BHS Consultants

Terra Nova Calcium Nitrate Module Design: Project Plan

Prepared for:

Tim Matthews, P. Eng., Wood Group PSN

Completed by:

Stephen Lundrigan
Helena Greene
Bradley Burton
Sarah Mapplebeck

February 4, 2013

Engineering 8700: Civil Engineering Project

Justin Skinner, P. Eng
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BHS Consultants
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Monday February 4, 2013

Tim Matthews, P. Eng.
Wood Group PSN
227-281 Water Street
St. John's, NL
A1C 6L3

Subject: Terra Nova Calcium Nitrate Module Design

Dear Mr. Matthews,

BHS Consultants is pleased to present the enclosed project plan for the design of the Terra Nova calcium nitrate module. This plan displays how the project will be undertaken in order to efficiently complete the module design. This plan is also a requirement for the Engineering 8700 project course.

The enclosed work plan provides an overview from start to finish of the project requirements. The design principles, project tasks and desired outcomes for this project will be discussed. A detailed preliminary design schedule will also be presented.

If you have any questions or concerns regarding this work plan, we would be glad to discuss them with you at your convenience.

Sincerely,

BHS Consultants

Stephen Lundrigan	Helena Greene
Bradley Burton	Sarah Mapplebeck

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1.0 Project Description

The Terra Nova is an FPSO (Floating Production, Storage and Offloading Vessel) operating in the Terra Nova oil field. The field is located about 350 km southeast off the coast of Newfoundland and the vessel has been in service there since 2002 (Suncor Energy, n.d.).

The Terra Nova requires aqueous calcium nitrate to combat an overabundance of hydrogen sulfide at the drilling location. The calcium nitrate will be stored on board the platform in a 100 m^2 tank, to be refilled approximately every two weeks. The project requires the design of such a tank, including material selection, design of a support structure for both the tank and pump, and a design for the lifting and the seafastening of the structures to the platform deck.

Throughout this design process, modern techniques will be utilized, and environmental sustainability will be kept in mind. To do this BHS Consultants will strive to utilize local products and manufacturers when available, and avoid waste in all parts of our design. The design life will be twenty years to meet future requirements for calcium nitrate. The function of the finished design is to combat the overabundance of hydrogen sulfide that is currently being released into the ocean environment.

[http://www.gjcahill.com/what-we-do/oil-and-gas/terra-nova-fpso]

2.0 Project Requirements

The design of the storage tank itself requires:

- Study of possible tank materials and corrosion coatings,
- Selecting a material,
- Finite element analysis,
- Loading cases for secured tank on support structure,
- Sea fastening design.

A support structure will be holding the tank 4.5 m above the Terra Nova deck, as required due to the location of the facility. The design of the support structure requires:

- Material selection,
- Loading cases to secure support to deck,
- Design of accompanying structures, such as a railing and ladder,
- Sea fastening design.

A design for lifting and placing these structures on the Terra Nova will be completed, this includes:

- Study of the available cranes for lifting,
- Rigging design,
- Loading cases during transport.

A cost estimate associated with the project, as well as a preliminary construction schedule are required as part of the completed design.

3.0 Methodology

The methodology section will outline the project organization, roles, principles and tasks. It details how the project is approached and carried out.

3.1 Project Approach

BHS will approach the project professionally to provide a solution that is of both high quality and efficiency and to the highest standard of engineering.

The first step is to familiarize all team members with the project background and scope. The team will review the project information provided by the client and research material information and properties. Next a tank material will be selected and the project plan will be created. Appropriate load cases will be determined and design loads calculated. The tank, support structure, lifting and seafastening and miscellaneous steel components will be designed. Then both a construction schedule and cost estimate will be generated. The final step is the creation of a report documenting the entire design process and its components.

3.2 Group Organization, Roles and Meetings

Regular meetings are scheduled for twice weekly. On Monday there is a business meeting and the team writes the agenda for the weekly client meeting, which is on Wednesday. A debrief of the client meeting is held on Thursday. On this day the tasks for the upcoming week are discussed and assigned and current progress is evaluated. In addition, meetings are held as required throughout the week.

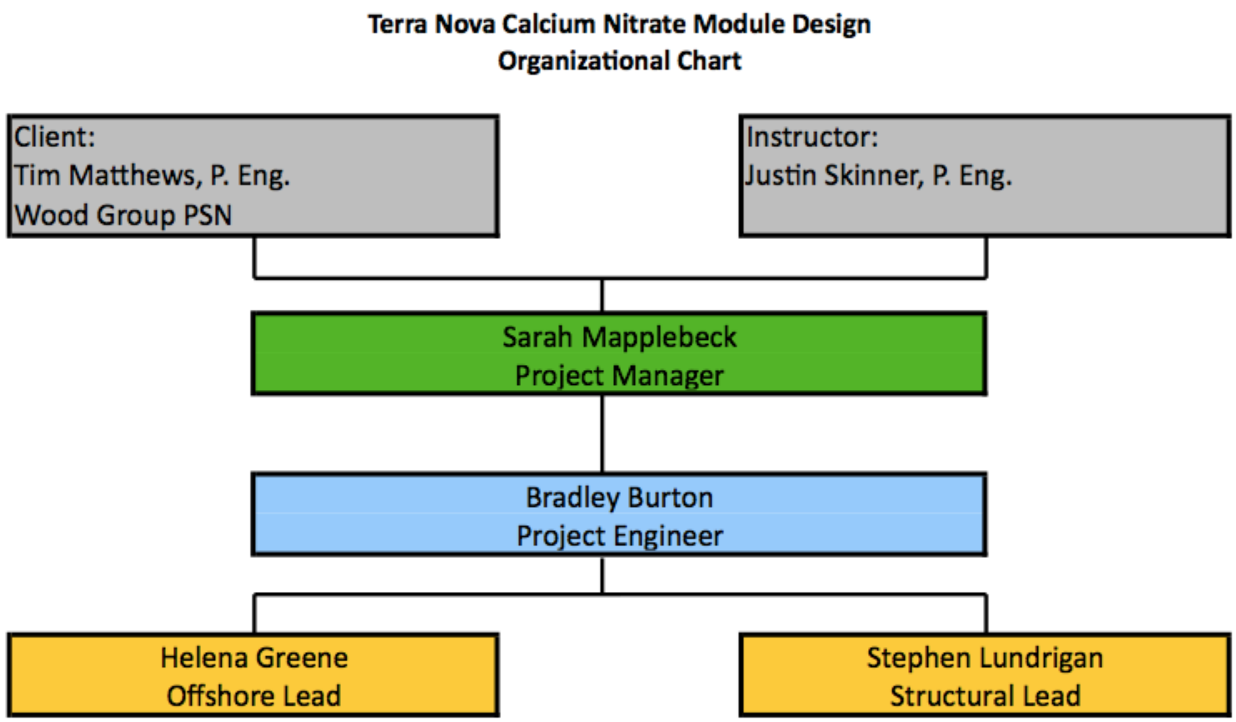
The entire team works together to complete the project. To ensure efficiency in the design process, all members will be assigned specific tasks based on their interests and strengths. The team's roles are as follows:

Table 3.1: Team Roles

Team Member	Primary Role	Secondary Role
Sarah Mapplebeck	Project Manager	Administration
Bradley Burton	Project Engineer	Technical Lead
Helena Greene	Offshore Lead	Client Liaison
Stephen Lundrigan	Structural Lead	Research Lead

The organizational chart including the course professor, client and team member interactions is as follows:

Figure 3.1: Organizational Chart



3.3 Client Interaction and Role

The BHS team will meet the client, Tim Matthews, weekly on Wednesday afternoons from 1:30-2:30 pm at the Wood Group PSN office in the Bowring Building, St. John's, NL. Each Monday, the team will create an agenda for the upcoming meeting and will ensure the client receives the agenda by Monday evening. Furthermore, the client provides information on the project and gives assistance when required. The primary means of communication with the client is via email.

3.4 Design Principles

In order to provide a high quality design all applicable design standards and codes must be followed. The following will be used throughout the design process:

- CISC Handbook of Steel Construction, 10th Edition
- ISO 19902 Petroleum and natural gas industries – Fixed steel offshore structures

Additional standards, codes or texts may be referred to throughout the design process.

3.5 Cost Estimating Strategy and Level of Accuracy

The goal is for the cost estimate to be within an accuracy of 10 %. Throughout the design process quantities of material will be recorded in order to provide a cost estimate at the end of the design. Labor costs will be included as well.

3.6 Desired Outcomes

BHS strives to create a functioning design that will meet the expectations of both the client and the Engineering 8700 course professors. The aim is to provide a design that meets all requirements on time and within budget.

3.7 Reporting and Deliverables

The deliverables of the project include:

- Design of a tank suitable for permanent use offshore within an operating volume of 100 m^3
- Design of a support structure for the tank and a smaller support structure for the pumps which facilitate operation and maintenance
- Design of the lifting and seafastening for installation offshore
- Provision of a construction schedule
- Provision of a cost estimate
- Provision of a final report detailing the design process
- Presentation of the project

3.8 Troubleshooting

The team is prepared to equip with problems that may arise throughout the duration of the project. Any conflict that arises within the team will be attempted to be resolved internally first. If a problem cannot be solved this way, either the client or course professor will be contacted based on the nature of the problem.

4.0 Project Tasks

Eight primary tasks have been identified for this project. These tasks, along with their associated subtasks are described below. The time that has been allocated for each task is also described.

1. Data/Information Compilation:

The first component of the work plan is the research and compilation of necessary data and information required to complete all required tasks of the project. This stage includes acquiring any structural guidelines from the Client and obtaining needed design software. Time Needed: 6 days

2. Design Loads:

This task involves the calculation of dead, live, snow, wind and seismic loads expected to act on the structure. The loads will be calculated based off information obtained from the Client. Time Needed: 11 days

3. Material Comparison/Material Choice:

This task involves taking the materials researched from the Design Criteria Phase for the tank and comparing them to each other. The goal is to find the most economical, structurally sound material available. This phase may also include the selection of a tank liner depending on the effects of Calcium Nitrate. Time Needed: 10 days

4. Tank Design

This task involves accessing the current platform and designing our tank structure to fit within the open space while maintaining the size requirements. Design will also include any rigging adaptations as well as platform connections. After the preliminary design is complete, it will be put into Abaqus to complete a finite element analysis of the proposed tank. The design is to be tweaked until it fits all design criteria and can withstand all potential loads. Time Needed: 13 days

5. Platform Design:

This task involves taking the weight from the tank as well as design loads and designing a platform that can carry the applied forces. It is necessary that a ladder be added to the platform and the connections between the tank/platform and the platform/ship deck have no hot work involved. Then this design will be put into Abaqus to complete a finite element analysis of the proposed design. The design is to be tweaked until it fits all design criteria and can withstand all potential loads. Time Needed :11 days

6. Design Drawings:

This phase of work involves completing AutoCAD drawings of the tank and platform, including all connections and architectural additions. Time Needed : 12 days

7. Installation Plan:

This task includes the creation of a plan to install both the tank and the platform during the shutdown phase of the structure. This phase will include the rigging setup, crane choice and sea fastening. Time Needed: 15 days

8. Quantity Takeoff and Cost Estimate:

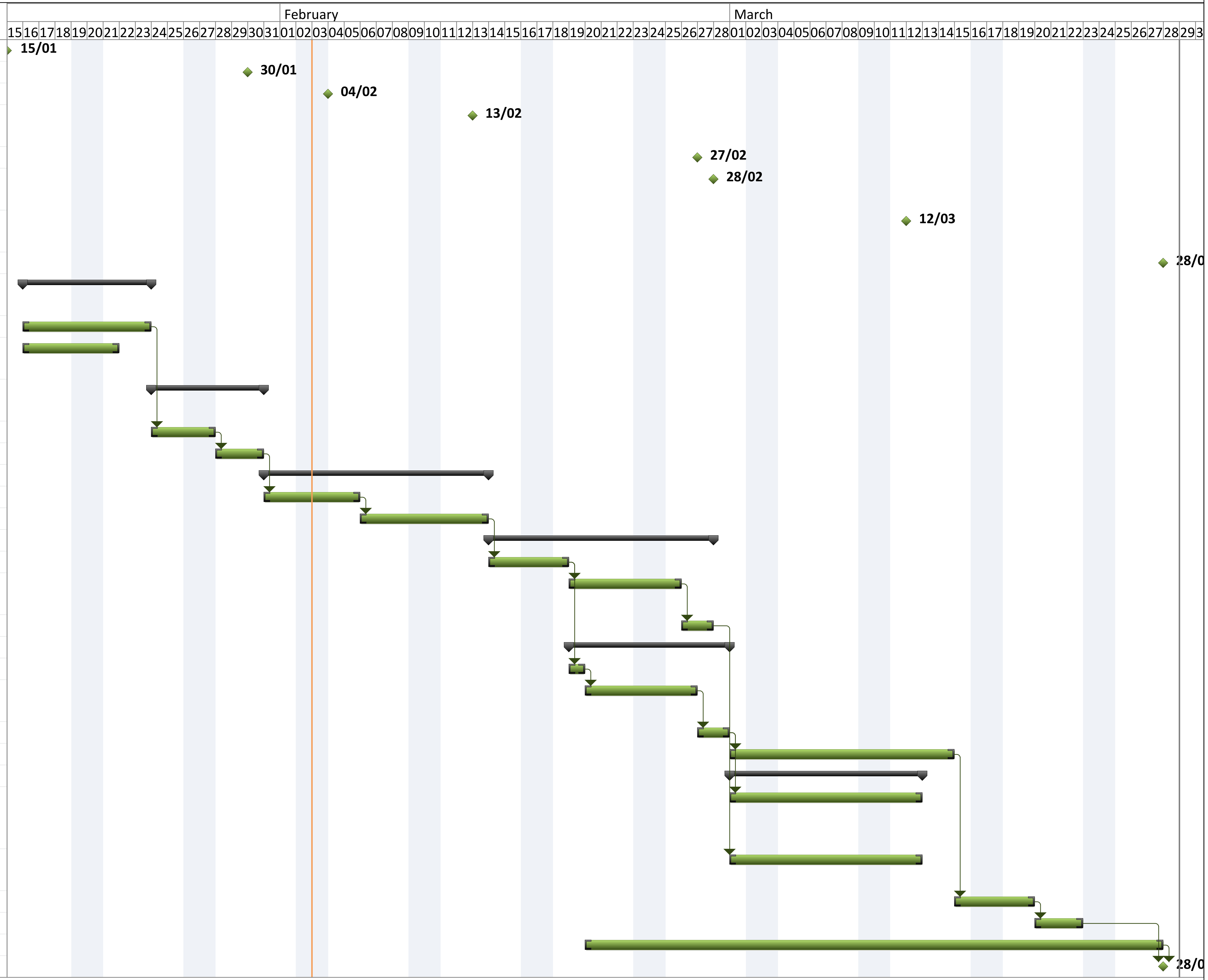
This portion of the work plan involves a quantity takeoff of the structural drawings in order to complete a cost analysis. Time Needed: 9 days

Table 4.1: Task Allocation

Primary Task	Subtasks	Personal	Time Allocation	Resources
Design Criteria	N/A	All	6 days	Internet Client Material
Design Loads	N/A	HG, SM	10 days	Client Material
Material Research	Material Comparison	BB	3 days	Internet Client
	Material Choice	All	1 day	Internet Client
Tank Design	Preliminary Design	All	3 days	Client Material Design Codes Dr. Hussein
	Model Creation	HG SM	5 days	Abaqus Design Codes Client
	Design Drawing	SL BB	5 days	AutoCAD
Platform Design	Preliminary Design	All	1 day	Client Material Design Codes Dr. Hussein
	Model Creation	HG SM	5 days	Abaqus Design Codes Client
	Design Drawing	SL BB	5 days	AutoCAD
Installation Plan	N/A	All	8 days	Client Design Codes
Quantity Takeoff	N/A	SL, BB	3 days	MS Office
Cost Estimate	N/A	HG, SM	3 days	MS Office

5.0 Schedule

ID	Task Name	Duration	Start	Finish
1	**Project Start-up**	**0 days**	**Tue 15/01/13**	**Tue 15/01/13**
2	**Material Chosen**	**0 days**	**Wed 30/01/13**	**Wed 30/01/13**
3	**Submit Project Plan**	**0 days**	**Mon 04/02/13**	**Mon 04/02/13**
4	**Complete Loading Conditions**	**0 days**	**Wed 13/02/13**	**Wed 13/02/13**
5	**Complete Tank Design**	**0 days**	**Wed 27/02/13**	**Wed 27/02/13**
6	**Complete Platform Design**	**0 days**	**Thu 28/02/13**	**Thu 28/02/13**
7	**Complete Installation Plans**	**0 days**	**Tue 12/03/13**	**Tue 12/03/13**
8	**Complete Final Report**	**0 days**	**Thu 28/03/13**	**Thu 28/03/13**
9	**Data/Information Compilation**	**6 days**	**Wed 16/01/13**	**Wed 23/01/13**
10	Research	6 days	Wed 16/01/13	Wed 23/01/13
11	Acquire Guides/Software	4 days	Wed 16/01/13	Mon 21/01/13
12	**Material Comparison/Selection**	**5 days**	**Thu 24/01/13**	**Wed 30/01/13**
13	Comparison	3 days	Thu 24/01/13	Sun 27/01/13
14	Selection	3 days	Mon 28/01/13	Wed 30/01/13
15	**Design Loads**	**10 days**	**Thu 31/01/13**	**Wed 13/02/13**
16	Set Up	4 days	Thu 31/01/13	Tue 05/02/13
17	Compute	6 days	Wed 06/02/13	Wed 13/02/13
18	**Tank Design**	**10 days**	**Thu 14/02/13**	**Wed 27/02/13**
19	Preliminary	3 days	Thu 14/02/13	Mon 18/02/13
20	Finite Element Analysis	5 days	Tue 19/02/13	Mon 25/02/13
21	Final Design	2 days	Tue 26/02/13	Wed 27/02/13
22	**Platform Design**	**8 days**	**Tue 19/02/13**	**Thu 28/02/13**
23	Preliminary Design	1 day	Tue 19/02/13	Tue 19/02/13
24	Finite Element Analysis	5 days	Wed 20/02/13	Tue 26/02/13
25	Final Design	2 days	Wed 27/02/13	Thu 28/02/13
26	**Design Drawings**	**10 days**	**Fri 01/03/13**	**Thu 14/03/13**
27	**Installation Plan**	**8 days**	**Fri 01/03/13**	**Tue 12/03/13**
28	Platform Rigging/Sea Fastening	8 days	Fri 01/03/13	Tue 12/03/13
29	Tank Rigging/Sea Fastening	8 days	Fri 01/03/13	Tue 12/03/13
30	**Quantity Take-off**	**3 days**	**Fri 15/03/13**	**Tue 19/03/13**
31	**Cost Estimate**	**3 days**	**Wed 20/03/13**	**Fri 22/03/13**
32	**Final Report**	**26 days**	**Wed 20/02/13**	**Wed 27/03/13**
33	**Project End**	**0 days**	**Thu 28/03/13**	**Thu 28/03/13**



6.0 Costs

BHS has budgeted the following costs associated with the client's project:

Table 6.1: Project Costs

Item	Forecast Cost ($)	Cost to Date ($)
Printing/Plotting	25	-
Transportation/Parking	100	15
Binder/Log Books	15	15
Binding	10	-
Total	150	30

7.0 Deliverables

A number of deliverables will be required for the successful completion of this project. All deliverables will be submitted to both the course professors and the client in both hard and soft copy. This section outlines and describes the deliverables.

Project plan: The project plan is a document that contains all the information required to understand the project and explains how and when the team plans to execute the project. The project plan will be delivered on Monday, February 4, 2013.

Structural calculations: The required calculations of the various load conditions, the tank design, the support structures design and the rigging and sea fastening design will be provided with the final report on Thursday, April 4, 2013. Calculations will also be delivered to the client throughout the course of the project.

Technical drawings: A set of detailed technical drawings for structural design will be completed for the storage tank and support structures using AutoCAD. These will be provided to the client and delivered with the final report on Thursday, April 4, 2013.

Structural analysis: The final design will be modelled and tested using Abaqus and STAAD. The results of these analyses will be delivered with the final report on Thursday, April 4, 2013

Cost estimate: A cost estimate will be determined once the final design has been completed. It will include costs of materials, installation and labour. The estimate will be delivered with the final report on Thursday, April 4, 2013.

Final report: A final report including all deliverables and any relevant project information will be submitted on Thursday, April 4, 2013.

Final presentation: The final design and the design process for the project will be presented to the course professors, client and other students in the course.

8.0 Risks

BHS Consultants always aims to minimize risks in this project. However, certain risks are identified and examined in an effort to help the project remain on schedule. Potential risks for this project include:

- Availability and familiarity of software: All software may not be readily available and issues may arise if there are great efforts required to obtain necessary software or there is a failure to obtain the software. This may result in the lengthening of certain tasks. To avoid time delays, efforts are exerted early to obtain all necessary software and to become familiar with the required programs.
- Availability of project details: Occasionally specific information will not be available to the team members when issues arise outside of scheduled client meetings or scheduled class times. To avoid any delays alternate methods of communication with either the client or the course professors have been determined. Furthermore, a week's tasks will always be planned out and the required information will be determined in meetings.
- Time delays: Time delays may result from poor weather conditions or unforeseen circumstances for either the team members or client. Any delays will cause a disruption in the project schedule and could result in further constraints. To avoid any potential delays plans and schedules will be created early and communication will be well maintained between both the team and client and between team members.
- Unavailability of a site visit: A site visit would help the team members to visualize the module and required design. To conceptualize the project structural drawings will be consulted and any layout questions will be asked to the client, as a site visit is not feasible.

9.0 References

Suncor Energy. (n.d.). Terra Nova. Retrieved from http://www.suncor.com/en/about/4001.aspx

Appendix A

BHS Consultants:
Summary of Qualifications

Stephen Lundrigan

Work Experience

- Canadian Coast Guard;
- American Bureau of Shipping;
- Nalcor Energy
- Memorial University of Newfoundland;
- AMEC Earth and Environmental

Stephen has worked in numerous fields including offshore engineering, structural engineering, highway engineering and materials testing. His work has taken him to Western Canada as well as the Southern United States but he has mainly been focused in the Newfoundland Region. Stephen's broad work portfolio has allowed him to become proficient with structural design and design research and he has developed into a proficient team member.

Helena Greene

Work Experience

- Heerema Marine Contractors;
- C-CORE;
- Biomedical Sciences, Faculty of
- Medicine, Memorial University; Department of Natural Resources, Government of Canada

Helena has worked both in Canada and overseas in a wide range of fields including offshore engineering, ice engineering, biomedical sciences and seismology. She has extensive laboratory experience as well as experience with various software programs. Helena's varied work terms have strongly developed her problem solving skills. Her strengths include time management and teamwork skills.

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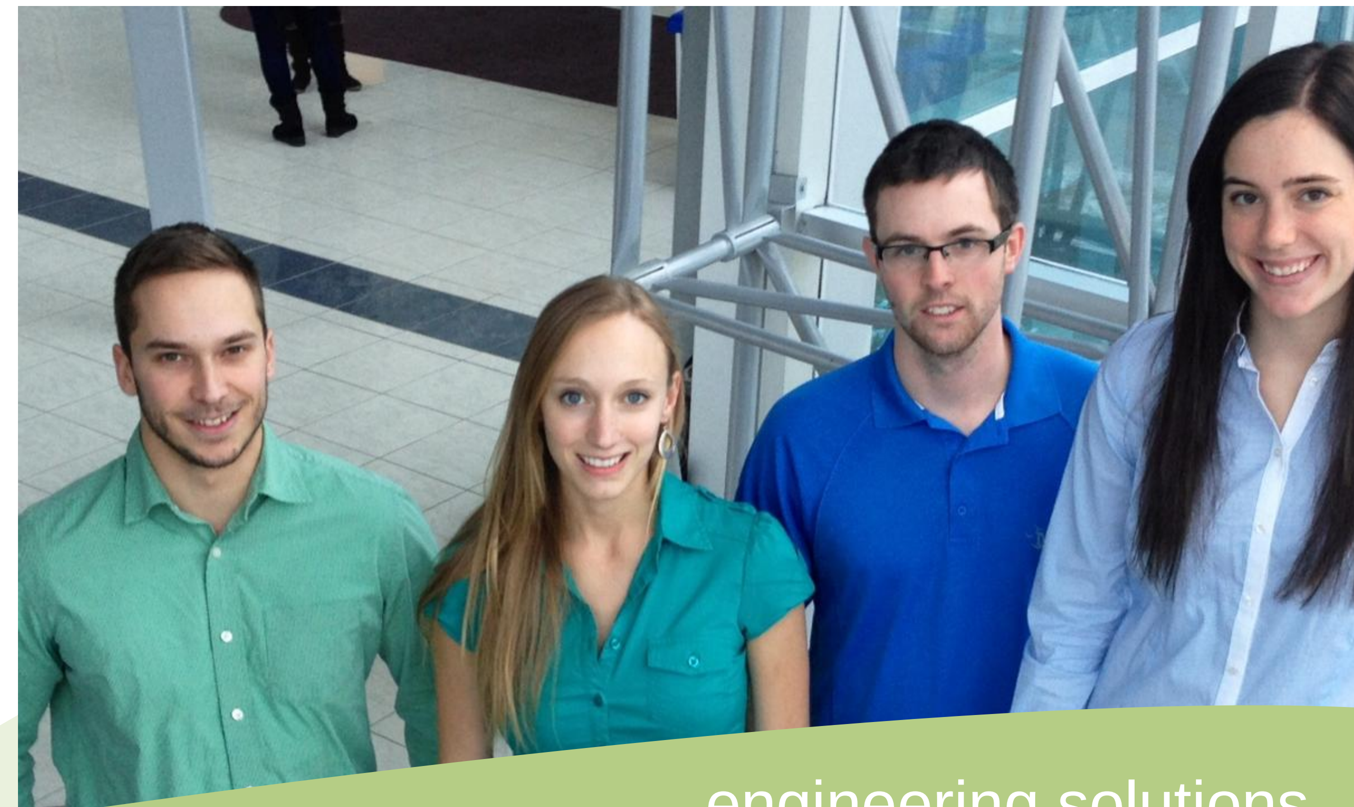

engineering solutions

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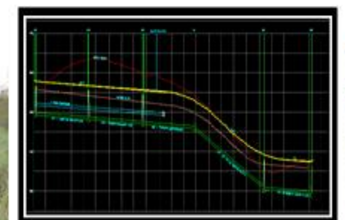
management
consulting
analysis
design

Mission Statement

To provide the highest standard of engineering support to our clients and keep quality and professionalism a high priority. We are driven to deliver quality projects in an efficient and effective manner; our solutions are innovative and tailored to meet our clients' requests. We strive to exceed our clients' expectations in providing project delivery which meets and exceeds civil and structural needs.



Company Profile

We are a consultancy of senior civil engineering students with a broad range of work experiences and a versatile set of technical and interpersonal skills. Our team has been working together for many years and we have excelled at working as a cohesive unit.

Area of Expertise

- Structural Design/Analysis
- Transmission lines
- Tower analysis
- Water and Wastewater
- Pipeline installation
- Sanitary sewer flow monitoring and analysis
- River erosion control
- Offshore Engineering
- Rigging design
- Offshore Engineering
- Rigging design
- Grillage and sea fastening design
- Materials Testing
- Seismology hazard analysis and event location
- AutoCAD, Microsoft Office, Solid Works, S-Frame, Seep/W, Bentley Microstation, MATLAB, SigmaStat, SigmaPlot, Softree

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Bradley Burton

Work Experience

- Memorial University Technical Services;
- BAE Newplan Group;
- Government of Yukon (Transportation Engineering Branch);
- Pennecon Heavy Civil Limited

Bradley's previous work experience involves heavy civil construction, municipal consultant and design. He has working knowledge of design software such as Softree and AutoCAD and has experience working with water and sewer along with structural marine works. All this experience makes Bradley a versatile individual who is eager to put his skills to use.

Sarah Mapplebeck

Work Experience

- Associated Engineering Alberta Ltd.;
- Altime Engineering Ltd.;
- Hiltz and Seamone Co. Ltd;
- Department of Natural Resources, Government of Newfoundland and Labrador

Throughout her work terms, Sarah was able to gain experience in many aspects of civil engineering including municipal, environmental and water resources. She has worked as site supervisor on many construction sites involving water and wastewater pipe installation and road construction. She has worked on such projects including subdivision design, river erosion analysis and sanitary monitoring and analysis. Sarah's Strengths are municipal and water resource engineering, team work and organizational skills.