main channel could readily form new flow patterns in this area.

5.0 From this assessment it is concluded that the location of the proposed Alton project is adjacent to a stable main channel section which is optimum for the proposed water withdrawal and outlet facilities.

N

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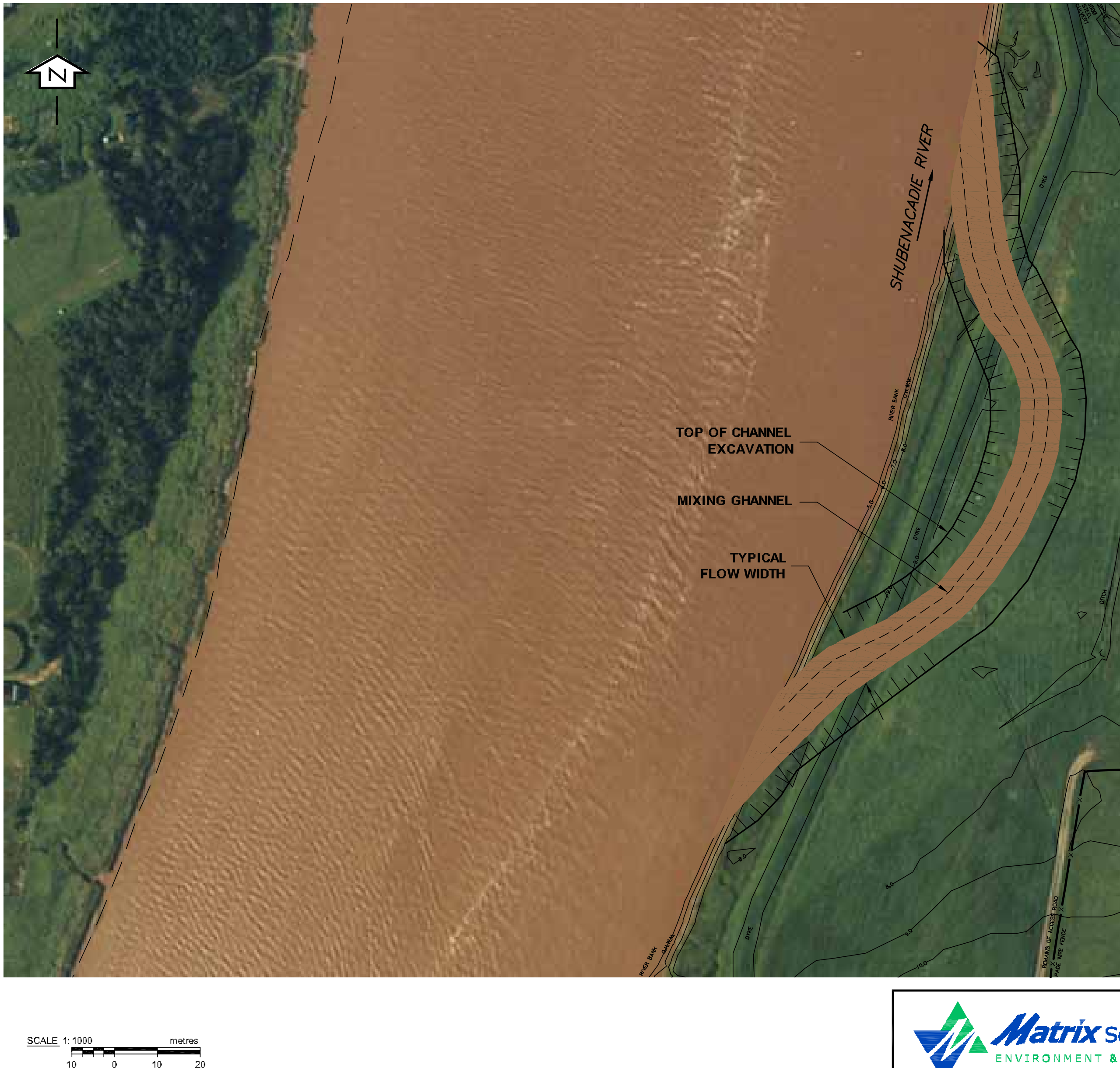
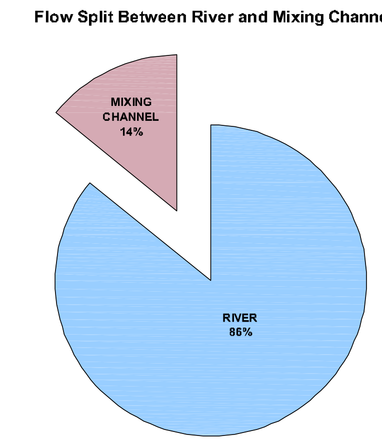
ALTON NATURAL GAS - NOVA SCOTIA

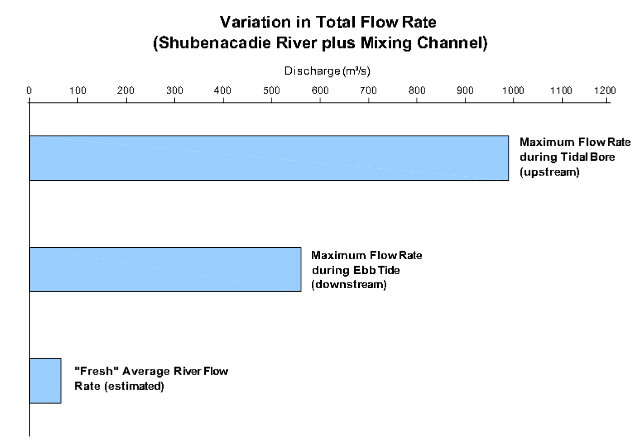
COMPARITIVE AIRPHOTOS
SHUBENACADIE RIVER
1974 - 2004

DATE:	FILE:	DESIGN:	DRAWN:	CHECK:		
NOV. 2007	3369-APL-07	WMV	AJG	DR	SHUBENACADIE RIVER WORKS	FIGURE 1





NOTE:
THE BRINE OUTFALL FLOW OF 0.1 m³/s IS 0.01% TO 0.15% OF THE TOTAL RIVER FLOW.



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ALTON NATURAL GAS - NOVA SCOTIA

SCHEMATIC AND GRAPHIC PRESENTATION OF MIXING CHANNEL AND BRINE FLOW RELATIVE TO THE SHUBENACADIE RIVER

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SHUBENACADIE RIVER WORKS

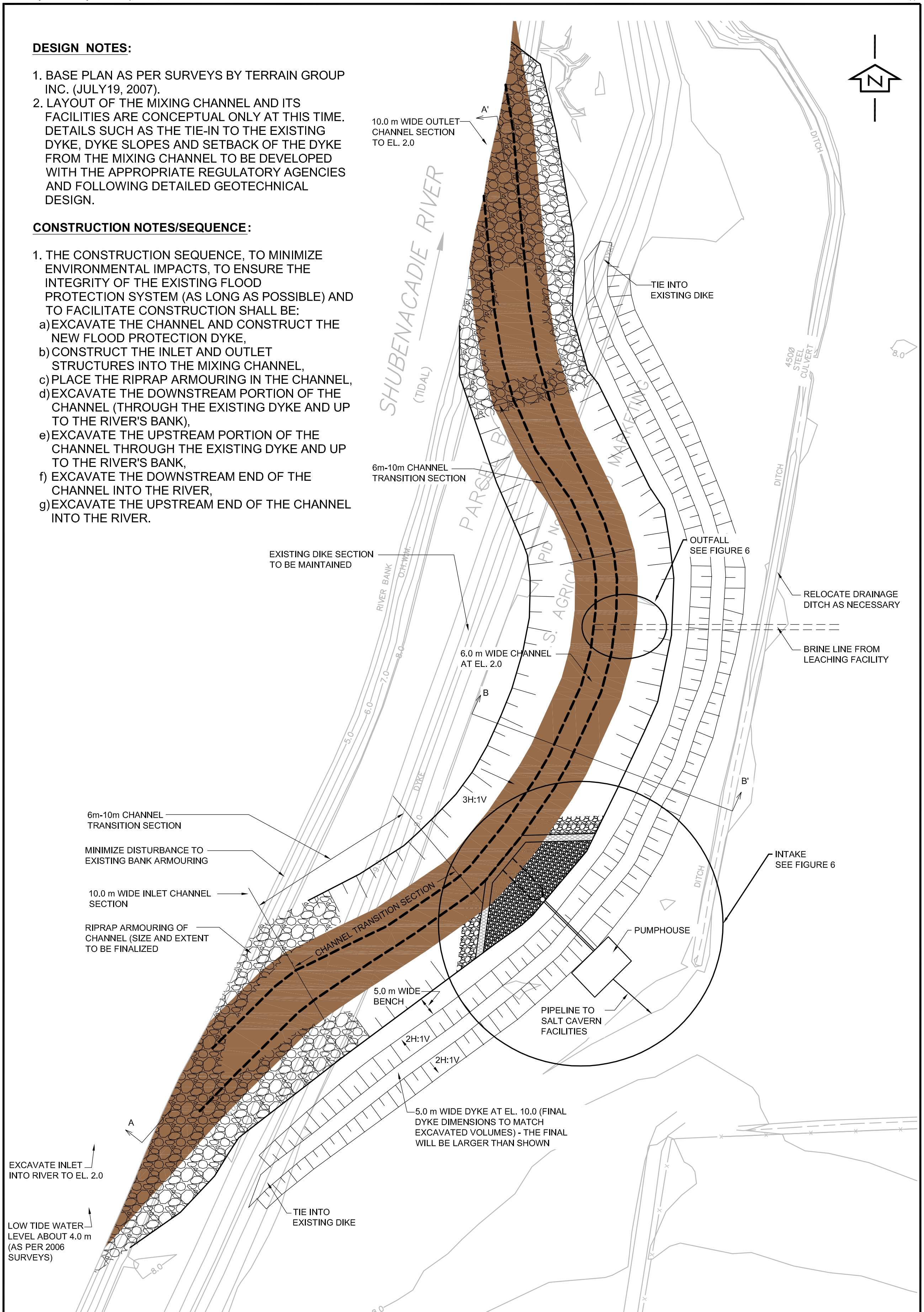
FIGURE 2

DESIGN NOTES:

1. BASE PLAN AS PER SURVEYS BY TERRAIN GROUP INC. (JULY19, 2007).
2. LAYOUT OF THE MIXING CHANNEL AND ITS FACILITIES ARE CONCEPTUAL ONLY AT THIS TIME. DETAILS SUCH AS THE TIE-IN TO THE EXISTING DYKE, DYKE SLOPES AND SETBACK OF THE DYKE FROM THE MIXING CHANNEL TO BE DEVELOPED WITH THE APPROPRIATE REGULATORY AGENCIES AND FOLLOWING DETAILED GEOTECHNICAL DESIGN.

CONSTRUCTION NOTES/SEQUENCE:

1. THE CONSTRUCTION SEQUENCE, TO MINIMIZE ENVIRONMENTAL IMPACTS, TO ENSURE THE INTEGRITY OF THE EXISTING FLOOD PROTECTION SYSTEM (AS LONG AS POSSIBLE) AND TO FACILITATE CONSTRUCTION SHALL BE:
   a) EXCAVATE THE CHANNEL AND CONSTRUCT THE NEW FLOOD PROTECTION DYKE,
   b) CONSTRUCT THE INLET AND OUTLET STRUCTURES INTO THE MIXING CHANNEL,
   c) PLACE THE RIPRAP ARMOURING IN THE CHANNEL,
   d) EXCAVATE THE DOWNSTREAM PORTION OF THE CHANNEL (THROUGH THE EXISTING DYKE AND UP TO THE RIVER'S BANK),
   e) EXCAVATE THE UPSTREAM PORTION OF THE CHANNEL THROUGH THE EXISTING DYKE AND UP TO THE RIVER'S BANK,
   f) EXCAVATE THE DOWNSTREAM END OF THE CHANNEL INTO THE RIVER,
   g) EXCAVATE THE UPSTREAM END OF THE CHANNEL INTO THE RIVER.



SCALE 1:1000 metres
10 0 10 20

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ALTON NATURAL GAS - NOVA SCOTIA

PRELIMINARY PLAN OF MIXING CHANNEL

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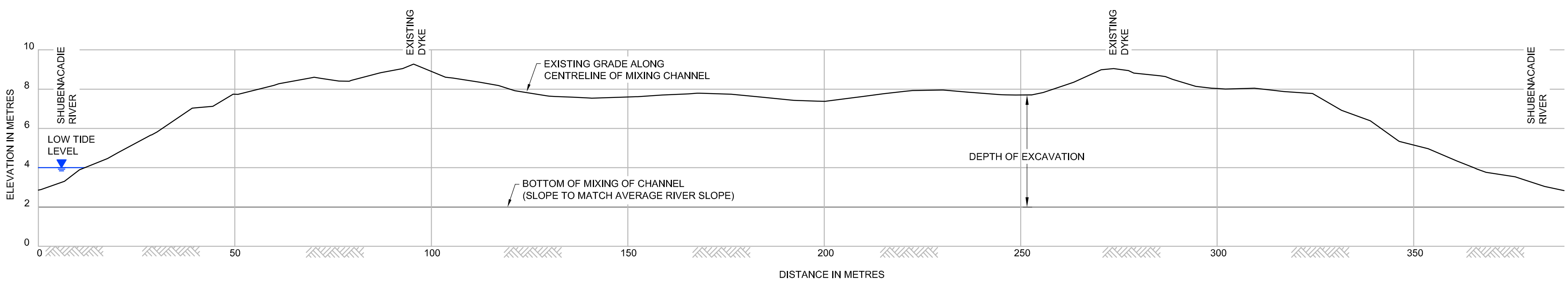
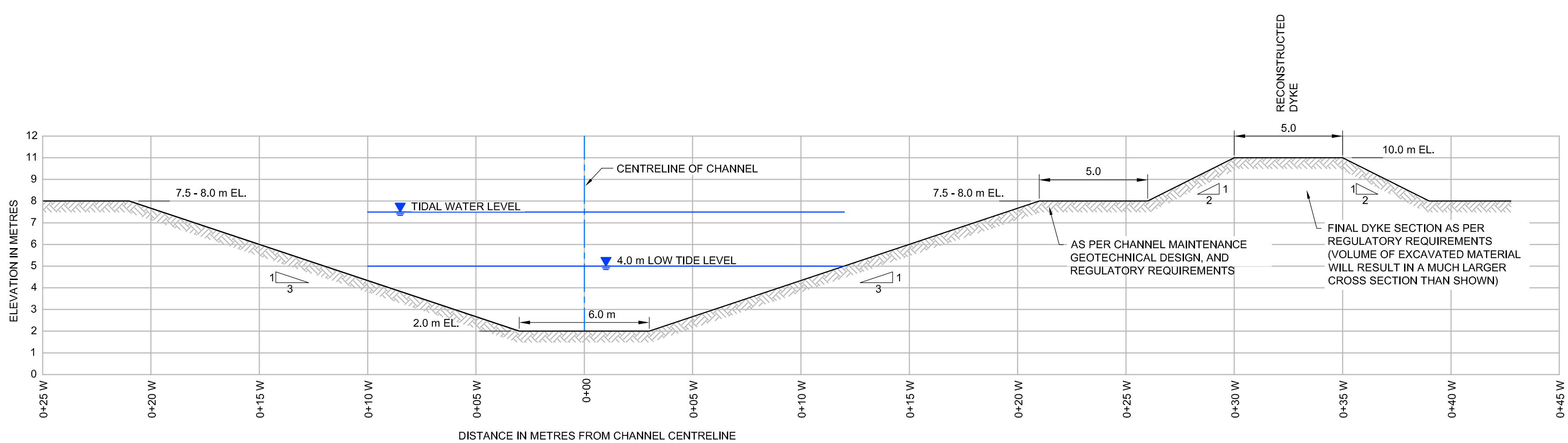
SHUBENACADIE RIVER WORKS

FIGURE 3



PROFILE A-A'

HORZ. SCALE 1:1000, VERT. SCALE 1:200



CROSS SECTION B-B'

SCALE 1:200

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ALTON NATURAL GAS - NOVA SCOTIA

MIXING CHANNEL PROFILE AND CROSS SECTION

SHUBENACADIE RIVER WORKS

FIGURE 4

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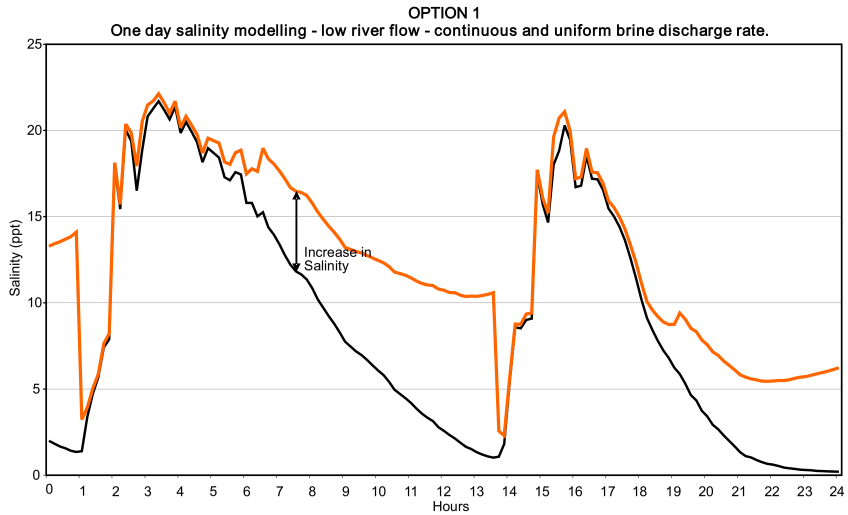

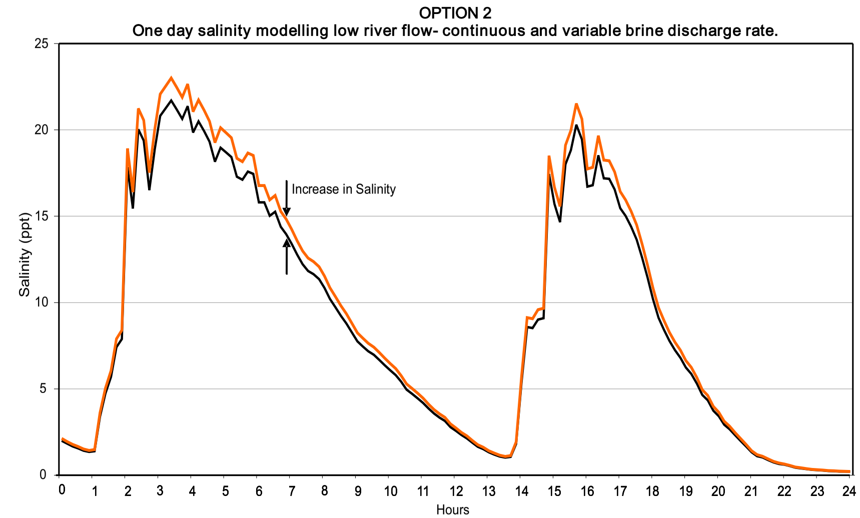

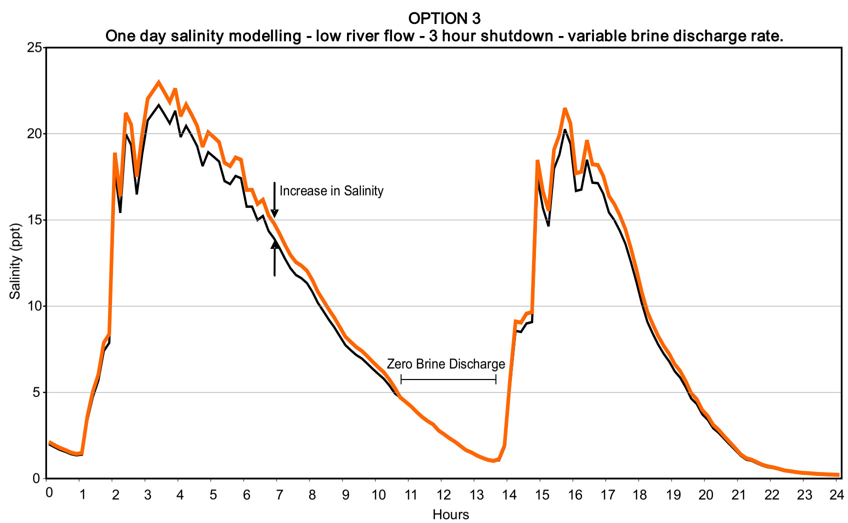

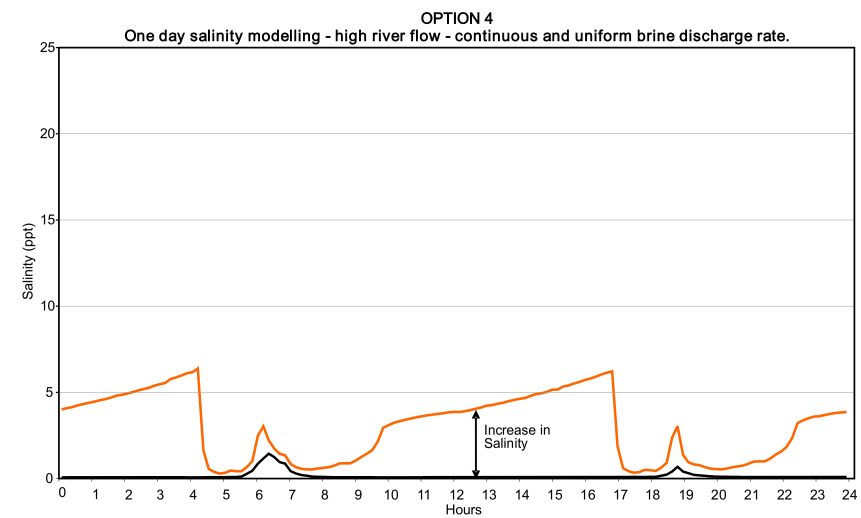

Legend

- Shubenacadie Salinity
- Channel Salinity

Notes:

1. Natural salinity values in the Shubenacadie River in May 2007 as per Martec Limited.
2. The salinity concentrations shown for the channel assume full mixing horizontally and vertically. The vertical mixing is assured by means of the outfall lines, rock and air lines. Complete horizontal mixing, from the outfalls located on the bottom of the channel to the full top width of the channel will occur within several metres to 20-30 m for low and high channel flow depths respectively.

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ALTON NATURAL GAS - NOVA SCOTIA

MIXING CHANNEL SALINITY FOR VARIOUS BRINE DISCHARGE AND RIVER FLOW SCENARIOS

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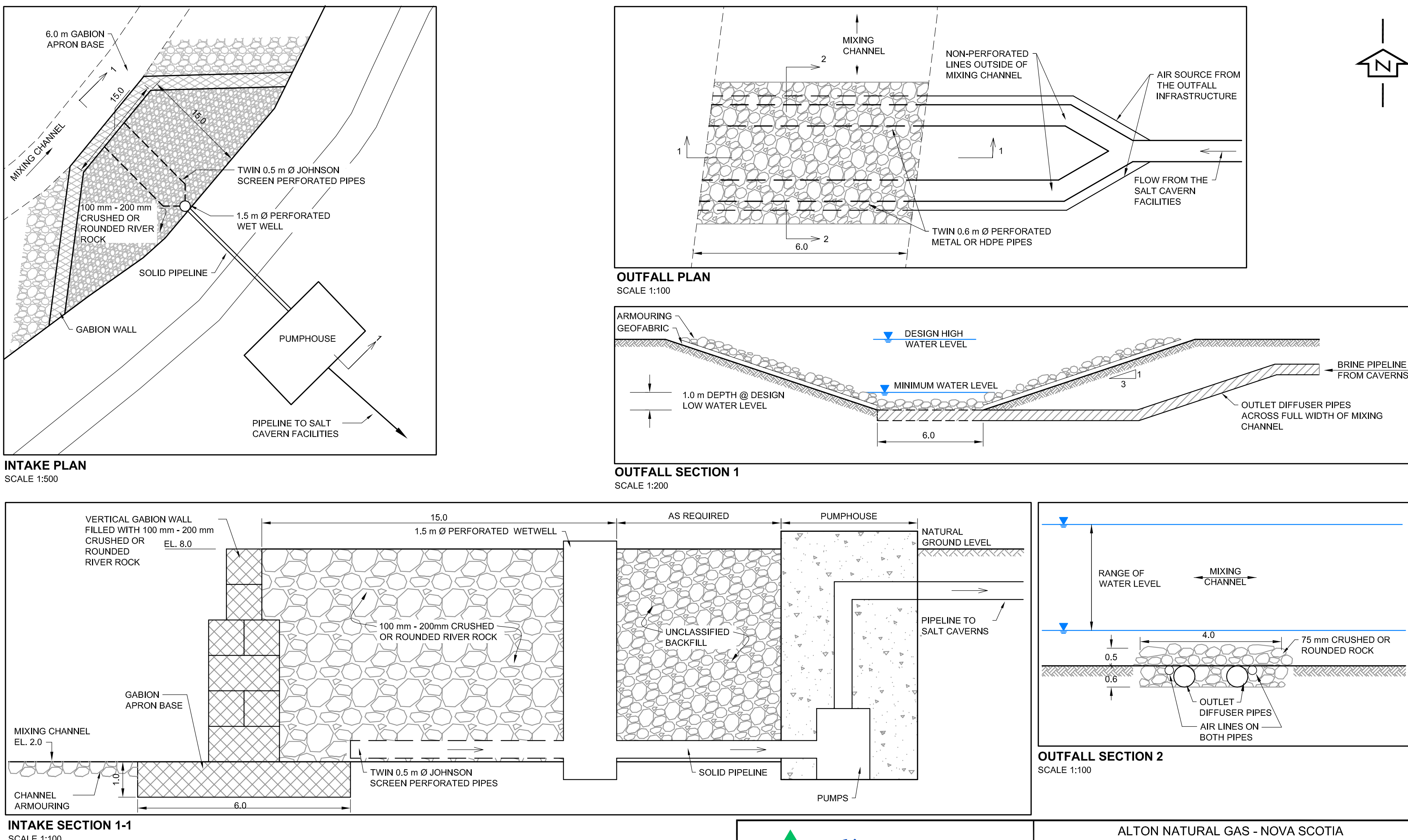
SHUBENACADIE RIVER WORKS

FIGURE 5



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DATE:	FILE (DWG):	DESIGN:	DRAWN:	CHECK:
NOV. 2007	6639-SP-07	WMV	AJG	DR

ALTON NATURAL GAS - NOVA SCOTIA

CONCEPTUAL INTAKE AND OUTFALL DETAILS

SHUBENACADIE RIVER WORKS

FIGURE 6

APPENDIX C

Biological Impact Statement

Alton Natural Gas Storage Project
Shubenacadie River
Nova Scotia

Biological Impact Statement

Follow up Report

November 18, 2007

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Table of Contents

Biological Impact Statement

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1.0 Introduction

This report is in response to the biological questions raised during the public and regulatory review of the Environmental Registration for the Proposed Alton Natural Gas Storage Project, Jacques Whitford, June 2007. The project design details can be found in the environmental registration and the report prepared by Martix Solutions Inc "Alton Natural Gas Storage Water Intake and Discharge Facilities" Shubenacadie River, Nova Scotia

The design of the mixing channel, water intake, and outfall has been better defined, than in the original submission, to allow a more detailed discussion of the environmental effects and to better address concerns raised by the public and regulatory agencies. The current design and the operational questions are answered in reports from Matrix Solutions and SolTech. Based on the information provided in these documents, a review has been conducted of how the fish species present at the site, including their various life stages, might be affected by the development.

Since this is a unique project in terms of the design of a mixing channel in a tidal area, the associated intake and outfall, and the species involved, there are several monitoring studies that will need to be done to ensure the predictions presented in this design phase are actually functioning as planned. Based on the results of this monitoring, adjustments will be made to the design or operations to protect the environment and fish populations.

Table 1 is a listing of the major species expected at the site and the anticipated affect of the operations on them. These have been grouped and summarized below.

2.0 Areas of potential impact

2.1 The Minas Basin

A concern has been raised that the introduction of additional sea salt from the cavern development will raise the salinity of the Basin.

There is evidence that the Minas Basin is a marine retention area, but marine retention areas are very leaky and only retain sediment, floating plants and animals, and dissolved chemicals that are taken up and cycled through the biota. For dissolved chemicals like salt that are not built up in the biota, the levels in the Bay can be compared to a sink with a small drain. When you turn the water on full, the sink retains some level of water until you turn the taps off. There is always a constant flow in and out, so retention can be calculated based on inflows and flushing time. If we look at the amount of salt being put into the Bay by the maximum operation level of this project (see Addendum of this report), we find that at the:

<u>Mixing channel outlet site:</u>
Ebb flow estimated to be 4,042,000 m^3 of water.
Discharge 4,500 m^3 of brine.
Ratio 898 to 1.
Estimated, increase salinity of approximately 0.278 ppt.
From 10 ppt, the typical ambient natural salinity to 10.278 ppt

Maitland mouth of the Shubenacadie River
Estimated flow to be 54,239,000 m^3.
Discharge 4,500 m^3 of brine.
Ratio 12,053 to 1.
Estimated effect on total salinity at Maitland, is approximately 0.0207 ppt.
Raising the salinity from 10 ppt, the typical ambient natural salinity, to 10.0207 ppt

Cobequid Bay
On a per tide cycle basis, using only the flushing volume of water out of Cobequid Bay, 2,446,070,000 m^3.
Discharge 4,500 m^3 of brine.
Ratio 543,571 to 1.
Estimated effect on total salinity in Cobequid Bay, approximately 0.00043 ppt.
Raising the salinity from 28 ppt, the typical ambient natural salinity, to 28.00043 ppt

Minas Basin
On a per tide cycle basis, using only the flushing volume of water out of the Minas Basin, 17,710,760,000 m^3 of ocean water.
Discharge 4,500 m^3 of brine.
Ratio 3,935,724 to 1.
Estimated affect Minas Basin, is approximately 0.000059 ppt.
Raising the salinity from 28 ppt, the typical ambient natural salinity to 28.000059 ppt

Bay of Fundy
On a per tide cycle basis, flushing volume of water 111,111,000,000 m^3 of ocean water.
Discharge 4,500 m^3 of bring.
Ratio 24,691,333 to 1.
Estimated increase in salinity of approximately 0.00000932 ppt.
Raising the salinity from 30 ppt, the typical ambient natural salinity to 30.00000932 ppt.

These increases are not biologically significant and insignificant in terms of the natural fluctuation of salinity, that the biological community is subject to on each turn of every tidal cycle.

There was also a concern expressed about retention in an erosion area adjacent to the original outfall site. The location of the mixing channel with respect to this retention erosion area is not clear. However, the water that might enter the area from the mixing channel has a salinity that is equal to or less than 10% above background and not above 25.25 ppt. This is well within the tolerance limits of eggs and larvae held in the area or any migratory fish passing through. Since the salt is not left in this retention area and the water moves out as fast as it moves in there is no chance of a build-up in salinity.

2.2 The Shubenacadie River

The question of raised salinity levels in the river has been addressed above. The water withdrawal is proportionally very small and is replaced within the mixing channel so there is no impact. Flow patterns in the river will not be significantly affected by taking the flow from the outside of the river meander in a flow through side channel. This will not negatively impact on migration routes. The impact on the river is insignificant.

3.0 The Mixing Channel

3.1 Intake

3.1.1 Eggs and larvae

There is a risk of entrainment of eggs and larval fish in the intake because they drift with the currents and have little or no swimming ability or known behavioural response to avoid the intake. There are several species involved with pelagic eggs and larvae that could come into the mixing channel. A listing of those considered can be found in Table 1 and include Striped bass, Tom cod, and Smooth flounder. Some of these eggs and larvae come from the marine, some from brackish water and others from freshwater.

Some eggs are buoyant some are semi-buoyant and others stay close to the bottom. What they have in common is that they are moved by water currents and stay suspended by the turbulence. Water velocities in excess of 30cm/sec (Bain, M. B. and Bain J. L., 1982) are required to keep the eggs suspended and prevent them from settling out and being buried in silt. The mixing channel is designed to have velocities above this level, and the intake wall extends to the channel to further increase the velocity passing the intake face. Intake withdrawal is at right angles to the flow and at a much lower velocity than in the mixing channel which will minimize the potential for eggs being entrained.

The larvae move with the current also, but do have the ability to move up and down in the water column following food and light levels. Their entrainment will be the same as for the eggs, but the turbidity in the water column may cause them to concentrate near the water surface.

Out of 100 drifting eggs and larvae, based on water flow, 86 will pass in the river, and 14 will enter the mixing channel and potentially 0.01 to 0.15 will enter the intake. The faster flow and turbulence pattern at right angles to the intake will reduce the potential entrainment of eggs and larvae to near zero.

To monitor the number of eggs drawn into the intake:

- Vertical plankton tows will be taken in front of the wet well intake to establish presence of eggs and larvae under the influence of this flow;
- Plankton samples will be taken from the flow entering the riprap face to estimate the numbers entering the rock structure; and

- Vertical tows will be taken in the wet well to determine if any eggs and larvae have come through to the pump intakes.

If eggs and larvae are being drawn in, modifications can be made to the intake or withdrawal rates can be lowered. Withdrawal rates may need to be lowered during various stages of the tide, or perhaps stopped when eggs and larvae are present. This will be determined by monitoring of the effects and the appropriate changes made.

The risk to the populations from the withdrawal is insignificant.

3.1.2 Migratory Fish

Migratory fish, juveniles and adults who may come into the mixing channel are large enough and have sufficient swimming ability to avoid entrainment in the intakes. The velocities at the riprap face are well within the freshwater screening guidelines for intakes, and the graduated rock size allows the smaller fish to take shelter behind the first layers of larger rock and to return to the mixing channel on the turn of the tide. This avoids the potential loss of small fish seen on many intake screens when they get held sideways against the small mesh.

Migratory fish will ride in on the tide and then swim against the currents on the falling tide, following the thalweg in the river. It is difficult to estimate what percentage of these fish will enter the mixing channel. Based on flows, of 100 fish moving in the river, 86 can be expected to pass by in the River, 14 to go through the mixing channel with 0.01 to 0.15 coming under the influence of the intake channel. What percentage this is of the total migratory populations is unknown for this site because of the location many of the fish may be actively swimming upstream on the falling tide.

For those fish that do not pass the site on the tide and move up river following the thalweg, 50% will be moving along the mixing channel side of the thalweg. Velocities in the channel at low flow are expected to be 30 to 40 cm/sec, velocities that are in the optimum range for migration of anadromous fish. It is expected that as many as half of these fish, 25% of those moving in on the falling tide could pass through the mixing channel. Of these 5% to 10% would come under the influence of the intake water, which they are capable of swimming against and will avoid due to the physical obstruction of the wall face and the loss of suitably attractive migration velocities.

3.1.3 Monitoring

We will monitor fish and currents at the intake:

- Plankton net vertical tows at the face of the intake to estimate the numbers of eggs and larvae that come under the influence of the intake flows (April through August).
- Plankton nets set into the riprap to estimate the impingement of eggs and larvae in the intake.

- Plankton net vertical tows in the wet well to estimate how many eggs and larvae come under the influence of the pump intakes.
- Actual measurements of the currents in the mixing channel passing across the face of the intake as well as the currents flowing into the structure during a tidal cycle. This will be done once the system is built and pumping.
- Impingement of adult and juvenile fish on the riprap – regular observations.

3.2 Outfall

3.2.1 Nearfield Salinities

The outfall is set into the bottom of the mixing channel and discharges through two 60 cm pipes 6 m long. With an average discharge rate of 0.1 m^3/sec; the mean velocity seeping out of the pipes will be 0.008 m/sec. This flow will be introduced into a berm of rock that covers the pipes and the tidal flow velocities through the berm of will be at least 0.30 m/sec with an open area of approximately 1.5 m^2 for a flow of 0.45 m^3 /sec or a 56 times dilution coming out of the rock berm. With a maximum salinity of 25ppt coming into the mixing channel; the outflow will have a maximum salinity of 29 ppt to 30 ppt as it comes out of the rock berm. The added turbulence of the flow over the berm will further dilute the out flow. This would be the worse case scenario of high output and high river salinity. Operationally it will always be lower. However these salinities are still with in the full sea salt level of 33 ppt and the tolerance range for most of the life in the channel. The higher salinity water will stay close to the bottom due to its high density, so it will only be in contact with biota in the bottom 0.5 m of the channel and on the down streamside of the outfall berm. If needed there is the built-in option of using air to enhance the mixing in the berm and to help flush out sediment.

3.2.2 Eggs and larvae

As above, only 14 out of 100 eggs and larvae are expected to enter the channel. The majority of these will be carried well up in the water column and pushed up and over the outlet berm. In high tide conditions virtually all the eggs and larvae would be passing in fully mixed water well with in tolerance levels. During low tide, half the flow through the channel will go through the rock berm and half the eggs and larvae with it. To mitigate this, brine discharge options 2 or 3 (refer to Section 2.1 in Appendix B, Water Intake and Discharge Facilities) will be used, shutting down the brine during low tide.

This means that virtually all the eggs and larvae entering the mixing channel will only contact salinities less than 10% higher than they would have in the river and normally less than 25 ppt, well within natural variation and their tolerance limits.

There is no significant impact on the pelagic eggs and larvae.

3.2.3 Migratory fish

The proportions of migratory fish entering the mixing channel have been described above. The behavior of migrating anadromous fish is to swim at or just below the Secchi disc depth. In this turbid water this depth is very close to the surface. The salinity levels at this depth during most tidal stages are very close to background. There will be no pools in the mixing channel for them to rest or hold in so they will move through quickly. Migratory fish are salt tolerant to full salt and there is nowhere in the channel they can exceed that level unless they enter the rock berm over the outfall. Since this is not an area they would frequent and they are able to sense and select salinities, effects on these fish is insignificant.

Bottom dwelling fish like smooth skate that might come into the mixing channel on feeding migrations are full salt tolerant and would swim up and over the 7.5cm rocks in the berm so will not contact the high salinities. Effects on these fish are insignificant.

3.2.4 Monitoring

We will need to monitor the outfall conditions:

- Actual salinity levels in 3D over a tidal cycle
- Plankton net vertical tows on either side of the outfall to look at egg and larvae numbers present and survival rates.
- Observations of the fish behaviour and any change in behaviour or mortality due to exposure to changes in salinity or high salinities

3.2.5 Temperature Changes

There will be very little if any temperature difference between the mixing channel water and the outfall and the mixing rate will take care of this very quickly (refer to Appendix H, Alton Heat Transfer Study). The concern was based on the perception we would be heating the water to get the salt to dissolve but this is not the case. In the monitoring of the operation of the outfall, we will get temperature and salinity data to confirm this. There is no significant impact of temperature.

4.0 References

Bain, K.B., and J.L. Bain. 1982. Habitat suitability index models: Coastal stocks of striped bass. U.S. Fish and Wildlife Service, Office of Biological Services, Washington, D.C. FWS/OBS-82/10.1. 29 pp.

Scott, W.B. and M.G. Scott 1988, Atlantic Fishes of Canada, Can, Bull, Fish, Aquat. Sci. 219: 731 pp.

Table 1: Species vs. Activity: Impact Assessment in the Mixing Channel

Species	Life Stage	Dates Present / Behaviour	Size /Swimming Ability	Intake Concerns	Intake Risk	Salinity Tolerance	Outfall Concerns	Outfall Risk	Mitigation & Monitoring (see end of table)
Anadromous Species									
Atlantic salmon (*Salmo salar*)	Adult/grilse	Spring to fall. Can be present all year Salmon moving in through the turbid waters will swim against the current following it along the thalweg of the river. Often carried in on the tidal bore	In excess of screening minimum requirements	Attraction to the flow Impingement	None – fish are moving upstream. Swimming ability will prevent impingement Will not move into the rock intake during outflow.	Full	Migrating fish will contact high salinity outflow They will contact high salinity plume at low tide	Low risk Swimming depth at Secchi disc reading turbid water will keep fish at surface in well-mixed water. Air bubbles will induce avoidance of mixing water. Salinity levels not expected to exceed tolerance level in any area of contact Contact with plume at low tide mitigated by reduced or stopped brine flow at this time	4 A
	Smolts	May Smolts are expected to move quickly through the estuary on their way out. The route is not well defined but likely moving in the out flowing current about 40cm /sec	In excess of screening minimum requirements	Follow currents into intake	None -Velocities at intake face well below velocities used by smolts for downstream passage. Visual barrier also present.	Adapting	Smolts will contact high salinity plume	Low risk – only a small portion of smolts will pass through the channel. They will be high in the water column due to turbidity. Plume will be not be present in low tide conditions.	1 A

Table 1: Species vs. Activity: Impact Assessment in the Mixing Channel

Species	Life Stage	Dates Present / Behaviour	Size /Swimming Ability	Intake Concerns	Intake Risk	Salinity Tolerance	Outfall Concerns	Outfall Risk	Mitigation & Monitoring (see end of table)
Alewife (*Alosa pseudoharengus*) Gaspereau (*Alosa pseudoharengus*	Adults	April -June Gaspereau ascend rivers in early spring and begin to spawn in late April in lakes, ponds, rivers above the tide head and spawning may last for two months (Scott and Scott 1988). Gaspereau feed primarily on zooplankton as both adults and juveniles. Passage thorough the estuary swimming against out flowing current 30 to 40 cm /sec. Holding in lower velocities. Often carried in on the tidal bore	In excess of screening minimum requirements	Attracted to flow on falling tide Pulled in to intake	Very low -Will not move into the rock intake during outflow. Velocity and currents to weak for attraction None - Swimming abilities well above intake velocities	Full	Contact with high salinity plume	Low – alewife will be at top of water column were the water is well mixed Low tide contact no effect	1 A
	Juveniles	August to June. The young Gaspereau feed and grow in the river during the summer and descend to the sea during the late summer & early fall. Remain in the estuary until the next spring when they join the main population. Distribution at the site is unknown although likely move outside of turbid zone very quickly to feed.	Close to minimum for screening guidelines	Moving downstream with the current – may impinge on the intake	Very low - Behaviour should cause them to avoid being drawn into rock filter Majority of fish should follow main river flow those in channel should follow main flow. Velocities entering the intake are below preferred velocities for migration available in main channel.	Adapting	Contact with high salinity plume	Low – alewife will be at top of water column were the water is well mixed Low tide contact no effect	1 A

Table 1: Species vs. Activity: Impact Assessment in the Mixing Channel

Species	Life Stage	Dates Present / Behaviour	Size /Swimming Ability	Intake Concerns	Intake Risk	Salinity Tolerance	Outfall Concerns	Outfall Risk	Mitigation & Monitoring (see end of table)
Sea lamprey (*Petromyzon marinus*)	Adults	Adult sea lampreys likely congregate in the Estuary during late winter and start to move upstream at night, following the onset of warming water temperatures; however, spawning does not occur until late May or early June.	In excess of screening minimum requirements	Will likely explore the rock filter face.	None - they are strong enough to escape any velocities encountered	Full	Travel on the bottom and will contact high salinities	Expected to avoid unsuitable salinities In the rock cover of the intake	1
	Juveniles	Young adults (approx. 25cm length) move to the estuary in the fall. It can be assumed some lamprey are in the estuary year round.	In excess of screening minimum requirements	Same as adults	Same as adults	Full			
Atlantic sturgeon (*Acipenser oxyrhynchus*)	Adults	Adult sturgeons are occasionally reported from Grand Lake; however, most adults spend the majority of their lives at sea where their movements are poorly understood. The Estuary in the vicinity of the proposed site likely provides foraging, migratory, and spawning habitat. They are present year round	In excess of screening minimum requirements	Drawn in or swim into intake	None - Rock face filter is smaller than the fish and their swimming ability is very high	Full	Travel near the bottom expect them to follow the thalweg and not enter mixing channel	Expected to avoid unsuitable salinities Salinity plume within their tolerance limits	1
	Eggs and larvae	Spring spawning likely occurs upstream in freshwater but the tidal action potentially moves the larvae past the site.	None to very poor	Drawn into intake	Same as striped bass				
	Juveniles	Juveniles bottom feed likely outside of the turbid tidal waters	Above min requirements of screening	Should pass below it in mixing channel. Good swimming ability and size	none	full	Travel near the bottom expect them to follow the thalweg and not enter mixing channel	Expected to avoid unsuitable salinities Salt plume likely within their tolerance limits.	3 A

Table 1: Species vs. Activity: Impact Assessment in the Mixing Channel

Species	Life Stage	Dates Present / Behaviour	Size /Swimming Ability	Intake Concerns	Intake Risk	Salinity Tolerance	Outfall Concerns	Outfall Risk	Mitigation & Monitoring (see end of table)
Brook trout (*Salvelinus fontinalis*)	Adults	Present in the area year round most abundant during summer low flow and winter periods. Concentrations during spring feeding and spawning runs. Most feeding outside of the turbid tidal areas.	Above min requirements of screening	None	None	Full	Travel at Secchi disc depth will be in mixed water at high tide possible exposure at low tide	None - above salinity plume and have suitable tolerance	1 A
Brown trout (*Salmo trutta*)	Adults	Brown trout are present in this river system. Brown trout are primarily a freshwater fish but have developed sea run populations whose marine behaviour appears to be the same as sea run Brook trout. They will be most abundant during spring feeding migrations and fall spawning runs but may be present year round in small numbers.	Above min requirements of screening	Drawn in or swim into intake	None	Full	Travel at Secchi disc depth will be in mixed water at high tide possible exposure at low tide	None - above salinity plume and have suitable tolerance	1 A
Rainbow trout (Oncorhynchus tshawytscha)	Adults	These fish are an introduced species and do take on several different life cycles. They do not successfully reproduce well or support a self-sustaining population. They are stocked by NS Fisheries in lakes and are escapes from aquaculture operations. There is no recent recorded stocking in this system (2006 & 2007). Presence is rare	Above min requirements of screening	Drawn in or swim into intake	None	Full	Travel at Secchi disc depth will be in mixed water at high tide possible exposure at low tide	None - above salinity plume and have suitable tolerance	

Table 1: Species vs. Activity: Impact Assessment in the Mixing Channel

Species	Life Stage	Dates Present / Behaviour	Size /Swimming Ability	Intake Concerns	Intake Risk	Salinity Tolerance	Outfall Concerns	Outfall Risk	Mitigation & Monitoring (see end of table)
Striped bass *(Morone saxatili)*	Adults	The Estuary at the site provides foraging and migratory habitat for striped bass. The striped bass population in the Estuary is thought to be genetically distinct with little to no gene flow from other populations and thus represents a unique evolutionary unit. A loss of individuals from the Shubenacadie and Stewiacke Rivers are considered to be significant to the overall genetic health and intraspecific diversity of the metapopulation (Douglas et al. 2002). The population number in the Shubenacadie and Stewiacke rivers is not known.	In excess of screening minimum requirements	Drawn in or swim into intake	None	Full	Travel at Secchi disc depth will be in mixed water at high tide possible exposure at low tide	None - above salinity plume and have suitable tolerance	
	Eggs and Larvae	Eggs and larvae may be present at high numbers during the spawning season (R. Bradford, pers. comm. 2007).	Smaller than screening capabilities. Swimming capability non-existent to poor. Move with water currents usually in the 30 to 40 cm/sec range to prevent settling on the bottom which is lethal in this habitat.	Drawn into intake Impingement	Moderate – the majority will pass in the main river Most in the channel will pass, Based on water flow if 100 eggs are in the water, 86 will pass in the river, 14 will enter the mixing channel, and 0.15 will enter the intake. However the currents in the mixing channel should carry more than that past the intake.	Low to moderate.	Eggs an larvae drifting with the current will contact high salinity outflow in the mixing channel plume at the bottom or in the cover berm	Moderate Most up in the water column will not contact high salinities. Currents should carry majority over the berm vs. trough it Brining will be shut off when tide is low and water freshest Exposure time is very short	1,2,3,4 A, B.

Table 1: Species vs. Activity: Impact Assessment in the Mixing Channel

Species	Life Stage	Dates Present / Behaviour	Size /Swimming Ability	Intake Concerns	Intake Risk	Salinity Tolerance	Outfall Concerns	Outfall Risk	Mitigation & Monitoring (see end of table)
					Velocities in intake low enough to cause eggs to settle most flushed back out during falling tide.				
	Juveniles	Post finfold fish	Min for size and ability	Drawn into intake	Low – majority will pass in river or channel currents. Those at the face of intake will have the ability to swim against the currents.	Full	Contact with high salinities	Tolerant of salinities in the mixing channel Behaviour and currents should carry them above the rock berm with the highest salinities.	1, 4 A .
Blue back herring (*Alosa aestivalis*)	Adults	Present in the Shubenacadie-Stewiacke watershed and estuary during spawning migrations (April to May)	Exceeds min requirements	Drawn in or impingement	Minimal	Full	Contact high salinities	None – position in the water column and tolerances prevent contact	1
	Juveniles	Descend into the estuary in August and live there and in costal areas joining the main population in the spring.	Young fish are subject to impingement on the water intake screens with velocities over 15 cm /sec.	Impingement	Minimal. Cover in riprap and reversing flows will prevent this.	Full	Contact high salinities	None – position in the water column and tolerances prevent contact	1
American shad (*Laos sapidissima*)	Adults	Present in the Shubenacadie-Stewiacke watershed and Estuary during spawning migrations arriving in June and staying until fall. Spawning is in slow moving freshwater and brackish (up to 15ppt) sections of the river and begins when the river temperature is above 12^0C.	In excess of screening criteria	None	None		Contact high salinities	None – position in the water column and tolerances prevent contact	

Table 1: Species vs. Activity: Impact Assessment in the Mixing Channel

Species	Life Stage	Dates Present / Behaviour	Size /Swimming Ability	Intake Concerns	Intake Risk	Salinity Tolerance	Outfall Concerns	Outfall Risk	Mitigation & Monitoring (see end of table)
	Eggs and larvae	Eggs are pelagic carried by the currents. They hatch in 8 to 12 days and are 5.7 to 10 mm long. They live in brackish water until 50 to 70 mm long then descend to sea	None to minimal	Same as striped bass	Same as striped bass	Optimum Salinity Range: 0 - 15 ppt (eggs)	Salinity will exceed tolerances	None - Natural salinity variation at the site exceeds tolerance levels added in minimal salinity has no effect	1,2,3,4 A, B.
	Juveniles	Live in schools in coastal waters then migrate south in the fall.		Same as striped bass		0 - 13 ppt (juveniles) Funderburke, S.L et al,	Salinity will exceed tolerances	None - Natural salinity variation at the site exceeds tolerance levels added salinity has no effect	1,4 A,B
Rainbow smelt (*Osmerus mordax*)	Adults	Live in the coastal waters during the summer. Form schools in the estuary in the fall and late winter. Spawn in spring above the head of tide. In April to May.	In excess of screening criteria	None	None	Full	Migration run will encounter high salinity outfall plume	None - Will be swimming near surface in well mixed water Mitigation using option 2 or 3 will negate impacts at low flow	
	Eggs and larvae	Eggs are laid In freshwater and are adhesive and stick to the bottom. Hatching time is temperature dependant. Fry are 5mm long when hatched and are carried by currents down to brackish water. They can be expected in early May.	Larvae minimal	Same as striped bass	Same as striped bass	Brackish	Contact with higher salinities	None - Natural salinity variation at the site exceeds tolerance levels added salinity has no effect	
	Juveniles	Grow rapidly in the brackish water moving to salt water in the fall.	In excess of screening guidelines	None – should be in clearer water to feed.	None	Full	Contact with higher salinities	None	

Table 1: Species vs. Activity: Impact Assessment in the Mixing Channel

Species	Life Stage	Dates Present / Behaviour	Size /Swimming Ability	Intake Concerns	Intake Risk	Salinity Tolerance	Outfall Concerns	Outfall Risk	Mitigation & Monitoring (see end of table)
Catadromous Species									
American eel (*Anguilla rostrata)*	Adult	Year round	In excess of screening minimum requirements	None	Flows within their swimming ability May live in intake rocks	Full	Contact with higher salinities	None	
	Elvers	April/ May/ June Glass eels are 60 to 65mm long when they enter the estuary. Can be present in very large numbers. Most move into freshwater but some will remain in brackish water	Should be able to use the shelter provided by currents in the riprap leaving in reverse flow.	Attracted to freshwater and moving upstream Impinged on intake	Outflow from intake will be of higher salinity and not attractive. Velocities within their swimming ability	Full	Contact with higher salinities	Minimal may enter outfall rock berm. Natural salinity selection they should avoid the area. Needs to be monitored.	1,4 A,B
Marine and Euryhaline Species									
Stickleback species (Family Gasterosteidae) Threespine Fourspine Black spotted Ninespine	All	Stickleback species are present in the Estuary year round. Spawning is generally from April to July in brackish to fresh water.	Minimal	May move into intake	Should be able to use the shelter from the current in the riprap and out flow to avoid impingement	Full	Contact with higher salinities	May enter the rock berm. Should be able to use the velocity cover in the rock to avoid being drawn in to high salinities Needs to be monitored.	1,$ A,B
Winter flounder (*Pseudopleuronectes americanus*)	Adult	Found in the estuary; ascend the Estuary intertidal areas during the flood tide to feed. Bottom feeders and will frequent the site when the salinity is high. Young fish prefer the shallow water and the larger fish sty in deep water.	Good	None	None	Full	Bottom fish could meet the high salinities.	Moderate – they should avoid high salinities. They are in only on the tide to feed	4 A

Table 1: Species vs. Activity: Impact Assessment in the Mixing Channel

Species	Life Stage	Dates Present / Behaviour	Size /Swimming Ability	Intake Concerns	Intake Risk	Salinity Tolerance	Outfall Concerns	Outfall Risk	Mitigation & Monitoring (see end of table)
	Eggs and larvae	Spawning is marine in May the eggs adhere to the bottom but there is a 2.5 to 3.5 month larval drift stage before settling to the bottom.	Larvae minimal	Can not be screened out	None - Should be in full salt water – low presence and will be carried by main current past intake	Full	Contact with higher salinities	None - Minimal contact due to pelagic behaviour	
Smooth flounder (*Pleuronectes putnami*)	Adults	Found in the estuary; ascend the Estuary intertidal areas during the flood tide to feed. Lives on the bottom in shallow waters and can tolerate low salinities.	Good	None but most common flounder expected	None	Full	Bottom fish could meet the high salinities	Moderate – they should avoid high salinities. They are in only on the tide to feed	4 A
	Eggs and larvae	Spawning early spring. Eggs pelagic, fry 3.1 to 3.6 mm long	Eggs none Larvae minimal	Can not be screened out	None - Normally in higher salinity water than at this site	Full	Contact with higher salinities	None - Minimal contact due to pelagic behaviour	
Windowpane	Adults	Found in the estuary; ascend the Estuary intertidal areas during the flood tide to feed. Common in Minas basin considered a dispersion center for young.	Good	None	None- Should be in full salt water present on tide.	Full	Bottom fish could meet the high salinities	minimal	4 A
	Eggs and larvae	Spawning late spring. Eggs pelagic 1 to2mm dia., larvae 2mm at hatch 5.5mm without yolk sac	None to minimal	Can not be screened out	None -Should be in full salt water viable fish should not be present	Full	Contact with higher salinities	Not likely present	
Witch flounder	Adult	Found in the estuary; ascend the Estuary intertidal areas during the flood tide to feed. Normally found in deeper water than at site considered occasional visitor.	Good	None	Should be in full salt water present on tide. Normally in deeper water.	Full	Bottom fish could meet the high salinities	Minimal	4 A
	Eggs and larvae	Spawning March to May eggs pelagic but near bottom in deep water. Larvae pelagic for up to 1 year	Eggs none Larvae minimal	Eggs none in deeper full salt water. Larvae may come in with tide	None Minimal	Full	None – should not be present	None	

Table 1: Species vs. Activity: Impact Assessment in the Mixing Channel

Species	Life Stage	Dates Present / Behaviour	Size /Swimming Ability	Intake Concerns	Intake Risk	Salinity Tolerance	Outfall Concerns	Outfall Risk	Mitigation & Monitoring (see end of table)
Mummichog (*Fundulus heteroclitus*)		Present in the Estuary throughout the year. Prefers areas of vegetation. Sometimes caught in the tide	Fair	Could be drawn in but very occasional visitor	Minimal they should be able to swim out of the riprap.	Full	Rare visitor in this habitat	None – full tolerance and very low numbers.	1 B
	Eggs and larvae	Eggs attaché to vegetation or clam shells Larvae in tidal marshes and algae beds	Eggs adhesive Larvae poor	None not present in this habitat			Not present		
Killifish (*Fundulus diaphanous)*	Adult	Normally a freshwater fish but has full salinity tolerance.	Fair	Could be drawn in	Minimal they should be able to swim out of the riprap.	full	In turbid water should be at surface on the edges of the channel not in contact with higher salinity plume	None	1 B
Atlantic silverside (*Menidia menidia*)		Silversides occur in the Estuary in the spring, summer and fall and anecdotal reports suggest that silversides reach their peak of abundance in late summer in the upper Bay of Fundy and adjoining estuaries.	Good - schooling fish	Able to swim against the intake velocities	None	Full	Contact with higher salinities	None - Position in flows and preference for slower flows will keep them out of high salinity areas	
	Eggs and larvae	Spawning inshore on vegetation in June/July. YOY very small	Eggs attached Larvae poor and pelagic	Could be drawn in to intake	Larvae can not be screened out	Full	Contact with higher salinities	Moderate - Same as other pelagic eggs & larvae	1,2,3,4 A, B.
Atlantic tomcod (*Microgadus tomcod*).		Present in the Estuary throughout the year and may spawn in the area of the proposed discharge and water withdrawal.	Good	None	None	Full	Contact with higher salinities	None- Salinity plume with in tolerance and rocks will keep them out of high areas.	
	Eggs and larvae	Spawning in late early or mid winter. Jan/Feb. Spawning over gravel to sand in fresh to full salt water. Eggs drift long bottom. Hatch in 52 days Larvae survive best in full salt water.	Eggs drift on bottom Larvae in full salt water	Eggs likely by pass the mixing channel velocities to high for spawning. Larvae in mainly in higher salinity water	Minimal Minimal	Fresh to full High to full	Contact with higher salinities	Eggs -Bottom drifters should stay in main channel – in mixing channel may drift into outfall rock berm – needs to be monitored Larvae should be in higher salinity water	1,2,3,4 A, B.

Table 1: Species vs. Activity: Impact Assessment in the Mixing Channel

Species	Life Stage	Dates Present / Behaviour	Size /Swimming Ability	Intake Concerns	Intake Risk	Salinity Tolerance	Outfall Concerns	Outfall Risk	Mitigation & Monitoring (see end of table)
Northern pipefish	All	Present all year. These fish live in marine plant beds and salt marshes and seldom venture out into brackish water. If they approach the site they will be carried in masses of marine plants drifting in the current. The males carry the young	Fair	Not present			Not present		
White perch (*Morone americana*)	Adults	Found in both in brackish and fresh waters and is likely present in the Estuary. White perch spawn from April through June in fresh to low-salinity waters of large rivers over fine gravel or sand. Salinity is too high for spawning at the site. O to 2ppt for eggs and larvae.	Good	None	None	Low	Caught in high salinity	none -- Perch are not likely to be in the area due to the high natural salinities on high tide. Occasional visitor during low salinity periods	
	Eggs and larvae	Not present at site							
Freshwater Species									
Chain pickerel (*Esox niger*)	Adults	Chain pickerel are common in the Shubenacadie-Stewiacke watershed but are likely not commonly found in the vicinity of the site, as their tolerance for high salinity is limited. However, in the eastern United States this species is known to penetrate into brackish waters (Scott and Crossman 1973) and may be present in the Estuary during the ebb tide when salinities are lowest.	Good	None	None	Low	None	None	
Yellow perch (*Perca flavescens*)	Adults	Widely distributed species in freshwater systems and can be found in brackish waters and may be present in the Estuary during ebb tides when salinities are lowest.	Good	None	None	Moderate	None		
Smallmouth bass	Adults	This is a freshwater fish that might reach the site occasionally during times of high river flow.	Good	None	None				

Table 1: Species vs. Activity: Impact Assessment in the Mixing Channel

Species	Life Stage	Dates Present / Behaviour	Size /Swimming Ability	Intake Concerns	Intake Risk	Salinity Tolerance	Outfall Concerns	Outfall Risk	Mitigation & Monitoring (see end of table)
Marine Species									
White hake/ silver hake	All	Marine species may come to the site in high tide as occasional visitors. Eggs and larvae are pelagic near the surface	Adults very good Larvae poor	Eggs& Larvae drawn in with flow	Low Marine fish require high salinities may ride in on the tide	Full	Subject to high salinities	Low – presence very occasional since natural salinity is below or just at survival level.	1,2,3,4 A, B.
Atlantic halibut									
Atlantic cod									
Pollack									
Atlantic menhaden									
Sea raven									
Lumpfish									
Sculpin									
Skates									
Rays									
Spiny dog fish	Adult	Appear in June	Very good	None	None	Full	None	Very occasional visitor at the site	
Atlantic herring	Adult	May come in with the tide	Good in excess of screening guidelines	None	None	Full	None		
	Eggs and larvae	Spring spawning in marine. This site is not in or near a spawning retention area for herring	Unlikely present		None		None		
Atlantic mackerel	Adult	Feeding migration	Very good	Drawn in	None – capable of avoiding intake	Full	Contact with higher salinities	None - high in the water column	
Lobster	Adult/ larvae	Lobsters are concentrated in the deeper areas of the Minas Channel, where strong currents sweep the gravely bottom free of silt	Not present in this habitat						
Soft shelled clams	Adult/ larvae	The most productive clam flats are located along the northern shore of the Basin, particularly between Five Islands and Bass River	Not in this habitat rock bottom channel			Minimum Salinity Range: 8 ppt			
Mussels	Adult	May be present although high saility swings on a tidal basis makes this poor habitat			none			none	
Blood worms	Adult	Live on the mud flats	Not in this habitat						
Corophium		Live on the sandy parts of the mud flats	Not in this habitat						

Table 1: Species vs. Activity: Impact Assessment in the Mixing Channel

Species	Life Stage	Dates Present / Behaviour	Size /Swimming Ability	Intake Concerns	Intake Risk	Salinity Tolerance	Outfall Concerns	Outfall Risk	Mitigation & Monitoring (see end of table)
Zooplankton		Drift with the currents moving in the surface water.	Minimal	Drawn in	Majority will go with the main flows. Some will be drawn in insignificant numbers.	Full	None – near the surface		
Phytoplankton		Drift with the currents moving in the surface water	None	Drawn in	Majority will go with the main flows. Some will be drawn in insignificant numbers.	Full	None – at the surface		
Vascular plants		Minimum Secchi Disk Reading: 80 cm (Tidal fresh) 80 cm (Oligohaline) 100 cm (Mesohaline) There will be some intertidal growth but it is not expected to be affected by the intake or out fall or affect their operations	None			Full	None -		

Monitoring

1. Monitor the water velocities at the intake both in and out to confirm design. Will need to monitor for fish impingement

2. Egg and larvae monitoring in front of the intake, entering the intake, and in the wet well at the pump intake.

3. Egg and larvae sampling for presence and to see if the salinity from the outfall is having a negative effect.

4. Fish behaviour will have to be monitored in the mixing channel to ensure they do not encounter high salinities that affect their survival. Operational changes can be made to lower brining rates, improve mixing, lower or stop brining during low tide when fish would be closer to the outfall. Fish should avoid unfavourable salinities and time exposure will very short as the water mixes

Mitigation

A. There are two options (2 and 3), presented in the Matrix report for the operation of the brine outfall, that include the shut down of the operation during low tide. If monitoring demonstrates the need one of these options will be used for the Brine outfall to prevent fish from contacting high salinities.

B, If monitoring demonstrates the need changes will be made to the intake design or operation including shut down or modification of pumping rates and tidal cycle timing when eggs and larvae are present as needed to prevent entrainment or impingement in significant numbers.

Addendum

<u>Alton Project Cumulative Effect on the Bay of Fundy Prepared by Alton Gas</u>

Conceptual Explanation of Brine Flushing into the Bay of Fundy

In order to conceptually explain the effect of the Alton Project on the Bay of Fundy, the amount of brackish water at the intake site and the amount of brine at the discharge site is being compared to several significant inlets that make up the Bay of Fundy as well as the Bay of Fundy itself.

The methodology for this process was to take tidal flow data collected by Martec, an engineering firm located in Halifax, and data that is readily available from the Department of Fisheries and Oceans and compare it to the 4,500 m^3 of brine with the salinity level of 260 ppt being discharged into the Shubenacadie Estuary. The estimated increase in salinity was calculated using a formula which would use the salinity levels that occur in the different estuaries and inlets at any given time which would then mix/dilute the discharged brine.

<u>Specifically, the Bay of Fundy fills and empties 111,111,000,000 m3 of ocean water per tidal cycle. This volume of water carries with it 3,500,000,000 tonnes of salt.</u>

Shubenacadie River

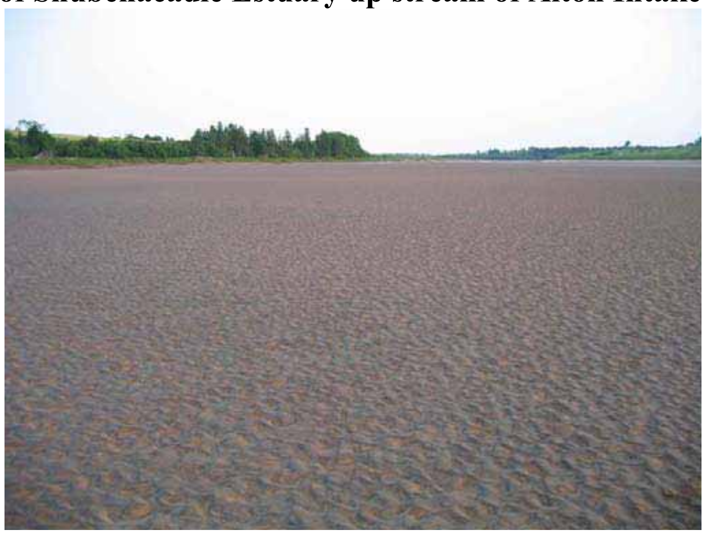
At a maximum brining rate, the Alton Project will inject 5,000 m^3 of brackish water each tidal cycle, into the salt formation to create caverns at the Alton Project storage site, located 12 km from the Alton Project intake and discharge site. At this brining rate, the discharge rate into a pre-mixing pond at the Alton Project discharge site would be 4,500 m^3 of brine with a salinity of 260 ppt. The salinity of the brine discharged into the estuary shall then mimic or mirror to the fullest extent practical, the natural salinity in the river and shall not exceed, in normal operations, 25 ppt, the typical maximum natural salinity. When the natural salinity in the estuary is 25 ppt or higher, the design objective shall be background plus 10% at a point 10 m from the outlet of the brine discharge into the estuary.

At the Alton Project intake and discharge site, the tide ebb flow for the Shubenacadie River was estimated to be 4,042,000 m^3 of water on November 6, 2006 (Martec, Halifax, NS). Based on the estimated tidal water volumes above, the Alton Project discharge site will discharge 4,500 m^3 of brine indirectly into 4,042,000 m^3 of brackish water which is a 898 to 1 mixing ratio. Estimated effect on total salinity at the Alton Project discharge site, assuming total mixing with the tidal flow, is an increase in salinity of approximately 0.278 ppt (Table 1).

Maitland

The tide ebb flow at Maitland, situated at the mouth of the Shubenacadie River (Figure 2), was estimated to be 54,239,000 m^3 on Dec 7, 2006 (Martec, Halifax, NS). On a per tide cycle basis, the Alton Project's discharge of 4,500 m^3 of brine at the discharge site will combine with 54,239,000 m^3 of brackish water resulting in a 12,053 to 1 mixing ratio. Estimated effect on total salinity at Maitland, assuming total mixing with the tidal flow, is approximately 0.0207 ppt (Table 2).

Figure 1: Photo of Shubenacadie Estuary up stream of Alton Intake at low tide.



Cobequid Bay

Comparatively, the flow rate for Cobequid Bay (Figure 2) is 2,446,070,000 m3 of water (http://www.mar.dfo-mpo.gc.ca/science/ocean/ceice/ceice.html) with near ocean salinity levels. On a per tide cycle basis, using only the flushing volume of water out of Cobequid Bay, the Alton Project will discharge 4,500 m^3 of brine into 2,446,070,000 m^3 ocean water a mixing ratio of 543,571 to 1. Estimated effect on total salinity in Cobequid Bay, assuming total mixing with the tidal flow, is approximately 0.00043 ppt for one tidal cycle (Table 3). The total flushing time for Cobequid Bay is 7.2 hours (http://www.mar.dfo-mpo.gc.ca/science/ocean/ceice/ceice.html).

Figure 2: Maitland and Cobequid Bay – Google Earth.

Minas Basin

The Minas Basin (Figure 3) has a flow rate of 17,710,760,000 m^3 of water (http://www.mar.dfo-mpo.gc.ca/science/ocean/ceice/ceice.html) with near ocean salinity levels. On a per tide cycle basis, using only the flushing volume of water out of the Minas Basin, the Alton Project will discharge 4,500 m^3 of brine into 17,710,760,000 m^3 of ocean water resulting in a 3,935,724 to 1 mixing ratio. Estimated effect on total salinity in Minas Basin, assuming total mixing with the tide flow, is approximately 0.000059 ppt (Table 4) for one tidal cycle.

The Minas Basin Flushing time is 32.2 hours. (http://www.mar.dfo-mpo.gc.ca/science/ocean/ceice/ceice.html)

Figure 3: Minas Basin and Bay of Fundy (1998 World-View Digital Imagery Ltd.)

Cumulative effect on the Bay of Fundy

In order to calculate the cumulative effect on the Bay of Fundy, we have assumed that this body of water has had no interaction or mixing with other bodies of water and have used the volume of ocean water which empties out of the Bay of Fundy during one tidal cycle, 111,111,000,000 m^3, with a salinity of 30 ppt.

Twice everyday the Bay of Fundy (Figure 3) fills and empties 111,111,000,000 m^3 of ocean water. On a per tide cycle basis, in using only the flushing volume of water out of the Bay of Fundy, the Alton Project will discharge 4,500 m^3 of brine into 111,111,000,000 m^3 of ocean water. This is a 24,691,333 to 1 mixing ratio or an estimated increase in salinity of 0.00000932 ppt (Table 5) for one tidal cycle.

Using the above methodology, if the Alton Project discharges brine into this above constant body of ocean water for 50 years at a rate of 9,000 m^3 per day (4,500 m^3 x 2 times per day) with a salinity of 260 ppt, 365 days a year, the estimated net increase in the salinity of the above volume of water would be 0.34 ppt, an increase from 30 ppt to 30.34 ppt. Assuming the same methodology the annual net increase would be 0.00679 ppt per year (Table 6).

Given the above flow volumes out of the Bay of Fundy, and the impact on salinities in a constant volume of water with no interaction with a larger body of water, it is clear there will be no long-term cumulative effect of the Alton Project on salinity levels in the Shubenacadie River, Cobequid Bay or Minas Basin or Bay of Fundy.

Summary of Salinity Effects

Intake and discharge site

Ebb flow estimated to be 4,042,000 m^3 of water.
Discharge 4,500 m^3 of brine.
Ratio 898 to 1.
Estimated, increase salinity of approximately 0.278 ppt.

Maitland mouth of the Shubenacadie River

Estimated flow to be 54,239,000 m^3.
Discharge 4,500 m^3 of brine.
Ratio 12,053 to 1.
Estimated effect on total salinity at Maitland, is approximately 0.0207 ppt.

Cobequid Bay

On a per tide cycle basis, using only the flushing volume of water out of Cobequid Bay, 2,446,070,000 m^3.

Discharge 4,500 m^3 of brine.

Ratio 543,571 to 1.

Estimated effect on total salinity in Cobequid Bay, approximately 0.00043 ppt.

Minas Basin

On a per tide cycle basis, using only the flushing volume of water out of the Minas Basin, 17,710,760,000 m^3 of ocean water.

Discharge 4,500 m^3 of brine.

Ratio 3,935,724 to 1.

Estimated affect Minas Basin, is approximately 0.000059 ppt.

Bay of Fundy

On a per tide cycle basis, flushing volume of water 111,111,000,000 m^3 of ocean water.

Discharge 4,500 m^3 of bring.

Ratio 24,691,333 to 1.

Estimated increase in salinity of approximately 0.00000932 ppt.

TABLE 1					
Estimated Change in Salinity at Alton Intake Site Per Tidal Cycle					
Ambient Start PPT	Brine PPT	Brine Vol M3	Target ambient vol. M3	Estimated Increase PPT	Ending Salinity PPT
4	260	4500	4042000	0.284690	4.285007
5	260	4500	4042000	0.283578	5.283894
6	260	4500	4042000	0.282466	6.282781
7	260	4500	4042000	0.281354	7.281667
8	260	4500	4042000	0.280242	8.280554
9	260	4500	4042000	0.279130	9.279441
10	260	4500	4042000	0.278018	10.278328
11	260	4500	4042000	0.276906	11.277214
12	260	4500	4042000	0.275794	12.276101
13	260	4500	4042000	0.274682	13.274988
14	260	4500	4042000	0.273570	14.273874
15	260	4500	4042000	0.272458	15.272761
16	260	4500	4042000	0.271346	16.271648
17	260	4500	4042000	0.270234	17.270534
18	260	4500	4042000	0.269121	18.269421
19	260	4500	4042000	0.268009	19.268308
20	260	4500	4042000	0.266897	20.267194
21	260	4500	4042000	0.265785	21.266081
22	260	4500	4042000	0.264673	22.264968
23	260	4500	4042000	0.263561	23.263855
24	260	4500	4042000	0.262449	24.262741
25	260	4500	4042000	0.261337	25.261628
26	260	4500	4042000	0.260225	26.260515
27	260	4500	4042000	0.259113	27.259401

TABLE 2					
Estimated Change in Salinity at Maitland Per Tidal Cycle					
Ambient Start PPT	Brine PPT	Brine Vol M3	Target ambient vol. M3	Estimated Increase PPT	Ending Salinity PPT
4	260	4500	54239000	0.021238	4.021239
5	260	4500	54239000	0.021155	5.021156
6	260	4500	54239000	0.021072	6.021073
7	260	4500	54239000	0.020989	7.020990
8	260	4500	54239000	0.020906	8.020907
9	260	4500	54239000	0.020823	9.020824
10	260	4500	54239000	0.020740	10.020742
11	260	4500	54239000	0.020657	11.020659
12	260	4500	54239000	0.020574	12.020576
13	260	4500	54239000	0.020491	13.020493
14	260	4500	54239000	0.020408	14.020410
15	260	4500	54239000	0.020325	15.020327
16	260	4500	54239000	0.020242	16.020244
17	260	4500	54239000	0.020159	17.020161
18	260	4500	54239000	0.020076	18.020078
19	260	4500	54239000	0.019993	19.019995
20	260	4500	54239000	0.019910	20.019912
21	260	4500	54239000	0.019827	21.019829
22	260	4500	54239000	0.019744	22.019746
23	260	4500	54239000	0.019661	23.019663
24	260	4500	54239000	0.019578	24.019580
25	260	4500	54239000	0.019495	25.019497
26	260	4500	54239000	0.019412	26.019414
27	260	4500	54239000	0.019330	27.019331

TABLE 3					
Estimated Change in Cobequid Bay Salinity Per Tidal Cycle					
Ambient Start PPT	Brine PPT	Brine Vol M3	Target ambient vol. Mean Tide M3	Estimated Increase PPT	Ending Salinity PPT
24	260	4500	2446070000	0.000434	24.000434
25	260	4500	2446070000	0.000432	25.000432
26	260	4500	2446070000	0.000430	26.000430
27	260	4500	2446070000	0.000429	27.000429
28	260	4500	2446070000	0.000427	28.000427
29	260	4500	2446070000	0.000425	29.000425
30	260	4500	2446070000	0.000423	30.000423
31	260	4500	2446070000	0.000421	31.000421
32	260	4500	2446070000	0.000419	32.000419

** Flushing time 7.2hr

TABLE 2					
Estimated Change in Salinity in Minas Basin (per tidal cycle) Per Tidal Cycle					
River Ambient Start PPT	Brine PPT	Brine Vol M3	Target ambient vol. Mean Tide M3	Estimated Increase PPT	Minas Ending Salinity PPT
24	260	4500	17710760000.0	0.000060	24.000060
25	260	4500	17710760000.0	0.000060	25.000060
26	260	4500	17710760000.0	0.000059	26.000059
27	260	4500	17710760000.0	0.000059	27.000059
28	260	4500	17710760000.0	0.000059	28.000059
29	260	4500	17710760000.0	0.000059	29.000059
30	260	4500	17710760000.0	0.000058	30.000058
31	260	4500	17710760000.0	0.000058	31.000058
32	260	4500	17710760000.0	0.000058	32.000058

** Flushing time 32.2 hr

TABLE 5					
Estimated Change in Bay of Fundy Salinity flushing volume only Per Tidal Cycle					
Ambient Start PPT	Brine PPT	Brine Vol M3	Target ambient vol. Mean Tide M3	Estimated Increase PPT	Ending Salinity PPT
24	260	4500	111111000000	0.0000096	24.0000096
25	260	4500	111111000000	0.0000095	25.0000095
26	260	4500	111111000000	0.0000095	26.0000095
27	260	4500	111111000000	0.0000094	27.0000094
28	260	4500	111111000000	0.0000094	28.0000094
29	260	4500	111111000000	0.0000094	29.0000094
30	260	4500	111111000000	0.0000093	30.0000093
31	260	4500	111111000000	0.0000093	31.0000093
32	260	4500	111111000000	0.0000092	32.0000092

TABLE 6					
Estimated Change in Bay of Fundy Salinity flushing volume only Per 730 Tidal Cycles (1 year) with no flushing					
Ambient Start PPT	Brine PPT	Brine Vol M3	Target ambient vol. Mean Tide M3	Estimated Increase PPT	Ending Salinity PPT
24	260	3285000	111111000000	0.006977	24.006977
25	260	3285000	111111000000	0.006948	25.006948
26	260	3285000	111111000000	0.006918	26.006918
27	260	3285000	111111000000	0.006888	27.006889
28	260	3285000	111111000000	0.006859	28.006859
29	260	3285000	111111000000	0.006829	29.006830
30	260	3285000	111111000000	0.006800	30.006800
31	260	3285000	111111000000	0.006770	31.006770
32	260	3285000	111111000000	0.006741	32.006741

APPENDIX D

Adaptive Management – The Cavern Development Process

Adaptive Management

The reports prepared for the Environmental Assessment (EA) and the Supplemental Information have been prepared using the maximum loading of salt, sediment and the maximum brine flow rate for the full duration of the cavern solution mining process. Due to the cavern development method, the initial flow rate of leach water, and therefore saturated brine, is substantially less than design rates and follows a slow progression. For this reason, an adaptive management approach will be used to mitigate any issues that may arise during cavern development.

The initial flow rate for each cavern will be less than half the design rate and will not reach the full design rate for approximately 16 weeks. When the first cavern well is drilled and available for solution mining, the water system will be commissioned and the mining process commenced. Drilling and completion of the second cavern well will follow, as will the third and fourth well in succession. Drilling, completion and connection construction timing will require a delay of about 6 weeks for each successive cavern to commence solution mining. As a result of this delay, the brine return pipeline will not reach maximum design flow rates until approximately 34 weeks after initial commencement of leaching operations.

When solution mining commences, the cavern volume is very small and the residence time of the leach water in the cavern is very short. Consequently, it does not dissolve enough salt to reach saturation, and the return brine contains much less than saturation volumes of salt. On each cavern, the return brine approaches saturation after approximately 45 weeks of solution mining. The return brine stream is a mixture of the brine from each cavern and therefore will not reach near saturation levels of salt content until the last cavern also reaches near saturation levels.

The first cavern should be fully developed in 96 weeks. At that time, solution mining will be discontinued, and the cavern converted for gas storage operation. De-watering of the cavern will take five weeks, and then that cavern will not contribute brine to the brine return system. The flow of brine will be reduced from that time on, until all four caverns are de-watered.

The result of the above is that the salt delivered to the Shubenacadie estuary will increase over most of the project, and the maximum brine rate and salt load in the brine return will not be reached until the end of solution mining operations. At approximately week 96, the brine flow will begin to decline until week 120, when all 4 caverns are placed in gas storage service. Figure 1 illustrates this scenario assuming the development of 4 caverns each with the capacity of holding 1 billion cubic feet (Bcf) of natural gas.

This development of brine salinity and release rate will allow for the adaptive management of the effects on the biology of the Shubenacadie estuary. Monitoring of the area will identify any adverse conditions that are beginning to develop and will allow for modifications in the operations to mitigate these conditions. These modifications may include modifying the release of brine, optimizing the use of the retention pond for storage and making adjustments to the intake and outlet areas. Regular maintenance could also be scheduled during sensitive times such as the bass spawning period.

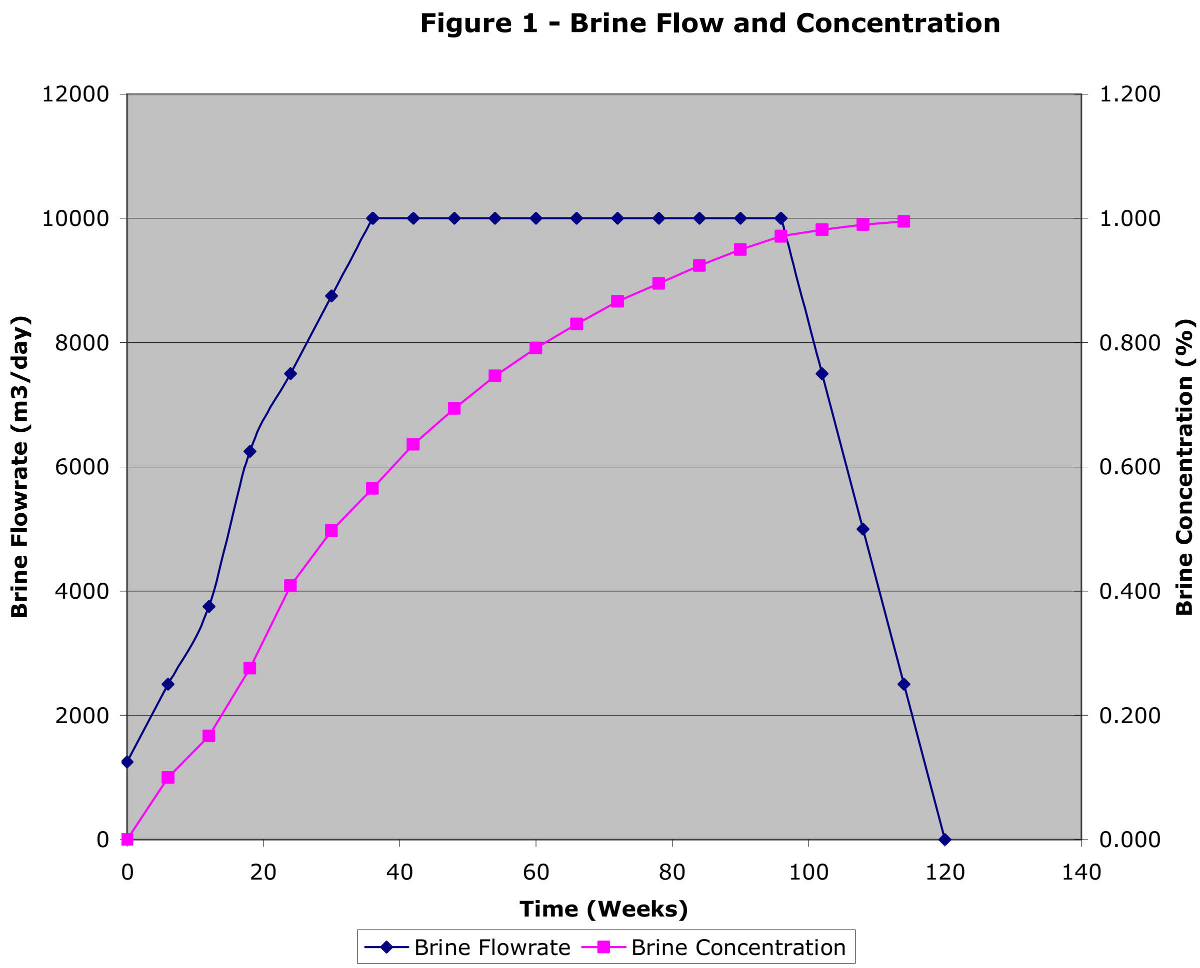


Figure 1 - Brine Flow and Concentration
Brine Flowrate (m3/day)
Brine Concentration (%)
Time (Weeks)
0
2000
4000
6000
8000
10000
12000
0.000
0.200
0.400
0.600
0.800
1.000
1.200
0
20
40
60
80
100
120
140
Brine Flowrate
Brine Concentration

APPENDIX E

Upset Conditions and Emergency Shutdowns

SolTech

Upset Conditions and Emergency Shutdowns

WHAT IF	HOW DETERMINED	IMPACT ON OPERATION	IMPACT ON THE ENVIRONMENT	POTENTIAL MITIGATIVE MEASURES - IF NECESSARY
What if upset conditions took place such as excessive pressure in any of the water or brine lines, excessive flow rate in the well lines.	Detected by sensors through the communication system.	Automatic shutdown of brining process until problem has been identified and resolved.	Due to the immediate detection, there would be no or very limited impact on the environment.	All emergency shutdown valves (ESVs) immediately close automatically, including the leach water supply valves, the brine return valves and nitrogen valves and pumps stop.
What if the pressure in the brine separators (located at each cavern) increase or decrease above normal operating pressures .	The brine separators are equipped with high and low pressure alarms, emergency shutdown valves (ESVs) and pressure safety valves (PSVs). An ESV is considered a switch-type device and is the accepted industry and code standard for over and under pressure protection, or leak protection, for pipelines and wellheads.For pressure vessels of any nature the accepted industry and code standard for over pressure protection is a PSV, which is a simple spring type device that will open and vent in case an over pressure upset.	Automatic shutdown of brining process in affected cavern until problem has been indentified and resolved.	Due to the immediate detection, there would be no or very limited impact on the environment.	Irregular pressures create an automatic shutown of the associated cavern.

Upset Conditions and Emergency Shutdowns

WHAT IF	HOW DETERMINED	IMPACT ON OPERATION	IMPACT ON THE ENVIRONMENT	POTENTIAL MITIGATIVE MEASURES - IF NECESSARY
What if the water pipeline or brine pipeline were to leak?	The pipelines are provided with flow measurement equipment at each end of the pipe line and a line balance calculated.	Automatic shutdown of brining process until problem Is identified and resolved.	Due to the immediate detection, there would be no or very limited impact on the environment.	An abnormal line balance will initiate an alarm and automatic shut down. The proposed leak detection excedes Code requirements.
What if the brine rentention pond levels become too high or too low?	Maximum and minimum levels in the brine pond will be monitored and the flow rate from the brine retention pond to the mixing channel will be measured.	Shutdown of brining process until problem is identified and resolved.	Due to the immediate detection, there would be no or very limited impact on the environment.	Levels in the brine retention pond that exceed high limits will initiate an alarm and automatic shutdown. The same will occur if flow rates from the retention pond to the mixing channel are outside high or low limits although, some zero flow is expected.
What if the levels in the surge tank located at the cavern site were to exceed minimum or maximum levels?	The surge tank contains a level transmitter to provide monitoring and level alarms and a separate set of high and low level switches.	Manual or automated shutdown of brining process until problem has been resolved.	No environmental impact.	The surge tank has a secondary containment dyke and liner that will contain the full volume of the tank in case of a leak.
What if there were to be an unexpected pressure change in the leach water injection pumps?	The pumps are provided with a low inlet and high discharge pressure switches as well as relief valves and wells equipped with flow and pressure transmitters.	Automatic shutdown of brining process until problem has been resolved.	Due to the immediate detection, there would be no or very limited impact on the environment.	The switches initiate an automatic shutdown during abnormal conditions.

Upset Conditions and Emergency Shutdowns

WHAT IF	HOW DETERMINED	IMPACT ON OPERATION	IMPACT ON THE ENVIRONMENT	POTENTIAL MITIGATIVE MEASURES - IF NECESSARY
What if an upset conditioned occurrs that does not have automatic monitoring associated with it?	Detected through visual inspection or other.	Manual shutdown of operation or reduce brining rate until problem has been identified and resolved.	Automated shutdowns are associated with all components which could have an effect on the environment therefore if any other upset condition were to occur, environmental impact would be minimal (i.e. an intruder).	Manual shutdown buttons will be located through the plant in order to initiate a shutdown of the entire plant in case of an emergency. Remote shutdown will also be provided so that any detected abnormal conditionwill allow the operator to initiate a shut-down in the event that the facility is un-manned.
What if there was a natural gas leak at the cavern well or in the gas pipeline?	Cavern wells are equipped with pressure transmitters and the gas pipeline has flow measurement equipement that continuously monitor gas inventory.	Shutdown of operation until problem has been resolved.	Natural gas is lighter than air and therefore any leak will rise and dissipate into the atmosphere minimizing any hazard to biological systems.	Any abnormal pressures will initiate an alarm and shutdown of each cavern by closing the ESVs. Flow measurements in the gas pipeline are automatically compared with cavern pressures to monitor inventory and should the balance be outside set limites, an automatic shutdown is initiated.
What if there is a power outage?	Alarm to operator from emergency and control panels (PLCs).	Pumps will stop.	No environmental impact.	Uniteruptable Power Supply (UPS) for instrumentation, PLCs, communications.
What if a low voltage / brownout occurs?	Alarm to operator from PLC.	Motor control center (MCC) will protect motors on low voltage / brownout. The MCC is the building where all the controls, computers, transformers, etc, associated with turning motors on or off, or controlling the motor speed, are housed.	None expected.	UPS for instrumentation, PLCs, communications.

Upset Conditions and Emergency Shutdowns

WHAT IF	HOW DETERMINED	IMPACT ON OPERATION	IMPACT ON THE ENVIRONMENT	POTENTIAL MITIGATIVE MEASURES - IF NECESSARY
What if the communication system/automated monitoring system fails?	Proposed set up would require automatic communications to check in (poll) regularly. Missed polling would initiate an alarm and possibly an emergency shutdown.	No line balance on pipeline, possible undetected leak.	Possible leak	Emergency and control panels (PLC's) are independant and emergency shtdown system are stand alone. Other redundant systems would mitigate leak potential.
What if there is a hurricane or major winter storm?	Weather forecast / Operational judgement.	Manual shutdown of operation.	No environmental impact.	Proper building and equipment design. Wind and snow loading is covered in basic design.

APPENDIX F

Management of Sediment

Jacques
Whitford

Management of Sediment

The sediment from the Shubenacadie River estuary has been addressed in the design and operational plans of the Alton project incorporating features to address biological concerns such as the protection fish and fish habitat.

The primary mechanism planned for managing sediment and silt at the intake site and mixing channel is through utilizing the hydrodynamics of the estuary flows to reduce deposition of the highly mobile sediment in the channel. An extensive study was undertaken to select an intake site that is on the outside of a gentle river curve, where no silt/sand bars have appeared in aerial photographs from the past 30 years, and where the normal propensity is for erosion rather than deposition. The site is stable because erosion has been blocked by the riprap armour on the riverbank and dyke.

During flood tide, the sediment load in the river increases considerably. Even so, samples have shown that at this time, the solids content is less than 1%, which is not enough to appreciably affect the intake pumps. However, the increased sediment will increase the solids flowing to the cyclone separators. The cyclone separators are designed to handle considerably higher sediment loads still. The net result of increased sediment load in the intake is that there will be a slightly higher power requirement and therefore a slightly higher operating cost for these pumps; this is an operational issue.

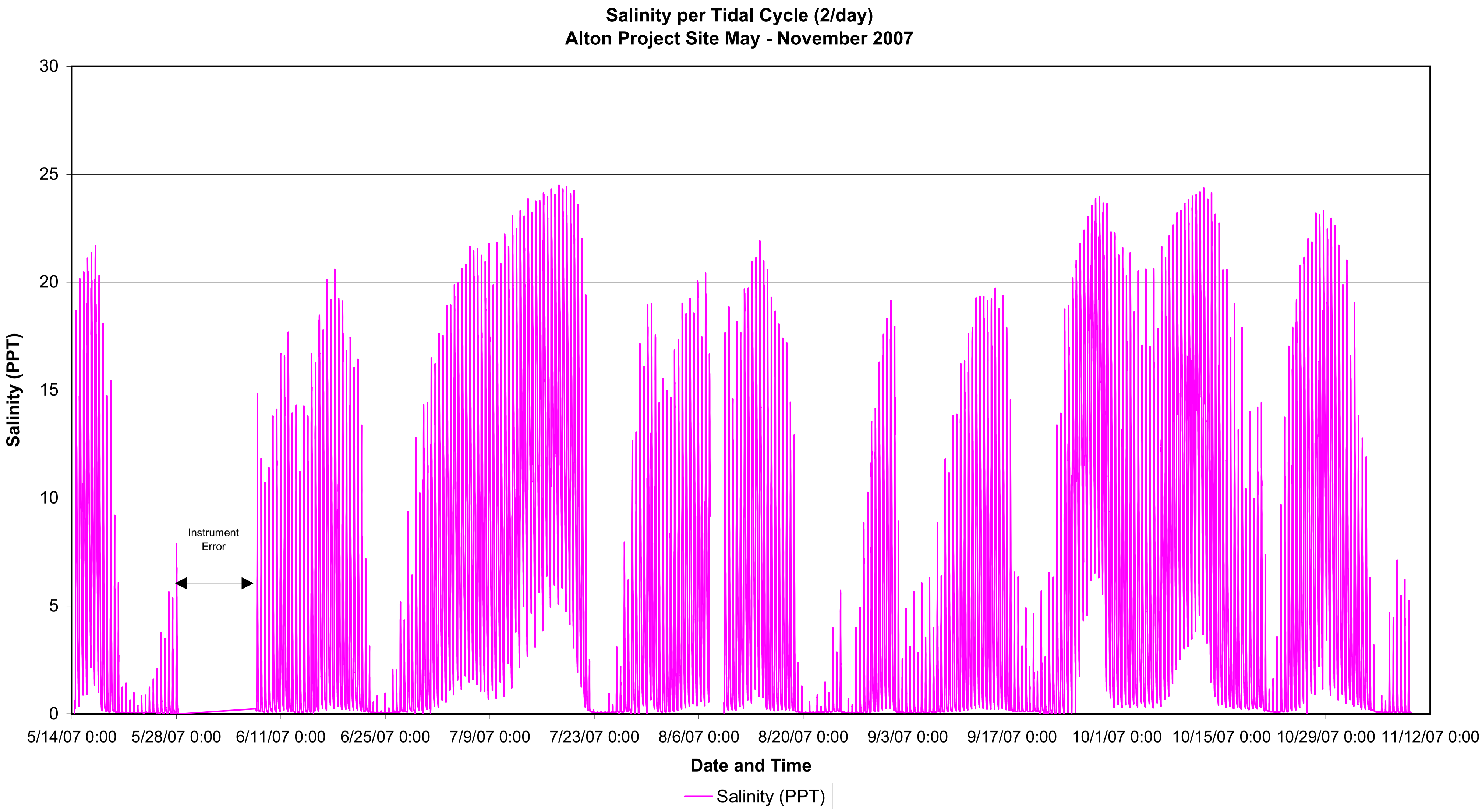
The cyclone separators are designed to remove over 95% of all sediment greater than 20 microns in size. Smaller sediment particles will pass through most downstream equipment. All equipment such as tanks where sedimentation could occur will be provided with “stinger” cleanout connections to allow for lifting and removing sediment, although residence times for settlement are short, precluding the build-up of large amounts in a short time. Any silt that does enter the caverns will settle out due to the long settlement times and very low internal velocity in the cavern. Return brine from the caverns will therefore be very clean and free of sediment. The amount of sediment that remains in the cavern will add approximately 150 to 200 mm of insolubles in the bottom of the cavern and will not cause any operational issues.

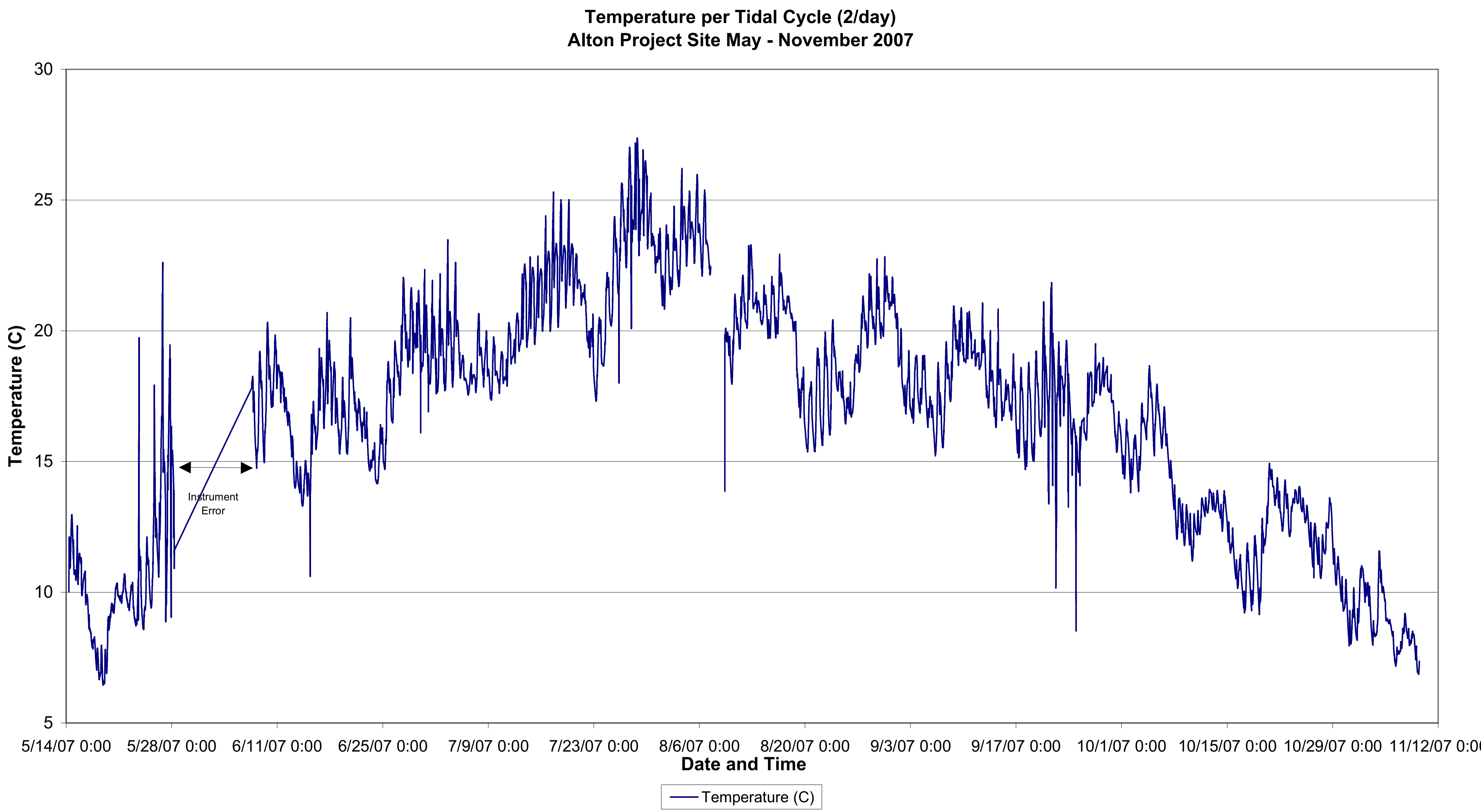
The mixing channel will incorporate features to reduce sedimentation of the mobile silt that enters this area. There may be a need to occasionally remove silt from the mixing channel and intake area. This may be done by a simplified hydraulic dredging system using a stream of river water to lift and mobilize the sediments during times of higher flow in the channel, allowing the current to move it as it typically does naturally.

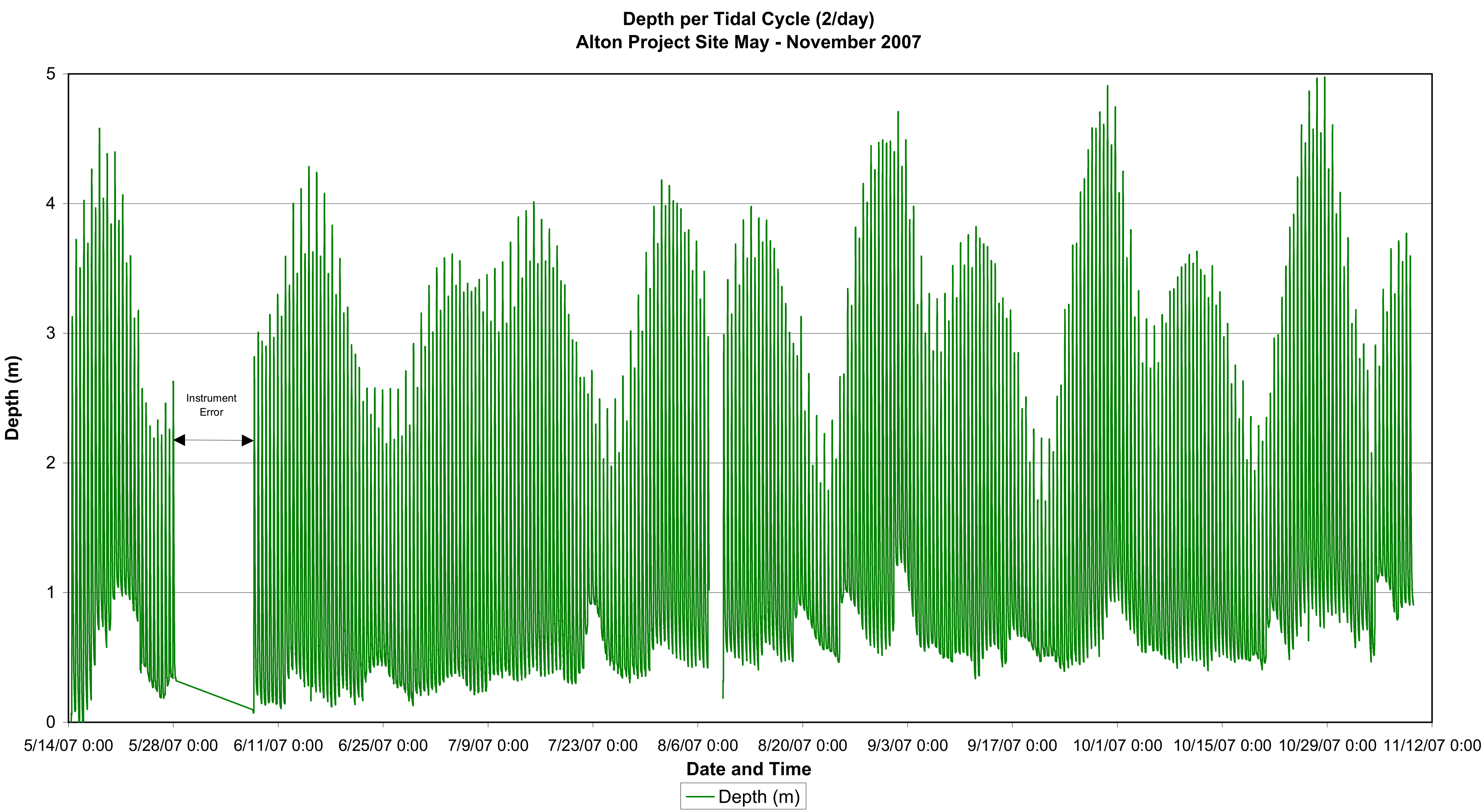
APPENDIX G

Shubenacadie River Monitoring
(Salinity, Depth and Temperature)

Jacques
Whitford


Salinity per Tidal Cycle (2/day)
Alton Project Site May - November 2007
Salinity (PPT)
30
25
20
15
10
5
0
Instrument
Error
5/14/07 0:00
5/28/07 0:00
6/11/07 0:00
6/25/07 0:00
7/9/07 0:00
7/23/07 0:00
8/6/07 0:00
8/20/07 0:00
9/3/07 0:00
9/17/07 0:00
10/1/07 0:00
10/15/07 0:00
10/29/07 0:00
11/12/07 0:00
Date and Time
Salinity (PPT)


Temperature per Tidal Cycle (2/day)
Alton Project Site May - November 2007
Temperature (C)
30
25
20
15
10
5
Instrument Error
5/14/07 0:00
5/28/07 0:00
6/11/07 0:00
6/25/07 0:00
7/9/07 0:00
7/23/07 0:00
8/6/07 0:00
8/20/07 0:00
9/3/07 0:00
9/17/07 0:00
10/1/07 0:00
10/15/07 0:00
10/29/07 0:00
11/12/07 0:00
Date and Time
Temperature (C)


Depth per Tidal Cycle (2/day)
Alton Project Site May - November 2007
Depth (m)
0
1
2
3
4
5
Instrument
Error
5/14/07 0:00
5/28/07 0:00
6/11/07 0:00
6/25/07 0:00
7/9/07 0:00
7/23/07 0:00
8/6/07 0:00
8/20/07 0:00
9/3/07 0:00
9/17/07 0:00
10/1/07 0:00
10/15/07 0:00
10/29/07 0:00
11/12/07 0:00
Date and Time
Depth (m)

APPENDIX H

Heat Transfer Study

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ALTON HEAT TRANSFER STUDY

This report covers the results of a study to determine the likely temperature of brine returning to the Shubenacadie River estuary from the cavern site. An environmental concern was raised that the temperature of the brine that is rejected into the mixing pond could be considerably warmer than the river water. It is ecologically undesirable to reject the water at a temperature that is warmer than the temperature in the estuary because the warmer water may attract fish to an area of relatively high concentration brine, resulting in the possible death of the fish. In response to this concern, SolTech Engineering Inc. (SolTech) performed a study to determine the brine discharge temperature into the estuary.

The Alton Natural Gas Storage project (Alton project) in Nova Scotia involves creating underground storage salt caverns by solution mining. In order to create such a cavern by leaching it is necessary to drill and to case a borehole down to the depth of the salt formation. Water from the Schubenacadie estuary is then injected through the borehole, rock salt is dissolved and a brine-filled cavity is created at the lower end of the borehole. The brine produced is, in turn, returned to the surface by another string, concentrically installed within the well.

Water from the Schubenacadie estuary is transported to the wellsite through 11 km of pipeline that is buried 1.8 m below the surface. On reaching the wellsite it is injected through the borehole, initially, to a depth of approximately 950 m below the surface. The brine produced returns to the surface, where it is pipelined to the brine retention pond via 11 km of pipe buried alongside the intake pipeline. From the brine retention pond it is mixed in a specially constructed channel with freshwater from the estuary to lower its salinity, and is then rejected into the estuary.

For the purpose of the study, the situation was divided into three segments –

- Water intake; water is taken from the estuary and pipelined to the wellsite.
- Water injection/brine withdrawal; water is injected continuously into the borehole while simultaneously withdrawing the brine.
- Brine discharge; return brine from the borehole is pipelined to the mixing pond.

The calculations were performed for "worst case" temperature conditions of the intake water and ground as follows:

- Water Temperature in the Schubenacadie estuary during the summer =22 ^{o}C.
- Water Temperature in the Schubenacadie estuary during the winter =4 ^{o}C.
- Ground Temperature at 1.8 m from the surface =14 ^{o}C in summer; 5 ^{o}C in winter
- Ground Temperature at 950 m from the surface (as measured during the logging of drill hole ALT 06-01) = 23 ^{o}C.

Water from the estuary is withdrawn at the maximum projected rate of 10,000 m^3/day. At the intake segment, calculations were performed to determine the heat transfer between the water flowing through the line and the surrounding ground. Owing to the high velocities of flow in the line it was found that there is almost no heat transferred. The water essentially reaches the wellsite at the same temperature it was at when taken from the river. The same result is valid at the brine discharge segment as well, again, due to the high velocity.

The bulk of the heat transfer to occurs on the way down the borehole, where the injection water and discharge brine flow within concentric tubes which act as a counter current heat exchanger. Based on the worst case scenario that leach water resides in the bottom of the borehole for a 60 day period during which it picks up most of the heat from the surrounding salt and reaches a temperature of 23 ^{o}C, the following results have been obtained:

	Summer	**Winter**
Leach Water Temperature (^{o}C)	22.0	4.0
Discharge Brine Temperature (^{o}C)	22.6	4.6

It was demonstrated that in the concentric wellbore tubes the discharge brine loses almost all of the heat gained at the base of the borehole to the water injected and the return brine temperature is the same within measurable tolerances, as the inlet water temperature.

Another source for temperature gain is the energy added while pumping the water/brine. However, the pump power is low compared with the volume and heat capacity of the water, so the final effect on the temperature is minimal. The results above reflect this increase.

The brine is discharged over a six metre width in the Mixing Channel, into a continuous flow of river water where it mixes quickly. Therefore, it was established in this study that the temperature of the brine discharged will not be measurably higher than the inlet and will not cause harm to the aquatic life in the Schubenacadie estuary.

APPENDIX I

Nitrogen and Oxygen

07/10/25

Oxygen

Water will be drawn from the Shubenacadie River estuary to provide water for brining caverns. The water from this river system is saturated with air due to the turbulence in the river. A vacuum deaerator located at the estuary site will be used as an effective and environmentally way to remove the oxygen before it enters the water pipeline system to the cavern. This removal of Oxygen is required to control corrosion on both the up and downstream equipment and piping.

As a result of using the vacuum deaerator, the return brine will also be devoid of dissolved oxygen which is needed in order to mimic the oxygen levels in the estuary. Alton's facilities will be designed to add air to the brine flow as it leaves the Retention Pond and flows to the Mixing Channel. This will be done by a control valve and flow rate meter in the piping between the Brine Retention Pond and the Mixing Channel that will allow for a controlled volume of air injection to this stream. Excess Oxygen will bubble from the brine distribution piping in the Mixing Channel, adding to turbulence in this area, with the benefit of producing additional mixing of the brine. The final brine stream entering the mixing channel will be near saturation levels for oxygen, mimicking the air saturation of the river.

Nitrogen

A control fluid is required in the formation of a salt cavern to control the development and ensure that the cavern is of ultimate shape and structurally sound. The use of nitrogen for this purpose is recommended, as it is inert and does not constitute an environmental concern if any were to leak. The nitrogen is compressed into the cavern where it stays between the cavern roof and the surface of the brine.

A small amount of nitrogen may be included in the returning brine therefore a nitrogen separator will be installed on the brine return lines for each of the caverns. These separators will allow the total amount of returning brine and nitrogen to be measured, which is critical for the proper monitoring and control of the cavern development as mentioned. The majority of the nitrogen which returns to the surface is removed by the nitrogen separator however any remaining amount will be carried with the brine to the retention pond where additional dissipation of the nitrogen will take place before the brine is mixed in the mixing channel.

APPENDIX J

First Nations and Aborgininal Correspondance

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Fax: 403.264.8365
www.altongas.com

September 9, 2007

Shubenacadie First Nation
522 Church St.
Micmac Post Office
Hants Co., NS B0N 2H0

Dear Chief Sack and Council:

As a follow-up to our previous letter of November 24, 2006, we are providing an update on the Alton Natural Gas Storage Project. As you may already know, on July 6, 2007 we submitted our environmental assessment registration to the Nova Scotia Minister of Environment and Labour for the development of an underground salt cavern facility for storage of natural gas in the Alton area. We have enclosed the latest map outlining the Project components.

You may be aware that a Mi'kmaq Ecological Knowledge Study was conducted. This study consisted of three main components:

- A historical review regarding past Mi'kmaq occupation and use of the area in question;
- Mi'kmaq traditional land and resource use activities, both past and present; and
- A Mi'kmaq significant species analysis, considering the resources which are important to Mi'kmaq use.

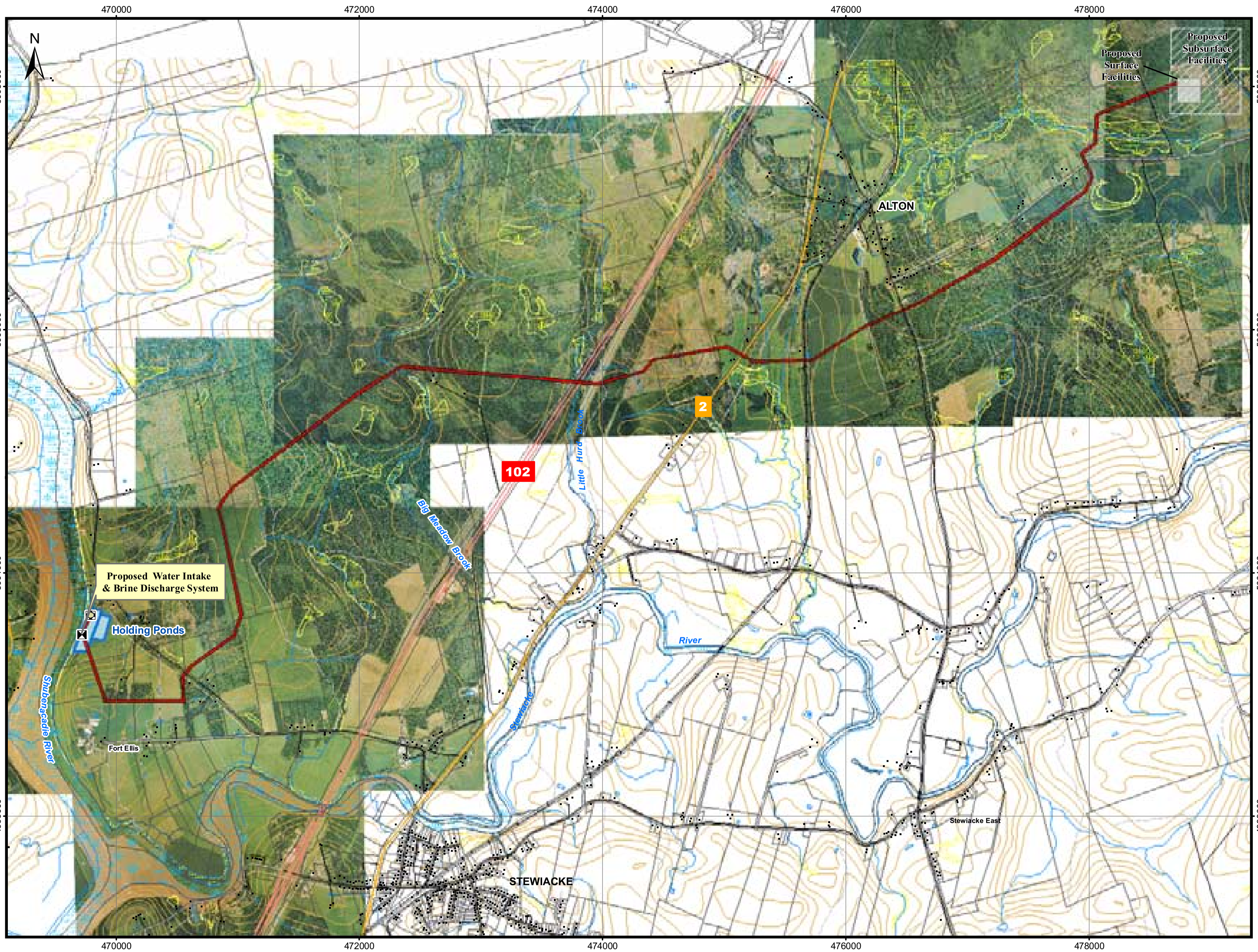
This report was included in the registration document that was filed for public review and can be accessed at www.gov.ns.ca/enla/ea.

On July 31, 2007, the Minister responded with his decision that he requires details and plans for how First Nations issues will be considered in the development and operation of the undertaking. Therefore, we would like an opportunity to meet with you to further share information on the project and to get your feedback. We anticipate completing an environmental assessment supplemental report in October 2007, so it may be appropriate to meet in September. We will follow up with you directly.

I can also be contacted at sgmcdonald@eastlink.ca or on my cell phone at (902) 488-3867.

Sincerely,

Scott McDonald
Project Manager
Alton Natural Gas Storage L.P.



Alton Gas Storage Project

Figure 1.2 Key Project Features

Map Features

- Water Intake
- Brine Discharge
- Building (1997, NSTS, 10k)
- Proposed Pipeline Route (20m ROW)
- Proposed Surface Facilities
- Proposed Subsurface Facilities
- Holding Ponds
- Bridge
- Major Highway
- Collector Highway
- Paved Road
- Unpaved Road
- Rail
- Utility Line
- Contour (5m)
- Watercourse
- Property Boundary

NSDNR Delineated Wetland

- NSDNR Freshwater Wetland
- NSDNR Saltwater Wetland
- Waterbody

Air Photos: Nova Scotia Aerial Photography, 2004

0 250 500 1,000
Metres

Map Parameters
Projection: UTM, NAD83, Zone 20
Scale 1 : 30,000
Date: June 06th, 2007
Project No.: 1012229.

Jacques Whitford

alton
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September 9, 2007

Millbrook First Nation
PO Box 634
Micmac Post Office
Truro, NS B2N 5E5

Dear Chief Paul and Council:

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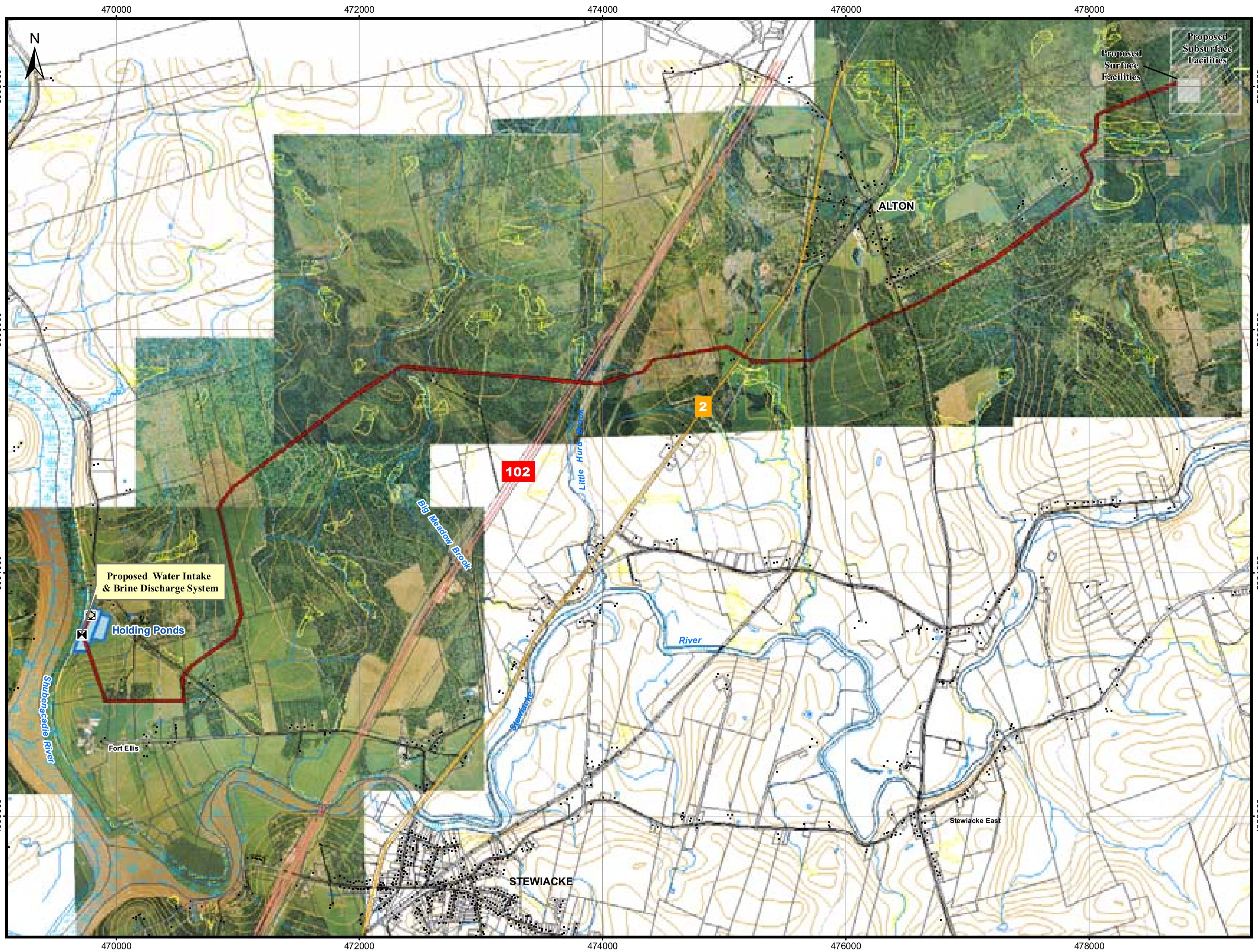

Alton Gas Storage Project

Figure 1.2
Key Project Features

Map Features

- Water Intake
- Brine Discharge
- Building (1997, NSTS, 10k)
- Proposed Pipeline Route (20m ROW)
- Proposed Surface Facilities
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July 26, 2007

Roger Hunka
Director of Aboriginal Intergovernmental Affairs
Maritime Aboriginal Peoples Council
Box 8, 172 Truro Heights Road
RR#1 Truro, Nova Scotia
B2N 5A9

Dear Mr. Hunka,

Thank you for meeting with us yesterday, July 25, 2007. We will continue to work with you and the community on all aspects of the project. We are committed to addressing your concerns on the environmental impact and native access to lands and waters immediately surrounding the proposed project.

Over the past 18 months, we've met with many individuals and organizations in the community as part of our commitment to community consultation; we have held many small meetings; advertised the project and hosted a community open house last fall. We've benefited from all of the input received so far. This input has helped inform our application for regulatory approval, including from discussions with the NS Salmon Association and the Mi'kmaq Ecological Knowledge Study.

We fully intend to continue to meet with you, and your team to keep you abreast of the project. The following are some of the answers to your questions:

1. **Whether the geology of the land would support the pumping process?**

   Extensive geotechnical studies (seismic, drilling) were conducted in the early planning stages to determine that this project was feasible and the geology could not only support underground storage caverns, but also the pumping of water into and out of the caverns.

2. **A fuller understanding of the long term environmental footprint and effects**

   Any residual environmental effects from the Project are fully described in Section 6 of the EA Registration document (*e.g.,* 6.1.7, 6.2.7, 6.3.7, etc).

   Regarding the brining in particular, Alton designed the proposed method of discharge so that the brine is diluted by pumped estuary water prior to being discharged into the Estuary. This will be accomplished by a holding pond and mixing pond which will be used to hold brine, dilute brine with estuary water and control the discharge back to the

Estuary. The diluted brine will be discharged around high tide to minimize the difference in salinity between the effluent and the receiving water body and to maximize the potential for mixing. Modeling results indicate that the salinity of the diluted brine discharged into the Estuary will be within the range of salinities that are normally experienced in the Estuary. This, as well as using relatively small amounts of water, compared to overall flow at the intake site, will minimize any potential impact on the aquatic environment. We have also committed to shut down brining if there are striped bass eggs detected at the discharge site.

The project is still subject to ongoing monitoring (*e.g.,* salinity) and management planning (*e.g.,* Environmental Management Plan and Environmental Protection Plan), as will be subject to additional environmental approvals such as a Water Approval and an Industrial Approval. In these approval applications, the technical details will be addressed in greater detail.

3. The actual composition of the discharge

From Section 6.1.5.1

Brine Discharge

The salt caverns that will be subject to solution mining consist predominantly of crystalline sodium chloride; however, other elements are also present, albeit at low levels. In order to quantify the risk of other elements eliciting toxic effects to fish and other aquatic organisms when discharged as diluted brine, a sample of the salt core was dissolved in distilled water and levels of metals were measured. The tested solution was prepared to mimic the discharge; saturated brine made by dissolving a sample of the salt core into distilled water (260 ppt) was diluted with distilled water so that the tested solution has a salinity of 26 ppt, which equates to approximately 10:1 dilution (distilled water to saturated brine). Total and available metals in the prepared solution were measured by Maxxam Analytical Laboratories. No exceptionally high levels of metals in the salt core were indicated and thus the present analytical results give a rough indicator of the potential risk that other metals in the salt-core pose to aquatic receptors (Table 6.1). However, as detection limits were above CCME guidelines in some cases the results of toxicity testing of the diluted brine on representative organisms will be important in further understanding the risk that metals in the discharge pose to aquatic receptors. The specifics of this toxicity testing program will be developed in consultation with regulators, most notably Environment Canada, see Section 6.1.6 for more discussion on this topic.

TABLE 6.1 Element Levels in Diluted (10:1) Brine

Elements	Units	Reported Level	Detection Level	CCME (Freshwater/ Marine)
Total Aluminum (Al)	ug/L	ND	100	5-100/NA
Total Arsenic (As)	ug/L	ND	0.1	5/12.5
Total Antimony (Sb)	ug/L	ND	20	160[a]
Total Barium (Ba)	ug/L	ND	50	4.0[a]
Total Beryllium (Be)	ug/L	ND	20	0.53[a]
Total Bismuth (Bi)	ug/L	ND	20	NA
Total Boron (B)	ug/L	ND	50	750[a]
Total Cadmium (Cd)	ug/L	ND	3	0.017/0.12
Total Chromium (Cr)	ug/L	ND	20	8.9/56
Total Cobalt (Co)	ug/L	ND	10	23[a]
Total Copper (Cu)	ug/L	ND	20	2-4/NA
Total Iron (Fe)	ug/L	ND	500	300/NA
Total Lead (Pb)	ug/L	ND	5	1-7/NA
Total Lithium (Li)	ug/L	ND	20	14[a]
Total Manganese (Mn)	ug/L	ND	20	120[a]
Total Molybdenum (Mo)	ug/L	ND	20	73/NA
Total Nickel (Ni)	ug/L	ND	20	25-150
Total Selenium (Se)	ug/L	ND	50	0.1/NA
Total Strontium (Sr)	ug/L	180	50	1500[a]
Total Thallium (Tl)	ug/L	ND	1	0.8/NA
Total Tin (Sn)	ug/L	ND	20	73[a]
Total Titanium (Ti)	ug/L	ND	20	NA
Total Uranium (U)	ug/L	ND	1	2.6[a]
Total Vanadium (V)	ug/L	ND	20	20[a]
Total Zinc (Zn)	ug/L	ND	50	300/NA
Available Cadmium (Cd)	ug/L	ND	0.1	See below*
Available Chromium (Cr)	ug/L	ND	0.5	See below*
Available Cobalt (Co)	ug/L	ND	0.1	NA
Available Copper (Cu)	ug/L	0.3	0.1	See below*
Available Iron (Fe)	ug/L	17	1	See below*
Available Lead (Pb)	ug/L	0.2	0.1	See below*
Available Manganese (Mn)	ug/L	2	1	NA
Available Nickel (Ni)	ug/L	ND	0.5	25-150/NA
Available Zinc (Zn)	ug/L	ND	1	See below*

*CCME Guidelines pertain to total metal levels

[a] Toxicity Reference Value (TRV) stipulated by the Environmental Restoration Division (ERD) of the US EPA

ND: Not detected, *i.e.,* levels below detection level

NA: No level stipulated by CCME or ERD

4. Access limitations on the land for hunting and fishing

From Section 6.4.4:

There may be short-term reduction in access to hunting, fishing, ATV/snowmobile use during construction, but Alton will be working with landowners to ensure disturbance is kept to a minimum. ATV use or other access along the water pipeline RoW may be restricted at the landowner's request. Permanent restriction to access will be required for safety and security purposes around the gas storage and brine management facilities.

5. Clarity on the salinity levels after the discharge of the brine into the Estuary (questioned reference to only 4 tests)

Alton is currently undertaking an extensive salinity monitoring program near the discharge site to refine its knowledge of fluctuating salinities over normal tidal cycles. However, Alton is confident that the brine management system will be able to successfully control discharge of diluted brine to minimize impacts on the aquatic ecosystem as described in detail in Section 6.1 of the EA Registration.

(From Appendix H, Disposition Table Comment EC-SZ-03): The Proponent will also be conducting the monitoring of salinity levels in diluted brine discharged to the Estuary during the brining stage of the Project and results will be made available to regulators for review. Discharge will be continuously monitored to ensure that salinity of the diluted brine does not exceed 25 ppt. Altering volumes of brine pumped into the mixing pond or temporary shut-down of brining will occur if salinity of diluted brine discharged to the Estuary exceeds 25 ppt. The details of the monitoring program of the diluted brine discharge, including protocols for reporting results and measures that will be taken if salinity exceeds 25 ppt, will be determined as part of the Industrial Approval Application.

In closing, we want to assure you that we want our project to be compliant with Nova Scotia's Green Policy. The Alton Natural Gas storage project will be developed in full consideration of environmental issues. The Project is designed to be constructed according to regulatory and modern industry standards including standards established by the Canadian Standards Association for this technology. All equipment used for the project will comply with state and federal regulations.

You can visit altongas.com for more information on the safety of salt caverns and our environmental considerations. Please advise us as to a suitable date and time for meetings with you and your team to continue our discussions.

Respectfully,

SCOTT G. MCDONALD

Scott MacDonald
Project Manager

CC:Chief Grace Conrad, Chief and President, NCNS

Tim Martin, Commissioner, Netukulimkewe'lCommission, NCNS
Honourable Mark Parent, Nova Scotia Minister of Environment and Labour
Peter Geddes, Environmental Assessment Officer, NSDE&L
Melanie MacLean, Habitat Assessment Biologist, Fisheries and Oceans Canada – Maritimes Region
Bob MacGregor, Senior Policy Advisor, Office of the Federal Interlocutor
Steve Wilson, Co-Chair, inner Bay of Fundy Atlantic Salmon Recovery Team
Joshua McNeely, Regional Facilitator, Ikanawtiket
Amada Facey, Oceans and Aquatic Resources Biologist, Maritime Aboriginal Aquatic Resources Secretatiat

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November 2, 2007

Shubenacadie First Nation
522 Church St.
Micmac Post Office
Hants Co., NS B0N 2H0

Dear Chief Sack and Council:

As a follow-up to our previous letters of November 24, 2006 and September 9, 2007, we are completing an environmental assessment supplemental report to our July 6, 2007 environmental assessment registration to the Nova Scotia Minister of Environment and Labour for the development of an underground salt cavern facility for storage of natural gas in the Alton area.

I plan to be in Nova Scotia during the week of November 12, 2007 and would welcome the opportunity to meet with you and Council to further share information on the project and to get your feedback. I can be contacted at david@landis.ca or on my cell phone at (403) 701-2118.

Sincerely,

David Birkett
President
Alton Natural Gas Storage L.P.

alton
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