St. Lawrence Ore Storage Facility
Project Plan

Delta Consultants

Where Experience Makes the Difference

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SNC·LAVALIN BAE-Newplan

February 2, 2011

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Mr. Ray Bailey, P.Eng. & Mr. Nick Gillis, P.Eng.
SNC-Lavalin/BAE-Newplan Group Ltd.
1133 Topsail Road
Mount Pearl, NL
A1N 5G2

Subject: *Civil Engineering 8700 Project Work Plan*

Dear Mr. Bailey and Mr. Gillis,

The following document is a project work plan for the design of the St. Lawrence Ore Storage Facility as part of the Civil Engineering Project course at Memorial University.

This project plan is comprised of a thorough project description and statement of project requirements as as previously discussed with SNC Lavalin. The methodology indicates how the project will be completed, including a schedule, milestones and tasks assigned to each team member. We have also included a summary of the estimated costs, deliverables and anticipated risks to be encountered.

If there are any questions or concerns regarding any aspect of this plan please do not hesitate to contact us.

Thank you for allowing Delta Consultants undertake the design of this project.

Yours Sincerely,

Allan Linegar
Project Manager

cc: Steve Bruneau, Ph.D, P.Eng.

Table of Contents

1 Project Description

SNC-Lavalin/BAE-Newplan Group (hereby known as “the client”) is a consulting company based in Newfoundland and Labrador providing multi-disciplinary engineering services throughout Atlantic Canada as well as throughout the nation. They offer consulting engineering in Heavy Civil, Structural Engineering, Environmental, Mining, etc.

One area in which the client is heavily involved is the St. Lawrence Fluorspar Mine located on the southeast coast of the Burin Peninsula. The first discovery of Fluorspar took place in 1931, in which the entrepreneur was very much interested in the non-metallic ore components present in this deposit. Fluorspar is a component used to manufacture such things as, aluminium, glass and the refrigerant Freon. At the time of discovery it was said that St. Lawrence held the largest fluorspar deposit in North America.

The client is currently developing a storage facility to store this filter cake material. As consultants our duty is to investigate structure type and shape for this facility and provide a detailed design and a cost estimate, noting that the annual production rate for the mine is 12,000 tonnes/yr with the possibility of a production rate of 18,000 tonnes/yr in the future.

The proposed location for this storage facility is the southeast corner of the site highlighted in red on the aerial view in Figure 1.1. As the mine is situated on the coastline, as seen in Figure 1.2, wind in this area is said to reach highs of up 160 km/hr. In addition to the wind, other climatic conditions such as heavy rain and snow must be taken into consideration due to the impact it may have on the structures stability. Delta Consultants is tasked to design a structure with a 25 yr design life to withstand these climatic conditions, which in the end will provide the best storage environment for this filter cake material.

Figure 1.1 - Aerial view of project site (c/o Google Earth)

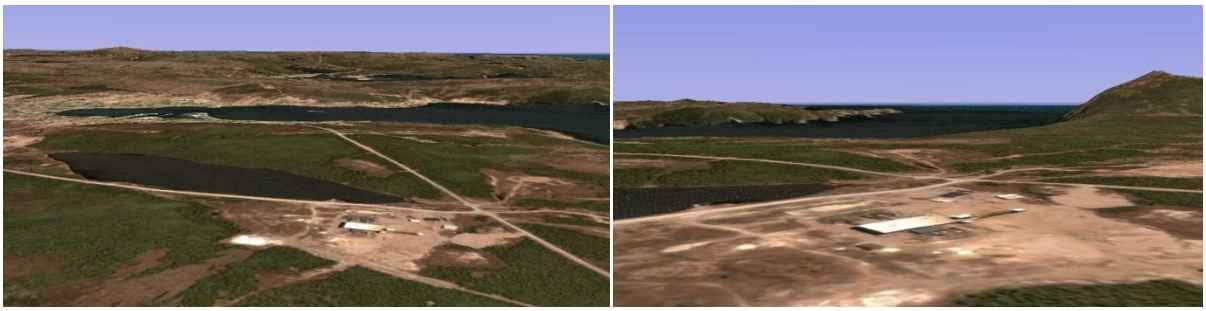

Figure 1.2 - Project site looking NE (left) and SE (right) (c/o Google Earth)

Due to its powder-like texture it is important that fluorspar is protected from contamination during transportation from mine to storage or storage to shipping. A materials handling system must be implemented in addition to the actual structure to transport ore into and out of the facility.

2 Statement of Project Requirements

Delta Consultants (DC) is responsible for providing SNC Lavalin/BAE-Newplan Group with the design for a facility to store filter cake material from the St. Lawrence Fluorspar mine. Various structure types must be investigated and evaluated with the most attractive option moving on to the preliminary design phase. Structural analysis, AutoCAD drawings, and a cost estimate will also be required for this option. Following all design work the completed package will be provided by Delta Consultants.

3 Methodology

3.1 Overview

The strategy to be employed by Delta Consultants in completing the St. Lawrence Ore Storage Facility Project will be a focus on comprehensive research and quality design work, covering all options to deliver the best possible recommendation to fulfill the needs of the client. A wide variety of work experience and new eyes and minds to the consulting industry will result in a range of traditional and non-traditional solutions to the problem presented. Guidance is readily available through several sources for all areas of non-certainty and inexperience in the group, ensuring a quality final product and a vast learning experience for all involved.

3.2 Individual Roles

Team members and their assigned roles can be found below. Roles were assigned following a discussion of individual strengths and interests, optimizing efficiency and productivity for the project.

Allan Linegar – Project Manager

- Provide leadership to ensure project deliverables are completed on-time and on-target
- Principle MS Excel and MS PowerPoint work
- Principle structural analysis work

Leah Barbour – Research Lead

- Lead research effort to ensure thorough and comprehensive search for information
- Lead report editor
- Lead cost estimator
- Principle AutoCAD work

Andrea Abbott – Design Lead

- Lead project through design phase and ensure all client requirements are met
- Lead report writer
- Record minutes of meetings
- Principle MS Project work

3.3 Organization and Communication

Organization and communication are key to overall productivity and project quality. A team email account was created for all communication with the client and professors so all team members have access to all correspondence pertaining to the project. Scheduled team meetings will be accompanied by frequent impromptu meetings to ensure constant alignment among members of current activities. A “Dropbox”, which will be accessible to all team

members, will be utilized to contain all important documentation ensuring that the most up-to-date information is available online at all times. Individual log books will be kept by each team member for complete documentation of all project activities.

3.4 Client Interaction

The client has provided a detailed scope of work to be completed and will provide guidance as needed to assist Delta Consultants in achieving the desired outcomes. In the early weeks of the project a weekly meeting will be held at the client's office to give progress updates and receive guidance. In the later stages a bi-weekly meeting schedule may be adopted. When information is needed between meetings communication with the client will be conducted primarily through email, with phone conversations reserved only for crucial matters.

3.5 Research Approach

Research will begin with a brainstorming session between all team members to identify all possibly structure types and construction materials. The research lead will then take this list and begin preliminary research, which will cover all options and possibly identify others. Detailed research will follow for options that show potential for his project. This is discussed in more detail in Section 4.1.

The strategy to be adopted for research will be to explore not only ore storage facilities used in other mining operations around the world, but also structures of similar shape, size, or applications. These include warehouses, airplane hangars, concrete or grain silos, inflatable tennis courts, etc. This approach will give the widest possible range of options and could possibly identify a creative solution to the problem presented.

3.6 Design Approach

The most desirable option identified by through research will undergo preliminary design. A "cold eyes" approach will allow for a fair comparison of all ideas. Options that are obviously not appropriate for this application will be discarded while new and creative ideas will be given equal consideration as more traditional approaches to the problem. Specific tasks in the design process are discussed further in Section 4.2.

While mining operations and storage structures have existed on this site in the past, all existing infrastructure has been or will be demolished, removing the option of integrating and existing buildings into the design. The location of the site has been chosen by the client because of its proximity to the process facilities and seaport and distance from the neighbouring town of St. Lawrence. A proposal will not be made to move this site to improve economics of the storage facility as this would likely have a large detrimental effect on the economics of other operations.

3.7 Cost Estimation

A cost estimate of the structure will be conducted based on the preliminary design developed. Material and quantity takeoffs will be calculated by Delta Consultants while the client will provide costing information. Experience in cost estimation was gained by all group members through ENGI 8749 – Construction Planning, Equipment, and Methods taught by Dr. Amgad Hussein.

3.8 Desired Outcomes

As discussed in the previous sections the desired outcomes for this project can be summarized with the following points:

- Preliminary research into all possibilities leading into detailed research into the most promising options
- Preliminary and detailed design of the most likely solution, with the selection fully justified by detailed research.
- Cost estimates of the chosen design

Upon completion of these outcomes, the needs of the client should be satisfied, the members of the group will have gained invaluable experience which can be applied to future projects, and the requirements for ENGI 8700 will be met.

3.9 Troubleshooting

As this is largely a new endeavour for Delta Consultants, some significant challenges are being anticipated. Strategies have been developed as solutions to these challenges and are presented in Table 3.1 below.

Table 3.1 – Challenges and Strategies

Challenge	Strategy
Lack of general knowledge of possible structure types	• Speak with engineers and professors for guidance on available structures • Extensive research into general structures with similar functions, rather than ore storage facilities alone
Geotechnical data availability	• If no site specific geotechnical data is available, consult with the client for general values to use in design
Experience with structural software	• Utilize online tutorials and user's manuals • Seek guidance from Dr. Hussein and Dr. Adluri if required

4 Tasks

The St. Lawrence Ore Storage Facility Project can be divided into a set of specific tasks, shown below. These tasks will be described in detail in the following sections.

1. Preliminary Research
2. Detailed Research
3. Structure Selection
4. Preliminary Design
5. Detailed Design
6. Cost Estimate
7. Final Design Recommendation

4.1 Research and Structure Selection

Encompassing Tasks 1-3 in the list above, comprehensive and detailed research will lead to a set of possible options to satisfy the needs of the client. A selection process will identify the two most attractive options, which will then enter preliminary design.

Research will be conducted in three stages: brainstorming, preliminary research and detailed research. During brainstorming a list of all possible structure types and construction materials will be generated, leading directly to preliminary research which will highlight promising options for the application described by the client. Identifying all options will allow for the identification of creative solutions rather than focusing mainly on traditional structure types.

Detailed research will be performed on options that show potential to fulfill the project requirements. This list will be generated by analysing the cost, constructability, and durability of all options. Following detailed research a selection matrix, shown in Figure 4.1, will be generated to aid in identifying the two most promising structures and provide justification in their selection. These structures will enter the preliminary design phase.

Criteria	Cost		Durability		Constructability		Operability		
Weight	40%		20%		20%		20%		
	Value	Weighted Value	Value	Weighted Value	Value	Weighted Value	Value	Weighted Value	Total
Option 1									
Option 2									
Option 3									
Option 4									

Figure 4.1 - Selection Matrix

The internet will act as the primary source of information for this project. Searches will identify structures that have been constructed for similar purposes. A literature search at the

Queen Elizabeth II Library will be conducted to cover any publications that may be related to the subject matter.

Research will be lead by Leah Barbour with preliminary and detailed research each allocated one week, ending February 2, 2011.

4.2 Preliminary Design

A preliminary design will be generated for the most promising option identified through research. Several subtasks must be undertaken to complete preliminary design, including:

- Site layout
- Determination of environmental loads
- Secondary details
- Structural analysis

All design work will be lead by Andrea Abbott with 4 weeks allocated to preliminary design.

4.2.1 Site Layout

A map of the mine site, provided by the client, will be used in choosing the appropriate placement of the ore storage facility. Considerations into the location will be made for accessibility, earthwork, and safety related to the paths of the dump trucks. Following selection, drawings will be generated using AutoCAD to illustrate the location of the proposed facility.

4.2.2 Determination of Environmental Loads

Designing the structure for the appropriate environmental loading is an extremely important element of this project. The site is located on a very exposed area near the Atlantic Ocean and will possibly be exposed to extreme wind and snow loads. Weather conditions for the area will be taken from the National Building Code of Canada, 2005 (NBC) for Grand Bank, which has been selected as an acceptable substitute as there are no published conditions for the area of St. Lawrence. Appropriate calculation and application of these loads will be performed as prescribed in the NBC and as taught in ENGI 8705 – Structural Building Systems, a course currently being taken by all group members. Guidance in applying these loads will be sought from the client as well as the professor for the course, Dr. Amgad Hussein.

4.2.3 Structural Design

All structural design will conform to the Concrete Design Handbook and Handbook of Steel Construction for steel and concrete, respectively, as well as the National Building Code of Canada. This design will be performed using what was learned in the relevant concrete and

steel courses taken by the group, as well as through guidance received from the client and various professors.

4.3 Detailed Design

Detailed design will include considerations into several secondary factors when designing the structure, including:

- Weather-Proof System
- Ore Transportation Systems
- Loading Bay and Entrances/Exits

An important characteristic of the storage facility is that it be completely enclosed from the elements and that all operations are self-contained. There is a concern with contamination of the fluorspar contained in the building, that being from water, wind carried debris, dirt from transportation vehicles, etc., so the design must reflect this concern. Features that will be included to meet this requirement include a weather-proof outer skin, a sufficient drainage system, and a loading area that includes a loading bay at a different elevation than the main facility to prevent transfer of debris from the truck tires to the wheels of the front-end loader, if that loading system is chosen. The entrance and exit doors will be designed to open and close quickly and will possibly have another form of weather deterrent while open, such as hanging strips of plastic or rubber.

The method of conveying ore into and out of the building will need to be chosen before any major design work is conducted, as it will likely have a significant impact on the final design. To get ore into the building some of the options to consider include a horizontal tripper conveyor, angled conveyor and gravity feed, and utilizing front-end loaders. The option chosen will have an effect on building shape and size, and may have an impact on the structural system. For example a conveyor system will need to be supported by or suspended by a frame, or by the roof of the structure itself. Options for conveying ore for transportation out of the facility include front-end loaders or an auger or conveyor system to automatically feed ore to the trucks. This choice will impact the loading area of the facility and must be given careful consideration.

Selection of these options must include consideration of ore production rates, conveyor loading capacities, front-end loader sizes and loading rates, and truck sizes and frequency. It would be undesirable for the ore storage facility to be a pinch point in the entire mining process, so these systems must be designed with sufficient capacities to handle the required ore throughput.

Trucks will be used to transport ore from the facility, requiring a separate area for loading and a large entrance and exit. Considerations into how the ore will be loaded into the trucks and where the entrance and exit will be placed may have an impact on the chosen design. Certain designs may present challenges in door placement, such as an A-frame warehouse type structure, while others may be simplified with a separate connected structure for loading, such as an inflatable or fabric facility. The paths of these trucks around the site will be

considered to maximize mobility and safety.

While the design of the HVAC system for the facility will not be required, space must be allocated for it and the structure must be able to handle the additional loading upon installation. The facility will be containing front-end loaders and trucks, so sufficient ventilation and/or air filtration system must be included to protect occupants from hazardous vehicle exhaust as well as dust created by the fluorspar.

As previously stated, all design work is to be lead by Andrea Abbott with 4 weeks allocated to detailed design.

4.3.1 Structural Analysis

Following preliminary design, structural analysis will be performed using S-Frame structural software. The appropriate environmental loading will be applied and all load cases will be considered to ensure the structure will be able to withstand the harsh environment in St. Lawrence. Experience with S-Frame was gained by all group members in the courses ENGI 6705 – Structural Analysis I and ENGI 7704 – Design of Steel Structures. Further guidance into model construction and analysis will be through Dr. Amgad Hussein.

Model construction and analysis is expected to take approximately 2 weeks and will be performed by Allan Linegar.

4.3.2 AutoCAD drawings

Following structural analysis, a set of AutoCAD drawings will be generated to illustrate the site layout as well as elevations and cross-sections of the structure. This task will be lead by Leah Barbour and is expected to take approximately 2 weeks.

4.4 Cost Estimate

Following structural analysis and development of drawings, a cost estimate will be performed on the chosen design. Material and quantity takeoffs will be calculated from these drawings and, using cost information provided by the client, an estimate will be developed. This task will be lead by Leah Barbour and is allocated 2 weeks of time to complete.

4.5 Final Report

The final product of this project will be the final report outlining the proposed design in detail. This package will include a summary of all research with justification into the chosen structure, all preliminary and detailed design work, a set of AutoCAD drawings for the site layout and elevations and cross-sections of the structure, cost estimate, and a report on the structural analysis performed. The report will likely be continuously updated throughout the

entirety of the project with the final 2 weeks dedicated solely to its completion. It is to be submitted to the client as well as Dr. Steve Bruneau.

5 Schedule

A Gantt chart has been created in MS Project 2003 to outline a schedule of tasks and milestones in guiding an efficient design process. Delta Consultants will follow the schedule through project execution and submission.

The schedule, as shown in Figure 5.1, summarizes the entire course of the project beginning on January 19, 2011 which marked our first meeting with the client. However, these durations are considered tentative and other tasks maybe appended.

Dates shaded in gray represent non-working days which include weekends, other commitments and holidays. However, these days will be treated as working days depending on time constraints for any component of the project.

Any other schedule revisions completed throughout the course of the project will be made only if necessary.

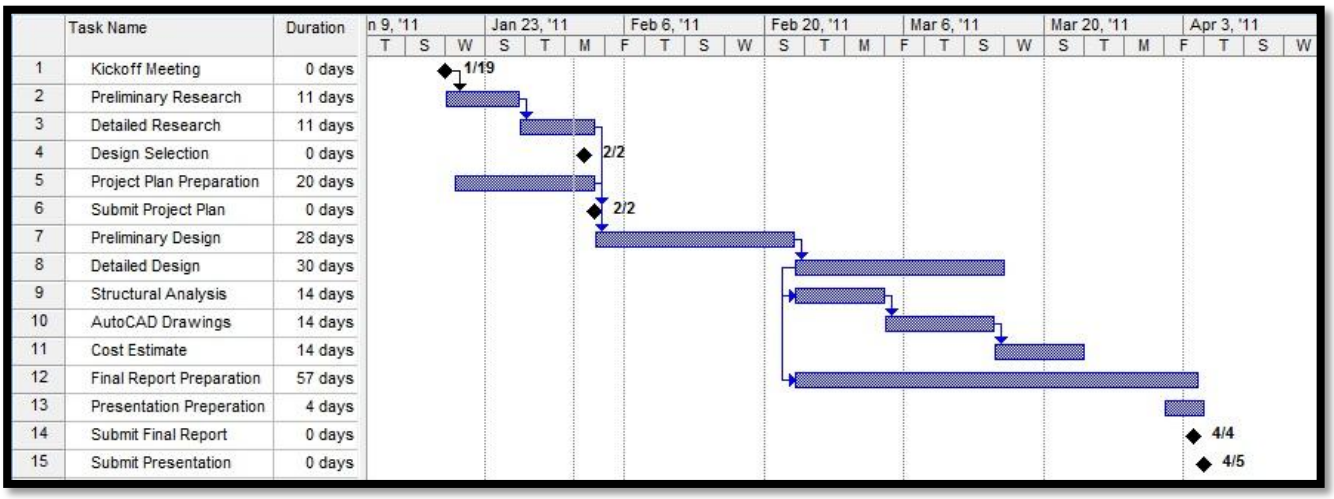

Figure 5.1 Project Schedule

6 Costs

Costs associated with the project execution will mainly consist of office supplies for report submissions and fuel costs to visit the client for weekly/biweekly meetings. This work plan report along with the final report submission will be printed and bound, while a project binder will be kept throughout the term. Meetings with the client are arranged to be weekly to begin our project, however, will change to a biweekly arrangement during the designing phase. A break down of the associated costs is provided in Table 6.1 below.

Table 6.1 Cost Breakdown for Project Course

Item	Quantity	Unit Price	Cost
Office Supplies			
Paper	200 sheets	$0.10	$20
Binding & Cover	2 Reports	$5.00	$10
Project Binder & Dividers	1	$15.00	$15
Travel Expense			
Fuel	40 km	$1.21	$48.40
Total		=	$93.40

7 Deliverables

A hard copy version of all course submissions will be provided as required. A summary of course specific deliverables and dates of submission are provided below in Table 7.1. A PDF version of the SOQ, Work Plan and Final report will also be provided, upon completion to SNC.

Table 7.1 Summary of Deliverables

Deliverable	Description	Date Due	Delivery Method
Statement of Qualifications	A mission statement and description of Delta Consultants to present to clients on match night	Jan.12/11	Submitted via email(PDF) and hard copy
Work Plan Report	A report stating the project description, requirements, tasks, and a schedule of project execution	Feb.2/11	Hard copy submitted to both Dr. Bruneau and the client
Meeting Agendas and Minutes	Weekly/Biweekly agendas provided to the client to describe how the meeting will progress and minutes recorded during meeting to highlight action items and other important items discussed	Apr. 4/11	Submitted via email (PDF) to the client one day prior to meeting
Weekly Reports	Provides project status, tasks completed, tasks upcoming an updated schedule, any issues or achievements and plans.	Weekly	Hard copy presented after a brief presentation by a member of Delta Consultants
Cost Estimate	Capital cost estimate to be provided on the structure option chosen	Apr. 4/11	Presented in the Final report via email (PDF) and hard copy to both Dr. Bruneau and the client
Design Drawings	AutoCAD drawings of site layout and structure elevations and cross-sections	Apr.4/11	Presented in the Final report via email (PDF) and hard copy to both Dr. Bruneau and the client
Project Binder	Includes: Agendas, Minutes, SOQ, Work plan, Final Report, Final Presentation and other miscellaneous work	Apr. 4/11	Hard copy Presented to Dr. Bruneau
Final Report	Final submission for the course to include all work completed by Delta Consultants including detailed drawings and a capital cost estimate	Apr.4/11	Submitted via email (PDF) and a hard copy to Dr. Bruneau and the client
Final Presentation	Summary of the final report and details of the design	Apr.5/11	Presented in-person to both the instructor and the client by Delta Consultants

8 Risks

Some risks are anticipated during the project design portion. Possible risks that may be encountered include:

- Team Stability – There is a concern that as the term progresses and the team gets busier that work on the project may decline.
- Weather Conditions – Considering this project design is being executed during the winter months, a concern arises in not making the weekly/biweekly meetings with the client due to weather
- Project Requirements – This project requires a significant amount of research. With time constraints, there is a concern that there will not be enough time to perform all of the necessary research to make the absolute best design recommendation.
- Design Issues – A materials handling system is required to be included with the structure. Due to a lack of experience within the team a concern arises that extra time will need to be allocated for research into these systems.

Delta Consultants are fully aware of these risks and will continue to review and reassess to ensure they are minimized.

9 References

1) Bruneau, S. (2011). Guide to Writing an Engineering Project Plan. Retrieved from Memorial University, Engineering 8700 Design Project Course Website: http://www.engr.mun.ca/~sbruneau/teaching/8700project/classof2011/project%20plan%20guide.pdf

2) Cement Association of Canada (2005). *Concrete Design Handbook, Third Edition.*

3) Canadian Institute of Steel Construction. (2006*). Handbook of Steel Construction, Ninth Edition.*

4) ENGI 5706 - Design of Concrete Structures, Course Notes

5) ENGI 6705 - Structural Analysis I, Course Notes

6) ENGI 6707 - Design of Concrete and Masonry Structures, Course Notes

7) ENGI 8705 - Structural Building Systems, Course Notes

8) ENGI 8749 – Construction Planning, Equipment, and Methods, Course Notes

9) National Research Council of Canada: Institute for Research in Construction. (2005). *National Building Code of Canada Part 4, Structural Design.*

Appendix A – Statement of Qualifications


Legend
Manhole
Pipe
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Mission Statement

Delta Consultants prides itself in providing sound, innovative and practical engineering design and consulting services to its Clients. For the Engineers at Delta Consultants, exercising due diligence on a daily basis is our first priority.

Profile

Delta Consultants is comprised of a group of three Civil engineering students completing their final term at Memorial University. Combined, the Engineers have a diverse work portfolio which includes Structural, Civil Works, Geotechnical and Oil & Gas engineering.

The Engineers at Delta Consultants are each self-motivated individuals yet they thrive in a team environment. This has been demonstrated time and time again over the past four years as the group has worked together on a number of different projects. Each member contributes their strengths while working efficiently and effectively to ensure a timely project delivery.

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Our Team

Personal Experience:
- **R.A.K. Engineering Consulting Engineering**
  - Mechanical/Electrical Consulting
- **IMTT-NTL Ltd.**
  - Project Management
- **Jacques Whitford Ltd.**
  - Materials Testing
- **Northern Geo Testing & Engineering Ltd.**
  - Materials Testing
- **Syncrude Canada Ltd.**
  - Mine Geotechnical Division

Andrea Abbott

Throughout the course of the civil engineering program, Andrea has gained valuable experience in geotechnical and materials engineering. Andrea's organizational skills, work ethic, along with her team oriented personality, greatly impacts Delta Consultants. During previous work terms, Andrea acquired extensive knowledge of soils, asphalt, and concrete testing, as well as various earth dam analysis including slope stability, seepage, and hydraulic fracture.

Leah Barbour

Through the co-operative Civil engineering program at Memorial, Leah has acquired a vast range of experience. She has been involved in storm sewer design and modelling using GIS based programs, InfoSewer and InfoSWMM. Leah has worked on residential development design in Long Harbour, civil works design, as well as project planning and management at the St. John's Airport. She has also had experience in the field and has prepared progress reports, quantity takeoffs and cost estimates on several work terms.

Personal Experience:
- **Nova Consultants Inc.**
  - Civil/Structural Consulting
- **City of St. John's**
  - Construction Division
- **City of St. John's**
  - Hydrological Division
- **Nova Consultants Inc.**
  - Civil/Structural Consulting
- **Isherwood Associates**
  - Geostructural Consulting
- **St. John's Intl. Airport Authority**
  - Infrastructure Planning

Personal Experience:
- **Dept. Of Transportation & Works**
  - Materials Engineering
- **Statoil Canada Ltd.**
  - Reservoir Engineering
- **ExxonMobil Canada East**
  - Subsurface Engineering
- **SBM Atlantia**
  - Structural Engineering
- **Imperial Oil Resources**
  - Structural Engineering
  - Drilling Engineering

Allan Linegar

With experience in structural applications in the Oil & Gas Industry and extensive knowledge of Microsoft Office products, including programming in Visual Basic, Allan brings a unique skill set to the group. His experience includes 3D modelling and finite element analysis using ANSYS and SACS, developing several tools in Microsoft Excel, including a tool to aid in module transportation for the Kearl Oil Sand Project, production system modelling and sensitivity analysis for the Hibernia Gas Lift Project, and researching and performing a cost analysis on various drilling waste management strategies for development of Horn River in Northeast BC.

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Selected Project Experience

- Earth Dam Analysis : Syncrude
- Standardized Materials Testing
- Warehouse Renovation Supervision
- Hydraulic Fracture Investigation: Syncrude
- Residential Development Design: Long Harbour
- Concrete Retaining Wall Construction: Circular Rd.
- Storm Sewer System Design: Shea Heights West
- River Cross Section HEC-RAS modelling : Goulds
- Queens River East InfoSWMM ArcGIS Model
- Proposed Parking Lot Expansion: Kensington Gate
- Timber Crib Rehabilitation: Red Bay, Labrador
- Site Drainage: RNC Campus Redevelopment
- Strategic Parking Development Plan: St. John's International Airport
- Tie-back Installation: Oakville
- Majors Path Road Widening and Realignment
- NL Highway Road Smoothness Testing
- Terra Nova Integrated Production Model
- Hibernia Gas Lift Project
- Hibernia Series 660 Bolt Integrity
- Offshore Wind Turbine 3D Modelling FEA
- Semisubmersible Oil Production Platform Structural Design
- Module Transportation Analysis for Kearl Initial Development
- Drilling Waste Management Strategies for Horn River, BC

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