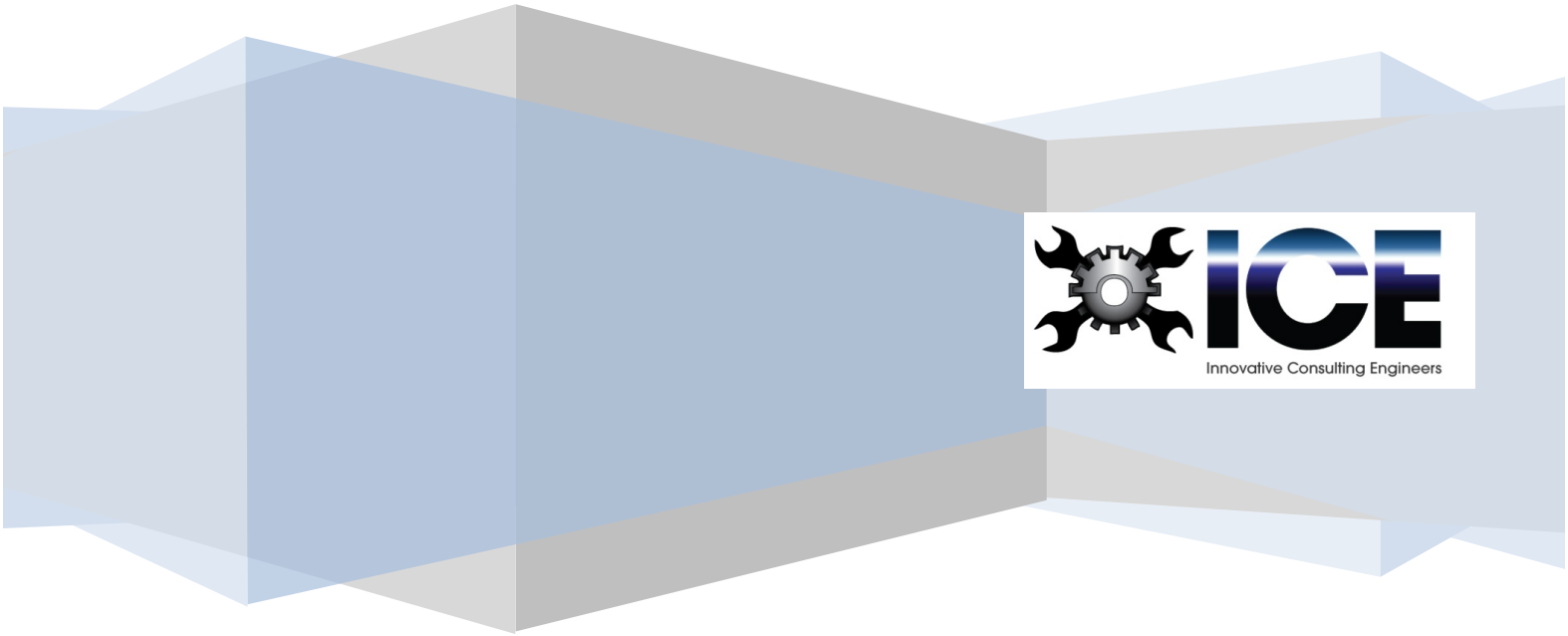
Innovative Consulting Engineers

Engineering 8700 Design Work Plan

AE Consulting – Westdale Condominiums



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1.0 Project Description

Innovative Consulting Engineers (ICE) have been contracted to design a condominium on Topsail Road across from the Brookfield fire station. The project consists of a 52-unit, 4 storey condo building with a partially underground parking area and a footprint of approximately 1600 m^2. The main structure is steel frame with wood truss roofing system. The flooring system consists of four Canam designed Hambro systems supported on steel beams. The fourth floor walls are also load bearing to help with roof loading.

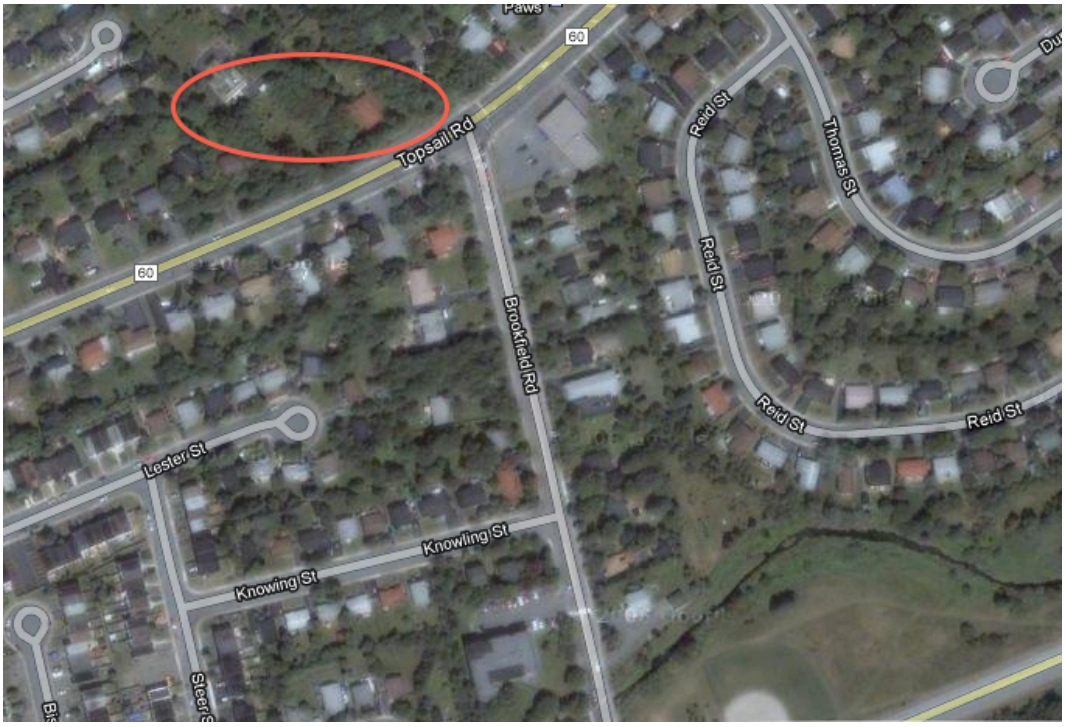


Figure 1: Proposed Site

The building will be laid out in an "L" shaped manner with the roof being supported by wooden trusses. These trusses will need to be cut into three sections such that they can be supported on the two rows of columns laid out in each wing. Also, to help with supporting the roof loads, the exterior wooden wall on the 4^{th} floor is load bearing. The steel columns extend from the 4^{th} floor to the 1^{st}, being supported on concrete columns at the bottom. The concrete columns extend down into the underground parking garage and will be square in shaped. The

foundation will consist mostly of spread footings and will have to be designed to accommodate varying soil pressure around the building.

2.0 Project Requirements

AE Consulting has contracted Innovative Consulting Engineers (ICE) to design the Westwood Condominiums. The following items are required for this design:

Layout of Roof Trusses

The first step in designing the condominium is to decide on the placement of the wooden roof trusses. Ice will complete this task by calculating the loads associated with the roof as per NBCC 2005 and placing the trusses in the appropriate areas. The trusses will likely need to be sectioned in three to accommodate the column spacing and span required.

Design of Shear Walls

The building's lateral bracing will be provided primarily by wooden shear walls. ICE must determine the most appropriate location for these walls and design them using the Manual of Wood Design.

Design of Steel Frame

The majority of the building's structure will be made of steel members. The columns and beams will have to be designed using the Steel Handbook.

Flooring System

The flooring system will be the Canam designed Hambro system. ICE will choose the design that meets the appropriate loading specifications. In addition, concrete balconies will be tied into the flooring system. These will be designed using the Concrete Code.

Design of Parking Area

The underground parking area will include square concrete columns which the steel columns are anchored into and a slab on grade. These will be designed using the Concrete Code.

Design of Concrete Foundations

Foundations of the condominium will be spread footings, however differential soil pressures on the back of the structure will require extra attention. The Concrete Code will be used once again.

Structural Drawings

Once the design of the building is finished, typical member, beam, slab and foundation drawings will be created by ICE using AutoCAD.

Cost Estimation

After design has finished, ICE will provide a Class D (±15% accuracy) cost estimate using the RSMeans software. Unit prices, including labour, will be obtained and a cost for the building's structure will be calculated. The estimate will be broken down by structural category (steel, concrete, floor, wood, etc.)

Schedule

In addition to the design, drawings, and cost estimate, a schedule will be provided. See Appendix B. The schedule will be provided to AE Consulting weekly along with an updated schedule showing current timelines.

3.0 Methodology

3.1 Project Approach

ICE plans to approach this project in a logical, strategic manner to increase the efficiency of our working time. The first stage of design is calculating both the lateral and roof loadings. Special care must be taken when applying these loads due to the irregular shape of the building. Once the proper loads have been applied, the team will establish a layout of the roof using wood trusses including any transfer beams that may be necessary. Once the roofing system has been designed and all forces transferred to the appropriate columns, design of the fourth floor of the condominiums will commence. The fourth floor will be designed separately from the other three due to the presence of load bearing walls. All lateral support in the building will be provided by shear walls. After ensuring that all floors can withstand the applied forces design of the parking garage and foundations can commence. During the design process any and all assumptions made will be tracked in a document with references to relevant codes and manuals. The project schedule will provide a more in-depth breakdown of tasks during the design of the building.

Quantity take-offs will be taken as each element of the design is completed. These take-offs will then be used to provide a Class “D” cost estimate. The cost estimate will not be compiled until the entire structure has been designed. Production of structural drawings will commence as the design of each floor/level of the structure is completed.

3.2 Group Organization, Roles, Meetings

While the major components of this project will be completed by the entire team ICE has assigned roles to each member based on interests, strengths and previous work experiences. The purpose of these roles is to ensure the efficiency of the team as a whole and also to provide the highest quality of work possible. The assigned roles are as follows:

Darren Andersen - Project Engineer

- Overseeing tasks within the project
- Compile meeting minutes
- AutoCAD drafting
- Concrete design

Melissa Gale - Chief Design Engineer

- Steel design
- Wood design
- Roof truss system design

Glen MacDonald - Design Engineer

- Steel design
- Concrete design
- Excel work for company documents

Adam Murray - Project Engineer

- Cost estimating
- Project scheduling
- Truss system layout
- Excel work for company documents

Kyle O'Grady - Chief Drafter and Design Engineer

- AutoCAD drafting
- Quantity take offs
- Roof truss system design

In addition to weekly meetings with the Client, ICE will have informal meetings throughout the week to both track the progress of the project and assigned duties and to work on larger elements of the project requiring more than a single individual to complete.

3.3 Client Interaction and Role

ICE will meet with Krista Hancock, the prime representative from the Client AE Consulting, every Monday at 2:00 pm in the Engineering Building. The Client is responsible for providing the initial Architectural Drawings for the condo, the Geotechnical Report compiled from the Geotechnical Investigation and other information as requested. As well, the Client will support the group with design requirements and assistance if needed. Weekly progress will be

communicated to the client at this time. ICE will be responsible for taking minutes of each of these meetings and distributing the minutes within 24 hours of the meeting. For any other matters the primary method of contact with the client will be via email.

3.4 Design Principles

ICE is committed to providing a quality structural design and as such will ensure that all components of the structure will meet applicable design standards and codes. Design of the Westdale Condominiums will follow limit state design principles through the use of the National Building Code of Canada and relevant CSA Standards. The following codes and standards will be used during the design process:

- CISC Handbook of Steel Construction, 10th Edition
- CAC Concrete Design Handbook, 3rd Edition
- CSA-086 Engineering Design in Wood
- National Building Code of Canada, 2010

Other relevant engineering texts may be consulted during the design process.

3.5 Cost Estimating Strategy and Level of Accuracy

ICE will be providing a Class "D" cost estimate which will provide an estimate within an accuracy level of ±15%. Quantities of materials for the estimate will be tracked in a spreadsheet as the design process is being completed and a cost estimate will be provided after the design has been finalized. Estimated unit prices will be provided by the Client as a reference, however the full cost estimate will consist of material take offs and labour costs. The data for material unit prices will be obtained from RSMeans.

3.6 Desired Outcomes

ICE aims to meet all requirements set forth by both the Client and the instructor of the Engineering 8700 Course (the Instructor). ICE has met with both the Client and the Instructor and has determined that the following deliverables have been requested:

- Complete set of structural calculations
- Applicable Structural drawings
- Material Take-off with Cost Estimate
- Final Report
- Final Presentation of Project

3.7 Troubleshooting

Any problems that occur during the project will first be documented and then resolved internally if possible. If the problem cannot be resolved internally ICE will contact either the Client or a member of the engineering faculty depending on the nature of the issue. The decision of whether to contact the Client or a member of the engineering faculty will be decided by a majority rules vote amongst members of the group.

4.0 Tasks

4.1 Primary Tasks

There are seven primary tasks involved with the Westdale Condominium project including; Layout of Roof Truss System, Design of Steel Structure, Design of Wood Structure, Design of Concrete Structure, Drafting, Cost Estimating and Course Requirements.

Layout of Roof Truss System

The first step in designing the condos will be to layout the roof truss system. To do this, the NBCC 2005 (or 2010) must be used to calculate the roof loading. Once this is completed the trusses will be laid out according to the loading pattern.

Design of Steel Structure

The design for the steel beams and columns in the condo can be started once the trusses are laid out and the loads have been calculated. However, there will be beams that must be designed after the flooring system has been placed. The Handbook of Steel Construction 10e S16-09 will be used in all steel designs. The connections between columns and beams will not be designed.

Design of Wood Structure

The lateral loads (wind loads) that will be applied to the structure will be taken by wooden shear walls to be placed and designed by ICE. As well, the 4th floor's exterior walls will be load bearing and thus will need to be designed. For these two items the Wood Design Manual will be used.

Design of Concrete Structure

In addition to steel and wood, the structure also includes concrete portions. Floor slabs are one example of this. The floor slab will be a Hambro system designed by Canam. ICE will select the correct flooring design that meets the loading needs. As well there are concrete balconies on each floor that tie into each slab.

ICE will also be required to design the concrete columns located in the parking garage area and the connection between these and the steel columns above. Finally, the building's foundation will be designed as a spread footing.

Every concrete member in the structure will be designed using the Concrete Design Handbook 3 Ed.

Drafting

Once design for the entirety of the building is completed typical structural drawings will be created using AutoCAD.

Cost Estimating

Using the AutoCAD drawings produced in the drafting component of the project, a complete quantity takeoff will be required to see how much material is needed to construct the condominium. Using these values, unit costs will be researched on RSMeans, factoring in required labour. This will produce a final cost figure for the project, within a 15% allowance for error.

Course Requirements

- Final Report
- Work Breakdown Structure
- Network Diagram
- Project Schedule
- Meeting Minutes

5.0 Schedule

ICE has outlined the project requirements by creating a work breakdown structure (WBS) as well as a rendering of the project schedule using Microsoft Project 2010.

The schedule begins on Feb 1st, 2012 and goes until March 15th, 2012. In the schedule, weekends have been marked as non-working day, however they may be used as working time if required. The main tasks are four design tasks, drafting, cost estimating, and course requirements. Each main task has been broken down into subtasks which have all been assigned appropriate durations.

To begin the Westdale Condominiums project ICE will complete the layout of the roof truss system, followed by the design of the steel structure, the design of the wooden walls, and the design of the concrete structure. After the design stage is completed the drafting and cost estimating will be complete simultaneously. The final report will then be put together when all other tasks are completed.

The schedule will be used to track ICE's progress on Westdale Condominiums throughout the course of the project. It will be updated after each weekly group meeting to properly reflect the work completed.

6.0 Costs

ICE has incurred the following costs associated with the client's project:

- Binder – $6
- Logbooks – 5 @ $8 ea.
- Printing costs - $20
- Binding - $10
- Site visit - $10 in gas

7.0 Deliverables

The following deliverables will be provided to the Client upon the completion of the project:

- Structural Drawings both hard and soft copy
- Structural Calculations
- Cost Estimate including labour and installation
- Final Report both hard and soft copy
- Presentation

8.0 Risks

ICE is committed to providing a quality product and will work diligently to meet deadlines. There are two foreseeable risks which put its milestones in jeopardy:

- Inadequate access to Structural Design software
- Weather delays

The first risk mentioned would hinder ICE's ability simply by increasing the work load of the design team. Each member in the structure must be checked against the loads applied, in a four storey building, with roughly 1600 m^2 in area per floor, there are a lot of members to be checked.

The second risk which may influence the productivity of the ICE team is weather delay. With much of the materials needed to achieve proper design in the Engineering Building, a snow day would severely limit the resources available to each team member.

9.0 References

[1] National Building Code off Canada 2010, (Ottawa: National Research Council of Canada 2010, 2010)
[2] Handbook of Steel Construction 10e, (Canada: Canadian Institute of Steel Construction, 2010)
[3] Concrete Design Handbook 3e, (Canada: Canadian Standards Association, 2006, 2006)
[4] Wood Design Manual 2010, (Canada: Canadian Wood Council, 2010,2010)

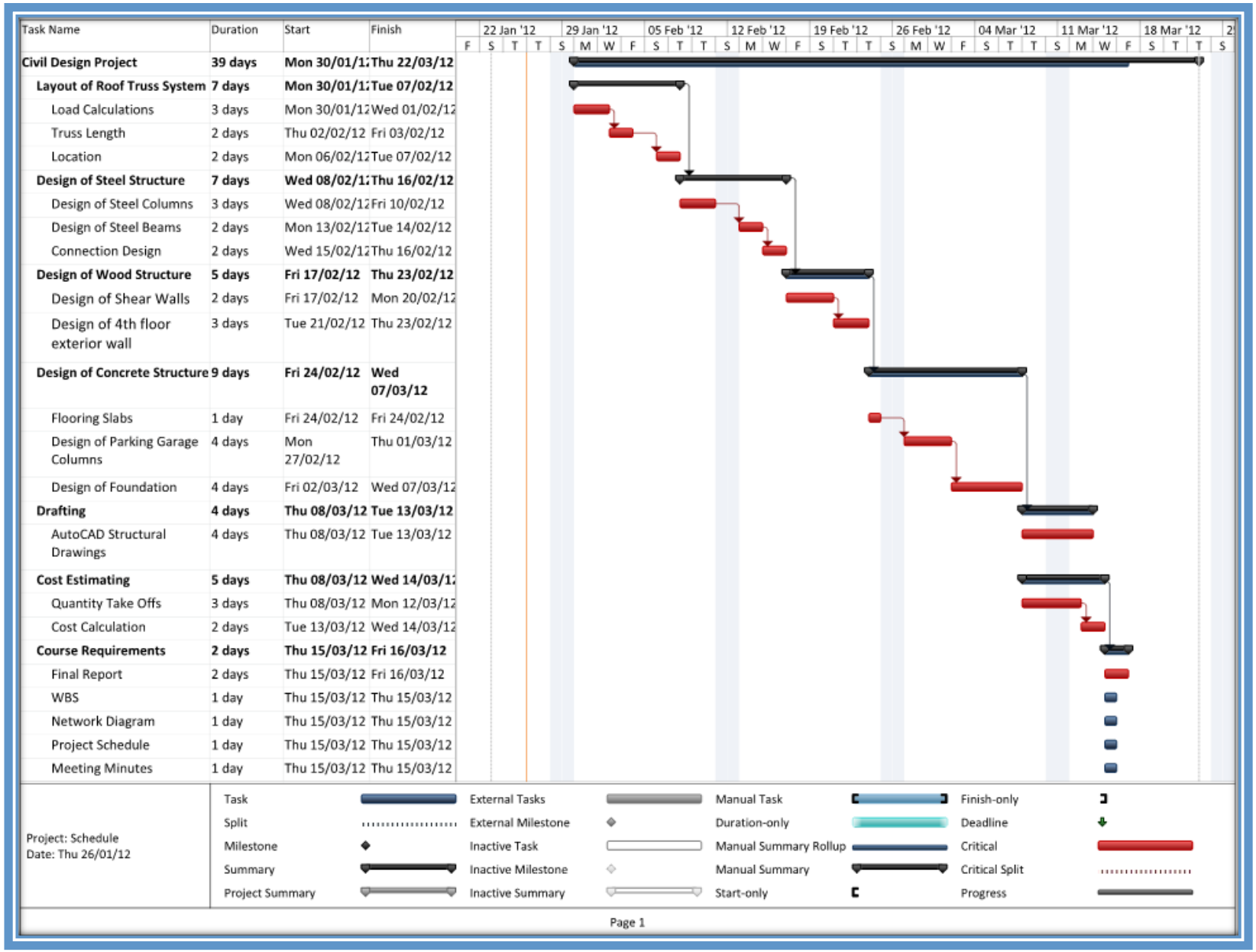
APPENDIX A

Task List

Primary Task	Subtasks	Personel	Duration(Days)	Resource Requirements
Layout of Roof Truss System	Load Calculation	KO, AM	3	NBC
	Truss Length	KO, AM	2	Wood Code
	Locations	KO, AM	2	Wood Code
Design of Steel Structure	Column Design	MG, GM	3	Steel Code
	Beam Design	MG, GM	2	Steel Code
	Connection Design	MG, GM	2	Steel Code
Design of Wood Structure	Shear Walls	MG	2	Wood Code
	4th Floor Exterior Wall	MG	3	Wood Code
Design of Concrete Structure	Flooring Slabs	DA, AM	3	Concrete Code
	Parking Garage Columns	DA, AM	2	Concrete Code
	Foundation	DA, AM	4	Concrete Code
Drafting	AutoCAD	KO	4	AutoCAD
	Typical Drawings	KO	1	AutoCAD
Cost Estimating	ICE's Cost	KO, AM	3	Excel, RS Means
	Quantity Take Offs	KO, AM	2	Excel
Course Requirements	Final Report	All	2	Word, Excel
	Work Breakdown Structure	GM	1	Excel
	Network Diagram	AM	1	MS Project
	Project Schedule	AM	1	MS Project
	Meeting Minutes	DA	1	Word

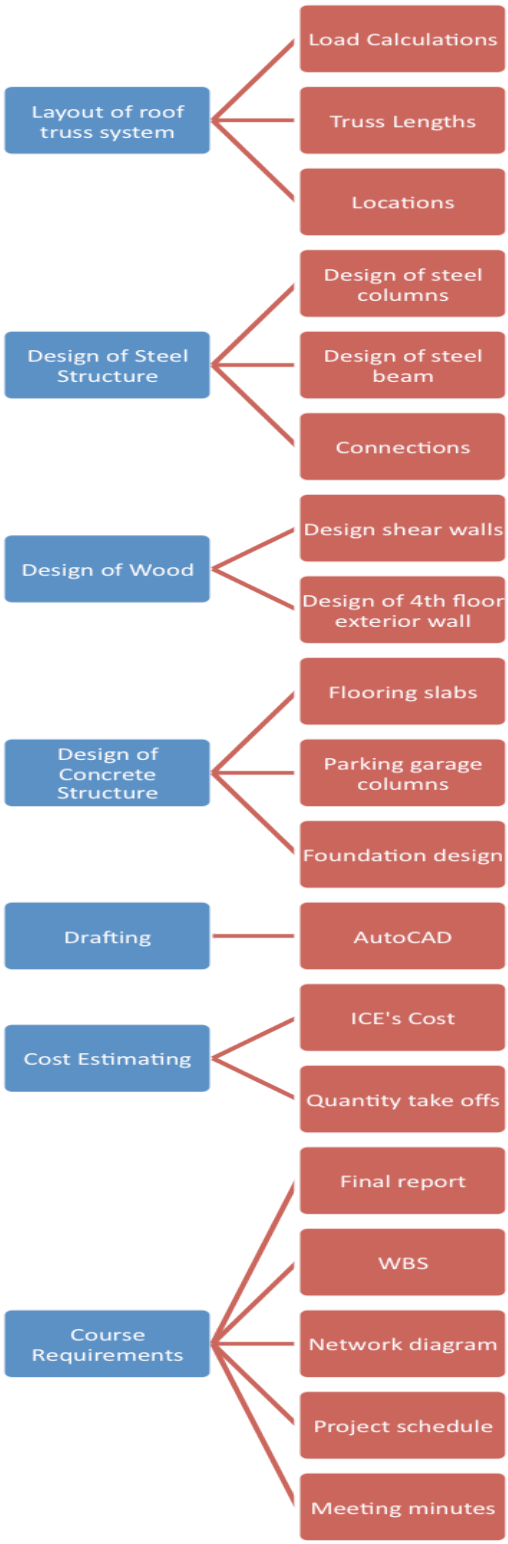
APPENDIX B

Project Schedule


Task Name
Duration
Start
Finish
Civil Design Project 39 days Mon 30/01/12 Thu 22/03/12
Layout of Roof Truss System 7 days Mon 30/01/12 Tue 07/02/12
Load Calculations 3 days Mon 30/01/12 Wed 01/02/12
Truss Length 2 days Thu 02/02/12 Fri 03/02/12
Location 2 days Mon 06/02/12 Tue 07/02/12
Design of Steel Structure 7 days Wed 08/02/12 Thu 16/02/12
Design of Steel Columns 3 days Wed 08/02/12 Fri 10/02/12
Design of Steel Beams 2 days Mon 13/02/12 Tue 14/02/12
Connection Design 2 days Wed 15/02/12 Thu 16/02/12
Design of Wood Structure 5 days Fri 17/02/12 Thu 23/02/12
Design of Shear Walls 2 days Fri 17/02/12 Mon 20/02/12
Design of 4th floor exterior wall 3 days Tue 21/02/12 Thu 23/02/12
Design of Concrete Structure 9 days Fri 24/02/12 Wed 07/03/12
Flooring Slabs 1 day Fri 24/02/12 Fri 24/02/12
Design of Parking Garage Columns 4 days Mon 27/02/12 Thu 01/03/12
Design of Foundation 4 days Fri 02/03/12 Wed 07/03/12
Drafting 4 days Thu 08/03/12 Tue 13/03/12
AutoCAD Structural Drawings 4 days Thu 08/03/12 Tue 13/03/12
Cost Estimating 5 days Thu 08/03/12 Wed 14/03/12
Quantity Take Offs 3 days Thu 08/03/12 Mon 12/03/12
Cost Calculation 2 days Tue 13/03/12 Wed 14/03/12
Course Requirements 2 days Thu 15/03/12 Fri 16/03/12
Final Report 2 days Thu 15/03/12 Fri 16/03/12
WBS 1 day Thu 15/03/12 Thu 15/03/12
Network Diagram 1 day Thu 15/03/12 Thu 15/03/12
Project Schedule 1 day Thu 15/03/12 Thu 15/03/12
Meeting Minutes 1 day Thu 15/03/12 Thu 15/03/12
22 Jan '12
29 Jan '12
05 Feb '12
12 Feb '12
19 Feb '12
26 Feb '12
04 Mar '12
11 Mar '12
18 Mar '12
F S T T S M W F S T T S M W F S T T S M W F S T T S M W F S T T S
Project: Schedule
Date: Thu 26/01/12
Task
Split
Milestone
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Deadline
Critical
Critical Split
Progress
Page 1

Appendix C

Work Breakdown Structure


Layout of roof truss system
Load Calculations
Truss Lengths
Locations
Design of Steel Structure
Design of steel columns
Design of steel beam
Connections
Design of Wood
Design shear walls
Design of 4th floor exterior wall
Design of Concrete Structure
Flooring slabs
Parking garage columns
Foundation design
Drafting
AutoCAD
Cost Estimating
ICE's Cost
Quantity take offs
Course Requirements
Final report
WBS
Network diagram
Project schedule
Meeting minutes

Appendix D

Statement of Qualifications

Innovative Consulting Engineers

Memorial University of Newfoundland
S.J. Carew Building;
EN2050
St. John's, NL A1B 3X5
InnovativeConsultingEngineers@gmail.com

Mission Statement

- **ICE**'s mission statement is to provide quality structural engineering services to a diverse group of clients in various industries. Safety, Economic and Timely execution is a top priority.

Innovative Consulting Engineers

Overall Work Experience

- Preliminary work of Hibernia OLS Base removal
- Terra Nova well bore pressure sensor drift analysis
- Developed geothermal gradient of Terra Nova Field
- Hebron topsides Front End Engineering Design
- Hebron camp construction/renovation/mold abatement
- Hebron: Bull Arm facility rehabilitation
- Hebron marine work , safety installations
- Shearwater Helicopter Hangers
- Woodframe building analysis
- Retaining wall structural analysis and rehabilitation
- 7 floor steel frame building structural analysis
- Boomstacker structural analysis

ICE
Innovative Consulting Engineers

Overall Work Experience Cont.

- RNC building roof replacement
- Design of Municipal Street Upgrades and Underground Utilities
- Quantity Take off and Cost Estimation
- Flood Plane Analysis, Sewer and Water design
- Design of Pressure Reducing Valve Housing Station. Rainfall Analysis.
- IOC dolomite blasting/Spillway construction
- Wabush mines stripping quantity
- Bloom Lake railway Right of Way construction
- Long Harbour ore processing plant: Geotechnical testing
- Concrete Placement and Earthworks for Long Harbour Processing Plant
- Crushed stone sampling

ICE
Innovative Consulting Engineers

Adam Murray

Work Experience

- City of St. John's: Municipal Division
- City of St. John's: Hydrological Division
- BAE Newplan Group
- H.J. O'Connell

Adam is a senior Civil Engineering student at Memorial University of Newfoundland. Over his Co-operative work terms he has gained experience in municipal Engineering, hydrological engineering, and heavy civil construction. He has valuable experience in both the office and the field. Adam's strengths include strong problem solving abilities, work ethic and teamwork.

ICE
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Darren Andersen

Work Experience

- Department of Transportation and Works
- Defence Construction Canada
- Stantec
- WorleyParsons
- Canadian Coast Guard

Darren is currently in his last term in Civil Engineering at Memorial University. During his cooperative work terms he has worked in a variety of fields including general construction, mining (geotechnical), project management and oil and gas. His varied work terms have enhanced his interpersonal skills, technical knowledge and his work ethic.

ICE
Innovative Consulting Engineers

Glen MacDonald

Work Experience

- Department of Transportation and Works
- Technip
- Suncor

Glen is a senior Civil Engineer student at Memorial University of Newfoundland and has gained the majority of his experience through work terms in the oil and gas industry. A structural position with Technip provided experience with Hibernia and pipe modelling in STADD.pro. Two work terms with Suncor has given him experience in production engineering within the Terra Nova field. This involved monitoring the field as well as equipment on the FPSO to ensure maximum production.

ICE
Innovative Consulting Engineers

Kyle O'Grady

Work Experience

- Harris and Associates
- Department of Municipal Affairs
- HJ O'Connell Construction
- Kiewit-Kvaerner Contractors

Kyle O'Grady is a senior Civil Engineering student at Memorial University. His experience is heavily oriented in the field of construction, and he is comfortable in both office and field environments. Work experience ranging from municipal work to mining and heavy construction makes Kyle a very versatile individual, with an eagerness to continue to learn.

ICE
Innovative Consulting Engineers

Melissa Gale

Work Experience

- Department of Transportation and Works
- NL Power
- Nalcor: Lower Churchill Project
- AMEC: Structural Division
- Tiller Engineering Inc.

Melissa is a senior Civil Engineering student at Memorial University student who has experience working in both the hydroelectric and structural consulting industries. She has a working knowledge of structural analysis software such as STAAD.PRO and has gained experience in the structural analysis and design of wood frame, steel and concrete structures.

ICE
Innovative Consulting Engineers

Contact Information

Client
Krista Hancock, P. Eng.
AE Consultants
341 Freshwater Road
Suite 202
PO Box 13156
St. John's, NL A1B 4A4
khancock@aeconsultants.ca

Professor
Dr. Steve Bruneau
Faculty of Engineering & Applied Science
Memorial University of Newfoundland
S.J. Carew Building
St. John's, NL A1B 3X5
sbruneau@mun.ca

ICE
c/o Engineering 8700 Project Group 1
Memorial University of Newfoundland
S.J. Carew Building
St. John's, NL A1B 3X5
innovativeconsultingengineers@gmail.com