Nalcor Energy – Lower Churchill Project

nalcor
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LOWER CHURCHILL PROJECT

SOBI Marine Crossing “Phase 2” Conceptual Design

ILK-PT-ED-8110-MR-RP-0001-01

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Acronym list

CAD	**C**anadian **D**ollars
CIV	**C**able **I**nstallation **V**essel
COPS	**C**ontinuous **O**perating **P**rotection **S**ystem
DCC	**D**ocument **C**ontrol **C**enter
DP	**D**ynamic **P**ositioning
EA	**E**nvironmental **A**ssessment
EIS	**E**nvironmental **I**mpact **S**tatement
EPC	**E**ngineering, **P**rocurement, **C**onstruction
FEED	**F**ront **E**nd **E**ngineering **D**esign
GVI	**G**eneral **V**isual **I**nspection
GPS	**G**lobal **P**ositioning **S**ystem
HDD	**H**orizontal **D**irectional **D**rilling
HDPE	**H**igh **D**ensity **P**olyethylene
HIRA	**H**azard **I**dentification **R**isk **A**ssessment
HMM	**H**atch-**M**ott **M**acdonald
HVDC	**H**igh **V**oltage **D**irect **C**urrent
IRM	**I**nspection, **R**epair **A**nd **M**aintenance
ITP	**I**nspection **T**esting **P**lan
LCC	**L**ine **C**ommutated **C**onversion
LCP	**L**ower **C**hurchill **P**roject
MI	**M**ass **I**mpregnated
NDA	**N**on-**D**isclosure **A**greement
NE-LCP	**N**alcor **E**nergy - **L**ower **C**hurchill **P**roject
NPT	**N**on-**P**roductive **T**ime
NPV	**N**et **P**resent **V**alue
PM&E	**P**roject **M**anagement **&** **E**ngineering
ROV	**R**emote **O**perated **V**ehicle
SOBI	**S**trait **O**f **B**elle **I**sle
TBM	**T**unnel **B**oring **M**achine
TDR	**T**ime **D**omain **R**eflectometry
UCS	**U**niaxial **C**ompressive **S**trength
VSC	**V**oltage **S**ource **C**onverter
WOW	**W**aiting **O**n **W**eather
WTO	**W**ork **T**ask **O**rder
XLPE	**C**ross **L**inked **P**olyethylene

1.0 STRAIT OF BELLE ISLE CROSSING

1.1 Background

Nalcor Energy is headquartered in St. John's, NL, Canada. Its business includes the development, generation, transmission and sale of electricity; the exploration, development, production and sale of oil and gas; industrial fabrication and energy marketing. Focused on sustainable growth, the company is leading the development of the province's energy resources and has a corporate-wide framework which facilitates the prudent management of its assets while continuing an unwavering focus on the safety of its workers and the public. Nalcor currently has five lines of business: Newfoundland and Labrador Hydro, Churchill Falls, Oil and Gas, Lower Churchill Project and Bull Arm Fabrication.

The Churchill River, located in the Province of Newfoundland and Labrador, Canada, is a significant source of renewable, clean electrical energy; however, the potential of this river has yet to be fully developed. The existing 5,428 megawatt (MW) Churchill Falls Generating Station, which began producing power in 1971, harnesses about 65 percent of the potential generating capacity of the River. The remaining 35 percent is planned to be developed via two sites on the lower Churchill River, known as the Lower Churchill Project.

The Project includes two undeveloped hydroelectric sites and associated transmission systems, specifically the *Lower Churchill Hydroelectric Generation Project* (Generation Project) and *Labrador – Island Transmission Link* (Transmission Project). The Generation Project consists of proposed generating facilities at two sites in on the lower Churchill River in Central Labrador- a 2250 MW facility at Gull Island and an 824 MW facility at Muskrat Falls. The *Labrador – Island Transmission Link* is a proposed 1,100km High Voltage direct current (HVdc) transmission line connecting Central Labrador with the island of Newfoundland's Avalon Peninsula.

In November 2010, Nalcor Energy entered a Partnership with Emera Inc. to develop phase one of the Lower Churchill Project. This development includes the Muskrat Falls generating facility, the Labrador – Island Transmission Link and an additional transmission line, the *Maritime Transmission Link*, connecting the island of Newfoundland and neighboring province, Nova Scotia. Phase one of the Project is valued at $6.2 billion.

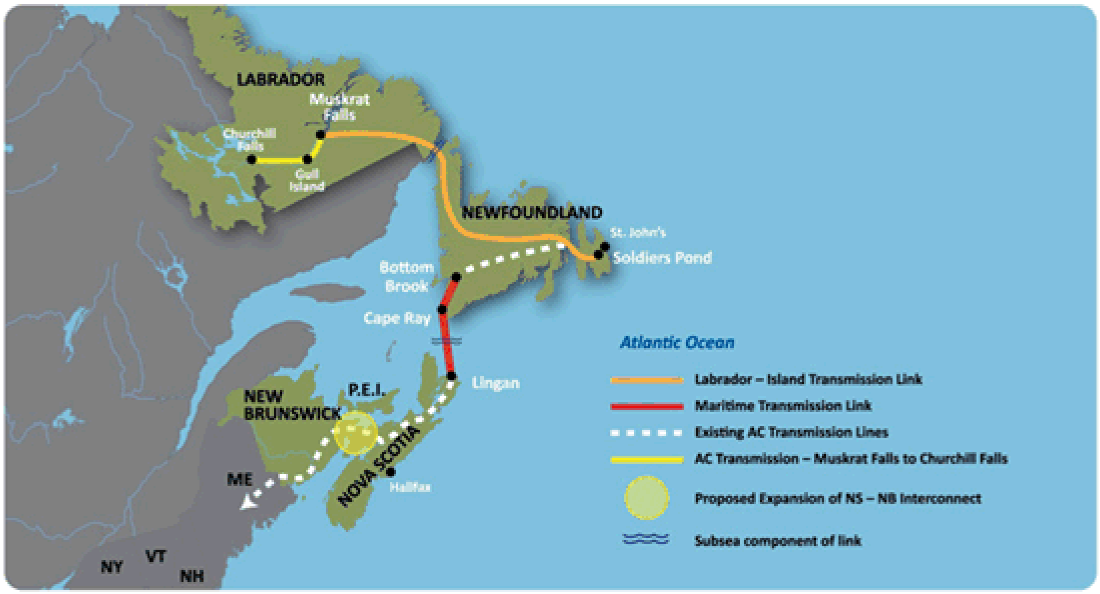


Figure 1 - Schematic Depiction of the HVdc Route

1.2 Scope of Work

With reference to the Lower Churchill Project Gateway Process LCP-PT-MD-0000-PM-0001-01 (refer to Figure 2), the SOBI seabed crossing conceptual design is required prior to moving into Phase 3.

The scope of work during Phase 2 involved development of a technically feasible solution for extending the HVdc transmission system across the SOBI. It has been determined that the seabed crossing would have cables placed on or beneath the seafloor. A SOBI Crossing Team Charter was established to outline the purpose, objectives, success factors, and roles for execution of the work. A specialized team was mobilized and technical feasibility analyses were undertaken to develop a conceptual design to meet the charter objectives. The results of the feasibility analyses, including the finalized conceptual design are described hereafter.

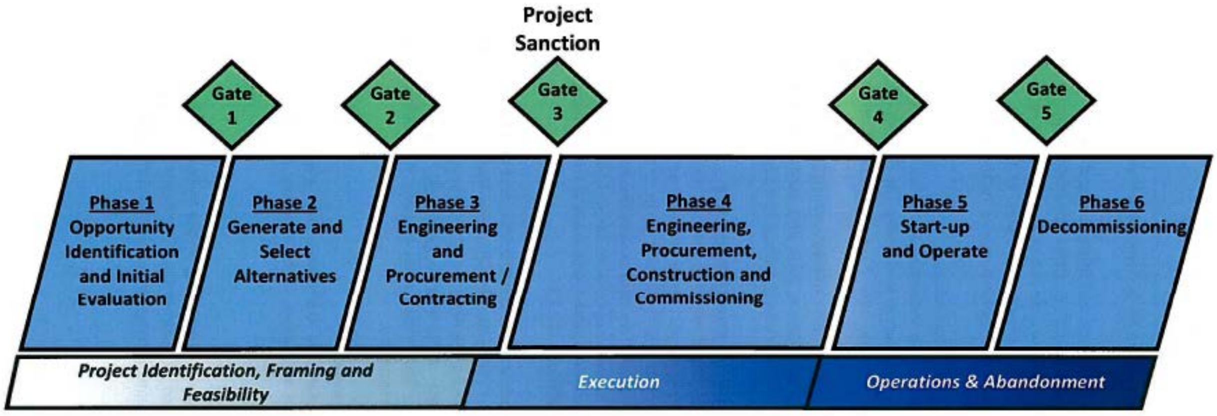


Figure 2 - Gateway Process

2.0 Conceptual Design Solution

The following sections detail the process for the cable installation on a conceptual design basis and include:

Routing

The cable corridor in which the conceptual cable route is to be defined is as shown in Figure 3. This corridor takes into account the landfall and protection methods discussed in this report. The estimated length is approximately 36 km with roughly 32 km on the sea floor. The route is depicted within a 500 m wide corridor with a 1500 m diameter circular seafloor piercing target zone for HDD. Detailed cable spacing and routing will be carried out in phase 3 [redacted]

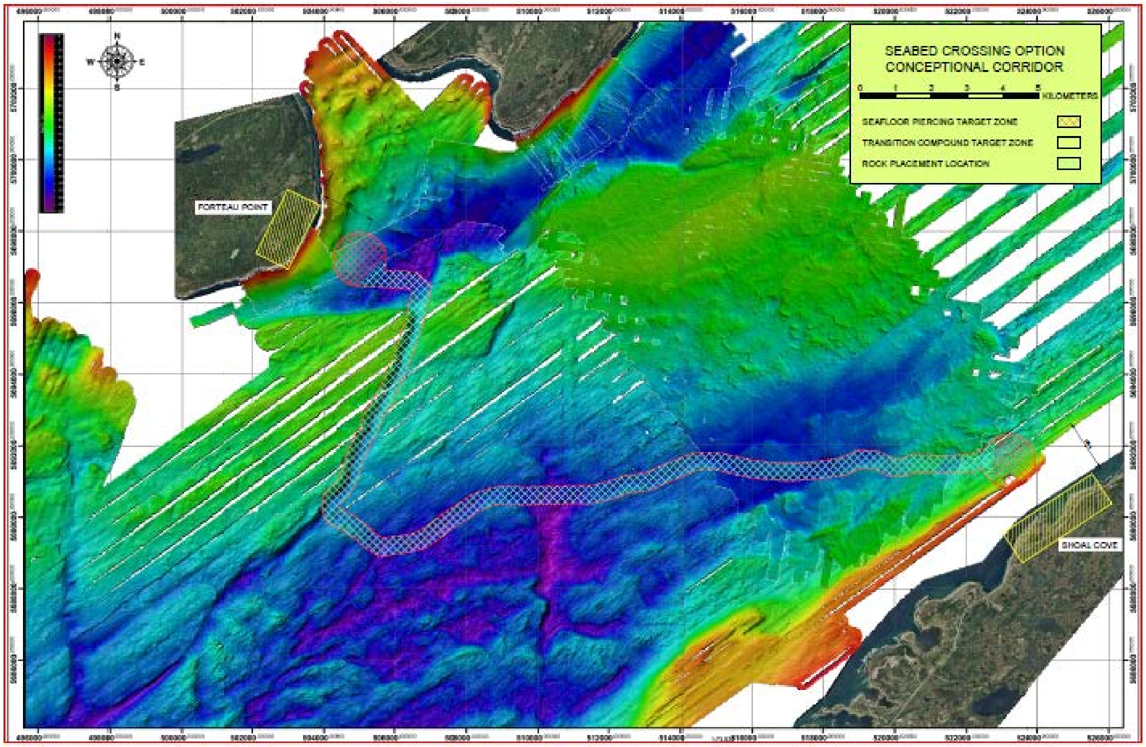


Figure 3 Conceptual Cable Corridor

Cables

The current conceptual cable design includes:

- Single Core (Copper or Aluminum conductor, pending detailed design)

- Mass impregnated paper insulated cables
- Double wire armor (DWA) in a counter-helical fashion to maximize pulling tension and provide rock armoring. Armor will consist of steel wire coated in Bitumen.
- Outer serving will consist of two layers of polypropylene yarn or high density polyethelyne as needed.
- Cables will each be rated to carry 450 MW at 320 kV.

The LCP preliminary cable design for the Strait of Belle Isle is within the limits of previous cable designs. While incorporating long-term field proven technology only. The cables for the 900 MW – 320 kV case could either be Mass Impregnated (MI) or Cross-linked Polyethylene (XLPE), with the former being the lowest risk design at this time due to the extensive global in-service track record. XLPE has been type tested at 320 kV, however the first 320 kV cable has not yet been installed. Long term aging tests have been completed as part of the type testing, but there is no significant field service data for 150 kV XLPE and above.

Transition Compounds and Terminations

At each side of the crossing, all three cables will terminate at a Transition Compound, to be designed, supplied, and constructed by the EPCM contractor. It is envisaged at this time that the cables will be pulled to shore then land trenched to the location of the transition compound. The compound location is not yet defined but will most likely be located 150 m to 1000 m from each shoreline. The compound will house the cable terminations, as well as any switch gear that is required for system operation. Actual footprint and height of the compounds will be determined by the EPCM and are based on isolation requirements and installation techniques of the terminations. The cables will enter the transition compound through a foundation penetration.

End terminations for each cable will reside inside the Transition Compound, and will be inclusive of the stand, insulator, and ancillary equipment. All equipment associated with the end termination will be supplied and installed as part of the cable supply contract.

Landfall - HDD

For both shore approaches, Horizontal Directional Drilling (HDD) will be utilized to protect the cables and will run from the shore to a point on the seafloor within the designated piercing target zone. This point will be approximately 2 km from the shoreline, however may become shorter or longer pending detailed design. The HDD solution will provide steel-lined boreholes for each shore approach. A footprint of approximately 2-6 acres is required on both Newfoundland and Labrador sides of the Strait to execute the HDD scope.

Cable Installation

The current philosophy is that the cable installation will include a subsea joint to allow for pull-in without laying an over length on the seafloor. The sequence for each current cable installation is as follows:

- Pull-in side 1
- Normal lay
- Abandon
- Pull-in side 2
- Normal lay
- Recover side 1
- Join
- Abandon

Deepwater Zones – Rock Placement

For the deepwater zones Rock Placement will be utilized to protect the cables between the HDD seafloor piercing on the Newfoundland side and the HDD seafloor piercing on the Labrador side. Each cable will be protected by a dedicated rock berm, which will be 0.5 - 1.5 m high with the potential for higher regions if additional protection is required. Preliminary studies suggest that the rock berm will have a nominal side slope ratio of 1:4 (rise:run) and will be 8-12 m wide at the base. The current rock has been based on a 8" D minus (maximum graded target size will be 8 inch diameter).

3.0 Feasibility Analysis and Approach

As of Q1 2010, a team was mobilized to progress feasibility of seabed cable installation with a target to complete a conceptual design by late Q4 2010. The following schematic outlines the process flow implemented by the team and timing for the feasibility study.

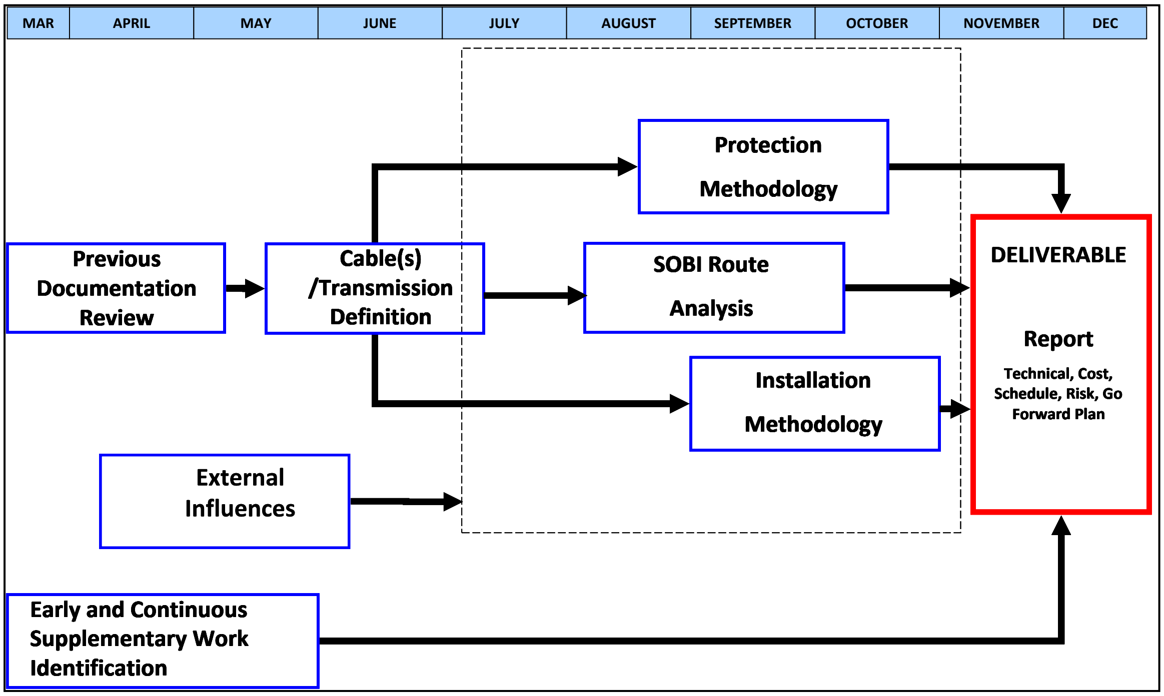
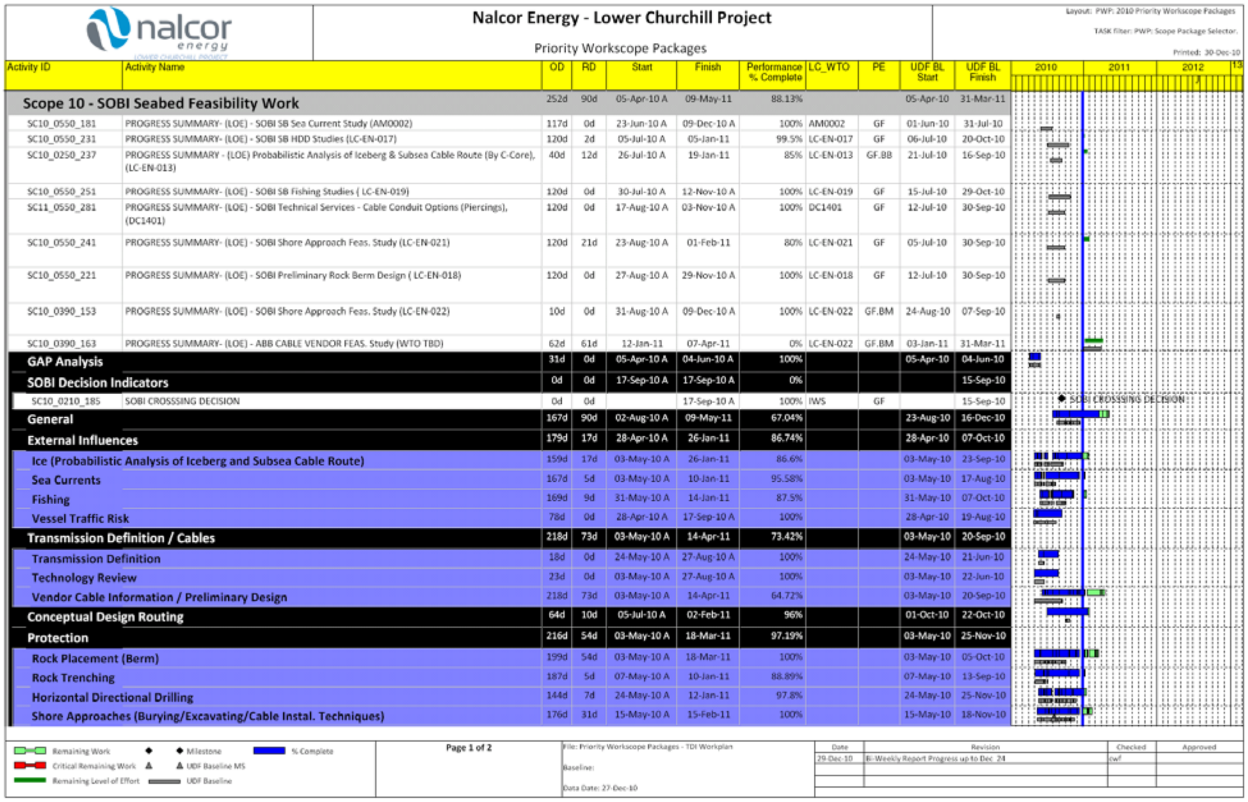


Figure 3 - Feasibility Study Execution Plan

The following is a summary of the schedule that was developed to progress the work. The detailed schedule is included in Appendix B.



Nalcor Energy - Lower Churchill Project

Priority Workscope Packages

Layout: PWP: 2010 Priority Workscope Packages

TASK filter: PWP: Scope Package Selector.

Printed: 30-Dec-10

Activity ID	Activity Name	OD	RD	Start	Finish	Performance % Complete	LC_WTO	PE	UDF BL Start	UDF BL Finish
Scope 10 - SOBI Seabed Feasibility Work		252d	90d	05-Apr-10 A	09-May-11	88.13%			05-Apr-10	31-Mar-11
SC10_0550_181	PROGRESS SUMMARY- (LOE) - SOBI SB Sea Current Study (AM0002)	117d	0d	23-Jun-10 A	09-Dec-10 A	100%	AM0002	GF	01-Jun-10	31-Jul-10
SC10_0550_231	PROGRESS SUMMARY- (LOE) - SOBI SB HDD Studies (LC-EN-017)	120d	2d	05-Jul-10 A	05-Jan-11	99.5%	LC-EN-017	GF	06-Jul-10	20-Oct-10
SC10_0250_237	PROGRESS SUMMARY - (LOE) Probabilistic Analysis of Iceberg & Subsea Cable Route (By C-Core), (LC-EN-013)	40d	12d	26-Jul-10 A	19-Jan-11	85%	LC-EN-013	GF.BB	21-Jul-10	16-Sep-10
SC10_0550_251	PROGRESS SUMMARY- (LOE) - SOBI SB Fishing Studies (LC-EN-019)	120d	0d	30-Jul-10 A	12-Nov-10 A	100%	LC-EN-019	GF	15-Jul-10	29-Oct-10
SC11_0550_281	PROGRESS SUMMARY- (LOE) - SOBI Technical Services - Cable Conduit Options (Piercings), (DC1401)	120d	0d	17-Aug-10 A	03-Nov-10 A	100%	DC1401	GF	12-Jul-10	30-Sep-10
SC10_0550_241	PROGRESS SUMMARY- (LOE) - SOBI Shore Approach Feas. Study (LC-EN-021)	120d	21d	23-Aug-10 A	01-Feb-11	80%	LC-EN-021	GF	05-Jul-10	30-Sep-10
SC10_0550_221	PROGRESS SUMMARY- (LOE) - SOBI Preliminary Rock Berm Design (LC-EN-018)	120d	0d	27-Aug-10 A	29-Nov-10 A	100%	LC-EN-018	GF	12-Jul-10	30-Sep-10
SC10_0390_153	PROGRESS SUMMARY- (LOE) - SOBI Shore Approach Feas. Study (LC-EN-022)	10d	0d	31-Aug-10 A	09-Dec-10 A	100%	LC-EN-022	GF.BM	24-Aug-10	07-Sep-10
SC10_0390_163	PROGRESS SUMMARY- (LOE) - ABB CABLE VENDOR FEAS. Study (WTO TBD)	62d	61d	12-Jan-11	07-Apr-11	0%	LC-EN-022	GF.BM	03-Jan-11	31-Mar-11
GAP Analysis		31d	0d	05-Apr-10 A	04-Jun-10 A	100%			05-Apr-10	04-Jun-10
SOBI Decision Indicators		0d	0d	17-Sep-10 A	17-Sep-10 A	0%				15-Sep-10
SC10_0210_185	SOBI CROSSSING DECISION	0d	0d		17-Sep-10 A	100%	IWS	GF		15-Sep-10
General		167d	90d	02-Aug-10 A	09-May-11	67.04%			23-Aug-10	16-Dec-10
External Influences		179d	17d	28-Apr-10 A	26-Jan-11	86.74%			28-Apr-10	07-Oct-10
Ice (Probabilistic Analysis of Iceberg and Subsea Cable Route)		159d	17d	03-May-10 A	26-Jan-11	86.6%			03-May-10	23-Sep-10
Sea Currents		167d	5d	03-May-10 A	10-Jan-11	95.58%			03-May-10	17-Aug-10
Fishing		169d	9d	31-May-10 A	14-Jan-11	87.5%			31-May-10	07-Oct-10
Vessel Traffic Risk		78d	0d	28-Apr-10 A	17-Sep-10 A	100%			28-Apr-10	19-Aug-10
Transmission Definition / Cables		218d	73d	03-May-10 A	14-Apr-11	73.42%			03-May-10	20-Sep-10
Transmission Definition		18d	0d	24-May-10 A	27-Aug-10 A	100%			24-May-10	21-Jun-10
Technology Review		23d	0d	03-May-10 A	27-Aug-10 A	100%			03-May-10	22-Jun-10
Vendor Cable Information / Preliminary Design		218d	73d	03-May-10 A	14-Apr-11	64.72%			03-May-10	20-Sep-10
Conceptual Design Routing		64d	10d	05-Jul-10 A	02-Feb-11	96%			01-Oct-10	22-Oct-10
Protection		216d	54d	03-May-10 A	18-Mar-11	97.19%			03-May-10	25-Nov-10
Rock Placement (Berm)		199d	54d	03-May-10 A	18-Mar-11	100%			03-May-10	05-Oct-10
Rock Trenching		187d	5d	07-May-10 A	10-Jan-11	88.89%			07-May-10	13-Sep-10
Horizontal Directional Drilling		144d	7d	24-May-10 A	12-Jan-11	97.8%			24-May-10	25-Nov-10
Shore Approaches (Burying/Excavating/Cable Instal. Techniques)		176d	31d	15-May-10 A	15-Feb-11	100%			15-May-10	18-Nov-10

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File: Priority Workscope Packages - TDI Workplan

Baseline:

Data Date: 27-Dec-10

Date	Revision	Checked	Approved
29-Dec-10	Bi-Weekly Report Progress up to Dec 24	cwf	

Figure 3 - Seabed Feasibility Summary Schedule

3.1 Documentation Review

A comprehensive documentation review was undertaken to understand all value added work completed prior to 2010. The scope involved reviewing all studies, reports, and project material for the past four decades. The objective was to identify all useful information that could be obtained from past studies, and identify gaps in the information. These gaps and opportunities were then incorporated into each of the individual sub-scopes for the HVdc cable crossing of the Strait of Belle Isle.

Through the course of the two month review, more than 100 reports, 70 drawings and maps, and 120 presentations were reviewed and assesed. An information and gap register was developed with over 850 line items for incorporation into the sub-scopes. This register is included in Appendix C.

3.2 Routing

The Strait of Belle Isle seabed crossing, although merely some 18 km from shore to shore, is extremely complex and poses numerous challenges for installation and protection that include sea currents, icebergs, pack-ice, tidal forces, hard rock sea bottom, varying water depths, fishing activities, and vessel traffic. Prior to the current task force's engagement to engineer a solution, two 0.5 km wide seafloor corridors were selected by a previous consultant, in cooperation with Nalcor Energy. This work was carried out in 2007. These routes have been cited as part of the environment assessment process. To minimize impact on the overall project schedule and prevent any environmental related re-work, the mandate of the team was to adhere to portions of the previously selected routing where technically feasible.

Analysis of various external influences and protection methods demonstrate that a portion of the easterly route selected in 2007 potentially poses a high level of risk and is, on a go-forward basis, not considered to be feasible for a seabed crossing unless there are new developments in iceberg risk compensation This is primarily applicable to the shelf area on the Labrador side that is located in an area of a higher risk for iceberg scour than the deep channel portion of the western corridor. In view of the above, the western corridor, combined with some portions of the easterly corridor, is preferred for the conceptual design seabed crossing route. Due to the ability to achieve deeper water in less distance from shore, an alternate route to Shoal Cove has been considered as the base case and will be carried forward in the environmental assessment process (refer to Appendix A)

To develop an adequate solution for the entire westerly corridor combined with portions of the easterly corridor, a zone approach was implemented. The route was divided into the following zones (refer to Figure 4):

- Labrador Landfall (Zone 1) – This zone starts on land that is nominally 150 to 1000 m from the shoreline, and extends to a water depth between 65 and 85 meters, near the Deepwater Channel. Protection in this zone is primarily required for tidal, pack ice, icebergs, and fishing.

- Deepwater Channel (Zone 2) – A nominally 400 – 750 m wide deepwater channel that starts on the Labrador side and runs to approximately the midpoint on the route. Protection in this zone is primarily required for vessel traffic (dropped objects) and fishing.

- Eastern Corridor (Zone 3) – A region of nominally 65 - 75 m water depth that runs from the Labrador Landfall to the Deepwater Basin. Protection in this zone is primarily required for vessel traffic and fishing and has a higher probability of iceberg scour.

- Deepwater Basin (Zone 4) – A region of nominally 100 to 120 m water depth that runs from Deepwater Channel to the Newfoundland landfall in both corridors. Protection in this zone is primarily required for vessel traffic (dropped objects) and fishing.

- Newfoundland Shore Approach (Zone 5) – This zone that is nominally 150 to 1000 m from the shoreline, and extends to a water depth between 65 and 85 meters. Protection in this zone is primarily required for tidal, pack ice, icebergs, and fishing.

These zones are depicted in the following schematic.

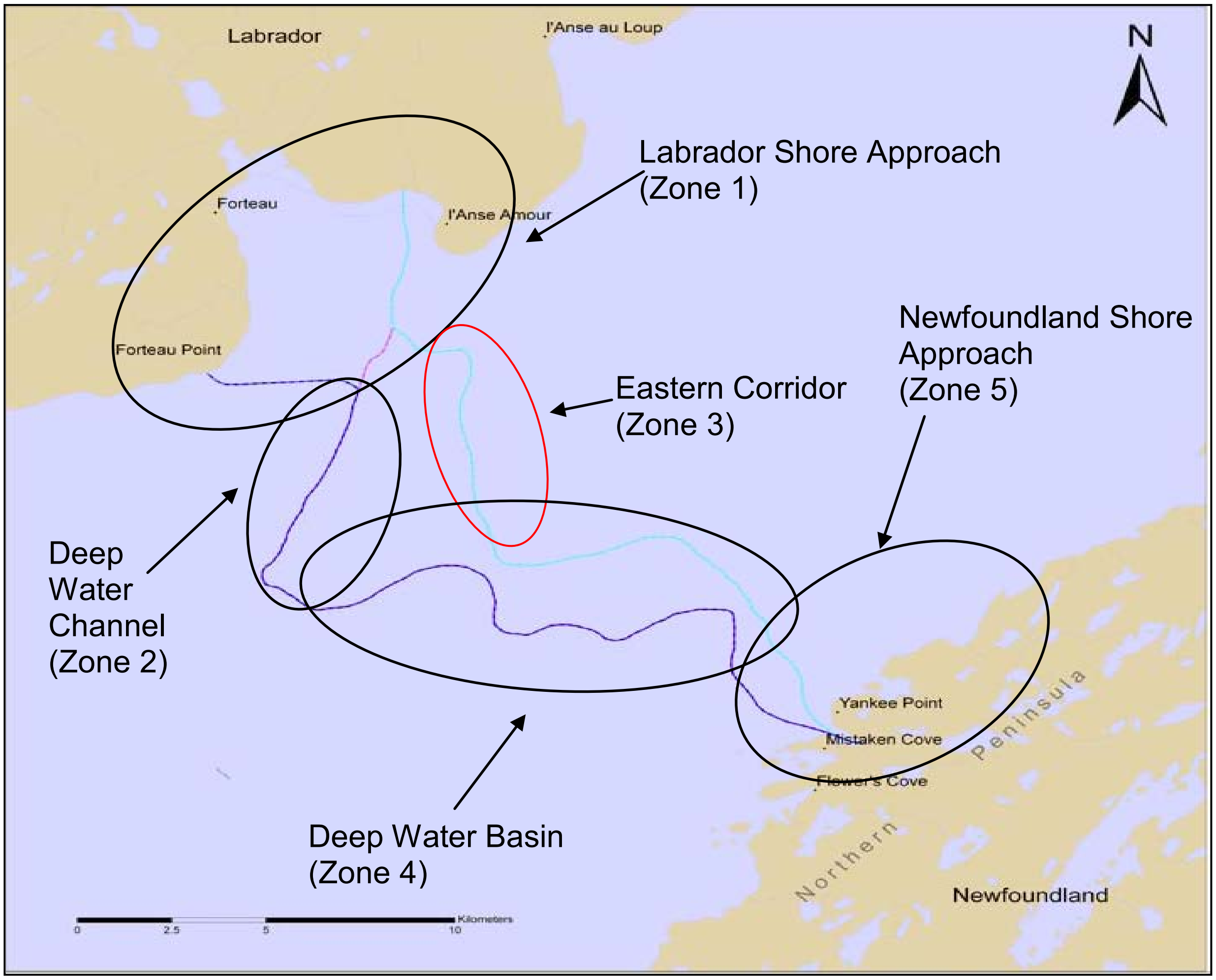


Figure 4 - Subsea Corridor Zones

Upon review of the current work status for the sub-scopes as detailed in Section 3.0, and owing to deliverables and indicators received as of December 2010 as described in that section, it was determined that the following is the recommended solution for the SOBI seabed crossing. The cable routing is as shown in Figure 3. This route takes into account the landfall and protection methods discussed in this report. The estimated length is approximately 36 km with roughly 32 km on the sea floor. The route is depicted as a 500 m wide corridor with a 1500 m diameter circular seafloor piercing target zone. Detailed cable spacing and routing will be carried out in phase 3 with a recommendation that a no fish zone be established.

This solution is feasible from a technical and schedule perspective. Developments and further engineering may result in a change in design through Phase 3.

The following sections outline the work performed for each component of the study execution plan. For all sub-scopes a work task order (WTO), a separate contract, or an internal research task was implemented.

3.3 Cables

An assessment of HVdc cable technologies to meet the transmission parameters, as outlined in the design basis, was commenced early Q2 2010. Extensive research into the cable industry in general, and more specifically, cable suppliers and relevant projects was carried out to gain an understanding of HVdc cables. Of the global cable manufacturers, ABB, Nexans, and Prysmian were selected as candidates for conceptual study work as they are the three leading HVdc cable manufacturers in volume and technology and have the proven track record when it comes to large-scale HVdc projects. These three vendors have all indicated that the solution definition as defined above is feasible for the SOBI.

To further establish the feasibility of existing cable technologies for SOBI conditions, a scope of work was developed to be issued to cable manufacturers for development of a conceptual level design. The scope of work issued included a comprehensive suite of input parameters. Each supplier was asked to perform preliminary design calculations and feasibility work, as well as to provide a cable recommendation for the SOBI criteria. Output specifications were requested and were to include all parameters pertinent to transmission, installation, protection, inspection, repair and maintenance.

3.3.1 ABB High Voltage Cables

The scope of work was issued to ABB on July 5th and ABB has since reverted with a detailed proposal. The proposal has been reviewed and accepted by Nalcor. A service agreement has been established and work will be completed by ABB in Phase 3.

To acquire information required for the SOBI decision, a site visit was carried out with ABB on August 24th in Karlskrona, Sweden at their engineering and fabrication facility. Meetings held included extensive details on design, supply, and installation for the project with ABB key personnel.

Of the three cable types being considered in the scope of work, ABB has indicated that oil-filled is not a viable option. Oil-filled cables carry the inherent environmental risk in the case of damage, and are considerably more complicated and expensive to produce.

Mass impregnated cables will be detailed in the scope of work and ABB will carry out appropriate design development where required. Mass impregnated cables can meet the transmission requirement established for the project, and the acceptable level of reliability for the link. Mechanical, electrical, and thermal specifications for mass impregnated cables meet the requirements as established in the solution definition for seabed cable installation. ABB has an excellent cable manufacturing track record, with no reported failures due to manufacturing defects for protected cables. Budgetary costs are included in Appendix D.

Cross-linked polyethylene (XLPE) insulated cable design will also be developed on a conceptual level for the SOBI crossing. ABB has recommended XLPE as they favor the technology from both a manufacturing and installation perspective. Type testing has been completed for 320 kV, which included 1 year long term aging tests. XLPE cables at this voltage have not yet been installed; however budgetary costs are included in Appendix D (Same as above).

ABB has indicated that the installation of HVdc cables in the Strait of Belle Isle is feasible according to the solution definition and installation criteria including HDD pull-in.

ABB has indicated that a 2-3 year booking lead time for a factory slot is necessary to ensure timely delivery of cable product. This is subject to market conditions and is likely to change given the large number of potential upcoming submarine cable projects. Given the current market conditions, it was recommended that a factory slot should be booked in Q4 2011 or Q1 2012, to meet a 2015 installation window.

3.3.2 Nexans Norway AS

The scope of work was issued to Nexans on June 29th. Upon review of the scope, Nexans indicated that they would not require a contract to execute the study work as they considered it typical of a budgetary exercise. Nexans commenced work on the scope during early August.

A site visit with Nexans was carried out on August 26th-27th to discuss cable design, supply, installation, and protection. Their head office is located in Oslo, Norway where installation and design discussions occurred. Further design, installation, and manufacturing details were discussed at their fabrication facility located in Halden, Norway.

The insulation type to be investigated as part of Nexans' study work will be Mass Impregnated. Oil filled cables have been described by the company as being least desirable for application in the Strait of Belle Isle, due to environmental concerns and costly design and manufacturing processes. XLPE will also not be considered by Nexans as a viable option for the Strait of Belle Isle. Nexans sights concerns regarding the time proven reliability of XLPE. 150 kV XLPE cables have been type tested and qualified by Nexans, but they have currently not produced a cable for a project with a higher voltage.

As per Nexans commentary, mass impregnated type cables are a well proven technology. Nexans has an excellent mass impregnated cable manufacturing track record, with no reported failures due to manufacturing defects for adequately protected cables. A cable recently recovered and tested that was installed in 1975 indicated no signs of degradation within the core, insulation, and armoring.

The Nexans recommendation for our project is mass impregnated type cables. These cables will meet and exceed the requirements as defined in the solution definition and installation criteria including HDD pull-in. Reference email in Appendix E. Budgetary costs for an MI cable with increased armor layers are included in Appendix F, along with the double armor layered cable that can meet our pull-in requirements. An MI cross-sectional breakdown for a cable with 2 armor layers is shown in Appendix G.

Nexans representatives state that a minimum of two years is required to book a factory slot, ideally in 2012 to meet the 2015 installation schedule. Nexans indicated that there are several projects on the horizon with thousands of kilometers of cable, many of which have target installation campaigns in the 2015-2016 installation seasons.

3.3.3 Prysmian Powerlink

The scope of work was issued to Prysmian on June 29th, 2010. Upon review of the scope, Prysmian indicated that they would not require a contract to execute the study work as they considered it typical of a budgetary exercise. Prysmian commenced work on the scope in early August.

Preliminary information regarding pulling tension and cable type was received on August 19th. This information confirms the HDD pull-in is feasible from a cable mechanical design perspective. Refer to Appendix H. On September 1st, the preliminary cable design was received from Prysmian. A design review was held with the company on Sept. 2nd. Refer to Appendix I for Prysmian cable design deliverables. Prysmian have indicated that the solution definition outlined above is fully feasible for MI cables. Prysmian currently has no track record for XLPE above 200 kV, but they are currently in the process of developing 320 kV, and have successfully type tested at 300 kV. A variation on the MI cable design is Polypropylene Laminate insulation which is designed to withstand higher temperatures and an onerous service level higher than that of MI. Budgetary costs are located in Appendix J with pricing for both Aluminum and Copper conductors.

Prysmian's offices and factory are located in Milan and Naples, Italy, respectively. They have stated that a minimum of 2 years is required for a factory slot booking, or at best 2012 to meet the 2015 installation schedule.

3.4 Transition Compounds

To understand how the cables terminate at each end, research was conducted into the details of the Transition Compound. A formal scope of work was not issued to a contractor as Transition Compounds as the topic of Transition Compound design was included during discussions with the cable manufacturers.

The investigation indicated that all three cables will terminate at a Transition Compound on each side of the SOBI. It is envisaged at this time that the cables will be pulled to shore and subsequently land trenched to the transition compound location, which will be located 150 m to 1000 m from each shoreline. The compound will house the cable terminations, as well as any switch gear that is required for system operation. Actual footprint and height of the compounds are still under investigation and are based on isolation requirements and installation techniques, however, at 320 kV, it is recommended that the terminations, at a minimum, need to have 3 m spacing.

End terminations for each cable will reside inside the Transition Compound, and will be inclusive of the stand, insulator, and ancillary equipment. All equipment associated with the end termination will be supplied and installed as part of the cable supply contract.

Further work will be undertaken to completely understand the all requirements for design and erection of the Transition Compounds.

3.5 Insulation Types and Conversion Technology

The European suppliers have indicated that XLPE is only appropriate for VSC technology, and not LCC. With VSC technology, power flow can be reversed without reversing polarity, and this can happen many times per day. LCC on the other hand, must invert polarity with power direction changes. With polarity inversion, stress application doubles therefore giving high risk of accelerated insulation breakdown with XLPE.

One of the three Asian manufacturer's, JPower, have indicated that their XLPE technology is different from that of the European suppliers and can withstand polarity reverses. They have stated that type tests have been completed and can be provided.

3.6 Integrated Fiber Optic Cable Installation

Installation of a fiber optic cable can be carried out in parallel with the cable installation by one of two means: Firstly, the fiber optic cable can be a separate cable and bundled by straps during installation to the HVdc cable as it is overboarded. To accommodate pull-in through the HDD borehole, the fiber optic external cable could be un-bundled for that length of the cable, and would have to be pulled in through a fiber optic dedicated borehole.

Secondly, the fiber optic cable can be made internal to the HVdc cable by one of two means; immediately external of the lead sheathing, and beneath the extruded polyethylene sheath or, by replacement of one or two of the armor wires. Some concerns have been raised with this method including damage to the fiber optic cable when the HVdc cable is in high tension and during manufacturing.

3.7 Burial Depth of Cables in HDD Boreholes

When designing cables for burial in HDD boreholes, the depth of burial and the thermal resistivity of the surrounding rock or soil must be known for detailed design of HDD boreholes. Boreholes that are too deep or thermal resistivity values that are too high can limit the ability of the cables to achieve rated transmission capacity. Further geotechnical investigation must be completed to determine thermal resistivity of the rock/soil surrounding the boreholes in order to design the cables. Borehole trajectories must be finalized through an interface process with cable supplier.

3.8 External Influences

External influences cover factors that pose a risk to the cables during the initial installation phase and throughout service life. These factors will have an influence on

Protection Methods, Cable Routing, Installation Methods, Cable Design, and Inspection, Repair and Maintenance (IRM). It was identified in the documentation review that further work was required to understand external influences that include icebergs, sea currents, vessel traffic, and fishing gear. Studies were undertaken to quantify the extent of these external influences, the details of which are included in the sections below.

3.8.1 Icebergs

As icebergs pose a significant risk to the installation and long term operation of the subsea cables, it is important to understand the probability of an iceberg coming into contact with the bottom and thus the installed cable.

In the past studies have noted a maximum depth that icebergs can scour the sea bed with water depths that range from 60 m to 110 m. The studies that have indicated a shallower max scour depth have provided a qualitative rationale to justify the numbers, while the reports that have indicated the deepest max depth have used theoretical situations and calculations without discussing the probability of such an event occurring, or are based on individual observations and not measurements. Thorough the literature review the majority of reports indicate that icebergs should only be considered a threat up to a depth in the range of 60-80 m. To be conservative this concept design is using 80 m and less to be the basis of protection for icebergs. As icebergs are further understood, this value may be revisited.

As an initial step to understand icebergs further, a study was conducted by C-Core to create a mathematical model to predict the occurrence of iceberg scour and provide a probability of impact along the proposed cable route. The study takes into accout all the most recent bathymetry and iceberg information. As part of this work, an iceberg scour database was generated. The results of this report can be found in Document number ILK-CC-CD-8110-EN-RP-0001-01 titled “Iceberg Risks to Subsea Cables in Strait of Belle Isle”.

The report indicates that the probability of impact between icebergs and the bottom (or a cable on the seafloor) is reduced with water depth.

The final depth to which protection will be provided for iceberg scour will be decided when all study work, including potential iceberg observation programs, is completed and will be based on a probability analysis of impact. It is recommended that throughout the design, icebergs be studied further and the model updated as more information become available.

3.8.2 Sea Currents

There had been several studies in the past that reviewed the sea currents in the Strait of Belle Isle. These studies provided snapshots into the currents at various locations along the Strait and were conducted for various durations at various times of the year. In addition to the results of the monitoring, there were attempts to predict the maximum currents that may be experienced in the Strait.

Most recently, in 2007, these reports were compiled in a summary report that described the environmental conditions in the Strait of Belle Isle. However, this report did not provide concise summary of the sea currents.

A study was undertaken by AMEC in summer 2010 to provide a summary of the expected average and maximum currents for the various seasons at near surface, mid depth and near bottom of the Strait. This report is intended to provide an overview that can be used as an input into the preliminary design and for accessing the constructability of the subsea crossing.

The report “Summary of Ocean Current Statistics for the Cable Crossing at the Strait of Belle Isle” ILK-AM-CD-0000-EN-RP-0001-01 has been received by Nalcor which provides average and maximum currents by season. The results from the report have been considered in the installation and protection methodologies. It is recommended that further current monitoring be carried out in the design phase.

3.8.3 Vessel Traffic

The Strait of Belle Isle is a commercial shipping route therefore, traffic in the route is monitored and records maintained. The Canadian Coast Guard was contacted and has provided a listing of the commercial vessel traffic over the past two years. This information has been used as an input into the cable protection design. Additionally, as the source of this information is established, ongoing and/or longer term records can be obtained should they be required (refer to Appendix K).

3.8.4 Fishing Gear

A significant amount of information regarding fishing activity has been obtained from a socio economic and environmental perspective, however recent information regarding fishing activities and gear utilized in the SOBI area was not available.

Canning and Pit Associates were contracted to execute a study on the current fishing gear and activities relating to the protection of the submarine cable.

The report “Review of Fishing Equipment – Strait of Belle Isle” ILK-CP-ED-0000-EN-RP-0001-01 has been received by Nalcor and indicated that the primary fishing activity in the Strait of Belle Isle is that of scallop fishing. This report provides information on the frequency of trawling activities, the types of gear and the potential impact forces that may be encountered due to the gear. See Appendix L for report

3.9 Protection Methods

3.9.1 Horizontal Directional Drilling (HDD) Landfall

Horizontal Directional Drilling (HDD) is a method of drilling a borehole with a shallow entry angle, controlling the route of the drilled hole and exiting the surface at a controlled location. For the SOBI application, the drilling equipment will be set up on shore and will drill out under the landfall zone and continue below the seafloor to its exit point. Once complete, this borehole will be used as a conduit for the HVdc cable to be pulled through.

Hatch Ltd. (Hatch Mott MacDonald - HMM) was contracted to complete a feasibility study of using HDD as a means of protection for the cables. This study "Feasibility Study for the Strait of Belle Isle" H336344-RPT-CA01-250 provides an assessment of current horizontal directional drilling technology to provide a conduit out to waters of significant depth to avoid the risk associated with pack-ice impact / scouring and to reduce the risk of iceberg impact to an acceptable level. Along with providing the feasibility of drilling the required length, this study addressed constructability and provides a construction schedule and cost estimate.

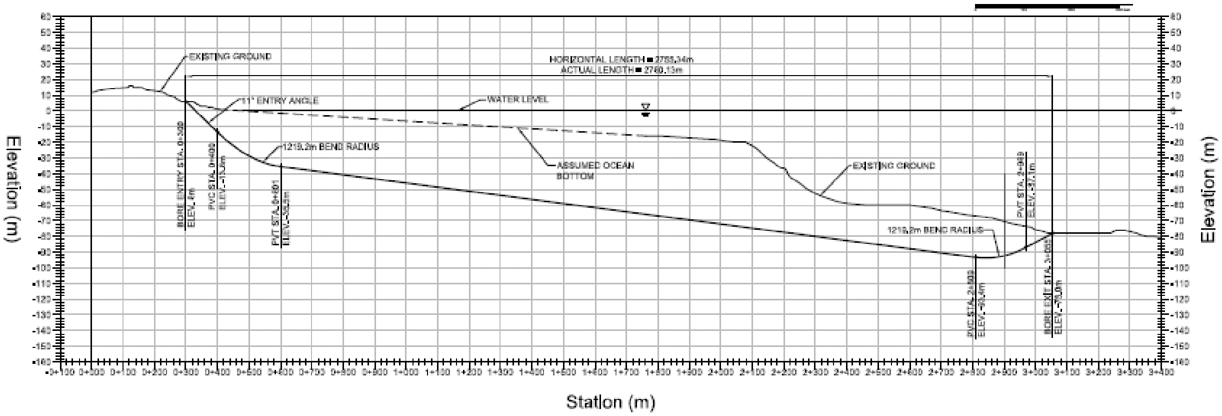


Figure 4 - Concept HDD Route

The report has confirmed that a HDD bore hole, complete with steel liner drilled to 80 m water depth is feasible on both sides of the strait. It has identified a concept profile for both sides as shown in Figure 7, with lengths of 1.2 km on the Labrador side and 2.7 km on the Island side. Reference Appendix M for details.

3.9.2 Rock Placement

The primary method of protection of the cable between the boreholes is by means of constructing a rock berm over the cables. This berm will provide on bottom stability of the cable and will provide protection from fishing activities.

A preliminary rock berm design was completed by Tideway "Lower Churchill Project Rock Berm Concept Development Study Report" document number ILK-TW-ED-0000-EN-RP-0001-01. The report has indicated that a berm is constructible in the conditions that are likely to be experienced in the Strait of Bell Isle. It also addresses minimum design rock cover and includes cost estimates.

3.9.3 Trenching

Trenching has been heavily investigated for the Strait of Belle Isle and can be appropriately broken into two categories, namely, rock and soft sediment trenching. A scope of work was developed to understand trenching capabilities globally from a supply and technical limits perspective. The scope of work centered on rock trenching as a potentially feasible solution for cable protection in the Strait seafloor conditions.

Extensive research was carried out as to who the vendors were that possessed the technology to trench in hard rock conditions. It was determined through correspondence and discussions with industry experts that no such technology exists. Currently there are only general concepts that have not been proven in rock over 60 MPa. Two of the most powerful trenchers in the world today are the RT-1, owned and operated by CTC Marine, and the Asso Trencher IV, owned and operated by Asso Divers. These trenchers are capable of cutting rock up to a UCS value of 60 MPa. See Appendix N for specs on the RT-1 and Asso Trencher IV.

Soft sediment trenching on the other hand, is utilized extensively on submarine cable projects throughout the world. The technology is very well established and there are numerous companies that supply and operate soft sediment trenching technology. Among the companies with the largest and most powerful equipment, and installation vessels, resides CTC Marine, Asso Divers and LD TravOcean.

Trenching could be considered as an optimization method for cable protection in the Strait of Belle Isle. A very high percentage of the seafloor on the designated cable route consists of bedrock with minimal overburden. The portions with overburden deep enough for cable burial are minimal, but the depth maybe be sufficient to protect the cable in an optimization scenario pending detailed design. Further investigations into company equipment are required to provide confirmation of suitability for Strait of Belle Isle conditions.

3.9.4 Trenched Landfall

The traditional landfall has been considered as a potential alternative to HDD.

The world leaders of landfall design, Royal Boskalis Westminster N.V and Tideway Offshore Contractors have been awarded a scope of work detailing landfall methodology. Nalcor Energy conducted a visit to the Netherlands with Boskalis and Tideway to discuss the potential for a trenched land fall in the SOBI.

A traditional landfall consists of cable protection from shore through the water line to approximately 20 m water depth. The envisaged protection would include three individual trenches excavated using a backhoe dredger with the possibility of drilling and blasting at locations of highly competent bedrock. Due to the amount of rock that would have to be excavated there is a possibility that drilling and blasting would be completed in a previous season or that two sets of equipment would be mobilized to complete the installation in one season. The feasibility and detail of the trenched landfall is provided in:

- Boskalis Shore Approach Feasibility Study - Strait of Belle Isle (SOBI) cable crossing – ILK-BV-ED-0000-EN-RP-0001-01
- Tidway Shore Approach Feasibility Study Report - ILK-TW-ED-0000-EN-RP-0002-01

3.9.5 Shore-based Tunnel with Seafloor Piercing Landfall

The report DC1130 “Submarine Cable-Strait of Belle Isle – Design, Method, Cost and Plan” which was executed by Stanett SF of Norway in 2007 / 2008 on a subcontract to Hatch Ltd. recommended that, as the preferred crossing solution, a 1.5 km long shore-based tunnel be constructed on the Labrador side of the Strait. The tunnel would extend out underneath the seabed to a point where the water depth above the termination of the tunnel would be 70 m. The 70 m water depth was based on that being the depth required to avoid iceberg impact on the cables. The subsea tunnel itself would terminate some 75 meters below the seabed. Microtunnels would be drilled vertically upwards from the end of the main tunnel to pierce the seabed. From there, the HVdc cables would be pulled-in to the shore-based tunnel through the microtunnels and therein joined to HVdc cables that would have already been installed in the main tunnel downward from the landward end. Special means would be taken to seal the microtunnels (i.e. using J-tubes / packers) to preclude the ingress of seawater into the main tunnel. The noted report also recommended the above approach as an option on the Newfoundland side of the Strait wherein the shore-based tunnel would need to be some 3.3 km long to reach the same water depths.

It was indicated in the referenced report that subsea tunnel to seafloor piercings are a common and mastered technique.

In 2010 a scope of work was developed to further investigate the technical feasibility of utilizing this technology in the SOBI. The scope was issued to Statnett. A main focus of the scope was for Statnett to provide further / definitive information regarding the ideas and concepts described and recommended by them in DC1130.

Part 1 of the noted report has been received. It is very clear from the report that the recommendations made by Statnett in the 2008 study essentially have no precedent. The report specifically states that “*this method has not been applied for a power cable before”.* It also notes that, with respect to the Troll A gas platform constructed in the 1990’s, the concept was considered but was not implemented. With respect to the sealing arrangement that would need to be implemented for the SOBI solution, the report notes that “*there is up to now no direct reference for the potential SOBI case where it would be a need for sealing against ca 7 bar water pressure”*. There has been an example of a project that utilized a subsea piercing for a gas pipeline pull-in, but presently this technology is not easily transferred to HVdc cables.

Following the completion of Part 1, Part 2 was also received from Statnett. With the additional details contained in Part 2, which was an elaboration of Part 1, there is still no precedent for applying this method to the Strait of Belle Isle.

Preliminary discussion with the 3 major cable vendors involved in the conceptual design have indicated that they have not executed, nor have any knowledge of projects where cables have been installed through a piercing of this nature.

See Appendix O for further details.

3.9.6 Micro-Tunneling Landfall

Microtunneling is a process that uses a remotely controlled Microtunnel Boring Machine (MTBM) combined with the pipe jacking technique to directly install product pipelines underground in a single pass. Nalcor Energy has investigated the feasibility through consultation with Tideway and has determined that micro-tunneling to the depths needed for the SOBI crossing are outside the limitations of today's technology. There remains a possibility of incorporating a more in depth study of the technology into existing landfall SOW to detail current and future micro-tunneling technologies.

3.9.7 Other Local Protection Technologies

For locations of potential increased risk several different options including combinations of protection methods can be utilized. Concrete mattresses consist of high strength concrete segments linked together with a network of high strength polypropylene ropes to form a continuous flexible concrete barrier. The designs vary from different suppliers however a local company, Pro-Dive Solutions, offers various designs outlined in Appendix P. Concrete mattresses are used for protection from external forces throughout the cable and oil and gas industry. The design can be made as robust as needed for the application of protection. Installation can be performed from a light intervention vessel with an adequate crane and an ROV.

Another form of mattressing is the Continuous Operating Protection System (COPS) offered by LD TravOcean. COPS is a system which is designed to lay a continuous concrete mattress of approx 500 m length each on the seabed over the cable. The grout is mixed on a support vessel and pumped down to the subsea crawler (remotely operated) to fill the mattress. Details of the COPS are outlined in Appendix Q.

Articulated steel half shells can be utilized as primary protection if bolted to the seabed bedrock using saddle clamps. The articulated pipes can also be used as secondary protection underneath mattresses or rock dumping in high iceberg return period scour locations along the SOBI Lay route. Several possible companies exist that provide this service including AHMTEC Cable Protection Systems and Vos Product Innovations BV. Refer to Appendix O and P for further information and correspondence regarding the articulated pipe protection.

3.10 Installation and Marine Operations

The current installation philosophy consists of the installation of three HVdc cables, each with one subsea joint, from a Cable Installation Vessel (CIV). Cable installation vessels that have been considered for this project are outlined in section 3.9.1.

The envisaged process includes transpooling the cables onto a capable CIV from the manufacturing plant and transporting to field. Possible manufacture locations are outlined in section 3.2 but are not limited to these specific sites. Cable installation will commence subsequent to the completion of all HDD bore holes to limit scheduling risk.

Initiation would consist of the abandonment of the first end (capped by a pulling head or prepared with Kellems Grips) at the location of the first bore hole on either side of the SOBI. Details of the HDD bore hole configuration are illustrated in section 3.8.1. A line from a high powered winch located onshore will be passed through the bore hole to the opening on the seafloor. An ROV will be utilized to secure the pulling head to the winch line and the vessel will pay out as the winch hauls the cable through the bore hole. Once the cable is secured onshore the CIV will perform normal lay to the proposed joint location and the cable 2nd end will be abandoned. The process would be repeated from the opposite side of the SOBI until both cable 2nd ends are positioned at the joint location.

There remains a possibility that the pull–in tensions will be above the limit of the cable. In this instance the cable could be fed down through the bore hole. The potential for this occurrence is highest at the Newfoundland side. The location of the joint would then be located close to the exit on the Newfoundland side.

Sufficient overage (~ 3 x water depths) would be included in the cable length to allow for the jointing operation. The full jointing operation details are incorporated in the IRM section 3.9.4. Protection removal and r einstatement is not applicable during initial installation. The general procedure includes recovery of the initially abandoned cable to the CIV and positioning both ends parallel to each other in the jointing house on deck in preparation for jointing activities. A jointing house, specified in section 3.9.4.2, will be included on the CIV. Subsequent to the jointing activity the joined cable would be abandoned using an A-Frame or similar device and abandon in an ohm shape.

Alternate Installation methodologies for the additional landfall technologies are understood and considered standard in the industry.

The installation for a traditional shore approach could include such technologies as a Seaserpent Cable Flotation for cable control due to currents. Details of the Seaserpent Cable Flotation system are illustrated in Appendix T. Included in the normal lay section could be the addition of articulated pipe for localized protection for potentially increased risk sections. This is normal practice and has minimal impact on lay speed.

Increased cable segmentation may be considered the optimal solution if the limitations of vessels, carousels reels or transportation deem necessary. This would increase the time of normal lay significantly, however shouldn’t impact first power.

This installation methodology has been formed from the contribution of consultations with Nexans, Prysmiam, ABB, Global Marine, Scanmudring, Five Oceans Limted, Boskalis, Tideway and Van Oord as well as research into technologies.

3.10.1 Cable Installation Vessels

Cable installation vessels have been examined considering the SOBI cable installation applicability. The equipment and s pecifications have been ex amined in detail and a re either currently capable or would be capable with a few inexpensive, standard alterations. The following vessels are considered as viable cable installers:

Vessel	Owner	Charter
Gulio Verne	Prysmian Powerlink	Prysmian Powerlink
Skagerrak	Nexans AS	Nexans AS

Team Oman	Team IV Ltd.	ABB
Cable Innovator	Global Marine System Ltd.	Global Marine System Ltd.
CS Sovereign	Global Marine System Ltd.	Global Marine System Ltd.
North Ocean 102	North Sea Shipping A/S	McDermott
Stemat Spirit	Visser and Smit Marine Contracting	Global Marine System Ltd.
M/V Elektron	Statnett Elecktron AS	
Teliri	Elettra TLC SPA	Elettra TLC SPA
ASEAN Explorer	ACPL Marine Pte. Ltd.	ASEAN Cableship
ASEAN Restorer	International Cableship Pte. Ltd	ASEAN Cableship
CS Teneo	Tyco Telecommunications	Tyco Tellecommunications
CS Global Sentinel	CS Global Sentinel LP	Tyco Tellecommunications
Emerald Sea	McDermott International	McDermott International

In depth datasheets and details of the above vessels are included in Appendix U.

Boskalis and Tideway are in the process of converting the Seahorse into a cable installation vessel. Tideway is also constructing the conversion of the Rolling stone into a cable installation vessel. These vessels will have a high cable capacity compared to today's standards.

To satisfy a turnkey manufacture and installation campaign, the cable suppliers outlined in section 3.9.1 would need a capable Cable Installation Vessel. As indicated above the Installation requirements will be fully satisfied by the Nexans Skaggerrak cable installation vessel. A detailed review of the vessel capabilities and installation of techniques was carried out while members of the team visited Halden, Norway. The extensive specifications are outlined in Appendix V.

ABB could use the Team Oman or the Aker Connector as installation vessels for the Strait of Belle Isle, dependent upon market conditions and availability. The Aker Connector details are not yet available as the vessel is not scheduled for completion until 2012.

Prysmiam would incorporate the highly capable Gulio Verne.

3.10.2 Other Intervention Vessels

The majority of CIV's have smaller intervention vessels on board to assist with termination and initiation onboard. Therefore, in this event, other intervention vessels are not needed. Maersk and Atlantic Towing currently have a fleet of intervention vessels that are experienced with subsea intervention. These companies also provide guard or patrol vessel for installation and protection activities.

3.10.3 Transportation

The transportation of cables in their entirety as well as the transportation of all installation equipment would ideally and likely be completed by the CIV. If there was an excess of cable or equipment a contracted barge would be fully capable to assist. Adequate barges with substantial deck space are available through Giant Marine, Jumbo Shipping and Big Lift Shipping.

3.10.4 Inspection, Repair, Maintenance (IRM)

3.10.4.1 Inspection

The envisaged inspection program will consist of a General Visual Inspection (GVI) campaign by ROV for 3 consecutive years post installation. This inspection will have emphasis on rock berm deterioration and general anomalies. The GVI campaign will be re-addressed following the 3 consecutive years to determine how frequent the inspection will need to be performed.

3.10.4.2 Repair

As losses of income are high for each day subsequent to a fault it is imperative that all steps for the repair are in place prior to damage. Subsequent to a fault the succeeding steps are generally followed:

- Fault Finding
- Securing of repair vessel contract
- Planning of repair operation
- Mobilization of repair vessel and equipment
- De-burial of the faulty cable portion
- Loading of spare cable and jointing kit
- Jointer crew embarks
- Repair effected and protection re-established.

Fault Finding

A number of methods for fault location are available. Cable damage can range from high-ohmic fault to low-ohmic insulation damage or a possible complete rupture of the cable.

Time domain reflectometry (TDR) is based on an electric impulse, which is sent into the faulty cable conductor. Knowing the impulse propagation velocity, one can calculate the distance to the fault by measuring travel time.

Bridge measurements are based on resistance measurements in the conductor from one cable end to the fault.

The above methods will find a fault within a few percentage points of the overall length. For a 35 km cable this generalizes the fault to a 350 – 750 m length location. For fine localization a signal current can be sent into the conductor from shore. At the cable fault the signal current exits through the damaged insulation which creates a difference in magnetic field on both sides of the fault location. A search coil on-board of the search vessel records the characteristics of the magnetic field from the signal current and records a significant change in signal intensity. The search coil can be mounted on an ROV for finer accuracy. The accuracy of this method is twice the water depth from coil location; therefore if the coil is located on an ROV the fault can be located within a couple of meters.

Spare Cable / Equipment

Spare cable in the magnitude of 2.5 - 5 percent of the installed length will be manufactured with the full length cables as well as a joint kit which would include a paper wrapping machine, soldering equipment and a lead tube.

Preparation for Recovery

Scanmudring has provided information on rock berm removal for cable repair and has proven feasible in the SOBI environment. The ROV that would be used for this operation is the Scanmaskin. Details of equipment and general costs are outlined in Appendix W. The Scanmudring equipment can be utilized on a cable installation vessel used for the repair or on an independent vessel.

Water jetting equipment can also be utilized as a less invasive and perilous alternative. The size of rock that is currently proposed is within the capabilities of such equipment.

If a fault occurs within the bore hole the cable would be cut at the mouth of the bore hole and the winch and winch line utilized during installation would be operated to and attached to the cable head while the cable vessel recovers the cable to deck. The operation would then be consistent with the current repair procedure with the winch and winch line reinstating the cable subsequent to the repair.

Repair Vessel

The vessel used for repair would be a cable lay vessel. The load capacity would eclipse the weight of handling the spare cable and handling equipment. Specifications for the vessel include a large open deck with sufficient space for the jointing house, cable engines, winches, cranes etc. A turntable or cable hold for the spare cable must be installed on the vessel as well as chutes to deploy the cable and joint overboard. The vessel must be equipped with an ROV for recovery. The environmental conditions and proximity to land for this project dictate that the repair vessel would be Dynamic Position (DP) equipped.

Repair Operation

The repair procedure completely depends on the depth and location of the fault. The location of the fault for the SOBI HVdc cable can occur in one of two scenarios. It could be located in the horizontally directionally drilled (HDD) bore hole or buried underneath the rock berm. A generic repair operation would consist of the following:

The cable is cut at the fault site. Cutting the cable can be completed with an ROV cutting tool as well as a cutting grapnel that is deployed similar to an anchor and dragged along the line. The faulty section of cable could be several hundred meters in length depending on the damage. The repair vessel would position itself over the cut section of cable that has both ends prepared with a transponder, a ground and ROV friendly clamp ensuring no water ingress. The repair vessel then would proceed to recover one end of the existing cable and position it in the jointing house. The jointing house can often be positioned bow to stern or port to starboard and this directly affects the position of the carousel as the spare cable and existing cable must be parallel in the jointing house to join. Subsequent to the jointing the joint and the spare cable must be laid as the repair vessel travels to the location of the other cut end of the existing cable. Recovery is performed similar to the recovery of the other end. The existing cable must be deflected around a structure that can deploy the cable after the join has been laid. The repair vessel would have a standard method of cable deployment. This structure is built for purpose and is determined from the deck layout. The spare cable section would be laid down in an ohm like overage loop.

Nexans has provided Nalcor Energy with their general description of a repair operation or the Nexans Skagerrak vessel. This general description is detailed in Appendix Y.

The Scanmaskin would then be available to reinstate the rock berm protection on the cable and for the overage loop other local protection technologies outlined in section 3.8.7 would be utilized either during abandonment (articulated pipe) or subsequent to abandonment.

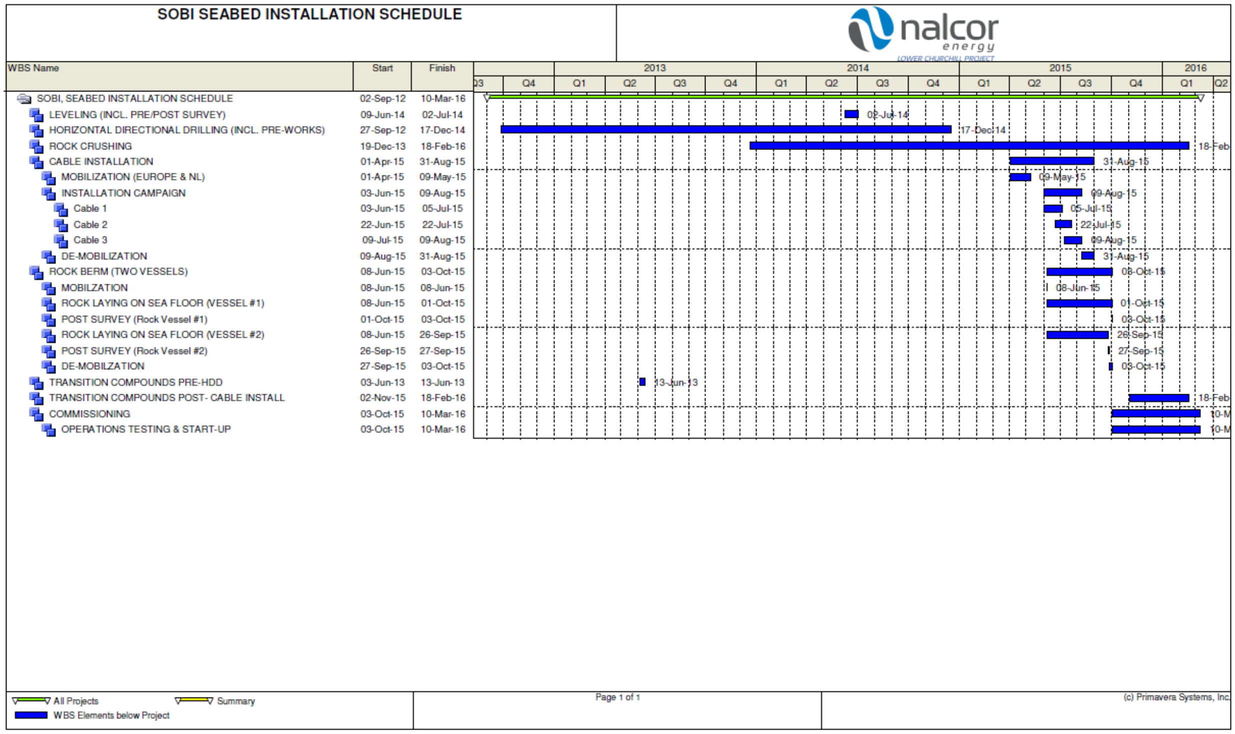
4.0 Qualitative Risks

A Westney Risk Assessment has been completed and the major risks identified. The document is live and will be updated as necessary.

5.0 Commitments and Construction Schedule

Long lead commitments, comprised of cable procurement factory slots and vessel booking, are required to achieve the desired construction schedule. As indicated by all three major cable vendors, the timing to place an order for cables and vessels slots to meet the 2015 installation season is currently late 2011 through early 2012. If seabed cable installation progresses, slot and vessel availability will be closely monitored to identify opportunities and threats to the commitment schedule.

For seabed cable installation two schedules have been considered, a two season aggressive installation schedule (2015 and 2016) and a three season window conservative installation schedule (2014, 2015, and 2016). There is no difference in work duration between the schedule options, however, the three season schedule completes installation early and allows for work roll-over into the 2016 season. For the purpose of this comparison the conservative 2014 start construction schedule has been selected. The following is the high level construction schedule. The detailed schedule is included in Appendix Z.



SOBI SEABED INSTALLATION SCHEDULE

WBS Name	Start	Finish
SOBI, SEABED INSTALLATION SCHEDULE	02-Sep-12	10-Mar-16
LEVELING (INCL. PRE/POST SURVEY)	09-Jun-14	02-Jul-14
HORIZONTAL DIRECTIONAL DRILLING (INCL. PRE-WORKS)	27-Sep-12	17-Dec-14
ROCK CRUSHING	19-Dec-13	18-Feb-16
CABLE INSTALLATION	01-Apr-15	31-Aug-15
MOBILIZATION (EUROPE & NL)	01-Apr-15	09-May-15
INSTALLATION CAMPAIGN	03-Jun-15	09-Aug-15
Cable 1	03-Jun-15	05-Jul-15
Cable 2	22-Jun-15	22-Jul-15
Cable 3	09-Jul-15	09-Aug-15
DE-MOBILIZATION	09-Aug-15	31-Aug-15
ROCK BERM (TWO VESSELS)	08-Jun-15	03-Oct-15
MOBILZATION	08-Jun-15	08-Jun-15
ROCK LAYING ON SEA FLOOR (VESSEL #1)	08-Jun-15	01-Oct-15
POST SURVEY (Rock Vessel #1)	01-Oct-15	03-Oct-15
ROCK LAYING ON SEA FLOOR (VESSEL #2)	08-Jun-15	26-Sep-15
POST SURVEY (Rock Vessel #2)	26-Sep-15	27-Sep-15
DE-MOBILZATION	27-Sep-15	03-Oct-15
TRANSITION COMPOUNDS PRE-HDD	03-Jun-13	13-Jun-13
TRANSITION COMPOUNDS POST- CABLE INSTALL	02-Nov-15	18-Feb-16
COMMISSIONING	03-Oct-15	10-Mar-16
OPERATIONS TESTING & START-UP	03-Oct-15	10-Mar-16

Figure 5 - SOBI Seabed Installation Schedule

6.0 Capital Cost

A Class 4 cost estimate (+30/-30%) has been prepared for the complete seabed crossing option inclusive of cable supply and installation, and protection. The estimate currently totals $280 MM CAD, the high level summary of which is outlined in the table below. The detailed cost estimate is included in Appendix AA, and identifies unit rates, quantities, and assumptions.

SOBI Seabed Crossing - Feasibility/Study Estimate

Date 15-Sep-10

Estimate is Study/Feasibility Level (+/- 30% Accuracy, 1-15% Engineering Complete)

General Assumptions / Estimate Basis:

1 3 Single Core Submarine cables.
2 Protection methodology maintains a high level of reliability.
3 Includes cable installation to Transition Compound location.
4 Estimate does not include contingency.
5 Estimate does not include PM&E.
6 Estimate does not include Waiting on Weather (WOW) nor Non-Productive Time (NPT).
7 Estimate does not include allowance for future recovery and repair operations.(priced separately)
8 Estimate does not include annual inspection allowance. (priced separately)

Pre/Post Survey [(i)]	[redacted]
HDD Site Works[(i)]	[redacted]
Seabed Leveling	[redacted]
Cable Supply (3x)	[redacted]
HDD	[redacted]
Cable Installation	[redacted]
Rock Berm (1/4 slope with 1 m cover)	[redacted]

Total $ 280,429,494 CAD (2010 Dollars)

(i) Assumed Allowance

7.0 Operating Cost

There is no direct operating nor maintenance costs associated with seabed cable installation, with the exception of visual inspection. Inspection will be required in two regions, the terminations in the transition compounds and the rock berm on the seabed.

The three terminations in each transition compound (six in total) are to be inspected annually to assess leakage of insulating fluid and deterioration. This is a low cost activity that does not required significant recourses.

The rock berm with a nominal length of 32 km will initially require a general visual inspection (GVI) annually during the summer months to assess berm condition and identify any degradation due to erosion (sea currents) or impacts (anchors / fishing). This inspection will involve flying the rock berms with an ROV and visually assessing deterioration. A local supply-type vessel with an observation class ROV or better will be required. The cost of the annual inspection is assumed to be approximately $500,000. This is based on utilizing a supply vessel with ROV spread from either St. John's or Halifax (~$100,000 / day) with a 1 day mobilization duration, 3 day inspection duration, and 1 day demobilization duration. Pending favorable results of the initial few annual inspections (no berm deterioration detected) the GVI frequency could be reduced to once every two years (or longer) for the remainder of the service life.

8.0 Repair Cost

As indicated by all three vendors, no cables in operation have failed due to manufacturing defects. All failures have been due to external influence such as fishing snags. Although cable protection will be designed to be sufficiently robust and a failure during the service life is unlikely, it may be possible in an extreme case to sustain damage and hence execute a repair.

For repair on a seabed cable an intervention vessel will be required with at a minimum a cable jointing area on the deck, a functioning crane, a work class ROV, and a suction / excavation type ROV. This type of vessel could be mobilized from the fleet of vessels based out of St. John's or Halifax. Also required would be a spare section of cable (included at the time of order and stored locally) and a cable vendor repair team with tools and consumables for execution of a repair. Localized protection for the expansion loop will also be required and will likely include articulated pipe, rock, or mattresses.

A preliminary cost has been developed for a repair and is $7.7 MM CAD. Breakdown of the cost is included in Appendix AB.

9.0 Spending Profile

The following is a preliminary envisaged capital spending profile for the project that indicates the percentage of the CAPEX estimate spent between now and 2016.

Year	2011	2012	2013	2014	2015	2016
% CAPEX	0%	10%	20%	30%	35%	5%

Appendix A- Proposed Seabed Crossing Route


SEABED CROSSING OPTION
CONCEPTIONAL CORRIDOR
0
1
2
3
4
5
KILOMETERS
SEAFLOOR PIERCING TARGET ZONE
TRANSITION COMPOUND TARGET ZONE
ROCK PLACEMENT LOCATION
Depth (m)
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
125
N
W
E
S
FORTEAU POINT
SHOAL COVE
1800
1500
496000.000000
498000.000000
500000.000000
502000.000000
504000.000000
506000.000000
508000.000000
510000.000000
512000.000000
514000.000000
516000.000000
518000.000000
520000.000000
522000.000000
524000.000000
526000.000000
5702000.000000
5700000.000000
5698000.000000
5696000.000000
5694000.000000
5692000.000000
5690000.000000
5688000.000000
5686000.000000
1:73,834

Appendix B- Work Scopes 2010

Nalcor Energy - Lower Churchill Project

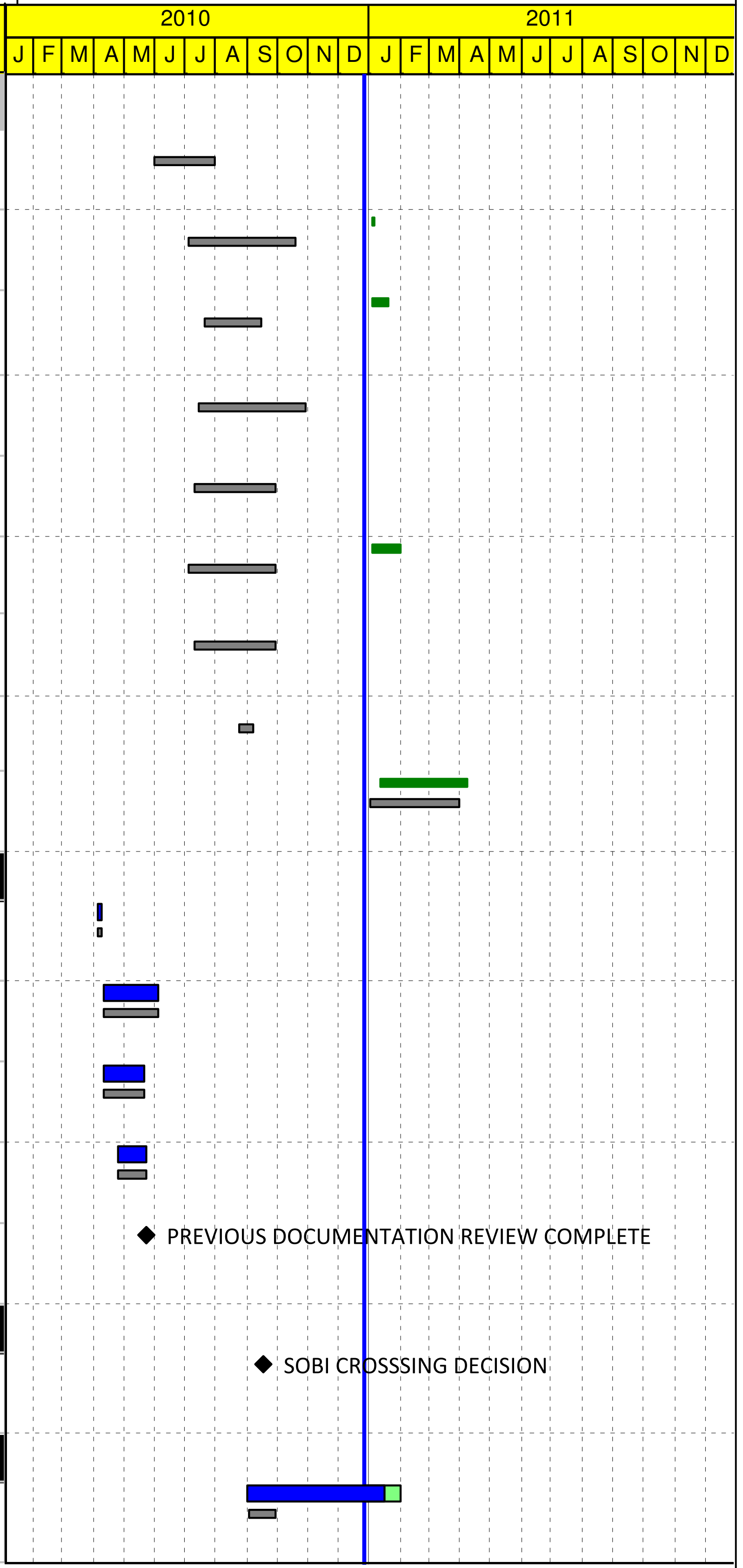
Priority Workscope Packages

Layout: PWP: 2010 Priority Workscope Packages

TASK filter: PWP: Scope Package Selector.

Printed: 29-Dec-10

Activity ID	Activity Name	OD	RD	Performance % Complete	LC_WTO	Start	Finish	PE	UDF BL Start	UDF BL Finish
Scope 10 - SOBI Seabed Feasibility Work										
SC10_0550_181	PROGRESS SUMMARY- (LOE) - SOBI SB Sea Current Study (AM0002)	117d	0d	100%	AM0002	23-Jun-10 A	09-Dec-10 A	GF	01-Jun-10	31-Jul-10
SC10_0550_231	PROGRESS SUMMARY- (LOE) - SOBI SB HDD Studies (LC-EN-017)	120d	2d	99.5%	LC-EN-017	05-Jul-10 A	05-Jan-11	GF	06-Jul-10	20-Oct-10
SC10_0250_237	PROGRESS SUMMARY - (LOE) Probabilistic Analysis of Iceberg & Subsea Cable Route (By C-Core), (LC-EN-013)	40d	12d	85%	LC-EN-013	26-Jul-10 A	19-Jan-11	GF.BB	21-Jul-10	16-Sep-10
SC10_0550_251	PROGRESS SUMMARY- (LOE) - SOBI SB Fishing Studies (LC-EN-019)	120d	0d	100%	LC-EN-019	30-Jul-10 A	12-Nov-10 A	GF	15-Jul-10	29-Oct-10
SC11_0550_281	PROGRESS SUMMARY- (LOE) - SOBI Technical Services - Cable Conduit Options (Piercings), (DC1401)	120d	0d	100%	DC1401	17-Aug-10 A	03-Nov-10 A	GF	12-Jul-10	30-Sep-10
SC10_0550_241	PROGRESS SUMMARY- (LOE) - SOBI Shore Approach Feas. Study (LC-EN-021)	120d	21d	80%	LC-EN-021	23-Aug-10 A	01-Feb-11	GF	05-Jul-10	30-Sep-10
SC10_0550_221	PROGRESS SUMMARY- (LOE) - SOBI Preliminary Rock Berm Design (LC-EN-018)	120d	0d	100%	LC-EN-018	27-Aug-10 A	29-Nov-10 A	GF	12-Jul-10	30-Sep-10
SC10_0390_153	PROGRESS SUMMARY- (LOE) - SOBI Shore Approach Feas. Study (LC-EN-022)	10d	0d	100%	LC-EN-022	31-Aug-10 A	09-Dec-10 A	GF.BM	24-Aug-10	07-Sep-10
SC10_0390_163	PROGRESS SUMMARY- (LOE) - ABB CABLE VENDOR FEAS. Study (WTO TBD)	62d	61d	0%	LC-EN-022	12-Jan-11	07-Apr-11	GF.BM	03-Jan-11	31-Mar-11
GAP Analysis										
SC10_0210_135	Identification of reports	5d	0d	100%	IWS	05-Apr-10 A	09-Apr-10 A	GF	05-Apr-10	09-Apr-10
SC10_0210_145	Review of Reports (Gap Analysis)	30d	0d	100%	IWS	12-Apr-10 A	04-Jun-10 A	GF	12-Apr-10	04-Jun-10
SC10_0210_155	Review of Posters and Maps	2d	0d	100%	IWS	12-Apr-10 A	21-May-10 A	GF	12-Apr-10	21-May-10
SC10_0210_165	Develop a categorized gap register	21d	0d	100%	IWS	26-Apr-10 A	24-May-10 A	GF	26-Apr-10	24-May-10
SC10_0210_175	PREVIOUS DOCUMENTATION REVIEW COMPLETE	0d	0d	100%	IWS		24-May-10 A	GF		24-May-10
SOBI Decision Indicators										
SC10_0210_185	SOBI CROSSSING DECISION	0d	0d	100%	IWS		17-Sep-10 A	GF		15-Sep-10
General										
SC10_0020_008	Conceptual Design Input for EIS Target	20d	20d	90%	IWS	01-Sep-10 A	31-Jan-11	GF	03-Sep-10	30-Sep-10



🟩 Remaining Work
🟥 Critical Remaining Work
▬ Remaining Level of Effort
◆ Milestone
△ UDF Baseline MS
▬ UDF Baseline
▬ % Complete

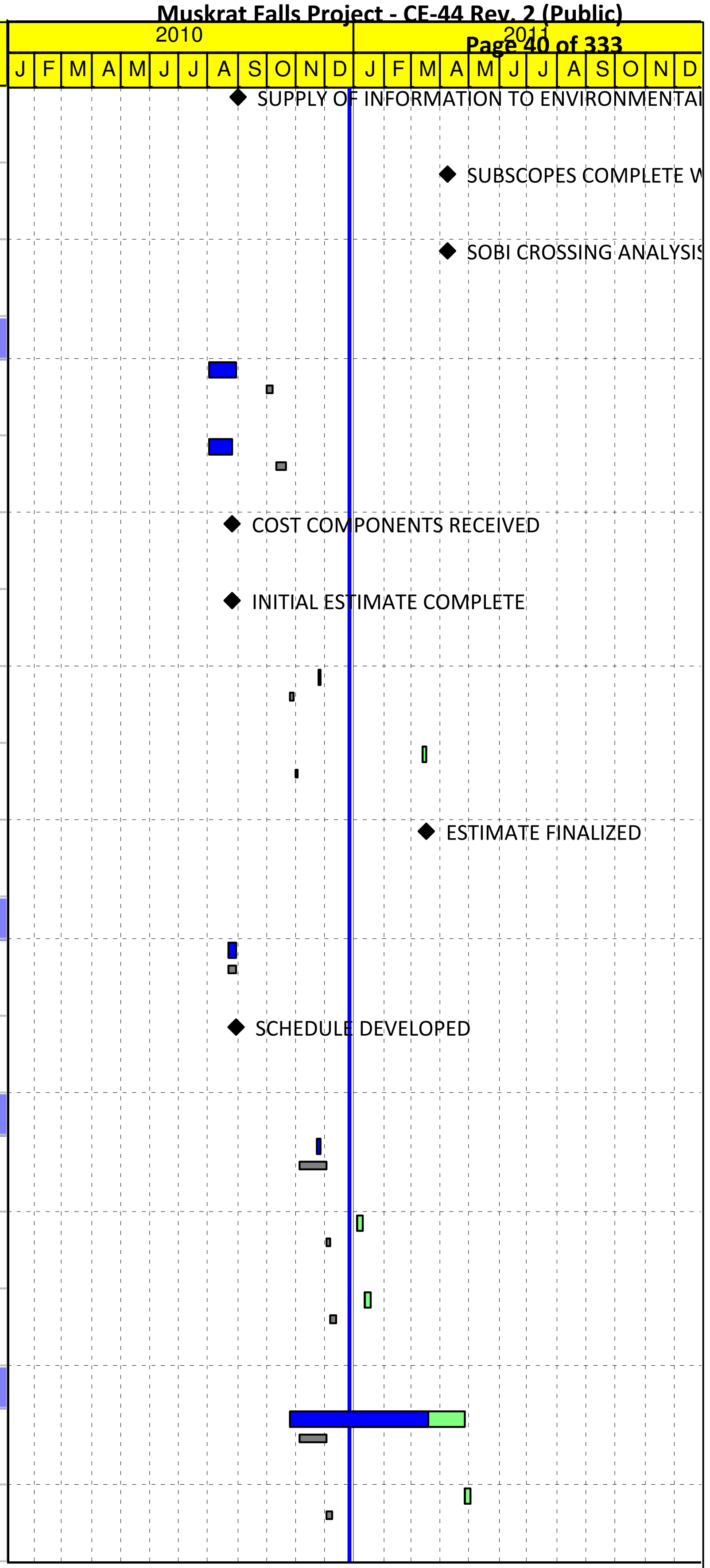
File: Priority Workscope Packages - TDI Workplan

Baseline:

Data Date: 27-Dec-10

Date	Revision	Checked	Approved
29-Dec-10	Bi-Weekly Report Progress up to Dec 24	cwf	

Activity ID	Activity Name	OD	RD	Performance % Complete	LC_WTO	Start	Finish	PE	UDF BL Start	UDF BL Finish
SC10_0020_028	SUPPLY OF INFORMATION TO ENVIRONMENTAL DEPT. FOR EIS	0d	0d	100%	IWS		01-Sep-10 A	GF		01-Sep-10
SC10_0080_009	SUBSCOPES COMPLETE WITH CLOSEOUT AND CONCEPT FINALIZED	0d	0d	0%	IWS		07-Apr-11	GF		26-Oct-10
SC10_0020_018	SOBI CROSSING ANALYSIS REPORT ISSUED TO SUPPORT MGT. DECISION	0d	0d	0%	IWS		07-Apr-11	GF		08-Dec-10
Cost										
SC10_0160_020	Cost Components Feed into Estimator	5d	0d	100%	IWS	02-Aug-10 A	31-Aug-10 A	GF	01-Oct-10	07-Oct-10
SC10_0170_021	Generate Initial Estimate	10d	0d	100%	IWS	02-Aug-10 A	27-Aug-10 A	GF	11-Oct-10	22-Oct-10
SC10_0030_015	COST COMPONENTS RECEIVED	0d	0d	100%	IWS	27-Aug-10 A		GF	01-Oct-10	
SC10_0180_022	INITIAL ESTIMATE COMPLETE	0d	0d	100%	IWS		27-Aug-10 A	GF		10-Dec-10
SC10_0190_023	Review of Initial Estimate	5d	0d	100%	IWS	24-Nov-10 A	26-Nov-10 A	GF	25-Oct-10	29-Oct-10
SC10_0200_024	Update Estimate	3d	3d	0%	IWS	14-Mar-11	16-Mar-11	GF	01-Nov-10	03-Nov-10
SC10_0210_025	ESTIMATE FINALIZED	0d	0d	0%	IWS		16-Mar-11	GF		03-Nov-10
Project Execution Schedule										
SC10_0210_035	Develop Project Execution Schedule (Cables, Installation, etc.)	20d	0d	100%	IWS	23-Aug-10 A	31-Aug-10 A	GF	23-Aug-10	31-Aug-10
SC10_0210_045	SCHEDULE DEVELOPED	0d	0d	100%	IWS		31-Aug-10 A	GF		02-Dec-10
Risk Identification (Workshop)										
SC10_0210_055	Determination of Appropriate Risk Analysis Method	5d	0d	100%	IWS	22-Nov-10 A	26-Nov-10 A	GF	04-Nov-10	02-Dec-10
SC10_0210_065	Risk Analysis Session	5d	5d	0%	IWS	04-Jan-11*	10-Jan-11	GF	03-Dec-10	06-Dec-10
SC10_0210_075	Finalization of Risks	5d	5d	0%	IWS	11-Jan-11	17-Jan-11	GF	07-Dec-10	13-Dec-10
Complete Feasibility Study - Final Report										
SC10_0210_085	Generation of Draft Report	12d	12d	80%	IWS	25-Oct-10 A	25-Apr-11	GF	04-Nov-10	02-Dec-10
SC10_0210_095	Review of report	5d	5d	0%	IWS	26-Apr-11	02-May-11	GF	03-Dec-10	09-Dec-10



🟩 Remaining Work ◆ Milestone ■ % Complete
🟥 Critical Remaining Work △ UDF Baseline MS
▬ Remaining Level of Effort ▬ UDF Baseline

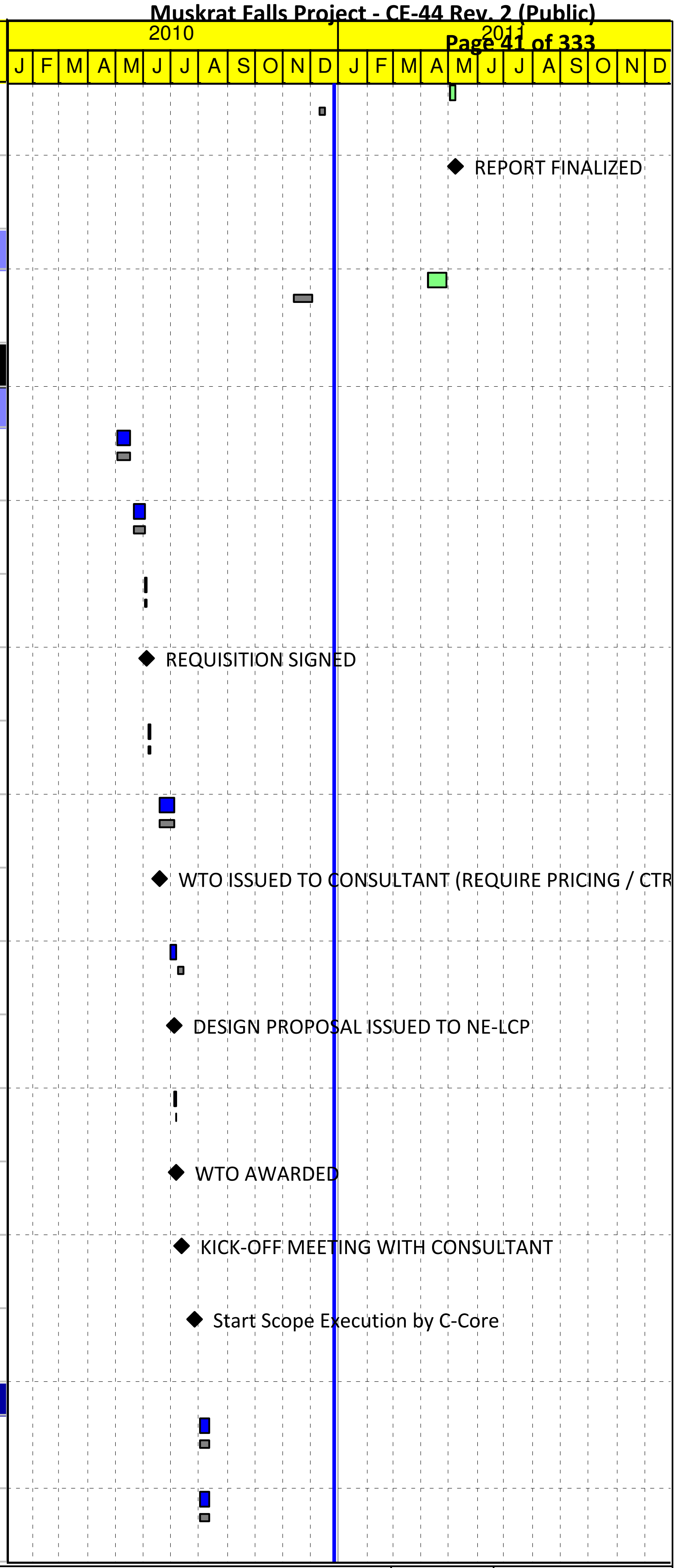
File: Priority Workscope Packages - TDI Workplan

Baseline:

Data Date: 27-Dec-10

Date	Revision	Checked	Approved
29-Dec-10	Bi-Weekly Report Progress up to Dec 24	cwf	

Activity ID	Activity Name	OD	RD	Performance % Complete	LC_WTO	Start	Finish	PE	UDF BL Start	UDF BL Finish
SC10_0210_105	Report updated	5d	5d	0%	IWS	03-May-11	09-May-11	GF	10-Dec-10	16-Dec-10
SC10_0210_115	REPORT FINALIZED	0d	0d	0%	IWS		09-May-11	GF		16-Dec-10
Other										
SC10_0210_125	Identification of Go Forward scope	15d	15d	0%	IWS	08-Apr-11	28-Apr-11	GF	12-Nov-10	02-Dec-10
External Influences										
Ice (Probabilistic Analysis of Iceberg and Subsea Cable Route)										
SC10_0050_036	Sub-Scope Understood	14d	0d	100%	LC-EN-013	03-May-10 A	17-May-10 A	GF.BB	03-May-10	17-May-10
SC10_0250_037	Consultant SOW Developed	12d	0d	100%	LC-EN-013	21-May-10 A	03-Jun-10 A	GF.BB	21-May-10	03-Jun-10
SC10_0250_047	Requisition Prepared and Circulated	2d	0d	100%	LC-EN-013	03-Jun-10 A	04-Jun-10 A	GF.BB	03-Jun-10	04-Jun-10
SC10_0250_057	REQUISITION SIGNED	0d	0d	100%	LC-EN-013		04-Jun-10 A	GF.BB		04-Jun-10
SC10_0250_067	WTO Generated	2d	0d	100%	LC-EN-013	07-Jun-10 A	09-Jun-10 A	GF.BB	07-Jun-10	09-Jun-10
SC10_0250_127	Consultant Prep. of Design Proposal incl. CTR's	10d	0d	100%	LC-EN-013	18-Jun-10 A	06-Jul-10 A	GF.BB	18-Jun-10	06-Jul-10
SC10_0250_077	WTO ISSUED TO CONSULTANT (REQUIRE PRICING / CTR'S)	0d	0d	100%	LC-EN-013		18-Jun-10 A	GF.BB		18-Jun-10
SC10_0250_217	WTO Updated and Signed-Off	5d	0d	100%	LC-EN-013	30-Jun-10 A	07-Jul-10 A	GF.BB	09-Jul-10	15-Jul-10
SC10_0250_137	DESIGN PROPOSAL ISSUED TO NE-LCP	0d	0d	100%	LC-EN-013		06-Jul-10 A	GF.BB		06-Jul-10
SC10_0250_147	NE-LCP Evaluate Proposal	2d	0d	100%	LC-EN-013	06-Jul-10 A	07-Jul-10 A	GF.BB	07-Jul-10	08-Jul-10
SC10_0250_087	WTO AWARDED	0d	0d	100%	LC-EN-013		08-Jul-10 A	GF.BB		15-Jul-10
SC10_0250_227	KICK-OFF MEETING WITH CONSULTANT	0d	0d	100%	LC-EN-013	13-Jul-10 A		GF.BB	13-Jul-10	
SC10_0250_097	Start Scope Execution by C-Core	0d	0d	100%	LC-EN-013	26-Jul-10 A		GF.BB	14-Jul-10	
Model Development										
SC10_0250_277	Bathymetry data file generated for initial Model 'runs'	40d	0d	100%	LC-EN-013	02-Aug-10 A	13-Aug-10 A	GF.BB	02-Aug-10	13-Aug-10
SC10_0250_287	Generated water dept profiles along cable route	40d	0d	100%	LC-EN-013	02-Aug-10 A	13-Aug-10 A	GF.BB	02-Aug-10	13-Aug-10



🟩 Remaining Work
🟥 Critical Remaining Work
▬ Remaining Level of Effort
◆ Milestone
△ UDF Baseline MS
▬ UDF Baseline
▬ % Complete

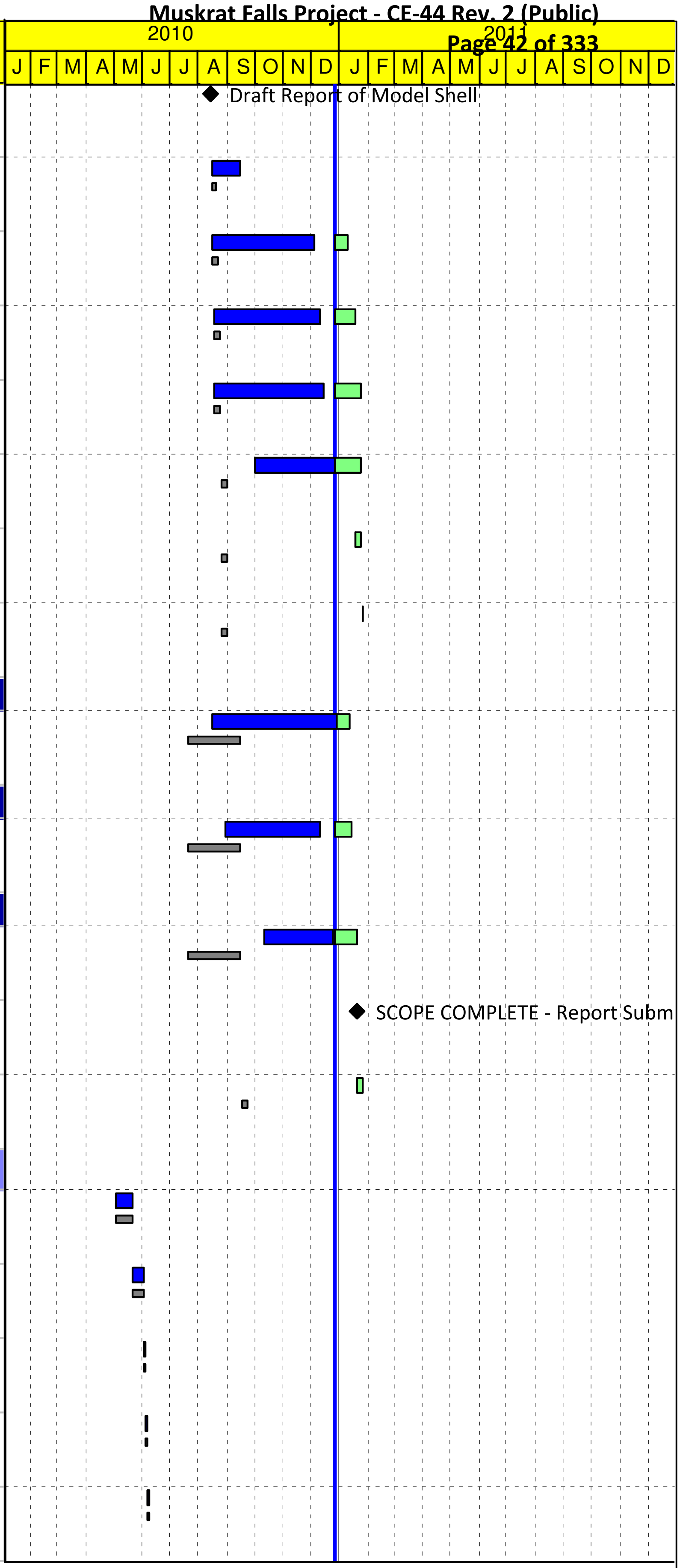
File: Priority Workscope Packages - TDI Workplan

Baseline:

Data Date: 27-Dec-10

Date	Revision	Checked	Approved
29-Dec-10	Bi-Weekly Report Progress up to Dec 24	cwf	

Activity ID	Activity Name	OD	RD	Performance % Complete	LC_WTO	Start	Finish	PE	UDF BL Start	UDF BL Finish
SC10_0250_297	Draft Report of Model Shell	0d	0d	100%	LC-EN-013		13-Aug-10 A	GF.BB		31-Aug-10
SC10_0250_307	Acquire/Evaluate alternate bathymetry data to extend model area (CHS)	5d	0d	100%	LC-EN-013	16-Aug-10 A	16-Sep-10 A	GF.BB	16-Aug-10	20-Aug-10
SC10_0250_317	Analyze available iceberg data for use in model	5d	5d	75%	LC-EN-013	16-Aug-10 A	10-Jan-11	GF.BB	17-Aug-10	23-Aug-10
SC10_0250_327	Generate/select relationship for iceberg deterioration	5d	5d	75%	LC-EN-013	18-Aug-10 A	17-Jan-11	GF.BB	18-Aug-10	24-Aug-10
SC10_0250_337	Begin coding contact model/generate initial run and evaulate output	5d	5d	75%	LC-EN-013	18-Aug-10 A	24-Jan-11	GF.BB	19-Aug-10	25-Aug-10
SC10_0250_347	Document contact model components	5d	5d	75%	LC-EN-013	01-Oct-10 A	24-Jan-11	GF.BB	26-Aug-10	01-Sep-10
SC10_0250_377	C-Core Model Finalization	5d	5d	0%	LC-EN-013	18-Jan-11	24-Jan-11	GF.BB	26-Aug-10	01-Sep-10
SC10_0250_367	Model Submitted to NE-LCP	2d	2d	0%	LC-EN-013	25-Jan-11	26-Jan-11	GF.BB	26-Aug-10	01-Sep-10
Scour Analysis										
SC10_0250_247	(LC-EN-013), Scour Analysis Database Delivery to C-Core (Jacques to Provide SOBI Bathymetry/Scouring D-Base)	40d	7d	90%	LC-EN-013	16-Aug-10 A	12-Jan-11	GF.BB	21-Jul-10	16-Sep-10
Cable Risk Assessment										
SC10_0250_257	C-Core Cable Risk Assessment	40d	2d	75%	LC-EN-013	30-Aug-10 A	14-Jan-11	GF.BB	21-Jul-10	16-Sep-10
Reporting										
SC10_0250_267	C-Core, Reporting (Incl. project Mgt.)	14d	3d	75%	LC-EN-013	11-Oct-10 A	19-Jan-11	GF.BB	21-Jul-10	16-Sep-10
SC10_0250_107	SCOPE COMPLETE - Report Submittal for NE_LCP Review	0d	0d	0%	LC-EN-013		19-Jan-11	GF.BB		16-Sep-10
SC10_0250_117	Closed-out	5d	5d	0%	LC-EN-013	20-Jan-11	26-Jan-11	GF.BB	17-Sep-10	23-Sep-10
Sea Currents										
SC10_0040_031	Sub-Scope Understood	1d	0d	100%		03-May-10 A	21-May-10 A	GF.BB	03-May-10	21-May-10
SC10_0150_032	Consultant SOW Developed	10d	0d	100%		21-May-10 A	03-Jun-10 A	GF.BB	21-May-10	03-Jun-10
SC10_0230_033	Requisition Prepared and Circulated	40d	0d	100%		03-Jun-10 A	04-Jun-10 A	GF.BB	03-Jun-10	04-Jun-10
SC10_0240_034	Requisition Signed	5d	0d	100%		04-Jun-10 A	07-Jun-10 A	GF.BB	04-Jun-10	07-Jun-10
SC10_0240_044	WTO Generated	5d	0d	100%		07-Jun-10 A	09-Jun-10 A	GF.BB	07-Jun-10	09-Jun-10



🟩 Remaining Work
🟥 Critical Remaining Work
▬ Remaining Level of Effort
◆ Milestone
△ UDF Baseline MS
▬ UDF Baseline
🟦 % Complete

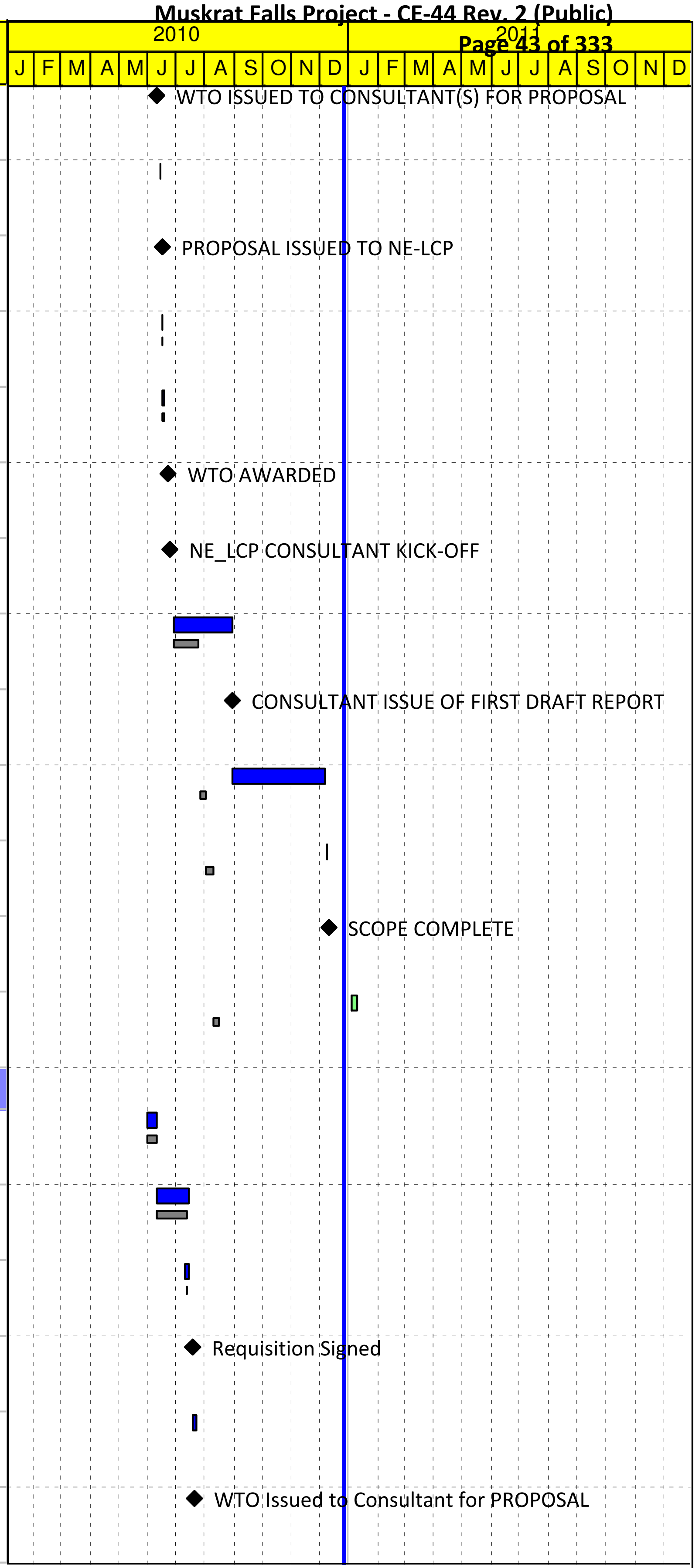
File: Priority Workscope Packages - TDI Workplan

Baseline:

Data Date: 27-Dec-10

Date	Revision	Checked	Approved
29-Dec-10	Bi-Weekly Report Progress up to Dec 24	cwf	

Activity ID	Activity Name	OD	RD	Performance % Complete	LC_WTO	Start	Finish	PE	UDF BL Start	UDF BL Finish
SC10_0240_054	WTO ISSUED TO CONSULTANT(S) FOR PROPOSAL	0d	0d	100%			11-Jun-10 A	GF.BB		11-Jun-10
SC10_0250_157	Consultant Prep. of Design Proposal incl. CTR's	10d	0d	100%		14-Jun-10 A	15-Jun-10 A	GF.BB	18-Jun-10	15-Jun-10
SC10_0250_167	PROPOSAL ISSUED TO NE-LCP	0d	0d	100%			16-Jun-10 A	GF.BB		18-Jun-10
SC10_0250_177	NE-LCP Evaluate Proposal	2d	0d	100%		17-Jun-10 A	17-Jun-10 A	GF.BB	17-Jun-10	17-Jun-10
SC10_0240_144	WTO Updated and Signed-Off	5d	0d	100%		17-Jun-10 A	18-Jun-10 A	GF.BB	17-Jun-10	18-Jun-10
SC10_0240_064	WTO AWARDED	0d	0d	100%	AM0002	23-Jun-10 A		GF.BB	23-Jun-10	
SC10_0240_104	NE_LCP CONSULTANT KICK-OFF	0d	0d	100%	AM0002	24-Jun-10 A		GF.BB	24-Jun-10	
SC10_0240_074	Consultant External Scope Execution	20d	0d	100%	AM0002	28-Jun-10 A	31-Aug-10 A	GF.BB	28-Jun-10	26-Jul-10
SC10_0240_124	CONSULTANT ISSUE OF FIRST DRAFT REPORT	0d	0d	100%	AM0002		31-Aug-10 A	GF.BB		26-Jul-10
SC10_0240_134	NE-LCP Review of Report and Provided Input As needed	5d	0d	100%	AM0002	31-Aug-10 A	07-Dec-10 A	GF.BB	27-Jul-10	02-Aug-10
SC10_0260_179	Consultant Issue Final Report With Updated Changes	5d	0d	100%	AM0002	08-Dec-10 A	09-Dec-10 A	GF.BB	03-Aug-10	10-Aug-10
SC10_0240_084	SCOPE COMPLETE	0d	0d	100%	AM0002		10-Dec-10 A	GF.BB		10-Aug-10
SC10_0240_094	Closed-out	5d	5d	0%	AM0002	04-Jan-11	10-Jan-11	GF.BB	11-Aug-10	17-Aug-10
Fishing										
SC10_0260_039	Sub-Scope Understood	5d	0d	100%		31-May-10 A	10-Jun-10 A	GF.BB	31-May-10	10-Jun-10
SC10_0260_129	Consultant SOW Developed	15d	0d	100%		10-Jun-10 A	15-Jul-10 A	GF.BB	10-Jun-10	13-Jul-10
SC10_0260_049	Requisition Prepared and Circulated	2d	0d	100%		12-Jul-10 A	16-Jul-10 A	GF.BB	14-Jul-10	14-Jul-10
SC10_0260_059	Requisition Signed	0d	0d	100%		19-Jul-10 A		GF.BB	15-Jul-10	
SC10_0260_089	WTO Generated	4d	0d	100%		19-Jul-10 A	22-Jul-10 A	GF.BB	15-Jul-10	
SC10_0260_139	WTO Issued to Consultant for PROPOSAL	0d	0d	100%		22-Jul-10 A		GF.BB	15-Jul-10	



🟩 Remaining Work ◆ ◆ Milestone 🟦 % Complete
🟥 Critical Remaining Work △ △ UDF Baseline MS
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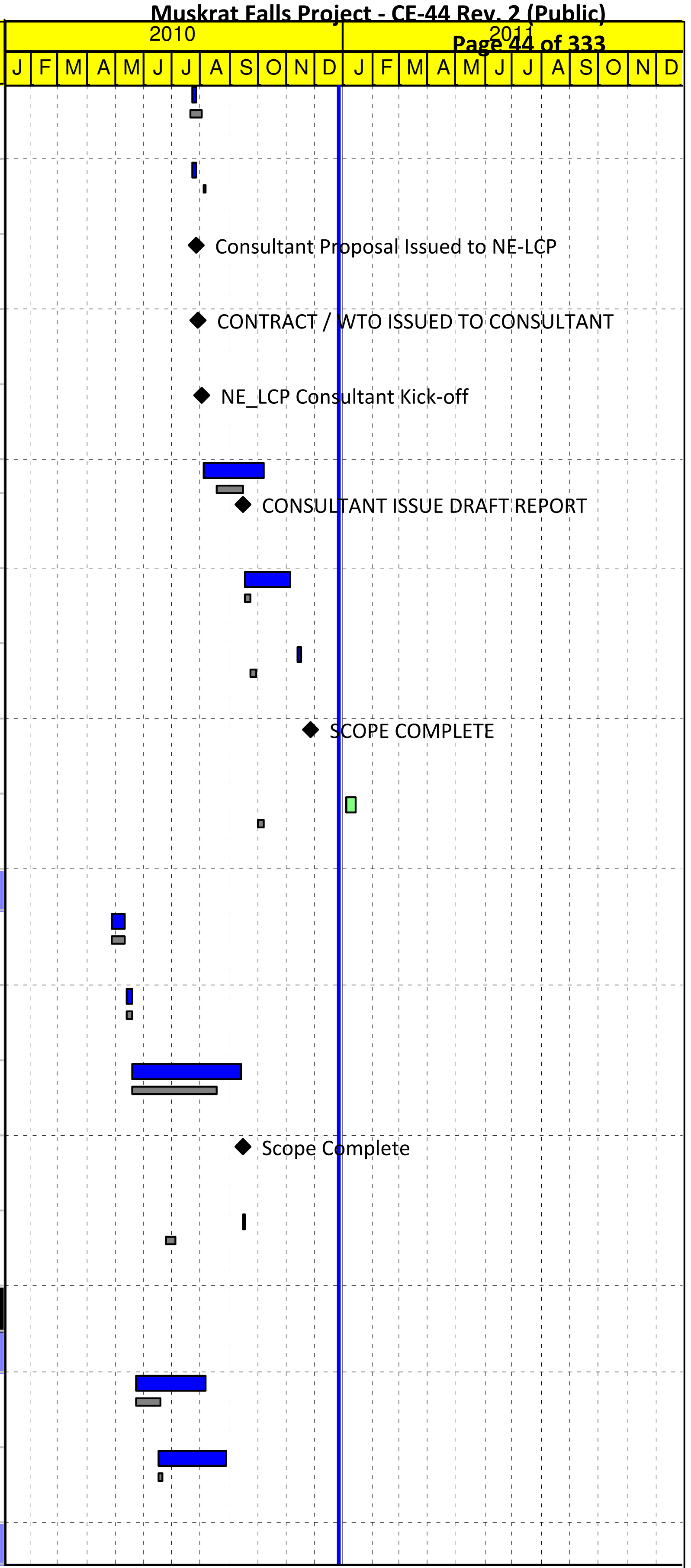
Date	Revision	Checked	Approved
29-Dec-10	Bi-Weekly Report Progress up to Dec 24	cwf	

Activity ID	Activity Name	OD	RD	Performance % Complete	LC_WTO	Start	Finish	PE	UDF BL Start	UDF BL Finish
SC10_0250_187	Consultant Prep. of Design Proposal incl. CTR's	10d	0d	100%		23-Jul-10 A	27-Jul-10 A	GF.BB	21-Jul-10	03-Aug-10
SC10_0250_207	NE-LCP Evaluate Proposal	2d	0d	100%		23-Jul-10 A	26-Jul-10 A	GF.BB	05-Aug-10	06-Aug-10
SC10_0250_197	Consultant Proposal Issued to NE-LCP	0d	0d	100%			27-Jul-10 A	GF.BB		03-Aug-10
SC10_0260_079	CONTRACT / WTO ISSUED TO CONSULTANT	0d	0d	100%	LC-EN-019	30-Jul-10 A		GF.BB	21-Jul-10	
SC10_0240_114	NE_LCP Consultant Kick-off	0d	0d	100%	LC-EN-019	02-Aug-10 A		GF.BB	17-Aug-10	
SC10_0260_099	External Scope Execution	15d	0d	100%	LC-EN-019	04-Aug-10 A	08-Oct-10 A	GF.BB	19-Aug-10	16-Sep-10
SC10_0260_149	CONSULTANT ISSUE DRAFT REPORT	0d	0d	100%	LC-EN-019		16-Sep-10 A	GF.BB		16-Sep-10
SC10_0260_159	NE-LCP Review of Report and Provide Input As needed	5d	0d	100%	LC-EN-019	17-Sep-10 A	05-Nov-10 A	GF.BB	17-Sep-10	23-Sep-10
SC10_0260_169	Consultant Issue Final Report With Updated Changes	5d	0d	100%	LC-EN-019	12-Nov-10 A	16-Nov-10 A	GF.BB	24-Sep-10	30-Sep-10
SC10_0260_109	SCOPE COMPLETE	0d	0d	100%	LC-EN-019		26-Nov-10 A	GF.BB		30-Sep-10
SC10_0260_119	Closed-out	9d	9d	0%	LC-EN-019	04-Jan-11	14-Jan-11	GF.BB	01-Oct-10	07-Oct-10
Vessel Traffic Risk										
SC10_0270_041	Sub-Scope Understood	10d	0d	100%		28-Apr-10 A	12-May-10 A	GF	28-Apr-10	12-May-10
SC10_0290_042	Gathering of External Information	4d	0d	100%		13-May-10 A	19-May-10 A	GF	13-May-10	19-May-10
SC10_0290_052	Analysis performed	5d	0d	100%		20-May-10 A	14-Sep-10 A	GF	20-May-10	19-Aug-10
SC10_0290_062	Scope Complete	0d	0d	100%			15-Sep-10 A	GF		24-Jun-10
SC10_0290_072	Closed-out	5d	0d	100%		16-Sep-10 A	17-Sep-10 A	GF	25-Jun-10	06-Jul-10
Transmission Definition / Cables										
Transmission Definition										
SC10_0290_082	Identify transmission requirements	15d	0d	100%		24-May-10 A	06-Aug-10 A	GF.TR	24-May-10	18-Jun-10
SC10_0290_112	Capture and updated LCP Design Basis Reflect	1d	0d	100%		16-Jun-10 A	27-Aug-10 A	GF.TR	16-Jun-10	21-Jun-10
Technology Review										



🟩 Remaining Work
🟥 Critical Remaining Work
▬ Remaining Level of Effort
◆ Milestone
△ UDF Baseline MS
▬ UDF Baseline
▬ % Complete

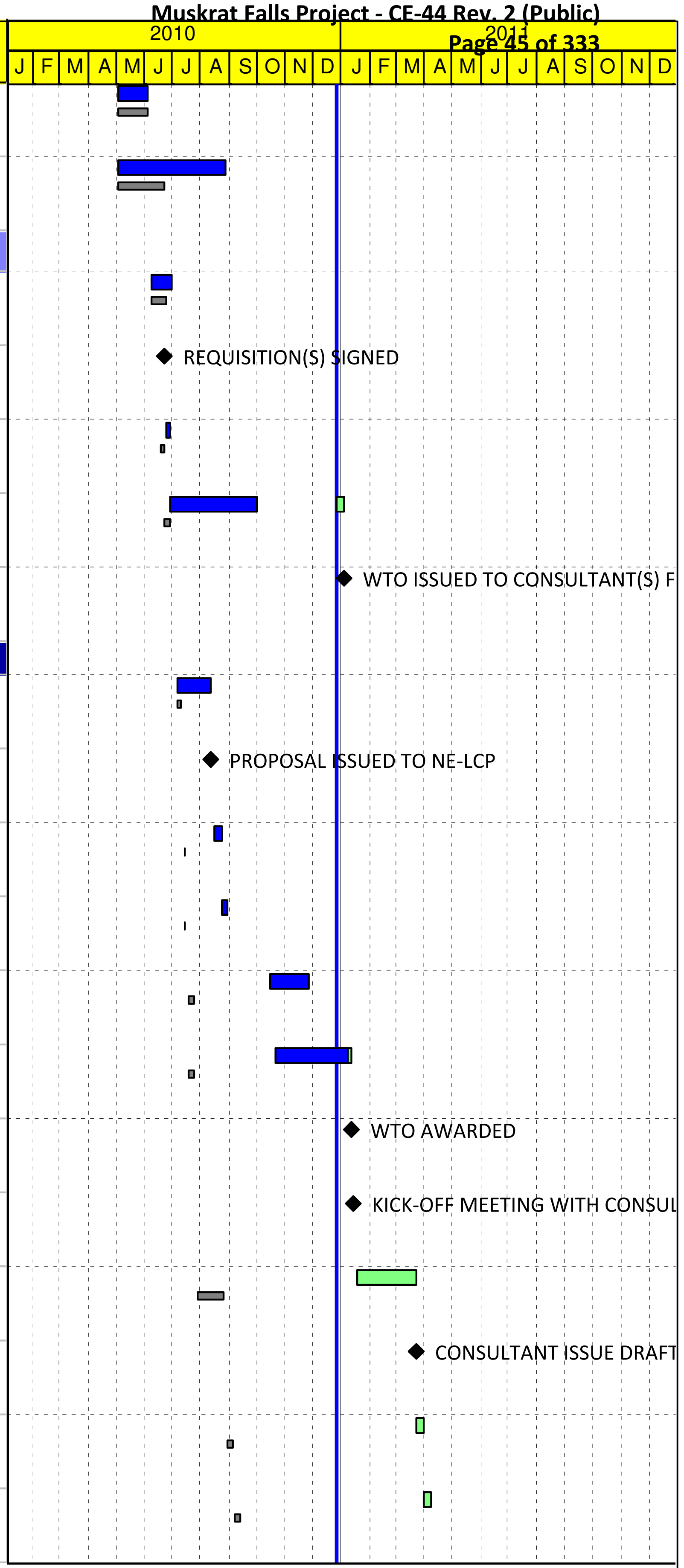
File: Priority Workscope Packages - TDI Workplan

Baseline:

Data Date: 27-Dec-10

Date	Revision	Checked	Approved
29-Dec-10	Bi-Weekly Report Progress up to Dec 24	cwf	

Activity ID	Activity Name	OD	RD	Performance % Complete	LC_WTO	Start	Finish	PE	UDF BL Start	UDF BL Finish
SC10_0290_092	Identify Suppliers and capture information	14d	0d	100%		03-May-10 A	04-Jun-10 A	GF.TR	03-May-10	04-Jun-10
SC10_0290_132	Identify relevant world projects and capture information	20d	0d	100%		03-May-10 A	27-Aug-10 A	GF.TR	03-May-10	22-Jun-10
Vendor Cable Information / Preliminary Design										
SC10_0290_102	Prepare a technical query document for cable manufacturers - Develop SOW	8d	0d	100%		09-Jun-10 A	30-Jun-10 A	GF.TR	09-Jun-10	25-Jun-10
SC10_0290_152	REQUISITION(S) SIGNED	0d	0d	100%		23-Jun-10 A		GF.TR	23-Jun-10	
SC10_0290_142	Requisition(s) Prepared and Circulated	3d	0d	100%		24-Jun-10 A	28-Jun-10 A	GF.TR	18-Jun-10	22-Jun-10
SC10_0290_162	WTO'S GENERATED	4d	0d	50%		28-Jun-10 A	04-Jan-11	GF.TR	23-Jun-10	29-Jun-10
SC10_0290_172	WTO ISSUED TO CONSULTANT(S) FOR PROPOSAL	0d	0d	0%		04-Jan-11		GF.TR	30-Jun-10	
ABB										
SC10_0290_192	Consultant Development of Proposal With CTR's	10d	0d	100%		07-Jul-10 A	12-Aug-10 A	GF.TR	07-Jul-10	12-Jul-10
SC10_0290_372	PROPOSAL ISSUED TO NE-LCP	0d	0d	100%		13-Aug-10 A		GF.TR	16-Jul-10	
SC10_0290_382	Proposal Evaluated By NE-LCP	2d	0d	100%		17-Aug-10 A	25-Aug-10 A	GF.TR	16-Jul-10	16-Jul-10
SC10_0290_632	NE-LCP Meetings with ABB	2d	0d	100%		25-Aug-10 A	31-Aug-10 A	GF.TR	16-Jul-10	16-Jul-10
SC10_0290_422	WTO Legal Review process / Contract negotiations with ABB	5d	0d	100%		15-Oct-10 A	26-Nov-10 A	GF.TR	20-Jul-10	26-Jul-10
SC10_0290_392	WTO Updated and Signed-Off	5d	6d	95%		22-Oct-10 A	11-Jan-11	GF.TR	20-Jul-10	26-Jul-10
SC10_0290_402	WTO AWARDED	0d	0d	0%		12-Jan-11		GF.TR	27-Jul-10	
SC10_0290_412	KICK-OFF MEETING WITH CONSULTANT	0d	0d	0%		13-Jan-11		GF.TR	28-Jul-10	
SC10_0290_232	External Scope Execution	20d	48d	0%		17-Jan-11	23-Mar-11	GF.TR	30-Jul-10	27-Aug-10
SC10_0260_219	CONSULTANT ISSUE DRAFT REPORT	0d	0d	0%			23-Mar-11	GF.TR		27-Aug-10
SC10_0260_229	NE-LCP Review of Report and Provide Input As needed	5d	5d	0%		24-Mar-11	30-Mar-11	GF.TR	30-Aug-10	06-Sep-10
SC10_0260_239	Consultant Issue Final Report With Updated Changes	5d	5d	0%		31-Mar-11	07-Apr-11	GF.TR	07-Sep-10	13-Sep-10



🟩 Remaining Work
🟥 Critical Remaining Work
Remaining Level of Effort
◆ Milestone
△ UDF Baseline MS
UDF Baseline
% Complete

File: Priority Workscope Packages - TDI Workplan

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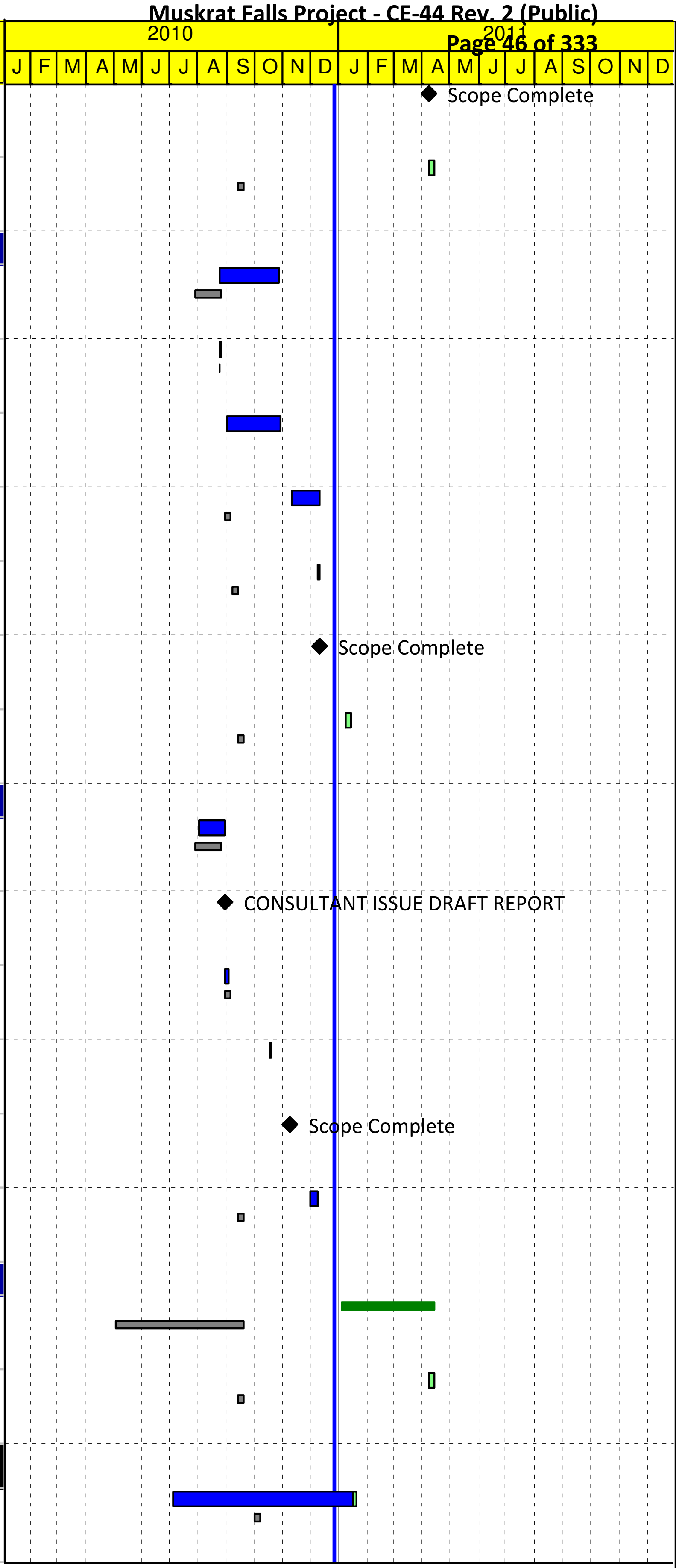
Activity ID	Activity Name	OD	RD	Performance % Complete	LC_WTO	Start	Finish	PE	UDF BL Start	UDF BL Finish
SC10_0290_242	Scope Complete	0d	0d	0%			07-Apr-11	GF.TR		13-Sep-10
SC10_0290_282	Closed-out	5d	5d	0%		08-Apr-11	14-Apr-11	GF.TR	14-Sep-10	20-Sep-10
Nexans										
SC10_0290_212	External Scope Execution	20d	0d	100%		24-Aug-10 A	28-Oct-10 A	GF.TR	30-Jul-10	27-Aug-10
SC10_0290_342	NE-LCP Meetings with Nexan	2d	0d	100%		24-Aug-10 A	26-Aug-10 A	GF.TR	24-Aug-10	25-Aug-10
SC10_0260_189	CONSULTANT ISSUE DRAFT REPORT	2d	0d	100%		01-Sep-10 A	30-Oct-10 A	GF.TR		27-Aug-10
SC10_0260_199	NE-LCP Review of Report and Provide Input As needed	5d	0d	100%		10-Nov-10 A	10-Dec-10 A	GF.TR	30-Aug-10	06-Sep-10
SC10_0260_209	Consultant Issue Final Report With Updated Changes	10d	0d	100%		08-Dec-10 A	10-Dec-10 A	GF.TR	07-Sep-10	13-Sep-10
SC10_0290_222	Scope Complete	0d	0d	100%			10-Dec-10 A	GF.TR		13-Sep-10
SC10_0290_292	Closed-out	5d	5d	0%		07-Jan-11	13-Jan-11	GF.TR	14-Sep-10	20-Sep-10
Prysmian										
SC10_0290_252	External Scope Execution (Not under NE-LCP Contract)	20d	0d	100%		02-Aug-10 A	31-Aug-10 A	GF.TR	30-Jul-10	27-Aug-10
SC10_0260_249	CONSULTANT ISSUE DRAFT REPORT	0d	0d	100%			31-Aug-10 A	GF.TR		27-Aug-10
SC10_0260_259	NE-LCP Review of Report and Provide Input As needed	5d	0d	100%		31-Aug-10 A	03-Sep-10 A	GF.TR	30-Aug-10	06-Sep-10
SC10_0290_352	SOBI Team Meeting with Prysmian	0d	0d	100%		18-Oct-10 A	19-Oct-10 A	GF.TR		13-Sep-10
SC10_0290_262	Scope Complete	0d	0d	100%			09-Nov-10 A	GF.TR		13-Sep-10
SC10_0290_272	Closed-out	5d	0d	100%		01-Dec-10 A	08-Dec-10 A	GF.TR	14-Sep-10	20-Sep-10
Study Outcome										
SC10_0290_312	Cable Recommendation Summary	25d	72d	50%		03-May-10 A	14-Apr-11	GF.TR	03-May-10	20-Sep-10
SC10_0290_302	Review of External works and analysis	5d	5d	0%		08-Apr-11	14-Apr-11	GF.TR	14-Sep-10	20-Sep-10
Conceptual Design Routing										
SC10_0060_079	Determine Zone Boundaries	5d	0d	98%		05-Jul-10 A	20-Jan-11	GF	01-Oct-10	07-Oct-10



🟩	Remaining Work
🟥	Critical Remaining Work
▬	Remaining Level of Effort
◆	Milestone
△	UDF Baseline MS
▬	UDF Baseline
🟦	% Complete

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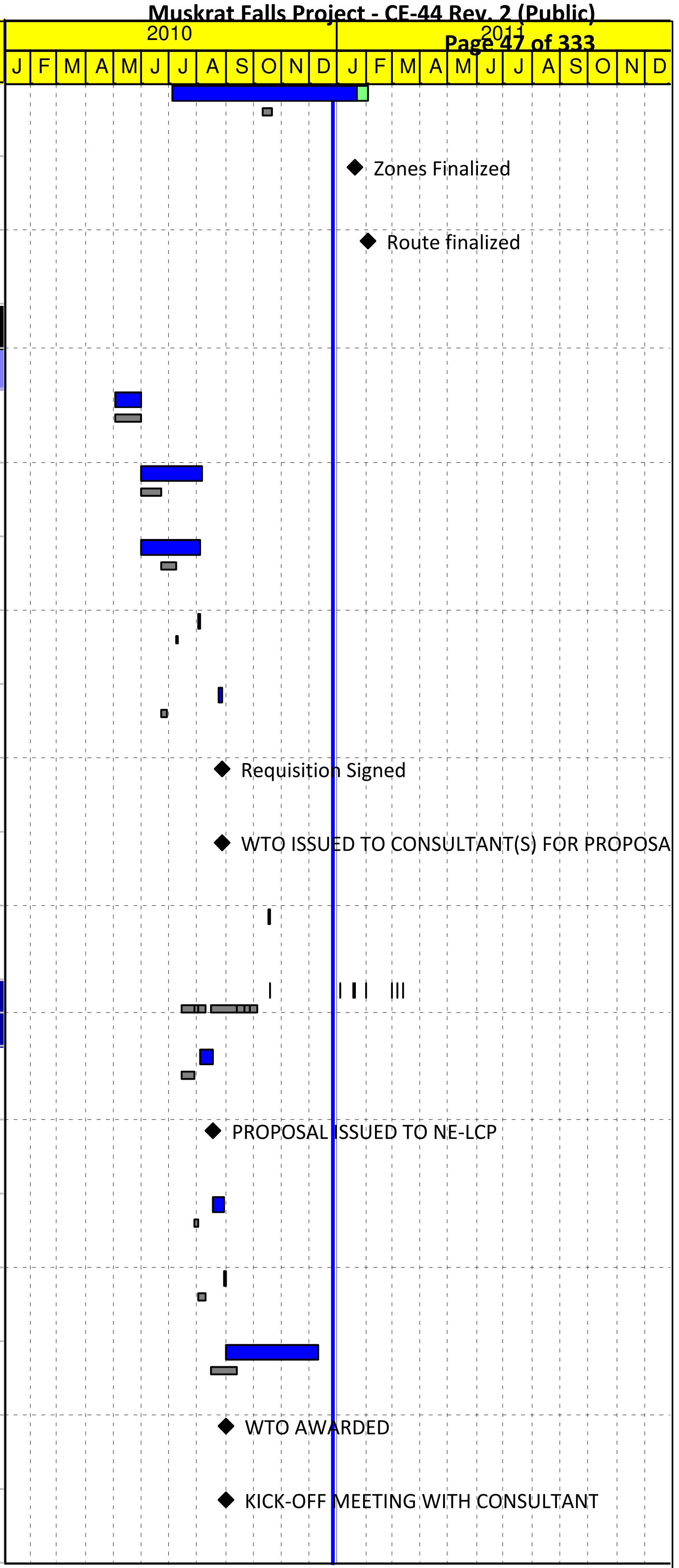
Activity ID	Activity Name	OD	RD	Performance % Complete	LC_WTO	Start	Finish	PE	UDF BL Start	UDF BL Finish
SC10_0060_099	Route selection in each Zone as based on other sub-scopes	10d	10d	95%		05-Jul-10 A	02-Feb-11	GF	11-Oct-10	22-Oct-10
SC10_0060_089	Zones Finalized	0d	0d	0%			20-Jan-11	GF		07-Oct-10
SC10_0060_109	Route finalized	0d	0d	0%			02-Feb-11	GF		22-Oct-10
Protection										
Rock Placement (Berm)										
SC10_0410_058	Investgation of Global Rock Placement contractors	25d	0d	100%	LC-EN-018	03-May-10 A	31-May-10 A	GF.BB	03-May-10	31-May-10
SC10_0420_059	Select Contractors to engage	5d	0d	100%	LC-EN-018	31-May-10 A	06-Aug-10 A	GF.BB	31-May-10	22-Jun-10
SC10_0410_068	Prepare SOW Developed and Issued For External Scope	10d	0d	100%	LC-EN-018	01-Jun-10 A	04-Aug-10 A	GF.BB	22-Jun-10	09-Jul-10
SC10_0410_078	Requisition Prepared	2d	0d	100%	LC-EN-018	03-Aug-10 A	05-Aug-10 A	GF.BB	09-Jul-10	12-Jul-10
SC10_0290_322	WTO'S GENERATED	4d	0d	100%	LC-EN-018	24-Aug-10 A	27-Aug-10 A	GF.BB	23-Jun-10	29-Jun-10
SC10_0410_108	Requisition Signed	0d	0d	100%	LC-EN-018		27-Aug-10 A	GF.BB		12-Jul-10
SC10_0290_332	WTO ISSUED TO CONSULTANT(S) FOR PROPOSAL	0d	0d	100%	LC-EN-018	27-Aug-10 A		GF.BB	30-Jun-10	
SC10_0290_362	SOBI Team Meeting with Rock Berm Consultant	0d	0d	100%		18-Oct-10 A	19-Oct-10 A	GF.TR		13-Sep-10
VAN OORD (SCOPE WILL NOT BE EXECUTED)										
Tideway										
SC10_0290_472	Consultant Development of Proposal With CTR's	10d	0d	100%	LC-EN-018	04-Aug-10 A	18-Aug-10 A	GF.BB	16-Jul-10	30-Jul-10
SC10_0290_482	PROPOSAL ISSUED TO NE-LCP	0d	0d	100%	LC-EN-018	18-Aug-10 A		GF.BB	30-Jul-10	
SC10_0290_492	Proposal Evaluated By NE-LCP	2d	0d	100%	LC-EN-018	18-Aug-10 A	30-Aug-10 A	GF.BB	30-Jul-10	03-Aug-10
SC10_0290_502	WTO Updated and Signed-Off	5d	0d	100%	LC-EN-018	31-Aug-10 A	01-Sep-10 A	GF.BB	03-Aug-10	11-Aug-10
SC10_0410_138	External Scope Execution	20d	0d	100%	LC-EN-018	01-Sep-10 A	10-Dec-10 A	GF.BB	16-Aug-10	14-Sep-10
SC10_0290_512	WTO AWARDED	0d	0d	100%	LC-EN-018	01-Sep-10 A		GF.BB	11-Aug-10	
SC10_0290_522	KICK-OFF MEETING WITH CONSULTANT	0d	0d	100%	LC-EN-018	01-Sep-10 A		GF.BB	12-Aug-10	



🟩	Remaining Work	◆	Milestone	🟦	% Complete
🟥	Critical Remaining Work	△	UDF Baseline MS		
🟩	Remaining Level of Effort	▬	UDF Baseline		

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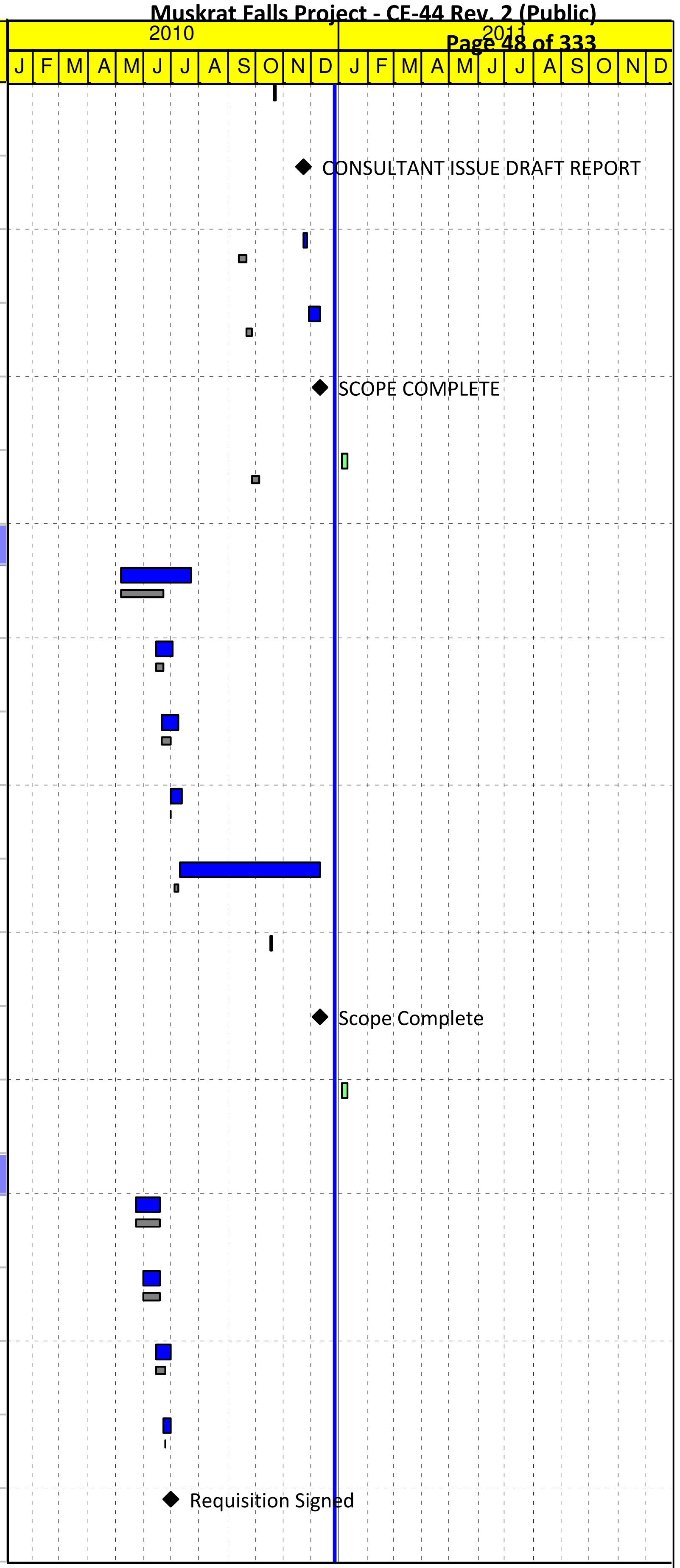
Activity ID	Activity Name	OD	RD	Performance % Complete	LC_WTO	Start	Finish	PE	UDF BL Start	UDF BL Finish
SC10_0290_442	SOBI Team Meeting with Tideway	0d	0d	100%		21-Oct-10 A	22-Oct-10 A	GF.TR		13-Sep-10
SC10_0260_279	CONSULTANT ISSUE DRAFT REPORT	0d	0d	100%	LC-EN-018		22-Nov-10 A	GF.BB		14-Sep-10
SC10_0260_289	NE-LCP Review of Report and Provide Input As needed	5d	0d	100%	LC-EN-018	22-Nov-10 A	26-Nov-10 A	GF.BB	14-Sep-10	21-Sep-10
SC10_0260_299	Consultant Issue Final Report With Updated Changes	5d	0d	100%	LC-EN-018	29-Nov-10 A	10-Dec-10 A	GF.BB	21-Sep-10	28-Sep-10
SC10_0410_148	SCOPE COMPLETE	0d	0d	100%	LC-EN-018		10-Dec-10 A	GF.BB		28-Sep-10
SC10_0410_158	Closed-out	5d	5d	0%	LC-EN-018	04-Jan-11	10-Jan-11	GF.BB	28-Sep-10	05-Oct-10
Rock Trenching										
SC10_0320_050	Investgation of Global trenching contractors	25d	0d	100%		07-May-10 A	23-Jul-10 A	GF.TR	07-May-10	22-Jun-10
SC10_0320_060	Select Contractors to engage	5d	0d	100%		15-Jun-10 A	02-Jul-10 A	GF.TR	15-Jun-10	23-Jun-10
SC10_0330_051	Prepare SOW and Issue for external works.	5d	0d	100%		21-Jun-10 A	09-Jul-10 A	GF.TR	21-Jun-10	30-Jun-10
SC10_0340_052	Execution of Rock Trenching Capability Study	1d	0d	100%		01-Jul-10 A	13-Jul-10 A	GF.TR	02-Jul-10	02-Jul-10
SC10_0350_063	Developed Capability Statement for Rock Trenching	4d	0d	100%		12-Jul-10 A	10-Dec-10 A	GF.TR	06-Jul-10	09-Jul-10
SC10_0290_452	SOBI Team Meeting with Rock Trenching Specilist	0d	0d	100%		18-Oct-10 A	19-Oct-10 A	GF.TR		13-Sep-10
SC10_0350_073	Scope Complete	0d	0d	100%			10-Dec-10 A	GF.TR		09-Jul-10
SC10_0350_053	Closeout Study	5d	5d	0%		04-Jan-11	10-Jan-11	GF.TR	06-Jul-10	
Horizontal Directional Drilling										
SC10_0370_086	Investgation of Global HDD contractors	20d	0d	100%	LC-EN-017	24-May-10 A	18-Jun-10 A	GF.BB	24-May-10	18-Jun-10
SC10_0370_096	Select Contractors to engage	5d	0d	100%	LC-EN-017	01-Jun-10 A	18-Jun-10 A	GF.BB	01-Jun-10	18-Jun-10
SC10_0370_106	Prepare SOW for external works.	10d	0d	100%	LC-EN-017	14-Jun-10 A	30-Jun-10 A	GF.BB	14-Jun-10	24-Jun-10
SC10_0370_116	Requisition Prepared	1d	0d	100%	LC-EN-017	22-Jun-10 A	30-Jun-10 A	GF.BB	25-Jun-10	25-Jun-10
SC10_0370_126	Requisition Signed	0d	0d	100%	LC-EN-017	30-Jun-10 A		GF.BB	29-Jun-10	



🟩 Remaining Work
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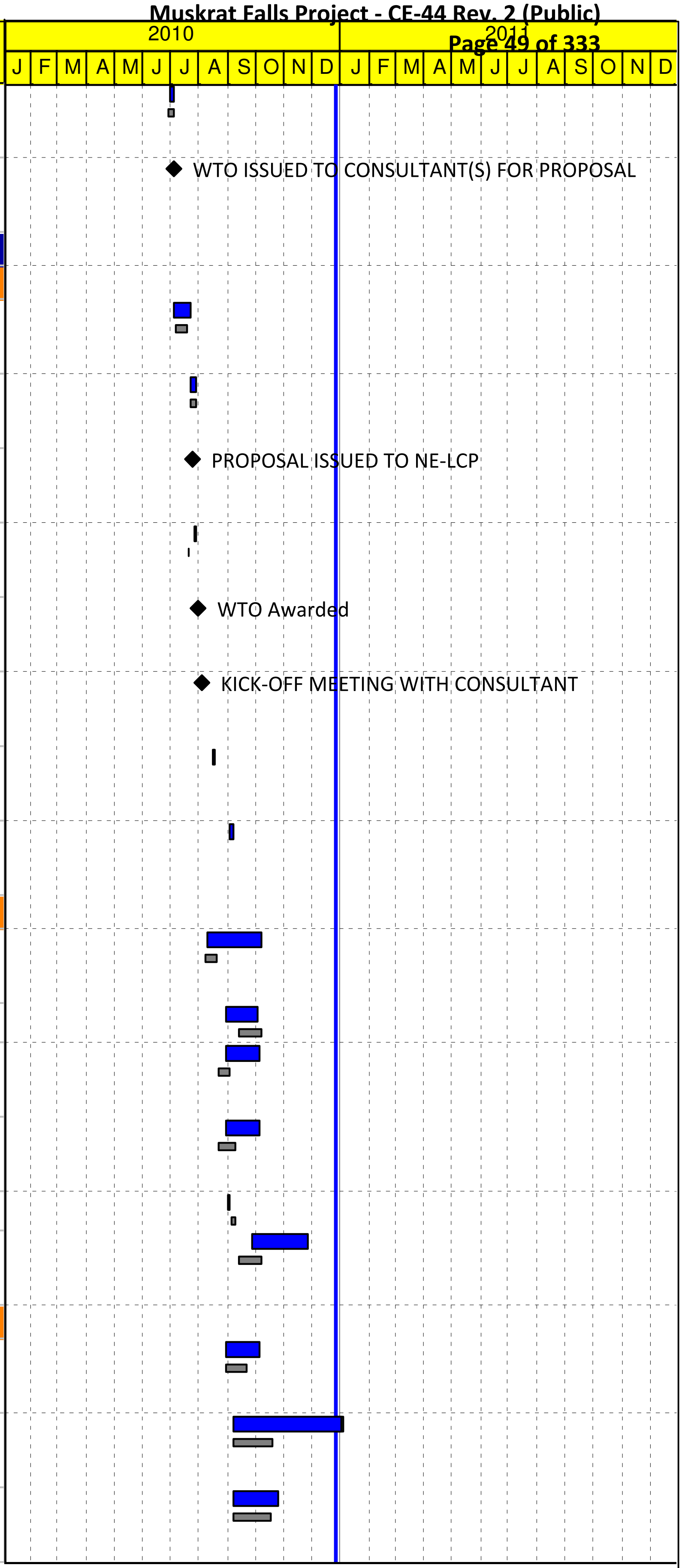
Activity ID	Activity Name	OD	RD	Performance % Complete	LC_WTO	Start	Finish	PE	UDF BL Start	UDF BL Finish
SC10_0370_136	WTOs Generated	4d	0d	100%	LC-EN-017	30-Jun-10 A	05-Jul-10 A	GF.BB	29-Jun-10	06-Jul-10
SC10_0370_146	WTO ISSUED TO CONSULTANT(S) FOR PROPOSAL	0d	0d	100%	LC-EN-017	05-Jul-10 A		GF.BB	07-Jul-10	
Hatch Mott (ENG. Deliverables)										
Scope Preparation										
SC10_0390_113	Consultant Development of Proposal With CTR's	10d	0d	100%	LC-EN-017	05-Jul-10 A	23-Jul-10 A	GF.BB	07-Jul-10	20-Jul-10
SC10_0290_752	WTO Updated and Signed-Off	5d	0d	100%	LC-EN-017	23-Jul-10 A	29-Jul-10 A	GF.BB	23-Jul-10	29-Jul-10
SC10_0290_732	PROPOSAL ISSUED TO NE-LCP	0d	0d	100%	LC-EN-017	26-Jul-10 A		GF.BB	21-Jul-10	
SC10_0290_742	Proposal Evaluated By NE-LCP	2d	0d	100%	LC-EN-017	27-Jul-10 A	30-Jul-10 A	GF.BB	21-Jul-10	22-Jul-10
SC10_0440_114	WTO Awarded	0d	0d	100%	LC-EN-017	30-Jul-10 A		GF.BB	30-Jul-10	
SC10_0290_762	KICK-OFF MEETING WITH CONSULTANT	0d	0d	100%	LC-EN-017	05-Aug-10 A		GF.BB	02-Aug-10	
SC10_0290_892	NE-LCP Meeting at Hatch-Mott MacDonald Office	2d	0d	100%	LC-EN-017	17-Aug-10 A	19-Aug-10 A	GF.BB	02-Aug-10	
SC10_0290_902	SOBI Site Meeting (NE-LCP / Hatch-Mott)	3d	0d	100%	LC-EN-017	03-Sep-10 A	06-Sep-10 A	GF.BB	02-Aug-10	
Part 1 (Data Review and Feas. Design										
SC10_0370_206	Review Exisitng Geotechnical info review	10d	0d	100%	LC-EN-017	10-Aug-10 A	08-Oct-10 A	GF.BB	09-Aug-10	20-Aug-10
SC10_0370_266	HDD Bore Profiles Development and Conceptual Design	20d	0d	100%	LC-EN-017	30-Aug-10 A	04-Oct-10 A	GF.BB	13-Sep-10	08-Oct-10
SC10_0370_216	HDD Industry assessment	10d	0d	100%	LC-EN-017	31-Aug-10 A	05-Oct-10 A	GF.BB	23-Aug-10	03-Sep-10
SC10_0370_286	HDD Assessment of Shoreline Design and Construction challenges	15d	0d	100%	LC-EN-017	31-Aug-10 A	05-Oct-10 A	GF.BB	23-Aug-10	10-Sep-10
SC10_0370_226	Site Visit	5d	0d	100%	LC-EN-017	01-Sep-10 A	03-Sep-10 A	GF.BB	06-Sep-10	10-Sep-10
SC10_0370_276	Complete Drawings for HDD Bore Profiles	20d	0d	100%	LC-EN-017	28-Sep-10 A	26-Nov-10 A	GF.BB	13-Sep-10	08-Oct-10
Part 2 (Cost Estimate / Schedule)										
SC10_0370_416	Develop Risk Mitigation Measure	15d	0d	100%	LC-EN-017	31-Aug-10 A	05-Oct-10 A	GF.BB	31-Aug-10	22-Sep-10
SC10_0370_376	Develop Construction Schedule (Level 2)	15d	0d	98%	LC-EN-017	07-Sep-10 A	04-Jan-11	GF.BB	07-Sep-10	20-Oct-10
SC10_0370_446	Develop Cost Estimate (AACEI Class 3)	15d	0d	100%	LC-EN-017	07-Sep-10 A	26-Oct-10 A	GF.BB	07-Sep-10	18-Oct-10



🟩 Remaining Work	◆ Milestone	🟦 % Complete	
🟥 Critical Remaining Work	△ UDF Baseline MS		
▬ Remaining Level of Effort	▬ UDF Baseline		

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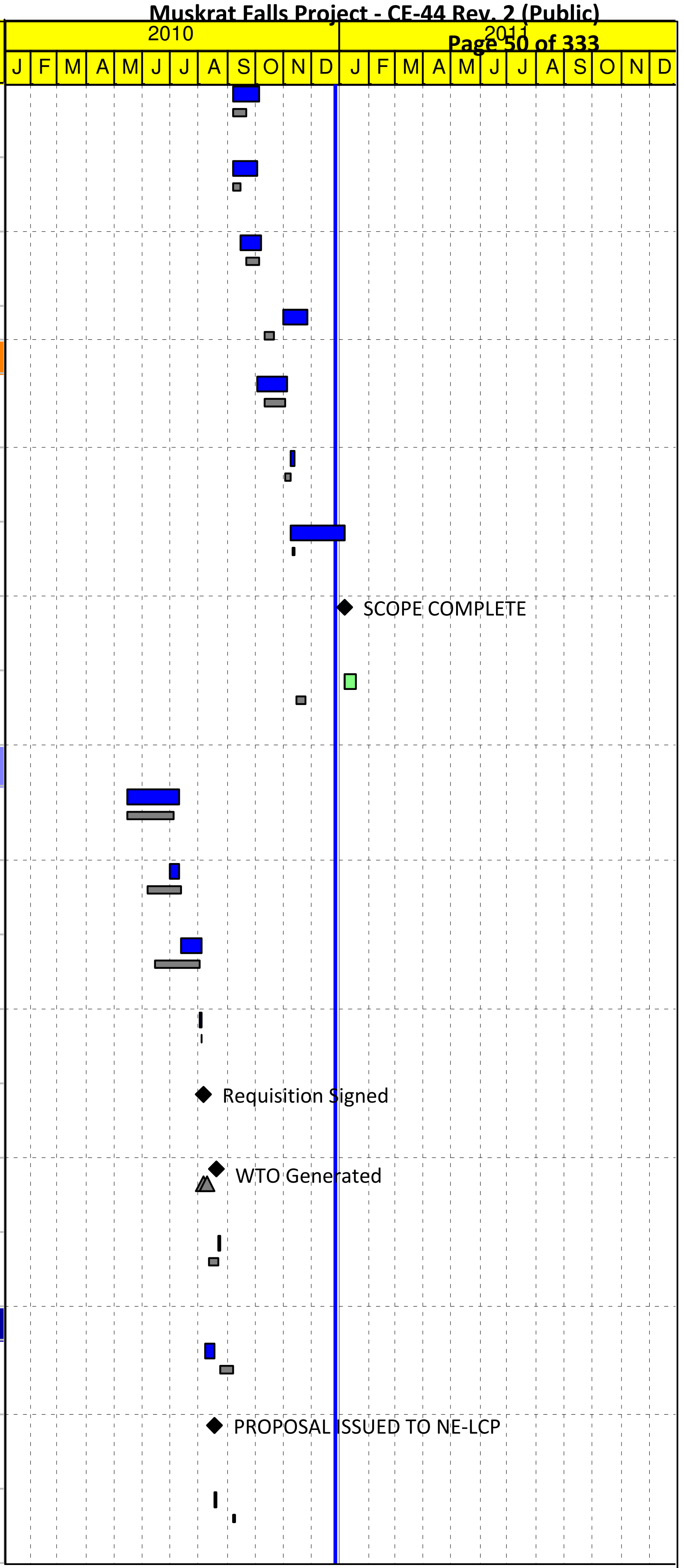
SC10_0370_296	Develop Risk Registry	10d	0d	100%	LC-EN-017	08-Sep-10 A	05-Oct-10 A	GF.BB	08-Sep-10	22-Sep-10
SC10_0370_586	Develop Basis of Estimate	10d	0d	100%	LC-EN-017	08-Sep-10 A	04-Oct-10 A	GF.BB	08-Sep-10	16-Sep-10
SC10_0370_496	Develop Risk Review Presentation	15d	0d	100%	LC-EN-017	15-Sep-10 A	08-Oct-10 A	GF.BB	22-Sep-10	06-Oct-10
SC10_0370_636	Monte-Carlo Analysis	10d	0d	100%	LC-EN-017	01-Nov-10 A	26-Nov-10 A	GF.BB	11-Oct-10	22-Oct-10
Reporting										
SC10_0260_399	Consultant Prep. of Draft Report for Issue to NE-LCP	14d	0d	100%	LC-EN-017	04-Oct-10 A	05-Nov-10 A	GF.BB	11-Oct-10	03-Nov-10
SC10_0260_409	NE-LCP Review of Report and Provide Input As needed	5d	0d	100%	LC-EN-017	08-Nov-10 A	12-Nov-10 A	GF.BB	03-Nov-10	09-Nov-10
SC10_0260_419	Consultant Issue Final Report With Updated Changes	2d	2d	99.5%	LC-EN-017	09-Nov-10 A	05-Jan-11	GF.BB	10-Nov-10	12-Nov-10
SC10_0370_186	SCOPE COMPLETE	0d	0d	0%	LC-EN-017		05-Jan-11	GF.BB		30-Sep-10
SC10_0370_196	Closed-out.	9d	9d	0%	LC-EN-017	06-Jan-11	18-Jan-11	GF.BB	15-Nov-10	25-Nov-10
Shore Approaches (Burying/Excavating/Cable Instal. Techniques)										
SC10_0370_306	Identification of Traditional Shore Approach Methods	10d	0d	100%	LC-EN-021	15-May-10 A	12-Jul-10 A	GF.BM	15-May-10	06-Jul-10
SC10_0370_316	Identification of traditional Shore approach Global Contractors	5d	0d	100%	LC-EN-021	30-Jun-10 A	12-Jul-10 A	GF.BM	07-Jun-10	13-Jul-10
SC10_0370_326	Consultant SOW Developed	15d	0d	100%	LC-EN-021	14-Jul-10 A	04-Aug-10 A	GF.BM	14-Jun-10	03-Aug-10
SC10_0370_336	Requisition Prepared	1d	0d	100%	LC-EN-021	02-Aug-10 A	05-Aug-10 A	GF.BM	05-Aug-10	05-Aug-10
SC10_0370_346	Requisition Signed	0d	0d	100%	LC-EN-021	06-Aug-10 A		GF.BM		
SC10_0370_356	WTO Generated	0d	0d	100%	LC-EN-021	20-Aug-10 A		GF.BM	06-Aug-10	11-Aug-10
SC10_0370_366	WTO Issued To Consultant(s) For Proposal	4d	0d	100%	LC-EN-021	23-Aug-10 A	24-Aug-10 A	GF.BM	12-Aug-10	23-Aug-10
Tideway										
SC10_0390_123	Consultant Development of Proposal With CTR's	10d	0d	100%	LC-EN-021	09-Aug-10 A	19-Aug-10 A	GF.BM	24-Aug-10	07-Sep-10
SC10_0290_772	PROPOSAL ISSUED TO NE-LCP	0d	0d	100%	LC-EN-021	18-Aug-10 A		GF.BM		
SC10_0290_782	Proposal Evaluated By NE-LCP	2d	0d	100%	LC-EN-021	19-Aug-10 A	20-Aug-10 A	GF.BM	08-Sep-10	09-Sep-10



🟩 Remaining Work
🟥 Critical Remaining Work
▬ Remaining Level of Effort
◆ Milestone
△ UDF Baseline MS
▬ UDF Baseline
▬ % Complete

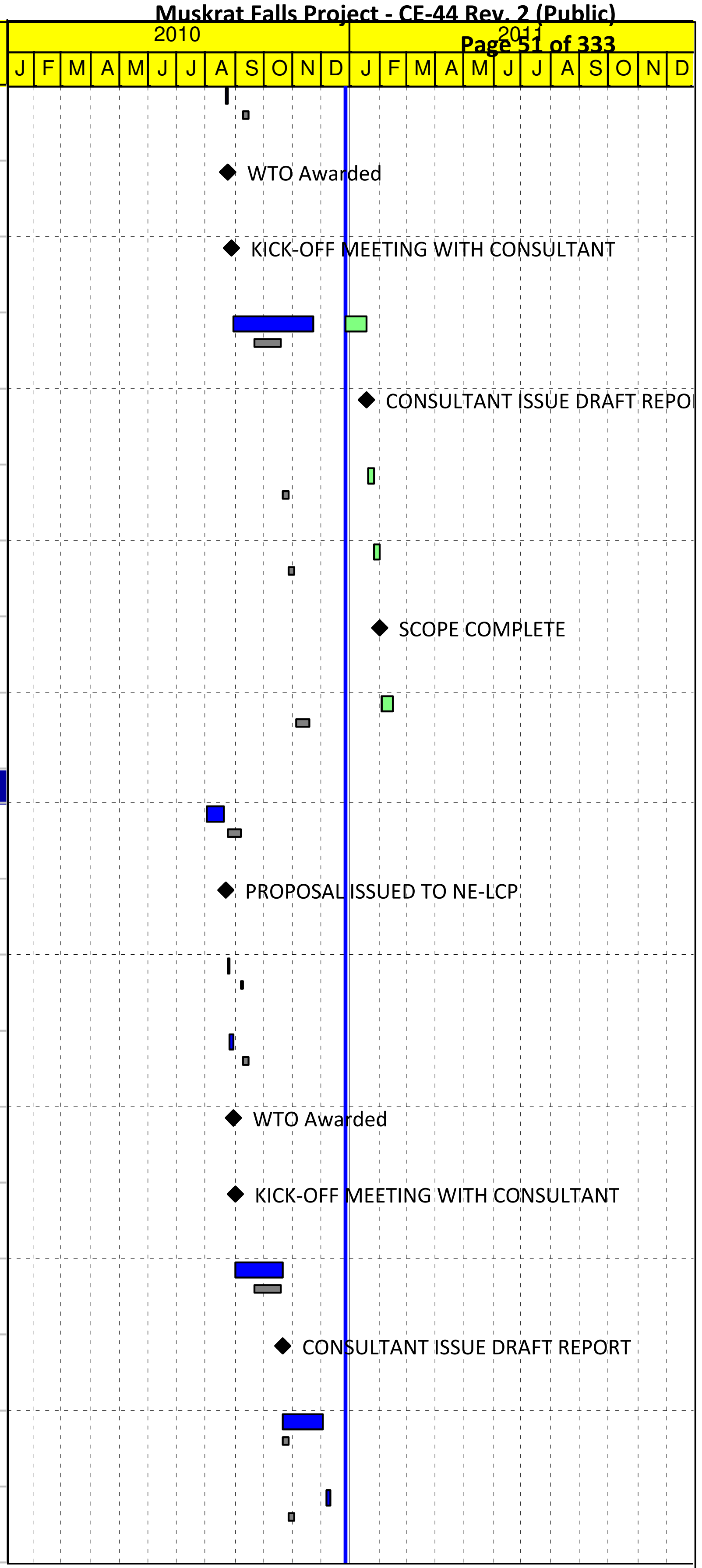
File: Priority Workscope Packages - TDI Workplan

Baseline:

Data Date: 27-Dec-10

Date	Revision	Checked	Approved
29-Dec-10	Bi-Weekly Report Progress up to Dec 24	cwf	

Activity ID	Activity Name	OD	RD	Performance % Complete	LC_WTO	Start	Finish	PE	UDF BL Start	UDF BL Finish
SC10_0290_792	WTO Updated and Signed-Off	5d	0d	100%	LC-EN-021	23-Aug-10 A	24-Aug-10 A	GF.BM	10-Sep-10	16-Sep-10
SC10_0440_124	WTO Awarded	0d	0d	100%	LC-EN-021	24-Aug-10 A		GF.BM		
SC10_0290_802	KICK-OFF MEETING WITH CONSULTANT	0d	0d	100%	LC-EN-021	27-Aug-10 A		GF.BM		
SC10_0370_386	External Scope Execution	20d	11d	60%	LC-EN-021	30-Aug-10 A	18-Jan-11	GF.BM	22-Sep-10	20-Oct-10
SC10_0260_489	CONSULTANT ISSUE DRAFT REPORT	0d	0d	0%	LC-EN-021		18-Jan-11	GF.BM		
SC10_0260_499	NE-LCP Review of Report and Provide Input As needed	5d	5d	0%	LC-EN-021	19-Jan-11	25-Jan-11	GF.BM	21-Oct-10	27-Oct-10
SC10_0260_509	Consultant Issue Final Report With Updated Changes	5d	5d	0%	LC-EN-021	26-Jan-11	01-Feb-11	GF.BM	28-Oct-10	03-Nov-10
SC10_0370_396	SCOPE COMPLETE	0d	0d	0%	LC-EN-021		01-Feb-11	GF.BM		
SC10_0370_406	Closed-out	10d	10d	0%	LC-EN-021	02-Feb-11	15-Feb-11	GF.BM	04-Nov-10	18-Nov-10
Boskalis										
SC10_0390_133	Consultant Development of Proposal With CTR's	10d	0d	100%	LC-EN-022	02-Aug-10 A	20-Aug-10 A	GF.BM	24-Aug-10	07-Sep-10
SC10_0290_812	PROPOSAL ISSUED TO NE-LCP	0d	0d	100%	LC-EN-022	23-Aug-10 A		GF.BM		
SC10_0290_822	Proposal Evaluated By NE-LCP	2d	0d	100%	LC-EN-022	24-Aug-10 A	26-Aug-10 A	GF.BM	08-Sep-10	09-Sep-10
SC10_0290_832	WTO Updated and Signed-Off	5d	0d	100%	LC-EN-022	27-Aug-10 A	31-Aug-10 A	GF.BM	10-Sep-10	16-Sep-10
SC10_0440_134	WTO Awarded	0d	0d	100%	LC-EN-022	31-Aug-10 A		GF.BM		
SC10_0290_842	KICK-OFF MEETING WITH CONSULTANT	0d	0d	100%	LC-EN-022	01-Sep-10 A		GF.BM		
SC10_0370_456	External Scope Execution	20d	0d	100%	LC-EN-022	02-Sep-10 A	21-Oct-10 A	GF.BM	22-Sep-10	20-Oct-10
SC10_0260_519	CONSULTANT ISSUE DRAFT REPORT	0d	0d	100%	LC-EN-022		22-Oct-10 A	GF.BM		
SC10_0260_529	NE-LCP Review of Report and Provide Input As needed	5d	0d	100%	LC-EN-022	22-Oct-10 A	03-Dec-10 A	GF.BM	21-Oct-10	27-Oct-10
SC10_0260_539	Consultant Issue Final Report With Updated Changes	5d	0d	100%	LC-EN-022	06-Dec-10 A	10-Dec-10 A	GF.BM	28-Oct-10	03-Nov-10



🟩 Remaining Work
🟥 Critical Remaining Work
Remaining Level of Effort
◆ Milestone
△ UDF Baseline MS
UDF Baseline
% Complete

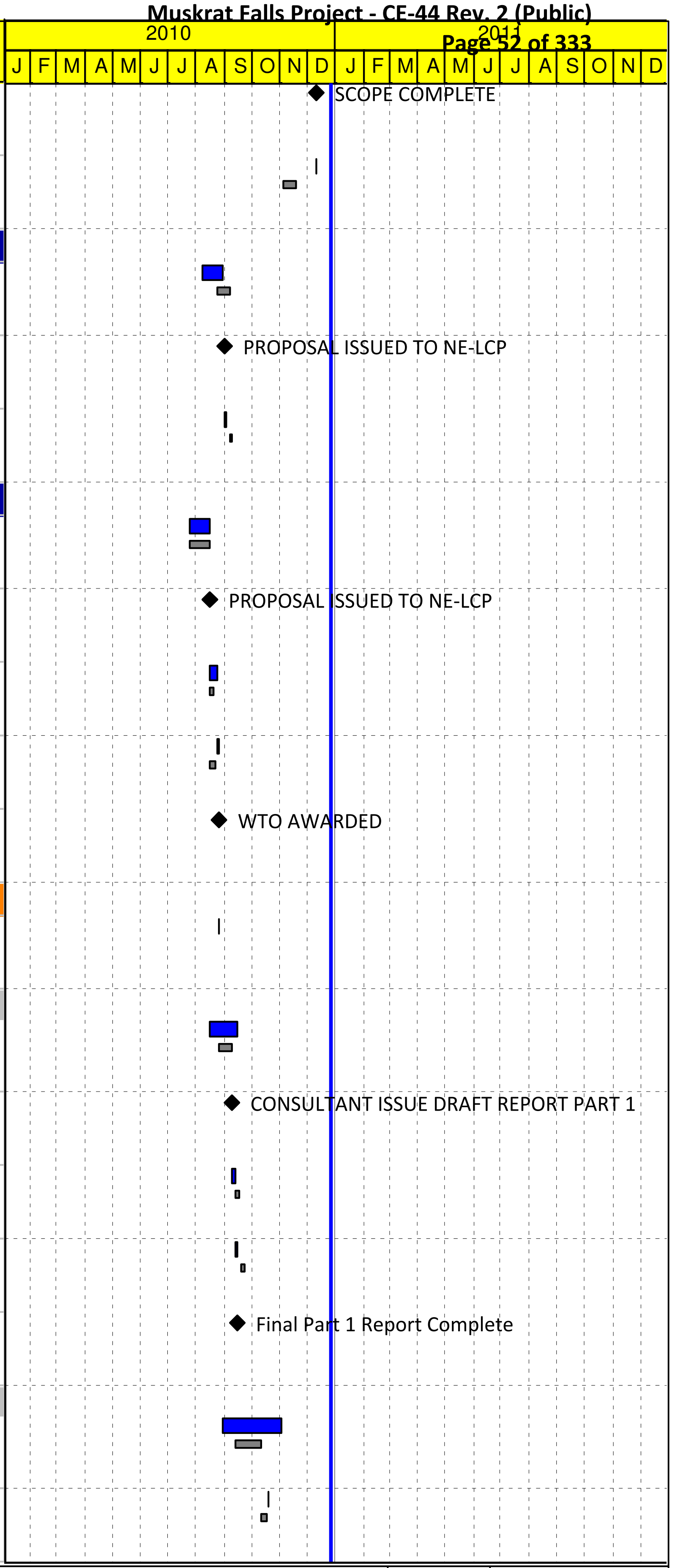
File: Priority Workscope Packages - TDI Workplan

Baseline:

Data Date: 27-Dec-10

Date	Revision	Checked	Approved
29-Dec-10	Bi-Weekly Report Progress up to Dec 24	cwf	

Activity ID	Activity Name	OD	RD	Performance % Complete	LC_WTO	Start	Finish	PE	UDF BL Start	UDF BL Finish
SC10_0370_466	SCOPE COMPLETE	0d	0d	100%	LC-EN-022		10-Dec-10 A	GF.BM		
SC10_0370_476	Closed-out	10d	0d	100%	LC-EN-022	10-Dec-10 A	10-Dec-10 A	GF.BM	04-Nov-10	18-Nov-10
Five Oceans Services (PROPOSAL REJECTED BY NE-LCP)										
SC10_0390_143	Consultant Development of Proposal With CTR's	10d	0d	100%	IWS	09-Aug-10 A	31-Aug-10 A	GF.BM	24-Aug-10	07-Sep-10
SC10_0290_852	PROPOSAL ISSUED TO NE-LCP	0d	0d	100%	IWS	01-Sep-10 A		GF.BM		
SC10_0290_862	Proposal Evaluated By NE-LCP	2d	0d	100%	IWS	01-Sep-10 A	03-Sep-10 A	GF.BM	08-Sep-10	09-Sep-10
Shore based tunnel										
SC10a_0290_001	Consultant Development of Proposal With CTR's	10d	0d	100%	DC1401	26-Jul-10 A	17-Aug-10 A	GF.TR	26-Jul-10	17-Aug-10
SC10a_0290_442	PROPOSAL ISSUED TO NE-LCP	0d	0d	100%	DC1401	17-Aug-10 A		GF.TR	17-Aug-10	
SC10a_0290_452	Proposal Evaluated By NE-LCP	2d	0d	100%	DC1401	17-Aug-10 A	24-Aug-10 A	GF.TR	17-Aug-10	20-Aug-10
SC10a_0290_462	WTO Updated and Signed-Off	3d	0d	100%	DC1401	25-Aug-10 A	26-Aug-10 A	GF.TR	17-Aug-10	23-Aug-10
SC10a_0290_572	WTO AWARDED	0d	0d	100%	DC1401	26-Aug-10 A		GF.TR	23-Aug-10	
Statnett										
SC10a_0290_582	KICK-OFF MEETING WITH CONSULTANT	1d	0d	100%	DC1401	27-Aug-10 A	27-Aug-10 A	GF.TR	26-Aug-10	
Part 1 DC1130 Submarine Piercings Clarification										
SC11_0290_362	External Scope Execution (Part 1, Clarification)	19d	0d	100%	DC1401	16-Aug-10 A	16-Sep-10 A	GF.TR	27-Aug-10	10-Sep-10
SC10a_0260_339	CONSULTANT ISSUE DRAFT REPORT PART 1	0d	0d	100%	DC1401		09-Sep-10 A	GF.TR		10-Sep-10
SC10a_0260_349	NE-LCP Review of Report and Provide Input As needed	5d	0d	100%	DC1401	10-Sep-10 A	13-Sep-10 A	GF.TR	13-Sep-10	17-Sep-10
SC10a_0260_359	Consultant Issue Final Report With Updated Changes	5d	0d	100%	DC1401	14-Sep-10 A	15-Sep-10 A	GF.TR	20-Sep-10	24-Sep-10
SC10a_0290_422	Final Part 1 Report Complete	0d	0d	100%	DC1401		15-Sep-10 A	GF.TR		24-Sep-10
Part 2 Conceptual Methods, Technologies and Applications										
SC11_0290_592	External Scope Execution (Part 2, Conceptual Methods/Applications)	20d	0d	100%	DC1401	31-Aug-10 A	03-Nov-10 A	GF.TR	13-Sep-10	11-Oct-10
SC10a_0290_602	Part 2 Draft Report Issued to NE-LCP for Review	2d	0d	100%	DC1401	19-Oct-10 A	19-Oct-10 A	GF.TR	12-Oct-10	18-Oct-10



🟩 Remaining Work	◆ Milestone		% Complete
🟥 Critical Remaining Work	△ UDF Baseline MS		
Remaining Level of Effort	UDF Baseline		

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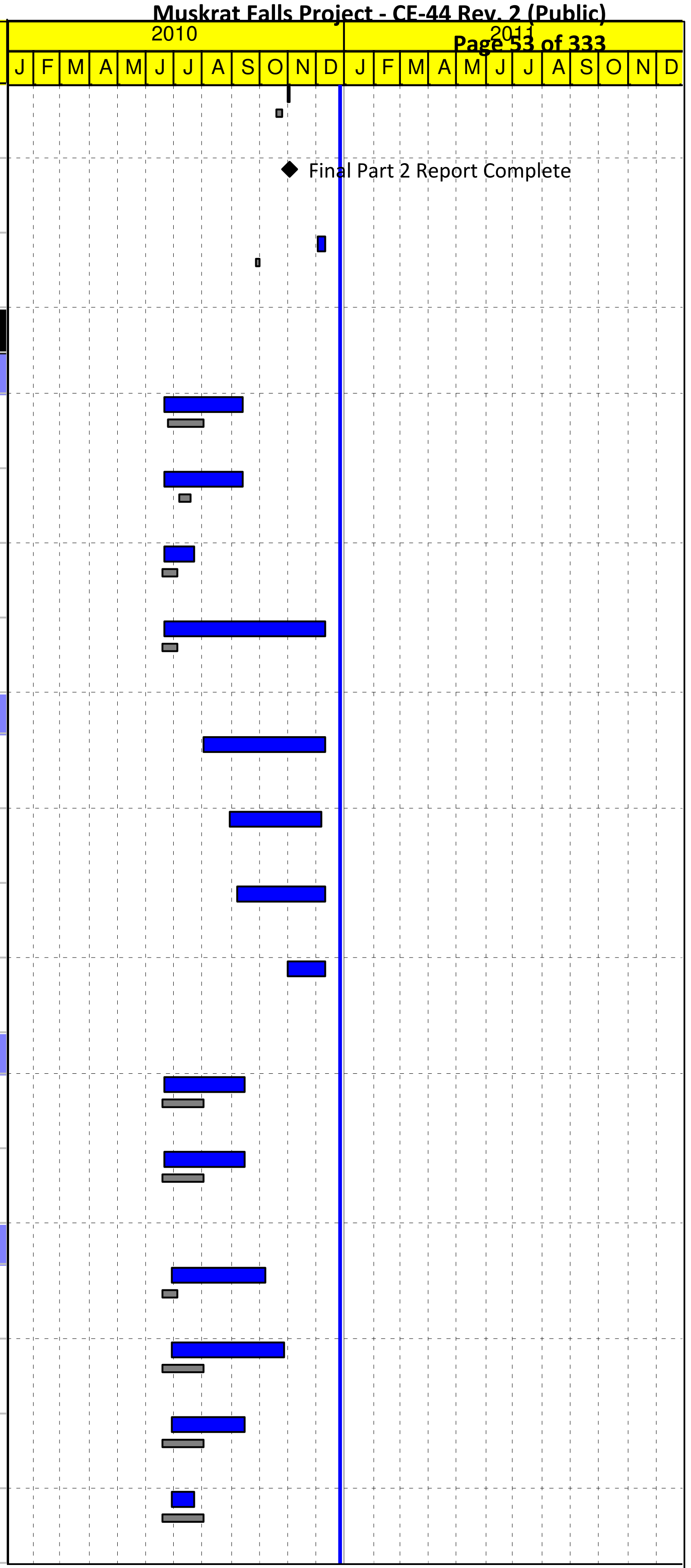
File: Priority Workscope Packages - TDI Workplan

Baseline:

Data Date: 27-Dec-10

Date	Revision	Checked	Approved
29-Dec-10	Bi-Weekly Report Progress up to Dec 24	cwf	

Activity ID	Activity Name	OD	RD	Performance % Complete	LC_WTO	Start	Finish	PE	UDF BL Start	UDF BL Finish
SC10a_0290_612	Part 2 Draft Report updated as required and re-Issued to NE-LCP	2d	0d	100%	DC1401	01-Nov-10 A	03-Nov-10 A	GF.TR	19-Oct-10	25-Oct-10
SC10a_0290_622	Final Part 2 Report Complete	0d	0d	100%	DC1401		03-Nov-10 A	GF.TR		25-Oct-10
SC10a_0290_432	Closed-out	20d	0d	100%	DC1401	03-Dec-10 A	10-Dec-10 A	GF.TR	27-Sep-10	01-Oct-10
SOBI Seabed Installation / Execution (Conceptual Design)										
Prep. Scope Development (Research and Studies)										
SC10_0370_426	Analysis to identify technologies that are applicable and uses	25d	0d	100%	IWS	21-Jun-10 A	13-Sep-10 A	GF.BM	25-Jun-10	03-Aug-10
SC10_0550_111	Review of capabilities	10d	0d	100%	IWS	21-Jun-10 A	13-Sep-10 A	GF.BM	07-Jul-10	20-Jul-10
SC10_0550_141	Bathymetry Survey	10d	0d	100%	IWS	21-Jun-10 A	23-Jul-10 A	GF.BM	18-Jun-10	06-Jul-10
SC10_0550_151	Ground Leveling	10d	0d	100%	IWS	21-Jun-10 A	10-Dec-10 A	GF.BM	18-Jun-10	06-Jul-10
Pre-Installation Tasks Based on (Other) SOBI Study Results										
SC10_0550_121	Cable Spacing Assessment	1d	0d	100%	IWS	02-Aug-10 A	10-Dec-10 A	GF.BM		18-Nov-10
SC10_0550_131	Determinantion of Environmental Conditions	1d	0d	100%	IWS	31-Aug-10 A	06-Dec-10 A	GF.BM		31-Jul-10
SC10_0550_171	HDD/Shore Approach	1d	0d	100%	IWS	06-Sep-10 A	10-Dec-10 A	GF.BM		30-Sep-10
SC10_0550_161	Rock Trenching	1d	0d	100%	IWS	01-Nov-10 A	10-Dec-10 A	GF.BM		30-Sep-10
Other Cable Protection Methods										
SC10_0370_436	Mattresses	30d	0d	100%	IWS	21-Jun-10 A	15-Sep-10 A	GF.BM	18-Jun-10	03-Aug-10
SC10_0370_486	Articulated pipe	30d	0d	100%	IWS	21-Jun-10 A	16-Sep-10 A	GF.BM	18-Jun-10	03-Aug-10
Scope Development - Installation / IRM Conceptual Design										
SC10_0550_091	Identification of Vessels, owners and specifications	10d	0d	100%	IWS	28-Jun-10 A	08-Oct-10 A	GF.BM	18-Jun-10	06-Jul-10
SC10_0370_546	HDD/Shore Approach Cable Initiation	10d	0d	100%	IWS	28-Jun-10 A	28-Oct-10 A	GF.BM	18-Jun-10	03-Aug-10
SC10_0370_566	Matresses	10d	0d	100%	IWS	28-Jun-10 A	16-Sep-10 A	GF.BM	18-Jun-10	03-Aug-10
SC10_0370_576	Sand Bags	10d	0d	100%	IWS	28-Jun-10 A	23-Jul-10 A	GF.BM	18-Jun-10	03-Aug-10



🟩 Remaining Work	◆ Milestone	■ % Complete
🟥 Critical Remaining Work	△ UDF Baseline MS	
▬ Remaining Level of Effort	▬ UDF Baseline	

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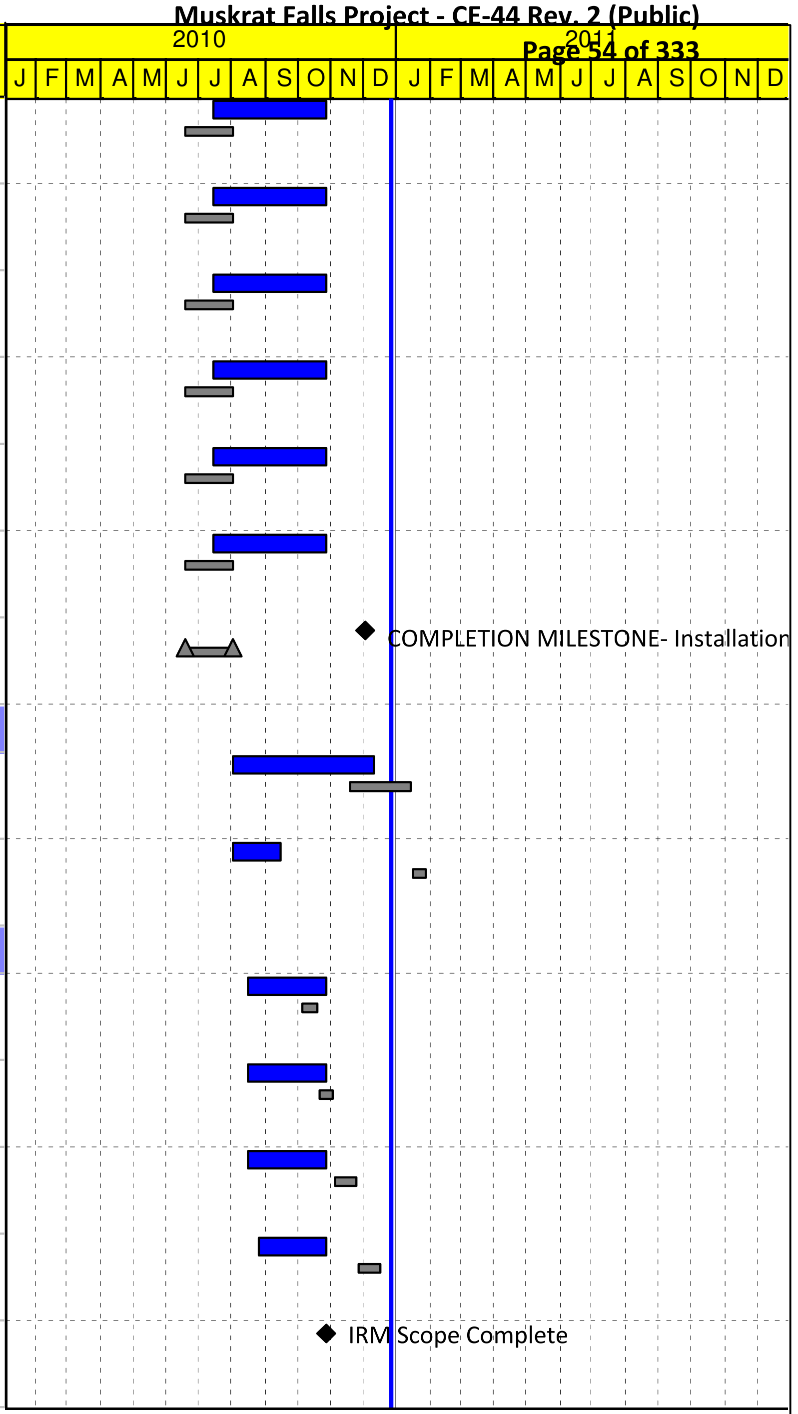
File: Priority Workscope Packages - TDI Workplan

Baseline:

Data Date: 27-Dec-10

Date	Revision	Checked	Approved
29-Dec-10	Bi-Weekly Report Progress up to Dec 24	cwf	

Activity ID	Activity Name	OD	RD	Performance % Complete	LC_WTO	Start	Finish	PE	UDF BL Start	UDF BL Finish
SC10_0370_506	Support Vessels	10d	0d	100%	IWS	16-Jul-10 A	28-Oct-10 A	GF.BM	18-Jun-10	03-Aug-10
SC10_0370_516	Transpooling	10d	0d	100%	IWS	16-Jul-10 A	28-Oct-10 A	GF.BM	18-Jun-10	03-Aug-10
SC10_0370_526	Transit	10d	0d	100%	IWS	16-Jul-10 A	28-Oct-10 A	GF.BM	18-Jun-10	03-Aug-10
SC10_0370_536	Mobilization	10d	0d	100%	IWS	16-Jul-10 A	28-Oct-10 A	GF.BM	18-Jun-10	03-Aug-10
SC10_0370_556	Cable Laying	10d	0d	100%	IWS	16-Jul-10 A	28-Oct-10 A	GF.BM	18-Jun-10	03-Aug-10
SC10_0370_596	Repair	10d	0d	100%	IWS	16-Jul-10 A	28-Oct-10 A	GF.BM	18-Jun-10	03-Aug-10
SC10_0370_606	COMPLETION MILESTONE- Installation / IRM	0d	0d	100%	IWS		03-Dec-10 A	GF.BM	18-Jun-10	03-Aug-10
SOBI Installation (Conceptual Design)										
SC10_0010	Development of Installation conceptual design as based on Study Results	30d	0d	100%	IWS	02-Aug-10 A	10-Dec-10 A	GF.BM	19-Nov-10	14-Jan-11
SC10_0030	Develop High Level Installation Schedule	10d	0d	100%	IWS	02-Aug-10 A	15-Sep-10 A	GF.BM	17-Jan-11	28-Jan-11
Inspection, Repair, Maintenace (IRM)										
SC10_0070_081	Determine Inspection Regime required for life of field operations	10d	0d	100%	IWS	16-Aug-10 A	28-Oct-10 A	GF.BM	06-Oct-10	20-Oct-10
SC10_0530_087	Determine potential maintenance requirements	10d	0d	100%	IWS	16-Aug-10 A	28-Oct-10 A	GF.BM	21-Oct-10	03-Nov-10
SC10_0570_083	Assess repair scenarions for cables protected by varying technologies	15d	0d	100%	IWS	16-Aug-10 A	28-Oct-10 A	GF.BM	04-Nov-10	25-Nov-10
SC10_0580_084	Develop repair method statements and costs.	15d	0d	100%	IWS	26-Aug-10 A	28-Oct-10 A	GF.BM	26-Nov-10	16-Dec-10
SC10_0540_089	IRM Scope Complete	0d	0d	100%	IWS		28-Oct-10 A	GF.BM		16-Dec-10



🟩 Remaining Work	◆ Milestone	▬ % Complete
🟥 Critical Remaining Work	△ UDF Baseline MS	
▬ Remaining Level of Effort	▬ UDF Baseline	

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File: Priority Workscope Packages - TDI Workplan

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Appendix C- Gap Registry

Year	Report Reference	Page	**R**oute, **P**rotection, **Ic**berg, **C**urrent, **Ca**ble, **I**nstallation, **O**ther	Actions: pose **Q**uestion, **C**hallenge, **V**alidate, **U**nknown, key **I**nfo	Description
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-1	R	I	Routing analysis based on surveys conducted by Hydro in August and September 2007
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-1	Ca	U	Redundant cable details
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-1	R	Q	Who recommended the corridors?
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-1	Ic	C	FJG says iceberg risk is only to be considered to 70 m. Scour data on Labrador side supports this. Only one observation on NL side.
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-1	R	V	Protection from natural bathymetric corridors
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-1	P	C	Proposed water jet trenching in deeper sections
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-1	P	U	Risk of damage by fishing gear and ship traffic.
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-1	P	C	1.5 km tunnel on Lab. Side and 3.5 km tunnel on NL side.
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-1	C	U	Current details
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-1	I	U	Risks deemed by installation contractor
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-1	C	I	HVdc cables in high currents in Cook Strait in New Zealand by the CIS Nexans Skagerrank?
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-1	I	V	Assumption that the cable laying vessel would need support tugs [Vessel Capabilities]
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-1	I	C	Marine spread for laying and trenching to be mobilized from Europe
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-2	P	V	Estimate: one tunnel, 392.9 M, two tunnel, 434.1 M
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-3	R	U	Additional information required in the upper 2-3 m of the seabed along the route as well as geological conditions at depth for tunneling
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-3	Ca	Q	Thermal resistively as it relates to cable design

Year	Report Reference	Page	**R**oute, **P**rotection, **Ic**berg, **C**urrent, **Ca**ble, **I**nstallation, **O**ther	Actions: pose **Q**uestion, **C**hallenge, **V**alidate, **U**nknown, key **I**nfo	Description
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-3	R	C	Clay and organic material that may contribute to high thermal resistively are assumed to not be present [review with env. Group]
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-3	Ca	Q	Cable design calcs are mentioned. What cable design calcs?
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-3	Ic	U	Iceberg scours in shallow waters - recommended camera review [Steve's surveys?]
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-3	I	U	Likelihood of free spans
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-3	C	U	Full current details - daily, weekly, annually
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-3	R	U	Survey data between KP29 and KP23 [32?]
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-3	Ca	C	Spare cable length of 2000 m + 4 joint repairs at the minimum
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-3	I	U	Post lay surveys in operations period
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 1 - Executive Summary	E-3	O	U	Repair preparedness plan and repair procedure
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	1-1	O	I	April 2007 Hydro contacted Hatch to undertake a program of studies
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	1-1	O	I	Statnett of Oslo
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	1-1	R	I	Proposed route and landfall alternatives have been derived from the results of a multibeam bathymetry, geophysical and ground-truthing survey undertaken by Fugro in 2007
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	1-1	I	V	Iceberg scours are 1-2 m deep
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	1-1	Ic	C	Iceberg protection is required for 70 m water depth or shallower
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	1-3	R	I	Desktop study and recent bathy survey undertaken by FJG in Aug. and Sept. 2007. MV Cansea and MV Anticosti.
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	1-5	R	V	The sub-bottom profiler is subjective, with uncertainties associated with the bedrock/overburden interface, leading to significant deficiencies in quantities for the cable protection

Year	Report Reference	Page	**R**oute, **P**rotection, **Ic**berg, **C**urrent, **Ca**ble, **I**nstallation, **O**ther	Actions: pose **Q**uestion, **C**hallenge, **V**alidate, **U**nknown, key **I**nfo	Description
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	1-5	R	V	Detailed seabed sediment distribution is unclear, leading to significant deficiencies in quantifying the cable protection
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	1-5	R	U	Targets identified from the side scan sonar data have not been visually verified. Interpretation of targets is not definitive
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	2-1	Ca	C	Min. lateral separation of 20 m (Eastern Corridor) allowing flexibility for repairs. 200 m recommended width
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	2-1	R	I	Table 2.1 - Summary of Eastern Route Corridor
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	2-4	Ca	C	Min. lateral separation of 20 m (Western route corridor) 175 m recommended overall width
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	2-4	R	I	Table 2.2 - Summary of Western Route Corridor
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	2-6	P	C	Tunnel alternative 20 m separation, 300 m wide
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	2-6	P	I	Tunnel summary table 2.3 and 2.4
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	2-6	P	C	Recommended tunneling to 70 m water depth
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	2-8	P	C	Rock trenches to 70 m water depth
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	2-9	P	I	Table 2.5 - Tunnel from Forteau Point to Mistaken Cove - Eastern Route Corridor
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	2-13	P	I	Table 2.5 - Tunnel to Forteau Point - Western Route Corridor
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	2-17	R	I	Sediments and sediment interpretation
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	2-17	P	U	Rock trenching
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	2-17	P	U	Rock dump design
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	2-17	Ic	U	Risk analysis for iceberg scour

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2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	2-17	I	U	Shallow water cable installation
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	2-17	P	C	Tunnel routing
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	2-17	R	U	Ship traffic
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	2-17	P	U	Fishing activity
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	2-17	P	C	Discussions of rock dump size with fisherman
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	2-17	R	U	archaeological find procedure
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	2-17	R	U	Landfall construction plan
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	2-18	C	C	Need for full water column measurements at 15 min. intervals
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-1	R	U	Exclusion zones
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-1	R	U	Coldwater corals [discuss with Steve]
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-1	R	V	Ideal sediment is < 40 kPa for cable lay
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-1	P	C	Preferred trenching is water jetting
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-1	R	U	Protected natural reserves
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-4	P	U	Extent of near shore wave action
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-4	R	U	Seismic activity along fault lines - ground displacements
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-4	P	V	Slopes steeper than 15 degrees should be avoided for jetting operations

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2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-4	P	U	Possible abrasion issues in shallow water
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-5	I	I	Vortex shedding and cycling drag at free spans - avoid!
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-5	I	V	In water depths less than 10 m, cable laying offshore vessels cannot operate
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-5	I	I	Inshore to be done with smaller spreads
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-5	R	U	Corals
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-5	Ca	U	Thermal resistively - important factor in cable design. A survey task is to provide data regarding the thermal resistively for impact into the cable design basis.
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-5	P	U	Trawl boards and beams [???]
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-5	P	U	Grapnels, anchors, and heavy deadweights
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-6	P	C	Recommended 1 m backfill over cable, hard ground 0.5 m over cable
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-6	P	U	Sinking vessels!
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-6	P	U	Anchor penetration
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-6	P	Q	Setup anchorage exclusion zone do-able?
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-6	P	U	Emergency ship grounding considerations
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-7	O	U	"Heavy Plant"?
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-7	P	C	"'disturbance of seabed down to several meters depth"
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-7	O	U	Oil and gas planned exploration

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2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-7	I	U	port facilities and bridges
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-7	R	U	Outfalls
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-7	R	V	Any existing cables buried [later in the report it is stated that there are no cables buried in the straight]
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-7	Ca	C	Cable - 2x water depth separation Pipelines - 3x water depth Telecable - 2km to be maintained for repeaters
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-7	Ca	U	Future cables
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-8	R	V	Wrecks older then 100 years are considered archaeological importance. Min. offset 100 m.
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-8	R	V	500 m wreck offset, 100 m arch. Offset, 100 m large debris offset
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-8	R	U	Military activities and exclusion zones
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-8	O	V	Currently the Canadian legislation is working to be in accordance with UNCLOs
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-8	O	U	Mines???
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	3-8	O	U	Dump Sites??
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	4-1	R	I	Most geophysical data came from FJG 2007
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	4-1	P	I	1970s methods - bedrock tunnel beneath strait - 2 bedrock …[check ref] - lay cables in premade … [check ref]
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	4-1	R	I	Bathy Resources - FJG 2007 - Route Survey and Interpretation Report - FJG 2007 - Desk top study - FJG 2007 - Bathy recon survey - AMEC Earth and Envi 2008 - CCORE 2007 Ice Scour Risk - JW 2007 Strait of Belle Isle Constraint Mapping Report

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2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-1	R	C	Eastern route is 27.989 km Western Route is 35.123 km
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-2	Ca	C	Eastern route proposed to contain 3 cables
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-2	R	I	Study has defined zones as landing being WD = 0 m, Near Shore being 0 m to 50 m, Strait being 50 - 150 m.
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-5	R	I	L'Anse Amour beach is sandy and 1 km long by 20-30 m wide
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-5	R	I	Behind raised beaches the valley side rises more than 100 m above sea level
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-7	R	I	The water depth increases steadily reaching 50 m at 1.6 km from the landing point [which route is this?]
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-7	R	C	Maximum gradient along track is < 3 deg.
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-8	R	I	Table 5.4 - Summary of near shore conditions
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-8	R	V	Lab-NL - hummocky topography with historical iceberg plough marks - sediment cover variable, sometimes less than 1 m - Shallowest point is 64 m [?] - Shallow area susceptible to iceberg scouring - Suggested significant rework of sediment in this area
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-9	R	I	Up to 6 m of sediment near KP 13
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-9	R	V	channel followed from KP 0.5 to KP 13
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-9	R	I	KP13 to 14.2, thin sediment < 1.0 m rarely more than 2 m thick
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-9	Ic	C	some following of historical iceberg marks occurring
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-9	R	I	sediment cover variable to KP20.5
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-9	R	C	Climbs from 106 m to 50 m between KP 19 and 23.77

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2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-9	R	I	Two steps in climb: HP 21.07 at 90m and 80 m at KP 22.2
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-9	R	C	Route corridor has been optimized to try and use as many areas of sediment as possible
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-9	R	I	50 m isobath located at KP23.7 where bedrock is at the surface or under a thin lay deposit
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-9	R	I	Table 5.5 - Summary of conditions - SOBI
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-14	R	I	Table 5.6 - Summary of Conditions - Near Shore Mistaken Cove
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-14	R	I	Vertical bedrock steps 2m - 6m KP 23.776 - 26.996
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-14	R	U	"Sediment migration identified… may provide inadequate protection of installed cables"
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-15	R	I	Table 5.8 - Areas of Sediment Migration
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-15	R	C	No excessive gradients have been found along the route (>15 deg), therefore it is not expected to encounter Sediment stability hazard's.
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-15	R	U	Bedrock steps
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-15	R	I	Table 5.9 - Areas of bedrock bluffs
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-16	R	I	Table 5.10 Areas of Bedrock Outcrops
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-17	Ca	V	No thermal resistively measurements have been acquired
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-17	P	I	Trenchability assessed based on SBP interpretation and isopach chart
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-17	P	C	Table 5.12 - Trenchability - Eastern Route e.g. KP 0.35-0.4, soil t is 0-2m = trenchable
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-21	R	I	Table 5.13 - SSS Targets +/- 10 m from Centerline

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2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-23	R	I	Table 5.14 - Turning points, western route corridor
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-27	R	I	Table 5.16 - Summary of near shore condition - western corridor 0-50 m
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-28	R	C	KP 15.427 - Paleo plough marks
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-28	R	I	KP 21.912 - max depth of 124 m
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-28	R	C	maximize sediment depth and maintain min 600 m offset from easterly route
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-28	R	I	KP 22.847 - KP 25.5 - particularly uneven topography due to plough marks
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-28	R	C	KP 25.5 to KP 28.723 - routing for sediment coverage
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-31	R	I	Table 5.18 Near Shore Mistaken Cove
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-32	R	I	Table 5.19 - Landing pt, mistaken cove
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-32	R	I	Table 5.20 Sediment Migration
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-33	R	I	Table 5.21 Bedrock Bluffs, Western Route
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-34	R	I	Table 5.22 Areas of Bedrock at Seabed
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-34	R	I	Soil thickness between 0 and 1 m from KP 29.7 to KP 34
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-34	Ca	U	Thermal resistively
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-34	P	C	Table 5.24 gives estimated trenchability
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-38	I	I	No crossings have been identified

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2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-39	R	I	Tunnel Route, Forteau Point to Western Corridor:
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-39	R	I	Joins route at KP 1.2, at 70 m water depth
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-39	R	I	Photo of Forteau Point
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-41	P	C	Yankee point tunnel proposal to carry cables to 70 m offshore
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-42	R	C	Table 5.27 - Borehole lay, Yankee Point
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-43	Ca	C	No thermal data for Forteau Point Tunnel route
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	5-43	P	C	Table 5.30 - Trechability data
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-1	R	I	Environmental conditions Overview
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-1	I	V	April to Sept. as working window
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-1	I	V	July to Sept. as optimal temp.
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-2	I	I	Wind Speeds - fig. 6.2
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-3	I	I	Fig. 6.3 - Monthly wind rose
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-3	I	V	Main wave directions are W and SW with height rarely greater than 3 m
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-3	C	V	Currents are greatest on Labrador coast and at surface
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-4	C	V	Highest currents speeds recorded are 5.1 kts at surface and 3.4 at bottom
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-4	I	U	CCORE report is thorough and attempts to model ice conditions. But, it predates survey so does not use latest bathy data but relays on digi. Data from 1992 (Woodward)

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2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-4	Ic	C	Table 6-5 - Iceberg grounding areas
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-4	Ic	C	Normally icebergs travel down Western channel of SOBI, grounding in water depths less than 70 m. Sometimes icebergs travel north along eastern side
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-6	Ic	I	Table 6.2 - Plough Mark Scour Depths - 2 m greatest depth risk
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-7	Ic	I	Table 6.3 - Plough mark scour cover depths for shielded - non-shielded contact events
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-7	Ic	C	Pack-ice scour risk - no risk data analyzed previously
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-8	Ic	I	Table 6.4 - Ice Keel/ Cable contact events
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-8	R	I	Water temp - 9-10 deg surface max, to < 0 deg in winter
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-9	O	I	Water salinity
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-10	P	I	Main fisheries - lobster, scallops, shrimp, cod, capelin, Greenland halibut
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-10	P	I	Lobster - shallow water, spring, 8-10 weeks, more on Lab. Side
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-10	P	I	Shellfish - Iceland scallop dragging, 45-55 m, uses drags/dredges pulled along seabed
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-10	P	I	Shrimp - 150 m to 350 m, closest fishing is Esq. Channel
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-10	P	U	Shrimp trawling in the strait
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-10	P	I	Fig. 6.8 - Commercial Fishing Figures
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-12	P	I	Cod fishing - long-lining, gill nets (fixed anchors to seabed), cod traps with anchored boxes
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-13	I	V	No cables or pipelines that cross proposed routes

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2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-14	R	U	Wrecks and debris - 40 identified with limited position data, 1 has arch. Importance (HMS Raleigh - ANY REMAINING EXPLOSIVES?)
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-14	R	U	May be unexploded ordinance lost in shallow water near wreck site
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-14	R	U	Historical assessment required for landfall sites
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-14	R	V	Any wrecks thought to be of arch importance require to be avoided by 100 m
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-14	R	V	The arch. Responsible department has the right to request video inspection data and any other data related to the route
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-14	R	I	Close liaison with archaeologists recommended from the get go
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-14	I	U	New legislation from UNLOSC requirements from Jan. 2008 may affect cable installation and operation
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	6-14	Ca	U	Details of cable between NB and PEI
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	7-1	R	C	Route selected based on sediment thickness, among other reasons
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	7-1	R	I	Table 7.1 Recommended Eastern Corridor
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	7-1	R	C	Routing (Plough marks, sediment, etc.)
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	7-3	R	I	Table 7.2 - Recommended Western Route Corridor
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	8-1	Ic	U	Recommended to obtain more data for pack ice limits, iceberg patterns, currents, wind and waves, and water temp.
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	8-1	Ic	C	Recommend CCORE Ice Scan report 2007 be revised and sampling devices be deployed to measure 12 month data
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	8-1	R	U	no previously installed subsea lines in existence
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	8-1	O	I	no hydrocarbon concessions required

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2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	8-1	P	C	Report recommends discussions with Fishing industry to understand rock protection size
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	8-1	P	I	Trawling and dredging are favored fishing methods
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	8-1	P	I	Recommend temp. protection until laid cables are covered to depth
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	8-2	I	V	Special notifications required for ship traffic during installation
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	8-2	I	C	minimum lay curve radius of 100 m
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	8-2	Ca	C	min separation of 20 m based on previous MI cable installation
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	8-2	Ca	C	5 m min separation in trenches
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	8-2	R	U	EBSA requires special treatment
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	8-2	Ca	U	Compass deviation considerations which might affect cable separation we recommended to be in line with accepted practice of max. acceptable deviation of 5 deg (Dutch, UK, German guidelines)
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	9-1	I	U	Use ROVs to lay cable between boulders and outcrops
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	9-1	I	V	ROV equipped cable layer?
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	9-1	I	C	Frequent stops during the laying with backing and re-laying are to be expected in order to verify that the cable is appropriately positioned through seabed irregularities around rocks and boulders
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	9-1	R	I	High slope angles can lead to fluidization of sediment and exposure of cable
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	9-1	R	I	Areas of rock steps and bedrock bluffs are present and will require protection for the cable (minimized for route selection).
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	9-2	C	C	Strong currents are likely to disrupt operation
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	9-2	I	C	Installation window is April to September

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2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	9-2	P	C	Water trenching for protection
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	9-2	P	I	Ploughs can be used but aren't recommended
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	9-3	R	U	Has archaeological assessment of landfall sites been completed?
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	10-1	Ca	C	3 cables in Eastern corridor and 2 in Western
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	10-1	R	I	Geotech samples recommended to be taken along the route to confirm sediment interpretation and establish trenchability of sediments
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	10-1	P	C	Trenching depth variable between 1m and 3 m maximum (in areas of possible enhanced iceberg scour)
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	10-1	Ic	U	Re-calculated risk analysis CCORE 2007 for ice scour based on the MBES data collected in 2007
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	10-1	I	U	Cable installation from small barges in Mistaken Cove (min. water depth for cable vessels is nominally 10 m found 2.442 km distance from the landing point)
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	10-1	R	U	Bedrock structure details
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	10-1	R	I	App. A: Route Position Listings
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	10-1	R	I	App. B: Long. Profiles
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	10-1	R	C	App. C: SSS Target Listings (Anything useful here??)
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	10-1	R	I	App. D: Grab sample listings
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	10-1	R	I	App. E: Photographic Listings
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 2 - Cable Routing	10-1	P	I	App. F: Fishing Equipment
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	1-1	Ca	C	Principle reason for two corridors is to reduce possibility of simultaneous failure of cables

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2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	2-1	Ca	I	Table 2.1 - Pole currents for various voltage levels
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	2-1	Ca	V	Conductor calcs done with 12 deg C. as acceptable temp. drop over insulation
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	2-1	Ca	I	Capacity calcs done based on IEC 60287 standard
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	2-1	Ca	I	Thermal pre-conditions: burial depth is 3 m, separation of 5 m, soil temp at landfall is 12 deg C and max conductor temp. is 55 deg C
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	2-1	Ca	V	Insulation in a MI cable is not pressurized and cavities may form during cooling after a load drop
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	2-2	Ca	I	Table 2.2 and 2.3 - Cable Properties as a function of Voltage
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	2-2	Ca	I	SCOF - self-contained oil filled - impregnated with very low viscosity oil to enable flow along the cable to and from pressurized oil expansion reservoirs at each end
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	2-3	Ca	I	Availability for cable repair in SOBI may be limited due to physical environment.
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	2-3	Ca	I	In the case of failure, the cable may leak oil for a long period until a repair operation can start
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	2-3	Ca	I	To avoid destructive water intrusion, oil reservoirs have to contain large quantities of oil
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	2-3	Ca	C	Oil leaks may be an environmental problem
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	2-3	Ca	I	Table 2.4 - Properties of SCOF cable - Generally bigger and heavier than MI

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2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	3-1	P	U	Otter/trawl boards
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	3-1	R	I	Table 3.1 - Eastern Route Sections
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	3-4	R	I	Table 3.2 - Western Route Sections
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	3-6	R	I	Routing with Tunnel on Both Sides - Table 3.3 - Eastern Route Sections
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	3-8	R	I	Table 3.4 - Western Route Sections
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	4-1	I	U	Transition Compounds
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	4-1	I	C	Indoor transition compounds cost more (source???)
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	4-1	I	C	Transition compounds assumed to be 400 m from shoreline on Lab. Side, and 600 m from shoreline on NL side
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-1	P	U	Extent of trawling in region
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-1	Ic	C	Suggested that iceberg risk is limited to < 70 m
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-1	P	C	"Protection against emergency anchoring operations can normally not be obtained by burial only"
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-1	P	C	Water jet trenching

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2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-1	P	v	Limestone/soft rock has been previously excavated to 3 m
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-2	R	I	Rock is grey and brown dolostone, 50% dolomite
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-2	R	I	Inside land on NL side is mostly boggy
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-2	R	I	Yankee point borehole 74-B-D1
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-2	R	I	Dolomite down to about 73 m
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-3	R	I	Pt. Amour diamond core (74-B-D2)
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-3	R	I	At Point Amour there are 27 m with interbedded limestone (dolostone) and shale that belongs to the Forteau Formation
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-3	P	C	"Tunneling from land and out under the seafloor is a well-proven technique"
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-4	I	C	"Recommend that the gradient be no deeper than 12%"
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-4	P	C	20 m^2 cross section for tunnel
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-4	P	V	Cable jointing chamber can be sealed off and pumped dry
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-4	P	V	Preferred drilling of micro tunnels is upwards

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2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-4	P	C	One or two spare tunnels should be drilled as contingency
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-4	P	C	Micro tunnels to have diameter of 300-400 mm
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-4	P	C	Table 5.4.3 - Water Jet Trenching
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-4	P	C	Micro tunnels to be laid with steel tubes. If rock is poor quality, micro tunnels have to be installed during drilling. Technology not yet fully developed.
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-4	P	U	Technology anticipated to be commercially viable in 2 to 3 years.
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-6	P	U	Use subsea excavator for rock trenching
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-6	P	I	Only good to 15 Mpa
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-6	P	Q	Which unit??? Www.scanmudring.no
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-6	I	C	20-70 m - offshore construction vessel with crane and winch capacity
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-6	I	C	2 m to 20 m - barge and mobile crane
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-6	P	C	Table 5.2 - rock trenching lengths
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-10	P	C	Lay in concrete Culverts or use sand protection with rock fill

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2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-10	C	C	Uncertain whether this can be done to currents
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-10	Ic	U	Iceberg impact on concrete culverts
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-10	P	C	Micro tunneling, plug application "Usually done" but yet technology is not developed??
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	5-11	Ca	C	"Stats show cables that are installed have high reliability"
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	6-1	I	C	There are only 2-3 purpose built cable installation vessels
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	6-1	I	U	Tug requirements
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	6-5	I	I	Installation analyses will be executed covering areas of cable installation work that requires analyses and computation. These analyses will be cased on governing documents and industry practice
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	6-5	R	U	Detailed route survey
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	6-5	Ca	V	Estimated loading for 2-3 cables is 6-7 days
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	6-5	I	V	18 days from Scandinavia to SOBI
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	6-5	I	C	Need 30-35 T bollard pull tug
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	6-7	Ca	U	Cable pull-in arrangement

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2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	6-8	I	I	ROV to monitor cable touchdown
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	6-8	I	C	Cable laying system called Capjet by Nexxans
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	6-9	Ca	U	Cable pull-in at Yankee Point - sensitivity of cable in water
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	7-1	Ca	U	Time for replacement delivery
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	7-1	Ca	U	Spares requirements
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	7-1	Ca	C	Sufficient spares to serve two repairs
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	7-1	P	I	An anchor hitting an unburied cable can damage up to 800 m as seen in Scandinavia
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	7-1	Ca	U	Number of repair joints required
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	7-1	Ca	V	Terminations may require up to 6 months delivery
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	7-1	Ca	U	Repair joint availability
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	7-1	Ca	I	Recommended repair preparedness plan and repair procedure to be pary of supply contract
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	7-1	P	I	Rock removal equipment: Scanmudring, Five Oceans Services, Van Oord

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2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	8-1	P	I	Rock costs used on Norned Cable
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	8-1	P	V	Rock trenching costs from Scanmudring - They have worked in NL
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	8-1	P	I	Tunneling costs based on Norwegian experience
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	8-1	Ca	I	Currently a supplier's market for cables
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	8-1	Ca	V	Factories fully loaded for next few years
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	8-1	Ca	V	Costs of cables increase 5-10%/year
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	8-1	Ca	V	New material costs increased by 25% last year…
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	8-2	P	I	Protection assumed at all route sections and at water depths greater than 70 m
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	8-2	P	C	Estimated volume is 40,000 m^3 for five cables
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	8-2	P	C	Assured suitable facilities for rock loading within 4 hours steam
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	8-2	Ca	I	Table 8.1 - Cost estimate summary for SOBI Hvdc cables
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	8-3	P	V	Cost increase for tunnel over Rock Trenches is $40 million

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2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	8-3	P	C	Water jetting assumed over 13 km. To use rock dumping instead, it would cost $17 M more.
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	9-1	Ca	V	European Suppliers Capacity: Nexxans, 250k/year, ABB 300 k/year, Prysmian, 400k/year
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	9-1	Ca	V	Japanese are more suited for manufacturing oil-filled cables than MI
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	9-1	Ca	I	Facilities may be upgraded to suit this kind of production
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	9-1	Ca	I	Nexxans has in the last year operated the paper-insulated cable facilities in VISCAS factory in Japan
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	9-1	Ca	I	Manufacturing schedule based on two parallel lines/impregnating vessels available continuously for 14-16 months
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	9-1	Ca	V	If type testing is required, cable would be ready in 26-28 months.
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	9-1	Ca	I	Recommended to include at least limited verification type tests of cable and joints
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	9-1	Ca	C	Both cable alternatives will require two laying campaigns
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	9-1	Ca	C	Statnett project: delivery of 130 km, 450 Kv HVdc cable, 90 k of which was land based. To achieve 2014 installation, commitments to manufacturing need to be made around 2008. Manufacturing time??
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	9-1	I	U	Vessel availability
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	9-1	Ca	I	App. A: Cross sections

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2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	9-1	Ca	I	App. B: Transition Compound
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	9-1	O	I	App. C: Project Schedules
2008	DC1130 - Submarine Cables - SOBI Hatch with Statnett, RSW, TGS Volume 3 - Design, Method, Cost and Plan	9-1	O	I	App. D: Cost Estimate
2008	DC1132 - Fugro Desktop Study - Appendix B Ice Scour Risk in Straight… Section 2.2.1 - Last Paragraph - " Since the avaliable date…..are limited and not suitable…"	2-2	I	Q	What data will be required to generate mean drift speeds? How do we get this data? How long will it take to get this data? Is there benefit in getting this data?
2008	DC1132 - Fugro Desktop Study - Appendix B Ice Scour Risk in Straight… Section 2.2.2 - Iceberg Density	2-3	Ic	Q	Should we use the degree square for which the crossing will take place and not reduce the density by averaging it with the adjoining square that is only 25% of it's value? This would result in more conservertative numbers. Was there any consideration to bathymetric sheilding when using the average?
2008	DC1132 - Fugro Desktop Study - Appendix B Ice Scour Risk in Straight… Section 2.2.2 - Iceberg Density	2-3	Ic	I	Quote - "This is approximately 20 times higher than the iceberg density in the Jeanne d'arc region of the grand banks"
2008	DC1132 - Fugro Desktop Study - Appendix B Ice Scour Risk in Straight… Section 2.2.2 - Iceberg Density	2-3	Ic	Q	What is the Standare Deviation for average iceberg density? i.e. What is a bad year and what was the worst year recorded?
2008	DC1132 - Fugro Desktop Study - Appendix B Ice Scour Risk in Straight… Section 2.2.2 - Iceberg Density	2-3	Ic	Q	Can we review these numbers including recent data up to and including 2009-2010 ice season? Are there any Trends noticed in ice density? Are the densities increasing. Decreasing, or remaining the same?
2008	DC1132 - Fugro Desktop Study - Appendix B Ice Scour Risk in Straight… Section 2.2.5 - Iceberg Drift Speed	2-8	Ic	Q	Statement = " Since a grounded Iceberg cannot ground a second time…" Question - Why not?
2008	DC1132 - Fugro Desktop Study - Appendix B Ice Scour Risk in Straight… Section 2.3 - Modeled Grounding Rates	2-9	Ic	Q	Statement = " It should be noted that ….model….does not account for mathymetric effect." Question - Why not? Question - How would data change if it did reflect sheilding?
2008	DC1132 - Fugro Desktop Study - Appendix B Ice Scour Risk in Straight… Section 3.4 - contact Frequency and Cover Depth	3-2	Ic	Q	Statement = " the analysis required to evaluate additional clearance..." Question - Can C-Core Do this? Question - If so, what infromation is required to complete the calculations?

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2008	DC1132 - Fugro Desktop Study - Appendix B Ice Scour Risk in Straight… Section 3.4 - contact Frequency and Cover Depth	3-2	Ic	Q	Continued………. Question - Is this calculation based on established principles, or is it R&D Question - Are there guidelines or a basis to cunduct these calculations for burried Cable (apposed to a rigid pipe)
2008	DC1132 - Fugro Desktop Study - Appendix B Ice Scour Risk in Straight… Section 3.4 - contact Frequency and Cover Depth	3-3	Ic	Q	Statement = " Clearance equal to half the scour depth was considered sufficient..." Question - What is this bases of this assumption? Question - How does this translate to use of cable vs pipeline?
2008	DC1132 - Fugro Desktop Study - Appendix B Ice Scour Risk in Straight… Section 3.4 - contact Frequency and Cover Depth	3-3 to 3-7	P	Q	General questions for entire section Theis section discussed various parameters like cover depths corresponding to return periods (table 3-2 & 3-3) and relationship between cover depth and return period (graph 3-3 & 3-4), however this is a generalized number for the whole route. Could this be done for smaller defined sections. This could assist in the optimization of protection methodsfor the cable. Additionally, clarification could be given as to wether this information is the mean or max for the whole line.
2008	DC1132 - Fugro Desktop Study - Appendix B Ice Scour Risk in Straight… Section 3.5 - Bathymetric Sheilding	3-4	Ic	Q	What is the probability of icebergs contacting cable route at incremental depth ranges?
2008	DC1132 - Fugro Desktop Study - Appendix B Ice Scour Risk in Straight… Section 3.5 - Bathymetric Sheilding	3-4	Ic	Q	Can it be extablished what bathymetric sheilding is present to determine the max iceberg depth? Then we can analyzise only portions of the route that are above this depth.
2008	DC1132 - Fugro Desktop Study - Appendix B Ice Scour Risk in Straight… Section 3.5 - Bathymetric Sheilding	3-4	Ic	Q	What is the probability of icebergs contacting cable if the cable is not covered? What are the forces that a iceberg can exert on contact per depth interval?
2008	DC1132 - Fugro Desktop Study - Appendix B Ice Scour Risk in Straight… Section 3.5 - Bathymetric Sheilding	3-4	Ic	Q	What soil properties are considered when establishing cover depths for iceberg scours?
2008	DC1132 - Fugro Desktop Study - Appendix B Ice Scour Risk in Straight… Section 3.5 - Bathymetric Sheilding	3-8	Ic	Q	Fig 3-3 Along route 3, there are three sections that indicate iceberg sheilding. Why are the portions of the route inbetween these not considered to be sheilded?
2008	DC1132 - Fugro Desktop Study - Appendix B Ice Scour Risk in Straight… Section 4.1 - Pack Ice Conditions	4-1	Ic	Q	Table 4.1 Can a similar table be produced to indicate Weekly or monthly iceberg observations with totals, means, etc.
2008	DC1132 - Fugro Desktop Study - Appendix B Ice Scour Risk in Straight… Section 4.1 - Pack Ice Conditions	4-1	Ic	Q	Can we review these numbers including recent data up to and including 2009-2010 ice season? Are there any Trends noticed in the pack ice conditions? Are the densities increasing. Decreasing, or remaining the same?
2008	DC1132 - Fugro Desktop Study - Appendix B Ice Scour Risk in Straight… Section 4.2 - Pack Ice Scour Risk	4-7	Ic	Q	Can probability of ice scour be developed for incremental depths from 0 down to max depth (35m noted for Beauford Sea) Additionally, can a force be determined for each interval.

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2008	DC1132 - Fugro Desktop Study - Appendix B Ice Scour Risk in Straight… Section 4.2 - Pack Ice Scour Risk	4-7	O	Q	What happens at shore - min tide -5m and max tide +5m
2008	DC1132 - Fugro Desktop Study - Appendix B Ice Scour Risk in Straight… General	all	Ic	Q	Do NALCOR have any information on PRISE - Pressure Ridge Ice Scour Experiment?
2008	DC1132 - Fugro Desktop Study - Appendix B Ice Scour Risk in Straight… General	all	O	Recommendation	Recommend that a scope of work be developed to answer lquestions from this report to further understand the ice interaction in the area of proposed route and to help understand the protection required.
1973	#4 Studies Undertaken SOBI Cable Crossing Feasibility Study Of Delivering Power From Gull Island Hydro Electric Site To NFLD Teshmont and H Zinder & Associates vol II-Technical Condiderations-appendicies	-	C	I	App. III Bathymetric and Bottom Profiling survey in SOBI NF by NSRC
1973	#4 Studies Undertaken SOBI Cable Crossing Feasibility Study Of Delivering Power From Gull Island Hydro Electric Site To NFLD Teshmont and H Zinder & Associates vol II-Technical Condiderations-appendicies	-	P	I	App. IV Study for design, time required, construction and cost estimates of a cable tunnel between Lab and NL
1973	#4 Studies Undertaken SOBI Cable Crossing Feasibility Study Of Delivering Power From Gull Island Hydro Electric Site To NFLD Teshmont and H Zinder & Associates vol II-Technical Condiderations-appendicies	2-4	R	I	Drill Hole NL-side Bottomed in Quartzite at 574' depth hard 20000 to 50000 psi, soft 6000 to 10000 psi
1973	#4 Studies Undertaken SOBI Cable Crossing Feasibility Study Of Delivering Power From Gull Island Hydro Electric Site To NFLD Teshmont and H Zinder & Associates vol II-Technical Condiderations-appendicies	14	Ic	V	Icebergs observed each day no evidence of gouging in photos, or TV unlikely exceed draft >200 ft

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1973	#4 Studies Undertaken SOBI Cable Crossing Feasibility Study Of Delivering Power From Gull Island Hydro Electric Site To NFLD Teshmont and H Zinder & Associates vol II-Technical Condiderations-appendicies	-	R	I	App. III Bathymetric and Bottom Profiling survey in SOBI NF by NSRC
1973	#5 Final Report On Bathymetry and Bottom Profiling survey In SOBI NL NSRC/Teshmont	-	R	I	Sub-bottom profiles and bathymetry superseded by Fugro's Report
1974	#6 Preliminary Data For The Tunnel Crossing the SOBI Teshmont Consultants Vol 1	-	R	I	Section 5 Diamond drill hole Point Amour, Southeast Labrador, Yankee Point, Northeast Labrador Section 6 Extension Diamond Drill hole Yankee Point Section 7 Diamond Drill Hole Point Amour Section 8 Diamond Drill Hole Point Amour, Southeast Labrador reloged by Patrick Harrison Company
1974	#7 Preliminary Data For the Tunnel Crossing Of The SOBI NSRC/Teshmont vol 2	14	Ic	V	Icebergs which penetrate the Belle Isle Strait to the vicinity of this survey are unlikely to exceed 200 ft draft and, therefore, would only constitute a hazard to the submarine cable.
1974	#7 Preliminary Data For the Tunnel Crossing Of The SOBI NSRC/Teshmont vol 2	34	C	V	5-6 feet above bottom current 0.3 to 1.3 knots
1974	#7 Preliminary Data For the Tunnel Crossing Of The SOBI NSRC/Teshmont vol 2	34-35	C	I	current and tidal graph
1973	#8 Study For Construction Of a Cable Tunnel Patrick Harrison and Company/ Teshmount Vol II appendix IV Of feasibility Study Delivering Power From Gull Island Hydro-Electric Site to NL	4	R	I	Soft Rock -6000 to 10000 psi Hard Rock- 20000 to 50000 psi Granite- 32000 psi
1974	#9 Preliminary Report On a Bathymetric and Bottom Profiling Survey In The SOBI NL NSRC/Teshmount	5	R	I	Profiles immediately to the east at distances of approximately 3000 and 6000 feet, show evidence of a fault or faults downthrowing towards the NL side by an amount of 300 to 400 feet respectively.
1974	#9 Preliminary Report On a Bathymetric and Bottom Profiling Survey In The SOBI NL NSRC/Teshmount	9	R	I	In general across most of the strait a variable thickness of coarse gravel is present
1974	#9 Preliminary Report On a Bathymetric and Bottom Profiling Survey In The SOBI NL NSRC/Teshmount	10	C	V	Current 1-2 knots

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1974	#10 Sedimentology Of The Narrowest Portion Of The Strait Of Belle Isle G. Drapeau Atlantic Oceanographic Laboratory, Bedford Institute	Fig 7	R	I	Sedimentary distribution SOBI
1974	#10 Sedimentology Of The Narrowest Portion Of The Strait Of Belle Isle G. Drapeau Atlantic Oceanographic Laboratory, Bedford Institute	Fig 8	R	I	Forteau Bay sediment distribution
1979	#41 The Current In The SOBI Preliminary Report Nordco Ltd.	5	C	V	Velocity 2m off bottom 70.1 cm/sec
1979	#41 The Current In The SOBI Preliminary Report Nordco Ltd.	5	C	V	Velocity 12m off bottom 90.4 cm/sec
1979	#41 The Current In The SOBI Preliminary Report Nordco Ltd.	5-6	C	V	Max Velocity At 12m from bottom 197.2 cm/sec=3.83 knots
1979	#41 The Current In The SOBI Preliminary Report Nordco Ltd.	18	C	V	12m from bottom about 4 knots
1981	#47 SOBI 1981 Program LCDC	4	Ic	I	Iceberg Scour Map
1981	#46 Oceanographic Data Collection SOBI Field Program/Draft	Fig 3d	I	V	Wave height 5m (max)
1981	#46 Oceanographic Data Collection SOBI Field Program/Draft	Fig 6	I	V	Wave height/ % exceedance
1980	#45 SOBI Crossing HVdc Transmission Submarine Cable Scheme Vol IV SNC Lavalin	-	C	V	App D Bottom Current Data
1980	#45 SOBI Crossing HVdc Transmission Submarine Cable Scheme Vol IV SNC Lavalin	-	C	V	Current Speed (cm/s) vs. Percentage Frequency
1980	#45 SOBI Crossing HVdc Transmission Submarine Cable Scheme Vol IV SNC Lavalin	-	C	V	2-12m off bottom max 120 cm/s
1980	#45 SOBI Crossing HVdc Transmission Submarine Cable Scheme Vol IV SNC Lavalin	-	O	I	App E Meteorological Data
1980	#45 SOBI Crossing HVdc Transmission Submarine Cable Scheme Vol IV SNC Lavalin	Fig Ex 8 5	I	I	Wind speed max 24 m/s
1980	#45 SOBI Crossing HVdc Transmission Submarine Cable Scheme Vol IV SNC Lavalin	-	I	V	App F Wave Data
1980	#45 SOBI Crossing HVdc Transmission Submarine Cable Scheme Vol IV SNC Lavalin	-	I	C	Min -13.4, Max 11.2 (worst Case)
1980	#44 SOBI Crossing Submarine Cable	-	Ic	V	App A Scour Probility

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1980	#44 SOBI Crossing Submarine Cable	-	R	I	App B Rock and Overburden Tests
1980	#44 SOBI Crossing Submarine Cable	-	R	I	App C Bottom Photographs
1980	#44 SOBI Crossing Submarine Cable	2	Ic	I	From Belle Isle Westward the water shoals, grounding out the larger icebergs and providing a filter allowing only the shallow draft icebergs to enter the strait proper
1980	#44 SOBI Crossing Submarine Cable	2	Ic	V	Depending on wind, larger icebergs can enter the strait once their drafts have been adjusted to shoaling conditions
1980	#44 SOBI Crossing Submarine Cable	3	Ic	V	Deterioration Processes Calving/Rollover
1980	#44 SOBI Crossing Submarine Cable	3	Ic	V	235 feet shore to shore forms restriction or filter which will limit draft of icebergs
1980	#44 SOBI Crossing Submarine Cable	7	Ic	V	Once icebergs of any shape pass over the sill they can roll or change orientation so that a deeper draft will be present
1980	#44 SOBI Crossing Submarine Cable	10-14	Ic	V	Rectangle can increase draft 110% Sphere stays the same Wedge can increase draft 200% Pyramid can increase draft 240%
1980	#44 SOBI Crossing Submarine Cable	20	Ic	V	35% of all icebergs able to drift over the sill posses dimensions capable of producing some scour implying 35% of all icebergs entering the Strait will have one dimension in excess of 175 ft
1980	#44 SOBI Crossing Submarine Cable	21	Ic	V	5% of population would be wedge or pyramid but due to transition 20% will be used
1980	#44 SOBI Crossing Submarine Cable	22	Ic	V	20% pyramid 65% rectangle 10% Rounded
1980	#44 SOBI Crossing Submarine Cable	22	Ic	V	0.6 probility blocky iceberg with draft smaller than any horizontal dimension will drift over the eastern sill
1980	#44 SOBI Crossing Submarine Cable	22	Ic	V	0.2 probability that a wedge or pyramid shape on its side will enter
1980	#44 SOBI Crossing Submarine Cable	25	Ic	V	0.1 probability to rotate to a deeper draft pyramid 0.2 probability for a blocky berg
1980	#44 SOBI Crossing Submarine Cable	28	Ic	V	If large icebergs have 195 ft draft 0.027 probability exists 3 in 100 will scour
1980	#44 SOBI Crossing Submarine Cable	28	Ic	V	0.001 or 1 in 1000 draft 225 ft will scour
1980	#44 SOBI Crossing Submarine Cable	30	Ic	V	All Probabilities taken into account to produce probability of scour
1980	#44 SOBI Crossing Submarine Cable	32	Ic	V	2 in 10000 will scour due to rotation but after deteriation changes to 3 in 1000 Once draft 165' 2 in 1000
1980	#44 SOBI Crossing Submarine Cable	34	Ic	V	Straight line distance 3 in 100 will scour the cable route
1980	#44 SOBI Crossing Submarine Cable	34	Ic	V	Optimized route 0.003 probability or an event every 4.4 years
1980	#44 SOBI Crossing Submarine Cable	Section 2-5	R	I	HB Orthoquartzite 213 Mpa Compressive Strength HB Limestone 357 Mpa Compressive Strength Precambrian Gneiss 111 Mpa Compressive Strength Forteau Dol-Limestone 257 Mpa Compressive Strength Brador Orthoquartzite 226 Mpa Compressive Strength
1980	# 43 SOBI Crossing HVdc Transmission Submarine Cable Crossing Volume III SNC-Lavalin	1-4	I	I	Wind speeds 20.8-25.3 km/hr Max Recorded 47.6 km/hr Gust 85 km/hr
1980	# 43 SOBI Crossing HVdc Transmission Submarine Cable Crossing Volume III SNC-Lavalin	1-4	I	V	Wave Height Max Observed 4.4m Max Measured 7.3m Mean wave Height 1.03m

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1980	# 43 SOBI Crossing HVdc Transmission Submarine Cable Crossing Volume III SNC-Lavalin	1-4	C	V	Surface current max (185cm/s) 3.6 knots Max bottom current 2.75 knots (12m from bottom) Max (2m from bottom) 2.2 knots
1980	# 43 SOBI Crossing HVdc Transmission Submarine Cable Crossing Volume III SNC-Lavalin	1-5	O	I	Tides 1m mean tide
1980	# 43 SOBI Crossing HVdc Transmission Submarine Cable Crossing Volume III SNC-Lavalin	1-5	O	I	1.5m large tides
1980	# 43 SOBI Crossing HVdc Transmission Submarine Cable Crossing Volume III SNC-Lavalin	1-5	Ic	V	From side scan sonar 8 scours seen 36-83m depth 2 scours in 83m off Point Amour No evidence of scour in deep water off Forteau Bay
1980	# 43 SOBI Crossing HVdc Transmission Submarine Cable Crossing Volume III SNC-Lavalin	1-5	Ic	V	Scours >70m means overturning/ Calving occurs for bergs to pass the sill
1980	# 43 SOBI Crossing HVdc Transmission Submarine Cable Crossing Volume III SNC-Lavalin	2-3	Ic	V	Both scours in 83m water the larger of the two is 250m long, 10m wide, 1m deep scoured 1m down to the bedrock (Plate 7)
1980	# 43 SOBI Crossing HVdc Transmission Submarine Cable Crossing Volume III SNC-Lavalin	2-4	Ic	I	<u>Eastern Area</u> 10 scours 4 close to shore (Ice ridge scours) 6 berg scours (55m depth)
1980	# 43 SOBI Crossing HVdc Transmission Submarine Cable Crossing Volume III SNC-Lavalin	4-2	I	I	Avg Wind Speed 29.4, 28.6, 35.2, 34.7 km/hr
1980	# 43 SOBI Crossing HVdc Transmission Submarine Cable Crossing Volume III SNC-Lavalin	5-1	C	I	<u>Dawson 1906 Current Study</u> West 3.45 Knots East 2.83 Knots
1980	# 43 SOBI Crossing HVdc Transmission Submarine Cable Crossing Volume III SNC-Lavalin	5-2	C	I	<u>Roughton 1964</u> Westward 3.4 Knots Eastward 2.8 Knots
1980	# 43 SOBI Crossing HVdc Transmission Submarine Cable Crossing Volume III SNC-Lavalin	5-3	C	V	The strongest westward surface current was stated at 5 knots near the northern shore, strong tidal and meteorological effects superimposed/ eastward was 3.5 knots
1980	# 43 SOBI Crossing HVdc Transmission Submarine Cable Crossing Volume III SNC-Lavalin	5-3	C	I	Nordco 2m from bottom 4knots 12m from bottom 3.15 knots
1980	# 43 SOBI Crossing HVdc Transmission Submarine Cable Crossing Volume III SNC-Lavalin	5-7	C	V	Max 2m from bottom 2.2 knots
1980	# 43 SOBI Crossing HVdc Transmission Submarine Cable Crossing Volume III SNC-Lavalin	5-7	C	V	<u>Max Current Velocity(Surface) cm/s with wave action</u> Yankee Point 131.8 Point Amour 112.1 Watts Point 88.8 Carrol Point 170.9
1980	# 43 SOBI Crossing HVdc Transmission Submarine Cable Crossing Volume III SNC-Lavalin	5-8	C	V	<u>Max Current Velocity(Surface) cm/s 1m depth</u> Yankee Point 130 Point Amour 126.3 Watts Point 130.1 Carrol Point 185.5

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1980	# 43 SOBI Crossing HVdc Transmission Submarine Cable Crossing Volume III SNC-Lavalin	Fig 6	C	I	Oscillating Current
1980	# 43 SOBI Crossing HVdc Transmission Submarine Cable Crossing Volume III SNC-Lavalin	5-10	C	I	Max observed fluctuations in direction at Yankee Point, Point Amour, Carrol Point, and Watts Point 71.1,31,63.5, 58.1 degrees
1980	# 43 SOBI Crossing HVdc Transmission Submarine Cable Crossing Volume III SNC-Lavalin	5-11	C	I	Currents can be opposite if high wind speed and direction opposite the tidal direction
1980	# 43 SOBI Crossing HVdc Transmission Submarine Cable Crossing Volume III SNC-Lavalin	5-17	I	I	Max predicted wave height 10.7m or 8.4m
1980	# 43 SOBI Crossing HVdc Transmission Submarine Cable Crossing Volume III SNC-Lavalin	6-1	Ic	I	1974 NSRF reported scour off Point Amour 110m while studies in 68 and 73 showed no scours in this area
1979	# 42 SOBI Crossing HVdc Transmission - Tunnel Scheme SNC-Lavalin Engineering Report, Cost Estimate and Schedule	1-5	Ca	I	Cables -Oil Filled cable system appears more economical than gas filled and is presently the preferred system (Cost Basis) -Oil filled cables require stop joints which in turn present a fire hazard in the shaft
1979	# 42 SOBI Crossing HVdc Transmission - Tunnel Scheme SNC-Lavalin Engineering Report, Cost Estimate and Schedule	2-2	Ic	V	Ice -Sill Limit Iceberg > 75m
1979	# 42 SOBI Crossing HVdc Transmission - Tunnel Scheme SNC-Lavalin Engineering Report, Cost Estimate and Schedule	-	C	V	Currents -Currents are tidally dominated max< 3.5 knots *Current info (Fraquharson & Bailey)
1979	# 42 SOBI Crossing HVdc Transmission - Tunnel Scheme SNC-Lavalin Engineering Report, Cost Estimate and Schedule	-	I	I	Wind -Max Gust 160 km/hr St Anthony -140 km/hr Battle Harbor
1979	# 42 SOBI Crossing HVdc Transmission - Tunnel Scheme SNC-Lavalin Engineering Report, Cost Estimate and Schedule	3-7	Ca	C	Oil Filled Cables (Tunnel) -Operation of HVdc oil filled cables in a very deep shaft, connecting to a long tunnel run is an unprecedented requirement. The hydraulic head of the oil column in the shaft cables is too high to be accommodated without hydraulic sectionalizing for which stop joints are required. These joints have been known to be critical components in any AC oil filled cable system *therefore they are avoided*
1979	# 42 SOBI Crossing HVdc Transmission - Tunnel Scheme SNC-Lavalin Engineering Report, Cost Estimate and Schedule	-	Ca	V	DC Very little operating experience with DC stop joints -Stop joint failure and replaced -Hair crack in stress central electrode

Year	Report Reference	Page	**R**oute, **P**rotection, **Ic**berg, **C**urrent, **Ca**ble, **I**nstallation, **O**ther	Actions: pose **Q**uestion, **C**hallenge, **V**alidate, **U**nknown, key **I**nfo	Description
1979	# 42 SOBI Crossing HVdc Transmission - Tunnel Scheme SNC-Lavalin Engineering Report, Cost Estimate and Schedule	4-13	R	I	Attempt made in 75 to obtain diamond drill core information in the SOBI (*This was unsuccessful*)
1979	# 42 SOBI Crossing HVdc Transmission - Tunnel Scheme SNC-Lavalin Engineering Report, Cost Estimate and Schedule	4-14	R	I	Medium Penetration Profiling Survey -Concluded that faulting was not present in any major extent and sedimentatary beds continuous under the strait -Only major fault 6km off NL coast -Some problems may be encountered under the deep trench along lab coast (geologic Conds)
1979	# 42 SOBI Crossing HVdc Transmission - Tunnel Scheme SNC-Lavalin Engineering Report, Cost Estimate and Schedule	4-16	R	I	Downhole Velocity Logging -Number of faults and fault zones present
1979	# 42 SOBI Crossing HVdc Transmission - Tunnel Scheme SNC-Lavalin Engineering Report, Cost Estimate and Schedule	4-17	R	I	14 Faults (seismic Interpretation)
1979	# 42 SOBI Crossing HVdc Transmission - Tunnel Scheme SNC-Lavalin Engineering Report, Cost Estimate and Schedule	4-20	R	U	Future Planning -Substantial increase in the amount of Geotech detail to be provided by rock core recovered from additional borings -Boreholes diamond Drilled 545 m
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	2-1	I	I	Wind Speed South Side 10m/s North Side 6m/s Max Gust 23.6m/s
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	2-4	I	I	Tides 1m mean tides 1.5m large tides
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	2-5	C	I	Current Bottom Max 2.75Knots (Lab Coast) Surface Currents 3.6 knots (Lab Coast) 2.8 knots (NL coast)
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	2-11	Ic	C	Iceberg Scour at 83m
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	3-2	Ca	I	Usual Cable Failure Reasons 1. External Mechanical Damage 2. Repair Joints 3.Factory Joints 4. Sheath Failure 5. Amour Corrosion 6. Other
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	3-8	Ic	I	0.03 probability of iceberg grounding between Point Amour and Yankee Point (Kollmeyer)

Year	Report Reference	Page	**R**oute, **P**rotection, **Ic**berg, **C**urrent, **Ca**ble, **I**nstallation, **O**ther	Actions: pose **Q**uestion, **C**hallenge, **V**alidate, **U**nknown, key **I**nfo	Description
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	3-8	Ic	I	0.003 probability of iceberg grounding along optimized route (Kollmeyer)
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	3-8	P	I	To Provide protection, the cable must be buried below the rock surface over its entire length
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	3-9	P	Q	Shore areas (trench, adit tunnel, borehole) Most practacle (trench cut in bedrock)
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	3-9	P	I	Trench max layer thickness 0.9m and depth 1.5m width 0.6m (English Channel)
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	3-9,10	P	I	Trawls and Anchors Anchors (1.5-2m) sandy bottom Trawls (Fishing Gear) 0.1-0.3m
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	3-10	P	I	If protected from icebergs it is more than adequately protected from fishing gear
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	3-14	Ca	Q	Cable Selection 1. MI 2. MI and gas Pressurized 3. Oil Filled
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	3-16	Ca	I	Oil Filled cable is the logical choice for the purposed submarine cable crossing * Reasoning Solid cables are not tested for service at 400kV Only one supplier STK (Based on 300kV test) No cost advantage Oil filled max temp 85 degrees, solid 55 degrees Thermal Resistively of solid insulation reduced current carrying capacity No warning of the existence of a pinhole or crack like oil filled Oil filled provide extra reliability under emergency conditions (Temp/Stress)
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	3-19	C	I	Reliability 100% transmission capacity with one cable on permanent outage Crossing consists of at least 3 cables (Due to the fact any fault in the remaining cable would lead to loss of load)
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	3-20	P	V	-From experience with cables embedded in the seabed it can be concluded that for the strait project with the cables in a rock trench covered with overburden the risk would be essentially 0 -Where rock trench is located in sound rock the risk is approximately 0, the trench may pass through areas of less competent rock, particularly where faulting occurs
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	3-21	Ic	V	14 faults most depth> 70m Probability of Iceberg is 0.03 Probability of Iceberg ground on fault 0.00023 (58 year return period)
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	3-21	Ic	C	With trench and burial (200yr return)

Year	Report Reference	Page	Route, Protection, Icberg, Current, Cable, Installation, Other	Actions: pose Question, Challenge, Validate, Unknown, key Info	Description
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	3-23	Ca	I	Cable Failure (table 4.1 other cable faults applied to the Strait) Rate 0.0377 Strait Crossing 18km 0.0068/year 1 failure every 147 years
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	3-24	Ca	C	Repair time (Assumed 1 year) Reasoning: Repair time 10 days to 2 months when ship can become available repair time estimated at 1 year due to the shipping season
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	3-32	Ca	I	Oil Spill data for oil filled cable
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	5-3	R	I	Location Selection survey 1979 (Point Amour-Yankee Point was selected): 1. Shortest most economical cable 2. No advantage to be gained by deep water (trench whole way) 3. Overburden is generally the same 4. Machine for trenching can operate >100m (No benefit of going in shallow water) 5. Geological studies indicate bedrock and trenching conditions generally the same throughout
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	5-8	R	I	Bedrock Conditions For Trench 22% Hard Limestone 17% Shaley Limestone 17% Sandstone 19% Shaley Sandstone 25% Shale
	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	6-1	I	I	3 options for install: 1. Lay cables on sea bed and subsequently bury 2. Lay and bury in a simultaneous operation 3. Cut trenches first and subsequently lay cables in trench
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	6-1,2	I	I	Options For Install: Trench first and lay cable afterwards (Option 3 preferred) Reasoning: -Carry out excavation over any time period, prior to cable laying and without exposing cable to risk -Possible to use more than 1 excavating rig -Possible to interrupt excavation operations if needed -Cables can be laid in short period of time on an established and proven route cables subjected to minimum handling -Blasting can be utilized during excavation on route deviation to avoid obstacles
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	6-2	P	I	Removal Of Overburden -Conventional Dredging (max 60m depth) -Monitors (Little control of overburden flushed) -Crawler Mounted Dredging Equipment -Jet Barges (recommended 6-19)

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1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	6-5,6	P	U	Rock Trenching 1. Drilling/Blasting (30-40m proven cost is high and procedure is slow) 2. Shaped Changes (Granite/Sandstone results negligable) Unsuitable 3. Trench Cutting Machine (needs development) Trench Cutting Machine -Operate on the rock surface controlled by vessel -A drum rotating around horizontal axis with tungston carbide teeth (Cutting/ripping) -Scroll rotating around a vertical axis with diameter equal to trench width tungston carbide tipped teeth again (Cutting/ripping) -High Speed rotating wheel tungston carbide tipped teeth to remove rock (Grinding action) -Two narrow high speed rotating discs diamond tipped teeth parallel slots in the rock
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	6-7	P	I	Ripping (1 Pass) Grinding (1 Pass) may leave rock to cut and remove later Two narrow Slots (rock inside the slots needs to be removed 2 passes)
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	6-9	I	I	Boreholes (Inclined)- Major problem with this difficult installing the cables. Treading of cables through the drill holes would require specially designed rollers at close spacing -Trenching seems to be best option on and offshore
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	6-11	Ca	C	Cable Manufacturers/Installers *No single company or organization is able to tackle the complete scheme
1980	#42A SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin	6-20	P	U	Trenching 1. The Land and Marine RTMII (Rotating wheel Ripper) 2. HB Zachry Trencher (High speed wheel grinding) -Excellent promise of being adapted
	Dynamic Aspects of Flow Through The SOBI	1	C	I	Dawson (1907) -Residual current fluctuations were unrelated to local winds that were correlated with large scale meteorological disturbances
1963	1963 Oceanographic Study	-	C	I	-Current meter (Hydrowerkstatten) Depth: 13 & 50m -The report is a statistical report with little portent information
1974	Sedimentology Of The Narrowest Portion Of SOBI G. Drapeau	-	R	I	This is Document #10
1981	#56 Laboratory Test Results, Selected Soil Samples-SOBI Crossing Newfoundland Geosciences	-	R	I	Laboratory Test Results -Summary of Index Test data -Grain size distribution -Direct shear test results -Triaxial shear test results * No commentary just test results tabular/ graphical form
1981	#57SOBI Marine Borings and Surveys Contract SNC-Lavalin	-	O	I	This document contains information on how to prepare the tenders, tentative work schedule. *No technical information
1981	#58Report Of Client Representative 1981 SOBI Marine Surveys Start Nearshore Survey	-	R	I	*Information covered in report #59

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1981	#59 Memorandum Re Positions and Samples of SOBI Offshore Core Holes 1974 Geomarine c/o SNC-Lavalin	1	O	I	Heron -170ft long built after WWII to lift submarine nets
1981	#59 Memorandum Re Positions and Samples of SOBI Offshore Core Holes 1974 Geomarine c/o SNC-Lavalin	2	O	I	Vessel -4x6000lbs anchors on 2000ft wire rope -Single 75 HP bow thrusters (*Not available for this job*) -A main propulsion generator was lost shortly after an engine room flooding while the ship was in Halifax en route to site
1981	#59 Memorandum Re Positions and Samples of SOBI Offshore Core Holes 1974 Geomarine c/o SNC-Lavalin	9	O	I	First site 74-B-D3 -Anchors begin to slide -Ship held relatively well -On the 11th attempt a decision was made to move ship to find thinner overburden -10" core recovered
1981	#59 Memorandum Re Positions and Samples of SOBI Offshore Core Holes 1974 Geomarine c/o SNC-Lavalin	9	O	I	Oct 7, 1974 Huron Positioned without trouble third Site 74-B-D11 -This ended after half a day with more lost gear and the whole program was terminated
1981	#59 Memorandum Re Positions and Samples of SOBI Offshore Core Holes 1974 Geomarine c/o SNC-Lavalin	9	C	I	The drilling vessel Heron had a least 2m play and the bending of the drill pipe, by all accounts in the currents encountered -Error 35-65m

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1981	#59 Memorandum Re Positions and Samples of SOBI Offshore Core Holes 1974 Geomarine c/o SNC-Lavalin	11 to 18	O	I	Jack Davis Notes -Sept 13 anchors dragging -Sept 14 One pipe joint bent permanently -Sept 15 Touched bottom again -Drill string slipped out of hole -penetrated bottom approx 2' but no recovery -Discovered loss of 3 collars inner and outter care barrels and diamond bit -Sept 16 Crown wire and anchor wire tangled failure to anchor -Sept 19 Found outter core and diamond bit missing -Sept 20 Drill string on bottom for start of 3rd attempt -8' penetration pulled inner core (no recovery) -Stopped drilling too rough (waiting , still in the hole) -Sept 21 Diamond bit found to be ruined -Sept 22 Drill String Jamming in hole -Sept 25 Poor anchorage ship drifted 3000ft -ninth attempt possibly bedrock -Pulled core barrel no recovery -Drill String jamming and continued all night -Ship moved approx 50' on her anchors -Sept 27 Union joint leaking spline coupling sheared, broke tong disassembling the strings return to Blanc Sablon -Oct 3 Broke Crown Wires -Oct 5 dragged anchors hull cracked -Oct 7 lost water pressure and weight indicator reading *There were a total of 19 attempts over 25 days and 4 sucessfull recoveries
1981	#60 Memorandum Re Positions and Samples of Strait Of Belle Isle Onshore Drill Holes Geomarine c/o SNC-Lavalin	-	O	I	*This report is trying to validate drill hole sites and the drilling program performed in 1981 (*No portent information in this report*)
1981	#61 Report Of Client Representative SOBI Marine Survey 1981 Offshore Survey and Conclusions of Onshore Survey June 1981 Geomarine c/o SNC-Lavalin	4	R	C	Atlas Ecosounder -First found to have a poor plug that ultimately ripped off then, 210 kHz dual frequency was connected, the atlas quit entirely
1981	#61 Report Of Client Representative SOBI Marine Survey 1981 Offshore Survey and Conclusions of Onshore Survey June 1981 Geomarine c/o SNC-Lavalin	-	O	I	Klein Sidescan Sonar - Developed a helix problem and would not print on one side -The most serious problem was bottom "crashes" the sidescan was put into the bottom at least 10 times during the survey and the fish was not lost
1981	#61 Report Of Client Representative SOBI Marine Survey 1981 Offshore Survey and Conclusions of Onshore Survey June 1981 Geomarine c/o SNC-Lavalin	-	O	I	Airgun -Was operational and working well throughout the testing however, Nordco was the owner and didn’t utilize it as much as was needed.

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1981	#61 Report Of Client Representative SOBI Marine Survey 1981 Offshore Survey and Conclusions of Onshore Survey June 1981 Geomarine c/o SNC-Lavalin	7,8	O	I	Log (problems) -June 4 fish delayed to allow completion -June 6 Dirty plug from manufacturer -June 7 Fish crashed (operator attention) acoustic window was cracked and replaced -June 10 Power supply went down -June 12 Still major power drawdown after supply was replaced -June 13 Drawdown due to lack of continuity in the cable -June 14 Cracked slip rings were discovered -June 16 ASU flooded, flooded second time and blew preamp, EO plug found to be no good and the external hydrophone removed -June 19 Boomer plate leaked 3 times and improperly installed o-ring was found -June 22 Sheared screws, fish leads wet, slip rings dirty (Minor problem)
1981	#61 Report Of Client Representative SOBI Marine Survey 1981 Offshore Survey and Conclusions of Onshore Survey June 1981 Geomarine c/o SNC-Lavalin	17	C	I	Current Meters - 3 Current meters were installed from June 2 to June 30 -Wave buoy appeared to work well but later in June went through long periods of poor data transmission or complete loss attributed to currents drawing the full mooring below the water.
1981	#61 Report Of Client Representative SOBI Marine Survey 1981 Offshore Survey and Conclusions of Onshore Survey June 1981 Geomarine c/o SNC-Lavalin	24	I	I	HMCS Raleigh -Shipwreck Point Amour Potentially has explosives on board and should be avoided (5700475N, 509715E)
1981	#61 Report Of Client Representative SOBI Marine Survey 1981 Offshore Survey and Conclusions of Onshore Survey June 1981 Geomarine c/o SNC-Lavalin	46	Ic	I	Iceberg Scour -Plates (5-6) 10-20m wide path, snake like sinuous mark sweeping from side to side 59.5-60 rocking and meta-stable -Grounded at 59.2m (Pock Mark) -One suspects overturning and the sharp scour from 59-58 was the same berg
1981	#61 Report Of Client Representative SOBI Marine Survey 1981 Offshore Survey and Conclusions of Onshore Survey June 1981 Geomarine c/o SNC-Lavalin	Plate 6	Ic	V	Scour may show tidal lifting or overturning scour should be examined for depth
1981	#61 Report Of Client Representative SOBI Marine Survey 1981 Offshore Survey and Conclusions of Onshore Survey June 1981 Geomarine c/o SNC-Lavalin	72	Ic	I	Big Rock documented a grounded berg off savage cove 30-40 ft high 84 ft draft
1980	#62A LCDC SOBI Crossing Preliminary Report Of The UK Rock Cutting Trials Land and Marine Engineering Ltd.	4	P	I	Llunddulas Limestone (143 Mpa)
1980	#62A LCDC SOBI Crossing Preliminary Report Of The UK Rock Cutting Trials Land and Marine Engineering Ltd.	5	P	I	Quartzite 134-222 Mpa (Rock to hard to drill)
1980	#62A LCDC SOBI Crossing Preliminary Report Of The UK Rock Cutting Trials Land and Marine Engineering Ltd.	6	P	I	Granite 157.8 Mpa
1980	#62A LCDC SOBI Crossing Preliminary Report Of The UK Rock Cutting Trials Land and Marine Engineering Ltd.	8	P	I	Basalt (Igneous Rock) 274 Mpa

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1980	#62A LCDC SOBI Crossing Preliminary Report Of The UK Rock Cutting Trials Land and Marine Engineering Ltd.	16	P	I	Limestone 108-178 Mpa 2m/min wear was slight
1980	#62A LCDC SOBI Crossing Preliminary Report Of The UK Rock Cutting Trials Land and Marine Engineering Ltd.	17	P	I	Orthoquartzite 70-210 Mpa 1.8 m/min to 0.5 to 0.8 m/min Abrasive Grinding and Degradation a lot of wear
1980	#62A LCDC SOBI Crossing Preliminary Report Of The UK Rock Cutting Trials Land and Marine Engineering Ltd.	18	P	I	Granite 68-188Mpa 1.4m/min overload 0.5m/min long duration Abrasive Grinding Bad wear (Not to the extent of Orthoquartzite)
1980	#62A LCDC SOBI Crossing Preliminary Report Of The UK Rock Cutting Trials Land and Marine Engineering Ltd.	18	P	I	Sandstone 58-250Mpa 0.6m/min Wear Polishing Mainly fracture
1980	#62A LCDC SOBI Crossing Preliminary Report Of The UK Rock Cutting Trials Land and Marine Engineering Ltd.	19	P	I	Basalt 166-308Mpa 0.6m/min Abrasive Degradation/ Fracture
1980	#62A LCDC SOBI Crossing Preliminary Report Of The UK Rock Cutting Trials Land and Marine Engineering Ltd.	obs	P	I	The testing was performed in Land Quarry with sample rock used to be similar to what will be experienced in the SOBI this data should be superseded with current rock hardness's from testing in the SOBI and from borehole samples.
1980	#62A LCDC SOBI Crossing Preliminary Report Of The UK Rock Cutting Trials Land and Marine Engineering Ltd.	19	P	I	The Cutter 2m Diameter drum 0.4m wide fitted with 114 heavy duty side pull lock pick holders. Trench 0.6m deep RTM I
1980	#62B LCDC SOBI Crossing Analysis Of The UK Rock Cutting Trials Land and Marine Engineering Ltd. On Behalf Westminster Land and Marine Pipelines Ltd. Vol 1, Vol 2 and Vol 8 (site photos)	-	P	I	Vol 1 - 62A Preliminary report Vol 2 - Test Result Data Sheets Vol 8 - Site Photos
1982	#62 SOBI Laboratory Rock Cutting Pick Test Levant Otdemir Colorado School Of Mines	1	R	C	Limestone Compressive Strength 70000psi Highest in there program was 62000psi
1982	#62 SOBI Laboratory Rock Cutting Pick Test Levent Otdemir Colorado School Of Mines	1	P	C	-The trench proposed though SOBI presents unique engineering challenges. These exist no previous application of underwater trenching machines in cutting very hard rock such as SOBI rock *New machine must be developed
1982	#62 SOBI Laboratory Rock Cutting Pick Test Levent Otdemir Colorado School Of Mines	1	P	I	Testing in linear rock cutting machine two columns and a cross beam on which the cutter holder frame is mounted
1982	#62 SOBI Laboratory Rock Cutting Pick Test Levent Otdemir Colorado School Of Mines	29	P	I	Cutter Bits Conical, plow bit Conical (Bortunco Inc.) Plow Bit (Sandvik)
1982	#62 SOBI Laboratory Rock Cutting Pick Test Levent Otdemir Colorado School Of Mines	51	R	I	HB Limestone 49531 psi Avg, 61831 max

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1982	#62 SOBI Laboratory Rock Cutting Pick Test Levent Otdemir Colorado School Of Mines	52	R	I	HB Sandstone 25517 psi Avg, 30494 max
1982	#62 SOBI Laboratory Rock Cutting Pick Test Levent Otdemir Colorado School Of Mines	53	R	I	Bradore Sandstone 14031 psi Avg, 19862 max
1982	#62 SOBI Laboratory Rock Cutting Pick Test Levent Otdemir Colorado School Of Mines	54	R	I	Forteau Limestone 28815 psi Avg, 30083 max
1982	#62 SOBI Laboratory Rock Cutting Pick Test Levent Otdemir Colorado School Of Mines	55	R	I	Forteau Limestone 24593 psi Avg, 28708 max
1982	#62 SOBI Laboratory Rock Cutting Pick Test Levent Otdemir Colorado School Of Mines	56	R	I	HB Limestone 38920 psi Avg, 43608 max
1982	#62 SOBI Laboratory Rock Cutting Pick Test Levent Otdemir Colorado School Of Mines	57	R	I	Forteau Limestone 23339 psi Avg, 26470 max
1982	#62 SOBI Laboratory Rock Cutting Pick Test Levent Otdemir Colorado School Of Mines	58	R	I	HB Sandstone 27975 psi Avg, 31341 max
1982	#62 SOBI Laboratory Rock Cutting Pick Test Levent Otdemir Colorado School Of Mines	59	R	I	HB Sandstone 25859 psi Avg, 28325 max
1982	#62 SOBI Laboratory Rock Cutting Pick Test Levent Otdemir Colorado School Of Mines	60	R	I	HB Limestone 55313 psi Avg,
1982	#62 SOBI Laboratory Rock Cutting Pick Test Levent Otdemir Colorado School Of Mines	80	P	I	Conical Pick 60 deg - 5 deg pick no 17 HB Limestone Dist (ft) 244-482 Length (in) 6.030 - 6.012 Weight (gr) 1282.5-1282.27
1982	#62 SOBI Laboratory Rock Cutting Pick Test Levent Otdemir Colorado School Of Mines	81	P	I	Conical Pick 60 deg - 5 deg pick no 17 Forteau Limestone Dist (ft) 0-1223 Length (in) 6.055 - 6.020 Weight (gr) 1290-1281.5
1982	#62 SOBI Laboratory Rock Cutting Pick Test Levent Otdemir Colorado School Of Mines	82	P	I	Conical Pick 60 deg - 5 deg pick no 17 HB sandstone Dist (ft) 0-487 Length (in) 6.075 - Pick Broke Weight (gr) 1287.5-1246.5

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1982	#62 SOBI Laboratory Rock Cutting Pick Test Levent Otdemir Colorado School Of Mines	83	P	I	Conical Pick 60 deg - 5 deg pick no 17 HB sandstone Dist (ft) 0-260 Length (in) 6.075 - 5.950 Weight (gr) 1284.75-1268.80
1982	#62 SOBI Laboratory Rock Cutting Pick Test Levent Otdemir Colorado School Of Mines	128	P	I	Conical bit force required 6900 lbs at a cut spacing 1.25", penetration 0.5"
1982	#62 SOBI Laboratory Rock Cutting Pick Test Levent Otdemir Colorado School Of Mines	129	P	I	Disc Cutter requires 50% more thrust - It becomes evident that from a cutter drum torque point of view, a machine with disc roller type cutters would have lower torque and power requirements
1982	#62 SOBI Laboratory Rock Cutting Pick Test Levent Otdemir Colorado School Of Mines	138	P	I	Plow bit by (Sandvik) Failed Not Feasible!
1982	#62 SOBI Laboratory Rock Cutting Pick Test Levent Otdemir Colorado School Of Mines	138	P	I	Conical Bit (Bortunco) can do the job, cut with minimal wear
1982	#62 SOBI Laboratory Rock Cutting Pick Test Levent Otdemir Colorado School Of Mines	140	P	I	Disc Cutting showed it can cut limestone (Superior wear characteristics)
1982	#63 Proposed SOBI Submarine Cable Installation Oceanographic Aspects R.G.Ingram	7	C	V	BIO 1980 current 15m 2-4 knots 50m 2-3 Knots Current Observed (Max) North Side 15m 5.2 knots 50m 3.8 knots South Side 15m 3.4 knots 50m 2.6 knots *Combining the maximum observed residual flow 1.6m/s and the largest tidal current 2.0 m/s would produce the 7.2 knot current at 15m and a max at 50 m of 5 knots
1982	#63 Proposed SOBI Submarine Cable Installation Oceanographic Aspects R.G.Ingram	17	C	U	SNC- No instrument placed at the narrowest section of the strait, depth in the section is also greater than that of the narrowest section therefore current for this area are likely lower then maximum.
1982	#63 Proposed SOBI Submarine Cable Installation Oceanographic Aspects R.G.Ingram	28	I	I	Max Wave 1981 Sept and Oct 5m
1982	#63 Proposed SOBI Submarine Cable Installation Oceanographic Aspects R.G.Ingram	39	Ic	V	Scouring can occur up to depths of 140m anywhere in SOBI

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1982	#63 Proposed SOBI Submarine Cable Installation Oceanographic Aspects R.G.Ingram	39	P	C	Cables to be placed in trenches 1.5m deep
1982	#64 Report On Seabottom Overburden Removal For SOBI Santa Fe Technical Services Co.	3-1	P	I	Due to excessively high drawdown forces 1800 tons or more it is not feasible to clear the overburden by plowing along recommended route. -Plowing is abandoned
1982	#64 Report On Seabottom Overburden Removal For SOBI Santa Fe Technical Services Co.	3-1	P	I	Hydraulic Jetting or/and pumping (educator pumps) better choice
1982	#64 Report On Seabottom Overburden Removal For SOBI Santa Fe Technical Services Co.	3-1	C	I	Nordco 1979 (bottom current 1 Knot)
1982	#64 Report On Seabottom Overburden Removal For SOBI Santa Fe Technical Services Co.	3-2	P	I	Recommended 7m wide, 4 m deep trench -Pump 95% of overburden + Plow 5 %
1982	#64 Report On Seabottom Overburden Removal For SOBI Santa Fe Technical Services Co.	4-8	P	I	Pumped & Plowed -Pumping 95% of overburden (Up to 3" size as specified) -Removing gravel and rocks by means of plowing
1982	#64 Report On Seabottom Overburden Removal For SOBI Santa Fe Technical Services Co.	4-15	P	I	Hydrautic Dredging Analysis -Pumping of submerged materials (Fine particles -6" rock in a water slurry) -Slurry flow is 30000 gpm 10% overburden
1982	#64 Report On Seabottom Overburden Removal For SOBI Santa Fe Technical Services Co.	4-16	P	I	From program and assumptions -2.5m deep, 7m wide -Volume/Unit Length 30m^3/m -Rate= 6.25m^3/min
1982	#64 Report On Seabottom Overburden Removal For SOBI Santa Fe Technical Services Co.	4-23	P	I	Plowing Analysis -R.J. Brown (Cohesive Soil) -Plow weight 100ton, 650 tons to excavate the ditch S.Hata Kyoto University Ditch is v-shaped with small width @ bottom: result 1950 tons
1982	#64 Report On Seabottom Overburden Removal For SOBI Santa Fe Technical Services Co.	4-24	P	I	Hydraulic Jetting Analysis Nozzle 1/8" to 7/16" 1000-2500 psig (various set ups)
1982	#64 Report On Seabottom Overburden Removal For SOBI Santa Fe Technical Services Co.	4-25	P	I	Sled Configuration 7m long, 4m deep One pass sled is recommended because: -Position control needed for multiple passes is difficult if not impossible in the environment regardless of number of passes, the spoil piles must be deposited the same distance from the ditch centerline and finally a one pass ditcher should be faster therefore less expensive -160 ton can only be met by towing -Unmanned sled is recommended -2000gpm pumps, jet nozzles for creating ditch -Not self Propelled

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1982	#64 Report On Seabottom Overburden Removal For SOBI Santa Fe Technical Services Co.	-	P	I	Recommended Ditcher -Water jets to break up overburden creating (slurry) -Water educators to transport the spoil -Trailing Plow to Punch aside larger rocks
1982	#64 Report On Seabottom Overburden Removal For SOBI Santa Fe Technical Services Co.	-	P	I	Barge Mooring Analysis Capable Requirements 1. wind & current (47000 lb) (3 knots) = 211000 (106 tons) 2. Sled Towing force (300000lb) (150tons)
1982	#65 Rock and Soil Testing SOBI Golder Associates	-	R	I	Sample Comp Strength (Mpa) 17 130 21 138 28 145 30 215 34 238 203 176 206A 248 39 244
1982	#66 SOBI HVdc Transmission Submarine Cable Scheme SNC-Lavalin	1-7	I	C	Waves up to 3m with swell currents
1982	#66 SOBI HVdc Transmission Submarine Cable Scheme SNC-Lavalin	2-17	R	C	HB Dolomitic Limestone 394MPa HB Orthoquartzite Sandstone 238 Mpa Forteau Limestone 257 Mpa Bradore Sandstone 150 Mpa
1982	#66 SOBI HVdc Transmission Submarine Cable Scheme SNC-Lavalin	2-18	R	C	One extreme sample 480 Mpa
1982	#66 SOBI HVdc Transmission Submarine Cable Scheme SNC-Lavalin	3-2	I	I	Table of wind speeds may, June, July, aug, sept, oct for 1971,81,
1982	#66 SOBI HVdc Transmission Submarine Cable Scheme SNC-Lavalin	-	C	V	Current Data again max was BIO 4.9 knots recorded BIO
1982	#66 SOBI HVdc Transmission Submarine Cable Scheme SNC-Lavalin	Table 4.4	C	V	Gumbel analysis extreme current predictions and Weibull Model as will max prediction 4.6 Knots 5yr return period.
1982	#66 SOBI HVdc Transmission Submarine Cable Scheme SNC-Lavalin	5-5	Ic	V	Max Draft increase of iceberg is 13.3m (70m draft) of tabular/drydock *Same iceberg information as in report #68
1982	#66 SOBI HVdc Transmission Submarine Cable Scheme SNC-Lavalin	Section A	-	-	Section A uses mostly same information as report 68

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1982	#66 SOBI HVdc Transmission Submarine Cable Scheme SNC-Lavalin	7-2	P	I	Dredging/ Jetting Companies That Need More Development But May be Feasible 1. Volker Stevin-Aveco 2. Zanen Verstoep 3. Land and Marine 4. Sante Fe 5. Verreault Navigation 6. Brown and Root *Some information about cutters and trenches but no proven technologies
1982	#67 Analysis Of The Available Information On The Overburden SOBI Crossing Jean-Y Changnon	26	C	V	Max measured bottom current 2.75 knots
1982	#67 Analysis Of The Available Information On The Overburden SOBI Crossing Jean-Y Changnon	27	C	V	Nordco Says 4 knots max measured 3.15 knots
1982	#67 Analysis Of The Available Information On The Overburden SOBI Crossing Jean-Y Changnon	27	C	V	RG Ingram 7 knots upper 3.8 bottom
1982	#67 Analysis Of The Available Information On The Overburden SOBI Crossing Jean-Y Changnon	-	R	I	*This report contains good overburden but is superseded Overburden 0-4m Avg 1.5m Lab side pockets up to 9m
1982	#68 SOBI Crossing HVdc Transmission Submarine Power Cable Scheme SNC-Lavalin Vol I Engineering Report-Cost Estimate and Project Schedule Part A (Not Included) Part B Summary description of 1981 results and related engineering studies	9-6	R	I	Rock Type Comp Strength Silica Content(%) HB Dolomitic 289 394 5 18.7 HB Orthoquartzite 144 238 77 95 Forteau Limestone 167 257 5 6.4 Bradore Sandstone 84 150 77 91.5
1982	#68 SOBI Crossing HVdc Transmission Submarine Power Cable Scheme SNC-Lavalin Vol I Engineering Report-Cost Estimate and Project Schedule Part A (Not Included) Part B Summary description of 1981 results and related engineering studies	-	O	I	Good meteorological Data However it is the same data from report #69 in less detail

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1982	#68 SOBI Crossing HVdc Transmission Submarine Power Cable Scheme SNC-Lavalin Vol I Engineering Report-Cost Estimate and Project Schedule Part A (Not Included) Part B Summary description of 1981 results and related engineering studies	12-13	Ic	I	Type / Draft / Rollover inc / Instantaneous Inc / Tilting Inc Tabular/Drydock 40 3 10 - 50 1.3 11.3 - 60 - 12.6 - 70 - 13.3 - Wedge/Pyramid 40 - - 7.2 50 - - 8 60 - - 8.7 70 - - 9.1 - means it cant happen
1982	#68 SOBI Crossing HVdc Transmission Submarine Power Cable Scheme SNC-Lavalin Vol I Engineering Report-Cost Estimate and Project Schedule Part A (Not Included) Part B Summary description of 1981 results and related engineering studies	12-13	Ic	I	*no icebergs analyzed in this study can increase draft more then 3m
1982	#68 SOBI Crossing HVdc Transmission Submarine Power Cable Scheme SNC-Lavalin Vol I Engineering Report-Cost Estimate and Project Schedule Part A (Not Included) Part B Summary description of 1981 results and related engineering studies	12-19	Ic	V	Draft / % Icebergs With Sufficient Energy To Cross Sill 75-80 50 80-85 20 85-90 5 *Rollover due to calving is not considered
1982	#68 SOBI Crossing HVdc Transmission Submarine Power Cable Scheme SNC-Lavalin Vol I Engineering Report-Cost Estimate and Project Schedule Part A (Not Included) Part B Summary description of 1981 results and related engineering studies	12-19	Ic	V	Pcc=Px X Pr X Pp Probable Iceberg Distribution at The Cable Crossing Px- Probability of crossing sill Pr- Probability of iceberg reaching the crossing Pp- Probable population distribution Sp=Pcc X Ps *From static stability Kollemeyers report is fine but fails to take into account the mechanism that would cause iceberg rollover, & the amount of energy necessary for rollover

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1982	#68 SOBI Crossing HVdc Transmission Submarine Power Cable Scheme SNC-Lavalin Vol I Engineering Report-Cost Estimate and Project Schedule Part A (Not Included) Part B Summary description of 1981 results and related engineering studies	13-7	Ca	I	Cable Amour -Single wire amour (interlocking steel tape) -Double Wire (counter helical amour) Depth > several 100m double wire amour is required to obtain a cable with sufficient tensile strength. This is not the case for the SOBI, so single wire amour is acceptable from pulling tension point of view Single Wire kinks easier only avoided by carefully controlled laying techniques which ensure that the cable tension is never released
1982	#68 SOBI Crossing HVdc Transmission Submarine Power Cable Scheme SNC-Lavalin Vol I Engineering Report-Cost Estimate and Project Schedule Part A (Not Included) Part B Summary description of 1981 results and related engineering studies	13-8	Ca	I	Double wire (counter helical amour) can not be coiled because the coiling process imparts one twist to the cable for each turn of the cable on the coil and the cable cant be twisted and therefore must be wound and unwound from a rotating turntable.
1982	#68 SOBI Crossing HVdc Transmission Submarine Power Cable Scheme SNC-Lavalin Vol I Engineering Report-Cost Estimate and Project Schedule Part A (Not Included) Part B Summary description of 1981 results and related engineering studies	14-5	Ca	C	Combined Risk Analysis Fault rate SOBI oil filled cable 0.000007 faults/cable year however to small this is too small so using multiple cables 0.08 faults/cable year External=0.005 if trench fails to protect the cable
1982	#68 SOBI Crossing HVdc Transmission Submarine Power Cable Scheme SNC-Lavalin Vol I Engineering Report-Cost Estimate and Project Schedule Part A (Not Included) Part B Summary description of 1981 results and related engineering studies	14-6	Ca	V	Repair Time Recovery/Repair/Relay 3 months Repair Window (weather) 6 months Waiting time for Repair Vessel 6 Months
1982	#68 SOBI Crossing HVdc Transmission Submarine Power Cable Scheme SNC-Lavalin Vol I Engineering Report-Cost Estimate and Project Schedule Part A (Not Included) Part B Summary description of 1981 results and related engineering studies	14-6,7	Ca	C	Reliability Analysis Internal Cable Failure 0.018 fault/cable year Probability of external damage 0.005 faults/ cable year Probability of consequential damage 0.10 (2 cables/trench) Probability Of Total Cable Outage 4 cables/ 2 trenches 0.000513 3 cables/3 trenches 0.000055 Probability Of Total Outage 4Cables/2trenches 0.0023 3 Cables/3trenches 0.00184

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1982	#68 SOBI Crossing HVdc Transmission Submarine Power Cable Scheme SNC-Lavalin Vol I Engineering Report-Cost Estimate and Project Schedule Part A (Not Included) Part B Summary description of 1981 results and related engineering studies	14A-7	Ca	I	Vancouver 138kV AC Crossing 9 out of 118 have occurred for oil filled HVdc cable installed in an ideal rock trench -Therefore cable fault rate of 0.034 faults/100km/year -To obtain a fault rate with 95% confidence level, the fault rate is 0.06 fault/100km/year -To take into account conditions of SOBI rate is 0.1 faults/100km/year
1982	#69 SOBI Crossing -HVdc Transmission Submarine Power Cable Scheme SNC-Lavalin Vol II - 1981 Field Program	2-2	Ic	V	Iceberg Scours in water >70m 1979 Kenting report (2 scours in 83m water depth)
1982	#69 SOBI Crossing -HVdc Transmission Submarine Power Cable Scheme SNC-Lavalin Vol II - 1981 Field Program	2-3	R	I	Worst fault is 7.2km NL side
1982	#69 SOBI Crossing -HVdc Transmission Submarine Power Cable Scheme SNC-Lavalin Vol II - 1981 Field Program	3-2	I	I	Wind Speed Point Amour Max 96.8 km/hr
1982	#69 SOBI Crossing -HVdc Transmission Submarine Power Cable Scheme SNC-Lavalin Vol II - 1981 Field Program	3-3	I	I	Wind Speed Savage Point Max 107.6 km/hr
1982	#69 SOBI Crossing -HVdc Transmission Submarine Power Cable Scheme SNC-Lavalin Vol II - 1981 Field Program	3-3	I	I	Wind Speed Point Amour Lighthouse Max 111 km/hr
1982	#69 SOBI Crossing -HVdc Transmission Submarine Power Cable Scheme SNC-Lavalin Vol II - 1981 Field Program	3-3	I	I	Wind Speed Rocky Giant 74 km/hr average
1982	#69 SOBI Crossing -HVdc Transmission Submarine Power Cable Scheme SNC-Lavalin Vol II - 1981 Field Program	3-16	I	V	Swells 1.5m, mean 1m July 0.6m August
1982	#69 SOBI Crossing -HVdc Transmission Submarine Power Cable Scheme SNC-Lavalin Vol II - 1981 Field Program	4-2	C	V	Current Data Dawson 1906 3.45 knots Huntsman 1954 2.2 Knots Captain F.A. Roughton 1964 3.4 knots Fraquharson & Bailey 1966 5.07 knots (13m) Nordco 2.1 knots seabed, 3.8 knots 12m SNC 2.18 knots seabed, 2.72 knots BIO 1980 4.85 knots 15m, 3.88 knots 50m

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1982	#69 SOBI Crossing -HVdc Transmission Submarine Power Cable Scheme SNC-Lavalin Vol II - 1981 Field Program	5-7	Ic	I	Iceberg Reports 1. Preece 1964 2. Snow 1968 3. Bridges 1968 4. Drapeau 1968 5. Mun 1972-73 6. NSRF 1973-74 7. Shawmont NL 1974 *60-90 Icebergs enter the Strait 17% emerging out the western end
1982	#69 SOBI Crossing -HVdc Transmission Submarine Power Cable Scheme SNC-Lavalin Vol II - 1981 Field Program	5-7	Ic	I	Year Icebergs 65 94 66 109 67 18 79 3 80 38 81 86 -Good data on groundings and distribution and frequency of bergs crossing route
1982	#70 SOBI Crossing HVdc Transmission Submarine Cable Scheme SNC-Lavalin Vol III - Environmental Field data Observations	-	I	I	A- Meteorological Data B-Oceanographic Data C- Wave Data
1982	#71 SOBI Transmission Crossing Submarine Cable Scheme SNC-Lavalin Volume V-Geology and Geotechnical Field Observations	-	R	I	E-Overburden & Borehole Logs F-Photographs and Marine Borehole Samples G-Bottom photographs at locations of Marine Borings *No Commentary just data sheets *Subsea Photos are useless (black and white) No validity
1982	#72 Evaluation Of Geophysical Surveys Conducted Across The SOBI Between 1975 and 1981 Paul Laroche	-	R	I	Reports Analyzed: Geoterrex CGG for Harison Bradford Associates 1975 Kenting 1979 SNC-Lavalin 1979 Bever Dredging 1981
1982	#72 Evaluation Of Geophysical Surveys Conducted Across The SOBI Between 1975 and 1981 Paul Laroche	8	R	U	Geoterrex/CGG -Some poorly coherent reflectors can be seen in place. However, there is no correlation what so ever possible between them because of the lack of continuity and the very high noise that obliterates the sections therefore it is impossible to interpret any continuous or faulted seismic reflector across SOBI *Basically Geoterrex 1975 survey did not achieve its purpose Cambrian contact remains unidentified
1982	#72 Evaluation Of Geophysical Surveys Conducted Across The SOBI Between 1975 and 1981 Paul Laroche	14 to 16	R	U	Kenting -Kenting noted they had poor data geophysical investigations by kenting are considered to be fair to good but the results obtained do no give sufficiently accurate and detailed results to determine the real thickness of overburden and the real configuration of the bedrock topography in the SOBI

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1982	#72 Evaluation Of Geophysical Surveys Conducted Across The SOBI Between 1975 and 1981 Paul Laroche	21	R	I	Bever Dredging -The Bever report is much the same as Kenting with some new information -The Bever Dredging company Ltd. Report gives a more detailed interpretation of the bedrock nature under the sea
1983	#73 Geology Of The SOBI Area Geological Survey Of Canada	-	R	I	Northwestern Insular NL, Southern Labrador Adjacent Quebec -Geologic Survey Of Canada
1982	#74 Final Report On SOBI Submarine Cable 83' Program Shawmont Vol 1	2-3	Ic	V	(79-80) 21 icebergs tracked 6 grounded 15-60m of water (80-81) 31 Icebergs tracked 7 grounded 15-60m of water (2 in 60m) (81-) 75 Icebergs Tracked 15 grounded 15-60m (4 in 60m)
1982	#74 Final Report On SOBI Submarine Cable 83' Program Shawmont Vol 1	2-5	C	V	Currents Max Surface 4.5 Knots narrow point (Point Amour & Yankee Point) Max Bottom Current 3.5 Knots
1982	#74 Final Report On SOBI Submarine Cable 83' Program Shawmont Vol 1	5-1	O	I	Shore Ice -1975 C-Core installed a test cable at the shoreline, laid directly on the seabed, anchored to rock on shore. Cable was completely exposed. Ice froze around the cable and moved it offshore *It was recovered out in the Bay.
1982	#74 Final Report On SOBI Submarine Cable 83' Program Shawmont Vol 1	5-3	P	I	Fishing Gear -Trawl Board on sandy bottom 85kN lateral compressive load -Cable hooked by trawl board bending stress and tensile load 400kN
1982	#74 Final Report On SOBI Submarine Cable 83' Program Shawmont Vol 1	5-4	Ic	V	Iceberg Scour -Previous Iceberg studies produced a conclusion that icebergs could scour at depths greater than the sill and also the probability of iceberg scour at depths > 85m was effectively 0. this led to recommendation by SNC to rock trench up to 85m
1982	#74 Final Report On SOBI Submarine Cable 83' Program Shawmont Vol 1	7-1	P	I	Burial Techniques 1. Pre-Trenching 2. Simultaneous Burial 3. Post Burial Dredging -Bucketwheel but no control of trench shape in high wave action -Not used for soft overburden generally Excavation Plowing Trenching (Drill & Blast proven)
1982	#74 Final Report On SOBI Submarine Cable 83' Program Shawmont Vol 1	9-10	I	C	Method of install for cables: -Plowing method
1984	#75 Final Report On SOBI Submarine Cable 83' Program Shawmont Vol 2	Appendices	R	I	-Seabed Photo's -Grain Size Distribution Analysis -Engineering Profiles

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1984	#76 Final Report On SOBI Submarine Cable 83' Program Shawmont Vol 3	Appendices	R	I	-Offshore Track Chart L'anse Au Clair -Offshore Track Chart St. Barbe -Nearshore Track Chart L'anse Au Clair -Nearshore Track Chart Forteau Bay -Nearshore Track Chart St. Barbe Bay -Offshore Bathymetry L'anse Au Clair
1984	#77 Final Report On SOBI Submarine Cable 83' Program Shawmont Vol 4	Appendices	R	I	-Offshore Bathymetry St. Barbe -Nearshore Bathymetry L'anse Au Clair -Nearshore Bathymetry Forteau -Nearshore Bathymetry St. Barbe -Nearshore Isopach L'anse Au Clair -Nearshore Isopach Forteau Bay -Nearshore Isopach St. Barbe
1984	#78 Final Report On SOBI Submarine Cable 83' Program Shawmont Vol 5	Appendices	R	I	-Composite Offshore Bathymetry L'anse Au Clair -Composite Offshore Bathymetry St. Barbe Bay
1984	#79 SOBI-HVdc Transmission- Submarine Cable Scheme '84 program vol VI	-	R	I	-Area Geology -Route Selection *Both superseded by current data
1984	#80 SOBI Crossing HVdc Transmission- Submarine Cable Scheme '84 Program ITM Vol VII	App B	P	I	Plow Survey Program
1984	#80 SOBI Crossing HVdc Transmission- Submarine Cable Scheme '84 Program ITM Vol VII	3-3	P	I	Plow weight 5 tones in air 4.3 tons in water
1984	#80 SOBI Crossing HVdc Transmission- Submarine Cable Scheme '84 Program ITM Vol VII	Section 5	P	I	Plow was sticking at intervals due to rocky bottom -Plow jamming occasionally, with which tension cont paying out at 40T setting -Plow jammed, plowing stopped to break out the plow
1984	#80 SOBI Crossing HVdc Transmission- Submarine Cable Scheme '84 Program ITM Vol VII	9-40	P	I	-An appropriate plow will have no difficulty in ploughing at least 600mm deep along the whole of any of the three routes surveyed.
1984	#80 SOBI Crossing HVdc Transmission- Submarine Cable Scheme '84 Program ITM Vol VII	10-17	P	I	Wear 1. Replacement both spigots for the points 2. Replacement of both paints (welded in place and pinned) 3. Rebuilding the edge of the ramp with square section steel bar 4. Steel plate welded on top of ramp face 5. Hard facing to most wearing edges and points 6. 1" cut off points
1984	#81 SOBI Power Cable Crossing- Review of Data March 1984 Geonautics Ltd.	-	-	-	

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1984	#82 SOBI HVdc Transmission Submarine Cable Scheme '84 Program Marenco Engineering Ltd. Vol VIII	-	I	I	Appendices C,D,E Landing Site Investigations F Horizontal Positioning G Fishing Activities Study
1984	#82 SOBI HVdc Transmission Submarine Cable Scheme '84 Program Marenco Engineering Ltd. Vol VIII	7	P	U	App c -L'Anse-Au-Clair will make excellent cable landing site 2-3m burial depth 20m *Recommend -Short length of trench be excavated near shore during the design stage to ensure the excavation will remain open long enough to allow for the install
1984	#82 SOBI HVdc Transmission Submarine Cable Scheme '84 Program Marenco Engineering Ltd. Vol VIII	2	R	I	App d Test on cemented sand 24-35 Mpa 3.4-31Mpa
1984	#82 SOBI HVdc Transmission Submarine Cable Scheme '84 Program Marenco Engineering Ltd. Vol VIII	15,16	P	V	App g Fishing Activities -Approx 95% of all damage caused to communication cables is attributed to fishing activities -Bottom Trawling has posed the main threat -December 1984 meeting of the international cable committee reported 100% success rate for all buried cables in terms of totally eliminating damage caused by fishing activities -However, sand waves have been a problem in some areas and have caused sections of buried cables to become exposed
1984	#82 SOBI HVdc Transmission Submarine Cable Scheme '84 Program Marenco Engineering Ltd. Vol VIII	16	P	I	Issue Cable Denmark-Sweden equipped with heavy armoring to withstand impacts of trawl gear 1968-73 considerable damage was caused to the cable by intensive trawling activities
1984	#82 SOBI HVdc Transmission Submarine Cable Scheme '84 Program Marenco Engineering Ltd. Vol VIII	17	P	I	Issue -PEI-NB 100MW submarine electric cable across Northumberland Strait. -This connection became known as the longest buried oil-filled cable 21.5km - 2 km could not be buried due to rock conditions (concrete mattresses) -Recent examination of the cable showed interference from fishing gear -In some sandy areas the cable has become exposed due to tide and current conditions
1984	#82 SOBI HVdc Transmission Submarine Cable Scheme '84 Program Marenco Engineering Ltd. Vol VIII	23	P	V	Impact from fishing gear 15-35 milliseconds
1984	#82 SOBI HVdc Transmission Submarine Cable Scheme '84 Program Marenco Engineering Ltd. Vol VIII	28	P	V	Fishing Gear Penetrate seabed 5-8 cm, 14cm in sand
1984	#83 1984 Subsea Plow Survey Program - Preliminary Results HW Green	2	P	I	ITM Test Plow -5 ton, 265cm long, 84cm high, 19cm wide
1984	#83 1984 Subsea Plow Survey Program - Preliminary Results HW Green	3	P	I	Test plow speed Avg 1km/hr, max speed 2.7km/hr

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1984	#83 1984 Subsea Plow Survey Program - Preliminary Results HW Green	3	R	I	In Areas of bedrock exposure on all 3 routes plow progress was temporarily halted when plow became stuck
1984	#83 1984 Subsea Plow Survey Program - Preliminary Results HW Green	5	P	I	-All three routes are plowable
1984	#83 1984 Subsea Plow Survey Program - Preliminary Results HW Green	section 4	P	C	Shawmont Portion Problems: -Plow to hang up and then shoot ahead rapidly as the tension in the tow wire increased to a sufficient level for it to break free -Tendency for the plow to ride in and out of the material very irregularly as it passes over boulders or ridges of rock. this has implications when laying the cable since the bending radius will cause it to ride the ridges and span the depressions thereby minimizing penetration and possibly causing point loads on the cable amour
1987	#84A Final Report SOBI Iceberg Tracking Program April 1987-Oct 1987 Fenco NFLD.	3-1	Ic	I	34 bergs 23 bergs made it inside area of interest
1987	#84A Final Report SOBI Iceberg Tracking Program April 1987-Oct 1987 Fenco NFLD.	3-3	Ic	V	Table Estimated Iceberg Parameter Information (number, type, draft grounding)
1987	#84A Final Report SOBI Iceberg Tracking Program April 1987-Oct 1987 Fenco NFLD.	3-11	Ic	V	Berg 15 5.5 nautical miles off Point Amour 70-80m water 3 hours stationary (Potential grounding)
1987	#84A Final Report SOBI Iceberg Tracking Program April 1987-Oct 1987 Fenco NFLD.	3-11	Ic	V	17 of 34 were noted to have grounded in 24 grounding events
1985	#84 SOBI Pisces IV Dives August 1985 Orca Marine Geological Consult	-	P	I	Manned submersible observations of submarine cable test trench in SOBI *Report to examine trench in a submarine not much portent information
1988	#85 Assessment Of The Practicality Of Installing A Bedrock Adit, Rock Trench or Overburden Trench For HVdc Cable Protection Beneath the SOBI C. Woodworth Lynas et al (C-Core)	18	P	C	Rock Trenching -The rock cutting characteristics of lithologies beneath the strait have been tested all rock types were found to be cuttable and preliminary designs for a rock trencher have been achieved
1988	#85 Assessment Of The Practicality Of Installing A Bedrock Adit, Rock Trench or Overburden Trench For HVdc Cable Protection Beneath the SOBI C. Woodworth Lynas et al (C-Core)	24	Ca	I	-Northumberland Strait 2x100MW cables installed by (Maritime Electric) 1977 burial depth of 2m -No scours>0.3m
2004	#88 Fixed Link Between Labrador and Newfoundland Pre Feasibility Study (Final Report) Hatch Mott MacDonald	10	Ic	I	-By late 1979 a risk associated with iceberg scour problems were conducted and concluded that a cable crossing (subsea) could be achieved with an appropriate probability of scour
2004	#88 Fixed Link Between Labrador and Newfoundland Pre Feasibility Study (Final Report) Hatch Mott MacDonald	20	C	V	Current 15m (7.2 knots) 50m (5 knots) *No conclusive results

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2004	#88 Fixed Link Between Labrador and Newfoundland Pre Feasibility Study (Final Report) Hatch Mott MacDonald	20	I	V	Waves 1/100 year 10m 1m>40% of time 2m<2.5% of time 3m< 100% of time
2004	#88 Fixed Link Between Labrador and Newfoundland Pre Feasibility Study (Final Report) Hatch Mott MacDonald	21	Ic	V	Icebergs 0.5 events /100 icebergs (possibility of scouring route) water depth >75m 0.1/100 depth >85m
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	1	R	I	Route chosen to use sediment deep enough to avoid iceberg scour
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	1	R	I	840,000 km of geophysical survey lines shot
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	1	R	I	Deep water/Nearshore data: - SBP Huntec - Multibeam bathy - side scan data
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	3	R	I	1. Seafloor generally gravelly with boulder lay deposit w/sand ribbons superimposed
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	3	R	I	2. >95m, numerous boulders and cobble rich berms
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	3	R	I	3. Thick sand sediments, 3-16 m thick between 10 and 58 m, Lab side.
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	3	R	I	4. 95m and in on NL side, mainly bedrock and sediment <1m thick.
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	3	R	I	- sequence of step-like bedrock scarps 1-2 m in elevation and exceptionally 6-7 m.
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	3	R	I	5. NNE-SSW bedrock channel dominates western portion of route between 82 and 106 m. 5.75 km long, 20-30 m deep w/3-10m of sediment.
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	3	R	V	6. Modern iceberg scours <0.5 m observed between 50-58 m on NL side, 48-77 m on Forteau side, <0.75 m deep.

Year	Report Reference	Page	**R**oute, **P**rotection, **Ic**berg, **C**urrent, **Ca**ble, **I**nstallation, **O**ther	Actions: pose **Q**uestion, **C**hallenge, **V**alidate, **U**nknown, key **I**nfo	Description
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	4	R	I	Survey routes designed on basis of desktop study
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	4	R	I	- SBP to map to 5 m depth or bedrock - vertical resolution 0.3 m, horizontal @ 2-5 m
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	5	Ca	C	Require up to 5 cables
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	5	Ca	C	15 cm diameter
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	5	Ca	I	Armored against tensile strain and bottom currents or soil creep
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	5	Ca	C	Minimum distance between cables with regard to mutual termic influence is 5 m
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	5	P	C	Trenching or burial requires separation of at least 10 m. Should in practice be greater.
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	5	Ca	C	Sparing should be water depth + 25%, e.g., at 100 m, 4 cables should be 375 m spacing total.
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	5	Ca	U	Thermal properties of substrate or embedding soil
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	7	Ic	I	Below 100 m, with transition zone starting at 80 m, seafloor is characterized by numerous intersecting berg scours. Above this depth, prominent features are absent suggestion burial or erased.
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	7	Ic	C	Scours below 100 m are interpreted as relict and several thousand years old.
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	7	Ic	C	Present day water depth shoal of about 75 m between Penware Bay and Green Island Brook prevents icebergs of drafts >75 m from entering the strait. Modern iceberg scours considerably smaller and occur less than 77 m.

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2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	7	Ic	C	Features previously thought to be ribbed moraines occur in zone of relict iceberg scours, and are in fact bouldery berms
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	7	R	I	Figure 2.2 - prominent physiographic seafloor features
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	7	R	I	Bathy data connected to LLWLT
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	14	R	I	Survey data presented in 10 horizontal alignment sheets
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	16	P	I	Max plough penetration in 1984 was 80 cm
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	18	R	I	Lab. Side tidal zone slopes at 3-8 deg.
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	18	R	I	Bedrock is Bradore formation sandstone on Lab. Side
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	18	R	I	Eastern route: sand 16 m deep at 50 m depth between kp 0.8 and 0.9.
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	21	Ic	V	WD 110, eastern route, scours with 2 m relief and 50-100 m wide, .5-2km long.
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	28	R	I	0.5-1.0 m high vertical steps in bedrock at KP 24-27. Stepped bedrock.
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	41	R	I	Glacial marine ridges are seen clearly on the isopach map, with discrete sediment thickening. 1. KP 25.3-25.5 2. KP 25.9-26 3. KP 26.7 4. KP 27
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	41	Ic	I	200 m east of route at KP 20, between 67 and 69 m water depth, fresh iceberg scour, 160 m long, 2-7 m wide, depth about 25 cm.

Year	Report Reference	Page	Route, Protection, Icberg, Current, Cable, Installation, Other	Actions: pose Question, Challenge, Validate, Unknown, key Info	Description
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	46	Ic	I	Scours at 48-77 m water depth near Forteau
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	47	R	I	Fig. 4.18 - side scan sonar mosaic
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	48	Ic	V	Table 4.1 - Fresh iceberg scours
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	48	R	I	17.5 km shortest route
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	51	Ic	V	NL coast < 69 m (scours???)
2008	Fugro Jacques Geosurveys Subsea Cable Route Survey DC1131 Volume 1 - Survey Results	51	R	I	Sonar Contacts
2007	C-CORE Ice scour risk in the Strait of Belle Isle and Cabot Strait	2-3	P	C	Iceberg density is 20 times higher than in the Jeanne d'Arc Basin
2007	C-CORE Ice scour risk in the Strait of Belle Isle and Cabot Strait	2-8	P	I	1979-1987, mean iceberg speed of 40 cm/s
2007	C-CORE Ice scour risk in the Strait of Belle Isle and Cabot Strait	3-4	P	I	table 3-1 - Variation in scour and pit depth w/water depth
2007	C-CORE Ice scour risk in the Strait of Belle Isle and Cabot Strait	3-6	P	U	Data for < 90 m was extrapolated
2007	C-CORE Ice scour risk in the Strait of Belle Isle and Cabot Strait	3-13	P	I	Scours filled in so quickly that they weren’t detectable a year after their formation. Recommend to collect scour data immediately after ice season.
2007	C-CORE Ice scour risk in the Strait of Belle Isle and Cabot Strait	5-14	P	I	Deepest scour in Beaufort Sea was 3.6 m.
2007	C-CORE Ice scour risk in the Strait of Belle Isle and Cabot Strait	5-23	P	I	Table 5-7, 5-25 - Pack ice and soil cover
2007	C-CORE Ice scour risk in the Strait of Belle Isle and Cabot Strait	2-1	P	U	- field data unavailable - insufficient mapping of the area - rapid infilling of scour features - data for iceberg trajectory is unknown

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2007	C-CORE Ice scour risk in the Strait of Belle Isle and Cabot Strait	3-1	P	U	Currently there is no scour data
2004	C-CORE Iceberg scour risk in the SOBI Prepared for SGE Acres	I	P	I	Required cover depths of 3-5.5 m for 100 and 1000 year returns, respectively
2004	C-CORE Iceberg scour risk in the SOBI Prepared for SGE Acres	1-1	Ic	I	Largest number of bergs between May and June
2004	C-CORE Iceberg scour risk in the SOBI Prepared for SGE Acres	-	Ic	V	An iceberg reaches the Cabot strait in 1980 (??)
2004	C-CORE Iceberg scour risk in the SOBI Prepared for SGE Acres	-	Ic	V	496 bergs were recorded by Belle Isle lighthouse keeper in 1858.
2004	C-CORE Iceberg scour risk in the SOBI Prepared for SGE Acres	-	Ic	C	0.5 events for every 100 where 85>WD>75 m 0.1 events for every 100 WD>85
2004	C-CORE Iceberg scour risk in the SOBI Prepared for SGE Acres	-	P	V	Previous studies aimed to beach and bury to 85 m
2004	C-CORE Iceberg scour risk in the SOBI Prepared for SGE Acres	2-1	Ic	I	No field data available for SOBI
2004	C-CORE Iceberg scour risk in the SOBI Prepared for SGE Acres	-	Ic	I	Data required for grounding model is available
2004	C-CORE Iceberg scour risk in the SOBI Prepared for SGE Acres	2-5	Ic	C	As opposed to C-CORE 2007, iceberg density is stated as 40x the Jeanne d'Arc region. [Reasoning was more ice charts analyzed].
2008	Fugro Jacques Geosurveys Proposed Subsea HVDC cable route - SOBI Desktop Compilation Desk Study DC1132	1	R	I	Bedrock is sandstone, limestone, dolomite w/shale.
2008	Fugro Jacques Geosurveys Proposed Subsea HVDC cable route - SOBI Desktop Compilation Desk Study DC1132	-	P	I	Plough: 0-80 cm penetration
2008	Fugro Jacques Geosurveys Proposed Subsea HVDC cable route - SOBI Desktop Compilation Desk Study DC1132	2	P	I	Directional drilling is an option

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2008	Fugro Jacques Geosurveys Proposed Subsea HVDC cable route - SOBI Desktop Compilation Desk Study DC1132	-	R	I	Recommended a route specific oceanographic monitoring program
2008	Fugro Jacques Geosurveys Proposed Subsea HVDC cable route - SOBI Desktop Compilation Desk Study DC1132	4	I	C	Minimum distance between cables with regard to mutual termic influence is 5 m
2008	Fugro Jacques Geosurveys Proposed Subsea HVDC cable route - SOBI Desktop Compilation Desk Study DC1132	-	P	C	Trenching and burial requires spacing of 10 m.
2008	Fugro Jacques Geosurveys Proposed Subsea HVDC cable route - SOBI Desktop Compilation Desk Study DC1132	-	Ca	U	Cables have dia. Of 30 cm
2008	Fugro Jacques Geosurveys Proposed Subsea HVDC cable route - SOBI Desktop Compilation Desk Study DC1132	5	Ca	C	WD + 25% for spacing
2008	Fugro Jacques Geosurveys Proposed Subsea HVDC cable route - SOBI Desktop Compilation Desk Study DC1132	10	R	I	Accurate mapping of bedrock units beneath the seafloor may become important if directional drilling of bedrock micro tunnels is determined to be a viable option
2008	Fugro Jacques Geosurveys Proposed Subsea HVDC cable route - SOBI Desktop Compilation Desk Study DC1132	14	R	I	Moraines are typically found in water depths greater than 85 m.
2008	Fugro Jacques Geosurveys Proposed Subsea HVDC cable route - SOBI Desktop Compilation Desk Study DC1132	20	R	U	Boulders under gravel lag surface
2008	Fugro Jacques Geosurveys Proposed Subsea HVDC cable route - SOBI Desktop Compilation Desk Study DC1132	72	R	I	Yankee point panding details = bedrock steps!
2007	AMEC Physical Environmental Description for the Cable Crossing of the SOBI	3	O	I	Daily average temps during summer are 12 deg. C

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2007	AMEC Physical Environmental Description for the Cable Crossing of the SOBI	4	Ic	I	Sea Ice begins to dissipate by the end of March
2007	AMEC Physical Environmental Description for the Cable Crossing of the SOBI	-	O	I	There is a lot of good climate data
2007	AMEC Physical Environmental Description for the Cable Crossing of the SOBI	15	I	I	April to June - Northeast & SW winds July-Dec - SW to W
2007	AMEC Physical Environmental Description for the Cable Crossing of the SOBI	17	O	I	Tidal energies flow in a counter clockwise fashion around the gulf increasing in height from 0.6 m at the Magdalen Islands to nearly 5 m at Quebec city.
2007	AMEC Physical Environmental Description for the Cable Crossing of the SOBI	19	O	I	Avg. summer temps are 10-11 deg C - below 60 m, -0.4 to 3.5 deg C - winter, -1.8 to 2.73 deg. C
2007	AMEC Physical Environmental Description for the Cable Crossing of the SOBI	22	I	V	Waves: 7 m @ 0.001% of the time, 0-0.5 @ 54%, 2-2.5 @ 2% Hs exceeded 2 m 8% of the time 7.3 m was maximum recorded
2007	AMEC Physical Environmental Description for the Cable Crossing of the SOBI	24	I	I	Wave data
2007	AMEC Physical Environmental Description for the Cable Crossing of the SOBI	35	C	I	Summary of max. current speeds
2007	AMEC Physical Environmental Description for the Cable Crossing of the SOBI	38	C	I	BIO current measurements
2007	AMEC Physical Environmental Description for the Cable Crossing of the SOBI	41	I	I	Tides - 2 highs and lows every 24-25 hours - mean small tide is 0.44, max 1 m - mean large tide is 1.6 m, max 2.2 m
2007	AMEC Physical Environmental Description for the Cable Crossing of the SOBI	-	I	I	Appendices: climate, wave, current data
2008	Jacques Whitford for FJG Strait of Belle Isle constraint Mapping	1	O	I	No primary sewage treatment in study area communities
2008	Jacques Whitford for FJG Strait of Belle Isle constraint Mapping	-	O	I	fish disposal sites at L'Anse au Loup and Red Bay
2008	Jacques Whitford for FJG Strait of Belle Isle constraint Mapping	-	R	U	Ordinances remaining at Raleigh site?
2008	Jacques Whitford for FJG Strait of Belle Isle constraint Mapping	3	I	I	40 shipwrecks in area, with 1 arch. Important (Raleigh)
2008	Jacques Whitford for FJG Strait of Belle Isle constraint Mapping	-	R	U	Historical resource assessments of cable landing sites may be required.
2008	Jacques Whitford for FJG Strait of Belle Isle constraint Mapping	-	R	I	100 m exclusion zones recommended
2008	Jacques Whitford for FJG Strait of Belle Isle constraint Mapping	-	R	U	PAO may require video

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2008	Jacques Whitford for FJG Strait of Belle Isle constraint Mapping	4	O	I	Several small craft harbors
2008	Jacques Whitford for FJG Strait of Belle Isle constraint Mapping	-	P	I	Scallop dredging at 45-55 m
2008	Jacques Whitford for FJG Strait of Belle Isle constraint Mapping	8	P	I	Shrimps > 150-350 m (more fishing info can be found here)
2008	Jacques Whitford for FJG Strait of Belle Isle constraint Mapping	-	O	I	Appendix E: Earthquake Magnitude
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	I	P	I	Risk analysis indicates deep cover depths of > 4 m
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	vi	Ic	V	Ice scour risk is low for WD > 250 m.
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	2-16	Ic	V	Iceberg scour formulae
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	2-25	Ic	V	Table 2-7 Unfactored iceberg design loads
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	2-31	P	U	Trawler scour depths
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	2-31	P	I	DNV publications 2001, 2006 and HSE 1999 on trawling details
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	2-35	R	U	Sedimentation rates
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	3-1	R	U	Soil properties
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	3-3	R	U	Subgouge deformation extents
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	3-4	R	U	Frost heave risks

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2007	C-CORE Screening study of production options for Labrador Gas V1 of2	3-8	O	I	Limit state and probabilistic design, stress vs. strain, upper bound design approach
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	3-16	P	I	HDD - a series of pulls?
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	3-17	P	U	Hybrid HDD technology
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	3-44	P	I	TTD - largest trench depth calculations
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	3-48	P	I	Table 3-9, pipeline plough companies
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	3-52	P	I	Table 3-10 - Jet trenchers and manufacturers
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	3-53	P	I	Cutting trenchers - buoyancy tanks
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	3-54	P	Q	Technip TM09
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	3-57	P	I	Cutter trenchers
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	5-61	Ca	U	Cable stability requirements
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	5-67	P	I	Self pipeline burial - interesting technology, not applicable to SOBI
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	5-75	R	I	Thaw and consolidation settlement

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2007	C-CORE Screening study of production options for Labrador Gas V1 of2	5-97	Ic	U	Ice management for vessels and laying operations
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	6-4	O	I	Pack ice up to 2 m thick, ridges up to 7.5 m
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	-	Ic	Q	Ice classification of construction vessels?
2007	C-CORE Screening study of production options for Labrador Gas V1 of2	7-19	R	U	Refined subgouge model
2004	Hatch Fixed link between Labrador and Newfoundland - Pre-feasibility Study - Final Report	20	C	V	Ingram, 1982 - 15 m WD, 7.2 knots, 50 m WD, 5 knots [SUGGESTED]
2004	Hatch Fixed link between Labrador and Newfoundland - Pre-feasibility Study - Final Report	37	Ca	I	Churchill Falls has 33, 270 kV low pressure oil-filled cables.
2004	Hatch Fixed link between Labrador and Newfoundland - Pre-feasibility Study - Final Report	-	Ca	V	Fire prevention systems required at feeder stations with oil filled cables?
2004	Hatch Fixed link between Labrador and Newfoundland - Pre-feasibility Study - Final Report	-	Ca	C	OD for CU of 100 mm
1975	Sob Pre-construction photos 1974-1975	-	R	I	Photo 100: Land approach photo showing sandy, gentle sloping landing point
1975	Sob Pre-construction photos 1974-1975	-	O	I	Photo 107: Aerial view of shaft site
1975	SOBI Misc. Reports	121	C	I	Cook strait project - 4.5 knots water speed
1975	SOBI Misc. Reports	-	Ca	I	Some good cable project info from that era (BC, Cook Strait)
1975	Support considerations for Newfoundland and Labrador Shafts	-	O	I	UCS: Med-High: 6000-25000 psi, Very High: > 25000 psi
1975	Report on Site investigations at Yankee Point	11	R	I	Frost penetration up to 9 feet
1975	Report on Site investigations at Yankee Point	-	R	I	Provides some soil condition info
1975	Report on soils investigation at Labrador Shaft Site	7	R	I	Bearing capacity of soils
1975	Report on soils investigation at Labrador Shaft Site	-	R	I	Depth of frost penetration, 5 feet
1975	Report on Geological Mapping Region for SOBI Crossing	-	R	I	RPO: Length description of rock outcrops and formations on either side of the strait.

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1976	Offshore Seismic Survey	8	R	I	Reasons for bad recording in the survey lines was probably due to very strong winds which caused strong lateral motion of the vessel.
1976	Report on Offshore Drilling and Coring Program SOBI	-	O	C	"It is currently our opinion that probably no drill ship or rig exists with equipment to handle all the conditions that can prevail in the Strait."
1976	Report on Offshore Drilling and Coring Program SOBI	-	O	C	Drill ship used was not ideal.
1976	Report on Offshore Drilling and Coring Program SOBI	-	O	C	Another company proposed a larger dia. Drill string less prone to bending. Proposal was not pursued.
1976	Report on Offshore Drilling and Coring Program SOBI	-	O	C	Geocon stated that standard drilling equipment could not handle the conditions. Exploration company was cheaper, so they were selected. The ultimate decision was based on cost and cost alone.
1976	Report on Offshore Drilling and Coring Program SOBI	-	C	C	Current reverses every 6 hours.
1976	Report on Offshore Drilling and Coring Program SOBI	-	C	C	Tidal flow on bottom can reverse direction as much as 3 hours earlier. Surface current up to 5 knots.
1976	Report on Offshore Drilling and Coring Program SOBI	-	O	C	Used local fishing vessels to handle ship's anchors.
1976	Report on Offshore Drilling and Coring Program SOBI	-	O	C	Built after WWII for handling sub nets. 170 feet long.
1976	Report on Offshore Drilling and Coring Program SOBI	27	O	I	E/R flooded en route to SOBI
1976	Report on Offshore Drilling and Coring Program SOBI	-	O	I	STBD main generator filled
1976	Report on Offshore Drilling and Coring Program SOBI	-	O	I	Power at half-capacity during drilling
1976	Report on Offshore Drilling and Coring Program SOBI	-	O	I	Bow thrusters were down and couldn't be used at any time.
1976	Report on Offshore Drilling and Coring Program SOBI	-	O	I	No reserve power for maneuvering.
1976	Report on Offshore Drilling and Coring Program SOBI	-	O	I	Lost drill bit and bottom equipment three times.
1976	Report on Offshore Drilling and Coring Program SOBI	28	O	I	So much vibration experienced on drill string, it unscrewed.
1976	Report on Offshore Drilling and Coring Program SOBI	-	O	I	Lost drill bit under good weather and good conditions.
1976	Report on Offshore Drilling and Coring Program SOBI	-	O	I	Lost bottom end of string when 4-5" pipe failed
1976	Report on Offshore Drilling and Coring Program SOBI	-	O	I	Drill shaft failed.
1976	Report on Offshore Drilling and Coring Program SOBI	-	R	I	Damaged tool while trying to penetrate the bottom.
1976	Report on Offshore Drilling and Coring Program SOBI	-	O	I	Tongs failed that were used to separate string segments.
1976	Report on Offshore Drilling and Coring Program SOBI	29	O	I	Bent drill string
1976	Report on Offshore Drilling and Coring Program SOBI	30	I	I	Vortex issues with string
1976	Report on Offshore Drilling and Coring Program SOBI	30	O	I	Anchors slipped

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1976	Report on Offshore Drilling and Coring Program SOBI	32	R	I	Drill bit severely damaged due to drilling in ground.
1976	Report on Offshore Drilling and Coring Program SOBI	35	O	I	The hull cracked open on the ship due to wave action.
1976	Report on Offshore Drilling and Coring Program SOBI	39	C	I	Geocon had proposed to use drill string tensioner that works in high currents and casing for entrance hole.
1976	Report on Offshore Drilling and Coring Program SOBI	40	O	I	Drill string tensioners had been recommended
1976	Report on Offshore Drilling and Coring Program SOBI	42	O	I	Drilling program a complete failure. Scheduling of the 1974 program didn't allow for proper preparation.
1976	Geological and Geotechnical Work Harrison Bradford	-	R	C	"…the greatest hazard exists for cables located in depths less than 35 fathoms, although some minor hazards exist at depths greater than 35 fathoms."
1977	NORDCO IDC Study of transportation and Electrical Power Link - SOBI	-	Ca	C	"Laying cables has been considered impractical"
1977	NORDCO IDC Study of transportation and Electrical Power Link - SOBI	-	C	I	Currents: 0.5 knots into strait (Lab. Current) 0.6 knots out (Gulf Water)
1977	NORDCO IDC Study of transportation and Electrical Power Link - SOBI	-	C	I	Current speeds up to 3 knots.
1977	NORDCO IDC Study of transportation and Electrical Power Link - SOBI	8	O	I	Late July, early Sept. temps: < 0 deg C for main body of water > 25 m, 10.3 deg C < 100 m, -1.6 deg C
1977	NORDCO IDC Study of transportation and Electrical Power Link - SOBI	10	R	I	Center Bank' shoal as shallow as 24 fathoms
1977	NORDCO IDC Study of transportation and Electrical Power Link - SOBI	24	O	I	Pack Ice Arrival 15th to 25th of December
1977	NORDCO IDC Study of transportation and Electrical Power Link - SOBI	24	Ic	I	Ice seen in strait as late as July (Arctic Ice)
1977	NORDCO IDC Study of transportation and Electrical Power Link - SOBI	28	Ic	U	Mass confusion regarding the number of bergs that enter the strait
1977	NORDCO IDC Study of transportation and Electrical Power Link - SOBI	29	Ic	I	Bergs 50-70 m high and 200 m wide [Briggs, 1968]
1977	NORDCO IDC Study of transportation and Electrical Power Link - SOBI	30	Ic	C	No iceberg drawing more than 30 fathoms can reach the Western end of SOBI without breaking up
1977	NORDCO IDC Study of transportation and Electrical Power Link - SOBI	-	Ic	I	Icebergs - April to October
1977	NORDCO IDC Study of transportation and Electrical Power Link - SOBI	57	Ca	C	Lay a test cable to see if it gets broken. [WOW… and we paid for this]

Year	Report Reference	Page	**R**oute, **P**rotection, **Ic**eberg, **C**urrent, **Ca**ble, **I**nstallation, **O**ther	Actions: pose **Q**uestion, **C**hallenge, **V**alidate, **U**nknown, key **I**nfo	Description
1977	Department of Mines and Energy Proposed Belle Isle Cable Crossing	8	C	I	Tides from 2-3 knots, up to 5 knots combined
1977	Department of Mines and Energy Proposed Belle Isle Cable Crossing	9	O	I	There is little statistical current data.
1977	Department of Mines and Energy Proposed Belle Isle Cable Crossing	9	I	C	Ice free between Aug and December
1977	Department of Mines and Energy Proposed Belle Isle Cable Crossing	12	I	Q	Skagerrak, reliability for four cables at 250 kV
1977	Department of Mines and Energy Proposed Belle Isle Cable Crossing	-	C	Q	Cook Inlet - 10 knots current
1977	Department of Mines and Energy Proposed Belle Isle Cable Crossing	16	Ca	Q	Sweden-Denmark - Several faults occurred on the cable - Otter boards caused the damage
1977	Department of Mines and Energy Proposed Belle Isle Cable Crossing	24	P	U	Otter board details
1977	Department of Mines and Energy Proposed Belle Isle Cable Crossing	27	Ca	I	Cost in 1977, 2 cables, supply and install, burial, at 50-60 m.
1978	NORDCO Interim Report, Current Metering Program SOBI	1	C	I	Emphasis placed on bottom currents
1978	NORDCO Interim Report, Current Metering Program SOBI	-	C	C	Numerous issues with battery failures, deployment, etc.
1978	NORDCO Interim Report, Current Metering Program SOBI	22	C	I	Preliminary assessment
1978	NORDCO Interim Report, Current Metering Program SOBI	28	C	V	Currents in upper level as high as 3.2 knots.
1979	Misc Notes	-	Ic	V	"Bergs have grounded in water 360 feet deep near the entrance to the Strait"
1979	Misc Notes	-	R	I	"Furrows have been found 2 miles long, 100' wide and 20' deep"
1979	Misc Notes	-	Ca	I	BC cable details: 525 kV, at 37 km, $23M supply and install
1980	Kenting Interpretation Report for Marine Survey	I	Ic	I	Eight iceberg scour marks occur in the Western area in WD ranging from 36 m to 83 m. - 2 found at 83 m.
1980	Kenting Interpretation Report for Marine Survey	11	Ic	I	Iceberg scours, SSS data, lines 1220 and 41 Scour dimensions 250 m x 10 m x 1 m and 100 m x 8 m x 1m
1980	Kenting Interpretation Report for Marine Survey	14	Ic	V	Iceberg scours - ten found in survey area lines: 510, 520, 530, 50 and 51 - one scour, 400 m long
1980	Kenting Interpretation Report for Marine Survey	-	Ic	V	Small scours (<100 m long) two scours on line 460, one on 480 and 530
1979	Shawmont SOBI Cable Crossing, Preliminary Engineering Report	-	Ca	I	Summary - recommended that cable suppliers and installers visit the site before they bid
1979	Shawmont SOBI Cable Crossing, Preliminary Engineering Report	-	Ic	V	The identification of scours in the 1974 survey contradicts 1968 and 1973 survey which had new marks. Some identified in 1974 located in depths in excess of 300 feet.

Year	Report Reference	Page	**R**oute, **P**rotection, **Ic**berg, **C**urrent, **Ca**ble, **I**nstallation, **O**ther	Actions: pose **Q**uestion, **C**hallenge, **V**alidate, **U**nknown, key **I**nfo	Description
1979	Shawmont SOBI Cable Crossing, Preliminary Engineering Report	-	C	V	1963 Fraquharson and Bailey found 3 knots to be greatest current
1979	Shawmont SOBI Cable Crossing, Preliminary Engineering Report	-	C	U	Recommend installing wave rider buoy for several months
1979	Shawmont SOBI Cable Crossing, Preliminary Engineering Report	2.9	P	I	Doors/Otter Boards - 6 x 4', 500 lbs each
1979	Shawmont SOBI Cable Crossing, Preliminary Engineering Report	-	R	Q	Ability to mark the charts with cable routing
???	[NORCO Current Study]	iii	C	V	- Max currents 4 knots at 12 m from bottom
1981	Beaver Dredging Company Marine Borings and Surveys Volume 1 - Executive Summary	10	C	V	Max water depths 115 m with currents up to 4 knots
1981	Beaver Dredging Company Marine Borings and Surveys Volume 1 - Executive Summary	19	Ic	V	- Bottom is not conducive to the preservation of iceberg scour marks - The veneer of sediment is not suited to preservation of scour imprints - 105 m scour found is most likely not from recent scour
1981	Beaver Dredging Company Marine Borings and Surveys Volume 1 - Executive Summary	21	C	V	4.1 knots of current max
1981	Beaver Dredging Company Marine Borings and Surveys Volume 1 - Executive Summary	24	R	I	fig 3.2.1 - Borehole locations across the Strait
1981	Beaver Dredging Company Marine Borings and Surveys Volume 1 - Executive Summary	25	O	I	ASK - dynamic positioning systems used by Rock Giant
1981	Beaver Dredging Company Marine Borings and Surveys Volume 1 - Executive Summary	30	R	I	Summary of drilled depths in overburden and rock
1981	Beaver Dredging Company Marine Borings and Surveys Volume 1 - Executive Summary	42	I	U	Weather can be different on both sides of the Strait, and in the middle
1981	Beaver Dredging Company Marine Borings and Surveys Volume 1 - Executive Summary	44	Ic	C	Used long liners to tow away growlers
1981	Beaver Dredging Company Marine Borings and Surveys Volume 2 - Marine Surveys	-	R	I	Excellent bottom profile data
1981	Beaver Dredging Company Marine Borings and Surveys Volume 2 - Marine Surveys	97	Ic	V	Thin score marks in area - believed to be caused by trawl boards, and not bergs
1981	Beaver Dredging Company Marine Borings and Surveys Volume 2 - Marine Surveys	98	Ic	V	Zone E: two icebergs features - pock mark and distinct scour (100 m)
1981	Beaver Dredging Company Marine Borings and Surveys Volume 2 - Marine Surveys	100	O	I	Appendix A.2 - Measured tidal extremes

Year	Report Reference	Page	**R**oute, **P**rotection, **Ic**berg, **C**urrent, **Ca**ble, **I**nstallation, **O**ther	Actions: pose **Q**uestion, **C**hallenge, **V**alidate, **U**nknown, key **I**nfo	Description
1981	Beaver Dredging Company Marine Borings and Surveys Volume 3 - Marine Borings	100	R	I	Appendix A.5 - Excellent photographs of seabed at boring locations
	ROCSAW Presentation in SOBI folder	-	P	C	Rocsaw claims they have cut rock at 358 Mpa
	Statnett_norvege	3	Ca	Q	What is PEX insulation?
	Submarine HVDC Links 2008-11-06	17	Ca	U	MI cold temperature limits
	Electrodes 2001-10-09	-	Ca	I	Good discussion on electrodes
	Overview of 2008 Norway & Iceland Trips	-	Ca	I	Overview of companies with expertise in the field
	Dir. Drilling - Device - HK Tunnel Examples	-	P	I	Info on HDD
	Currents in the SOBI - May 5 2009	-	C	V	Previous current work overview presentation

Appendix D- ABB Cable Cost

To: StephenDriscoll@nalcorenergy.com <StephenDriscoll@nalcorenergy.com>,
Cc:
Bcc:
Subject: Fw: Budgetary Pricing for Cables and Vessels

----- Forwarded by Tim Ralph/NLHydro on 09/14/2010 09:57 AM -----

From: Bengt Johnnerfelt <bengt.johnnerfelt@se.abb.com>
To: TimRalph@nalcorenergy.com
Cc: ColleenSimpson@nalcorenergy.com, GerryHumphrey@nalcorenergy.com, GregFleming@nalcorenergy.com
Date: 09/14/2010 09:55 AM
Subject: Re: Budgetary Pricing for Cables and Vessels

Tim,

Here are our budgetary prices (+/- 30%)
They are in Swedish Krona ,SEK, to avoid fluctuations in currencies .
Please note that the prices are per cable and you will need two cables as this will be a bipole .

Best regards,
Bengt

Appendix E- Nexans HDD Pulling Tension Confirmation

Strait of Belle Isle Current Information - pulling tension
Morten LANGNES
to:
TimRalph@nalcorenergy.com
09/09/2010 05:57 AM
Cc:
"GregFleming@nalcorenergy.com"
Show Details

History: This message has been replied to and forwarded.

Tim,

Our engineering team has confirmed that allowable max pulling tension for the applicable cable design will exceed the estimated pulling force required. Therefore, from a cable point of view the pull-ins can be achieved.

Best regards

Morten Langnes
Export Sales Manager
Nexans Norway AS, Energy Division
T: +47 22886293 | M: +47 99571588

Appendix F- Nexans Cable Cost

Fw: Strait of Belle Isle Current Information

Tim Ralph to: Tim Ralph 09/03/2010 10:23 AM

----- Forwarded by Tim Ralph/NLHydro on 09/03/2010 10:23 AM -----

From: Morten LANGNES <morten.langnes@nexans.com>
To: "TimRalph@nalcorenergy.com" <TimRalph@nalcorenergy.com>
Cc: "GregFleming@nalcorenergy.com" <GregFleming@nalcorenergy.com>
Date: 09/01/2010 10:54 AM
Subject: RE: Strait of Belle Isle Current Information

Tim,

I have updated our budget estimate to take into account that we double the amount of steel armour compared with the data sheets you received earlier.

The above will be our early information to assist you in your effort to meet the gate deadline. It is my intention to compile the various pieces of information into a document later.

I hope this is sufficient at the moment, otherwise let me know if you need further details of any kind.

Best regards

Morten Langnes
Export Sales Manager
Nexans Norway AS, Energy Division
T: +47 22886293 | M: +47 99571588

Appendix G- Nexans MI Cross Sectional Breakdown

Vendor design information deleted from filing.

Appendix H- Prysmian Pulling Tension

Vendor design information deleted from filing.

Appendix I- Prysmian Study Results

Vendor design information deleted from filing.

Appendix J- Cu and Al Budgetary Costs

Budgetary Costs Cu and Al
Tim Ralph to: Tim Ralph 01/04/2011 09:44 AM

----- Forwarded by Tim Ralph/NLHydro on 01/04/2011 09:43 AM -----

From: "Livigni Massimiliano, IT" <massimiliano.livigni@prysmian.com>
To: <TimRalph@nalcorenergy.com>
Cc: <GregFleming@nalcorenergy.com>, <GerryHumphrey@nalcorenergy.com>
Date: 10/29/2010 03:15 PM
Subject: RE: Trip Follow-up

Tim,

I am glad that you and Greg found the visit interesting and that we had the chance to discuss some key project issues face to face.

I copied my presentation on Greg's key.

Attached please find the presentation from Nikola as well as a drawing of a typical anchoring device for a double wire armored cable that we discussed at the meeting.

Regarding prices, please see below:

Budgetary price per meter of submarine cable (Al design):
Budgetary price per meter of submarine cable (Cu design):
Vessel day Rate: Eur

The above are indicative prices only and we reserve ther right to modify them based on receipt of additional project information and specific market conditions at the time of project execution.

Have a good week end.

Max

Appendix K- Vessel Traffic

MARINE COMMUNICATIONS AND TRAFFIC SERVICE STATISTICS - VTS

MCTS CENTRE: *St. Anthony*
MONTH/YEAR *April 2008*

Vessel Type	Inbound	Outbound	Transit	In-Zone	Out-Zone	Total
Tanker <50,000 DWT		1				1
Tanker >50,000 DWT						0
Chemical Tanker						0
LPG/LNG Carrier						0
General Cargo						0
Bulk Cargo						0
Container						0
Tug			1			1
Tug with Oil Barge						0
Tug with Chemical Barge						0
Tug with Tow						0
Government						0
Fishing	1					1
Passenger						0
Other (vsls >20m)						0
Vessels < 20m						0
Sub-Total Movements	1	1	1	0	0	3
Ferry						
Total	1	1	1	0	0	3

MARINE COMMUNICATIONS AND TRAFFIC SERVICE STATISTICS - VTS

MCTS CENTRE:	***St. Anthony***
MONTH/YEAR	***April 2009***

Vessel Type	Inbound	Outbound	Transit	In-Zone	Out-Zone	Total
Tanker <50,000 DWT						0
Tanker >50,000 DWT						0
Chemical Tanker						0
LPG/LNG Carrier						0
General Cargo						0
Bulk Cargo			2			2
Container						0
Tug						0
Tug with Oil Barge						0
Tug with Chemical Barge						0
Tug with Tow						0
Government			1			1
Fishing						0
Passenger						0
Other (vsls >20m)						0
Vessels < 20m						0
Sub-Total Movements	0	0	3	0	0	3
Ferry						
Total	0	0	3	0	0	3

MARINE COMMUNICATIONS AND TRAFFIC SERVICE STATISTICS - VTS

MCTS CENTRE:	***St. Anthony***
MONTH/YEAR	***2010***

Vessel Type	Inbound	Outbound	Transit	In-Zone	Out-Zone	Total
Tanker <50,000 DWT			3	0		3
Tanker >50,000 DWT						
Chemical Tanker						
LPG/LNG Carrier						
General Cargo			3			3
Bulk Cargo			4			4
Container			0			0
Tug						0
Tug with Oil Barge						0
Tug with Chemical Barge						0
Tug with Tow						0
Government	1	2	1	0		4
Fishing			3			3
Passenger			0			0
Other (vsls >20m)						0
Vessels < 20m						
Sub-Total Movements	1	2	14	0	0	17
Ferry			1			1
Total	1	2	15	0	0	18

MARINE COMMUNICATIONS AND TRAFFIC SERVICE STATISTICS - VTS

MCTS CENTRE:	***St. Anthony***
MONTH/YEAR	***August 2008***

Vessel Type	Inbound	Outbound	Transit	In-Zone	Out-Zone	Total
Tanker <50,000 DWT			8			8
Tanker >50,000 DWT						0
Chemical Tanker						0
LPG/LNG Carrier						0
General Cargo		2	30			32
Bulk Cargo			43			43
Container			31			31
Tug			1			1
Tug with Oil Barge						0
Tug with Chemical Barge						0
Tug with Tow		1	9		10	20
Government			3	8		11
Fishing			8			8
Passenger		1	3			4
Other (vsls >20m)				1		1
Vessels < 20m						0
Sub-Total Movements	0	4	136	9	10	159
Ferry						
Total	0	4	136	9	10	159

MARINE COMMUNICATIONS & TRAFFIC SERVICES STATISTICS - MCTS

HIGH LEVEL

MCTS Centre: St. Anthony

Month / Year: August-2009

MOVEMENTS BY VESSEL TYPE	INBOUND	OUTBOUND	TRANSITING	IN-ZONE	OUT-OF-ZONE	TOTAL
Tanker < 50000 DWT	0	0	11	1	0	12
Tanker > 50000 DWT	0	0	0	0	0	0
Chemical Tanker	0	0	0	0	0	0
LPG/LNG Carrier	0	0	0	0	0	0
Cargo - General	0	0	21	0	0	21
Cargo - Bulk	0	0	22	0	0	22
Container	0	0	20	0	0	20
Tug	0	0	1	0	0	1
Tug with oil barge	0	0	0	0	0	0
Tug with chemical barge	0	0	0	0	0	0
Tug with Tow	0	0	3	0	0	3
Government	0	0	6	0	0	6
Fishing	0	0	3	0	0	3
Passenger Vessels	1	1	1	3	0	6
Other Vessels > 20 m	0	0	1	0	0	1
Other Vessels < 20 m	0	0		0	0	0
Sub-Total Movements	1	1	89	4	0	95
Ferry	0	0	0	0	0	0
Grand Total Movements	1	1	89	4	0	95

MARINE COMMUNICATIONS AND TRAFFIC SERVICE STATISTICS - VTS

MCTS CENTRE: *St. Anthony*
MONTH/YEAR *December 2008*

Vessel Type	Inbound	Outbound	Transit	In-Zone	Out-Zone	Total
Tanker <50,000 DWT	1	1	4			6
Tanker >50,000 DWT						0
Chemical Tanker						0
LPG/LNG Carrier						0
General Cargo			5			5
Bulk Cargo	1	1	16			18
Container	1		17			18
Tug			1			1
Tug with Oil Barge						0
Tug with Chemical Barge						0
Tug with Tow			2			2
Government	1	1				2
Fishing			1			1
Passenger			1			1
Other (vsls >20m)			1			1
Vessels < 20m						0
Sub-Total Movements	4	3	48	0	0	55
Ferry						
Total	4	3	48	0	0	55

MARINE COMMUNICATIONS AND TRAFFIC SERVICE STATISTICS - VTS

MCTS CENTRE:	***St. Anthony***
MONTH/YEAR	***December 2009***

Vessel Type	Inbound	Outbound	Transit	In-Zone	Out-Zone	Total
Tanker <50,000 DWT			9	1		10
Tanker >50,000 DWT						
Chemical Tanker						
LPG/LNG Carrier						
General Cargo			7			7
Bulk Cargo			42			42
Container			33			33
Tug						
Tug with Oil Barge						
Tug with Chemical Barge						
Tug with Tow						0
Government	3	2	2	4		11
Fishing			5			5
Passenger			2			2
Other (vsls >20m)						0
Vessels < 20m						0
Sub-Total Movements	3	2	100	5	0	110
Ferry						
Total	3	2	100	5	0	110

Marine Communications and Traffic Services Statistics
St. Anthony M.C.T.S. / Belle Isle Traffic
February 2008

Movements By Vessel Type	**Inbound**	**Outbound**	**Transiting**	**In-Zone**	**Out-of-Zone**	**Total**
Tanker <50000						
Tanker >50000						
Chem. Tanker						
LPG/LNG Carrier						
Cargo – General			**1**			**1**
Cargo – Bulk			**3**			**3**
Container						
Tug						
Tug with Oil Barge						
Tug with Chem. Barge						
Tug with Tow						
Government						
Fishing						
Passenger Vessels						
Other Vessels > 20m						
Other Vessels < 20m						
Sub-Total Movements			**4**			**4**
Ferry						
Grand Total Movements2			**4**			**4**

MARINE COMMUNICATIONS AND TRAFFIC SERVICE STATISTICS - VTS

MCTS CENTRE:	***St. Anthony***
MONTH/YEAR	***February 2009***

Vessel Type	Inbound	Outbound	Transit	In-Zone	Out-Zone	Total
Tanker <50,000 DWT						0
Tanker >50,000 DWT						0
Chemical Tanker						0
LPG/LNG Carrier						0
General Cargo						0
Bulk Cargo			4			4
Container						0
Tug						0
Tug with Oil Barge						0
Tug with Chemical Barge						0
Tug with Tow						0
Government						0
Fishing						0
Passenger						0
Other (vsls >20m)						0
Vessels < 20m						0
Sub-Total Movements	0	0	4	0	0	4
Ferry						
Total	0	0	4	0	0	4

MARINE COMMUNICATIONS AND TRAFFIC SERVICE STATISTICS - VTS

MCTS CENTRE:	***St. Anthony***
MONTH/YEAR	***February 2010***

Vessel Type	Inbound	Outbound	Transit	In-Zone	Out-Zone	Total
Tanker <50,000 DWT						0
Tanker >50,000 DWT						0
Chemical Tanker						0
LPG/LNG Carrier						0
General Cargo			3			3
Bulk Cargo						0
Container			11			11
Tug						0
Tug with Oil Barge						0
Tug with Chemical Barge						0
Tug with Tow						0
Government			2	1		3
Fishing			3			3
Passenger						0
Other (vsls >20m)						0
Vessels < 20m						0
Sub-Total Movements			19	1		20
Ferry			1			1
Total			20	1		21

Marine Communications and Traffic Services Statistics
St. Anthony M.C.T.S. / Belle Isle Traffic
January 2008

Movements By Vessel Type	Inbound	Outbound	Transiting	In-Zone	Out-of-Zone	Total
Tanker <50000						
Tanker >50000						
Chem. Tanker						
LPG/LNG Carrier						
Cargo – General			**1**			**1**
Cargo – Bulk			**4**			**4**
Container			**2**			**2**
Tug						
Tug with Oil Barge						
Tug with Chem. Barge						
Tug with Tow						
Government		**1**	**2**	**2**		**5**
Fishing			**1**			**1**
Passenger Vessels						
Other Vessels > 20m						
Other Vessels < 20m						
Sub-Total Movements		**1**	**10**	**2**		**13**
Ferry						
Grand Total Movements		**1**	**10**	**2**		**13**

MARINE COMMUNICATIONS AND TRAFFIC SERVICE STATISTICS - VTS

MCTS CENTRE: ***St. Anthony***
MONTH/YEAR ***January 2009***

Vessel Type	Inbound	Outbound	Transit	In-Zone	Out-Zone	Total
Tanker <50,000 DWT			6			6
Tanker >50,000 DWT			1			1
Chemical Tanker						0
LPG/LNG Carrier						0
General Cargo			11			11
Bulk Cargo			12			12
Container	1	1	13			15
Tug						0
Tug with Oil Barge						0
Tug with Chemical Barge						0
Tug with Tow			5			5
Government	1		2			3
Fishing			5			5
Passenger						0
Other (vsls >20m)	1		1			2
Vessels < 20m						0
Sub-Total Movements	3	1	56	0	0	60
Ferry					1	
Total	3	1	56	0	1	60

MARINE COMMUNICATIONS AND TRAFFIC SERVICE STATISTICS - VTS

MCTS CENTRE: ***St. Anthony***
MONTH/YEAR ***January 2010***

Vessel Type	Inbound	Outbound	Transit	In-Zone	Out-Zone	Total
Tanker <50,000 DWT			5			5
Tanker >50,000 DWT						0
Chemical Tanker						0
LPG/LNG Carrier						0
General Cargo			2			2
Bulk Cargo			16			16
Container			20			20
Tug						0
Tug with Oil Barge						0
Tug with Chemical Barge						0
Tug with Tow						0
Government			1			1
Fishing			2			2
Passenger						0
Other (vsls >20m)						0
Vessels < 20m						0
Sub-Total Movements			46			46
Ferry			1			1
Total			47			47

MARINE COMMUNICATIONS AND TRAFFIC SERVICE STATISTICS - VTS

MCTS CENTRE: *St. Anthony*
MONTH/YEAR *July 2008*

Vessel Type	Inbound	Outbound	Transit	In-Zone	Out-Zone	Total
Tanker <50,000 DWT			13			13
Tanker >50,000 DWT						0
Chemical Tanker						0
LPG/LNG Carrier						0
General Cargo			29			29
Bulk Cargo			27			27
Container			12			12
Tug						0
Tug with Oil Barge						0
Tug with Chemical Barge						0
Tug with Tow			6			6
Government	1	1	3			5
Fishing			4			4
Passenger			2	1		3
Other (vsls >20m)	1		1			2
Vessels < 20m						0
Sub-Total Movements	2	1	97	1	0	101
Ferry						
Total	2	1	97	1	0	101

MARINE COMMUNICATIONS & TRAFFIC SERVICES STATISTICS - MCTS

HIGH LEVEL

MCTS Centre: St. Anthony

Month / Year: July-2009

MOVEMENTS BY VESSEL TYPE	INBOUND	OUTBOUND	TRANSITING	IN-ZONE	OUT-OF-ZONE	TOTAL
Tanker < 50000 DWT	0	0	9	0	0	9
Tanker > 50000 DWT	0	0	2	0	0	2
Chemical Tanker	0	0	1	0	0	1
LPG/LNG Carrier	0	0	0	0	0	0
Cargo - General	0	0	11	0	0	11
Cargo - Bulk	0	0	19	0	0	19
Container	0	0	5	0	0	5
Tug	0	0	3	0	0	3
Tug with oil barge	0	0	0	0	0	0
Tug with chemical barge	0	0	0	0	0	0
Tug with Tow	0	0	4	0	0	4
Government	0	1	5	1	0	7
Fishing	0	0	4	0	0	4
Passenger Vessels	1	1	2	0	0	4
Other Vessels > 20 m	0	0	3	0	0	3
Other Vessels < 20 m	0	0	0	0	0	0
Sub-Total Movements	1	2	68	1	0	72
Ferry	0	0	0	0	0	0
Grand Total Movements	1	2	68	1	0	72

MARINE COMMUNICATIONS AND TRAFFIC SERVICE STATISTICS - VTS

MCTS CENTRE: ***St. Anthony***
MONTH/YEAR ***June 2008***

Vessel Type	Inbound	Outbound	Transit	In-Zone	Out-Zone	Total
Tanker <50,000 DWT			9			9
Tanker >50,000 DWT						0
Chemical Tanker						0
LPG/LNG Carrier						0
General Cargo			15			15
Bulk Cargo			22			22
Container			13			13
Tug						0
Tug with Oil Barge						0
Tug with Chemical Barge						0
Tug with Tow			1			1
Government		1	6			7
Fishing			7			7
Passenger	2	3		1		6
Other (vsls >20m)						0
Vessels < 20m						0
Sub-Total Movements	2	4	73	1	0	80
Ferry						
Total	2	4	73	1	0	80

Participating Vessels	2.67	Defects/Deficiencies		
Clearances Requested		Pollution Reports Land/Sea		
Reports to OGDs		Contraventions(Infringements/Violations)		
PPO Instructions		Traffic Recommendations		
Traffic Directions				

MARINE COMMUNICATIONS & TRAFFIC SERVICES STATISTICS - MCTS

HIGH LEVEL

MCTS Centre: St. Anthony

Month / Year: June-2009

MOVEMENTS						
BY VESSEL TYPE	**INBOUND**	**OUTBOUND**	**TRANSITING**	**IN-ZONE**	**OUT-OF-ZONE**	**TOTAL**
Tanker < 50000 DWT	0	0	5	0	0	5
Tanker > 50000 DWT	0	0	0	0	0	0
Chemical Tanker	0	0	0	0	0	0
LPG/LNG Carrier	0	0	0	0	0	0
Cargo - General	0	0	6	0	0	6
Cargo - Bulk	0	0	7	0	0	7
Container	0	0	1	0	0	1
Tug	0	0	1	0	0	1
Tug with oil barge	0	0	0	0	0	0
Tug with chemical barge	0	0	0	0	0	0
Tug with Tow	0	0	1	0	0	1
Government	1	2	2	1	0	6
Fishing	0	0	5	0	0	5
Passenger Vessels	0	0	0	0	0	0
Other Vessels > 20 m	0	0	0	0	0	0
Other Vessels < 20 m	0	0	0	0	0	0
Sub-Total Movements	1	2	28	1	0	32
Ferry	0	0	0	0	0	0
Grand Total Movements	1	2	28	1	0	32

Marine Communications and Traffic Services Statistics
St. Anthony M.C.T.S. / Belle Isle Traffic
March 2008

Movements By Vessel Type	**Inbound**	**Outbound**	**Transiting**	**In-Zone**	**Out-of-Zone**	**Total**
Tanker <50000						
Tanker >50000						
Chem. Tanker						
LPG/LNG Carrier						
Cargo – General						
Cargo – Bulk			**3**			**3**
Container						
Tug						
Tug with Oil Barge						
Tug with Chem. Barge						
Tug with Tow						
Government						
Fishing						
Passenger Vessels						
Other Vessels > 20m						
Other Vessels < 20m						
Sub-Total Movements			**3**			**3**
Ferry						
Grand Total Movements			**3**			**3**

MARINE COMMUNICATIONS AND TRAFFIC SERVICE STATISTICS - VTS

MCTS CENTRE:	***St. Anthony***
MONTH/YEAR	***March 2009***

Vessel Type	Inbound	Outbound	Transit	In-Zone	Out-Zone	Total
Tanker <50,000 DWT						0
Tanker >50,000 DWT						0
Chemical Tanker						0
LPG/LNG Carrier						0
General Cargo						0
Bulk Cargo			4			4
Container						0
Tug						0
Tug with Oil Barge						0
Tug with Chemical Barge						0
Tug with Tow						0
Government						0
Fishing						0
Passenger						0
Other (vsls >20m)						0
Vessels < 20m						0
Sub-Total Movements	0	0	4	0	0	4
Ferry						
Total	0	0	4	0	0	4

MARINE COMMUNICATIONS AND TRAFFIC SERVICE STATISTICS - VTS

MCTS CENTRE:	***St. Anthony***
MONTH/YEAR	***March 2010***

Vessel Type	Inbound	Outbound	Transit	In-Zone	Out-Zone	Total
Tanker <50,000 DWT						0
Tanker >50,000 DWT						0
Chemical Tanker						0
LPG/LNG Carrier						0
General Cargo			1			1
Bulk Cargo			5			5
Container			14			14
Tug						0
Tug with Oil Barge						0
Tug with Chemical Barge						0
Tug with Tow						0
Government	1	1	3	4		9
Fishing			4			4
Passenger						0
Other (vsls >20m)						0
Vessels < 20m						0
Sub-Total Movements	1	1	27	4		33
Ferry						
Total	1	1	27	4		33

MARINE COMMUNICATIONS AND TRAFFIC SERVICE STATISTICS - VTS

MCTS CENTRE:	***St. Anthony***
MONTH/YEAR	***May 2008***

Vessel Type	Inbound	Outbound	Transit	In-Zone	Out-Zone	Total
Tanker <50,000 DWT	2	1	7			10
Tanker >50,000 DWT						0
Chemical Tanker						0
LPG/LNG Carrier						0
General Cargo			5			5
Bulk Cargo			6			6
Container						0
Tug						0
Tug with Oil Barge						0
Tug with Chemical Barge						0
Tug with Tow						0
Government			4			4
Fishing			4			4
Passenger						0
Other (vsls >20m)						0
Vessels < 20m						0
Sub-Total Movements	2	1	26	0	0	29
Ferry						
Total	2	1	26	0	0	29

MARINE COMMUNICATIONS AND TRAFFIC SERVICE STATISTICS - VTS

MCTS CENTRE: *St. Anthony*
MONTH/YEAR *May 2009*

Vessel Type	Inbound	Outbound	Transit	In-Zone	Out-Zone	Total
Tanker <50,000 DWT			2	2		4
Tanker >50,000 DWT						0
Chemical Tanker						0
LPG/LNG Carrier						0
General Cargo						0
Bulk Cargo			1			1
Container						0
Tug						0
Tug with Oil Barge						0
Tug with Chemical Barge						0
Tug with Tow						0
Government				2		2
Fishing			1			1
Passenger						0
Other (vsls >20m)						0
Vessels < 20m						0
Sub-Total Movements	0	0	4	4	0	8
Ferry						
Total	0	0	4	4	0	8

MARINE COMMUNICATIONS AND TRAFFIC SERVICE STATISTICS - VTS

MCTS CENTRE:	***St. Anthony***
MONTH/YEAR	***November 2008***

Vessel Type	Inbound	Outbound	Transit	In-Zone	Out-Zone	Total
Tanker <50,000 DWT	1	1	13	4		19
Tanker >50,000 DWT						0
Chemical Tanker						0
LPG/LNG Carrier						0
General Cargo			18			18
Bulk Cargo		1	35			36
Container			34			34
Tug			1			1
Tug with Oil Barge						0
Tug with Chemical Barge						0
Tug with Tow			3			3
Government		1	3	1		5
Fishing			2			2
Passenger						0
Other (vsls >20m)						0
Vessels < 20m			1			1
Sub-Total Movements	1	3	110	5	0	119
Ferry						
Total	1	3	110	5	0	119

MARINE COMMUNICATIONS AND TRAFFIC SERVICE STATISTICS - VTS

MCTS CENTRE: *St. Anthony*
MONTH/YEAR *November 2009*

Vessel Type	Inbound	Outbound	Transit	In-Zone	Out-Zone	Total
Tanker <50,000 DWT	1	1	15			17
Tanker >50,000 DWT						
Chemical Tanker						
LPG/LNG Carrier						
General Cargo			12			12
Bulk Cargo	1	1	44			46
Container			31			31
Tug						
Tug with Oil Barge						
Tug with Chemical Barge						
Tug with Tow			5			5
Government			1			1
Fishing			4			4
Passenger						0
Other (vsls >20m)			1			1
Vessels < 20m						0
Sub-Total Movements	2	2	113	0	0	117
Ferry						
Total	2	2	113	0	0	117

MARINE COMMUNICATIONS AND TRAFFIC SERVICE STATISTICS - VTS

MCTS CENTRE: *St. Anthony*
MONTH/YEAR *October 2008*

Vessel Type	Inbound	Outbound	Transit	In-Zone	Out-Zone	Total
Tanker <50,000 DWT			13			13
Tanker >50,000 DWT						0
Chemical Tanker						0
LPG/LNG Carrier						0
General Cargo			25			25
Bulk Cargo			36			36
Container			37			37
Tug			4			4
Tug with Oil Barge						0
Tug with Chemical Barge						0
Tug with Tow			3			3
Government	1	1	5	1		8
Fishing			2			2
Passenger	1	2				3
Other (vsls >20m)						0
Vessels < 20m						0
Sub-Total Movements	2	3	125	1	0	131
Ferry						
Total	2	3	125	1	0	131

MARINE COMMUNICATIONS AND TRAFFIC SERVICE STATISTICS - VTS

MCTS CENTRE:	***St. Anthony***
MONTH/YEAR	***October 2009***

Vessel Type	Inbound	Outbound	Transit	In-Zone	Out-Zone	Total
Tanker <50,000 DWT			20			20
Tanker >50,000 DWT						
Chemical Tanker						
LPG/LNG Carrier						
General Cargo			22			22
Bulk Cargo			29			0
Container			22			22
Tug		1				1
Tug with Oil Barge						
Tug with Chemical Barge						
Tug with Tow		1	6	2		9
Government			2			
Fishing			7			7
Passenger	1	1	2			4
Other (vsls >20m)			1			1
Vessels < 20m						0
Sub-Total Movements	1	3	111	2	0	117
Ferry						
Total	1	3	111	2	0	117

MARINE COMMUNICATIONS AND TRAFFIC SERVICE STATISTICS - VTS

MCTS CENTRE:	***St. Anthony***
MONTH/YEAR	***September 2008***

Vessel Type	Inbound	Outbound	Transit	In-Zone	Out-Zone	Total
Tanker <50,000 DWT	2	2	12	1		17
Tanker >50,000 DWT						0
Chemical Tanker						0
LPG/LNG Carrier						0
General Cargo			26			26
Bulk Cargo			32			32
Container			44			44
Tug			1			1
Tug with Oil Barge						0
Tug with Chemical Barge						0
Tug with Tow			2			2
Government	2	1	3	1		7
Fishing		1	8			9
Passenger		1	4	1		6
Other (vsls >20m)			1			1
Vessels < 20m						0
Sub-Total Movements	4	5	133	3	0	145
Ferry						
Total	4	5	133	3	0	145

MARINE COMMUNICATIONS AND TRAFFIC SERVICE STATISTICS - VTS

MCTS CENTRE:	***St. Anthony***
MONTH/YEAR	***Sept 2009***

Vessel Type	Inbound	Outbound	Transit	In-Zone	Out-Zone	Total
Tanker <50,000 DWT			12			12
Tanker >50,000 DWT						
Chemical Tanker						
LPG/LNG Carrier						
General Cargo	1		15			16
Bulk Cargo			28			0
Container			23			23
Tug						
Tug with Oil Barge						
Tug with Chemical Barge						
Tug with Tow			5			5
Government						
Fishing			5			5
Passenger	2	2	4			8
Other (vsls >20m)			1			1
Vessels < 20m						0
Sub-Total Movements	3	2	93	0	0	98
Ferry						
Total	3	2	93	0	0	98

Appendix L- Fishing Gear

Final report filed separately as Exhibit 34.

Appendix M- HDD Feasibility Report

Final report filed separately as CE-41

Appendix N- RT-1 and Assotrencher IV

RT-1 ROCK TRENCHER

ASSET OVERVIEW SHEET

RT-1 Rock Trencher

The RT-1 Rock Trencher is the world's largest tracked underwater trencher. With 2.35MW of effective trenching power it is designed specifically for the burial of pipelines/ trunklines in hard soil regions.

The innovative, unique triple chain cutter configuration defines a wide, sloping 'V' shaped trench allowing the stabilisation and protection of large diameter pipeline for trunkline burial. This methodology delivers improved economic and environmental benefits in comparison to other protection methodologies.

RT-1's advanced designed pipe lifting technology allows the lift of heavy flooded pipelines. The unique cutting system is adaptable to allow burial of flexible products such as umbilicals and flowlines in a variety of soils.

CTC operate some of the world's largest, most technically advanced marine trenching vehicles and vessels enabling us to complete workscopes ranging from trenching, to a more comprehensive subsea protection service for the international offshore construction industry.

Key Features

- Trunkline burial in cemented materials
- Dredge system for high efficiency
- Flexibility for hard or soft soils
- Trench depths up to 2m at current configuration

ASSET OVERVIEW SHEET

The RT-1 Rock Trencher is not limited to these parameters and can be modified by CTC to complete workscopes in excess of its current configuration.

GENERAL

Operating Depth	500m
Maximum Trench Depth	2m
Trench Profile	'V' Trench – 45 degree wall
Pipe Size	1500mm O.D maximum clearance (includes allowance for anodes, joints and piggy-back line)
Pipe Following	TSS440 pipe tracker, OA sonar and cameras

DIMENSIONS

Length	22.5m
Width	13m
Height	9.6m
Weight in Air	202te

PIPE HANDLING

Configuration	2 cradles
Pipe Load	65te maximum per cradle
Pipe Size	1500mm O.D lateral clearance 1500mm O.D vertical clearance
Roller Configuration	2 sets of triple rollers per cradle

SOIL TYPES

Suitable for a range of sands, clays and rock

CHAIN CUTTER SYSTEM

Configuration	Three individually powered and positioned cutter chains, set at 45 degrees
Pipe Load	Chain 1 – 250kW Chain 2 – 400kW Chain 3 – 400kW
Pipe Size	Heavy duty interleaved chain
Roller Configuration	Chain 1 - variable to 2.4m/s Chain 2 - variable up to 3.2m/s Chain 3 - variable up to 3.2m/s
Cutter Width	800mm

DREDGE AND JETTING SYSTEM

Configuration	Four hydraulically driven dredge pumps. Two mid mounted units to remove spoil excavated in front of the main chain cutters. Two rear mounted units for clearing re-circulated spoil from the chain cutters and any premature backfill from soft overburden collapse
Pumps	4 x 80kW heavy duty dredge pumps. Operating point approximately 1500m³/hr @ 0.75 bar
Main Jetting System	2 x 350kW direct coupled motor/ pump sets – approximately 2400m³/hr @ 7 bar. Supplies rear jet legs, dredge heads, cutter chain cleaning and HPU cooling as required

TRICOMARINE GROUP
ADEPT AT ADAPTING

DEEPOCEAN TRICOOFFSHORE CTCMARINE

Head Office
Coniscliffe House, Coniscliffe Road,
Darlington, DL3 7EE, England
T | (+44) 0 1325 390 500
F | (+44) 0 1325 390 555
E | commercial@ctcmarine.com

Singapore Office
15 Changi South St1,
Singapore, 486783
T | (+65) 6329 9642
F | (+65) 6543 3416
E | singapore@ctcmarine.com

Perth Office
Level 2, 33 Barrack Street,
Perth, 6000, Western Australia
T | (+61) 8 9218 8400
E | australia@ctcmarine.com

Aberdeen Office
The Enterprise Centre,
Exploration Drive,
Bridge of Don, Aberdeen,
AB23 8GX, Scotland
T | (+44) 0 1224 355 440

Dubai Office
P.O. Box 54455, Office No. 5WA 228,
West Wing Building #5A,
Dubai Airport Free Zone,
Dubai U.A.E
T | (+971) 4 299 3677
F | (+971) 4 299 3946

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Assotrencher IV

Assotrencher IV, built for the purpose of executing burial works in soils and conditions where three factors co exist; Very hard soils, Uneven territories and little or no slack given to the cables. Its unique design and method of operation, enables the loading and securing of heavy cables on the vehicle, without reducing its' ability to maneuver or perform effectively the trenching operation.

Although its' long dimensions, Assotrencher IV is able to maneuver effectively in rough territories and to withstand the extraordinary shear forces and tensions resulting from trenching in areas full of rocks and boulders.

Assotrencher IV, as the entire "Assotrencher" family vehicle, uses high end technology to show the operator and record all crucial information necessary to accumulate the condition of the vehicle and the cable. Crucial data are recorded in real-time, including images from cameras and profiling and scanning sonars.

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Assotrencher IV

MAIN DATA

Length:	6.5 m
Breadth:	3.9 m
Height:	3.5 m
Weight:	25,000 kg
Depth rating:	200m

TOOL OPTIONS

Cutting Wheel (1)
Used in hard soils (rock, hard clay)
Diameter: 2.0 m
Weight: 2,500 kg

Cutting Wheel (2)
Used in hard soils (rock, hard clay)
Diameter: 2.5 m
Weight: 6,500 kg

Rocksaw
Used in mix soils (gravel, stones)
Length: 4.9 m
Weight: 5,000 kg

CABLE LOADING SYSTEM

A system of four (4) remote operated grabbers is fitted onto the vehicle for loading the underwater cables to be protected. This system is diver less and utilized these specially made grabbers installed on the lower part of the vehicle, for bottom – loading power cables that have little slack available.

UMBILICAL

Consisting of multiple Medium Voltage Lines for powering the vehicle and single mode fibers for the communication purposes. Extra simple power lines are also installed for backup purposes, in case of failure of the primary communication lines.

POWER STATION

A container fitted with the necessary medium voltage fields and the necessary safety measures for the powering of the vehicle is used and installed nearby the generating sets. This container is remotely controlled and monitored from the control room container.

CONTROL ROOM

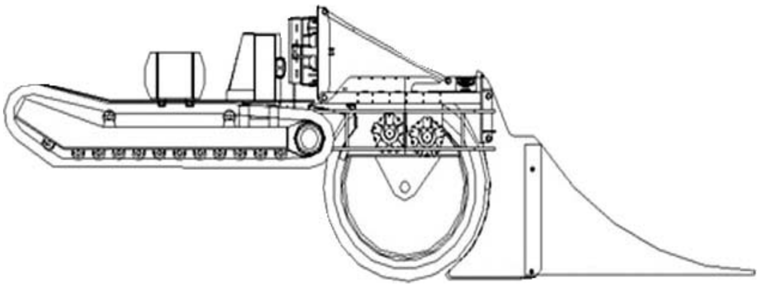
The control system of the vehicle is installed inside a air conditioned 20ft container with large windows for monitoring the launch and recovering activities on deck.

Inside this control room all the necessary controls, monitors (video and VGA), recording devices and powering arrangements are installed, while uplink outputs are available for the connection of the control room to the remote viewing stations on the support vessel.

Monitoring of the vehicle and recording is done from PC-based software with graphic user-friendly display.
Back-up systems are also installed for handling emergency situations.

SENSOR EQUIPMENT

- Simrad/Mesotech scanning sonar
- Simrad/Mesotech profiling sonar
- 8 low light underwater cameras
- 2 Pan-Tilt camera modules
- Simrad Transponder/Responder
- Compass/Attitude sensors
- 6 Underwater lights
- Pressure monitoring system
- TSS 350 Cable Tracker (option)
- Onboard small inspection ROV (option)



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Appendix O- Shore Based Tunnel to Seabed Techniques

ADDR.: Statnett SF
Projects/Cable Technology
Hoffsveien 70B, 0377 Oslo
PO Box 5192 Majorstuen
N-0302 OSLO, NORWAY

Document title

SOBI Cable Crossing

Shore based tunnel to seabed techniques Immediate comments

Classification **Confidential**	Project No. **IFS 55247**	
Responsible department **BK**	Document No. **1456707**	Pages + attachments **8**
Client **Nalcor Energy**	Client reference WTO DC1401	Order No. LC-PM-007

Summary, result:

The Lower Churchill Project is in the process of comparing the tunnel crossing option and the submarine cable option for the HVDC cable crossing of the Strait of Belles Isles.

This preliminary report is giving immediate answers to details regarding tunnel to seabed techniques. A final report will be issued shortly.

It seems to be a sufficient experience base for thinking that a safe shore approach consisting of a combination of tunnel and drilled holes can be constructed, even if the tunnel ends far below the water surface.

Distribution

Rev	Date	Description	Author	Checked	Approved
2					
2A					
1	2010-09-10	Issued for client review	TL/GJ/JES	KRø	JES

CONTENTS

1 INTRODUCTION

Statnett worked under a sub-contract with Hatch, until December 2008 with a preliminary cable study based on a seabed installation concept.

This report contains immediate answers to questions raised by LCP in WTO DC1401 under Advisory contract LC-PM-007.

The report aims at giving immediate comments to the Part 1 questions raised in the scope of work for the Shore based tunnel to seabed techniques task.

Further elaboration will be presented in a final Part 1 and 2 reports.

2 BACKGROUND

The Strait of Belle Isle is being considered as the location for the subsea power cables that would transmit the electricity to the island of Newfoundland. The Strait of Belle Isle is 17.5 km across at its narrowest point and is perhaps considered on the difficult end of the prectrum for cable projects. The Strait is fraught with sea ice and icebergs for a majority of the year, high currents, difficult bathymetry, harsh weather conditions and significant geotechnocal challenges.

To further develop this project, Nalcor is in the process of conducting studies for two potential crossing scenarios with one being the seabed option, and the other being a tunnel option.

For the seabed option, the exact cable route has not been finalized; however, it is assumed that it will have a shore approach on the Labrador coast with a landing site in the area near Pointe Amour and on the Newfoundland Side in the area year Yankee Point.

The purpose of this scope of work is to further understand methods, technologies, and details for installing a cable from a shore-based tunnel to the seafloor. It is the goal of the SOBI task force team to fully understand the capabilities and limits of the technologies associated with these operations, as well as examples from around the globe where these techniques have been utilized. The Hatch report prepared by Statnett, “DC1130 – Submarine Cables, Strait of Belle Isle”, submitted to Nalcor Energy in December 2008, alludes to the application of such methods. Further details are desired in order to understand the opportunity for application for the seabed crossing.

3 ALTERNATIVE SHORE APPROACH METHODS

When considering shore approach methods for the SOBI crossing it is interesting to compare conditions and methods used earlier with what is relevant and feasible in Strait of Belle Isle. The below table lists some of the world’s most important power cable connections.

	Name	Route length km	Cable length km	Max. depth m	Voltage kV	Year	Make
1	Gotland – Sweden	93	93	170		1953	ABB
2	Kontiskan (Sweden – Jutland)	88	88	80		1964	ABB
3	Skagerrak 1 & 2	128	256	550	250	1976	Nx

4	Italy– Corsica – Sardinia	119	238	500	200	1965	P
5	Fenno Skan 1 (Sweden– Finland)	200	200	120		1989	ABB/Nx
6	Basslink (Victoria – Tasmania)	295	295	200	400	2006	P
7	SwePol (Sweden – Poland)	250	250	80	450	2000	ABB
8	Italy – Greece	163	163	1000		2000	P
9	NorNed (Norway – Netherlands)	580	1160	410	450	2007	ABB/Nx
10	Italy – Corsica – Sardinia	120	-	500	-	D	P/Nx
11	Spain – Mallorca	ca 180	-	900-1800	-	D	P/Nx
12	Fenno Skan 2	200	200	120	500	2011	Nx
13	Spain – Morocco (SCFF)	25	175	615	420	1995	Nx/P
14	Gulf of Aqaba (SCFF)	15	60	800	420	1998	Nx

ABB – ABB High Voltage Cables
P – Prysmian
Nx – Nexans Norway
D – Project under development

It is an obvious fact that none of the existing connections is directly comparable to the planned SOBI crossing. The combination of the relatively shallow and very rocky conditions combined with severe ice conditions both in terms of drifting winter ice as well as icebergs drifting through the strait, makes the shore approach challenges new and special.

This is why the solution applied in the NorNed case has inspired the method described in the feasibility report issued by Hatch with Statnett as subcontractor.

This method will be given immediate comments in this report while the comparison with other installations will be further developed in the complete report to be issued later.

3.1 Examples

It is perhaps five categories of cable installation methods which might be of interest for the SOBI crossing: The a.“NorNed method”, b.directional drilled installations, c.pre-installed pipes ,d.J-tubes and e.subsea tunnel with vertical riser shaft.

a. The **NorNed method** is shown on the drawing below. It is the only of its kind.

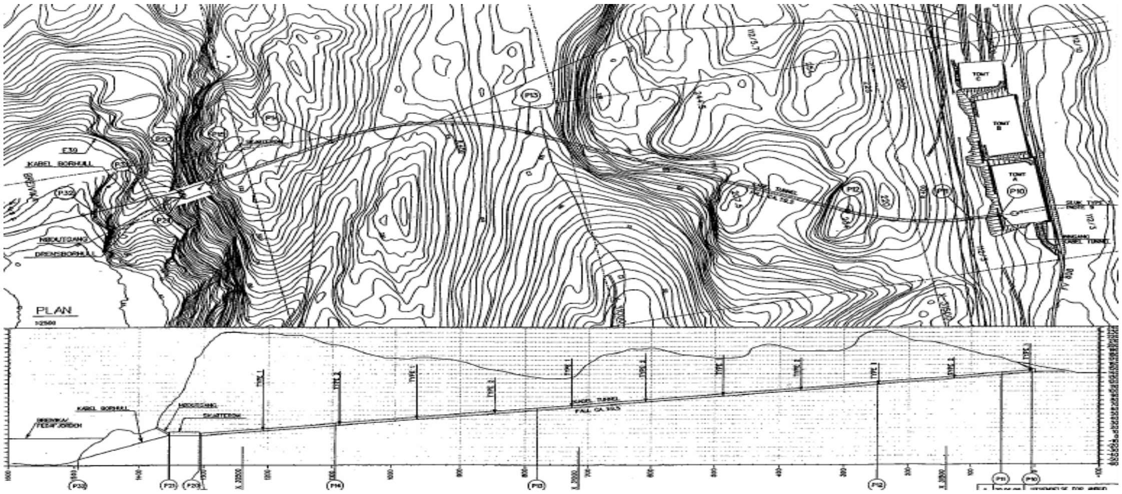


Figure1 The NorNed tunnel and drill hole cable installation

A large tunnel 25 m^2 with 12% steepness is leading from the converter station and down to a jointing chamber approximately 5m above highest water level. To the jointing chamber the submarine cables were pulled in through 300 mm drilled rock holes lined with thick walled polyethylene pipes.

Basically the same concept has been presumed in the Statnett/ Hatch report, the main difference being that the drilled holes will have to be directed horizontally or probably upwards and would need to penetrate towards e.g. 7 bar water pressure.

Exactly this method has not been applied for a large power cable before. However, at Kallsto west of Haugesund a similar method was used for a gas pipeline and for a control cable. This will be further described in the final report.

b. Directional drilled installations

Pulling of all sorts of cable through drilled, lined holes has become quite common in cable connections for example in motor road crossings, river crossings, etc.

The longest pulling known to us so far with cable of a relevant weight is 500m. The safe length will depend on the friction and of number and character of the bends and whether horizontal or vertical.

c. Pre-installed pipes

Solid shore approach protection can be achieved by pre-installing steel pipes or polyethylene pipes. The pipes can be put into blasted or excavated trenches and be anchored and protected by concreting, rock dump, sandbagging or other.

This method was used in Osundet in the first power from shore project to Troll A platform. The large cable was pulled through approximately 50 m thick walled polyethylene pipes from 5 m water depth and up to a jointing pit.

Another example known to us is a river crossing in Tinn river close to Notodden in Norway. To protect and anchor the three single core cables in the strong river current three polyethylene pipes were laid in a pre made trench and special concrete was used for under water concreting of the trench backfill.

d. J-tubes

When bringing cables (as well as umbilicals) from sea floor and up to the topside of an offshore platform J-tubes of steel is being used. The experience with pulling of cables and sealing at the entrance and on the top of these J-tubes is relevant when trying to find good safe methods for SOBI shore approaches.

World wide it is a large number of this type of installation.

e. Subsea tunnel with vertical riser shaft

The perhaps most important example is the Troll A pipeline to shore approach. Two 1 m diameter, two flow pipelines was to be installed from 350 m water depth and to shore over a relatively short distance and through very uneven, rocky seabed.

It was decided to let the last 3.6 km towards shore be installed in a subsea tunnel. The connection to the seabed was made by blasting a vertical shaft.

3.2 NorNed and Troll Cable shore approaches

As already explained **NorNed** utilises a combination of tunnel and drilled holes. The very steep, rocky shore made this solution simple to apply since the bore hole reached 50 m water depth with a length of 150 m only.
The tunnel as such and the way the cable is installed is relevant and applicable for SOBI shore approach tunnels. However, the fact that the tunnel will end a considerable number of metres below the water surface creates many additional challenges.

When the 70 km 52 kV AC cable from shore to the **Troll A** gas platform was to be engineered in 1993 it was carefully considered if the power cable should utilise the same shore approach as the two large pipelines. The concept for that shore approach is shown as an artist's impression in figure 2 below.

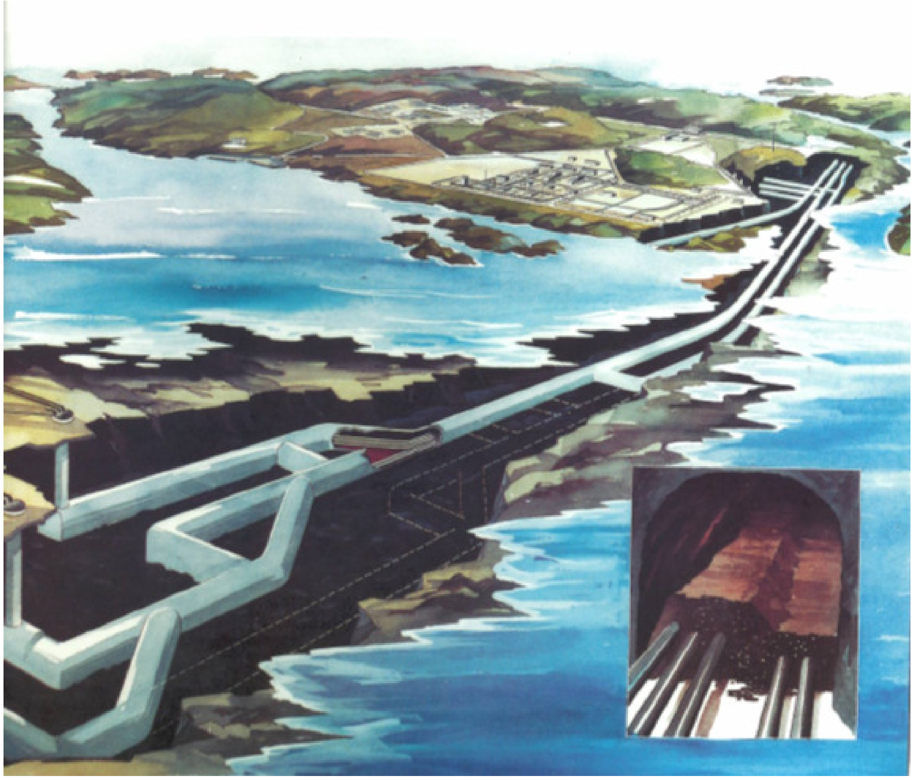


Figure 2 – The Troll gas pipeline shore approach tunnel system

The principle used is the same as developed for hydro power schemes built inside mountains. When the headrace tunnel reaches the intake dam the piercing is normally done by means of a vertical shaft and the last remaining metres blasted under water letting the blasted rock fall down into the tunnel.
The pipeline transition from seafloor to tunnel was arranged as a vertical riser with pre-installed bends in the "hat" which was mounted at the top of the vertical shaft. The subsea tie in was done as usual.

A method for cable tie in was developed and cost estimated and a thorough comparison was done with a bit longer cable route but with a more normal shore approach. The latter was chosen for the following main reasons:

1. Lower cost
2. Risk related to prototype installation method
3. The very large tunnel was for safety reasons (gas) to be operated flooded and it would take 2-3 months to empty and make the tunnel ready for a potential cable repair.

3.3 Miscellaneous

Tunnel gradient The 12% gradient has been recommended as that gradient makes both construction as well as later use of the tunnel practical based on ordinary truck driving.

Cable jointing chamber The design of a rock cavern for jointing will be determined by usage aspects like initial and future number of cables, requirements for any safety or service facilities, the need for turning a truck. The jointing itself will take place in some sort of jointing house (in most cases part of the cable supplier delivery) inside the tunnel, normally with much smaller dimensions than the tunnel or the cavern.

Sealing arrangement As can be understood from the examples described, there is up to now no direct reference for the potential SOBI case where it would be a need for sealing against ca 7 bar water pressure. However, based on the Kallsto experience and on engineering using a combination of previous, well established methods, we see clear possibility to basically maintain the proposed shore approach method. The intention is to describe this in more detail in the final report.

Construction of micro tunnels There exist different drilling techniques for construction of micro tunnels. Examples will be described in the final report. Although we think that micro tunnelling can be used also when working against water pressure, it is reason to alternatively consider use of the vertical shaft method for the piercing.

Drilling gradient Upwards drilling gradient is preferred because it is easier to get rid of the drill mud. It is, however, quite possible to drill downwards. This was done in the NorNed case.

Micro tunnel diameter is determined by the cable pulling conditions. The rule of thumb is to try to achieve an inner diameter of the micro tunnel of 1.5 times the outer cable diameter. That could typically lead to a 200 mm requirement. With a thick-walled lining and some need for clearance for installation of the lining a 300 mm bore hole is in many cases practical. And this type of diameter can most often be achieved in one single drilling operation.

Steel tube lining With micro tunnels in rock different types of lining can be used. In the NorNed case thick-walled polyethylene was used. However, when sealing against considerable water pressure is to be part of the system, steel lining is most likely a more practical solution.

Details on steel lining installation Something more on this subject will be made part of the final report. It is, however, important to be aware that different contractors would have different preferences with respect to construction methods. In the rock hole case the lining will and can in most cases be installed after the drilling has been completed by pulling the full length into the hole in one continuous pulling operation.

Drilling technology status As already stated this subject will be elaborated on in the final report.

Achievable hole lengths Our understanding is that the present longest experienced micro tunnel drilling onshore is 750 m. More update on this later.

Available contractors It is presently three-four Norwegian companies specialising in rock micro tunnelling. A broader picture to be established in the final report.

3.4 Tunnel and sealing details

Answers raised will be answered more completely in the final report.
A large plug in the tunnel will rather be made by a combination of steel and concrete.

The question regarding permanent or temporary pumping arrangement needs to be determined after having established an operational philosophy for the cable crossing.
The system which will give the quickest access and readiness for inspections and a potential repair is of course to install permanent lighting and a pumping system. Anyway a pumping system during construction will most likely be necessary.

3.5 Pull-in and installation of cable

The main principle for the pull-in operation is to get the cable connected to a winch wire and get the cable pulled in in a controlled manner by subsea ROV monitoring and proper communication between the different operators on the cable ship and in the tunnel. At a depth of 70 m only this type of operation is a well established operation. The plan is to get this described and illustrated in the final report.

4 SHORE APPOACH LABRADOR

The character of the Labrador shore is different from the Newfoundland side. Relatively deep water is reached much faster. Before finally concluding that a subsea tunnel is needed, we suggest to review the conditions to see if the NorNed concept after all could be utilised on that side. If so, easier operations and lower cost would be achieved.

5 SHORE APPROACH NEWFOUNDLAND

Construction wise the Newfoundland side is the most challenging because of the shallow, very rocky shore. It might be that a shore approach tunnel will be the best solution in order to achieve an ice safe installation. It would easily be high cost and a difficult task to get sufficient cable protection all the way down to 70 m water depth. And such an operation is also very unpredictable.

Appendix P- Pro Dive Solutions

Subsea Mattress

FoundOcean

Pro-Dive Marine Services, in conjunction with FoundOcean, provides specialized geo-technical and structural services to the Canadian oil and gas industry. Focusing on installation, maintenance, repair and protection of platforms, templates and pipelines, a range of activities from feasibility studies through conceptual design, trials, procurement and construction to the provision of personnel and equipment for field operations are undertaken.

In 1989 Pro-Dive Marine Services entered into an exclusive agreement with FoundOcean to provide the FoundOcean line of products to the Canadian marketplace. Subsequently, both companies have successfully undertaken various client-specific projects.

Pro-Dive Marine Services and FoundOcean continually endeavor to comply with our client's specific requests. Emphasizing safety, quality products, and on time delivery, we can provide innovative low cost solutions to subsea related problems.

Services Offered

Pro-Dive Marine Services, in conjunction with FoundOcean, offers an extensive range of products and services, which include:

- Consultation, feasibility studies and systems related engineering
- Flexible concrete mattresses, precast units and ScourMat
- Grout mixing and pumping equipment
- Pipeline protection and stabilization
- Design and manufacture of fabric formworks
- Ballasting using viscous and heavy slurries
- Pipeline abandonment and plugging
- Inspection, repair and strengthening of offshore structures

The following subsections summarize the specialized offshore construction services offered by Pro-Dive Marine Services and FoundOcean.

Flexible Concrete Mattresses and Pre-Cast Units

- Flexible pre-cast concrete mattresses are used for weight coating, support, stabilization and protection of pipelines and umbilicals. Lift frames are also available for subsea installation by diver, ROV, or top side deployment.
- Precast concrete units for crossings, ramps, supports and pipeline protection.

Massiv Mesh

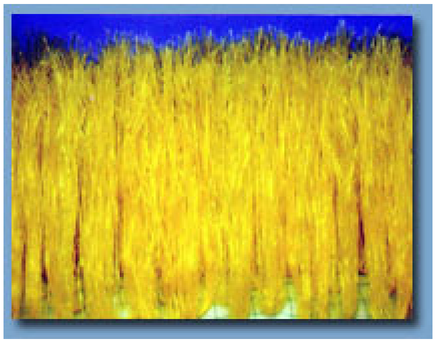
Massiv Mesh is a flexible, concrete mattress consisting of hexagonal concrete elements linked together with high strength non-degradable polypropylene rope.

The mattresses have many uses in the protection, support and stabilization of subsea structures and have been designed for their flexibility and ease of handling during installation.

Flexiweight

Flexiweight is a concrete mattress consisting of hexagonal section bars, reinforced with steel and linked by polypropylene rope. Flexiweight is flexible, robust, designed for ease of installation and available in a range of sizes and concrete densities.

Flexiweight has an established track record for such applications as Stabilization, Crossovers, Trawlboard, Cable protection and Scour prevention.



ScourMat

Tides and currents cause erosion of the seabed adjacent to solid objects known as scour. Scour affects the stability of pipelines and subsea structures and can also cause considerable damage to coastal areas.

ScourMat is made from a series of polypropylene fronds attached to a polypropylene net and linked by a framing network of webbing that extends around the periphery and crosses the mat at regular intervals. A number of specially designed anchors are attached to the webbing.

Underwater, the fronds open out to form a fan like array, which slows down the local current and causes particulate matter to settle. This eventually builds up a new sandbank, effectively reinstating the seabed. This fiber-reinforced sandbank will then resist further erosion.

SeaMat

SeaMat, a stabilization and protection system, based on bitumen-coated aggregates encased within a man-made woven fiber envelope, complete with integral lifting straps. Reinforcement is achieved by the use of a polypropylene Geogrid cage.

SeaMat is designed to remedy the following subsea problems:

- Scour
- Crossover protection
- Impact damage

Provision of Mixing and Pumping Equipment

Pro-Dive Marine Services, in conjunction with FoundOcean, has an extensive range of cement mixing and pumping equipment, for all types of offshore construction activities, available. The equipment is capable of mixing very low water content (viscous and heavy) slurries. A wide selection of pump sets provides the optimum rate required for the best results. This equipment has been used for the following applications:

- Grouting activities associated with fabric formworks
- Platform construction pile grouting
- Perform repair and maintenance
- Template / structure ballasting
- Concrete structure repair and maintenance
- Pipeline plugging and well abandonment

Pro-Dive Marine Services has the total capacity and flexibility to work as a primary contractor in association with design engineers, operators and contractors, throughout the various phases of a project, from solution design through to the implementation of the project.

Fabric Formwork

Engineering fabric formwork offers a considerable range of possibilities to the offshore industry. In addition to the standard pipeline supports, specially designed fabric formwork is supplied for specific requirements, including:

- Mattresses for load distribution
- Pipeline crossings
- Riser supports
- Anti-scour systems
- Fabric seals for structural work in platforms

These varied systems have been used in water depths of 340 meters; deeper waters are within the scope of the plant. Subsea procedures are developed to ensure that the underwater contractor correctly applies the solutions. Attention to detail ensures that subsea time, whether for divers or ROV's is reduced, thus reducing the overall cost of the operation.

Specialized Grouting Equipment

Pro-Dive Marine Services and FoundOcean have acquired specially developed grouting equipment suitable to the wide range of work undertaken in the offshore environment. The well proven colloidal mixing principle gives excellent grout qualities suitable for underwater applications and has been adopted for all equipment.

The main characteristics are:

- Compact skid mounted module units for restricted working space
- Established colloidal mixing system for underwater grouting
- Provision of pressurized bulk cement silos
- Ability to handle bagged materials (if required)
- A range of grouting outputs and injection pressures to suit application
- Facility to place grout at substantial underwater depths

In addition to fabric related applications Pro-Dive Marine Services and FoundOcean have the necessary expertise to undertake all aspects of offshore grouting including:

- Infilling of tubulars
- Annulus grouting
- Foundation underbase grouting
- Structural repairs

Appendix Q- COPS Report

COPS

Vehicle

Chapter n°	XXX
Révision	2
Date	07 / 2010
Page	1 / 7

DESCRIPTION

1.0 Summary

1.1 Description

The COPS spread is meant for the protection of submarine cables, umbilicals and pipelines. Equipped with all features for tracking cables or P/L's, the COPS consists in laying a grout-filled formwork astride the cable, umbilical or P/L to be protected.

1.1.1 Vehicle

Dimensions: 7.0m x 5.2m x 4.2m (L x W x H)
Weight (vehicle equipped with standard devices and empty bag reel):

- in air .... 15.9 tons
- in water .... 9.0 tons

1.1.2 Frame

The crawler frame is a flanged pipe structure which can be dismantled for containerisation. CAD technique and finite elements computations were used for optimisation.

1.1.3 Track System

Track assembly with Caterpillar® chain (D3) and standard 1.2m-wide polypenco grousers motorised via 2 sprocket wheels driven by hydraulic motor. They can be controlled at slow speed (down to 10 m/hr) for good synchronisation with grout injection.
Bench length: 5 m.

1.1.4 Thrusters

2 horizontal thrusters (2 x 250daN pull) for azimuth orientation driven by hydraulic motor.

1.1.5 Hydraulic Power System

One electric motor (45kW - 760V 60Hz or 40kW - 660V 50Hz) drives a set of 2 dual pumps (25 cm^3/r, 37.5-45 l/min) with adjustable flow and proportional control. The distributors for switch-over between tracks and thrusters and capacity adjustment are housed inside the hydraulic tank.

1.1.6 Process Table

This is a light alloy structure where the formwork is being deployed at the outlet of the reel for grout injection and which carries all accessories and sensors necessary to the process (grout injection retractable nozzle, bag cutting and stapling tool, inclinometers for grout level monitoring, proximity sensors, etc.)

1.2 Vehicle Performances

The vehicle characteristics are such as to achieve the best productivity in terms of formwork injection & laying based on the expected slurry production level.

1.2.1 Ground Pressure

With 12m2 overall bearing surface based on the standard [1.2m-wide] grousers, the pressures exerted on the ground are:

- in air .... 0.1325 daN/cm^2
- in water .... 0.0750 daN/cm^2

1.2.2 Speed

Adjustable between 0 and 500 m/hr (380V 3Ph 50Hz) or 0 to 600 m/hr (440V 3Ph 60Hz).

1.2.3 Safety Devices

In case of breakdown, the vehicle has hydraulic capacity to undertake the following emergency functions: retracting the grout injection nozzle, closing (stapling) and cutting the formwork, opening the grout by-pass valve and clutching the handling device for the recovery.

1.2.3 Main Control Functions

From the Control Van where the position of the crawler in relation to the cable is displayed based on measurements from the cable/pipe tracker, two control modes are applicable to drive the machine :

- Manual mode where all functions are pilot-controlled, or
- Auto-heading mode where the pilot selects a set heading an drives the vehicle strictly based on speed control.

1.3 Controls & Sensors

1.3.1 Sector Scanning Sonar

1 x Tritech Sector Scanning Sonar type ST525BT.

1.3.2 Profilers

2 x Dual Head Profilers (ST1000's from Tritech) are mounted at the bottom of the machine to display a picture of the COPS bag being laid.

1.3.3 Compass

1 x Fluxgate compass (KVH-C100) with gyroscopic compensation. Data from this sensor is used in one of the telemetry driving modes.

1.3.4 Cable Tracker

1 x ''IMPEC 3'' Cable / Pipe Tracking System. This system is an active one (tone tracking). It gives to the operator an accurate position of the machine relative to the cable or pipe (accuracy better than 10 cm at midpoint of measuring range).
Should be replace by TSS 440 dualtrack.

1.3.5 Other Sensors & Accessories

1x Altimeter, 1 x Sensorex SX 42700 Pitch & Roll Sensor, 2 pan & tilt video cameras, 3 fixed video cameras, 1 x speed and laid bag sensor.

1.3.6 Control / Power Van

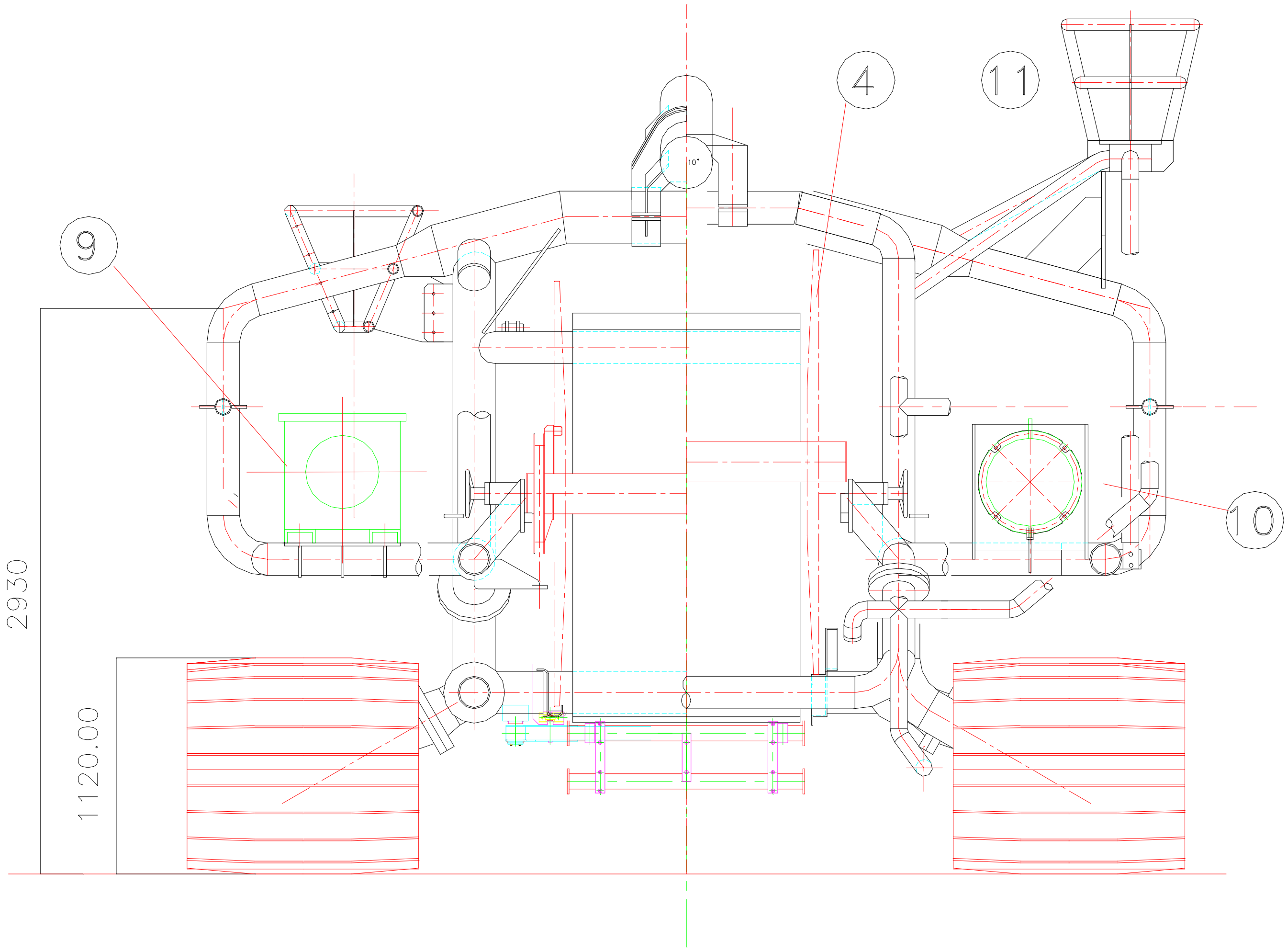
The crawler comes complete with a Control & Power Van featuring on one side a power room with power supplies to the different system components and on the other side the control room with its synoptic panel, computerised controls and VCR's.

1.3.7 Umbilical Winch and Slip Ring

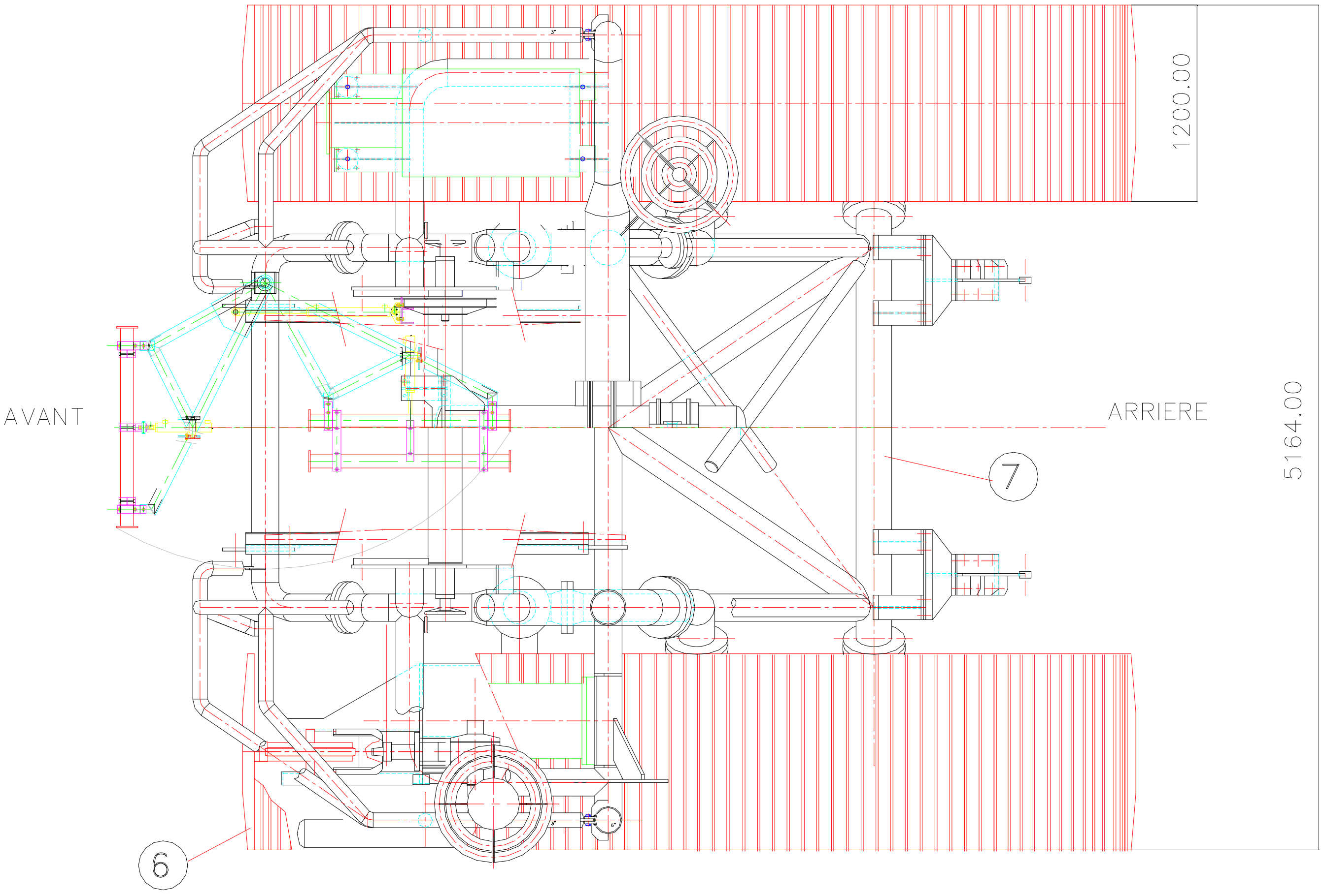
A containerised winch with its hydraulic power pack provides storage for the umbilical (250m length, pulling load 5T, breaking load 15T, weight in air 3.8 kg/ml, weight in water 1.5 kg/ml, ∅55 mm).
Winch: drum capacity 500m of ∅55mm cable, pulling force 3T with safety brake adjustable between 0.5 and 3T.

1.4 Drawings

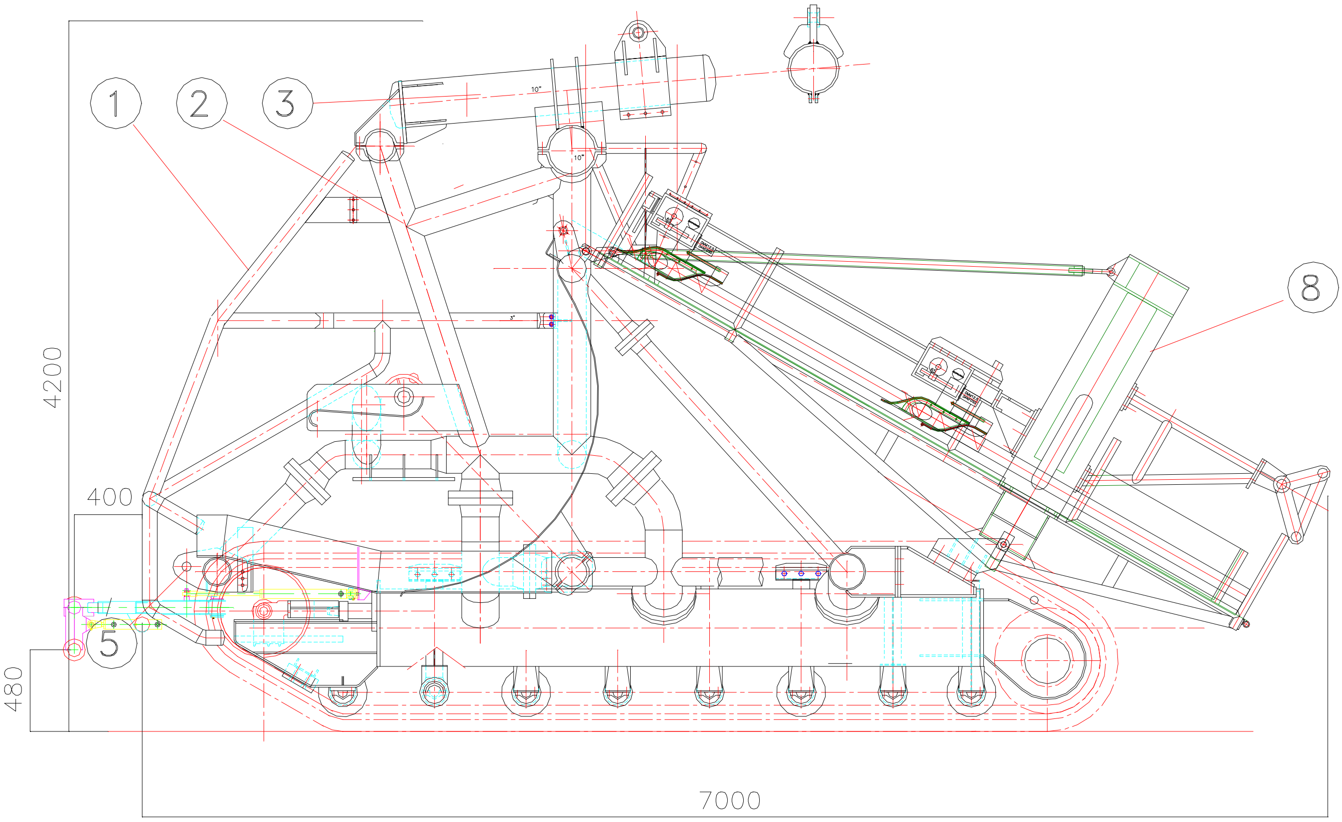
1.4.1 Front view

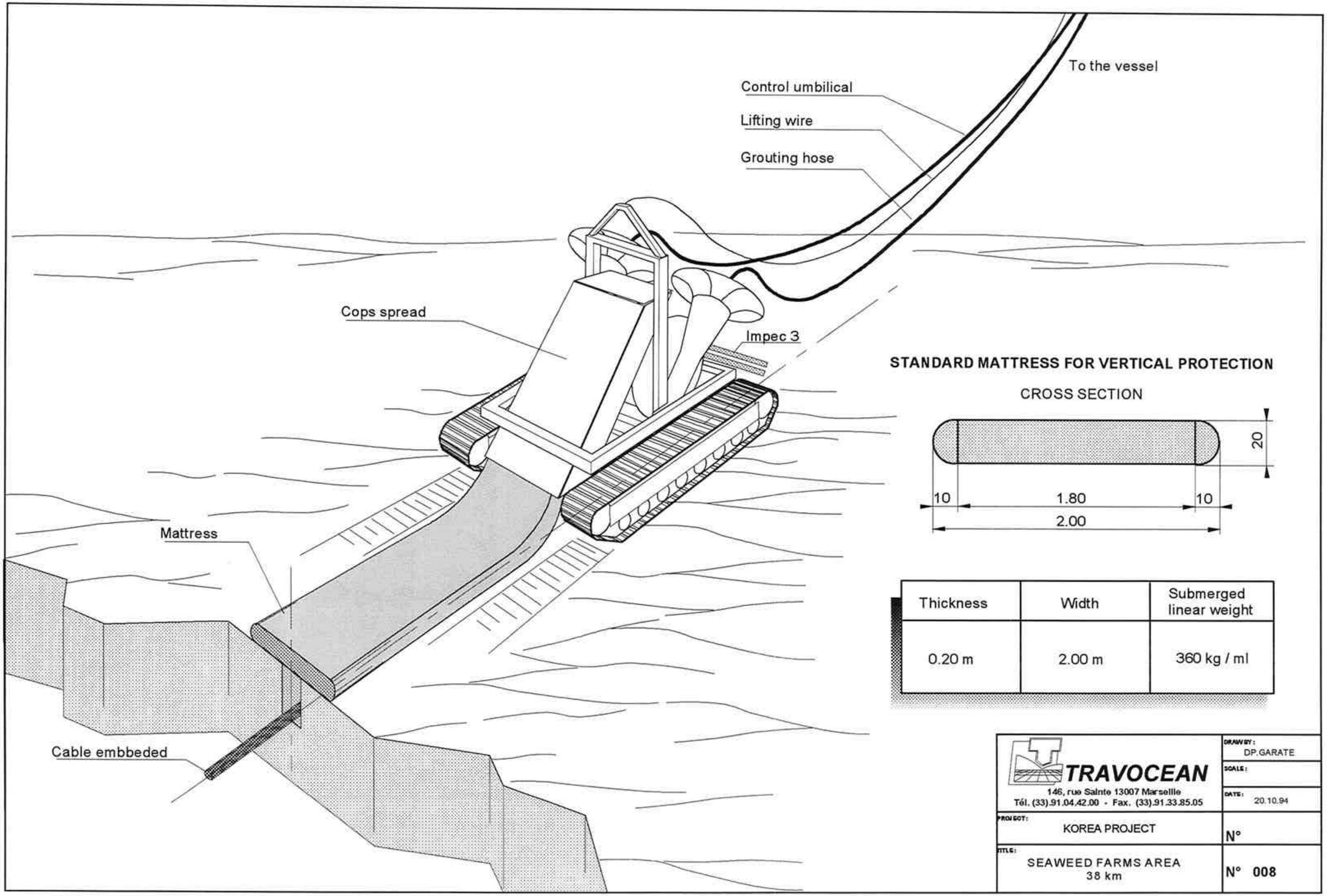


1.4.2 Top view (Process table not shown)



1.4.3 Side view (Tracking system ''IMPEC 3'' shown in working position) – option for TSS Dual





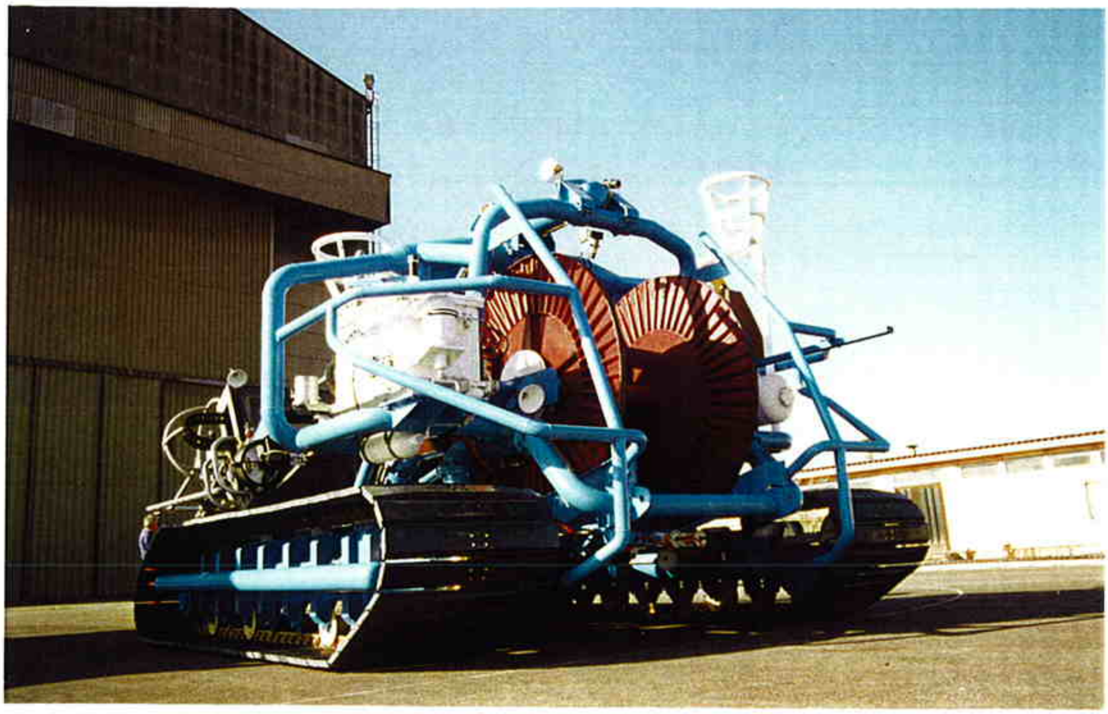
STANDARD MATTRESS FOR VERTICAL PROTECTION

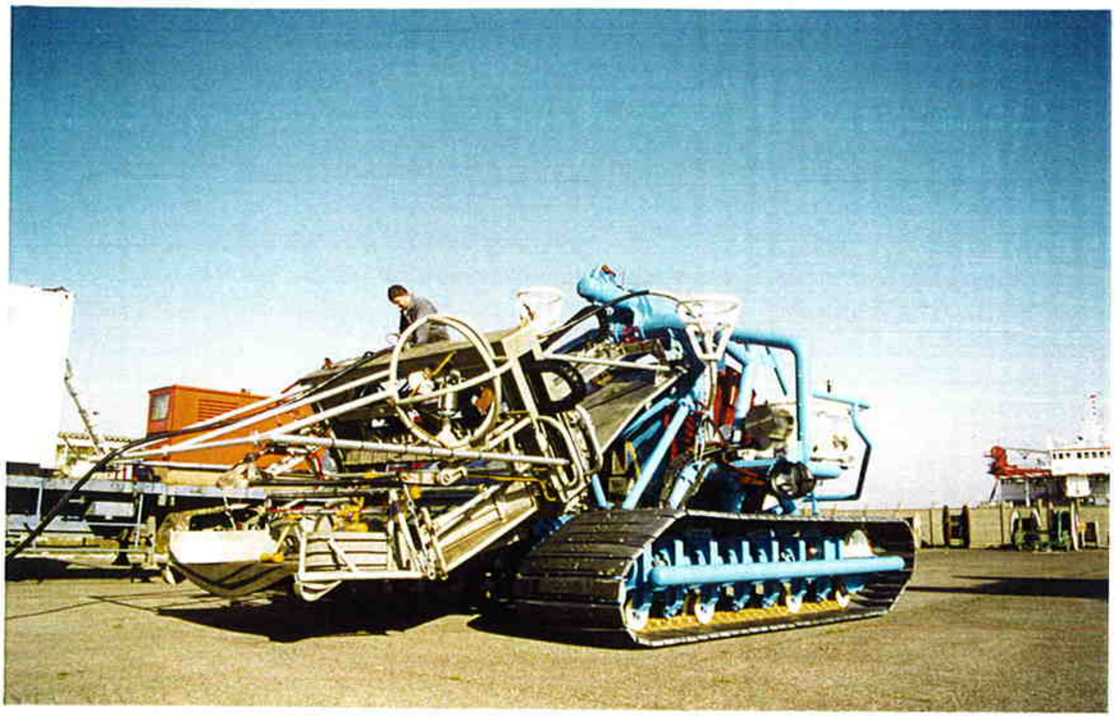
Thickness	Width	Submerged linear weight
0.20 m	2.00 m	360 kg / ml

TRAVOCEAN
146, rue Sainte 13007 Marseille
Tél. (33).91.04.42.00 - Fax. (33).91.33.85.05

DRAWN BY: DP.GARATE
SCALE:
DATE: 20.10.94
PROJECT: KOREA PROJECT
N°
TITLE: SEAWEED FARMS AREA
38 km
N° 008

- COPS vehicle structure integration in DUNKIRK (2/2)





Accurate follow up of the cable to be protected by the laid mattress

6.2.3 - Offshore operations

6.2.3.1 - Support vessel

- General views of CSO Alliance

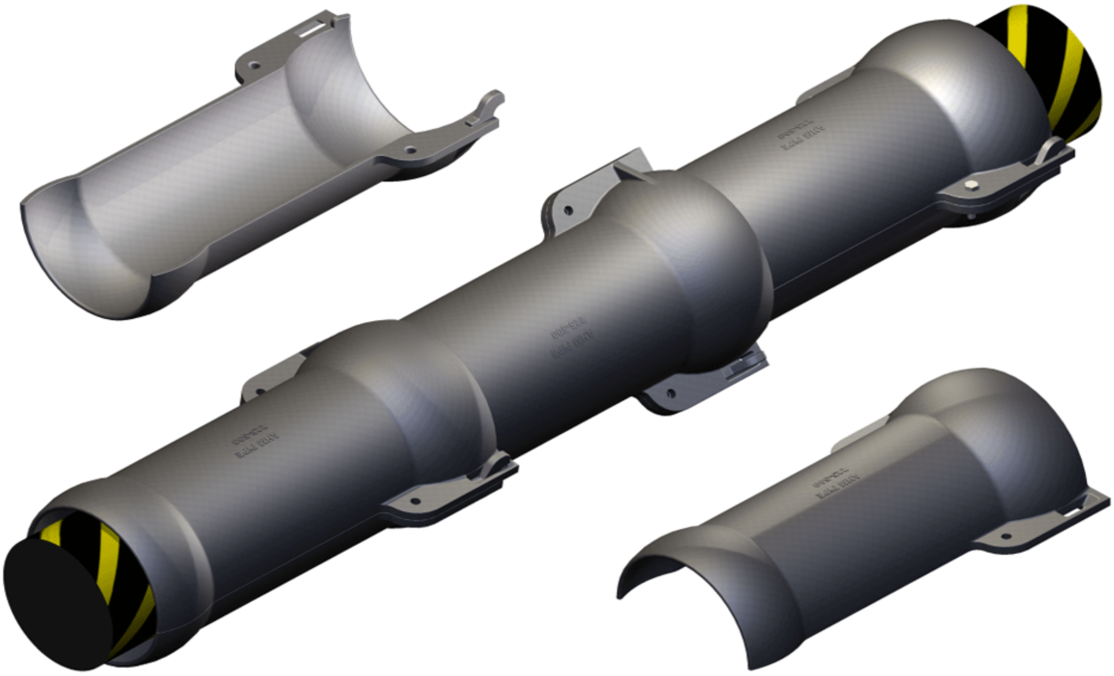
Appendix R- AHMTEC Cable Protection System

AHM-Pipe

Submarine Cable Protection System

AHM-Pipe 225-500

Technical Specification



Overall segment length : 606 mm
Effective segment length : 500 mm
Inner diameter minimum : 225 mm (suitable for cables up to 200 mm outer diameter)
Outer diameter maximum : 343 mm
Minimum bending radius : 3.2 m
Typical bending radius : 3.5 m

Weight per segment : 14.9 kg
Weight per section : 29.8 kg
Weight per meter in air : 59.6 kg
Weight per meter in seawater : 51.4 kg

Material : EN-GJS-400-15 (DIN EN 1563)
Pipe impact resistance : > 5 kJ (ISO 13628-1 & Norsok U-001)
Pipe tensile strength : > 366 kN
Abrasions resistance : Good
Corrosion resistance : Very Good
Average material loss : 0.10 mm/year (ISO 11306 & DIN 81249-2)
Recommended bolt type : M10 x 50 - 8.8 (ISO 4014 or ISO 4017)
Recommended nut type : M10 - 8 (ISO 4032)

The AHM-Pipe submarine cable protectors are formed out-of two identical half-shells which form a self-locking articulated pipe. Due to its design the AHM-Pipe can be installed in various manners to obtain the protection that submarine cables require. During installation AHM-Pipe can either be fitted directly to the submarine cable and could be floated-out during e.g. shore end installation or can alternatively be installed by divers once the submarine cable has already been laid. Typical installation locations include but are not limited to shore end, subsea crossings and areas with extreme environmental conditions.

AHMTEC GmbH
Hafenstrasse 6c
D-26789 Leer / Germany
Tel.: +49-(0)491-20980500
Fax: +49-(0)491-20980509
Email: info@ahmtec.de
Web: www.ahmtec.de

AHMTEC
cable protection systems

Appendix S- Vos Product Innovation

VOS PRODECT
innovations

Pro-Pipe Cable Clamp CC- 130 Datasheet

Version and date	Preliminary	07-04-2010

Total length	355 mm	
Effective length	300 mm	
Total weight (excl. bolts & nuts)	20,5 kg	
Volume	2,81 l	
Wall thickness	8 mm	
Maximum outer diameter	199 mm	
Minimum inner diameter	130 mm	
Clamping range	96 - 110 mm	
Segment tensile strength	693,7 kN	

Submerged weight per set¹	17,6 kg	

Bolt and nut size Shells	M10	
Bolt and nut size Clamps	M10	

Material	EN-GJS-400-15	In accordance with EN 1563
Density	7200 kg/m³	
Break elongation	15 %	
Tensile Strength	400 N/mm²	

1) Based on seawater with a density of 1024 kg/m³. The density of seawater varies with temperature and salinity of the water.

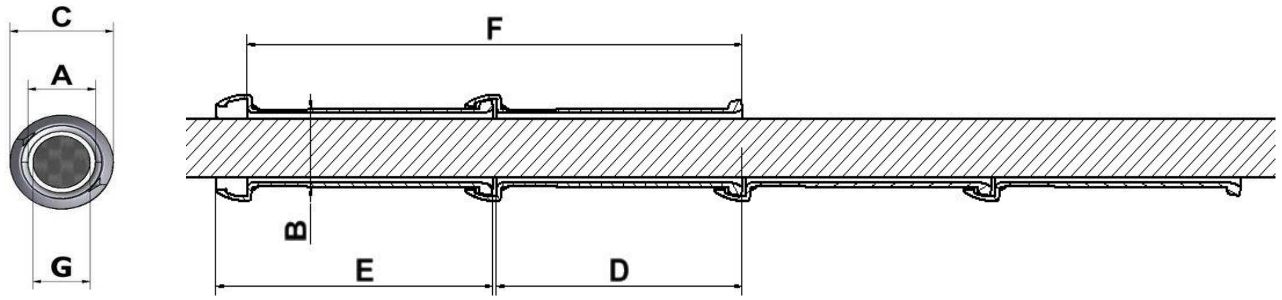
Pro-Pipe submarine cable & pipe protectors can be installed in various ways to obtain the protection that submarine cables and pipes require. During installation the Pro-Pipe can be fitted directly to the cable or pipe before floating the cable in. The Pro-Pipe can also be post-lay installed by divers. As a remedial protection the Pro-Pipe can also be installed on the beach or even offshore at locations of crossings or aggressive seabed conditions.

Please do not hesitate to ask us for detailed information

Vos Prodect Innovations B.V.
Doorndistel 1, 7891 WV Klazienaveen, The Netherlands
T +31 (0)591 315600 · **F** +31 (0)591 317828 · **E** info@vos-prodect.com

VOS PRODECT *innovations*

QUICK REFERENCE CHART PRO-CPS



6° bend restriction

Typical protection string for entering an I- or J-Tube

PRO-CPS Pipe Reference Number	Minimum Inner Diameter [mm] A	Minimum Outer Diameter [mm] B	Maximum Outer Diameter [mm] C	Individual Working Length [mm] D	Total Overall Length [mm] E	Assembled Working Length [mm] F	Mass per Segment in Air [kg]	Mass per Meter in Air [kg]	Mass per Meter in Water [kg]	Maximum Bending Angle [°]	Maximum Bending Radius [mm]	Maximum Cable Outer Diameter [mm] G
030-250	30	44	98	250	285	1000	1,56	12,48	10,7	6 °	2400	18
030-500	30	44	98	500	534	1000	1,93	7,72	6,6	6 °	4800	18
040-250	40	54	106	250	287	1000	1,70	13,6	11,7	6 °	2400	26
040-500	40	54	106	500	536	1000	2,38	9,52	8,2	6 °	4800	26
055-250	55	71	123	250	290	1000	2,65	21,2	18,2	6 °	2400	40
055-500	55	71	123	500	539	1000	4,00	16	13,8	6 °	4800	40
070-250	70	86	137	250	293	1000	3,15	25,2	21,7	6 °	2400	55
070-500	70	86	137	500	542	1000	4,85	19,4	16,7	6 °	4800	55
085-250	85	101	152	250	295	1000	3,65	29,2	25,1	6 °	2400	70
085-500	85	101	152	500	545	1000	5,70	22,8	19,6	6 °	4800	70
100-250	100	116	170	250	296	1000	4,45	35,6	30,6	6 °	2400	85
100-500	100	116	170	500	545	1000	6,80	27,2	23,4	6 °	4800	85
115-250	115	131	184	250	298	1000	5,50	44	37,8	6 °	2400	100
115-500	115	131	184	500	548	1000	7,75	31	26,7	6 °	4800	100
130-250	130	146	199	250	300	1000	5,60	44,8	38,5	6 °	2400	110
130-500	130	146	199	500	550	1000	8,65	34,6	29,7	6 °	4800	110
145-250	145	161	214	250	300	1000	6,40	51,2	44,0	6 °	2400	125
145-500	145	161	214	500	550	1000	9,80	39,2	33,7	6 °	4800	125
160-250	160	176	228	250	302	1000	7,00	56	48,1	6 °	2400	140
160-500	160	176	228	500	553	1000	10,70	42,8	36,8	6 °	4800	140
175-250	175	191	243	250	304	1000	7,65	61,2	52,6	6 °	2400	155
175-500	175	191	243	500	554	1000	11,70	46,8	40,2	6 °	4800	155
190-250	190	206	258	250	307	1000	8,50	68	58,5	6 °	2400	170
190-500	190	206	258	500	557	1000	12,90	51,6	44,4	6 °	4800	170
205-250	205	221	273	250	311	1000	9,15	73,2	62,9	6 °	2400	185
205-500	205	221	273	500	561	1000	13,90	55,6	47,8	6 °	4800	185
220-250	220	236	288	250	313	1000	9,75	78	67,1	6 °	2400	200
220-500	220	236	288	500	563	1000	14,85	59,4	51,1	6 °	4800	200
235-250	235	251	303	250	313	1000	10,80	86,4	74,3	6 °	2400	215
235-500	235	251	303	500	563	1000	16,25	65	55,9	6 °	4800	215
250-250	250	266	319	250	315	1000	11,55	92,4	79,4	6 °	2400	230
250-500	250	266	319	500	565	1000	17,30	69,2	59,5	6 °	4800	230

Pro CPS 250 series

Pro CPS 500 series

All Pro-Pipe equipment has been tested and checked 100% when delivered to our valued customers

Certification for the chemical or mechanical properties will be supplied upon request.

Datasheets and test reports are available upon request

Please do not hesitate to ask us for detailed information

Vos Prodect Innovations B.V.
Doorndistel 1, 7891 WV Klazienaveen, The Netherlands
T +31 (0)591 315600 · **F** +31 (0)591 317828 · **E** info@vos-prodect.com

VOS PRODECT
innovations

PRO-Pipe ASSEMBLY INSTRUCTIONS

Infosheet

The PRO-Pipe Cable Protection System is easy to install, as the pieces consist out of two identical half-shells. The clamp ball-end (female) is shaped to receive the stub-end (male).

Step 1:
Place the first shell under the cable.

Step 2:
Place the second shell under the cable by rotating it slightly before placing it on the first one.

Step 3:
Place the first top shell at a 15 degress angle to the left, ensuring the Z-shaped lugs engage. Turn the upper shell towards the cable, until positioned directly over the bottom shell, then lower and engage to the bottom shell.

Step 4:
Secure the first pair with bolts and nuts.

Step 5:
Place the third shell under the cable, as in step 2

Step 6:
Repeat step 3.

Step 7:
Repeat steps 5 and 6.

Pre-casted recesses ensure that the nuts are locked and will not turn during fastening.

Note:
We recommend to secure the PRO-Pipe as follows:
- at the start (first pair)
- at the end (last pair)
- every 10 m (at least)
- using socket head bolts.

Pro-Pipe submarine cable & pipe protectors can be installed in various ways to obtain the protection that submarine cables and pipes require. During installation the Pro-Pipe can be fitted directly to the cable or pipe before floating the cable in. The Pro-Pipe can also be post-lay installed by divers. As a remedial protection the Pro-Pipe can also be installed on the beach or even offshore at locations of crossings or aggressive seabed conditions.

Please do not hesitate to ask us for detailed information

Vos Prodect Innovations B.V.
Doorndistel 1, 7891 WV Klazienaveen, The Netherlands
T +31 (0)591 315600 · **F** +31 (0)591 317828 · **E** info@vos-prodect.com

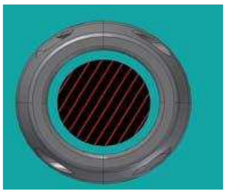
VOS PRODECT innovations

PRO-Pipe SEDIMENT FILL

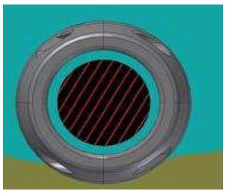
Infosheet

Using cast iron protectors has a lot of advantages, because:

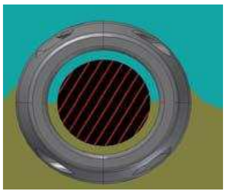
- Heavy weight
- Very High impact values
- A build in Bend restrictor.
- Quick assembling onto Pipe or Cable.
- Assembling on board or vessel, on shore landing site or assembling by divers.
- Round protectors, no obstacles to hook on or hook to (fishing nets / anchors etc).
- **Sediment fill**



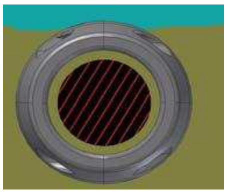
01 After assembling the Pro-Pipe Cable and Pipe Protectors the assembled string can be placed into position on the Sea / River bottom. As alternative divers can place the protection equipment at site.



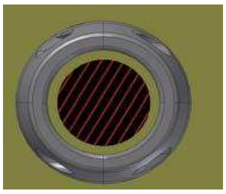
02 The Protector String will sink onto its lowest position on the Sea / River bottom. and will sink into the surrounding sediment (depending of Sea or River-floor conditions). Any movements of the Protector string will be maximized by the bend restriction of the protectors and the total weight of the protector string (incl. sediment, Cable / Pipe and Pipe content).



03 Due to the enlargement of the Cable / Pipe weight, the protector string will sink into the sediment. Because the Protector string has small openings, the sediment also will flow inside the protectors, creating an extra protection layer around the cable or pipe, but protected by the Pro-Pipe Protector. Due to this, the Protector string could be secured for tidal/ wave actions.



04 Depending on the Sea / River floor conditions the Protector string will lower itselves into the sediment, whereas the sediment fills up the protector string, creating an extra Cable / Pipe Protection free of charge. As an extra feature, the sediment will creat a positive influence for any further bending of the Protector string.



05 In certain circumstances the protector string can fully sink into the Sea / River floor, due to weights and the shape of our Pro-Pipe protectors. Any temperature changes (high voltage cables) will be adopted by its surrounding.

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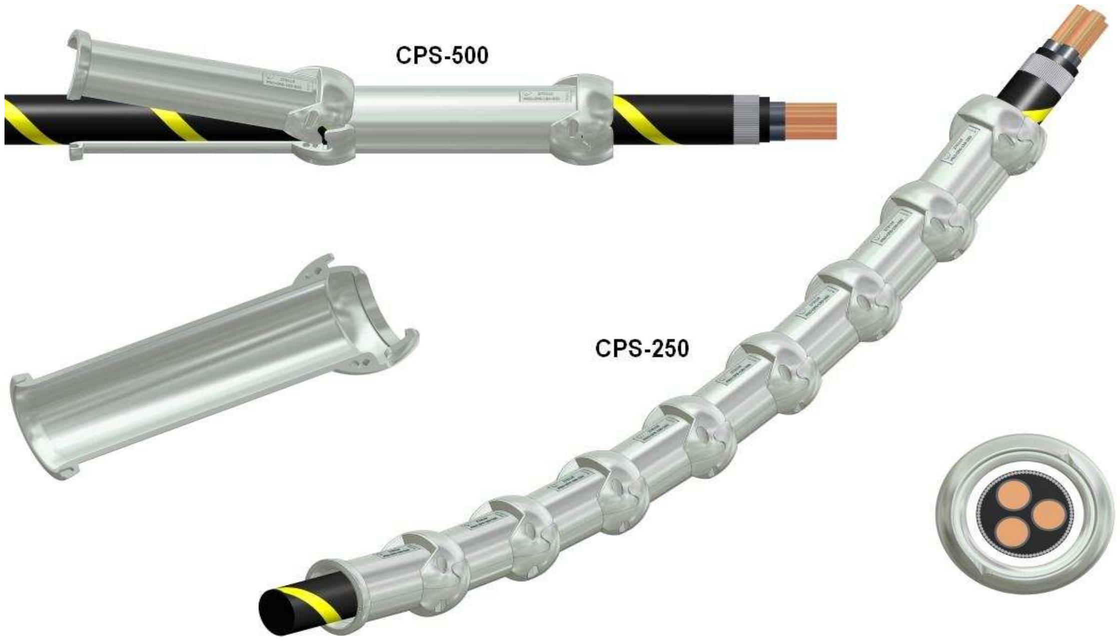
Pro-Pipe Cable Protection — CPS- 175 500 — Datasheet



Version and date	Preliminary	07-04-2010

Total length	554 mm	
Effective length	500 mm	
Weight per set	23,4 kg	
Volume per set	3,20 l	
Wall thickness	8 mm	
Maximum outer diameter	243 mm	
Minimum inner diameter	175 mm	
Maximum cable diameter	155 mm	
Bend radius restriction	4,8 m	
Segment tensile strength	919,9 kN	

Weight per meter	46,8 kg/m	
Submerged weight per meter[1]	40,2 kg/m	

Material	EN-GJS-400-15	In accordance with EN 1563
Density	7200 kg/m^3	
Break elongation	15 %	
Tensile Strength	400 N/mm^2	

1) Based on seawater with a density of 1024 kg/m^3. The density of seawater varies with temperature and salinity of the water.

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Pro-Pipe submarine cable & pipe protectors can be installed in various ways to obtain the protection that submarine cables and pipes require. During installation the Pro-Pipe can be fitted directly to the cable or pipe before floating the cable in. The Pro-Pipe can also be post-lay installed by divers. As a remedial protection the Pro-Pipe can also be installed on the beach or even offshore at locations of crossings or aggressive seabed conditions.

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Doorndistel 1, 7891 WV Klazienaveen, The Netherlands
T +31 (0)591 315600 · **F** +31 (0)591 317828 · **E** info@vos-prodect.com

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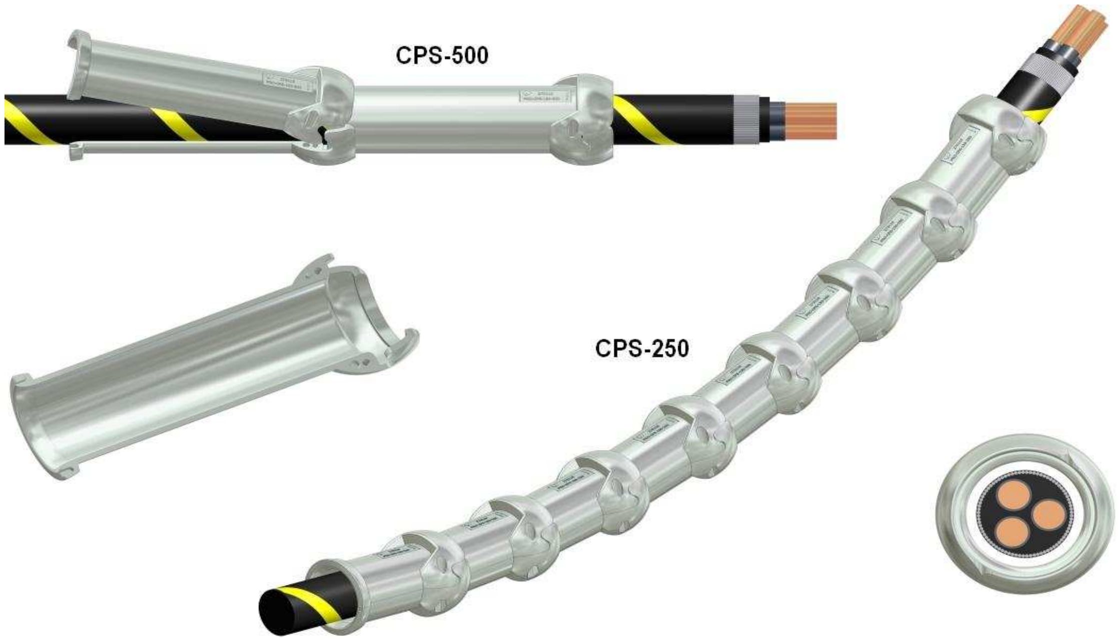
innovations

Pro-Pipe Cable Protection CPS- 175 250 Datasheet



Version and date	Preliminary	07-04-2010

Total length	304 mm	
Effective length	250 mm	
Weight per set	15,3 kg	
Volume per set	2,09 l	
Wall thickness	8 mm	
Maximum outer diameter	243 mm	
Minimum inner diameter	175 mm	
Maximum cable diameter	155 mm	
Bend radius restriction	2,4 m	
Segment tensile strength	919,9 kN	

Weight per meter	61,1 kg/m	
Submerged weight per meter[1]	52,5 kg/m	

Material	EN-GJS-400-15	In accordance with EN 1563
Density	7200 kg/m^3	
Break elongation	15 %	
Tensile Strength	400 N/mm^2	

1) Based on seawater with a density of 1024 kg/m^3. The density of seawater varies with temperature and salinity of the water.

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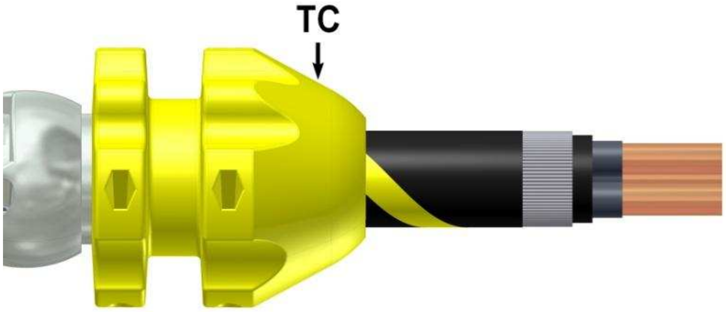
Pro-Pipe Tube Centraliser TC 175 xxx Datasheet



Version and date	Preliminary	18-06-2010

Segment length (total)	- mm	On request, depends on tube Ø
Weight per set	- kg	On request, depends on tube Ø
Volume per set	- l	On request, depends on tube Ø
Maximum outer diameter	- mm	On request, depends on tube Ø
Minimum inner diameter	165 mm	
Minimum inner tube diameter	- mm	On request, depends on tube Ø

Submerged weight per set[1]	- kg	On request, depends on tube Ø

Bolt and nut size	M10	

Material PU	PU shore 80A	
Density PU	1250 kg/m^3	
Break elongation	550 %	
Tensile Strength	60 N/mm^2	

1) Based on seawater with a density of 1024 kg/m^3. The density of seawater varies with temperature and salinity of the water.

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Pro-Pipe Cable Clamp CC- 175 Datasheet

Version and date	Preliminary	07-04-2010

Total length	409 mm	
Effective length	350 mm	
Total weight (excl. bolts & nuts)	29,6 kg	
Volume	4,05 l	
Wall thickness	8 mm	
Maximum outer diameter	243 mm	
Minimum inner diameter	175 mm	
Clamping range	141 - 155 mm	
Segment tensile strength	919,9 kN	

Submerged weight per set[1]	25,4 kg	

Bolt and nut size Shells	M10	
Bolt and nut size Clamps	M10	

Material	EN-GJS-400-15	In accordance with EN 1563
Density	7200 kg/m³	
Break elongation	15 %	
Tensile Strength	400 N/mm²	

1) Based on seawater with a density of 1024 kg/m³. The density of seawater varies with temperature and salinity of the water.

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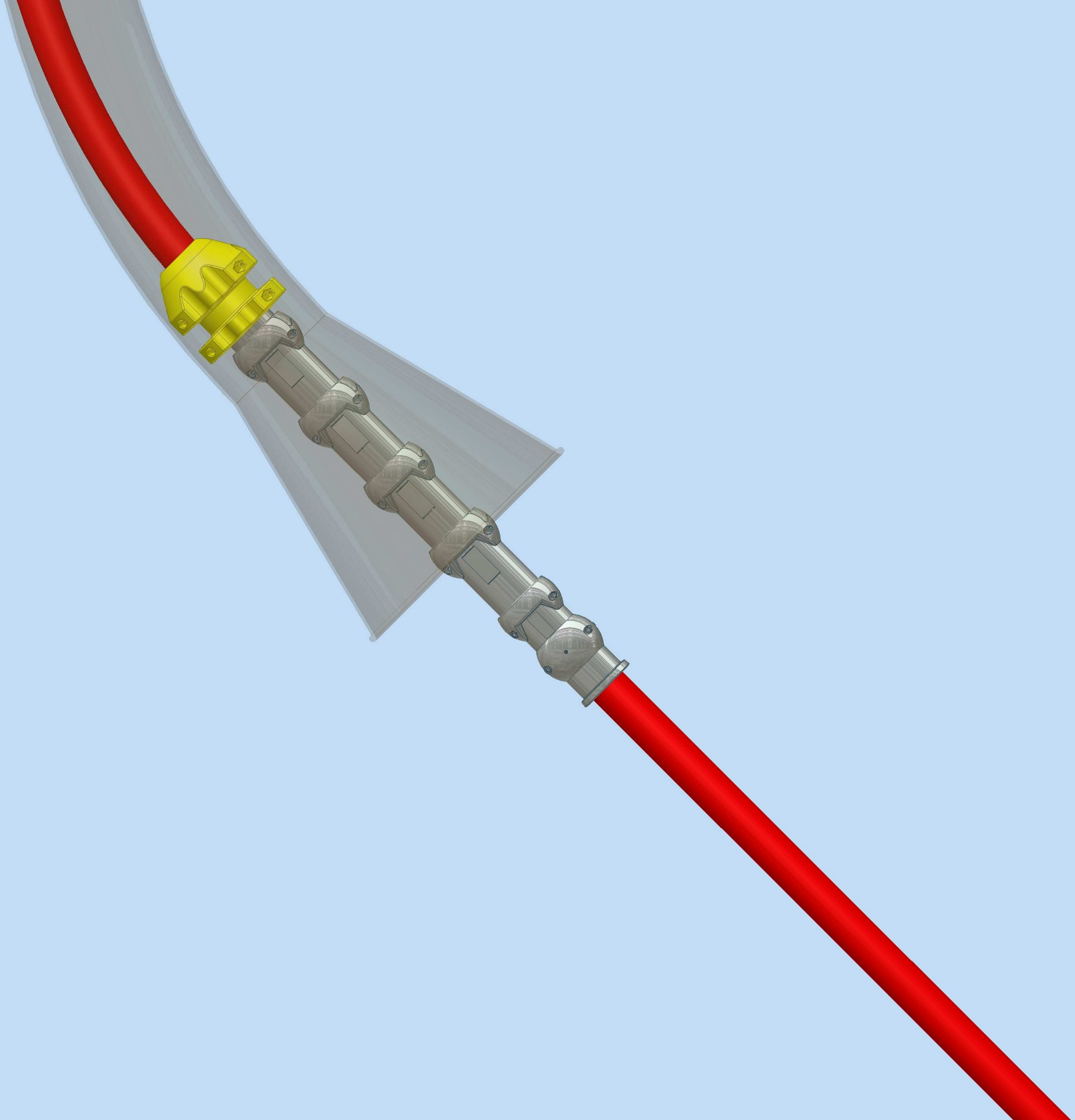


Appendix T- Serpent Cable Flotation System

SEAFLEX
FLEXIBLE BUOYANCY

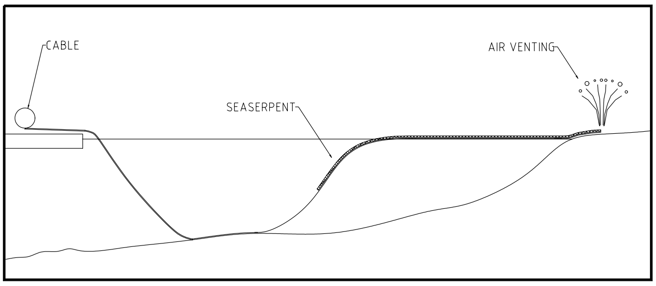
Product Overview:
SEASERPENT CABLE FLOTATION

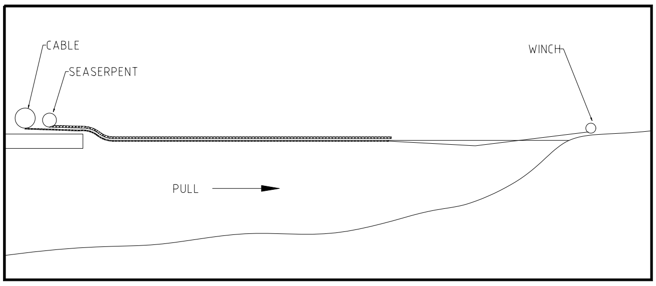
THE CONTROLLED WAY TO INSTALL CABLES IN SHALLOW WATER

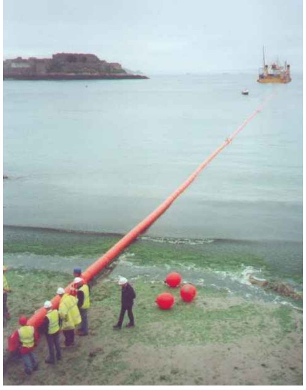
Instead of using multiple floats to support a submarine cable during installation in shallow water, the SeaSerpent is a continuous inflatable tube attached to the cable at 1m spacing. While its support and control of the cable is excellent, perhaps its most advantageous characteristic is the operational flexibility it allows the installer.

Supplied in ‘lay flat’ form on a transport, deployment, recovery (TDR) drum the tube is inflated as it unwinds and is attached to the cable just before the launch point. This allows rapid and near continuous deployment.

When the correct length of cable is afloat and positioned accurately on its line, the air is vented from one end of the tube allowing the cable to sink progressively into the desired position. This sinking process is under complete control and may be slowed, stopped or reversed at will.







The form stiffness developed by the SeaSerpent decreases kinking tendencies and eliminates sagging between floats and the requirement to keep constant tension on the cable. This characteristic, coupled with the unrivalled control of the sinking process, allows installers much greater flexibility in procedures. It is for instance possible to park the cable on the bottom during adverse tidal periods and re-float it when required, or tow sections of cable to installation sites several kilometres from the launch point.

The SeaSerpent eliminates losses of individual buoyancy units and saves a huge amount of space and manpower at the launch point. With only $1.5m^2$ of deck space required for 1km of buoyancy, the SeaSerpent offers significant savings in transport, storage and replacement costs as well as the operational advantages of speed and control.

Seaflex can manufacture SeaSerpent for individual buoyancy requirements although most cable weights are applicable to Seaflex’s Standard Range. The table shows Standard Range SeaSerpent specifications. SeaSerpent and ancillary transport, deployment and recovery systems are available for hire or purchase.

Since 1996 Seaflex Limited have been certified to ISO9002 by Lloyds Register Quality Assurance for - ‘The manufacture, repair and hire of heavy duty flexible load bearing structures, primarily air lift bags and fluid storage tanks’.

TYPE	Buoyancy (kg/m)	Lay Flat Width (mm)	Inflated dia. (mm)
2650/9/30	6	141	90
2650/8/25	8	160	102
2650/7/20	10	182	116
2650/6/15	13	213	136
2650/5/15	20	259	164
2650/4/12	33	320	205
2650/3/10	60	435	280
2650/2/6	130	650	420

Appendix U- Cable Laying Vessel Specifications

Giulio Verne

Owner	Prysmian
Contractors:	Pirelli/Prysmian
Specifications:	
MAIN DIMENSIONS & PERFORMANCE	
Length Overall	133.18 m
Moulded Breadth	30.48 m
Draft at max load (operating four thrusters)	8.50 m
Moulded Depth	7.62 m
Loaded Draft Summer Freeboard	5.197 m
Summer Freeboard	1.79 m
Deadweight Tonnage	8,840 tons
Gross Tonnage	10,617 tons
Net Tonnage	3,185 tons
Deck Strength Uniform Loading	9.28 tons/m²
Max speed	10 knots
Bollard pull	100 tons
Light weight	8,004 tons
PROPULSION & MACHINERY	
The vessel is powered by five Daihatsu diesel gen sets running on gasoil	
Diesel Engines	Daihatsu 6 DV 22A V12 2,200 BHP at 1,000 RPM
Generators	Fuji 1500 KW 600 Volt GFV 563ZB-6Z Emergency/Harbour Generator
Engine type	Caterpillar 3508 DITA (Marine) 1500 RPM
Generator	Hyundai Electrical Engineering HFC 3-454-4 500 KVA
Power Supply	600 Volt - 50 Hz for Propulsion
	440 Volt - 50 Hz for General Board Network
	220 Volt - 50 Hz for user supplies
Aft	Two Schottel Lips Azimuth Fixed Pitch Thrusters with

Type	1500/1000 ZS driven by Fuji Electric Motors 1000 RPM, 1250 kW, 600 Volt direct current.Speed control by SCR type
Forward	Two Retractable Schottel Lips Azimuth Fixed Pitch Thrusters with Propellers in Nozzles.
Type	S 1000 LSV driven by Fuji Electric Motors 720 RPM, 1250 kW, 600 Volt direct current Speed control by SCR type
Bulb	Tunnel thruster
Type	Kamewa TT 1650 K/BMS-CP 710 kW, 380 V, 50 Hz.
DYNAMIC POSITIONING SYSTEM	
Giulio Verne is equipped with a DP	SIMRAD SDP 21
SPEED AND FUEL CONSUMPTION	
Transit Speed	9 knots in good sea and wind conditions
Maximum Speed	10 knots
Consumption in transit	15 - 20 tons/day
Consumption in DP operations	7 - 11 tons/day
Consumption in port	2 tons/day
CARGO CAPACITY AND AVAILABLE DECK AREA	
Total cargo capacity is approximately 8,000 tons. :	
The turntable has a maximum capacity of 7,000 tons of cable.	
On the main deck, ahead from the turntable, an area of about 500 m² is available, in which a cable	
TANK CAPACITY	
Fresh water	650 tons
Gas Oil	650 tons
REFRIGERATION STORAGE	
Freezer Room -18°C 26 m³	
Vegetable Room +4°C 17 m³	
Dry Provision 50 m³	
ACCOMMODATION	
Crew	18 - 40
Technicians and Representatives	50 max
Total	90
The ship is anyway certified for 96 people	
Hospital with two beds	
Two Clients offices	
One Officer lounge	
Two Crew/General lounges	
HEATING AND VENTILATION	
Accommodation and laying-testing control rooms are air-conditioned	
NAVIGATION EQUIPMENT	
One - Radar (also A.R.P.A.)	Kelvin Hughes 3 cm (Band X) Nucleus 6000 A
One - Radar	Kelvin Hughes 10 cm (Band S) Nucleus 5000 T
One - Hydrographic Echo Sounder	SIMRAD EA500
One - Echo Sounder	One - Echo Sounder JRC Type NJA 178 S
One - Echo Sounder	Kelvin Hughes Type MS 50
One - Doppler Log	One - Doppler Log JRC type JLN 203
One - GPS Satellite Navigator	Furuno GPS GP 80
One - GPS Satellite Navigator	Furuno GPS GP 30
Two - VHF Radiotelephone	Sailor Type RT 144B

One - VHF Radiotelephone	Furuno VHF FM 8500 (DSC)
One - Weather Facsimile	JRC Type Jax 9A
One - Autopilot	Incorporated into DP System
Two - GPS	Trimble 4000 DS
Two - Gyro Compass	Sperry Type SR 220
One - Gyro Compass	Brown
COMMUNICATION EQUIPMENT	
One - VHF Transceiver	Furuno FM 8500 (DSC)
One - SSB Transceiver	Furuno FS 1562-15
One - MF DSC terminal receiver	Furuno MF DSC-6A
One - Satellite tel/facsimile	Canon Fax-B-150
Two - Inmarsat C	Furuno Type PIB581
Two - Inmarsat C	teleprinter Furuno PP-510
One - Inmarsat B	Furuno Felcom 81
One - Inmarsat B	teleprinter Furuno PP-510
One - Navtex Receiver	Marac Navtex Tel. 100
BRIDGE, SAFETY AND OTHER EQUIPMENTS	
Three GMDSS Emergency VHF Sailor	
One Sarsart Cospas (Epirb) Jotron Tron 30S MK2	
One Fire Detection System Autronics	
One Fire Detection System Notifier AFP 200	
Two Radar Trasponder Jotron	
Wind Measurement System (2 Sets incorporated into DP System)	
Doppler Log	
Electronic Fog Bell and Gong System	
LSA EQUIPMENT	
Four totally enclosed lifeboats, 50 persons each	
Maker	Watercraft (totally enclosed, equipped in accordance with
Four liferafts	
Type	Viking DK (for 12 persons with emergency pack)
Four liferafts	
Type	Pirelli Londra 86 (for 16 persons with emergency pack)
CAPSTANS AND MOORING WINCHES	
Three electric capstans of 6 tons capacity with line speed 15 meter per minute.	
Mooring winches	
Forward	Four single drum waterfall winches with 50 tons pull on step 1, 25 tons pull on step 2.Up to 1200 meter of 52 mm wire. One winch each side classed as a windlass.
Winch type	Norwinch 1S-50-1T
Static load Max	150 ton
Total Brake Torque	52,650 kgm
Winch pull, step 1	50 tons 1st wrap - 16.25 ton·m
Winch pull, step 2	25 tons 1st wrap - 8.125 ton·m
Winch barrel dimensions	Drum diameter 650 mm
	Drum width 1250 mm
	Flange diameter 2000 mm
	Flange depth 675 mm
Nominal capacity	1200 meter of 52 mm wire

Aft	Two double drum waterfall winches with 80 tons pull using both motors onto one drum, 40 tons pull using one motor on each drum. 1200 meter of 52 mm wire.
Winch type	Norwinch 2S-80-2T
Static load maximum	150 ton - 1st wrap
Winch pull (2 into 1	80 ton 1st wrap- 28.4 ton·m
Winch pull (1 into 1	40 ton 1st wrap - 14.2 ton·m
Winch Barrel dimensions	Drum diameter 710 mm
	Drum width 1500 mm
	Flange diameter 1850 mm
	Flange depth 570 mm
Nominal capacity	1200 meter of 52 mm wire
CRANAGE	
Four Asea cranes	Hook capacity 25 tons at 22 metres; revolving capacity on
	One Electric 2 tons Store Davit next to accommodation starboard side
	One Sormec crane 13 tons at 6 m
ANCHORS	
Eight Flipper Delta Anchors of 7 tons each	
CABLE LAYING EQUIPMENT	
STARBOARD LAYING LINE	
Pick-up arm	Fitted with motorised wheels
	3 m bending radius
DOHB machine	Caterpillar type
	Maximum pulling tension 5 tons at 2 knots in laying mode
Capstan	6 m diameter
	Laying performance:
	50 tons at 2 knots
	20 tons at 5 knots
	Recovering performance:
	50 tons at 0.5 knots
	20 tons at 1 knot
Auxiliary machine	Caterpillar type
	Maximum pulling tension 2 tons (seaward)
Stern sheave	6 m diameter
	Fitted with dynamometer for max 50 tons
PORTSIDE LAYING LINE	
Pick-up arm	Fitted with motorised wheels
	3 m bending radius
Linear machine	Maximum pulling tension 10 tons in laying/recovering
Stern sheave	6 m diameter
	Fitted with dynamometer for max 20 tons
7000 TONS TURNTABLE	
Carousel outer diameter 25 m	
Carousel inner diameter 6 m	
Carousel height 4 m (extendible to 4.5 m)	
Maximum linear speed at inner diameter: 2 knots	
FIXED CABLE STORAGE AREA	
Ahead from the turntable an area is available where a fixed platform for coilable cables can be	
The maximum diameter is 19 m; the maximum capacity is approx. 2500 tons of cable	

CABLE BURIAL EQUIPMENT
One of the Pirelli ploughs is usually on board, positioned on a suitable structure in the aft area of the
MISCELLANEOUS
Rubber boats for cable pulling and landing
Stoppers - ropes, wires, etc.
Cable jointing equipment
Electrical test equipment
Measuring system for optical cable (power meter, back scattering, etc.)
HELIDECK
The Helideck is mounted forward on top of the bridge and has been approved suitable for a
having a maximum take-off weight equal to 5080 kg.
PROJECTS
Trans Bay Cable
Basslink
Spain-Morocco II
Itialy-Greece
Neptune
Cometa

C/S Bourbon Skagerrak

Owner	Nexans
Contractors:	Nexans
Specifications:	
MAIN DIMENSIONS & PERFORMANCE	
Length oa including laying wheels	106.00 m
Breadth moulded	32.15 m
Depth moulded	8.00 m
Draft an max deadweight with bow	8.13m
Deadweight	7886 t
Ballast capacity	4400 t
Vessel speed	10 kts
Classification	DNV 1A1 Cable Laying Vessel E0 DYNPOS-AUTR
PROPULSION & MACHINERY	
Power generation	4 x 500 kVA
	1 X 600 kVA
Stern thrusters	2 x 1943 kW (2640 HP) azimuth units
	1 X 1000 kW (1360 HP) azimuth unit
Bow thrusters	1 x 1820 kW (2475 HP) retractable azimuth unit
	1 x 957 kW (1300 HP) tunnel unit
DYNAMIC POSITIONING SYSTEM	
NMD/IMO class	2
ERN	99.99.99
Type	Simrad ADP-503
Reference systems	2 x DGPS
	1 x tracking USSBL transducer
	1 x Artemis mk III
	1 x Fanbeam (Optional)
CARGO CAPACITY AND AVAILABLE DECK AREA	
Main turntable	Outer diameter : 29 m
	Inner diameter : 12 m
	Load capacity : 6600 t
Deck area	Approx. 650 m^2

Deck capacity	10 t/m^2
ACCOMMODATION	
Single cabins	49
Hospital (Single)	1
CAPSTANS AND MOORING WINCHES	
A & R winches	2 x 30 t SWL linear winches
Stern cherry pickers	2 x hydlaulic manriding cherry
Cable capstan system	Cable capstan with linear engine.
Total pull/breaking capacity :	50 t
Maximum laying speed :	50 m/min
CRANAGE	
A-Frame	40 t SWL
Main crane forward	20 t SWL
Aft deck crane	3 x 5 t SWL
CABLE LAYING EQUIPMENT	
Laying wheels	1 x 10 m diameter stern wheel
	1 x 5 m diameter stern wheel
Cable guiding	Complete guiding of cable
	from turntable to laying wheel.
	Guiding minimum radius : 5 m.
Laying instrumentation	Computer based laying control
	system with the
	following input sensors:
	2 x lay speed/length sensors
	1 x lay wheel load sensor
	1 x cable top angle sensor
	1 x high accuracy echo sounder
	Plus depth and position of ROV
	during touch down monitoring.
ROV	
ROV	ARGUS Mariner XL
Trenching (Option)	The vessel can carry Capjet 1 MV trenching
	units for burial operations
MISCELLANEOUS	
Cable repair equipment	
Splice area	A 3 x 15 meter, enclosed area is purpose designed for performance of High Voltage cable repair.
Cable splice eq.	All required equipment for splicing can be accommodated with ready connections to ship utilities
Cable handling eq.	Main equipment for cable handling during a repair is permanently stored onboard
Other	The vessel can be fitted with further equipment from our cable handling tool pool. Thus the vessel can perform : *Cable repair including subsea cutting and retrieval of damage sections. *Simultaneous laying of two cables with controlled separation. *Piggyback laying
Availability:	
Availability:	Booked couple year waiting list (3 years Approx)

PROJECTS
Skagerrak 1&2
FennoSkan
FennoSkan2
Cook Straight
Skagerrak3
Moyle
NorNed
SAPEI
BP Valhall
COMETA
London Array (windfarm) (XLPE)
Lincs (windfarm) (XLPE)
French Island (La Reunion in the Indian Ocean) (XLPE)
Sheringham Shoal (windfarm)(XLPE)
Islands in Krabi (Southern Thialand) (XLPE)
Spanish Mainland - Balearic Island (Cometa Cable)
Hainan Island -Chinese Mainland (Oil Filled)
Wolfe Island(XLPE)
Horns Rev 2 (AC XLPE)
Abu Dhabi-Delma Island
Long Island Replacement (XLPE)

Team Oman

Owner	Nico Middle East
Contractors:	Oceanteam
Specifications:	
MAIN DIMENSIONS & PERFORMANCE	
Type:	DP II Cable and
Year Built / Builder:	1999, De Hoop B.V., Lobith,
Port/No of Registry	Kingstown
Call Sign :	J8B2641
Class:	DNV+1A1 Cable lay vessel DYNPOS AUTR
Length Overall	86.00 m
Breadth Moulded	24.00 m
Depth Moulded	5.50 m
Draft Loaded	4.50 m
Freeboard	1.013 m
Deadweight	5320 tonnes
Registered Tonnage	4073 tonnes
	NRT 1221 tonnes
PROPULSION & MACHINERY	
Main Engines	4 x CAT. 3512 DITA 1445 kW
	each at 1800 rpm
Main Propulsion	2 x electric driven Azimuth thrusters
Stern Thrusters	make Schottel type SRP 1212 FP with
	fixed pitched propellers, 1200KW each
Bow Thrusters	1 x 1200 kW retractable Azimuth
	1 x 1100 kW Tunnel Thruster
Auxiliary / Generators	4 x Leroy Somer, LSA 51L9
	60 Hz, 480 V, 1800 kVA each
Emergency Generator	1 x 219 kVA 175 kW – 238 HP
Sewage Treatment Plant	Aquamar Bio-Unit Mod. MSP III
Oily Water Seperator	DVZ – VL
DYNAMIC POSITIONING SYSTEM	
DP System	Alstom Cegelec

DP System	DPS 902 Duplex
Joystick	Cegelec 900 series
	forward & aft control
SPEED AND FUEL CONSUMPTION	
Max Speed	Approx. 10 knots
Economical Speed	Approx 8 knots
Fuel Consumption	Appox. 10 ton/day
CARGO CAPACITY AND AVAILABLE DECK AREA	
TURN TABLE / 4800 Tonnes	
Inside diameter	8 m
Outside diameter	24 m
Height	4 m
Surface ring	379 mC
Volume of ring	1515 mD
Turn table Speed	2 rpm max
STATIC COIL (Optional)	
Outer Diameter	15m
Inner Diameter	4 m
Deck Cargo Capacity	5000 tonnes
Clear Deck Area	61 x 24 m. 1464 mC
TANK CAPACITY	
Fuel Oil	545 mD
Fresh Water	2900 mD
REFRIGERATION STORAGE	
Refrigerator / Freezer	2 x 28 mD each
ACCOMMODATION	
Crew + Catering	Abt. 18 + 5
Passengers	Abt. 33
NAVIGATION EQUIPMENT	
Magnetic Compass	1 x Datema
Gyro Compass	Sperry SR 180 MK 1
Gyro Repeaters	2 x C Plath
Auto Pilot	2 x Alstom
Radars (ARPA)	1 x Furuno FAR 2815
	1 x FR-2135 S
	and FMD-8010
Echo Sounder	Furuno FE 606
	Navisound – 210
Depth Indicator	Furuno ED 222
Navtex Receiver	1 x Furuno NX 5000
GPS	1 x Leica K 10 DGPS
	1 x Garmin GPS-128
Doppler Speed Lod	Furuno DS 70
COMMUNICATION EQUIPMENT	
GMDSS Station	1 x Furuno Area 3
SSB	1 x Furuno
VHF (4)	Furuno
Satellite Phone / Fax	Nera
Inmarsat	Satcom B, C
EPIRB	1 x McMurdo E3
	Pains Wessex
SART	2 x JXJ Tron Sart

BRIDGE, SAFETY AND OTHER EQUIPMENTS	
Fire Extinguisher	20 x COc, 12 x Foam,
	10 D/P
Emergency Fire / Pump	1 x 50 mD/hr
Fixed CO2	Flooding System in
	Generator Room
LSA EQUIPMENT	
Life rafts	8 x 15 persons
Rescue / Workboat	6 persons
CAPSTANS AND MOORING WINCHES	
4 Point Mooring system	4 x electric self
	tensioning winches
	2 x 60 tonnes
	& 2 x 48 tonnes
Anchors	2 x 3.5 tonnes
	& 2 x 2.5 tonnes
Capstans	2 x 10 tonnes
	electric driven
Bollard Pull	40 M tonnes
CRANAGE	
Deck Crane	15 tonnes
	26.5 m reach
A- Frame	24 tonnes SWL
Supply Crane	4 tonnes

Cable Innovator

Owner	Global Marine
Contractors:	Global Marine
Specifications:	
MAIN DIMENSIONS & PERFORMANCE	
Type of Ship	Cable Ship
Builders	Kvaerner Masa Shipyard,Turku,Finland 1995
IMO Number	9101132
ABS I.D.	95146744
Call Sign	MVEP4
Port of Registry	London
Length Overall	145.50 metres
Length Between Perpendiculars	124.12 metres
Breadth Moulded	24.00 metres
Depth Moulded (to Deck 3)	13.5m metres
Designed Draft	8.30 metres
Deadweight	10557 tonnes
Summer Draft	8.517 metres
Gross Registered Tonnage	14277 tonnes
Net Registered Tonnage	4283 tonnes
Suez Tonnage	15619.1 tonnes
Panama Tonnage	11977 tonnes
Classifications	Cable Layer. A1, AMS, ACCU, DPS-2
PROPULSION & MACHINERY	
Main Engines	3 xWARTSILA 9R32E @ 3645kW
Auxiliary Engines	2 xWARTSILA 6R22/2E @ 975 kW
Thrusters	-1 x Bow Thrust - White Gill GEC Elliot 70T3S - 24t -1 x Bow Thrust - Tunnel - KAMEWA - 16t, provides excellent manoeuvring capabilities
	- 2 x Stern tunnel - KAMEWA - 12t each
Auxiliary Services	None

Switch boards	3.3 kV Main Switchboard, 440v / 60 Hz distribution
Emergency generator	1 x CUMMINS 350kW
DYNAMIC POSITIONING SYSTEM	
Dynamic positioning system	Converteam DPS A-Series - Version 4 (Duplex)
SPEED AND FUEL CONSUMPTION	
Fuel Consumption in Port	4t/day
Fuel Consumption Cable Laying	10-18t/day
Fuel Consumption Economic	16t/day
Fuel Consumption Transit	12 knots @17-27t/day dependent upon load/weather
Fuel Consumption Max Speed	35t/day
Maximum Bunker Capacity	1662 tonnes
Endurance	Normal 42 days at sea and with logistical can be extended to approx. 60 days
Speed:	Economic Speed: 10 Knots
	Service Speed: 12 Knots
	Max Speed: 16.9 Knots
CARGO CAPACITY AND AVAILABLE DECK AREA	
Main cable tanks	3
Internal Diameter	16.7m
Cone Outter Diameter	3.5-3.1 (Tapered)
Tank Height	9.4m
Cone height	7.2m
Maximum load per tank	2333 tonnes Nominal
Tank Top Loading	14 tonnes/square meter
Volume Of Cable Tankes	1808 m^3
Spare Cable Tanks	1
Internal Diameter	8.8m
Cone Outter Diameter	2m
Tank Height	9.2m
Max Load per Tank	500 tonnes
Volume Of Spare Tank	323 m^3
TANK CAPACITY	
Fresh Water Capacity	1322.8 tonnes
Fresh Water Usage	16-20 tonnes/day
Fresh Water Generation	2 x ALPHA LAVAL JWP-26-C80 20 tonnes/ day dependent upon engine load condition.
ACCOMMODATION	
Total Berths	80
Officer Cabins	42
Crew Cabins	36
Representative Suites	2
Hospital	2 beds
NAVIGATION & COMUNICATION EQUIPMENT	
Radars	9800 ARPA and SAM Electronics NG3028
GPS	1 x Trimble + Probeacon DGPS
	2 x JAVAD + Varipos DGPS
	1 x Fugro 90938 + Redbox Starfix DGPS
Infrared-laser	1 x Cyscan
Gyro Compasses	2 x Sperry Mk37
	1 x SG Brown TSS Meridian Standard

Magnetic Compasses	JC Krohn MOD390
Control Unit Auto pilot	Trackpilot Atlas 1100
Rudder angle indicator	Yes
Navtex	JRC NCR 300A
Echo Sounder	2 x Simrad EA 500 (Deep water), 1 x Simrad EN 200 (Shallow water)
Modes of Operation	- Joystick Manual/Auto Heading
	- Duplex DP
	- Auto Track
	- Min Power
	- ROV Follow
	- Plough/Trencher High Tension Slow Down
Stand by mode	Mixed Manual / Auto mode
	Auto Heading / Positioning
	Thruster Allocation / Control
	Power Load monitoring Blackout Prevention
	Trainer / Simulator Mode
	Alarm System
	Auto Track (high speed) / Auto Track (low speed)
	Follow Target mode / ROV follow
	Cable Laying / Trenching
Fire Alarm	Consilium
GMDSS	JRC
Sat-Com	1 x SAT B - NERA
	1 x SAT C - SAILOR DT 4646E
	1 x SAT C - JRC NDZ-127C
	MF/HF - SAILOR HC4500B
	VHF - JRC JHS-31
	JUE - 45A JRC
	1 x SEA-TEL KU BAND VSAT
A Frame	35 tonne SWL (Sea State 5)
	Plough tow winch SWL 100T
Cranes	1 x Forward (Hydralift) 2.0T @ 10.0m
	1 x Forward (Hydralift) 5.0T @ 10.0m
	2 x Aft (Manufacturer Hydra lift)
	10T @ 8.0m, 2T @ 18.5m
	Tugger Winches 4 x 2T SWL
CABLE LAYING EQUIPMENT	
LCE	21 wheel pair Linear Cable Engine (Dowty)
Cable Drum	Electrically driven cable drum with fixed angled pay out
Diameter	4m
Pull Load	40 tonnes/ knot
Brake Load	40 tonnes
Drum Speed	6.6 knots max
	- 4 wheel pair Hydraulic Drive DO/HB unit, with a hydraulic cable diverter.
	- 1 x 2 wheel pair Dowty Hydraulic - Drive Cable Transporter

	- 1 x 2 wheel pair Dowty Electric - Drive Cable Transporter
	- 2 x 1 wheel pair Dowty Hydraulic Drive Cable Transporter (In line)
Repeater Stowage	3 temperature controlled repeater stacks situated adjacent to each main cable tank. Total repeater capacity of 135.
ROV	
• A 2000m depth rated work class ROV side launched	
• An optional observation class ROV is provided from a deck mounted A-Frame	

CS Sovereign

Owner	N/A
Contractors:	Statnett
Specifications:	
MAIN DIMENSIONS & PERFORMANCE	
Builders:	Van de Geiessen-de Noordm, Netherlands
IMO Number:	8918629
ABS I.D:	91143143
Call Sign:	MNNU8
Port of Registry:	Southampton (British)
Length Overall:	130.70 metres (inc. gantry)
Length Between Perpendiculars:	116.68 metres
Breadth Moulded:	21.00 metres
Depth Moulded (to Deck 4):	13.00 metres
Designed Draft:	7.014 metres
Deadweight:	7417 tonnes
Summer Draft:	2.508 metres
Gross Registered Tonnage:	11242 tonnes
Net Registered Tonnage:	3372 tonnes
Suez Tonnage:	12121.25 tonnes
Panama Tonnage:	12034.94 tonnes
Classifications:	ABS Ice Class 1C 14445 kw,AMS, ACCU, DPS2
PROPULSION & MACHINERY	
Propulsion and Electric Power Generation	6.6 KV Generating Sets
For Propulsion & services comprising:	2 x Stork Wartsila SW280 12 Cylinder 3.1 MWE at 750 RPM each
	2 x Brush Alternators 3.8 MVA @ 6.6 KV each
	1 x Stork Wartsila SW280 16 Cylinder 4.2 MWE at 750 RPM each
	1 x Brush Alternator 5.1 MVA @ 6.6 KV

Auxilliary Generator	For Harbour use only: 1 x Stork Wartsila FHD 240 G 6 Cyl 0.75MW at 750RPM
Bow Thrusters	2 x Ulstien Type 375 TV-C, variable pitch, (Motor output each 1.0 MW) Max Lateral Bow
	Thrust 2 x 14 tonnes
Azimuth Stern Thrusters:	2 x Lipps Type S2514 LSCP 360° azimuth thrusters each with a nozzle
SPEED AND FUEL CONSUMPTION	
Fuel Consumptions:	95% max capacity, 1108 Tonnes Marine Gas Oil (Max Lift, No reserve allowed)
Economic Speed:	9@12.5 tonnes/day
Max Speed:	12.5@28 tonnes/day
Endurance:	30 days at 12 knots
CARGO CAPACITY AND AVAILABLE DECK AREA	
Main Cable Tanks	2
Internal Diameter:	17.00m
Cone Outer Diameter:	3.00m
Tank Height:	8.00m
Cone Height:	6.5m
Maximum Load per Tank:	Equating to 2668 tonnes each
Tank Top Loading:	15 tonnes/sq m
Volume of Cable Tanks:	1327 cubic metres
Main Wing Tanks:	2
Internal Diameter:	6.60m
Cone Outer Diameter:	2.45m
Tank Height:	8.00m
Cone Height:	6.60m
Maximum Load per Tank:	2668 tons
Tank Top Loading:	15 tonnes/ sq m
Volume of Wing Tanks:	199 cubic metres
TANK CAPACITY	
Fresh Water Capacity:	720 tonnes
Fresh Water Usage:	Approx. 15 tonnes/ day
ACCOMMODATION	
Total Berths:	76
Officer Cabins:	13
Crew Cabins:	23 x Single, 19 x Double
Representative Suites:	2
Hospital:	2 Berth Hospital (Deck 5)
NAVIGATION & COMUNICATION EQUIPMENT	
Radars:	2 x Kelvin Hughes Nucleus 6000A ‘X’&‘S’ Band Interchangable
Navigation Receivers:	2 x Leica Mk412 DGPS
	1 x Racal Skyfix Decoder 90938
	2 x JAVAD dual GPS GLONASS DGPS Rxs
Gyro Compasses:	2 x Sperry SR-220
	1 x Sperry Navigat X Mk2

Echo Sounder:	1 x Marconi International Marine Seachart 3 (0 - 1200 Metres)
	1 x Honeywell Elac LAZ 4400 (0-15000 metres) with wide beam transducer
DP Vertical Reference Units:	2 x units
DP Acoustic Reference System:	1 x Sonardyne System
DP Taut Wire Reference System:	2 x CEGELEC units - max operating depth approx. 300metres
DP Artemis Reference System:	1 x Artemis Mk 4 - ships station only. Cyscan Reference System: 1 x Cyscan short range ref system (hired in) (mobilised as required)
NavTex:	1 x ICS Nav 5 NAVTEX
Satcom:	1 x SAT C
	2 x SATCOM B
	1 x SEA-TEL KU BAND VSAT
	Fitted with 'Navigator' survey spread for instant & accurate position referencing and post processing capability to meet all clients needs.
CRANAGE	
A Frame:	35 tonnes
ROV Crane SWL:	1 x Fassi Retractable Crane. 1.0 tonnes @ 10.10m, 5.57 tonnes @ 2.54m
Forward Cranes:	1 x 5 tonne @ 20m, 2 x Gantry Hoists (5 Tons Each)
Aft Cranes:	2 x 2 tonne @ 6m
CABLE LAYING EQUIPMENT	
Forward Machinery:	2 x Hydraulic Powered Drums & 4 Wheel Pair Haul-off gear.
Drum Diameter:	3.50m
Drum Speed:	12.6km/hr @ 25kN
Pull Load:	400kN @ 2.5km/hr
Haul-off Gear:	4 Pair Opposed Wheel unit. Variable tension 0 to 4 tonnes
Cable Transporters:	1 x Hyrdaulic Powered 2 Wheel Pairs - 2 tonne pull, 1 x Hydraulic Powered single Pair
Aft Machinery:	1 Hydraulic Powered Drum & 6 Wheel Pair Haul-off gear.
Drum Diameter:	4.00m
Drum Speed:	14.4km/hr @ 20kN
Pull Load:	200kN @5.4km/hr
Haul-off Gear:	Electrically Powered 6 Pair Vertical Wheel unit. Variable Tension 0 to 4 tonnes.
Auxilliary Haul-off gear:	Dowty 2 Pair Vertical, Hydraulic Powered machine 1.5 tonne pull.

Repeater Stowage 90 with Portable Stacking	
ROV	
ROV:	PowerfulTrenching/World class Atlas 1
MISCELLANEOUS	
Certification of Financial repsonsibility - Water Pollution	

North Ocean 102

Owner	Oceanteam/Mcdermott
Contractors:	Oceanteam/ABB
Specifications:	
MAIN DIMENSIONS & PERFORMANCE	
Vessel	102
Type	Cable & Umbilical lay vessel
	Construction Support Vessel
Delivery	On Schedule
Year Built	2009
Length OA	137m
Length BP	120.4m
Beam	27 m
Draft Max	6.85m
Depth Main Deck	9.7m
Speed fully loaded	15 knots
Deadweight	10000 tons
PROPULSION & MACHINERY	
Propulsion:	2 x 3500 kW c.p.p. Azipull aft
	1 x 1500 kW Retracktable Azimuth c.p.p. forw
	1 x 1500 kW SS Tunnel Thr. c.p. forw.
	1 x 1500 kW SS Tunnel Thr c.p.p. forw.
DYNAMIC POSITIONING SYSTEM	
Mark	Kongsberg Maratime K-Pos 21
Class	DnV Dynpos-AUTR complies NMD class 2
CARGO CAPACITY AND AVAILABLE DECK AREA	
Product capacity	7000mtons
Deck space	2400m^2
Deck Strength	10 tonnes/m^2
Deck Hatches	two 4x3m, one with coaming
ACCOMMODATION	
Accommodation	199 people

CAPSTANS AND MOORING WINCHES	
Deck Winch	140 tonnes SWL, wier rope
CRANAGE	
Main Crane	Knuckle Jib Crane Aftships, PS 100 tonnes AHC @ 6m 25 tonnes @ 32m
Auxiliary	10 tonnes @ 34m
Provision Crane	S.W.L. 2 tonnes @12m
HELIDECK	
Helideck	D-Value 20.88m
MISCELLANEOUS	
Moon pool	7.2 / 7.2 m
Product collection	Rapid product loading, state of the system Large product carrying capacity (5000t/7000t) High transit speed fully loaded, 15 knots DP2, weather operability sea state
Stabalizing Equipment	Two passive roll reduction tanks one ant heating systems
PROJECTS	
Project STATOILHydro GJØA	
Britned	
CICSA (Oil and Gas)	

Stemat Spirit

Owner	vsmc
Contractors:	Global Marine
Specifications:	
MAIN DIMENSIONS & PERFORMANCE	
Type of vessel	DP2 special service workboat
Class	Bureau Veritas +Hull +Mach +AUT UMS +Dynapos AM/AT R Special Service Workboat - Unrestricted Navigation
Trading area	Unrestricted navigation
Flag	The Netherlands
Length over all	90,0 m
Moulded depth	6,5 m
Moulded Width	28,0 m
Maximum draught	4,70 m (7,00 m bow thrusters down)
Minimum draught approx.	1,90 m (4,20 m bow thrusters down)
Gross Tonnage	5.551 GT
Deadweight	6.901 ton
PROPULSION & MACHINERY	
Main engines	2x Caterpillar 3512HD
Stern thrusters	2x HRP 6111 azimuting thrusters 1140 kW
Bow thrusters	2x Caterpillar 3512B 2x HRP 6111 retractable azimuting thrusters 1118 kW
	1x Electric driven tunnel thruster 650 kW
Auxiliary / Generators	3x 850 kW Parallel running/PM System
Emergency/Harbour generator	1x 200 kW
DYNAMIC POSITIONING SYSTEM	
Regulatory approved	BV Class AM/AT R
SPEED AND FUEL CONSUMPTION	
Speed (maximum with minimum draft)	Approx. 10 knots
Fuel oil capacity	Up to 1.400 m3
Fuel consumption	Subject to kind of work
CARGO CAPACITY AND AVAILABLE DECK AREA	

Open deck space	1.500 m2
Deck strength	15 ton / m2
TANK CAPACITY	
Fresh water maker plant	2x 12 m3/hr
Fresh water tank capacity	Approx. 300 m3
Ballast system tank capacity	Approx. 2.000 m3
Ballast pumps	2x 400 m3/hr
ACCOMMODATION	
Single / Double cabins	28-Apr
Hospital (single)	1
Total number of beds / POB	60
Air-conditioning / electric heating	
Client office	2
Conference room	1
Deck store	2
NAVIGATION & COMUNICATION EQUIPMENT	
Magnetic Compass	Cassens & Path Reflecta 1
Satellite communications	Seatel VSAT 4006
DGPS navigator	2x Furuno GP-150D
Navigation echosounder	2x Furuno FE-700
Marine radar	1x Furuno FAR-2117/1xFuruno FAR-2137S
Speedlog	Furuno DS-80
Gyro compass	1x Anschutz Standard 22 G/GM + 2x Anschutz Standard 22 Compact
AIS system	Furuno FA-150
VHF radiotelephone Transceiver	3x Furuno FM-8800S
MF/HF radiotelephone Transceiver	Furuno FS-1570
Inmarsat C terminal	1x Furuno Felcom 15 + 1x Furuno Felcom 15SSAS
Inmarsat F terminal	1x Thrane-Thrane F33
Navtex receiver	Furuno NX-700
Windsensor	2x Observator OMC-160
Position Reference Systems	Glonass Javad LGG100 Fanbeam MDL Fanbeam 4.2 GPS Trimble DSM-232
Vessel Control System	L-3 NMS6000, comprising:
	Class 2 Dynamic Positioning System, Thruster Control System, Environmental and Position Reference Sensors
GMDSS portable VHF transceivers	3x Jotron TR-20
Epirb	Jotron Tron-40S
Radar transponder	2x Jotron Tron Sart
GSM telephone	Sagem RT-3000
Satellite TV system	Seatel 5004
Voyage Data Recorder (VDR)	Danelec DM-500
Chart software	Transas Navigator Pro
LSA EQUIPMENT	
MOB / Lifeboat	1
Lifeboat	1
The vessel comply with Solas, IMO and Marpol requirements	
CAPSTANS AND MOORING WINCHES	
6 Point Mooring System	6x 60 ton pull/100 ton hold full C.T.

CRANAGE	
Hydraulic deck crane	18 ton at 14 m (hook) / 15 ton at 16 m single line (winch)
ANCHORS	
Anchor wires	6x 1.000 m / 48 mm
Anchors	6x SSHP anchor 7 tonnes
MISCELLANEOUS	
Sewage treatment plant	
Incinerator	25 kg/hr
PROJECTS	
Walney 1Offshore Wind Farm	

M/V “ELEKTRON"

Owner	N/A
Contractors:	Statnett
Specifications:	
MAIN DIMENSIONS & PERFORMANCE	
Type:	Roll-on / Roll-off Carrier
Class DnV	1A1 ICE-C General Cargo Carrier RO/RO E0 DYNPOS-AUTR CLEAN
Certificates	World Wide, Solas, Load line conv. 1966 NMD.
Other	Vessel built: B.no 189 2008 Flekkefjord Slipp & Port of registry : Drammen Flag : Norwegian
Length o.a	87.35 m
Length p.p	82.55 m
Breadth	18.00 m
Depth	4.80 m
Depth Mld 1st deck	6.50 m
GT (ITC 69)	3205 t
NT (ITC 69)	961 t
GWT	3514 t
PROPULSION & MACHINERY	
Main engines	1 x 1825 kW Caterpillar 3516 B engine 2 x 1360 kW Caterpillar 3512 B engines
Main Propulsion	2 x Rolls Royce Aquamaster 1200 kW
Thruster	2 x Rolls Royce Bow-thrusters 883 kW
SPEED AND FUEL CONSUMPTION	
Consumption	Approx. in standby : 1,2 – 1,5 m³ / 24 hours Max speed : 14.0 m³, 12 knots / 24 hours Service speed : 9.0 m³, 10 knots / 24 hour
Speed	Max : 12.0 knots
	Service : 10.0 knots

CARGO CAPACITY AND AVAILABLE DECK AREA	
Cargo deck area	890 m^2
Cargo deck length	60 m
Cargo deck load	2000 t
TANK CAPACITY	
Water ballast pump	2 x 300 m3
Fuel oil	430 m3
Fresh water	240 m3
Water ballast	2850 m3
ACCOMMODATION	
Accommodation	Total 21 cabins (9 crew and 12 passenger cabins)
	Total 32 beds (9 crew and 23 passenger bed)
	Very good facilities for the crew. Max. 34 people.
NAVIGATION & COMUNICATION EQUIPMENT	
Navigation equipment	1 x JRC 10 cm Radar.
	1 x JRC 3 cm Radar
	2 x Meridrian Standard Gyro compass
	1 x JRC JLR-10 GPS compasss
	1 x Kongsberg K-Pos DP2
	1 x Northstar MX500 D-GPS
	2 x Simrad CS68 ECDIS
	1 x Simrad AP50 Autopilot
Communication equipment	Vingtor intercom and ascom (portable)
	GMDSS A3 JRC Radio station
	2 x McMurdo 9 Ghz SART
	2 x E5 Smartfind Cospas - Sarsat EPIRB
	3 x Jotron Tron TR20 VHF porable
	9 x Motorola GP340 UHF portable
	1 x JRC NCR-333 Navtex
	1 x JRC JHS 182 AIS
	Sealink Phone, email an fax
CRANAGE	
HMC 1800 LK 50-30	5 t x 30 m
MISCELLANEOUS	
QA – Requirements	ISM certified
	ISPS certified
	ISO-9001:2000 certified
	ISO-14001:2004 certified
STERN RAMP	
Length	16 m
Breath drive-way	9.6 / 11.4 m
Frame (height / breath)	10 m / 11.4 m
Max load on ramp	500 t

CS Sovereign

Owner	N/A
Contractors:	Elettra TLC SPA
Specifications:	
MAIN DIMENSIONS & PERFORMANCE	
Flag	Italian
Base port	Catania (Italy)
Classification	R.I.Na. * 100 - A - 1.1. MNPe Pcv CNP ELI – IAQ1 –IPD-2
Built/year	1996
Length overall	111.5 m
Length between perpendiculars	95.0 m
Breadth, moulded	19.0 m
Max. draft	6.5 m
Max speed	14 kts
Bollard pull	60t
DYNAMIC POSITIONING SYSTEM	
Dynamic position system	Kongsberg SIMRAD ADP 702
CARGO CAPACITY AND AVAILABLE DECK AREA	
Load Capacity	2,500 t (Note: SOIB requires a load of 4500 tons)
ACCOMMODATION	
Accommodation	68
CAPSTANS AND MOORING WINCHES	
SMD Towing winch system fitted with 4,000m of 40mm diameter tow wire	SWL: 55t on brake Max speed 30m/min @ 10t 8m/min @ 35t
CRANAGE	
SMD A-Frame with plough stabilizing and docking system	Lifting capacity SWL 30t
MISCELLANEOUS	
PLOUGH HANDLING AND TOWING EQUIPMENT	
PROJECTS	
ATTICA-MILOS-CHANIA - Lay	
MECMA - Repair n.8 "IC-1 Seg.9; Seg.6" + PLIB	

JANNA - Lay Seg.2 + PLIB
JANNA - Lay Seg.1 + PLIB
MECMA - Repair n.1 "Crete-Karpathos"
MECMA - Repair n.8 "Licata-Linosa"
OTE - Lay "Kerkira-Plataria" and "Patmos-Samos"

ASEAN Explorer

Owner	N/A
Contractors:	Asean Cableship
Specifications:	
MAIN DIMENSIONS & PERFORMANCE	
Length Overall	141.93 meters
Breadth Moulded	23.0 meters
Depth Main Deck	12.5 meters
Design Draft	7.5 meters
Scantling Draft	8.0 meters
Freeboard at Design Draft	5.0 meters
Classification	Lloyds Register + 100A1 +LMC UMS DP (AA) CG
PROPULSION & MACHINERY	
Speed at Design Draft	14.5 knots
Endurance	60 days
Bollard Pull	More than 100 tons
Propulsion Plant	Two (2) Azimuth Thrusters of 3700 KW each
Bow Thrusters	Three (3) Tunnel Bow Thrusters of 1700 KW each
Main Engine	Four (4) sets, 3240 KW each.
Aux Engine	One set, 1325 KW
DYNAMIC POSITIONING SYSTEM	
Dynamic Positioning System	Duplex System (100% redundancy)
CARGO CAPACITY AND AVAILABLE DECK AREA	
Main Cable Tank 3 off each	15.5 meters
Spare Cable Tanks 2 off each	6.0 meters
Cable Deadweight	5760 tons (excluding spare tanks)
Cable Stowage Volume	3600 m3
ACCOMMODATION	
Accommodation	70 persons single berth en suite cabin
CABLE LAYING EQUIPMENT	

Cable Engine	Two drum engines, 40 tons, 4 meters in diameter and 21 wheelpair linear cable engine.
Cable Transporters	Two, 2 tons
Stern Sheaves	2 x 4 meters sheaves
Sub Sea Plant	
ROV	
ROV Capability	The vessel is equipped with space, power and other ancillary services for the future deployment of a work-class ROV system.

ASEAN Restorer

Owner	N/A
Contractors:	Asean Cableship
Specifications:	
MAIN DIMENSIONS & PERFORMANCE	
Length Overall	131.4 meters
Breadth moulded	21.8 meters
Depth Main Deck	11.5 meters
Draft (Design)	6.5 meters
Gross Registered Tonnage GRT	11,156
Net Registered tonnage NRT	3,346 tons
Lightweight	5,846 tons approx.
Deadweight	4,825 tons at 6.3m draft
Classification	Lloyds Register + 100A1 +LMC UMS DP (AM) CG
PROPULSION & MACHINERY	
Bollard pull	80 tons
Speed	16 knots
ACCOMMODATION	
Accommodation	80 persons single berth with facilities
CARGO CAPACITY AND AVAILABLE DECK AREA	
Cable Storage Volume	1,361 cu m

CS Teneo & CS Global Sentinel

Owner	Tyco Telecommunication
Contractors:	Tyco Telecommunication
Specifications:	
MAIN DIMENSIONS & PERFORMANCE	
Vessel Particulars (Reliance Class)	
Year Built	2001-2003
Range	25000 nautical miles or 60 days
Service Speed	14 knots
Length Overall	140m
Molded Beam	21m
Deep Draft	8.4m
Gross Registered Tonnage	12,184
Deadweight	9200 MT
Classification	ABS + ACCU, +AMS, +DPS-2, NBLES, UWILD
PROPULSION & MACHINERY	
Type	Diesel Electric
Main Engines	5x KRGB-9 Bergen 1990kW each
Forward Bow Thruster	1x Ulstein-1700 kW/0-900 RPM
Aft Bow Thruster	1x Ulstein-1700 kW/0-1800 RPM
Azimuthing stern Thruster	2x Ulstein-3100 kW/0-720 RPM
DYNAMIC POSITIONING SYSTEM	
Dynamic Positioning	Kongsberg Simrad SDP 21 DP system
CARGO CAPACITY AND AVAILABLE DECK AREA	
Cable Capacity	5465.5 MT (total for 3 tanks)
Tope Tank Capacity	107 MT
TANK CAPACITY	

Fresh Water	440.5 MT
Fuel Oil	3242.9 MT
Water Ballast	4403 MT
ACCOMMODATION	
Accommodations	80
CRANAGE	
After Deck Cranes	2x10 ton SWL
Mobile Cable Transporters	3x1.5 tons (T-2000)
CABLE LAYING EQUIPMENT	
Stern Linear Cable Engine	1x ODIM, 20 wheel pair, 16 ton capacity
Stern Drum Cable Engine	2x Kley France (ODIM), 4m diameter
	30 ton lifting capacity
Dynamometers	WAMAC roller type and load cells
Draw Off/ Hold Back	2x ODIM, 4 wheel pair, 4 ton capacity
Stern Sheaves	3x3.5m diameter
ROV	
ROV	Perry Tritech-Triton ST200 Series
Sea Plow	EB3/ SMD MD3
MISCELLANEOUS	
Automation Control	S.V.C
Software Tools	WinFrog, Makai
Note: The CS Teneo and CS Global Sentinal are sister ship and have indentical specification (Reliance Class), there other sister ships include:	
CS Global Sentinel	
BC Teneo	
CS Tyco Reliance	
CS Tyco Responder	
CS Tyco Resolute	
CS Tyco Dependable	
CS Tyco Decisive	
CS Tyco Durable	

Emerald Sea (Formerly the Maersk Defender)

Owner	McDermott International
Contractors:	McDermott International
Specifications:	
Flag	Danish
Construction year	1996
Conversion year	N/A
Length, overall	96,00 m
Breath	20,00 m
Draught	8,40 m
Deadweight	7960 t
PROPULSION & MACHINERY	
Bollard pull	100 t
Generator capacity	2x600 kW, 2x2400 kW shaft generators
Thrusters	2x736 kW, 1x1100 kW, 1 Azimuth 883 kW
Propulsion	: 2 x 3520 kW
SPEED AND FUEL CONSUMPTION	
Transit speed	16,0 knots
CARGO CAPACITY AND AVAILABLE DECK AREA	
Cable tank capacity	2 x 2500 t + 2 x 500 t
Repeater storage	2 x 56 units
CABLE LAYING EQUIPMENT	
Cable machinery	1 x LCE 20-WP 20 t + 1 x CDE 4,0 m 25 t
ROV	
Type of plough	SMD (installation only)
Type of ROV	CMR4, 300 kW, 1000 m depth, 1,5m burial
MISCELLANEOUS	

Former cable lay ship, was purchased by Secunda (sub company of McDermott International in 2006 and converted to a subsea support ship. The ship has been upgraded in late 07 with additional living quarters, moonpool, a helideck and a 100t subsea crane.

Giulio Verne

North Ocean 102

CS Global Sentinel and CS Teneo

Teliri

Emerald Sea

Team Oman

Skagerrak

M/V “ELEKTRON"

ASEAN Explorer

Stemat Spirit

Cable Innovator

CS Sovereign

ASEAN Restorer

* From my research the six vessels listed are the most suitable from the job of installing the cable in SC
* Thought may also be given to Vessels of Global Marine's Fleet: CS Sovereign,Cable Innovator,Cable
* Thought may also be given to Tyco Telecommunications Fleet: CS Tyco Reliance,CS Tyco Responde
*Thought may be given to Ile De Batz, and Ile De Sein of Alcatel
*Statnett's M/V Electron was converted to Cable lay vessel in 2009
http://www.shipspotting.com/modules/myalbum/viewcat.php?pos=510&cid=38&num=10&orderby=hitsA

BI
Networker (Barge), Wave Sentinel
er,CS Tyco Resolute,CS Tyco Dependable,CS Tyco Decisive,CS Tyco Durable,CS Global

Intresting site

Appendix V- Skagerrak Information

C/S NEXANS SKAGERRAK

OWNER: NEXANS SKAGERRAK AS
(A wholly-owned subsidiary of Nexans Norway AS)

NOTE. **The vessel was extended 12.5 metres by mid April 2010. The vessel data has therefore been updated.**

GENERAL

C/S NEXANS SKAGERRAK is specially built for laying and repair of heavy submarine power cables. The main features are the 7000 tonnes and 29 m diameter turntable and purpose designed cable laying gear based on a cable capstan and linear engine combination with a 5 m cable radius throughout.

The fully redundant dynamic positioning system allows C/S NEXANS SKAGERRAK to operate close to offshore structures and perform accurate cable laying operations.

Nexans

THE VESSEL

GENERAL

IMO NO:	7619458
Call sign	LCEK

CLASSIFICATION

Classification society:	DNV
Class	✠1A1 MW. EO. Cable Laying Vessel DYNPOS AUTR. Unrestricted trade
DNV ERN	99.99.99
Flag	Norwegian (NOR)

THE HULL

Gross Tons (GT):	7382	(ITC 69)
Net Tons (NT):	2214	(ITC 69)
DWT:	7150	
Length of hull:		
- over all length:	112.25 m	(368.2 ft.)
- incl. laying sheave:	118.50 m	(389.8 ft.)
Total width:	32.15 m	(105.5 ft.)
Depth moulded:	8.00 m	(26.2 ft)
Draught at 7150 DWT.:	5.40 m	(17.7 ft.)
- incl. stern propellers:	6.17 m	(20.2 ft.)
- bow propeller lowered	8.13 m	(26.7 ft.)
Deck load:	10 tonnes/m^2	
Ballast capacity:	5948 tonnes	
Speed, approx.:	10 knots	

PROPULSION MACHINERY

Stern thrusters:		
- steerable, port side:	1943 kW	(2640 HP)
- steerable, starb. side:	1943 kW	(2640 HP)
- steerable, center:	1000 kW	(1360 HP)
Bow thrusters:		
- steerable, center:	1820 kW	(2475 HP)
- tunnel:	957 kW	(1300 HP)

AUXILIARY ENGINES

Motor generators:	380 V, 50 Hz
Number of generators:	5

Capacity:	4 x 500 kVA 1 x 600 kVA

ACCOMMODATION FACILITIES

Single berth cabins:	60
Double berth hospital:	1
Accommodation container(s):	Option

ELECTRONIC EQUIPMENT

NAVIGATION EQUIPMENT

Radar, 3 cm and 10 cm.
Gyros
Echo sounding equipment.
Satellite navigation.
Doppler log.
Autopilot.

SURFACE REFERENCE SYSTEMS

Differential GPS
Differential GPS/GLONASS
IALA
UHF
Fanbeam

UNDERWATER POSITION REFERENCE SYSTEM

Kongsberg Simrad HIPAP 500

DYNAMIC POSITIONING EQUIPMENT

Kongsberg Simrad SDP 521

NAVIGATION BACK-UP AND DATA LOGGING SYSTEM

Fugro software.

COMMUNICATION EQUIPMENT

Marine Radio System.
VHF-stations.
Mobile VHF and UHF stations for the cable operations.
Closed circuit TV-system.

CABLE LAYING MACHINERY

ELECTRICALLY DRIVEN TURNTABLE

Outer diameter:	29 m
Inner diameter:	12 m
Load capacity:	7000 tonnes
Max. speed:	1.2 r.p.m.

PICK-UP ARM

Min. bending diameter:	9 m
Max. opening	400 mm

PRETENSIONER

Duplex belt caterpillar	
Number of units:	1
Pulling/braking force:	max. 2 tonnes
Pick-up/pay-out speed:	max. 70 m/min.
Belt squeezing force:	0 - 4 tonnes
Belt opening:	30 - 350 mm
Contact length:	1000 mm

CABLE CAPSTAN

Drum diameter:	10 m
Pulling/braking force:	max. 47 tonnes
Laying speed:	max. 60 m/min.
Heaving speed:	20 m/min. at max. cable tension.

LINEAR CABLE ENGINE

Number of wheel-pairs:	12
Wheel dimensions:	18" x 7"
Pulling/braking force:	max. 8.5 tonnes
Breaking force, intermittent	max. 10.0 tonnes
Laying speed:	max. 50 m/min.
Heaving speed:	max. 25 m/min.

LAYING SHEAVES

Starboard, outer diameter:	10 m
Port, outer diameter:	5 m

CABLE REPAIR WINCH

Low pressure hydraulic winches with separate wire drums, for cable repair.	
Number of units:	2
Wire dimension:	38 mm
Wire length:	3000 m
Pulling force:	max. SWL 30 tonnes

MOORING CAPSTANS

Two speed electrically operated capstans.	
Number of units:	4
Pulling force:	max. 10 tonnes each
Low pressure hydraulic capstans on forecastle.	
Number of units:	2
Pulling force:	12 tonnes
Speed:	max. 42 m/min.

MAIN ANCHOR WINCHES

Number of units:	2
Pulling force:	12/20 tonnes each
Length of chain:	550 m
Anchor weight:	4.59 tonnes each

CRANES

HYDRAULIC CRANES ON CABLE REPAIR DECK

Number of units:	3
Boom length:	16 m
Lifting capacity:	SWL 5 tonnes each

A-FRAME

Lifting capacity:	SWL 40 tonnes

OTHER CRANES

Lifting capacity:	20 tonnes on 16 metres

MISCELLANEOUS

AUXILIARY EQUIPMENT

For a cable laying or a cable repair operation, C/S NEXANS SKAGERRAK can be equipped with the following auxiliary equipment:

- work boats.
- Subsea cable cutting and retrieving equipment
- Equipment for the cable testing and splicing operations.

The vessel has her own stores of equipment needed for laying or recovery operations and a mechanical work-shop equipped for various types of metal processing and repair work.

ROV

The vessel is equipped with a Remote Operated Vehicle (ROV) of type ARGUS Mariner XL as standard, in order to monitor the cable touch down point on the seabed, perform subsea intervention tasks or execute pre- and post-lay surveys.

TRENCHING

The vessel can be used as support vessel for various subsea tasks including cable and flowline trenching operations using the CAPJET waterjet based trenching systems developed by Nexans Norway.

VESSEL CAPABILITY PLOT

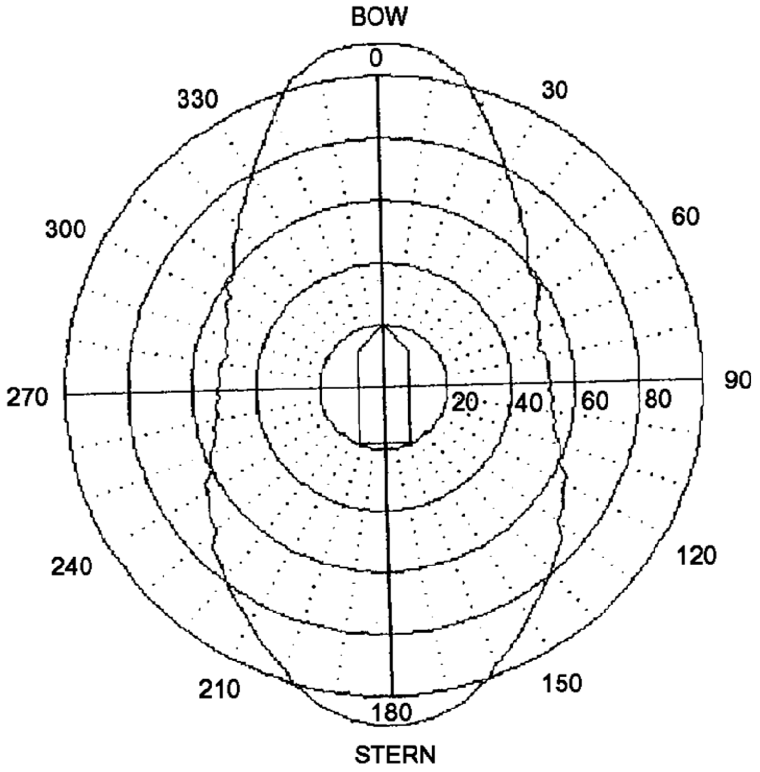
(New plot in progress)

A vessel capability plot shows the extreme weather conditions during which the vessel has enough thrusters force to maintain position. A capability plot for C/S NEXANS SKAGERRAK is presented below with the following conditions:

Current: 2 knots
Thruster force:

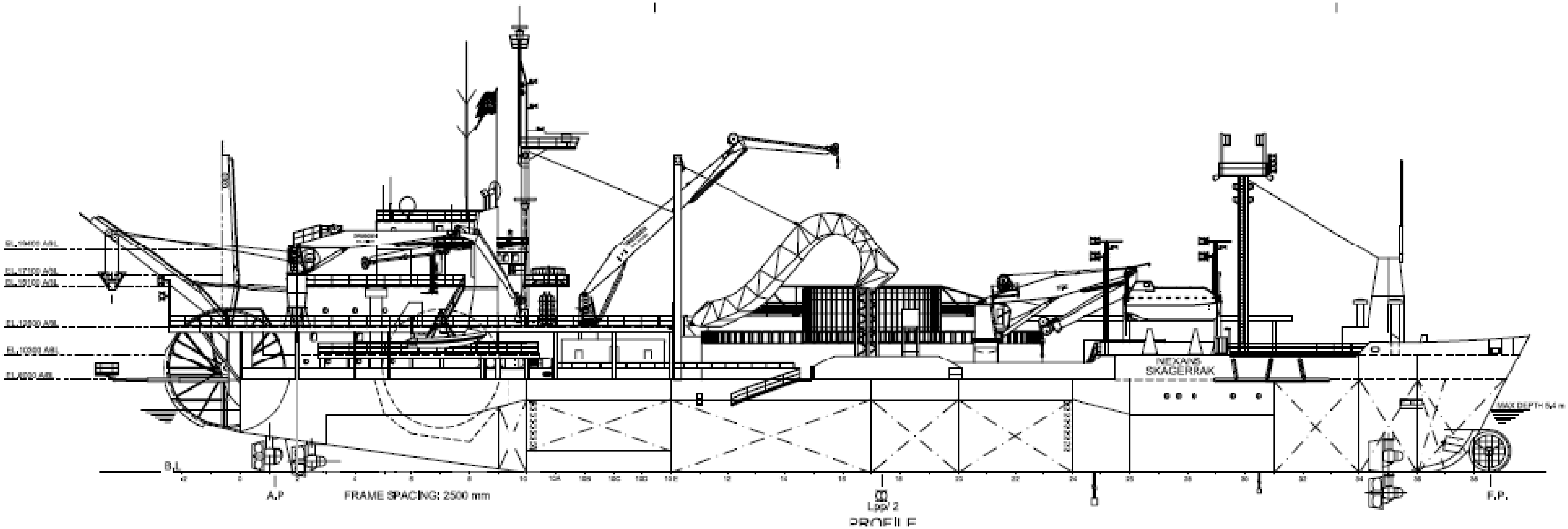
Thruster No	Positive Force (tonnes)	Negative Force (tonnes)
1	16.0	16.0
2	27.5	12.0
3	34.0	16.0
4	34.0	16.0
5	19.0	12.0

Environmental incident angle of wind, wave and current



Circles are wind speed in knots

GENERAL ARRANGEMENT
(Profile only)

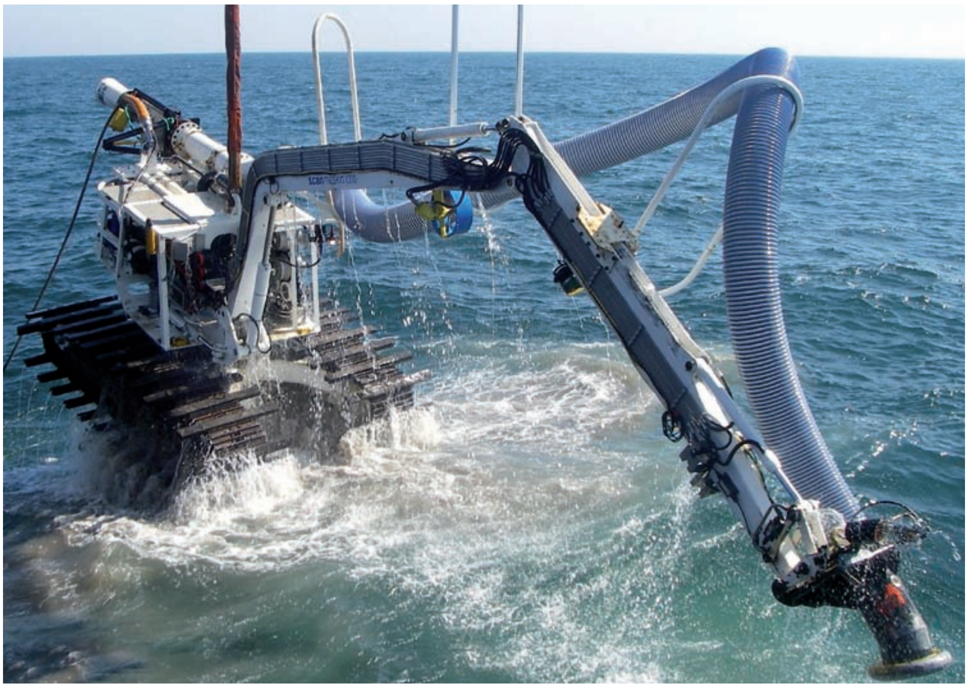


Appendix W- Scanmudring SCANmaskin Specifications

scanmaskin1000

Precision subsea excavator and tool-carrier

scanmudring



The Scanmaskin tool-carrying systems are designed for implementing dredging, excavator, cutting, and various other hydraulically operated tools. They have been successfully deployed in many deep, shallow, harsh water, high current, and low visibility underwater construction activities such as:

- Subsea precision excavation in connection with repairs, hot-tapping, pile cutting, and inspection
- Levelling and modification of seabed (rock dump, hard and soft clays, and soils)
- Rock dump, drillcut, boulder, and debris removal/relocation
- Pipeline and cable deburial, maintenance, location, and inspection
- Grouting removal
- Trenching tasks
- Assistance and preparation for installation and decommissioning of platforms and subsea assets
- Near shore programs (such as precision drilling in preparation for blasting and High Voltage cable repair)

The Scanmaskin subsea excavator and tool-carrier systems are based on modified excavators combined with state of the art ROV technologies with open tool interfaces. This combination harnesses the experience of both the advanced subsea technologies and the ruggedness of land based construction machines.

The Scanmaskin systems are designed for rapid mobilisation and opetation in water depths up to 1000m. A special monitoring system (MoS), enables safer operation and improved productivity in poor visibility applications. This is most valuable when operating close to live assets or in projects requiring the combination of power and precision.

The excavation capability in hard soil is excellent. Our hydraulic drum cutter has been successful tested on concrete slabs with hardness of about 15 MPa.

scanmudring
Ballastgt. 3
NO-4515 Mandal

Tel.: +47 38 27 80 30
Fax: +47 38 27 80 39
postmaster@scanmudring.no

www.scanmudring.no

scanmaskin1000

TECHNICAL SPECIFICATION

scanmudring

GENERAL

Name:	**Scanmaskin1000**
Manufacturer:	Scanmudring
Rov class:	Norsok ROV class IV
Type:	Tracked (bottom crawling) ROV system
Work capabilities:	Subsea construction and excavation work
Available tools:	12”, 14”, and 16” suction ejector systems Excavator and and special hydraulic operated tools (bucket, gripper, water jet, drill, cutter, blower, drum cutter, back flush) Excavator monitoring system (MoS) for accurate levelling and construction work Several configurations of arms and undercarriages available
Number of available units:	3 operational Scanmaskin 1000 complete systems available in several set-ups

DIMENSIONS AND WEIGHT

	No.1	**No.2**	**No.3**
Length* (m):	7.2	11.0	8.5
Width (m):	2.2	3.1	2.4
Height (m):	3.3	5.7	3.3
Weight in air (ton):	11	20	13
Manipulator reach (m):	5.5	11.0	6.5/9.5

* Stated dimensions in storage position with manipulator folded and with standard ejector.

OPERATING PARAMETERS

Operating depth (m):	5 - 1000	5 - 1000	5 - 1000
Relocation range:			
With standard ejector(rock) (m)	13	19	17
Drillcutting with exhaust hose (m)	13 + 50	19 + 50	17 + 50
With slurry pump (m):	NA	200	200
Water capacity (m^3/h):	1950	1950	1950
Max removal capacity (m^3/h):	95**	95**	95**
Navigation:			
Cameras: BW/Colour/low light:	3/1/1	3/1/1	3/1/1
Gyro:	1	1	1
MoS (excavation monitoring system), accuracy +/-5cm:	Yes	Yes	Yes

SHIPBOARD SUPPORT

LARS lift capacity (ton):	25	35	25
Deck space requirements***:			
Wooden landing area (m):	10x10	10x15	10x10
Umbilical winch (m):	4.5x2.2	4.5x2.2	4.5x2.2
Number of 20’ containers:	2	2	3
Number of 10’ containers:	N/A	1	N/A
Number of Baskets:	N/A	1	N/A
Space for spares/suction hoses (m):	12x2	12x2	12x2

Power supply requirements:	265kW, 440V, 60Hz, 250-400A, depending on tools fitted 12kW, 220V, 60Hz, 32-63A, depending on ambient temperature
Operators:	6 operators for 24hours operation supplied by Scanmudring.

** The removal capacity is heavily dependant on soil characteristics, ejector/pump sizes, and the operation conditions present at site. As a guideline about 5 per cent mixtures in water is possible when using the 12” to 16” ejectors, but the actual achieved capacity is normally lower. For project estimates a general removal capacity about 2-3 per cent should be expected. In order to achieve an efficient capacity, it is recommended to use an ejectors size about twice the average size of the items to be relocated.

*** Subject to system tool and project configuration. Different umbilical winches and container spreads will have an effect.

scanmudring

Ballastgt. 3, NO-4515 Mandal, Tel.: +47 38 27 80 30, Fax: +47 38 27 80 39, E-mail: postmaster@scanmudring.no
www.scanmudring.no

Appendix X- Cutting Grapnel

Cutting Grapnel

Asset no. GA 2-1 and 2-2

Cable Types: -	Lightweight and Armoured Cable
	Up to 100mm Diameter
Grapnel Dimensions: -	
Length	2.8m
Width	1.12m
Height	1.0m
Weight	1.85 Tonnes
Maximum Operating Depth	2000 Fathoms (3657m)
Operating Temperature	Minus 5C to + 50C
Storage Temperature	Minus 40C to + 50C
Power Pack Dimensions: -	
Length	1.0m
Width	0.8m
Height	1.2m
Weight	1.0 Tonne
Power Supply	3 Phase, 415V, 50 Hz
Oil Type	Tellus 32
Gas Type	Oxygen Free Nitrogen
Acoustic Receiver	114 or Equivalent
Pinger	138 or Equivalent

1 DESCRIPTION

Substantial accidental damage can be caused to submarine cables that need to be lifted from the sea-bed to a surface repair ship, particularly when there is insufficient slack in the cable to allow it to be lifted unbroken.

Cable and Wireless (Marine) have introduced the Cutting Grapnel as a simple and highly effective solution to the problem. It will cut the most heavily armoured communications cables at depths down to 2000 fathoms with only the minimum of disturbance caused to the cable line.

After being hydraulically charged the cutting grapnel is lowered to the sea-bed, to a maximum depth of 2000 fathoms and dragged across the cable line to the point where it hooks the cable. Progress of the 'catch' is monitored on the ship, as the grapnel has an in-built acoustic transmitter.

Once hooked, the previously charged hydraulic guillotine cuts through the cable. Because the cutting action is hydraulic and not by means of cable tension little disturbance is caused either to the cable itself or to the repeaters. Cuts can be made to all thicknesses of cable, from lightweight to heavily armoured.

Once the cut is made, the Cutting Grapnel is retrieved and two cable ends are lifted using conventional grapnels.

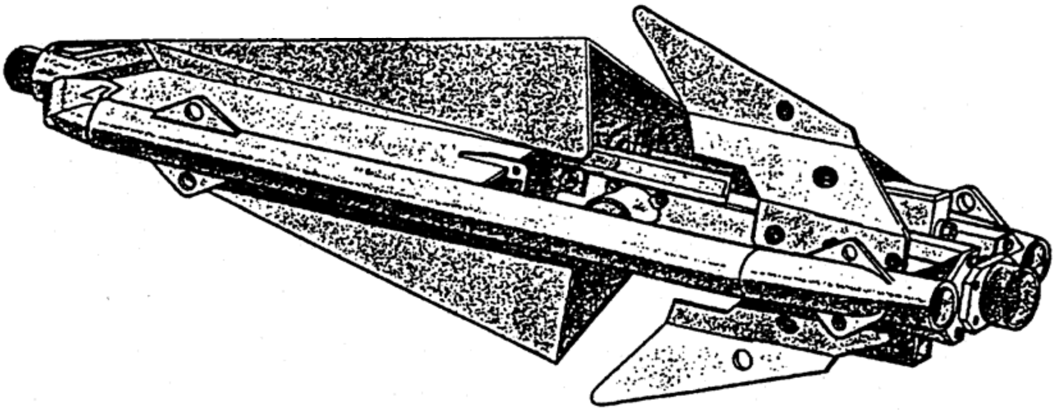


FIGURE 1 THE ACTIVE CUTTING GRAPNEL ASSEMBLY

1 General Description of Sonar Equipment

The pinger makes a noise which sounds like a very loud high-pitched 'ping' every few seconds. The hydrophone is an underwater microphone with a small built-in amplifier. It can hear the pings up to five miles away in water. The signal from the hydrophone is fed to the receiver and can be heard from its loudspeaker, seen as a blip on the screen.

While the grapnel is being towed searching for the cable (trawl mode), it pings every eight seconds at a frequency of 9.1 kHz. As soon as the cable is hooked it triggers the grapnel hydraulics and this switches the pinger to one every second, at a frequency of 9.6 kHz. Once the operation is complete the ping rate switches to one every four seconds at a frequency of 10.1 kHz.

*** Further reference should be made to the HSE Manual contained in Appendix A.**

1.2 Technical Data

Weight of Active Cutting Grapnel	1984.1 lbs	900 kg
Weight of Power Pack	2204.6 lbs	1 000 kg
Overall Length of Active Cutting Grapnel	85.98 ins	2184- mm
Maximum Height of Active Cutting Grapnel	32 ins	813 mm
Maximum Width of Active Cutting Grapnel	10 ins	254 mm
Length of Power Pack	56.1 ins	14254 mm
Height of Power Pack	55.1 ins	1400 mm
Width of Power Pack	39.37 ins	1000 mm
Power Supply	415 volts 3 phase 50 Hz	
Material	BS 4360	
Operating Temperature	-5° C to +50° C	
Storage Temperature	-40° C to +70° C	
Operating Depth	3657.5 m	2000 fathoms

Appendix Y- Nexans Skagerrak Cable Repair Specifications

GENERAL DESCRIPTION OF A REPAIR OPERATION
C/S " NEXANS SKAGERRAK"

This paper describes in general terms the operation for repairing submarine cables by using C/S NEXANS SKAGERRAK as repair vessel. Minor adjustments in procedure may occur due to local conditions.

A submarine cable repair operation starts by loading a sufficient length of spare cable into the turntable. Repair joints and repair crew are mobilised onboard. Grappling/cutting anchors and two repair bows are also included in the equipment.

The fault is previously pinpointed by fault location equipment, ROV, or divers and the vessel will sail to this location.

C/S NEXANS SKAGERRAK will stay in position above the cable damage. The existing cable will be cut and one end retrieved to the vessel. This may be performed by divers equipped with hydraulic compressing and cutting devices or by ROV equipped with special cutting tool. (Fig. 1). If the cable is buried a certain section of the cable has to be uncovered by water jets, suction or similar equipment before this operation starts.

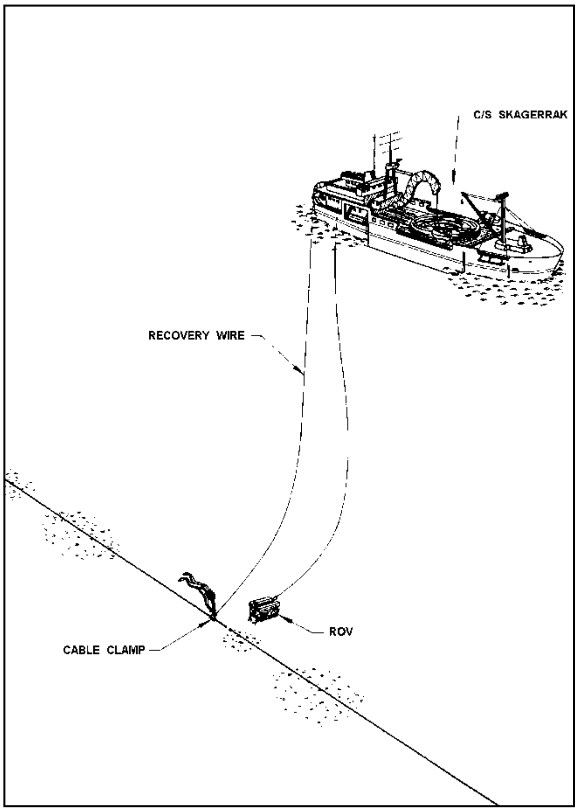


Fig. 1

It is essential that the ends of a paper insulated oil filled cable are properly compressed in order to minimise the oil leakage to the sea. In addition the winch wire is attached to the cable a certain distance from the cable end. During heaving the cable end is pointing downwards ("swan neck").

A winch wire is positioned through the caterpillar linear tensioner, the capstan and the linear cable laying machine. This wire is connected to the grappling anchor or to a cable clamp on the cable. The cable end is carefully brought to the surface as the vessel moves slowly backwards along the original route.

The cable end is carefully pulled in over the cable laying wheel, through the linear cable laying machine, over the capstan and through the caterpillar linear machine.

During the recovery operation the cable is visually inspected, and damaged cable is cut on the turntable. The cable end is then sealed and lowered down to the seabed with a steel wire connected to a surface buoy, for later recovery.

The other end of the cable is now being recovered and brought up to the vessel following the same procedure as for the first end. Damaged cable is cut on the turntable.

While the cable end is still in the cable guide above the turntable the spare cable is pulled on guides from the turntable through the repair deck on starboard side, around the repair bow (at the stern) up to the jointing room located at the port side of the vessel. The cable end is secured in the jointing room. (Fig. 2 & 3).

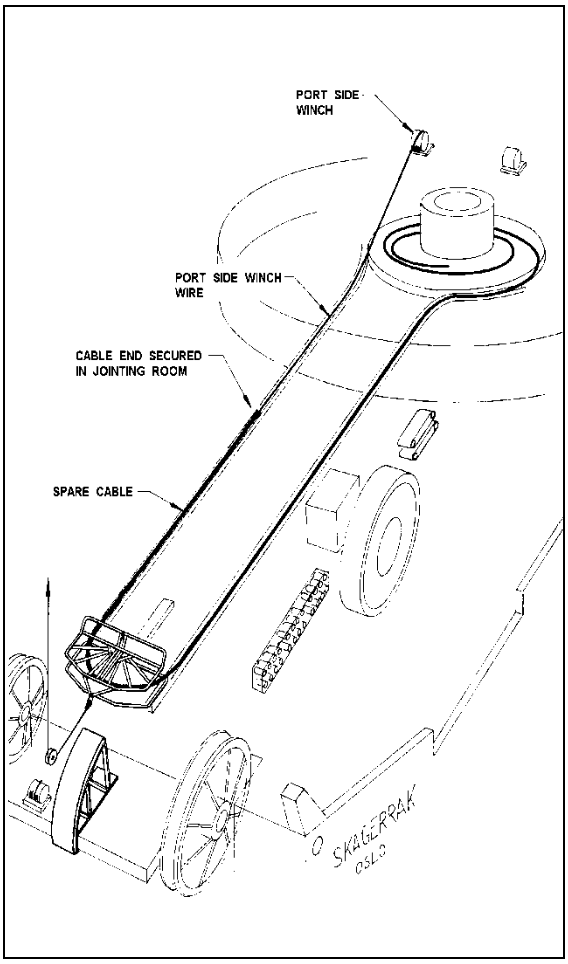


Fig. 2

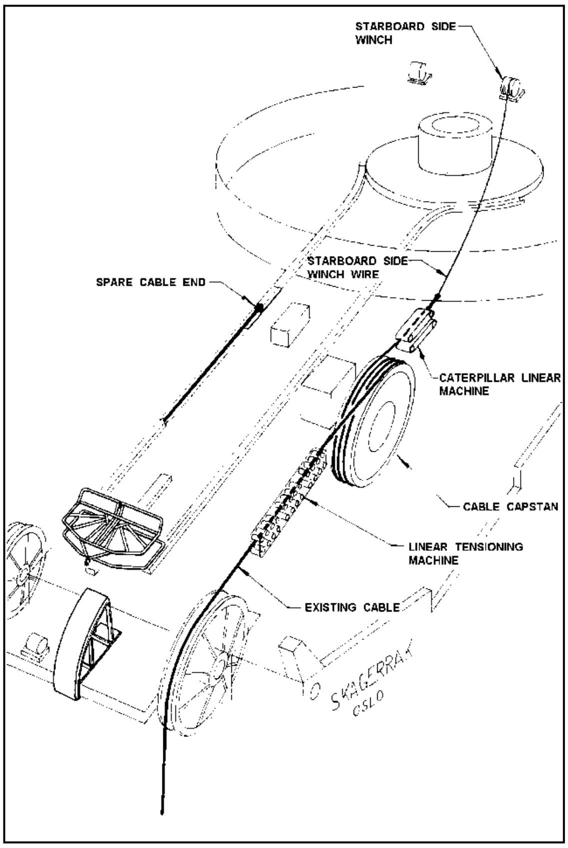


Fig. 3

The recovered cable is pulled around the turntable and into the repair room as C/S NEXANS SKAGERRAK recovers more cable while moving backwards. The operation stops when the cable end has reached the repair room. The cable is secured. (Fig. 4).

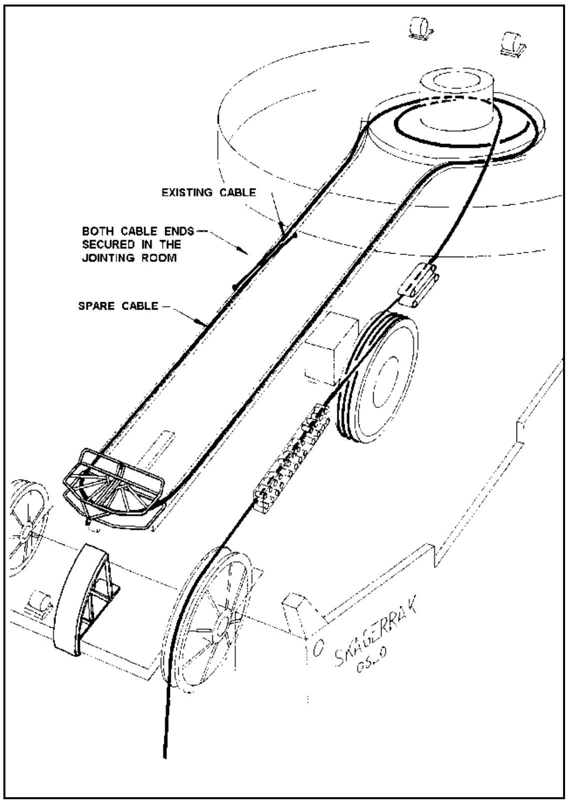


Fig. 4

The first cable joint between spare cable and existing cable is performed by skilled jointers. The jointing method depends upon the type of cable.

During the jointing work C/S NEXANS SKAGERRAK stays in position by DP.

Finishing the jointing work all supports that keep the repair bow in position, is released. The laying operation will commence, and the tension in the cable will pull the repair bow forwards. The operation stops when the bow has reached its end position nearby the turntable. The repair bow is lifted up and removed. All spare cable and the first repair joint are now placed on the turntable. (Fig. 5).

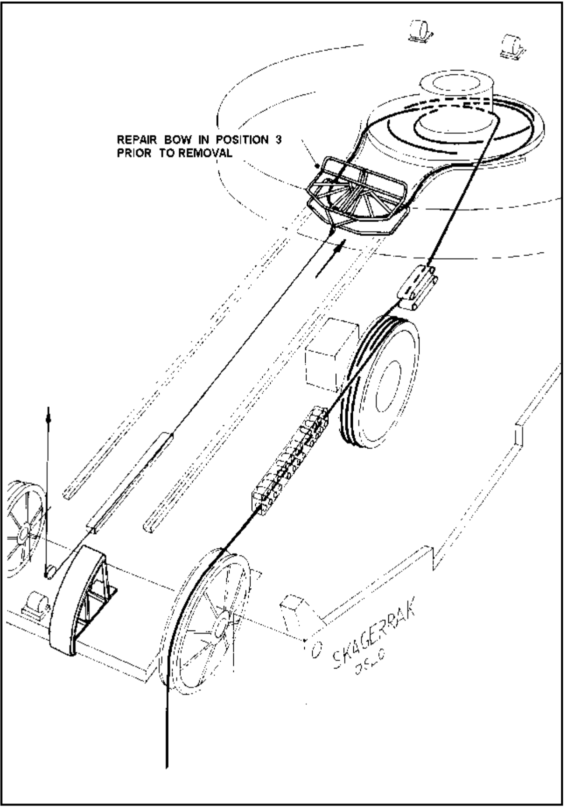


Fig. 5

C/S NEXANS SKAGERRAK continues to lay the cable along the original route until the vessel reaches the position above the second end of the existing cable.

The second cable end is retrieved. C/S NEXANS SKAGERRAK moves slowly forwards along the route and pays out more spare cable while the second end of the existing cable is carefully being pulled on board over the repair sheave. The operation stops when undamaged cable has reached the repair room and been secured.

The spare cable is cut and the ends sealed. The spare cable is paid out until the end has passed through the caterpillar linear machine and the cable capstan. The cable is pulled through roller guides from the linear tensioning machine and pulled over the repair bow (now located nearby the turntable) and back into the repair room. The cable end is secured. Both cables are now secured at the stern laying wheel and stern repair sheave respectively. (Fig. 6).

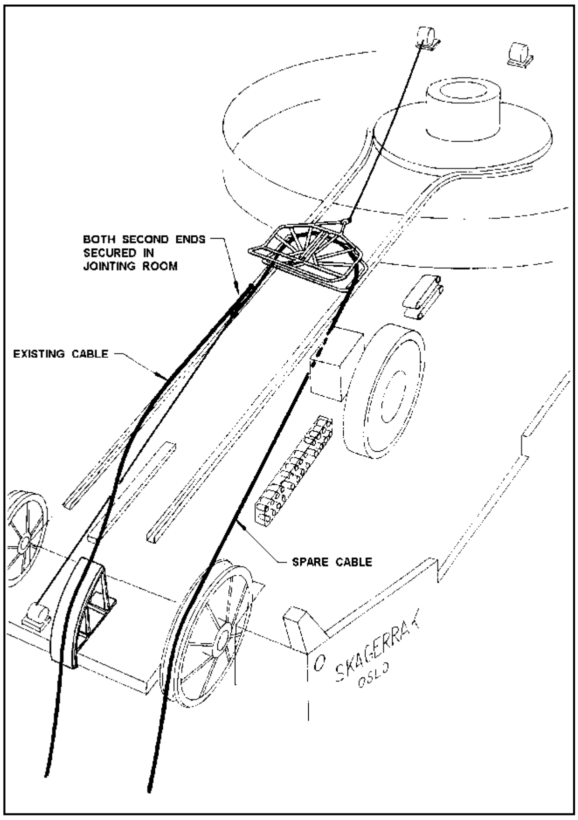


Fig. 6

The second joint between spare cable and existing cable is now being performed.

During the jointing work C/S NEXANS SKAGERRAK stays in position by DP.

When the second joint is finished the securing locks at the stern laying wheel and stern repair sheave are removed. The winch wire attached to the repair bow is slacken. The cable is laid out over the wheel and sheave while C/S NEXANS SKAGERRAK is moving slowly perpendicular to the cable route. The tension in the cable will move the repair bow toward the stern as the winch wire is slacken away. The operation stops temporary when the repair bow has reached the aft part of the repair deck. (Fig. 7).

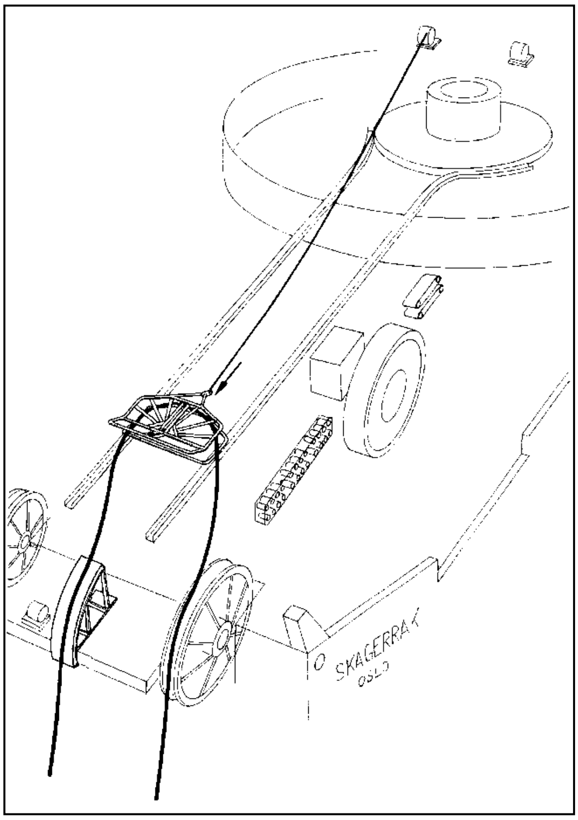


Fig. 7

A winch wire running through a pulley at the top of the A-frame, is connected to the repair bow. The repair bow is carefully lifted up until the hair-pin loop is hanging in the A-frame. The hair-pin loop is lowered while C/S "NEXANS SKAGERRAK" continues moving perpendicular to the route. (Fig. 8 & 9).

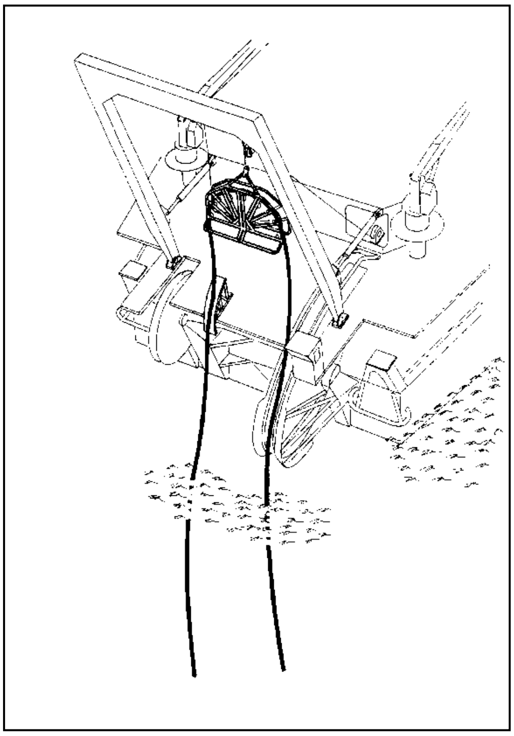


Fig. 8

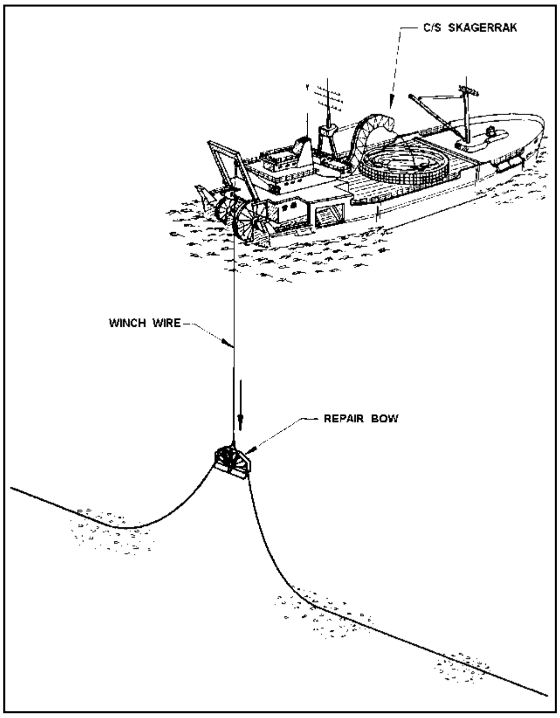


Fig. 9

The operation stops when the repair bow has reached the seabed. The repair bow is released from the loop and lifted on board the vessel.

At this point the repaired cable deviates from a "straight" line forming a curve on the seabed. The "extra" length is slightly above twice the water depth.

The cable can now be buried, if required.

NOTE

The description above explains the procedure when a spare cable is jointed into an existing cable. However, when the damage is located near the landfall the cable can be retrieved from this end. In this case only some of the stages are applicable. The (spare) cable is re-laid following the procedures for a cable laying and second end pull-in at the landfall. Only one subsea repair joint is required and the cable is laid in a "straight" line. The need for a joint at the shore is dependent on the location of the termination. If located near the shore the spare cable will replace the previous laid cable from the subsea joint to the termination.

Operational limits during jointing

The operations are based on weather conditions not exceeding the following parameters given below. However, the values are guidelines only. The Captain and the Operation Manager will evaluate the weather conditions on site and act accordingly. The direction of wind and current resulting sea state might give other values.

	Retrieve cable end	Jointing operation	Laying the joint
Wind force:	12 m/s (23 knots)	15 m/s (29 knots)	12 m/s (23 knots)
Max. wave height:	3.5 m	5 m	3.5 m
Current, surface:	1.3 m/s (2.5 knots)	1.3 m/s (2.5 knots	1.3 m/s (2.5 knots
Current, bottom:	1.3 m/s (2.5 knots	N/A	1.3 m/s (2.5 knots
Surface visibility:	N/A	N/A	N/A
Visibility in water:	2 m	N/A	2 m

Appendix Z- SOBI Seabed Installation Schedule

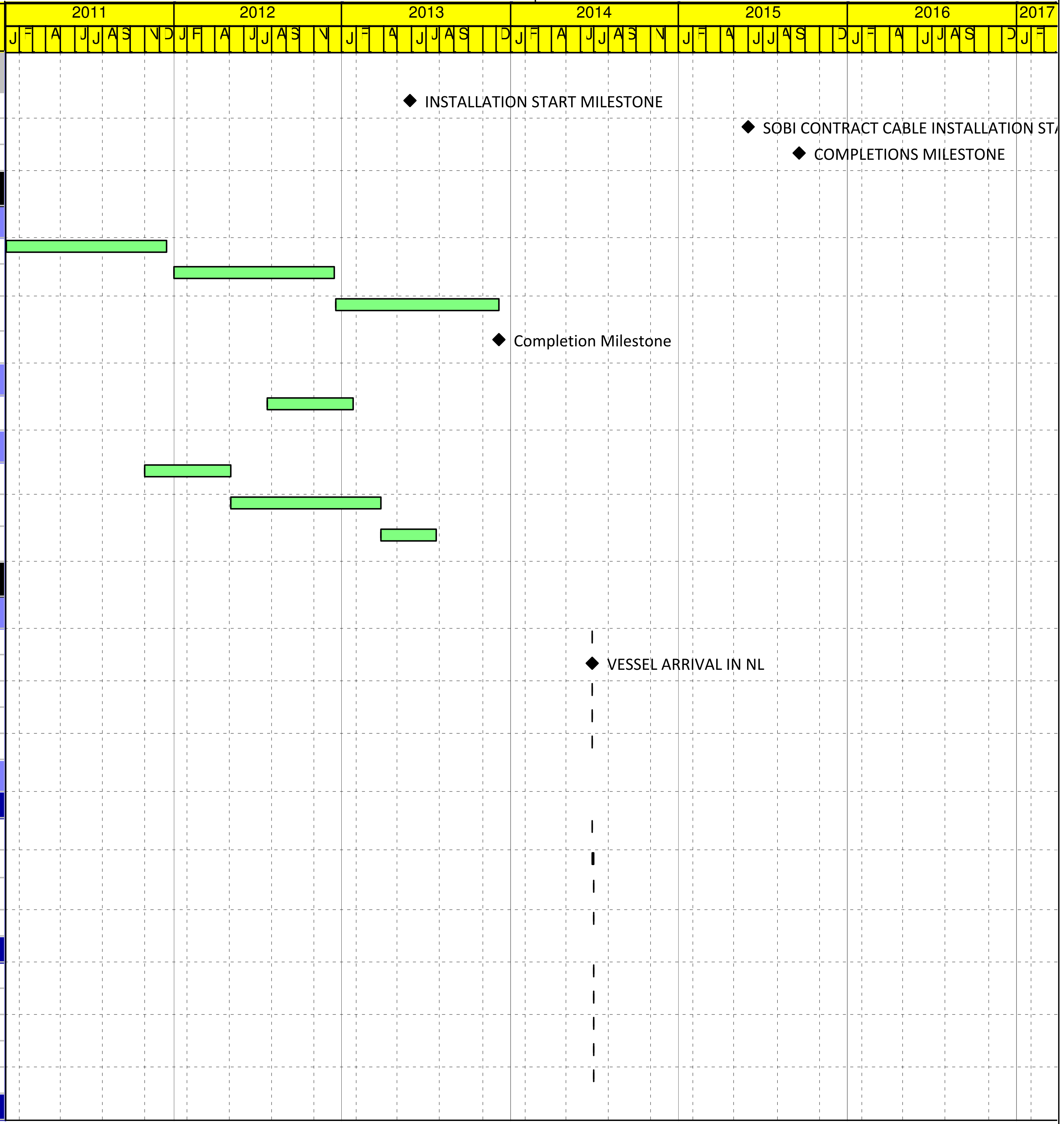
nalcor energy
LOWER CHURCHILL PROJECT

Nalcor Energy - Lower Churchill Project

SOBI SEABED INSTALLATION SCHEDULE

Layout: SOBI Seabed Installation Schedule
TASK filter: PWP: Scope Package Selector_2.
Printed: 26-Nov-10

Activity ID	Activity Name	Start	Finish
SOBI Seabed Installation			
SOBI_IL_0011150	INSTALLATION START MILESTONE	27-May-13*	
SOBI_IL_0011170	SOBI CONTRACT CABLE INSTALLATION START (VESSELS 'IN' WATER)	01-Jun-15*	
SOBI_IL_0011110	COMPLETIONS MILESTONE		19-Sep-15
CONTRACTING			
CABLE SUPPLY & INSTALL			
SOBI_IL_0012550	Bid, Evaluate, and Award	04-Jan-11*	16-Dec-11
SOBI_IL_0013400	Vendor Engineering	03-Jan-12	14-Dec-12
SOBI_IL_0013410	Vendor Fabrication	17-Dec-12*	06-Dec-13
SOBI_IL_0013430	Completion Milestone		06-Dec-13
ROCK BERM CONSTRUCTION (INCL. SUPPLY)			
SOBI_IL_0013380	Bid, Evaluate & Award - (Contractor Supply & Install)	23-Jul-12*	24-Jan-13
HORIZONTAL DIRECTIONAL DRILLING			
SOBI_IL_0013370	Bid, Evaluate, and Award - Engineering	01-Nov-11*	03-May-12
SOBI_IL_0012730	Engineering	04-May-12	25-Mar-13
SOBI_IL_0013390	Bid, Evaluate, & Award HDD Contractor	26-Mar-13	22-Jul-13
LEVELING			
MOB.			
SOBI_IL_0011310	Vessel loadout	26-Jun-14*	26-Jun-14
SOBI_IL_0011900	VESSEL ARRIVAL IN NL	26-Jun-14*	
SOBI_IL_0011010	Bunkering	26-Jun-14*	27-Jun-14
SOBI_IL_0011020	Equipment Loadout	27-Jun-14	27-Jun-14
SOBI_IL_0011030	Personnel Change	27-Jun-14	28-Jun-14
Execution			
Trip 1			
SOBI_IL_0011340	Transit	28-Jun-14	28-Jun-14
SOBI_IL_0011050	PreSurvey	28-Jun-14*	29-Jun-14
SOBI_IL_0011060	Rock Laying	29-Jun-14	29-Jun-14
SOBI_IL_0011510	Transit	29-Jun-14	30-Jun-14
Trip 2			
SOBI_IL_0011490	Vessel Loadout	30-Jun-14	30-Jun-14
SOBI_IL_0011520	Transit	30-Jun-14	30-Jun-14
SOBI_IL_0011470	Rock Laying	30-Jun-14	01-Jul-14
SOBI_IL_0011070	Post Survey	01-Jul-14	01-Jul-14
SOBI_IL_0011530	Transit	01-Jul-14	01-Jul-14
DE-MOB.			



🟩 Remaining Work	◆	◆ Milestone	▬ % Complete
🟥 Critical Remaining Work	△	△ UDF Baseline MS	
▬ Remaining Level of Effort	▬ UDF Baseline		

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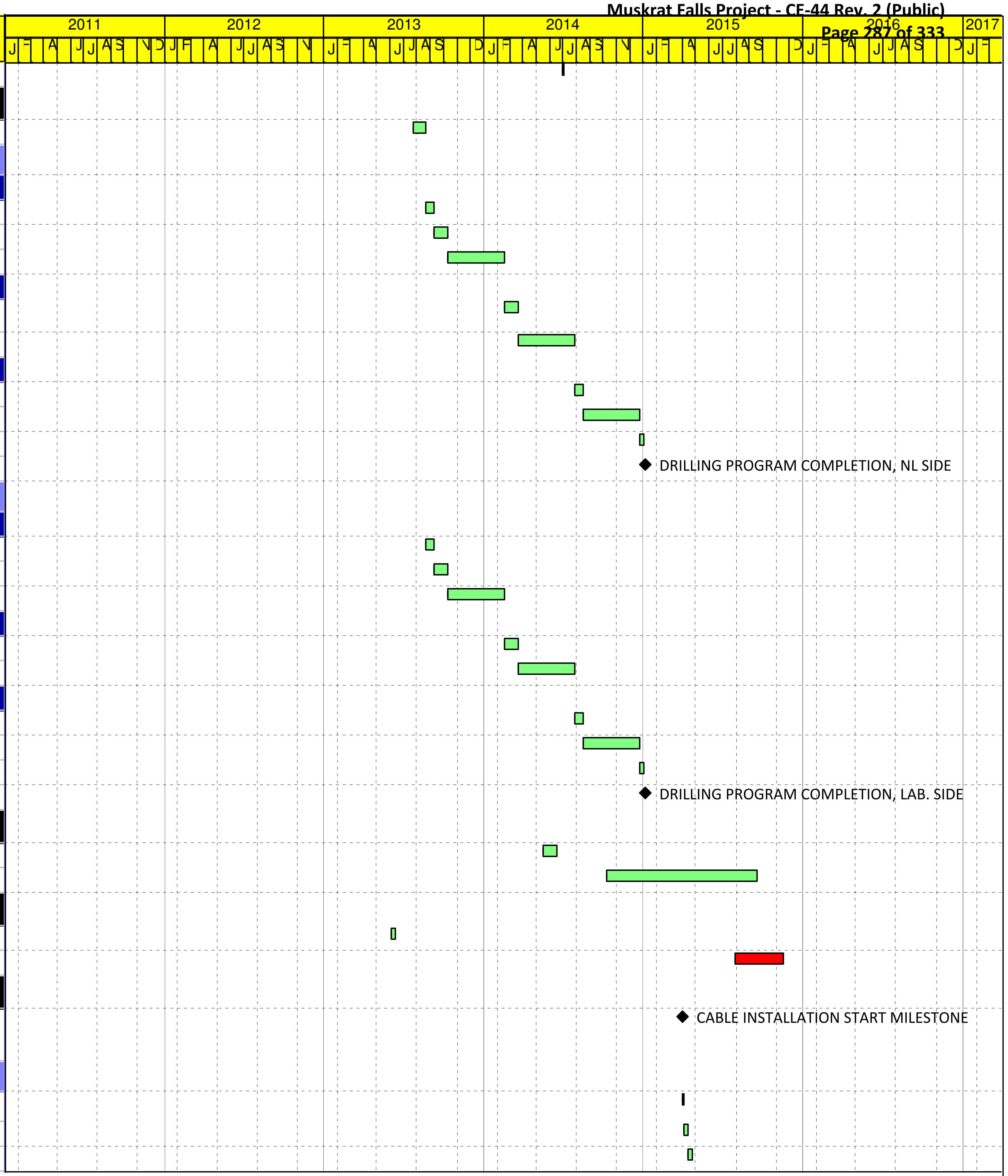
Baseline:
Data Date: 01-Jan-11

Date	Revision	Checked	Approved

Activity ID	Activity Name	Start	Finish
SOBI_IL_0011080	Equipment Offload	01-Jul-14	02-Jul-14
HDD (Horizontal Directional Drilling)			
SOBI_IL_0011600	Pre-Works for HDD	22-Jul-13	21-Aug-13
NL Side			
Hole for Cable 1			
SOBI_IL_0011420	Mobilization	21-Aug-13	10-Sep-13
SOBI_IL_0011120	Rigging Drill Rig - Hole 1	10-Sep-13	10-Oct-13
SOBI_IL_0011130	Drilling Hole - Hole 1	10-Oct-13	17-Feb-14
Hole for Cable 2			
SOBI_IL_0011210	Rigging Drill Rig - Hole 2	17-Feb-14	19-Mar-14
SOBI_IL_0011250	Drilling Hole - Hole 2	19-Mar-14	27-Jul-14
Hole for Cable 3			
SOBI_IL_0011220	Rigging Drill Rig - Hole 3	27-Jul-14	16-Aug-14
SOBI_IL_0011240	Drilling Hole - Hole 3	16-Aug-14	24-Dec-14
SOBI_IL_0011260	De-Mob. - Hole 3	24-Dec-14	03-Jan-15
SOBI_IL_0011430	DRILLING PROGRAM COMPLETION, NL SIDE		04-Jan-15
Labrador Side			
Hole for Cable 1			
SOBI_IL_0011620	Mobilization	21-Aug-13	10-Sep-13
SOBI_IL_0011270	Rigging Drill Rig - Hole 1	10-Sep-13	10-Oct-13
SOBI_IL_0011580	Drilling Holes - Hole 1	10-Oct-13	17-Feb-14
Hole for Cable 2			
SOBI_IL_0011630	Rigging Drill Rig - Hole 1	17-Feb-14	19-Mar-14
SOBI_IL_0011650	Drilling Holes - Hole 1	19-Mar-14	27-Jul-14
Hole for Cable 3			
SOBI_IL_0011750	Rigging Drill Rig - Hole 1	27-Jul-14	16-Aug-14
SOBI_IL_0011820	Drilling Holes - Hole 1	16-Aug-14	24-Dec-14
SOBI_IL_0011830	De-Mob. - Hole 1	24-Dec-14	03-Jan-15
SOBI_IL_0011450	DRILLING PROGRAM COMPLETION, LAB. SIDE		04-Jan-15
ROCK SUPPLY / CRUSHING			
SOBI_IL_0011140	Rock Crushing (Initial Leveling campaign)	17-May-14	16-Jun-14
SOBI_IL_0011040	Rock Crushing (for Rock dumping campaign)	09-Oct-14*	19-Sep-15
TRANSITION COMPOUNDS			
SOBI_IL_0011090	Transition Compounds (Before HDD)	03-Jun-13*	13-Jun-13
SOBI_IL_0011100	Transition Compounds (After Rock Dumping)	31-Jul-15	16-Nov-15
CABLE INSTALLATION			
SOBI_IL_0011320	CABLE INSTALLATION START MILESTONE	01-Apr-15*	
EURO MOB.			
SOBI_IL_0011730	Transit to Factory	01-Apr-15	04-Apr-15
SOBI_IL_0011740	Loading at factory	04-Apr-15	14-Apr-15
SOBI_IL_0011640	Transit to NL	14-Apr-15	23-Apr-15



🟩 Remaining Work
🟥 Critical Remaining Work
▬ Remaining Level of Effort
◆ Milestone
△ UDF Baseline MS
▬ UDF Baseline
▬ % Complete

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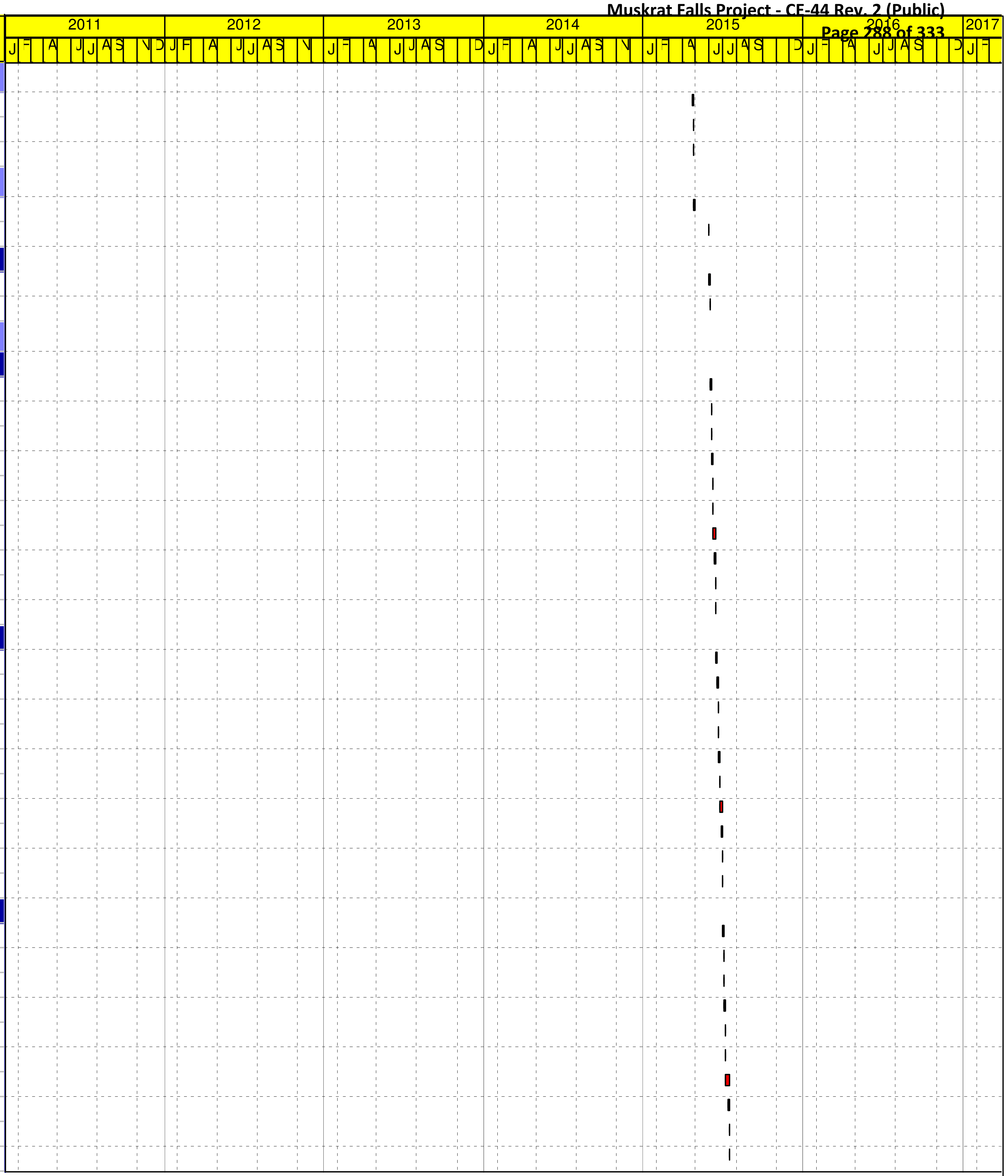
Baseline:

Data Date: 01-Jan-11

Date	Revision	Checked	Approved

Activity ID	Activity Name	Start	Finish
NL MOB.			
SOBI_IL_0011160	Bunkering	23-Apr-15	25-Apr-15
SOBI_IL_0011180	Equipment Transfer	25-Apr-15	26-Apr-15
SOBI_IL_0011680	Personnel Change	26-Apr-15	27-Apr-15
Additional Prep. Work			
SOBI_IL_0011230	Transit	27-Apr-15	29-Apr-15
SOBI_IL_0011200	Pre-Survey	31-May-15	01-Jun-15*
Leveling			
SOBI_IL_0011280	Matressing	01-Jun-15	01-Jun-15
SOBI_IL_0011290	Sandbagging	01-Jun-15	02-Jun-15
EXECUTION			
Cable 1			
SOBI_IL_0011300	Cable Pull-in, Side 1	03-Jun-15	05-Jun-15
SOBI_IL_0011330	Cable Laying	05-Jun-15	06-Jun-15
SOBI_IL_0011400	Cable Abandonment at join location	06-Jun-15	06-Jun-15
SOBI_IL_0011920	Cable pull side 2	06-Jun-15	08-Jun-15
SOBI_IL_0012020	Cable laying	08-Jun-15	10-Jun-15
SOBI_IL_0012500	Cable recovery	10-Jun-15	10-Jun-15
SOBI_IL_0011930	Cable join	10-Jun-15	16-Jun-15
SOBI_IL_0011690	Testing	14-Jun-15	17-Jun-15
SOBI_IL_0011940	Cable abandon	16-Jun-15	17-Jun-15
SOBI_IL_0011700	Surveying	17-Jun-15	17-Jun-15
Cable 2			
SOBI_IL_0011350	Cable Pull-in, Side 1	17-Jun-15	19-Jun-15
SOBI_IL_0011360	Cable Laying	19-Jun-15	20-Jun-15
SOBI_IL_0011390	Cable Abandonment at join location	20-Jun-15	21-Jun-15
SOBI_IL_0011960	Cable pull-in side 2	21-Jun-15	23-Jun-15
SOBI_IL_0011970	Cable laying	23-Jun-15	24-Jun-15
SOBI_IL_0011980	Cable recovery	24-Jun-15	24-Jun-15
SOBI_IL_0012510	Cable join	24-Jun-15	01-Jul-15
SOBI_IL_0011370	Testing	28-Jun-15	01-Jul-15
SOBI_IL_0012520	Cable abandon	01-Jul-15	01-Jul-15
SOBI_IL_0011710	Surveying	01-Jul-15	02-Jul-15
Cable 3			
SOBI_IL_0011440	Cable Pull-in, Side 1	02-Jul-15	04-Jul-15
SOBI_IL_0011660	Cable Laying	04-Jul-15	05-Jul-15
SOBI_IL_0011410	Cable Abandonment at join location	05-Jul-15	05-Jul-15
SOBI_IL_0011990	Cable pull-in side 2	05-Jul-15	07-Jul-15
SOBI_IL_0012000	Cable laying	07-Jul-15	09-Jul-15
SOBI_IL_0012010	Cable recovery	09-Jul-15	09-Jul-15
SOBI_IL_0012530	Cable join	09-Jul-15	16-Jul-15
SOBI_IL_0011670	Testing	13-Jul-15	16-Jul-15
SOBI_IL_0012540	Cable abandon	16-Jul-15	16-Jul-15
SOBI_IL_0011720	Surveying	16-Jul-15	16-Jul-15



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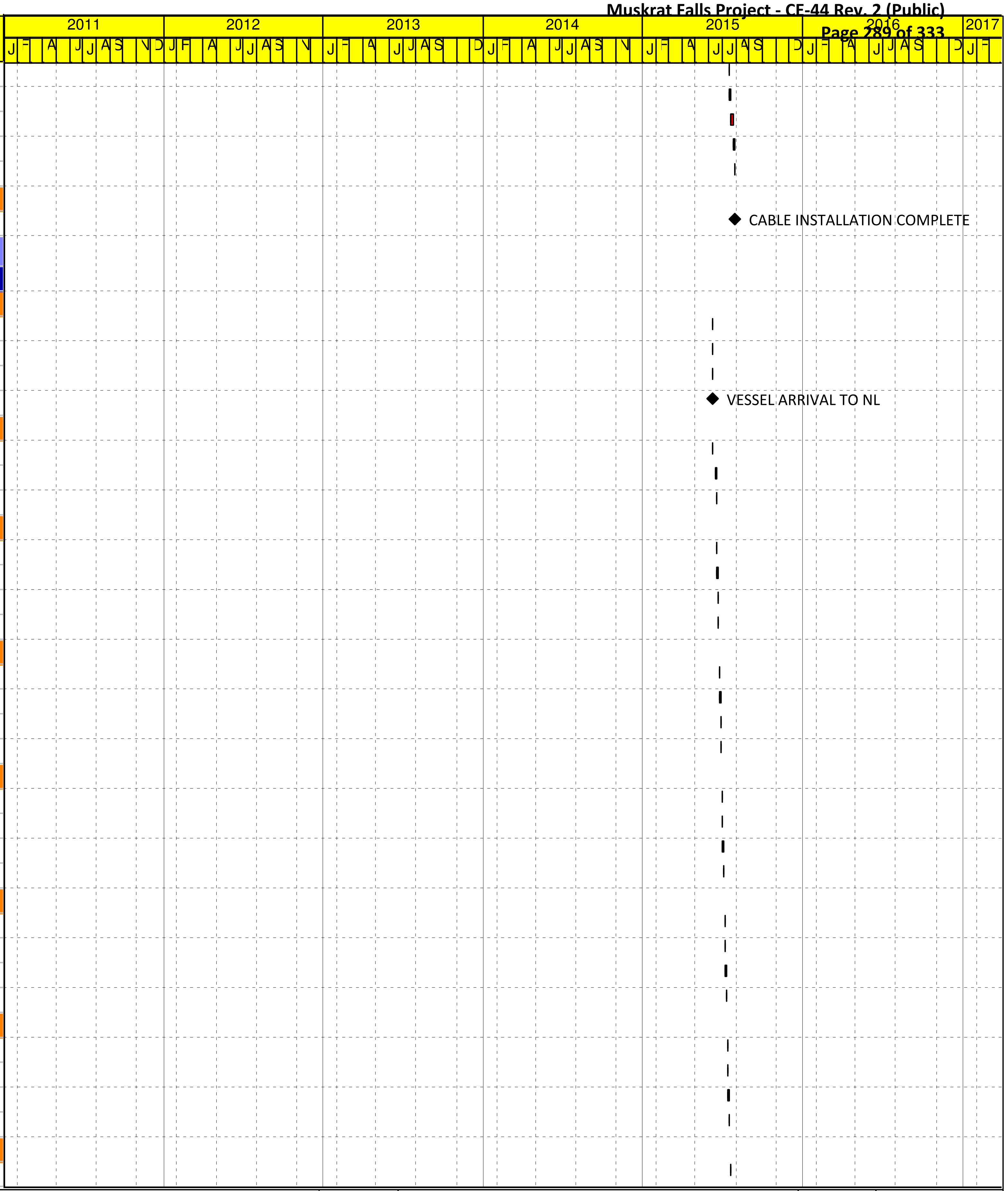
Data Date: 01-Jan-11

Date	Revision	Checked	Approved

Activity ID	Activity Name	Start	Finish
SOBI_IL_0011770	Transit	16-Jul-15	17-Jul-15
SOBI_IL_0011780	NL De-MOB.	17-Jul-15	19-Jul-15
SOBI_IL_0011790	Transit	19-Jul-15	26-Jul-15
SOBI_IL_0011800	Equipment Load-out	26-Jul-15	28-Jul-15
SOBI_IL_0011810	Transit from Factory	28-Jul-15	31-Jul-15
Cable Installation			
SOBI_IL_0011950	CABLE INSTALLATION COMPLETE		31-Jul-15
ROCK BERM			
Rock Laying (Vessel#1)- (Trips, approx. 17,500 t/load)			
MOB.			
SOBI_IL_0011480	Personnel Change	08-Jun-15*	08-Jun-15
SOBI_IL_0011540	Equipment Loadout	08-Jun-15	08-Jun-15
SOBI_IL_0011550	Rock Loading (L1)	08-Jun-15*	09-Jun-15
SOBI_IL_0011910	VESSEL ARRIVAL TO NL	08-Jun-15*	
Load 1			
SOBI_IL_0012030	Transit	08-Jun-15	09-Jun-15
SOBI_IL_0012040	Rock laying	17-Jun-15	18-Jun-15
SOBI_IL_0012570	Transit	18-Jun-15	19-Jun-15
Load 2			
SOBI_IL_0012050	Rock Loading (L2)	19-Jun-15	20-Jun-15
SOBI_IL_0012060	Transit	20-Jun-15	21-Jun-15
SOBI_IL_0012070	Rock laying	21-Jun-15	22-Jun-15
SOBI_IL_0012580	Transit	22-Jun-15	23-Jun-15
Load 3			
SOBI_IL_0012080	Rock Loading (L3)	25-Jun-15	26-Jun-15
SOBI_IL_0012090	Transit	26-Jun-15	27-Jun-15
SOBI_IL_0012100	Rock laying	27-Jun-15	28-Jun-15
SOBI_IL_0012590	Transit	28-Jun-15	29-Jun-15
Load 4			
SOBI_IL_0012110	Rock Loading (L4)	01-Jul-15	02-Jul-15
SOBI_IL_0012120	Transit	02-Jul-15	03-Jul-15
SOBI_IL_0012130	Rock laying	03-Jul-15	04-Jul-15
SOBI_IL_0012600	Transit	04-Jul-15	05-Jul-15
Load 5			
SOBI_IL_0012140	Rock Loading (L5)	07-Jul-15	08-Jul-15
SOBI_IL_0012150	Transit	08-Jul-15	09-Jul-15
SOBI_IL_0012160	Rock laying	09-Jul-15	10-Jul-15
SOBI_IL_0012610	Transit	10-Jul-15	11-Jul-15
Load 6			
SOBI_IL_0012170	Rock Loading (L6)	13-Jul-15	14-Jul-15
SOBI_IL_0012180	Transit	14-Jul-15	15-Jul-15
SOBI_IL_0012190	Rock laying	15-Jul-15	16-Jul-15
SOBI_IL_0012620	Transit	16-Jul-15	17-Jul-15
Load 7			
SOBI_IL_0012200	Rock Loading (L7)	19-Jul-15	20-Jul-15



🟩	Remaining Work
🟥	Critical Remaining Work
▬	Remaining Level of Effort
◆	Milestone
△	UDF Baseline MS
▬	UDF Baseline
▬	% Complete

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Baseline:

Data Date: 01-Jan-11

Date	Revision	Checked	Approved

Activity ID	Activity Name	Start	Finish
SOBI_IL_0012210	Transit	20-Jul-15	21-Jul-15
SOBI_IL_0012220	Rock laying	21-Jul-15	22-Jul-15
SOBI_IL_0012630	Transit	22-Jul-15	23-Jul-15
Load 8			
SOBI_IL_0012230	Rock Loading (L8)	25-Jul-15	26-Jul-15
SOBI_IL_0012240	Transit	26-Jul-15	27-Jul-15
SOBI_IL_0012250	Rock laying	27-Jul-15	28-Jul-15
SOBI_IL_0012640	Transit	28-Jul-15	29-Jul-15
Load 9			
SOBI_IL_0012260	Rock Loading (L9)	31-Jul-15	01-Aug-15
SOBI_IL_0012270	Transit	01-Aug-15	02-Aug-15
SOBI_IL_0012280	Rock laying	02-Aug-15	03-Aug-15
SOBI_IL_0012650	Transit	03-Aug-15	04-Aug-15
Load 10			
SOBI_IL_0012290	Rock Loading (L10)	06-Aug-15	07-Aug-15
SOBI_IL_0012300	Transit	07-Aug-15	08-Aug-15
SOBI_IL_0012310	Rock laying	08-Aug-15	09-Aug-15
SOBI_IL_0012660	Transit	09-Aug-15	10-Aug-15
Load 11			
SOBI_IL_0012320	Rock Loading (L11)	12-Aug-15	13-Aug-15
SOBI_IL_0012330	Transit	13-Aug-15	14-Aug-15
SOBI_IL_0012340	Rock laying	14-Aug-15	15-Aug-15
SOBI_IL_0012670	Transit	15-Aug-15	16-Aug-15
Load 12			
SOBI_IL_0012350	Rock Loading (L12)	18-Aug-15	19-Aug-15
SOBI_IL_0012360	Transit	19-Aug-15	20-Aug-15
SOBI_IL_0012370	Rock laying	20-Aug-15	21-Aug-15
SOBI_IL_0012680	Transit	21-Aug-15	22-Aug-15
Load 13			
SOBI_IL_0012380	Rock Loading (L13)	24-Aug-15	25-Aug-15
SOBI_IL_0012390	Transit	25-Aug-15	26-Aug-15
SOBI_IL_0012400	Rock laying	26-Aug-15	27-Aug-15
SOBI_IL_0012690	Transit	27-Aug-15	28-Aug-15
Load 14			
SOBI_IL_0012410	Rock Loading (L14)	30-Aug-15	31-Aug-15
SOBI_IL_0012420	Transit	31-Aug-15	01-Sep-15
SOBI_IL_0012430	Rock laying	01-Sep-15	02-Sep-15
SOBI_IL_0012700	Transit	02-Sep-15	03-Sep-15
Load 15			
SOBI_IL_0012440	Rock Loading (L15)	07-Sep-15	08-Sep-15
SOBI_IL_0012450	Transit	08-Sep-15	09-Sep-15
SOBI_IL_0012460	Rock laying	09-Sep-15	10-Sep-15
SOBI_IL_0012710	Transit	10-Sep-15	11-Sep-15
Load 16			
SOBI_IL_0012470	Rock Loading (L16)	13-Sep-15	14-Sep-15

🟩 Remaining Work ◆ Milestone ▬ % Complete
🟥 Critical Remaining Work △ UDF Baseline MS
▬ Remaining Level of Effort ▬ UDF Baseline

File: SOBI...

Baseline:

Data Date: 01-Jan-11

Date	Revision	Checked	Approved

Activity ID	Activity Name	Start	Finish
SOBI_IL_0012480	Transit	14-Sep-15	15-Sep-15
SOBI_IL_0012490	Rock laying	15-Sep-15	16-Sep-15
SOBI_IL_0012720	Transit	16-Sep-15	17-Sep-15
Post Survey			
SOBI_IL_0011760	Post Survey (Rock Dumper #1)	17-Sep-15	17-Sep-15
De-MOB.			
SOBI_IL_0011470a10	De-Mob.	17-Sep-15	19-Sep-15
Rock Laying (Vessel #2)- (Trips, approx. 17,500 t/load)			
MOB.			
SOBI_IL_0011560	Personnel Change	09-Jun-15*	09-Jun-15
SOBI_IL_0011570	Equipment Loadout	09-Jun-15	09-Jun-15
SOBI_IL_0011610	Rock Loading (L1)	11-Jun-15*	12-Jun-15
Load 1			
SOBI_IL_0012740	Transit	12-Jun-15	13-Jun-15
SOBI_IL_0012750	Rock laying	13-Jun-15	14-Jun-15
SOBI_IL_0012760	Transit	14-Jun-15	15-Jun-15
Load 2			
SOBI_IL_0012770	Rock Loading (L2)	22-Jun-15	23-Jun-15
SOBI_IL_0012780	Transit	23-Jun-15	24-Jun-15
SOBI_IL_0012790	Rock laying	24-Jun-15	25-Jun-15
SOBI_IL_0012800	Transit	25-Jun-15	26-Jun-15
Load 3			
SOBI_IL_0012810	Rock Loading (L3)	28-Jun-15	29-Jun-15
SOBI_IL_0012820	Transit	29-Jun-15	30-Jun-15
SOBI_IL_0012830	Rock laying	30-Jun-15	01-Jul-15
SOBI_IL_0012840	Transit	01-Jul-15	02-Jul-15
Load 4			
SOBI_IL_0012850	Rock Loading (L4)	04-Jul-15	05-Jul-15
SOBI_IL_0012860	Transit	05-Jul-15	06-Jul-15
SOBI_IL_0012870	Rock laying	06-Jul-15	07-Jul-15
SOBI_IL_0012880	Transit	07-Jul-15	08-Jul-15
Load 5			
SOBI_IL_0012890	Rock Loading (L5)	10-Jul-15	11-Jul-15
SOBI_IL_0012900	Transit	11-Jul-15	12-Jul-15
SOBI_IL_0012910	Rock laying	12-Jul-15	13-Jul-15
SOBI_IL_0012920	Transit	13-Jul-15	14-Jul-15
Load 6			
SOBI_IL_0012930	Rock Loading (L6)	16-Jul-15	17-Jul-15
SOBI_IL_0012940	Transit	17-Jul-15	18-Jul-15
SOBI_IL_0012950	Rock laying	18-Jul-15	19-Jul-15
SOBI_IL_0012960	Transit	19-Jul-15	20-Jul-15
Load 7			
SOBI_IL_0012970	Rock Loading (L7)	22-Jul-15	23-Jul-15
SOBI_IL_0012980	Transit	23-Jul-15	24-Jul-15
SOBI_IL_0012990	Rock laying	24-Jul-15	25-Jul-15

🟩 Remaining Work
🟥 Critical Remaining Work
▬ Remaining Level of Effort
◆ Milestone
△ UDF Baseline MS
▬ UDF Baseline
▬ % Complete

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File: SOBI...
Baseline:
Data Date: 01-Jan-11

Date	Revision	Checked	Approved

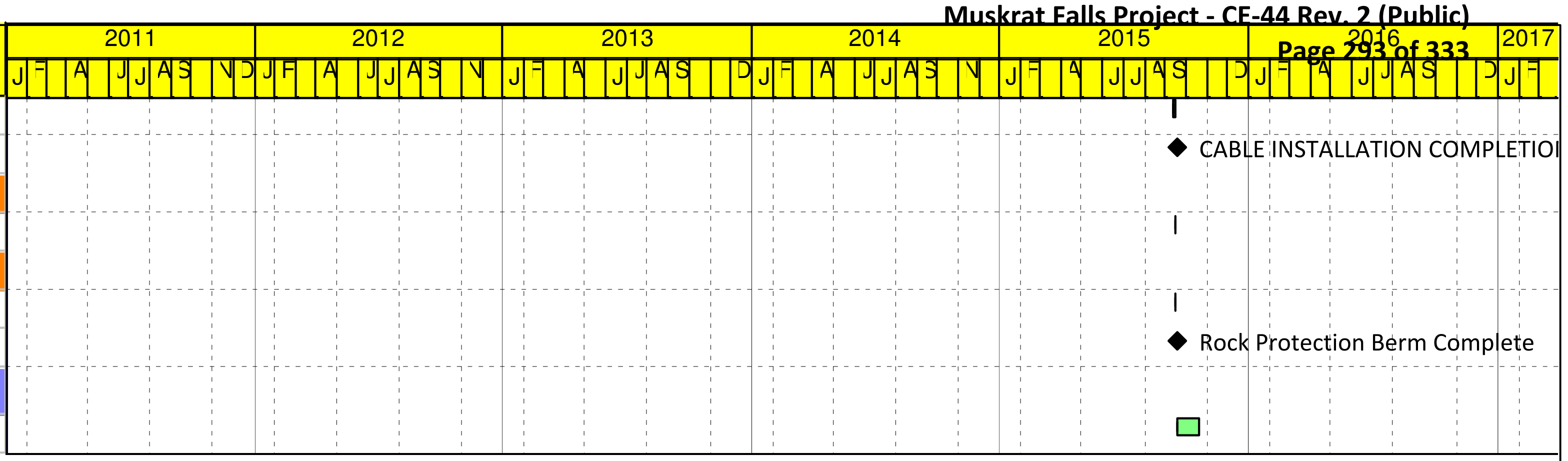
Activity ID	Activity Name	Start	Finish
SOBI_IL_0013000	Transit	25-Jul-15	26-Jul-15
Load 8			
SOBI_IL_0013010	Rock Loading (L8)	28-Jul-15	29-Jul-15
SOBI_IL_0013020	Transit	29-Jul-15	30-Jul-15
SOBI_IL_0013030	Rock laying	30-Jul-15	31-Jul-15
SOBI_IL_0013040	Transit	31-Jul-15	01-Aug-15
Load 9			
SOBI_IL_0013050	Rock Loading (L9)	03-Aug-15	04-Aug-15
SOBI_IL_0013060	Transit	04-Aug-15	05-Aug-15
SOBI_IL_0013070	Rock laying	05-Aug-15	06-Aug-15
SOBI_IL_0013080	Transit	06-Aug-15	07-Aug-15
Load 10			
SOBI_IL_0013090	Rock Loading (L10)	09-Aug-15	10-Aug-15
SOBI_IL_0013100	Transit	10-Aug-15	11-Aug-15
SOBI_IL_0013110	Rock laying	11-Aug-15	12-Aug-15
SOBI_IL_0013120	Transit	12-Aug-15	13-Aug-15
Load 11			
SOBI_IL_0013130	Rock Loading (L11)	15-Aug-15	16-Aug-15
SOBI_IL_0013140	Transit	16-Aug-15	17-Aug-15
SOBI_IL_0013150	Rock laying	17-Aug-15	18-Aug-15
SOBI_IL_0013160	Transit	18-Aug-15	19-Aug-15
Load 12			
SOBI_IL_0013170	Rock Loading (L12)	21-Aug-15	22-Aug-15
SOBI_IL_0013180	Transit	22-Aug-15	23-Aug-15
SOBI_IL_0013190	Rock laying	23-Aug-15	24-Aug-15
SOBI_IL_0013200	Transit	24-Aug-15	25-Aug-15
Load 13			
SOBI_IL_0013210	Rock Loading (L13)	27-Aug-15	28-Aug-15
SOBI_IL_0013220	Transit	28-Aug-15	29-Aug-15
SOBI_IL_0013230	Rock laying	29-Aug-15	30-Aug-15
SOBI_IL_0013240	Transit	30-Aug-15	31-Aug-15
Load 14			
SOBI_IL_0013250	Rock Loading (L14)	31-Aug-15	01-Sep-15
SOBI_IL_0013260	Transit	01-Sep-15	02-Sep-15
SOBI_IL_0013270	Rock laying	02-Sep-15	03-Sep-15
SOBI_IL_0013280	Transit	03-Sep-15	04-Sep-15
Load 15			
SOBI_IL_0013290	Rock Loading (L14)	04-Sep-15	05-Sep-15
SOBI_IL_0013300	Transit	05-Sep-15	06-Sep-15
SOBI_IL_0013310	Rock laying	06-Sep-15	07-Sep-15
SOBI_IL_0013320	Transit	07-Sep-15	08-Sep-15
Load 16			
SOBI_IL_0013330	Rock Loading (L15)	10-Sep-15	11-Sep-15
SOBI_IL_0013340	Transit	11-Sep-15	12-Sep-15
SOBI_IL_0013350	Rock laying	12-Sep-15	13-Sep-15

🟩 Remaining Work
🟥 Critical Remaining Work
▬ Remaining Level of Effort
◆ Milestone
△ UDF Baseline MS
▬ UDF Baseline
▬ % Complete

File: SOBI...
Baseline:
Data Date: 01-Jan-11

Date	Revision	Checked	Approved

Activity ID	Activity Name	Start	Finish
SOBI_IL_0013360	Transit	13-Sep-15	14-Sep-15
SOBI_IL_0011380	CABLE INSTALLATION COMPLETION (WITH ROCK BERM)		19-Sep-15
Post Survey			
SOBI_IL_0011500	Post Survey (Rock Dumper # 2)	14-Sep-15	14-Sep-15
De-MOB.			
SOBI_IL_0011470a	De-Mob.	14-Sep-15	16-Sep-15
SOBI_IL_0011590	Rock Protection Berm Complete		19-Sep-15
COMMISSIONING			
SOBI_IL_0012560	CABLE SYSTEM COMMISIOING & TESTING	19-Sep-15	19-Oct-15



🟩 Remaining Work	◆ Milestone	▬ % Complete
🟥 Critical Remaining Work	△ UDF Baseline MS	
▬ Remaining Level of Effort	▬ UDF Baseline	

Page 8 of 8

File: SOBI...

Baseline:

Data Date: 01-Jan-11

Date	Revision	Checked	Approved

Appendix AA- Cost Estimate

Detailed cost estimate deleted from filing

Appendix AB- Repair Cost

Cable Single Fault Repair

Date 14-Jan-11

Mob/Demob

Mob/Demob	[redacted]	days	Assume MOB out of Atlantic Canada
Transit	[redacted]	days	
Vessel Mobilization rate	[redacted]	$/day	
Excavation ROV rate	[redacted]	$/day	Assume MOB out of St.John's

Mob / Demob Costs **$** **1,629,000** **$ CAD**

Repair

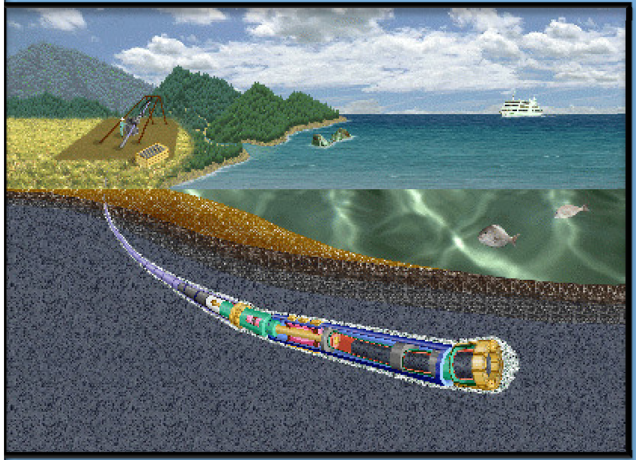
Cable Repair Joints	[redacted]	days	2 joints per repair
Rock Removal	[redacted]	days	
Rock Reinstatment	[redacted]	days	
Cutting, Retreival and Re-lay	[redacted]	days	
Length of Protection (MAX)	[redacted]	m	
Cost Per Mattress	[redacted]	$ CAD	6m Cover
Number of Mattresses	[redacted]		
Vessel Time	[redacted]	days	
Cost of Matresses	[redacted]		Includes Vessel Installation Cost
Vessel day rate	[redacted]	$/day	With excavating ROV
Joint Team	[redacted]		6 people 24hr
Jointing Consumables	[redacted]		

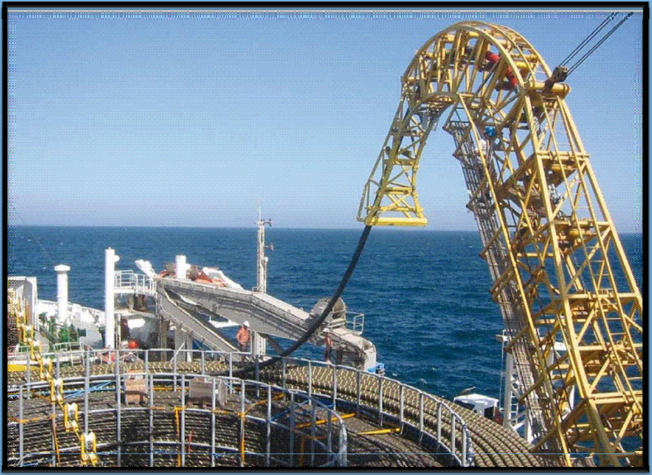
Total Repair Costs **$** **6,072,470** **$ CAD** NOTE:Spares in initial cable order

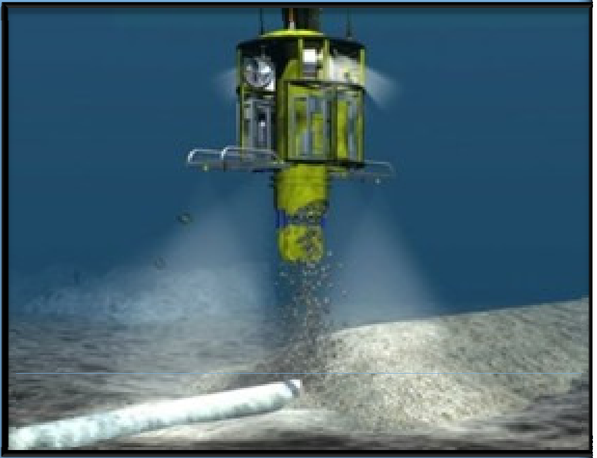
$ 7,701,470 $ CAD

Appendix AC - Westney Risk Report

Lower Churchill Project
Strait of Belle Isle Crossing







Cost & Schedule Risk Assessment

St. Johns, NL

November 29, 2010 – December 3, 2010

Risk Resolution®

Westney™
Consulting Group, Inc.
www.westney.com

21-Dec-2010 Final Report

General Information

This document contains information that is the confidential and proprietary property of Nalcor and is for the sole use of the intended recipient(s). Any use, review, reliance, dissemination, forwarding, printing or copying of this document without the express consent of Nalcor is strictly prohibited.

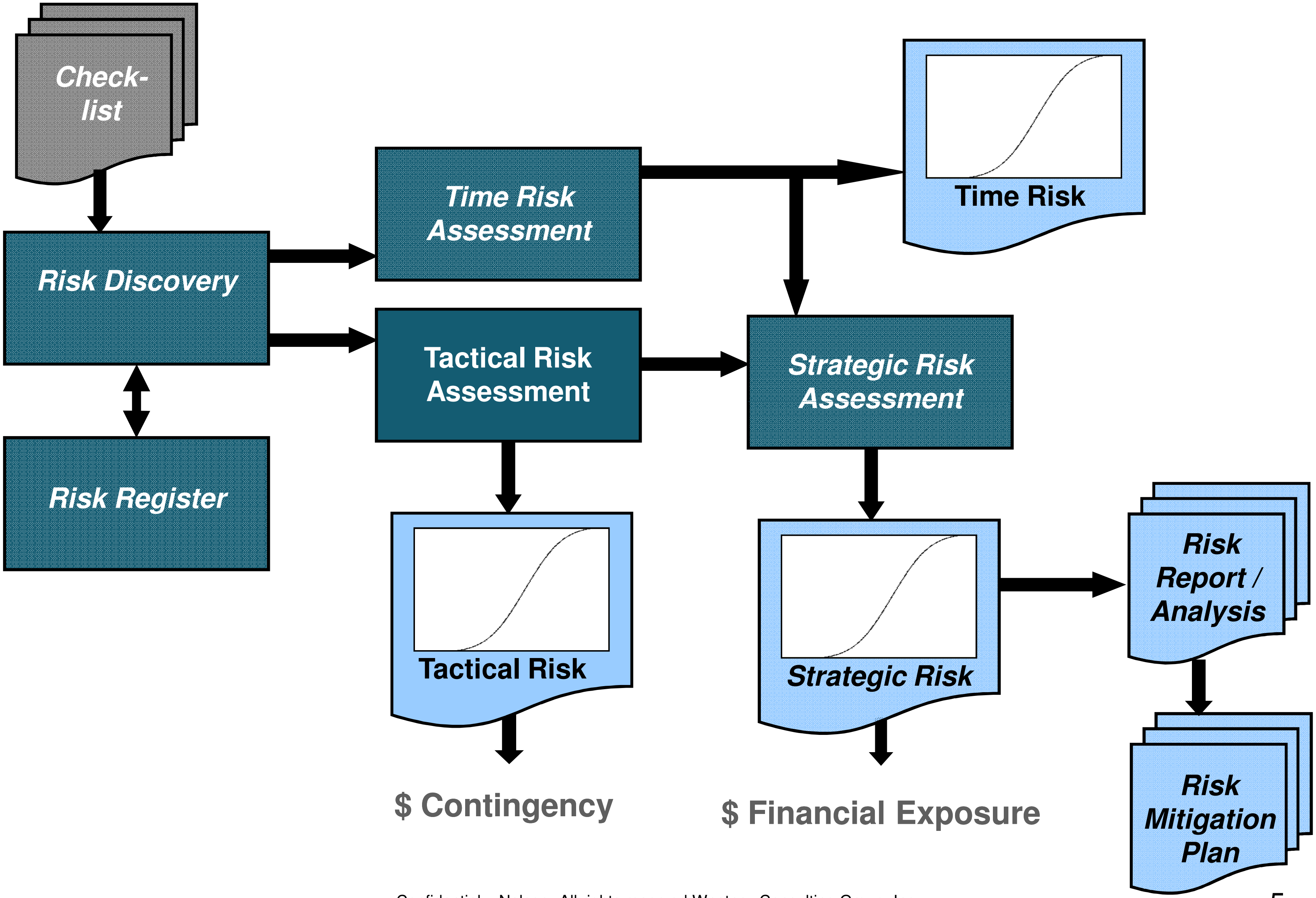
It is important to note that the scope of work for Westney Consulting Group was for Westney to guide and facilitate the Risk Ranging Process, using the consultants' experience to ask the right questions and, where appropriate, challenge the Nalcor participant's thinking. This resulted in an outcome of the analysis that represented the best thinking and efforts of both the Nalcor participants and the consultants from Westney.

Contents

Consultants' Comments

- The SOBI Crossing project is in an early stage of definition and this risk assessment was performed to obtain an indication of the probabilistic outcomes of the project and calibrate the near-term activities of the project team to reduce the level of project risk well in advance of a project sanction.
- There are limited technical options for achieving project objectives. Good progress has been made defining the scope of work and plans are in place for the additional surveys, investigations, and studies to reduce the level of risk and necessary to support the level of detail needed for a quality sanction-level estimate, schedule, and Execution Plan.
- The current deterministic schedule is optimistic in the durations assumed for approval of the Island Link EA, the HDD, and the Rock Protection. Time-Risk Modelling indicates a likely slippage of 0 to 9 months for project completion. The projected slippage is due to EA delay, HDD geotechnical unknowns, and weather. Contingent activities that the project can possibly undertake to reduce slippage will be validated by more detailed investigations currently planned during 2011.
- The current cost estimate is reasonable, has a limited number of variables, and is based on good estimating practices appropriate for the current level of definition. Estimate ranging incorporated a broad spectrum of tactical possibilities around the currently defined execution strategy. More detailed definition will be developed in the investigations scheduled during 2011.
- At this early stage of the project, the level of unmitigated risk is high because of limited definition and detailed planning. The possibilities for risk mitigation, however, are also significant and currently planned activities in 2011 will validate the possible Strategic Risk mitigation strategies shown in this report. The effects of these possible risk mitigations are shown in the Strategic Risk section of this report.

The Westney Risk Resolution® Process



Check-list

Risk Discovery

Risk Register

Time Risk Assessment

Tactical Risk Assessment

Strategic Risk Assessment

Time Risk

Tactical Risk

Strategic Risk

$ Contingency

$ Financial Exposure

Risk Report / Analysis

Risk Mitigation Plan

Risk Discovery

The Westney Risk Discovery process involves interviewing the key knowledge holders of the project. Because of the early stage of this project, the discovery process was expanded to include a technical risk workshop to initiate a project risk register for the project. An initial project risk register was also developed for the Maritime Link.

This workshop was attended by the key SOBI project personnel and facilitated by Westney. The project team identified over 200 risks to the project and made initial qualitative assessments. These identified risks informed the subsequent Time, Tactical, and Strategic Risk ranging sessions.

The initial Risk Registers developed by the project team are not part of this report. They will be completed by the project team and used throughout the project to monitor and manage individual risks and mitigations on the project.

Assessment Summary

Time Risk	The SOBI project schedule was analyzed on its own and does not tie into the LCP First Power milestone. The modeled results show a predictive range (P25 to P75) for Ready to Transmit Power of October 2015 to July 2016, which equates to 0 to 9 months later than the current schedule of October 2015.	The delays are driven by several key model activities: a delay in the EA causes a delay to the start of HDD; geotechnical unknowns extend the duration of HDD on the Newfoundland side which delays the cable installation. This delays rock placement which, interrupted by winter weather, cannot resume until the spring of 2016.
Tactical Risk	The predictive range for the Tactical-Risk analysis for SOBI Crossing is $317 million to $384 million, with the P50 value being $350 million.	The P50 value of $350 million compares to a budgeted estimate of $310 million, suggesting that an estimate contingency of $40 million (13%) would be appropriate for SOBI Crossing at this stage of development.
Strategic Risk	The predictive range for the Unmitigated Risk Exposure is $64 million to $136 million; the predictive range for the Mitigated Risk Exposure drops to $-2 million to $30 million based on possible mitigation strategies.	This strategic risk assessment was performed to provide insight for the recommendation of the appropriate level of management reserve for the project.

Time-Risk Assessment

Basis of Assessment

A Time-Risk model was built for the SOBI Crossing using Microsoft Project. The model logic incorporates the dates, durations, and key dependencies that are in the current project schedule. The key activities were identified and framed by Nalcor. Parameters for the weather modeling were also identified by Nalcor.

Westney consultants met with the Nalcor project team at Nalcor's St. John's office to discuss possible outcomes for each modeled activity. Final ranging was performed by the Nalcor team, but it was vetted and questioned by the Westney participants. The modeling simulation was performed by Westney using the @Risk Monte Carlo technique with 10,000 iterations.

Assessment Results

The modeled results had a predictive range for Ready to Transmit Power approximately 0 to 9 months after the currently scheduled date of October 14, 2015.

Predictive Range	
P25	**P75**
October 11, 2015	**July 20, 2016**

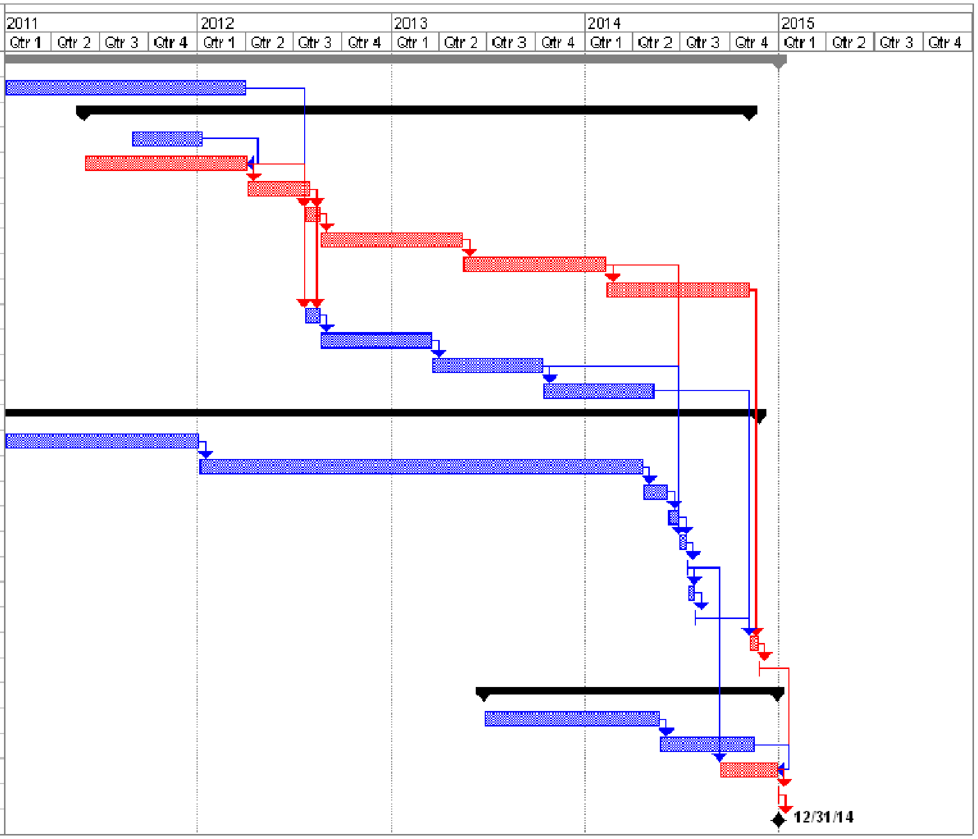
These results are driven by modeled delays in several key activities, particularly the EA, as well as the HDD on the Newfoundland side which delays the cable lay. These delays result in the rock placement activity being delayed by winter weather/ice cover and completing the next year. Because of the weather issues, there is a likely probability for multiple mobilizations of the cable lay and rock placement vessels.

Assumptions in the Time Risk Model

- Procurement efforts and funding (i.e., willing to make financial commitments for long lead items) will not delay award of cable manufacturing to secure a favorable manufacturing slot. Significant award slippage will likely delay Ready to Transmit Power.
- The 2011 geotechnical investigation provides sufficient information to proceed with HDD engineering and award of HDD Construction.
- The location of the Transition Compounds is established prior to the start of HDD Engineering and contract award for cable manufacturing.
- The volume of rock required for leveling and protection is obtained locally and produced in sufficient volume to support the rock placement vessel requirements.
- The construction of the Transition Compounds can be done separately and will not impact the SOBI Crossing Project.
- This analysis excludes any implications of scheduling conflicts with the Maritime Link.
- This analysis assumed that the SOBI Crossing project proceeds regardless of any delay in LCP Project Sanction.

Time-Risk Model

ID	Name	Duration	Start	Finish
0	**Nalcor Energy - LCP - SOBI Seabed Crossing**	**1458 d**	**01/04/11**	**12/31/14**
1	Island Link EA	454 d	01/04/11	04/01/12
2	**Horizontal Directional Drilling**	**1256 d**	**06/01/11**	**11/07/14**
3	Bid, Evaluate & Award HDD Engineering	132 d	09/01/11	01/10/12
4	Geotech Characterization & HDD Engineering	308 d	06/01/11	04/03/12
5	Bid, Evaluate & Award HDD Construction	119 d	04/04/12	07/31/12
6	HDD Pre-work (Newfoundland)	30 d	07/21/12	08/19/12
7	Drill Newfoundland Borehole 1 (incl. casing run)	270 d	08/20/12	05/16/13
8	Drill Newfoundland Borehole 2 (incl. casing run)	270 d	05/17/13	02/10/14
9	Drill Newfoundland Borehole 3 (incl. casing run)	270 d	02/11/14	11/07/14
10	HDD Pre-work (Labrador)	30 d	07/21/12	08/19/12
11	Drill Labrador Borehole 1 (incl. casing run)	210 d	08/20/12	03/17/13
12	Drill Labrador Borehole 2 (incl. casing run)	210 d	03/18/13	10/13/13
13	Drill Labrador Borehole 3 (incl. casing run)	210 d	10/14/13	05/11/14
14	**Cable Supply & Installation**	**1420 d**	**01/04/11**	**11/23/14**
15	Bid, Evaluate & Award Cable Supply & Installation	365 d	01/04/11	01/03/12
16	Cable Design and Manufacture	836 d	01/04/12	04/18/14
17	Mobilization	49 d	04/19/14	06/06/14
18	Pre-lay Survey and Prep.	14 d	06/07/14	06/26/14
19	Cable #1 Lay/Join	14 d	06/27/14	07/10/14
20	Cable #1 Test	2 d	07/11/14	07/12/14
21	Cable #2 Lay/Join	14 d	07/13/14	07/26/14
22	Cable #2 Test	2 d	07/27/14	07/28/14
23	Cable #3 Lay/Join	14 d	11/08/14	11/21/14
24	Cable #3 Test	2 d	11/22/14	11/23/14
25	**Cable Protection**	**551 d**	**06/26/13**	**12/28/14**
26	Bid, Evaluate & Award Rock Supply & Berm	330 d	06/26/13	05/21/14
27	Rock Crushing for Leveling and Placement	180 d	05/22/14	11/17/14
28	Rock Placement (protection)	95 d	09/11/14	12/28/14
29	Cable System Testing and Commissioning	3 d	12/29/14	12/31/14
30	SOBI Seabed Crossing Ready to Transmit Power	0 d	12/31/14	12/31/14



Time-Risk Ranging

Lower Churchill Project Time-Risk Assessment

Ranging Sheet - SOBI Seabed Crossing

		Time-Risk Model			Changes in Days	
ID	**Task Description**	**Duration**	**Start**	**Finish**	**Best**	**Worst**
01	Island Link EA	454 d	4-Jan-11	1-Apr-12	150	456
02	**Horizontal Directional Drilling**	**1256 d**	**1-Jun-11**	**7-Nov-14**		
03	Bid, Evaluate & Award HDD Engineering	132 d	1-Sep-11	10-Jan-12	-75	45
04	Geotech Characterization & HDD Engineering	308 d	1-Jun-11	3-Apr-12	-150	150
05	Bid, Evaluate & Award HDD Construction	119 d	4-Apr-12	31-Jul-12	0	90
06	HDD Pre-work (Newfoundland)	30 d	21-Jul-12	19-Aug-12	-10	60
07	Drill Newfoundland Borehole 1 (incl. casing run)	270 d	20-Aug-12	16-May-13	-90	240
08	Drill Newfoundland Borehole 2 (incl. casing run)	270 d	17-May-13	10-Feb-14	-90	120
09	Drill Newfoundland Borehole 3 (incl. casing run)	270 d	11-Feb-14	7-Nov-14	-90	120
10	HDD Pre-work (Labrador)	30 d	21-Jul-12	19-Aug-12	-10	60
11	Drill Labrador Borehole 1 (incl. casing run)	210 d	20-Aug-12	17-Mar-13	-60	160
12	Drill Labrador Borehole 2 (incl. casing run)	210 d	18-Mar-13	13-Oct-13	-60	80
13	Drill Labrador Borehole 3 (incl. casing run)	210 d	14-Oct-13	11-May-14	-60	80
14	**Cable Supply & Installation**	**1420 d**	**4-Jan-11**	**23-Nov-14**		
15	Bid, Evaluate & Award Cable Supply & Installation	365 d	4-Jan-11	3-Jan-12	-30	90
16	Cable Design and Manufacture	836 d	4-Jan-12	18-Apr-14	-120	120
17	Mobilization	49 d	19-Apr-14	6-Jun-14		
18	Pre-lay Survey and Prep.	14 d	7-Jun-14	26-Jun-14	-8	8
19	Cable #1 Lay/Join	14 d	27-Jun-14	10-Jul-14	-4	14
20	Cable #1 Test	2 d	11-Jul-14	12-Jul-14		

Time-Risk Ranging

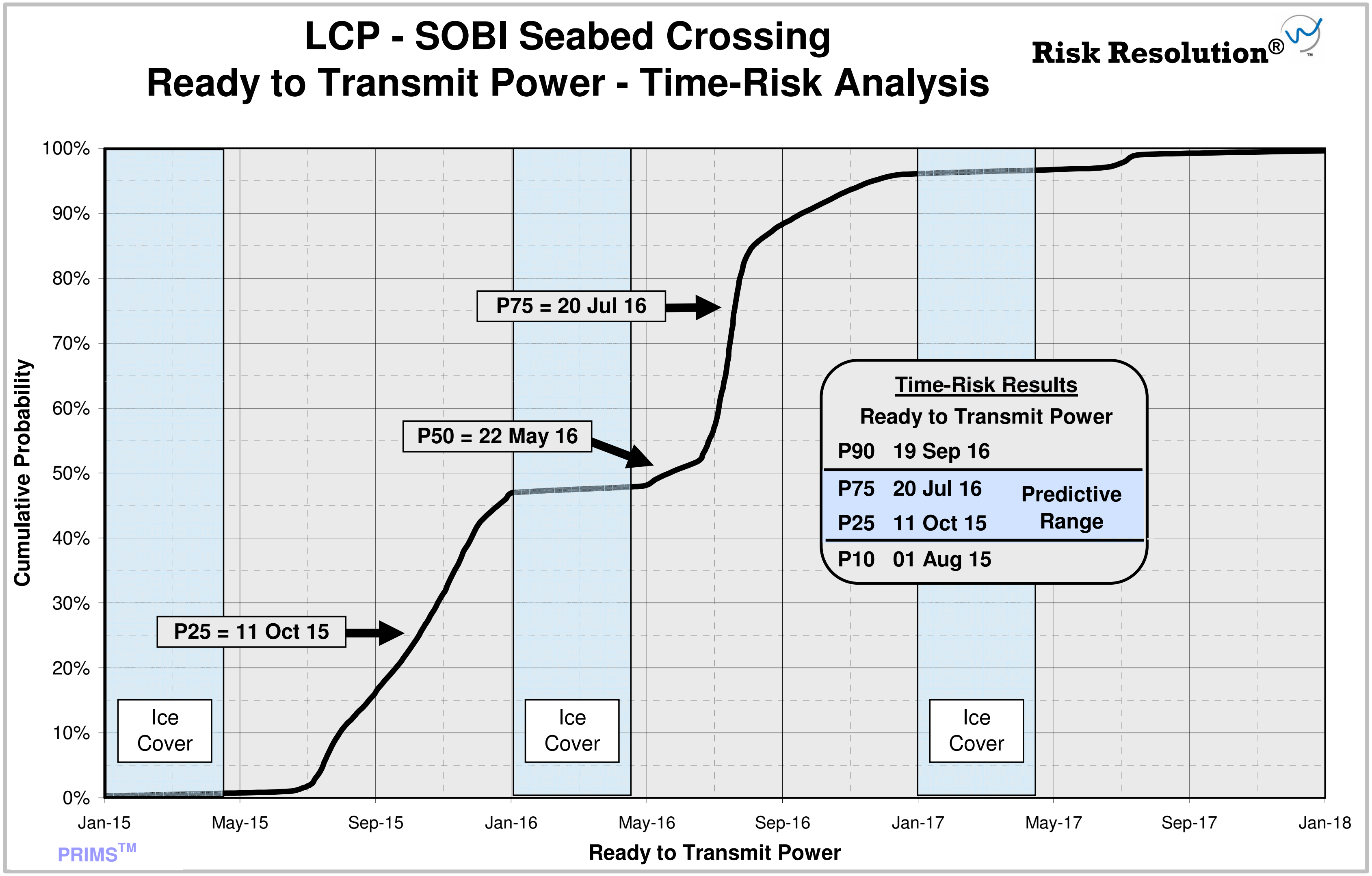
Lower Churchill Project Time-Risk Assessment

Ranging Sheet - SOBI Seabed Crossing

Time-Risk Model					Changes in Days	
ID	**Task Description**	**Duration**	**Start**	**Finish**	**Best**	**Worst**
21	Cable #2 Lay/Join	14 d	13-Jul-14	26-Jul-14	-4	14
22	Cable #2 Test	2 d	27-Jul-14	28-Jul-14		
23	Cable #3 Lay/Join	14 d	8-Nov-14	21-Nov-14	-4	14
24	Cable #3 Test	2 d	22-Nov-14	23-Nov-14		
25	**Cable Protection**	**551 d**	**26-Jun-13**	**28-Dec-14**		
26	Bid, Evaluate & Award Rock Supply & Berm	330 d	26-Jun-13	21-May-14	-210	-90
27	Rock Crushing for Leveling and Placement	180 d	22-May-14	17-Nov-14	-90	0
28	Rock Placement (protection)	95 d	11-Sep-14	28-Dec-14	-8	95
29	Cable System Testing and Commissioning	3 d	29-Dec-14	31-Dec-14	-1	3
30	**SOBI Seabed Crossing Ready to Transmit Power**	**0 d**	**31-Dec-14**	**31-Dec-14**		
	Last Line					

21-Dec-2010 Final Report

Time-Risk Assessment Results

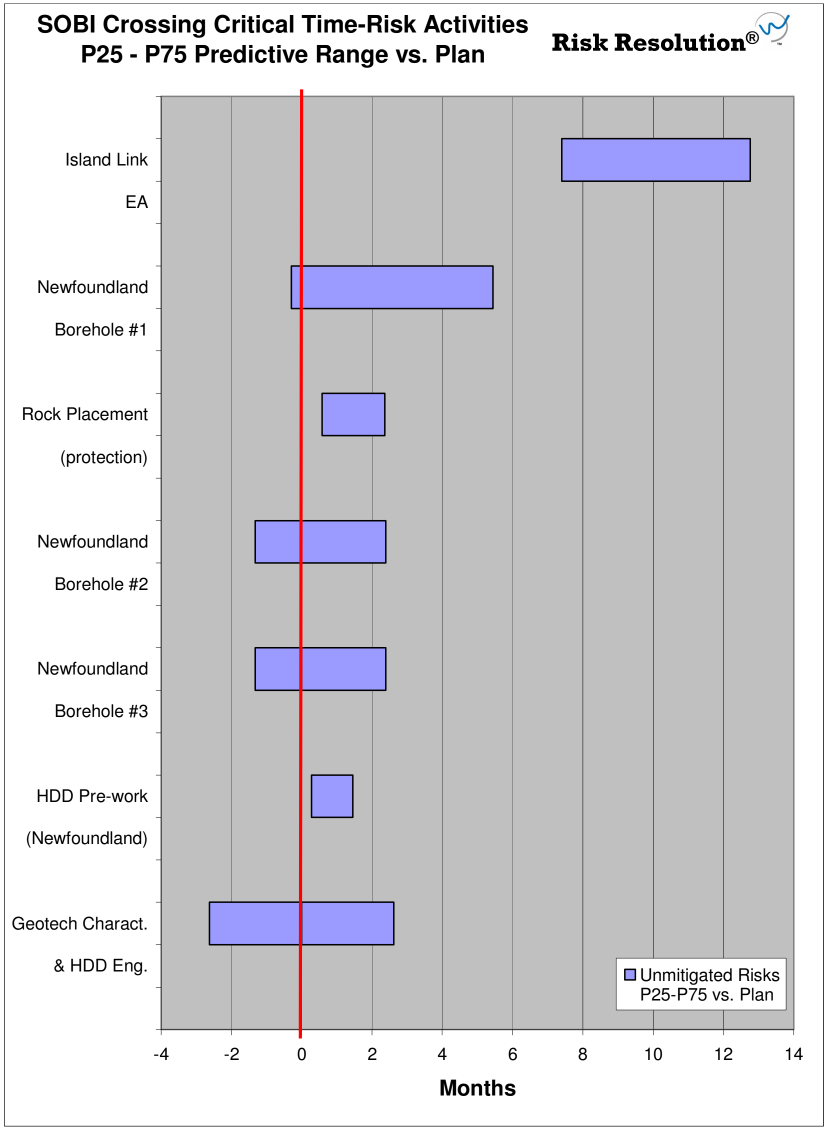


LCP - SOBI Seabed Crossing
Ready to Transmit Power - Time-Risk Analysis

Time-Risk Results
Ready to Transmit Power

P90	19 Sep 16	
P75	20 Jul 16	Predictive Range
P25	11 Oct 15	
P10	01 Aug 15	

Time-Risk Tornado Chart



Percent of Time on
Probabilistic Critical Path

50%

53%

100%

53%

40%

53%

13%

The P25-P75 vs. Plan ranges (shown in blue) indicate which tasks have a high level of uncertainty; the information on probabilistic critical paths indicates the likelihood of a given risk impacting project results.

To accelerate the expected timing of Ready to Transmit Power, it is recommended that risk mitigation efforts focus on those tasks which have a high level of uncertainty and are on the probabilistic critical path a high percentage of the time. It may also be helpful to take action that would change the model logic.

Time-Risk Milestones

Milestone Description	P25	P50	P75
All HDD Complete	28 Jun. 2015	26 Oct. 2015	08 Mar. 2016
Cable #2 Installed/Tested	18 Dec. 2014	09 Jul. 2015	29 Jul. 2015
Rock Placement Complete	05 Oct. 2015	10 May 2016	15 Jul. 2016

Tactical-Risk Assessment

Basis of Assessment

The Tactical-Risk Assessment considers the impact of definition and performance risks on the project cost estimate. Nalcor provided the estimate for the SOBI Crossing. Each cost estimate was broken down by major category. Adjustments were made to the categories to reflect decisions made since the estimate was published.

Westney consultants met with the Nalcor project team to discuss the Best and Worst Case ranges around the estimate for each cost category using input from Risk Discovery as key framing input. The final ranging was performed by Nalcor, but it was vetted and questioned by the Westney Participants. Westney selected the Probability distributions to use with the ranged data and ran the Monte Carlo simulation.

Assessment Results

The P50 of the Tactical-Risk Assessment equates to the cost estimate plus the recommended contingency. The Tactical-Risk Assessment yields the following results for the SOBI Crossing:

	Millions of C$
Tactical-Risk P50:	**$350**
SOBI Crossing Estimate[1]:	**- $310**
Recommended Contingency:	**$40 (13%)**

[1] September 14, 2010 Estimate

nalcor energy
LOWER CHURCHILL PROJECT

Tactical-Risk Ranging

Lower Churchill Project - SOBI Seabed Crossing Tactical Cost Ranging Sheet					Risk Range			
Cost Category	**Original Estimate (C$ M)**	**Spent to Date (C$ M)**	**Special Adjust-ments (C$ M)**	**Cost to be Risked (C$ M)**	**Best - What % Less Could It Cost? (enter as negative)**	**Worst - What % More Could It Cost?**	**Best Cost (C$ M)**	**Worst Cost (C$ M)**
Pre/Post Survey								
Pre/Post Survey	[redacted]			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Pre/Post Survey Total, C$ M	[redacted]	[redacted]	[redacted]	[redacted]				
Horizontal Directional Drilling Site Works								
Horizontal Directional Drilling Site Works	[redacted]			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
HDD Site Works Total, C$ M	[redacted]	[redacted]	[redacted]	[redacted]				
Transition Compounds								
Cost of Compounds	[redacted]			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Site Access / Foteau Excavation	[redacted]			[redacted]	[redacted]	[redacted]	[redacted]	2,250
Transition Compounds Total, C$ M	[redacted]	[redacted]	[redacted]	[redacted]				
Seabed Leveling								
Cost for Rock Placement for Leveling	[redacted]			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Mobilization and Demobilization	[redacted]			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Seabed Leveling Total, C$ M	[redacted]	[redacted]	[redacted]	[redacted]				
Cable Supply								
Cost for 3 Cables	[redacted]			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Cable Supply Total, C$ M	[redacted]	[redacted]	[redacted]	[redacted]				

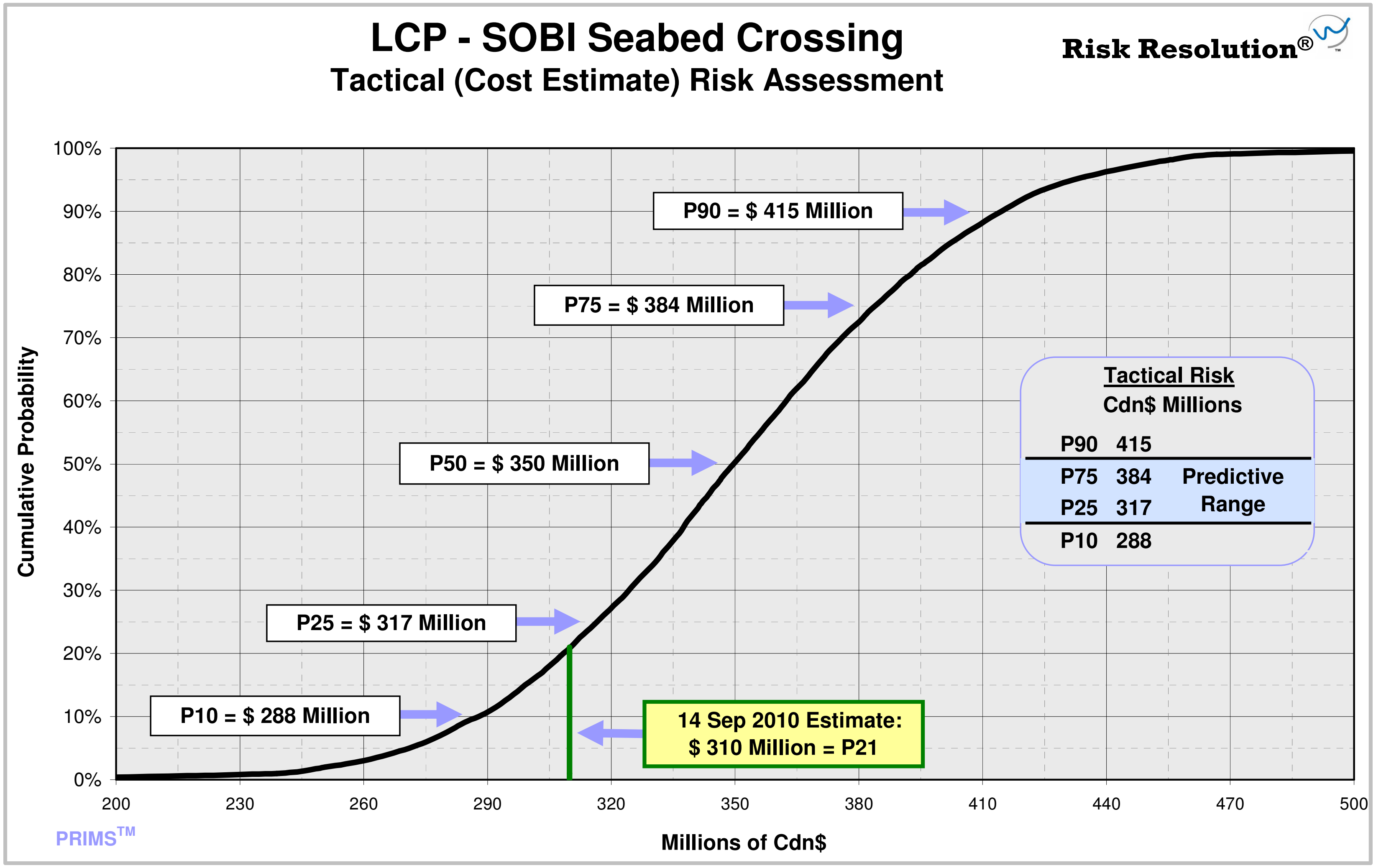
Tactical-Risk Ranging

Lower Churchill Project - SOBI Seabed Crossing

Tactical Cost Ranging Sheet

Cost Category	Original Estimate (C$ M)	Spent to Date (C$ M)	Special Adjust-ments (C$ M)	Cost to be Risked (C$ M)	Risk Range Best - What % Less Could It Cost? (enter as negative)	 Worst - What % More Could It Cost?	 Best Cost (C$ M)	 Worst Cost (C$ M)
Horizontal Directional Drilling								
Mobilization and Demobilization for 2 Rigs	[redacted]			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Contractor Submittals	[redacted]		[redacted]	[redacted]			[redacted]	[redacted]
Cost for 3 Newfoundland Boreholes	[redacted]			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Cost for 3 Labrador Boreholes	[redacted]			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Vessel Cost	[redacted]			[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Horizontal Directional Drilling Total, C$ M	[redacted]	[redacted]	[redacted]	[redacted]				
Cable Installation								
Installation Cost	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Mobilization and Demobilization	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Support Costs	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Cable Installation Total, C$ M	[redacted]	[redacted]	[redacted]	[redacted]				
Rock Berms								
Cost of Rock	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Rock Installation	[redacted]		[redacted]	[redacted]				
Mobilization and Demobilization	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Loading Facility Upgrade	[redacted]		[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Rock Berms (three) Total, C$ M	[redacted]	[redacted]	[redacted]	[redacted]				
Project Total Cost								
Project Total Cost, C$ M	309,923	0	-4,084	305,839				

Tactical-Risk Assessment



Tactical Risk
Cdn$ Millions

P90	415	
P75	384	Predictive Range
P25	317	
P10	288	

Strategic-Risk Assessment

Basis of Assessment

The Strategic-Risk Assessment does not include the impact of tactical risks (i.e., estimate contingency) on the costs of the Lower Churchill Project. This assessment dealt solely with CAPEX issues.

The strategic risks for the SOBI Crossing were identified and framed on a preliminary basis by the Nalcor team. Westney consultants met with the Nalcor project team to discuss possible outcomes for the unmitigated cases. The final ranging was performed by the Nalcor team, but it was vetted and questioned by the Westney participants. Mitigation strategies were endorsed by the project team. The Monte Carlo simulations were run by Westney.

Assessment Results

The Strategic Risk Exposure is the range of the costs that might be incurred that currently would not be incorporated into the estimate. A decision will be required as to whether these risks become costs in the estimate or remain as Risk Exposure above the estimate.

	Predictive Range	
	P25 (mil)	P75 (mil)
Unmitigated Risk Exposure	**$64**	**$136**
Mitigated Risk Exposure*	**$-2**	**$30**

***Includes costs of mitigation.**
All currency is in C$.

Strategic-Risk Modeling

The following probability weightings were used in conjunction with probability distributions to analyze the Strategic Risks and the Risk Mitigations.

Classification	Probability
Remote	0% - 2%
Very Low	3% - 10%
Low	11% - 35%
Medium	36% - 64%
High	65% - 89%
Very High	90% - 97%
Almost Certain	98% -100%

Strategic Risks Considered in Analysis

Key Risks / Possible Mitigations

Probability / Impact ($MM)
Unmitigated
Mitigated*
*including cost of mitigation

Definition Risks

1 Geotechnical evaluation of the HDD sites has not been completed

- Challenging HDD site and drilling conditions
- **Possible Mitigation - significant geotechnical investigation/evaluation**
  - **Pilot hole(s) and other bore samples**
  - **Geotechnical and drilling studies**
  - **Environmental impact analysis**

Medium / $60
Low / $60

2 Final locations for the Transition Compounds not established

- Delayed decisions leading to schedule slippage and cost increases
- Incorrect cable length order/ change during manufacturing
- **Possible Mitigation – Early selection of sites with proper geotechnical /environmental evaluation**
  - **Pilot bore and Geotechnical program**

Very Low / $10
Very Low / $1

3 Final length and specification of subsea cable not established

- Late location of Transition Compounds
- Changed transmission requirements
- Re-routing on seabed
- **Possible Mitigation – Early selection of sites, detailed survey of the seabed route, and Vessel Program**

Very Low / $20
Remote / $1

Strategic Risks Considered in Analysis

Key Risks / Possible Mitigations

Bold Comments are Possible Mitigations

Probability / Impact ($MM)
Unmitigated
Mitigated*
*including cost of mitigation

Definition Risks (Continued)

4 **Thickness and volume of subsea cable rock cover has not been finalized**

- Late changes in the thickness of rock cover
- Late changes in the width of the rock berm
- **Possible Mitigation – Long term current studies**

Very Low / $30
Remote / $1

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5 **Engineering data dependences have not been established**

- 2011 studies, investigations, and surveys may produce inappropriate detail or incorrect information
- **Possible Mitigation – Detailed planning of engineering data requirements and dependencies to verify completeness of planned 2011 investigations, surveys & studies**

Very Low / $30
Remote / $5

Enterprise Risks

6 **EA Significantly delays Cable order and site work**

- Delays placement of cable order – missed manufacturing slot – missed vessel availability
- Delays HDD site work - delays installation and Mechanical Completion
- **Possible Mitigation– increase LCP team resources to allow for proactive management and support of the EA process. Socialize the need for possible funding to procure long-lead items and vessel commitments**

High / $30
High / $30

Strategic Risks Considered in Analysis

Key Risks / Possible Mitigations

Bold Comments are Possible Mitigations

Probability / Impact ($MM)
Unmitigated
Mitigated*
*including cost of mitigation

Enterprise Risks (Continued)

7 **Inability to attract and retain competent resources in Nalcor**

- High turnover of staff
- Rework, errors & omissions, lack of contractor oversight
- **Possible Mitigation – Continue recruiting experienced people, early mobilization, implement HR practices for retention such as mentoring and succession planning, competitive with other local industry practices and rates**

Medium / $20
Very Low / $5

8 **Inability to bid, select, and award contracts in a timely manner**

- Project delays
- Inability to attract high-quality contractors
- **Possible Mitigation – Alignment between Project Team and Supply Chain Management on coordination and requirements. Alignment with Nalcor management on funding requirements, added contracts resources**

Medium / $30
Very Low / $10

9 **Poor governance impacts project and team performance**

- High turnover of project personnel
- Project delays
- Increased rework
- **Possible Mitigation – Clear delegations of authority for both commercial and technical decision-making along realistic timeframes for decisions**

Very Low / $30
Remote / $1

Strategic Risks Considered in Analysis

Key Risks / Possible Mitigations

Bold Comments are Possible Mitigations

Probability / Impact ($MM)
Unmitigated
Mitigated*
*including cost of mitigation

Interface

10 **Transition Compound design and construction activities impact SOBI project performance**

- Interface issues with EPCM delays project
- **Possible Mitigation – Expedite engineering/operational requirements from Transmission Team. Locate Transition compounds where interference with the SOBI project can be minimised (i.e. separation of the landing site and transition compound, linked via land trenching), Interface & MOC processes**

Low / $10
Remote / $1

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11 **Late requirements change from Transmission Project**

- Significant project delays
- Reduced operability:
- **Possible Mitigation – Early design requirements freeze on transmission power requirements, Interface & MOC processes**

Low / $100
Very Low/ $5

Strategic Risks Considered in Analysis

Key Risks / Possible Mitigations

Bold Comments are Possible Mitigations

Probability / Impact ($MM)
Unmitigated
Mitigated*
*including cost of mitigation

Engineering / Technical Risks

12 **Unexpected conditions discovered after start of cable mfg. cause thermal management issues**	– Changes to the design of the rock protection – Water circulation required within the HDD casing – Added ancillary protection (ex. mattresses, grout bags, etc.) – **Possible Mitigation – Geotechnical program/ Pilot bore, Early HDD design, sediment analysis along the route survey, and early cable design for interface and drilling engineer mobilization**	**Very Low / $30** **Very Low / $5**
13 **Deviations during HDD or design errors limit ability to pull/install cable without damage**	– Significant project delay – Possible start up with limited or no redundancy – **Possible Mitigation - Engage experienced engineering and construction contractors. Share risk with HDD contractor if possible, consider insurance products. Mobilize drilling engineer and contracting strategy**	**Very Low / $100** **Remote / $25**

Execution

14 **Iceberg scour damages cable during construction**	– **Low Probability with limited opportunity to mitigate beyond current design. Possible other mitigations include iceberg towing/deflection, flexible installation methods and scheduling, iceberg monitoring program**	**Remote / $30** **Remote / $30**

10-Dec-2010 Draft-For Discussion

Strategic Risks Considered in Analysis

Key Risks / Possible Mitigations

Bold Comments are Possible Mitigations

Probability / Impact ($MM)
Unmitigated
Mitigated*
*including cost of mitigation

Execution (Continued)

15 **Limited Contractor resources and poor performance**

- Design errors, construction rework
- Project Delays / Added Cost
- **Possible Mitigation – Early staffing and engagement, in-depth due diligence on all contractors, communications with local unions, key personnel provisions in contracts**

Low / $30
Very Low / $15

16 **Unavailability of favorable cable manufacturing slots cause delay/added costs**

- Project delays and/or added costs
- Use of lower tier manufacturer introduces additional risks
- **Possible Mitigation – Early definition of cable length and specification, on-going monitoring of targeted companies' backlogs, early bid and interface, availability of early funding to secure commitment**

Very Low / $30
Remote / $1

17 **Unavailability of appropriate vessels cause delay/added cost**

- Project delays and/or added costs
- Use of lower tier manufacturer introduces additional risks
- **Possible Mitigation – On-going monitoring of targeted vessel commitments, early bid to get flexibility, availability of early funding to secure commitments, turnkey contracting strategy of cable manufacture & install**

Very Low / $20
Very Low / $5

Strategic Risks Considered in Analysis

Key Risks / Possible Mitigations

Bold Comments are Possible Mitigations

Probability / Impact ($MM)
Unmitigated
Mitigated*
*including cost of mitigation

Execution Risks (Continued)

18 **Performance issues in the commodity supply chain cause project delays**	– Construction delays and/or added cost – Lowered productivity – **Possible Mitigation – detailed logistics planning by the project team and all contractors**	**Medium / $10** **Very Low / $3**
19 **Significant Weather Downtime (including currents, sea states, etc.)**	– Delayed offshore cable installation / rock placement – Delayed onshore construction – **Possible Mitigation – Start lay early/on time, detailed planning and timely execution to limit the work performed during adverse weather periods, shift liability for weather downtime to contractor**	**Medium / $25** **Very Low / $5**

Other Risks

Other risks such as Foreign Exchange and Inflation were discussed. Because they will be addressed by the Lower Churchill Project as a whole they were not included in this analysis.

Strategic Risks Considered in Analysis

Key Risks / Possible Mitigations

Bold Comments are Possible Mitigations

Impact ($MM)
Unmitigated
Mitigated*
*including cost of mitigation

Opportunities / Risks

20 **Deviation from guidelines set forth in the EA that must be changed after EA sanction (ex change in cable route outside of EA approved zone**

- Possible change in routing reduces/increases length of cable & rock cover
- **Possible Mitigation/Enabling Activity – Review EIS wording to allow maximum flexibility in routing**

-$20 - +$10
-$20 - $0

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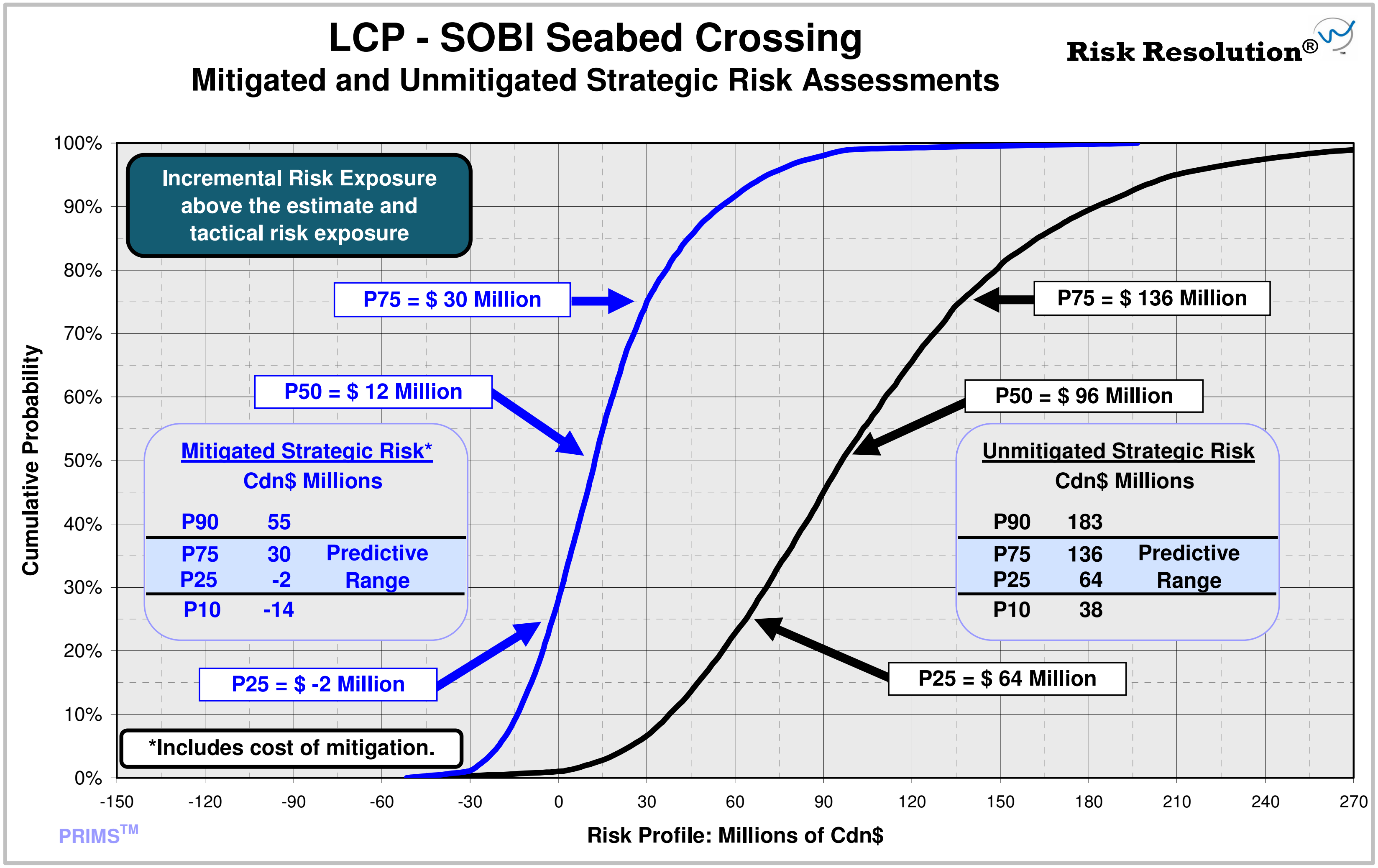
21 **Issues arising due to marine habitat compensation/credits**

- Cable lay / rock cover will change the existing marine habitat. However the installation may provide an improved environment for desirable species.
- **Enabling Activity– Early engagement of appropriate environmental authorities and early application for possible credits**

-$5 - +$5
-$5 - $0

Strategic Risk Exposure



LCP - SOBI Seabed Crossing

Mitigated and Unmitigated Strategic Risk Assessments

Risk Resolution®

Incremental Risk Exposure above the estimate and tactical risk exposure

P75 = $ 30 Million

P50 = $ 12 Million

P25 = $ -2 Million

P75 = $ 136 Million

P50 = $ 96 Million

P25 = $ 64 Million

Mitigated Strategic Risk*

Cdn$ Millions

P90	55	
P75	30	Predictive
P25	-2	Range
P10	-14	

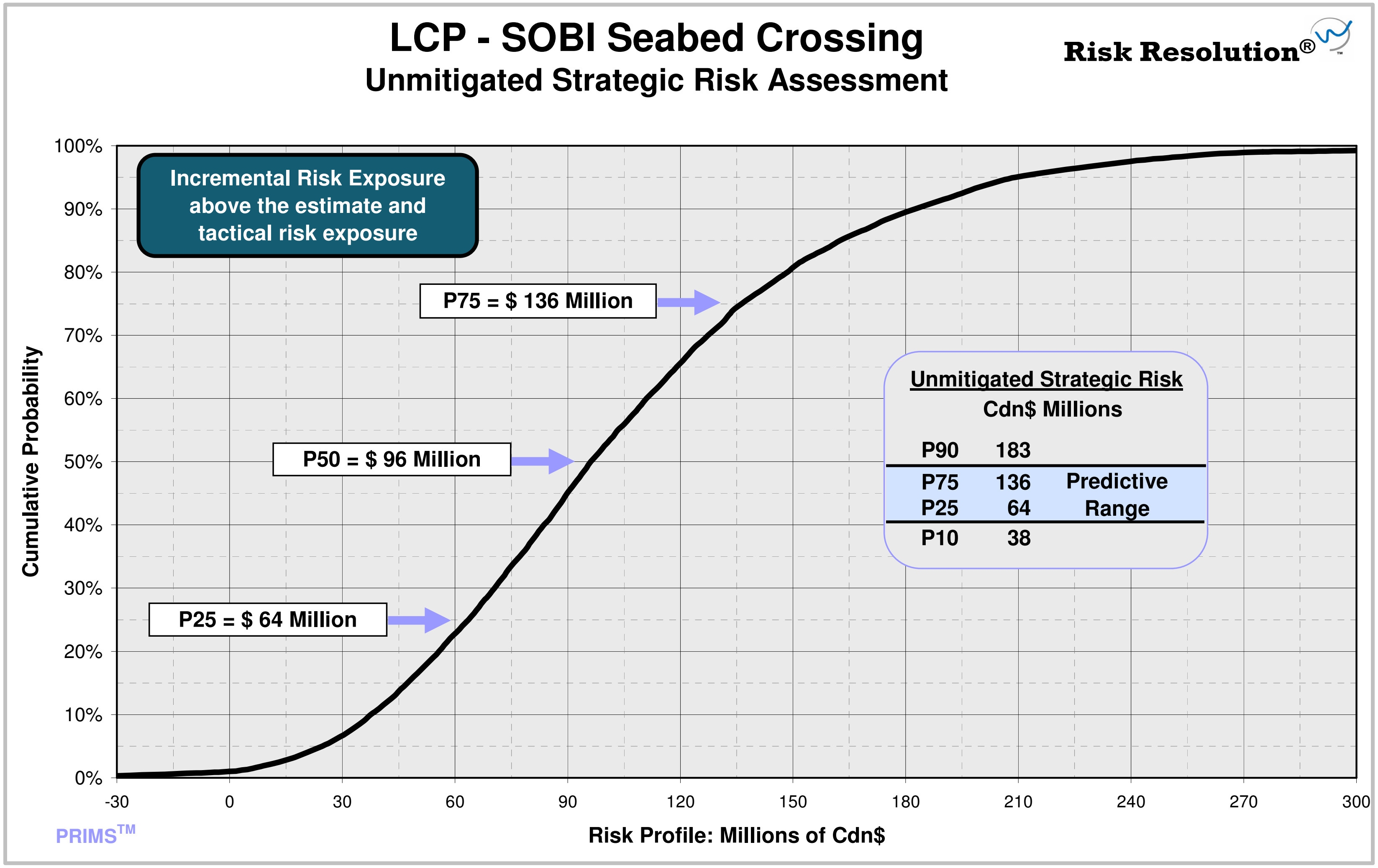
Unmitigated Strategic Risk

Cdn$ Millions

P90	183	
P75	136	Predictive
P25	64	Range
P10	38	

*Includes cost of mitigation.

Unmitigated Risk Exposure



LCP - SOBI Seabed Crossing

Unmitigated Strategic Risk Assessment

Risk Resolution®

Incremental Risk Exposure above the estimate and tactical risk exposure

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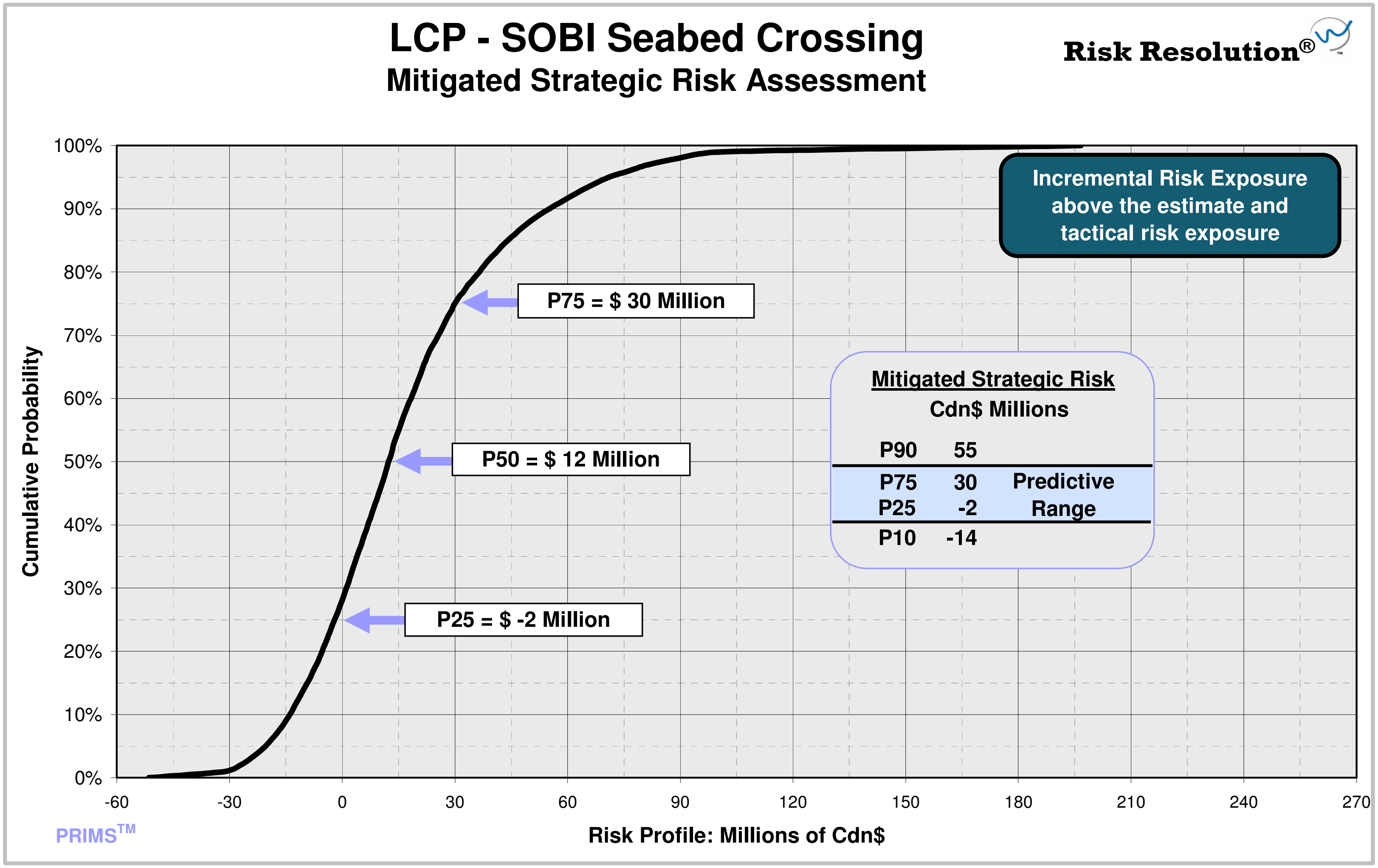
P50 = $ 96 Million

P25 = $ 64 Million

Unmitigated Strategic Risk
Cdn$ Millions

P90	183	
P75	136	Predictive Range
P25	64	
P10	38	

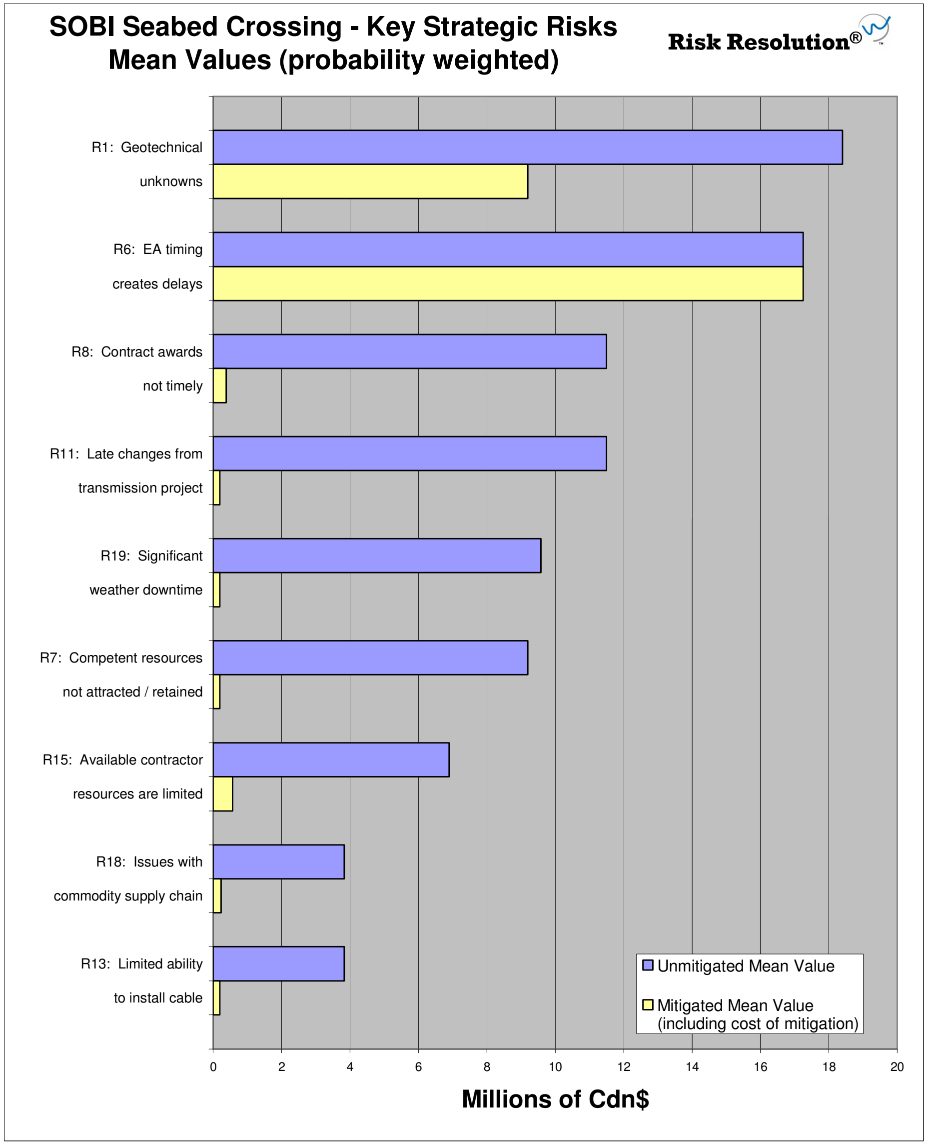
Mitigated Risk Exposure



Mitigated Strategic Risk
Cdn$ Millions

P90	55	
P75	30	Predictive
P25	-2	Range
P10	-14	

Strategic-Risk Tornado Chart



SOBI Seabed Crossing - Key Strategic Risks
Mean Values (probability weighted)

Supplemental Information

Predictive Range

Predictive Range: The term predictive range is used throughout this report when describing the results of Monte Carlo simulations for all types of risk assessments. Specifically, the predictive range refers to the P25 to P75 band of results for a given assessment. Because the predictive range is comprised of the middle 50% of the results, it is usually thought to be the most relevant indicator of future outcomes when assessing a modeled situation.

Weather Windows - Time-Risk Activities

The following weather windows are used in the Time-Risk analysis:

For Task 18: Pre-lay Survey and Prep.
Task 19: Cable #1 Lay/Join
Task 21: Cable #2 Lay/Join
Task 23: Cable #3 Lay/Join
Task 28: Rock Placement (protection)

January 1 – April 15: Ice Cover - No offshore activity
April 16 – June 15: 25% productivity
June 16 – November 30: 100% productivity
December 1 – December 31: 50% productivity