Fundy Ocean Research Centre for Energy

Environmental Assessment Addendum (2021)

To the reports:

- Environmental Assessment Registration Document: Fundy Tidal Energy Demonstration Project, Volumes 1 and 2 (June 10, 2009)
- Environmental Assessment Addendum (July 22, 2010)
- Environmental Assessment Addendum (May 4, 2015)

Prepared By:
Fundy Ocean Research Centre for Energy

February 23, 2021

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Mr. Jeremy Higgins
Environmental Assessment Branch
NS Department of Environment
Suite 2085, 1903 Barrington Street
PO Box 442, Halifax, NS, B3J 2P8

RE: Addendum for FORCE Environmental Assessment Approval

Dear Mr. Higgins,

I write to inform you of proposed changes at Fundy Ocean Research Centre for Energy (FORCE) that may affect its Environmental Assessment approval, granted June 10, 2009 and amended July 22, 2010 and May 4, 2015. Attached to this letter is an Environmental Assessment Addendum report for your review and consideration.

In brief, two new demonstration technologies are being introduced to the project: the first is the PLAT-I, a smaller floating platform, used by both Sustainable Marine Energy and Minas Tidal, and replacing their previous designs; both projects are now administered by Spicer Marine Energy. The second is BigMoon Power's prototype. In September 2020, Nova Scotia Department of Energy and Mines announced that an independent procurement administrator selected BigMoon to fill berth D. As part of the agreement with the Province, the company will also remove Cape Sharp Tidal's non-operational turbine.

While the overall scope of demonstration projects approved by the Province at FORCE remains 22 megawatts, a project update is attached given changes to berth holder composition, berth location, and Nova Scotia Department of Energy and Mines' licensed projects since 2015.

FORCE was approved under a joint federal/provincial EA, but is applying for an amendment under the Nova Scotia Environment Act due to amendments to the former Canadian Environmental Assessment Agency's Project List (2012). We continue to engage federal regulators in other matters in their jurisdiction, particularly relating to marine life and navigation.

The attached report provides an overview of EA changes from original approval to the present proposal, an overview of FORCE's environmental monitoring and engagement activities since the 2015 addendum, and new project descriptions for 2021 from individual berth holders.

Please don't hesitate to contact me should you have additional questions or concerns. I can be reached at (902) 406-1166 or Tony.Wright@fundyforce.ca

Sincerely,

Tony Wright, General Manager
Fundy Ocean Research Centre for Energy

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Appendices

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Appendix B. DP Energy: Berths B and E

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Acronym List

ADCP – Acoustic Doppler Current Profiler
CEAA – Canadian Environmental Assessment Act
CLA – Crown Lease Area
DFO – Federal Department of Fisheries and Oceans
EA – Environmental Assessment
EMAC – Environmental Monitoring Advisory Committee
EEMP – Environmental Effects Monitoring Plan
EMP – Environmental Management Program
FAST – Fundy Applied Sensor Technology
FORCE – Fundy Ocean Research Centre for Energy Limited
MRE – Marine Renewable Energy
MW – Megawatt
NRCan - Natural Resources Canada
NSDEM – Nova Scotia Department of Energy and Mines
NSE - Nova Scotia Environment

1.0 Introduction

1.1 Introduction

The Fundy Ocean Research Centre for Energy was created and commissioned by the Province of Nova Scotia to explore the potential for tidal stream energy to contribute to the province's future clean energy supply. While still an emerging technology, tidal stream has the potential to:

- Provide clean, sustainable electricity
- Reduce greenhouse gas emission from electricity generation
- Contribute to action on climate change
- Spur industrial and local economic growth by capitalizing on skills and assets already present in other sectors
- Meet up to 100% of Nova Scotia's energy needs during flow and ebb tides

Tidal stream technology offers a significant strategic advantage over wind and solar: it is predictable. Tidal energy is not weather dependent; its power is derived by the movement of the earth combined with the gravitational influence of the sun and moon. This offers utilities an ability to reliably predict tidal resource levels years in advance.

Over the past decade, the Governments of Nova Scotia and Canada have established supportive policy, made key investments in technology demonstration infrastructure and technical and environmental research, and spurred activity by connecting a steadily growing supply chain of Atlantic Canadian businesses – over 500 companies have participated in the sector to date. As a result, Nova Scotia is often recognized for its strategic approach, slowly building the experience, knowledge, and innovation necessary to advance tidal sector activity.

Challenges remain: the sector has not yet converged on a single design solution for energy capture or mooring, working with new technologies in marine environments is expensive, and more research is required to understand any potential environmental effects.

Nova Scotia's tidal stream sector faces many of the same challenges the global sector faces: lack of market, challenges attracting finance, knowledge and technology gaps, and depending on location, insufficient infrastructure. FORCE was created to respond to these challenges.

1.1 FORCE

The Fundy Ocean Research Centre for Energy (FORCE) is a world-leading demonstration facility for tidal stream technology, located in the Minas Passage – home to the world's highest tides. FORCE has two major roles: host and steward to tidal stream energy activity.

Host:

FORCE acts as a host to tidal stream developers, providing a shared observation facility, subsea power cables and grid connection. Since the original EA approval, FORCE has:

- Built and installed an 11km network of 34.5kV subsea power cables
- Built and activated a 30MW substation and associated electrical equipment
- Built and maintained a public observation facility with over 30,000 guests since opening
- Hosted three tidal stream device deployments
- Conducted over 10,000 hours of site characterization work

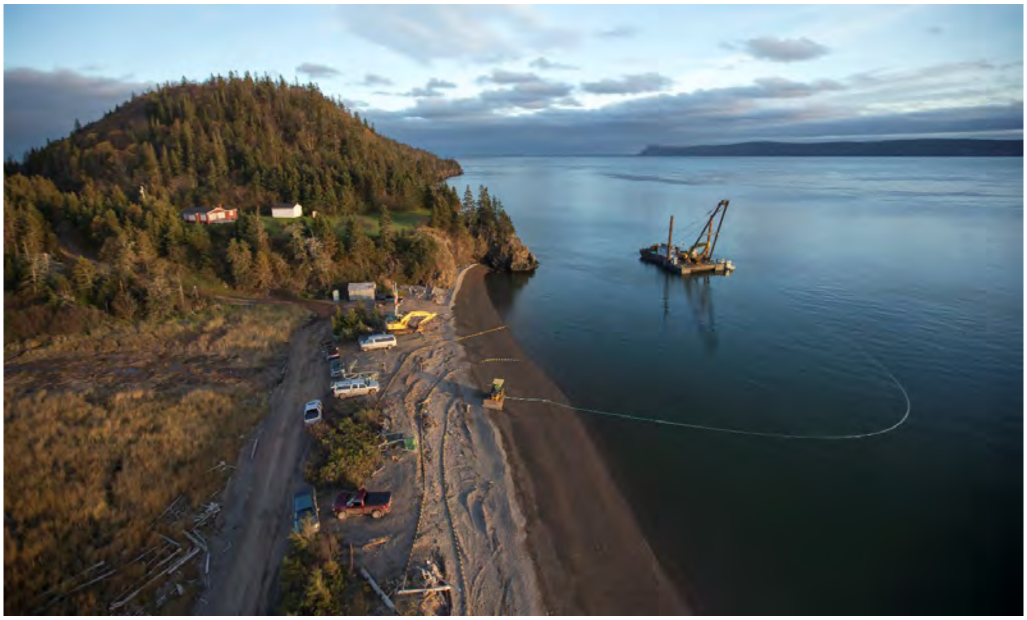

Figure 1. Power cables come ashore at FORCE.

There are currently five sites permitted for a total of 22 MW at FORCE, allotted as follows:

Table 1: Present FORCE Berth Allotments

BERTH	ENTITY
A	Minas Tidal Limited Partnership (MTLP)
B	Rio Fundo Operations Canada Ltd. (RFOCL) (DP Energy-owned)
C	Sustainable Marine Energy Canada (SMEC)
D	Big Moon Power Canada. (BMP) (former Cape Sharp Tidal Venture berth)
E	Haligonia Tidal Energy Ltd. (HTEL) (DP Energy-owned)

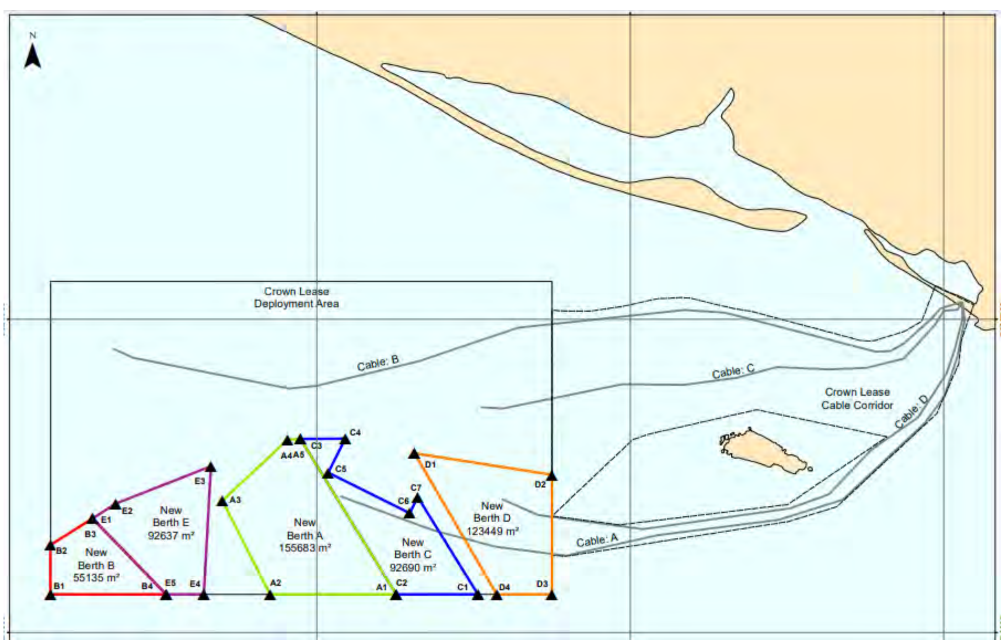

Figure 2. Locations of berths

OpenHydro, now defunct, deployed three tidal stream devices at FORCE; while the company ultimately failed, they reached critical milestones in the demonstration process: a tidal stream device in the Minas Passage can be deployed, retrieved, connected to subsea cabling, generate power, and supply electricity to the provincial grid.

As host, FORCE is expecting activity in the forthcoming year: Sustainable Marine Energy Canada (SMEC) announced successful energy generation from its 280-kilowatt floating platform PLAT-I in Grand Passage in 2019, and has been granted a license for a 1.26MW tidal array at FORCE in 2021 from Nova Scotia's Department of Energy and Mines (NSDEM).


Figure 3. SME's PLAT-I platform installed in Grand Passage, NS

DP Energy announced the successful deployment of ADCPs at berth E with support from Nova Scotia companies Seaforth Geosurveys and Huntley's Sub Aqua Construction in 2019, in preparation for the deployment of six Andritz Hydro Mk1 1.5MW seabed mounted tidal turbines. In September 2020, NSDEM also announced that the tender for a new developer at berth D was awarded to Big Moon Power Canada; this tender includes the removal and disposal of the existing OpenHydro turbine.

Steward:

FORCE acts as a steward to the site, in accordance with the conditions of its Environmental Assessment approval and fundamental to FORCE's mandate: to better understand the effects turbines have on the environment and report these findings to the public.

FORCE has increased its capacity for science leadership significantly in recent years, enabling FORCE to speak with expertise to regulators, scientists, academics and stakeholders on fisheries management, and is also able to design studies in-house as FORCE continues to adaptively manage its environmental effects monitoring programs. After spending the first five years focused on capital construction of onshore and offshore assets, FORCE has spent the last five years sharpening its focus on environmental stewardship. Staff are now primarily science-based, including a core group of research scientists and ocean technologists, who are working to better understand the physical and biological conditions of this site.

Since the start of the project in 2009, FORCE has conducted baseline environmental studies, applied research, and environmental monitoring work at its site in the Minas Passage. FORCE receives ongoing monitoring advice through an independent environmental monitoring advisory committee, with membership from the scientific, fishing, and First Nations communities.

To date, international research studies of tidal stream devices indicate that fish and marine mammals generally avoid turbines. But this must be proven conclusively in the Minas Passage. This remains difficult: the intense turbulence characteristic of the FORCE site makes it challenging for sensors to capture optical and acoustic data. This means not only environmental monitoring but also research and data modelling programs are all critical to retiring risk and uncertainty about potential impacts.

Much of FORCE's science work is conducted with partners: these include the University of Maine, the Sea Mammal Research Unit Consulting (Canada), Envirosphere Consultants, Acadia University, TriNav Fisheries Consultants, JASCO Applied Scientists, Ocean Sonics, Dalhousie University, Nexus Coastal Resource Management, and Geospectrum.

Figure 4. C-PODs: Ocean technology staff haul a C-POD SUBS package aboard during recovery.

Monitoring: FORCE's environmental effects monitoring program (EEMP) is designed to better understand the natural environment of the Minas Passage and the potential effects of turbines as related to fish, seabirds, marine mammals, lobster, marine noise, benthic habitat and other variables. All documents are available online: fundyforce.ca/document-collection

Since 2016, this work now represents more than 4,300 'C-POD' marine mammal monitoring days, over 400 hours of hydroacoustic fish surveys, bi-weekly shoreline observations, 49 observational seabird surveys, as well as lobster surveys, drifting marine sound surveys and additional sound monitoring.

Research: FORCE advances research through its growing team of science personnel and onshore and offshore assets. Dr. Dan Hasselman and Dr. Joel Culina, two leading experts in fish monitoring and hydrodynamics, together with FORCE's team of ocean field technologists, are able to deliver a sector-leading science program in partnership with universities and other research entities.

FORCE's onshore assets include a meteorological station, video cameras, an X-band radar system, and tide gauge. Offshore assets include modular subsea platforms for both autonomous and cabled data collection and a suite of instrumentation for a variety of research purposes. Research priorities are based on consultation with regulators, other Fundy users, academics, and industry; each project is aimed at reducing risk. Projects include:

Hydroacoustics Platform: comparing bottom-mounted fish profiling data collection to downward facing fish profiling data from vessel transects, this may determine both the most effective way to monitoring fish long term in tidal energy sites.

***Cabled Platform*:** delivering real-time monitoring data from near-turbine locations using a variety of sensors (like the Tritech Gemini imaging sonar) to detect marine life in the vicinity of operating turbines. This platform may prove to be an essential piece of monitoring equipment.

***The Vectron*:** the world's first stand-alone instrument to remotely measure turbulence in the mid-water column in high resolution. Vectron analysis will help tidal energy companies to better design devices, plan marine operations, and characterize the tidal energy resource.

In addition, new tools are being developed to assist in assessing the impacts of the turbines under the FAST program. The projects within this program will enable technology innovation and development of high flow technologies and techniques, providing information on currents turbulence, marine life activity, noise levels, and seabed suitability at the hub height of the deployed turbines.

RAP: the Risk Assessment Program (RAP) for tidal stream energy is designed to create a detailed, credible assessment tool to gauge the probability that fish will encounter a tidal device. The encounter probability will be determined by combining two real-world data sets:

- Biological Data: RAP will build the largest multi-species, spatiotemporal data set of fish distribution in the Bay of Fundy (through the analysis of hydroacoustic tagging data for multiple species).
- Physical Data: RAP will build a high-resolution radar network to create the first spatiotemporal flow atlas of the Minas Passage. This upgrades existing site data to deliver real-time hydrographic mapping of currents, eddies, and waves–important determinants of marine animal distribution..

This is a team effort, involving many partners critical to conducting this research. That includes:

- The Ocean Tracking Network at Dalhousie University
- The Mi'kmaw Conservation Group
- Acadia University
- Marine Renewables Canada

1.2 Background

The original 2009 EA was a joint Federal/Nova Scotia Process directed by the NS Federal / Provincial One Window Committee on Tidal Energy comprised of the relevant regulatory and permitting agencies. This joint process was established to minimize duplication between federal and NS EA processes. It was agreed that FORCE would prepare the EA Registration Document for the complete project, so that new individual berth holders would not be required to make an EA application independently. This was agreed upon as long as their tidal stream energy device occupied one of the existing berths in the FORCE CLA; replaced one of the turbines being tested; and, was not predicted to have significantly different environmental impacts identified under the approved EA. Each berth holder, however, was required to apply and secure all permits for their individual turbines and berth. The Project received its EA Approval on September 15, 2009.

In July 2010, FORCE submitted an EA Addendum on changes to the FORCE project since the original EA Approval, including: the location of the landfall site; the construction of transmission line; and, the addition of a fourth TISEC berth and power cable. The purpose of the Addendum was to identify if there were any additional environmental impacts based on the above noted project changes. NS Environment officially responded to FORCE on July 27, 2010 indicating that no further environmental assessment was required under NS regulations at that time as they did not see the project changes, including the addition of the fourth berth, as a significant change.

In 2012, an expansion of the FORCE EA approval was selected by the Energy and Mines Ministers' Conference's 'Regulatory Reform Working Group' ('RRWG') to serve as a pilot project designed to improve alignment of federal-provincial/territorial regulatory systems. The intent was to seek approval, from both federal and provincial regulators, to amend the existing EA approval to a larger (potentially 20-megawatt (MW)) facility. In light of amendments to the *CEAA* (2012) Project List, the proposed expansion of the FORCE facility no longer fell under federal jurisdiction, therefore, removing the FORCE project from the RRWG.

In May 2015, FORCE submitted a second EA Addendum; project changes included: 1) the deployment of small arrays; 2) the deployment of new technologies; and 3) the creation of a fifth berth (Berth E). Nova Scotia Environment officially responded to FORCE on November 10, 2015, authorizing the proposed amendments.

1.3 Present Request

FORCE is proceeding with requesting the approval of a third EA addendum from the NSE EA branch. This EA Addendum Report is organized to describe the changes to the Project:

- Section 2.0 describes the nature of the changes to the Project from what was originally proposed and approved in 2009, 2010, and 2015.
- Section 3.0 provides a summary of environmental effects monitoring for the valued environmental components which may be affected by Project changes and identified in the original EA Registration Document.
- Section 4.0 describes stakeholder engagement conducted to date and ongoing regarding the Project.
- Section 5.0 provides a detailed summary of the proposed amendments.

2.0 Environmental Assessment (EA) Approvals

2.1 EA Approval (2009)

The original scope of the Project, given EA approval on September 15, 2009, was for FORCE to construct, operate, and decommission a 'Tidal Energy Demonstration Facility' with the following objectives:

- To build and operate a test centre to test the commercial potential of in-stream tidal energy devices;

- To acquire information to assess the performance of these devices/turbines, including environmental impacts; and
- To develop monitoring techniques and methodologies for these in-stream tidal energy devices/turbines.

At the time of the approval, three turbines were approved for deployment with the expectation each would be deployed for a period of one (1) to four (4) years prior to removal. The intent of the Project was to address the potential impacts associated with the short-term deployments of the three turbines listed in Table 2: Original Devices Scheduled for Deployment.

Table 2: Original Berth Holders (2009)

Berth Holder	Device Description
Clean Current Power	2.2 MW shrouded turbine with a gravity base
NS Power	1.0 MW OpenHydro shrouded turbine with a gravity base
Minas Energy	1.2 MW Marine Current Turbines device drilled into a subsea foundation; surface piercing

2.2 EA Addendum (2010)

The 2010 EA Addendum, accepted July 27, 2010 followed a $20M award from Natural Resources Canada (NRCan) under the Clean Energy Fund (CEF), and included a revised location for the landfall portion of the project, the addition of a fourth berth and subsea electrical cable, and construction of a transmission line. The new turbine design for the fourth berth had not been selected, but was anticipated to be similar to others previously approved and, therefore, did not warrant a reassessment of in-stream tidal energy technologies.

As noted under Section 1, NSE determined that no further environmental assessment work was required in relation to FORCE's EA Addendum request, but that the project was subject to the Terms and Conditions of the original EA Approval. NRCan approved the screening in February 2011 with no additional conditions related to the marine FORCE demonstration area. The terrestrial conditions in the approval related to the addition of the Transmission Line. FORCE also committed, in addition to having an archaeologist on site, to informing the First Nations in advance, and inviting their participation, of any excavation where there is the potential for the discovery of historical and/or First Nations artifacts.

Table 3: Berth Holders (2010)

Berth Holder	Device Description
Alstom	1 MW design based on Clean Current shrouded turbine with a gravity base
NS Power	1.0 MW OpenHydro shrouded turbine with a gravity base
Minas Energy	1.2 MW Marine Current Turbines device drilled into a subsea foundation; surface piercing
Atlantis Resources Canada	1.0 MW AK-1000 shrouded turbine with a gravity base

2.3 EA Addendum (2015)

The 2015 Addendum, authorized November 10, 2015, arose from a change in the project scope assigned to each berth holder. Berth holders indicated to the Province that the financial market collapse of 2008 had negatively impacted the clean tech sector's ability to secure financing for early stage "one-off" single devices, and without a pathway to arrays they were unable to find investors. The 2014 Strategic Environmental Assessment Update of the Bay of Fundy also noted that "demand for sites that can host arrays of turbines for commercial purposes (rather than for demonstration of their technologies, which have been tested elsewhere), is increasing." In response, the NS Department of Energy increased the project scope: tendering a vacant berth (berth D) for 4MW and assigning individual berth increases up to 5MW (from a previous maximum of 2MW). The addendum reflected this increase, as well as changes to both berth holders and their technologies, and the creation of a fifth berth (berth E) for DP Energy.

Table 4: Berth Holders (2015)

Berth Holder	Device Description
Minas Energy	2 x 2MW SeaGen F Floating Platform (Siemens/BlueTEC design)
Black Rock Tidal Power	2 x 2.5MW Triton - large subsea foundation with multiple small turbines; pivot for surface access
Atlantis Resources Canada	3 x 1.5 MW AR-1500 horizontal axis turbine with subsea foundation
Cape Sharp Tidal	2 x 2.0 MW OpenHydro shrouded turbine with a gravity base
DP Energy	3 x 1.5 MW Andritz Hydro Hammerfest horizontal axis turbine with subsea foundation

2.4 EA Addendum (2021)

While the overall scope and the total nameplate capacity of the demonstration projects approved by NSDEM at FORCE has not changed since the 2015 addendum (remaining at 22 megawatts), NSDEM has approved several changes to berth holder technologies. Two new technologies are being introduced to the project: the *PLAT-I*, a smaller floating platform, used by both Sustainable Marine Energy Canada and Minas Tidal and replacing their previous designs, and Big Moon Power's BMP generator. All but one berth (berth E) has seen a change to technology, project composition, and/or berth location. These changes include:

- Berth A, Minas Tidal, technology change to PLAT-I device
- Berth C, technology change to Sustainable Marine Energy (SMEC)'s PLAT-I device
- Co-management of berths A and C by Minas Tidal and SMEC by Spicer Marine Energy, (and together referred to as the *Pempa'q Tidal Energy Project*)
- Berth B, Rio Fundo Canada, change of technology (to Andritz Hydro Hammerfest) and change of berth location (closer to existing berth E, Haligonia Tidal Energy Ltd. (HTEL))
- Co-management of berths B and E by DP Energy
- Berth D, project developer and technology change to the Big Moon Power generator

The chart below illustrates changes from the last addendum; in addition, the colour coding indicates that two sets of berths will be co-managed.

Table 5: Berth Holders (2021)

Berth Holder	Device Description
Minas Tidal (Berth A)	9 x 420kW PLAT-I surface floating platform; blades swing up for surface access.
Sustainable Marine Energy Canada (Berth C)	12 x 420kW PLAT-I (Berths A + C are co-managed by Minas Tidal and SMEC; total project scope is 9MW. See Project Description for more info)
Rio Fundo Operations Canada Ltd. (DP Energy-owned) (Berth B)	3 x 1.5 MW device horizontal axis with subsea foundation
Haligonia Tidal Energy Ltd. (DP Energy-owned) (Berth E)	3 x 1.5 MW device horizontal axis with subsea foundation
Big Moon Power Canada	0.5MW BMP Kinetic Platform; surface platform directs flow of water into kinetic wheel chamber via accelerator plates

Additional details on the proposed amendments are provided in section 5 and in the attached appendices.

3.0 Environmental Effects Monitoring Program

3.1 Overview

FORCE's environmental effects monitoring program (EEMP) is designed to better understand the natural environment of the Minas Passage and the potential effects of turbines.

This is a central condition of FORCE's 2009 EA approval – to provide comprehensive, ongoing, and adaptive environmental management. FORCE posts all monitoring reports online at: www.fundyforce.ca/document-collection

FORCE's monitoring program was developed in consultation with SLR Consulting (Canada), and strengthened by review and contributions by national and international experts and scientists, provincial and federal regulators, and FORCE's environmental monitoring advisory committee (EMAC), which includes representatives from scientific, First Nations, and fishing communities.

The EEMP was designed to:

- monitor the environmental effects of operating turbines
- focus on five subject areas: lobsters, fish, marine mammals, seabirds, and marine noise
- be adaptive, based on monitoring results and input from regulators and EMAC

While monitoring began in 2009, the most critical work encompasses May 2016 to present, spanning turbine pre-deployment, deployment and operation, and retrieval.

The design and completion of monitoring data collection and analysis is conducted with academic and research partners, including the University of Maine, the Sea Mammal Research Unit Consulting (Canada), Nexus Coastal Resource Management, Envirosphere Consultants, Acadia University, Dalhousie University, TriNav Fisheries Consultants, JASCO Applied Science, Ocean Sonics, and GeoSpectrum Technologies Inc.

Monitoring is divided into *near-field* (100m or less from a tidal stream device) and *mid-field* (more than 100m). FORCE leads mid-field monitoring; individual berth holders – as approved by regulators – lead near-field monitoring, in recognition of the unique design and operational requirements of different tidal stream technologies. Both near-field and mid-field monitoring programs are reviewed by EMAC and federal and provincial regulators prior to turbine installation.

Also, before device installation FORCE and berth holders submit an environmental management plan (EMP) to regulators for review. EMPs include environmental management roles and responsibilities and commitments, environmental protection plans, maintenance and inspection requirements, training and education requirements, and reporting protocols.

Overall, the risks associated with single device or small array projects at FORCE are anticipated to be low given the relative size and scale of devices. OpenHydro's two-megawatt turbine represents approximately 1/1,000th of the cross-sectional area in the Minas Passage (Figure 1). But a full evaluation of the risks of tidal stream energy devices will not be possible until more are tested over a longer-term period with monitoring that documents local impacts, considers far-field and cumulative effects, and adds to the growing global knowledge base.

Figure 5. The scale of a single turbine (based on the dimensions of the OpenHydro turbine deployed by CSTV, indicated by the red dot and above the blue arrow) in relation to the cross-sectional area of the Minas Passage. The Passage reaches a width of ~ 5.4 km and a depth of 130 m.

3.2 International Effort

FORCE's research and monitoring is part of an international effort to evaluate the risks tidal energy poses to marine life. Presently, countries such as China, France, Italy, the Netherlands, South Korea, the United Kingdom, and the United States are exploring tidal energy, supporting environmental monitoring and innovative R&D projects. Recent research includes assessments of operational sounds on marine fauna, the utility of PAM sensors for monitoring marine mammal interactions with turbines and collision risk, and the influence of tidal turbines on fish behavior.

Through connections to groups supporting tidal energy demonstration and R&D, FORCE is working to inform the global body of knowledge pertaining to environmental effects associated with tidal power projects. This includes participation in the Fundy Energy Research Network,[1] the UK-based Offshore Renewables Joint Industry Programme,[2] TC114,[3] and the Atlantic Canadian-based Ocean Supercluster.[4]

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[1] FERN is a research network designed to" coordinate and foster research collaborations, capacity building and information exchange" (Source: fern.acadiau.ca/about.html).
[2] ORJIP is a UK-wide collaborate programme of environmental research with the aim of reducing consenting risks for marine energy projects. Learn more: www.orjip.org.uk
[3] TC114 is the Canadian Subcommittee created by the International Electrotechnical Commission (IEC) to prepare international standards for marine energy conversion systems. Learn more: tc114.oreg.ca.
[4] The OSC was established with a mandate to "better leverage science and technology in Canada's ocean sectors and to build a digitally-powered, knowledge-based ocean economy." Learn more: www.oceansupercluster.ca.

Another key group is OES Environmental (formerly Annex IV): a forum to explore the present state of environmental effects monitoring around MRE devices.[5] Last year, FORCE worked with OES Environmental members[6] to discuss best management practices regarding data transferability: i.e. transferring data from an already permitted/consented MRE project or analogous industry to inform potential environmental effects and consenting for a future MRE project; and collection consistency: i.e. transferring practices and learnings across jurisdictions and project sites.

FORCE Science Director, Dr. Daniel J. Hasselman, collaborated with 14 co-authors from around the world representing academic institutions, governmental organizations, non-governmental organizations, and other relevant stakeholders to produce a chapter entitled 'Environmental Monitoring Technologies and Techniques for Detecting Interactions of Marine Animals with Turbines' for the OES 'State of the Science Report 2020'. The chapter describes the state of development of environmental monitoring around tidal energy turbines, the outcomes that have been shown, and a process for applying consistent monitoring practices.

The report was published June 8, 2020. Lead author of the report, Dr. Andrea Copping, an oceanographer with the U.S. Department of Energy's Pacific Northwest National Laboratory, made the following general comments regarding the 2020 report:

- *We believe that small numbers of operational marine energy devices are unlikely to cause harm to marine animals, including marine mammals, fish, diving seabirds, and benthic animals; change habitats on the seafloor or in the water significantly; or change the natural flow of ocean waters or waves.*
- *Despite our findings, we still need more data about what might, or might not, happen to animals swimming close to operating turbines underwater. In the years to come, we will continue to focus our research on examining this issue and building our knowledge base to help progress this important renewable energy industry.*

FORCE will continue to work closely with OES Environmental and its members to document and improve the state of knowledge pertaining to MRE devices' interactions with the marine environment.

3.3 EEMP Study Areas

Working in partnership with universities, research entities, and local marine operators, FORCE has led a monitoring program focused on the five key variables mentioned above: fish, marine mammals, lobster, seabirds, and marine sound. Since 2016, FORCE has completed:

- Over 560 hours of hydroacoustic fish surveys
- Over 5,000 'C-POD' marine mammal monitoring days
- Bi-weekly shoreline observations
- 49 observational seabird surveys
- Four drifting marine sound surveys and additional sound monitoring, and
- 11 days of lobster surveys

[5] Annex IV was established by the International Energy Agency (IEA) Ocean Energy Systems (OES) in January 2010 to examine environmental effects of marine renewable energy development. Further information is available at https://tethys.pnnl.gov.

[6] Member nations of OES Environmental are: Australia, China, Canada, Denmark, France, India, Ireland, Japan, Norway, Portugal, South Africa, Spain, Sweden, United Kingdom, and United States.

Table 6: The objectives of each of the 'mid-field' environmental effects monitoring activity, which consider various Valued Ecosystem Components (VECs), led by FORCE.

Mid-Field Environmental Effects Monitoring VEC	Objectives
Lobster	● to determine if the presence of a tidal stream energy turbine affects commercial lobster catches
Fish	● to test for indirect effects of tidal stream energy turbines on water column fish density and fish vertical distribution ● to estimate probability of fish encountering a device based on fish density proportions in the water column relative to turbine depth in the water column
Marine Mammals	● to determine if there is permanent avoidance of the mid-field study area during turbine operations ● to determine if there is a change in the distribution of a portion of the population across the mid-field study area
Marine Sound (Acoustics)	● to conduct ambient sound measurements to characterize the soundscape prior to and following deployment of the in-stream turbines
Seabirds	● to understand the occurrence and movement of bird species in the vicinity of tidal stream energy turbines ● to confirm FORCE's Environmental Assessment predictions relating to the avoidance and/or attraction of birds to tidal stream energy turbines

3.3.1 Lobster

In fall 2017, FORCE conducted a baseline lobster catchability survey (NEXUS Coastal Resource Management Ltd., 2017). The survey design consists of the deployment of commercial lobster traps at varying distances from an operating turbine or, as the case was in 2017, the location for a turbine. The catch-and-release survey was completed by NEXUS Coastal Resource Management Ltd. (Halifax, NS) over 11 days in fall 2017. Lobsters were retrieved from traps and measured (carapace length), sex and reproductive stage were determined (male, female, and berried female), and shell condition evaluated.

Overall, the 2017 survey noted high catchability rates (> 2.7 kg/trap)[7] and measured 351 lobsters. Preliminary qualitative analysis by NEXUS indicates that catch rates declined during the survey period, likely due to increasing tidal velocities during the progression of the study – there was a statistically significant negative relationship between catch rates and maximum tidal range, indicating lower catch rates during higher flows. Further, catch rates did not increase significantly with depth, and qualitative analyses suggested no significant difference in catch rates across separate locations from the proposed turbine deployment location. These initial results may indicate that the impact of turbines may be higher on lobster catchability than anticipated in the EA (AECOM, 2009); however, data collection in the presence of an operational turbine is needed to compare to the 2017 survey dataset and to verify the EA predictions.

FORCE and NEXUS had planned to conduct a second lobster catchability survey in fall 2018 to complete a comparative analysis with the baseline data from 2017. The intent of the comparative study was to determine if the presence of a tidal stream energy turbine affects commercial lobster

[7] This is classified as 'high' according to DFO's Catch Per Unit Effort (CPUE) index (Serdynska and Coffen-Smout, 2017).

catches within the Minas Passage. Specifically, this study – with pre-installation and operating turbine data collection periods – was designed to test the EA prediction that tidal stream turbines will have minimal impacts on lobster populations within the FORCE test site (AECOM, 2009). However, this study was contingent on the presence of an operational turbine in order to assess the impacts a turbine might have on lobster in the Minas Passage. Given the non-operational status of the CSTV turbine, the objectives of the 2018 survey effort could not be achieved, and the survey has been postponed until such time that an operational turbine is present at the site.

In 2019, FORCE commissioned TriNav Fisheries Consultants Ltd. to redesign FORCE's lobster monitoring program based on feedback from regulators to include a more statistically robust study design for monitoring lobster at the FORCE test site. TriNav Fisheries Consultants evaluated the efficacy of using a variety of methods including divers and hydroacoustic tags to track lobster movements. However, given the strong tidal flows and brief window available during periods of slack tide, divers are not a viable option due to safety concerns. Ultimately, TriNav Fisheries Consultants identified the combination of a modified catchability survey design and a mark-recapture study using conventional tags as the best approach for monitoring lobster at the FORCE site.

Observations to date

- 351 lobster caught, measured, and released in fall 2017
- Study to be repeated in presence of a turbine to assess potential impacts

3.3.2 Fish

FORCE and its partner the University of Maine (Orono, Maine) have been conducting mobile fish surveys since May 2016 to:

- test for indirect effects of tidal stream energy turbines on water column fish density and fish vertical distribution; and
- estimate the probability of fish encountering a device based on any 'co-occurrence' relative to turbine depth in the water column.

These goals were laid out to test the EA prediction that tidal stream turbines are unlikely to cause substantial impacts to fishes at the test site (AECOM, 2009). These surveys are designed to permit a comparison of data collected before a turbine is installed with data collected while a turbine is operational at the FORCE site as well as in relation to a reference site along the south side of the Minas Passage – the nature of this design is referred to as 'BACI': Before/After, Control/Impact.

The surveys occur over a 24-hour period to include two tidal cycles and day/night periods using a scientific grade echosounder, a Simrad EK80, mounted onto a vessel, the Nova Endeavor (Huntley's Sub-Aqua Construction, Wolfville, NS). This instrument is an active acoustic monitoring device as it uses sonar technology to detect fish by recording reflections of a fish's swim bladder. In January 2019, FORCE staff underwent additional training on the EK80 from Kongsberg Maritime Canada Ltd. (Dartmouth, NS) to learn about the software through an operational review detailing the features and new updates for the EK60, EK80 and WBAT instruments. The training highlighted ways to optimize data collection and options available for real-time trouble shooting. Throughout the course attendees presented their user experience to Kongsberg staff as well. These lessons will be an asset for future fish surveys to know the limits of the equipment and to ensure quality data is collected.

Analyses of hydroacoustic fish surveys completed during baseline studies in 2011 and 2012 (Melvin and Cochrane, 2014) and surveys May 2016 – August 2017 (Daroux and Zydlewski, 2017) have observed similar fish densities at the FORCE test site and the reference site, including similar patterns of seasonal change. These analyses also evaluated changes in fish densities in association with diel stage (day/night), tidal stage (ebb/flood), and turbine presence or absence. During the evaluated periods an OpenHydro turbine was present November 2016 – June 2017. Results to-date support the EA prediction that tidal stream devices have minimal impact on marine fishes; however, further data in relation to an operating turbine is required to fully test this prediction. FORCE has completed the processing of all mobile hydroacoustic fish surveys, and is pursuing the analyses of the most recent surveys that will help to contribute to the growing body of knowledge of fish species at the FORCE site.

The University of Maine has recently completed a thorough analysis and report for 15 hydroacoustic fish surveys conducted at FORCE from 2011-2017 (Appendix IV). The hydroacoustic data set included six 'historical' surveys conducted between August 2011 and May 2012, and nine 'contemporary' surveys conducted between May 2016 and August 2017. The report provides an overall approach for understanding the information contained within the hydroacoustic data sets, including data visualization and statistical analyses. Moreover, the University of Maine has provided FORCE with the data scripts/coding and hands-on training required for analysis and data visualization so that deeper explorations of the data may be undertaken to investigate questions that are specific to the needs of FORCE. The analyses included comparisons of fish presence/absence and relative fish density with respect to a series of temporal (historical vs. contemporary, or by survey), spatial (CLA vs. reference study area, or by transect) and environmental (tide phase, diel state, or with and against predicted tidal flow) explanatory variables. The report identified a statistically significant difference in fish presence/absence and relative fish density between the historical and contemporary data sets that may be attributable to differences in the survey design/execution between the time periods or could reflect changes in fish usage of the site. Considering this result, remaining analyses were restricted to the contemporary data sets alone. The authors identified a statistically significant difference in fish presence/absence and relative density between the CLA and the reference site suggesting that the reference site may not be sufficiently representative to serve as a reference for the CLA. Other key findings include: i) data collection during the ebb tide and during the night are both important factors for understanding fish presence in the CLA, ii) a variety of explanatory variables and their additive effects should be explored further, iii) increasing the frequency of surveys within each month (perhaps on consecutive days), particularly during May, may be required to understand patterns and variability of fish presence and density in Minas Passage, and iv) results suggest modifying the survey design to exclude adjacent pairings of transects.

It is important to note, however, that like the lobster survey program, the fish monitoring program requires the presence of an operational turbine at the FORCE site in 2018 for testing its effects. Further, a non-operational turbine may bias baseline data collection as the turbine may serve as a Fish Aggregation Device (i.e., a 'FAD') (Wilhelmsson et al. 2006). FORCE was planning to conduct fish surveys during known periods of peak migration in 2019 – notably, in spring to capture migration periods of alewife, Atlantic herring, striped bass, Atlantic sturgeon, American shad, Atlantic mackerel, and rainbow smelt (Baker et al., 2014; Stokesbury et al., 2016) and also in late fall in consideration of outward migration of Atlantic herring, blueback herring, and alewife (Townsend et al., 1989). However, these data collection efforts were contingent on removal of the non-operational CSTV turbine from the FORCE site and suitable weather conditions. Given that the CSTV turbine currently remains at the FORCE site, these surveys were not conducted.

In the interim, FORCE in cooperation with Echoview Software (Tasmania, Australia) and the University of Maine, has been focusing efforts on data processing and analysis of fish survey data as well as in support of a comparative analysis with data collected from a bottom-mounted system. FORCE staff completed the Echoview software training course in Q2 2019 to build the skillset of processing hydroacoustic data within Nova Scotia. This training enables the FORCE team to better complete data collection activities moving forward.

Observations to Date

- Preliminary findings suggest no significant effect of turbine on fish density or distribution
- Variability of fish density is caused by a number of factors, including tidal stage, time, location

3.3.3 Marine Mammals

In 2019, FORCE continues to conduct two main activities aimed at testing the EA prediction that project activities are not likely to cause significant adverse residual effects on marine mammals within the FORCE test site (AECOM, 2009). These activities have been ongoing on a regular basis since 2016. Specifically, FORCE in continuing to:

- Conduct passive acoustic monitoring (PAM) using 'click recorders' known as C-PODs; and
- Implement an observation program that includes shoreline, stationary, and vessel-based observations.

Passive Acoustic Monitoring:

The first component of FORCE's marine mammal monitoring program involves the use of PAM mammal detectors known as C-PODs, which record the vocalizations of toothed whales, porpoises, and dolphins.[8] The program focuses mainly on harbour porpoise – the key marine mammal species in the Minas Passage that is known to have a small population that inhabits the inner Bay of Fundy (Gaskin, 1992). The goal of this program is to understand if there is a change in marine mammal presence in proximity to a deployed tidal stream energy device and builds upon baseline C-POD data collection within the Minas Passage since 2011.

From 2011 to early 2018, more than 4,695 'C-POD days'[9] of data were collected in the Minas Passage. Over the study period, it was found that harbour porpoise use and movement varies over long (i.e., seasonal peaks and lunar cycles) and short (i.e., nocturnal preference and tide stage) timescales. This analysis, completed by Sea Mammal Research Unit (Canada) (Vancouver, BC), showed some evidence to suggest marine mammal exclusion within the near-field of CSTV turbine when it was operational (November 2016 – June 2017) (Joy et al., 2018). This analysis showed that the C-PODs in closest proximity to the turbine (230 m and 210 m distance) had shown decreases in detections whereas there is no evidence of mid-field avoidance with a turbine present and operating. The latest findings also showed a decrease in detections during turbine installation activities which is consistent with previous findings (Joy et al., 2017), but will require additional data collected in relation to an operating turbine to allow for a full assessment of the EA predictions.

[8] The C-PODs, purchased from Chelonia Limited, are designed to passively detect marine mammal 'clicks' from toothed whales, dolphins, and porpoises.
[9] A 'C-POD day' refers to the number of total days each C-POD was deployed times the number of C-PODs deployed.

The C-PODs were initially deployed on December 6, 2018 and recovered on March 29, 2019. Following inspection and data-recovery, maintenance activities included replacement of CPOD batteries, replacement of acoustic release batteries, refurbishment of one SUBS package, and the fabrication and installment of mounts for the MetOcean Telematics (Dartmouth, NS) beacons. The C-PODs were subsequently re-deployed on May 3, 2019. The delay for the re-deployment was caused by the amount of maintenance required during that period as well as the vessel availability for the operation. The vessels normally used for this operation were both away on location for other jobs. It took a special weather window for a vessel to return to the area, and also have time for the deployment. This summer, the C-PODs were recovered on August 14th to download data and were re-deployed during the same day to continue collection of baseline data. They were subsequently recovered on December 13th and are currently undergoing refurbishment so they can be deployed again in early January 2020.

In 2019, FORCE received an F-POD from Chelonia Limited (makers of the C-PODs; Cornwall, UK), and deployed it at the FORCE site. This instrument was included in FORCE's comparative PAM study outlined in its 2019 EEMP plan. This study aims to understand the relative performance of multiple PAM devices (i.e., C-POD, F-POD, SoundTrap, icListenHF, and AMAR) across the range of tidal flows experienced at the FORCE site. The first phase (i.e., Aquatron testing; Figure 1) was completed and confirmed that each device could detect synthetic click trains emitted by an icTalk used to mimic harbour porpoise vocalizations. FORCE subsequently deployed the devices on a FAST platform at the FORCE site to complete the field trial component of this study (Figure 2, 3). The field trials included playing the synthetic click trains with the icTalk while passively drifting over the FAST platform over the course of a full tidal cycle, followed by a week of data collection for harbour porpoise transiting the FORCE site. The platform was recovered on September 13th, and the data was downloaded from the instruments and sent to Sea Mammal Research Unit (Canada) for analyses. FORCE expects to receive a report on the relative performance of each PAM device in 2020.

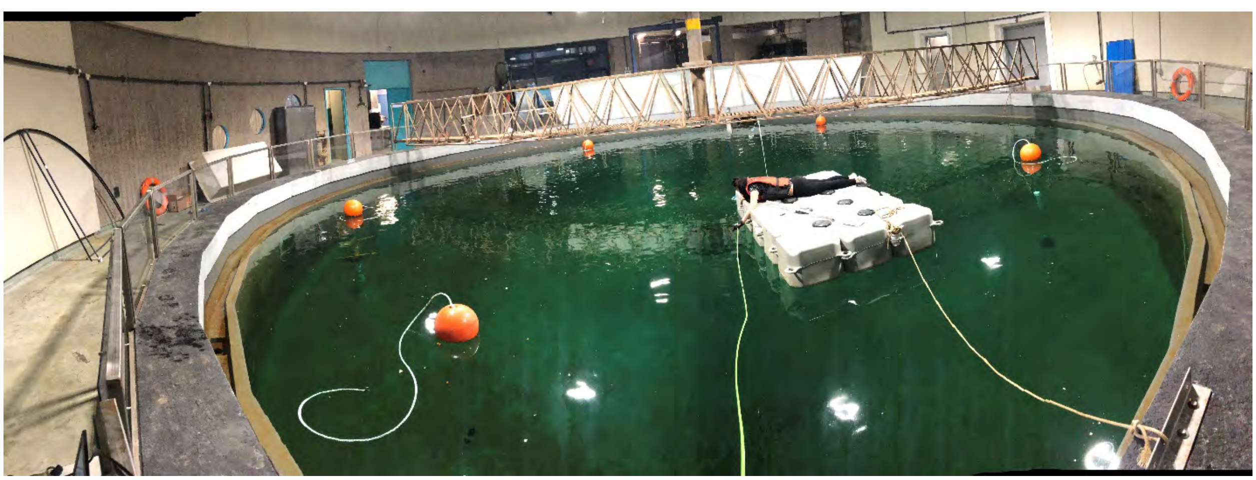

Figure 6. One of FORCE's Ocean Technologists assists with testing PAM devices in the Aquatron pool-tank facility at Dalhousie University.

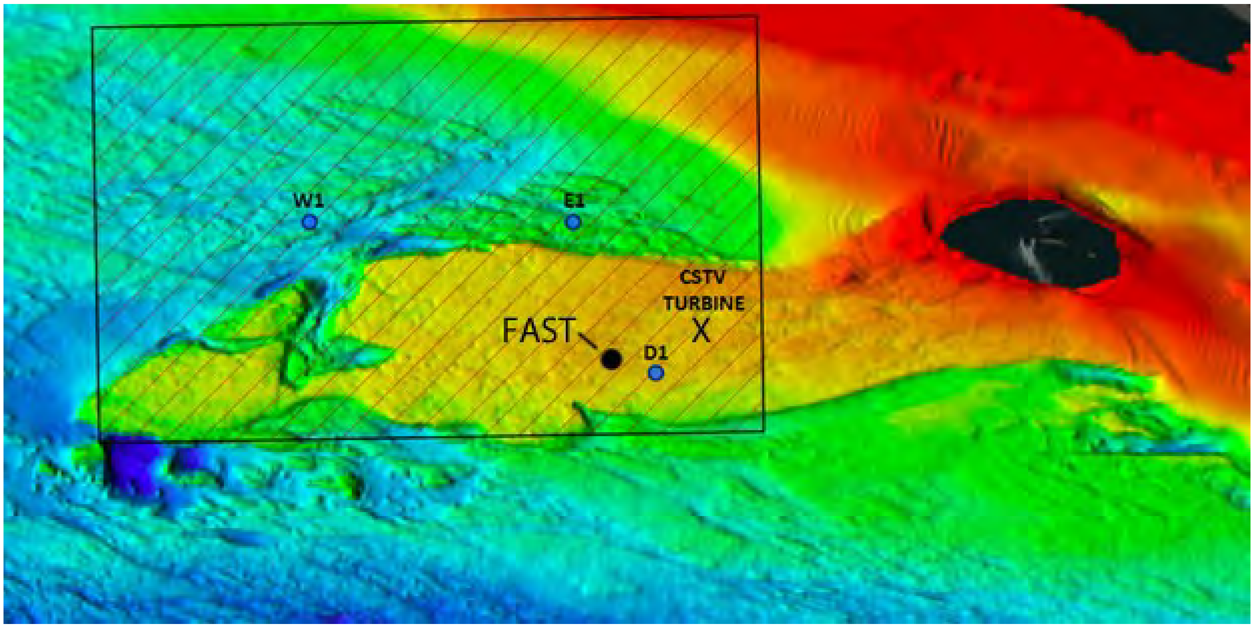

Figure 7. Map of FORCE test site showing approximate locations for C-PODs deployed on SUBS packages (W1, E1, D1), and the planned location for deployment of the FAST platform mounted with PAM devices (•). The location of the Cape Sharp Tidal Venture Turbine is indicated by an ‘X’.

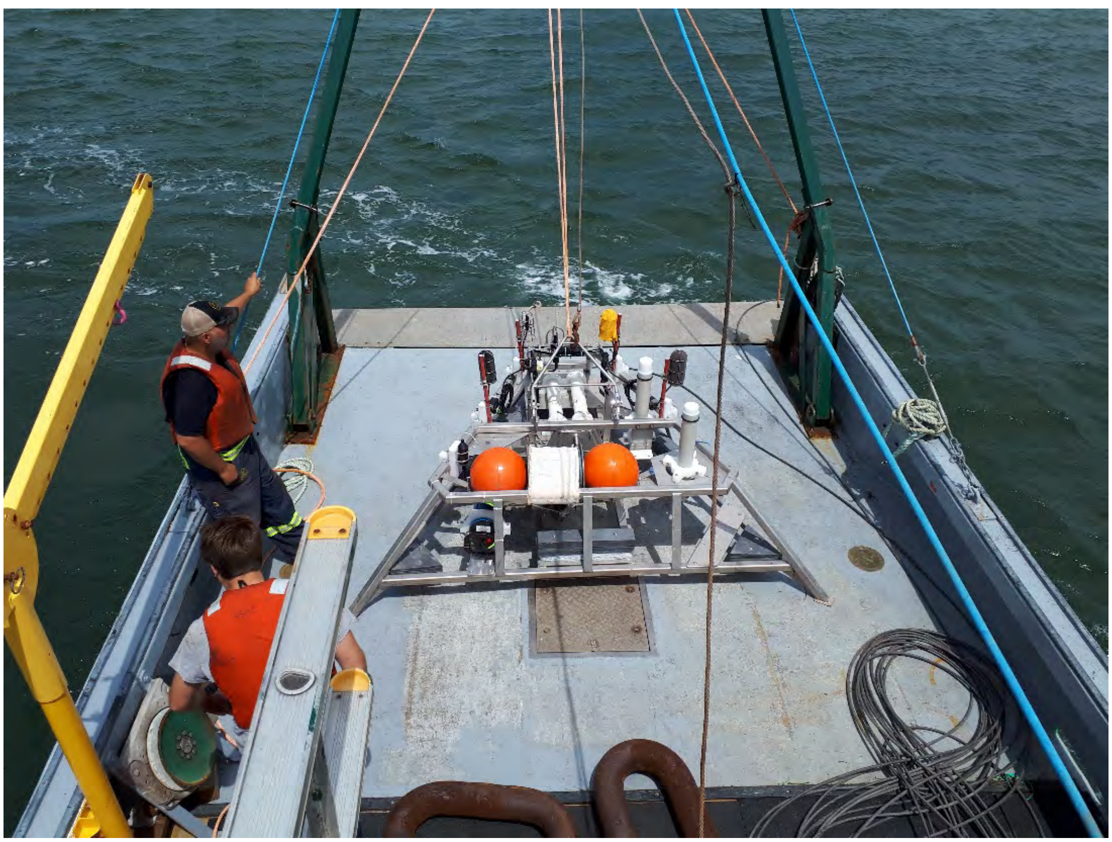

Figure 8: Five PAM devices were mounted on the FAST platform for the comparative PAM study. Photograph depicts the platform on the deck of the Nova Endeavour prior to deployment at the FORCE site.

Observation Program:

FORCE's marine mammal observation program in 2019 includes observations made during bi-weekly shoreline surveys, stationary observations at the FORCE Visitor Centre, and marine-based observations during marine operations. All observations and sightings are recorded, along with weather data, tide state, and other environmental data. Any marine mammal observations are shared with SMRU Consulting to support validation efforts of PAM activities.

FORCE will also continue to explore the utility of using an Unmanned Aerial Vehicle (UAV) for collecting observational data along the shoreline and over the FORCE site using transects by programming GPS waypoints in the UAV to standardize the flight paths. In recent months a number of FORCE staff received training to operate FORCE's UAV. Recent changes to Transport Canada's regulations for Remotely Piloted Aircraft Systems (RPAS) necessitated FORCE staff acquiring UAV pilot certification by successfully passing the 2019 Canadian Drone Pilot Basic Operations Examination. Several trained staff have now acquired this certification and are licensed to safely operate the UAV at the FORCE site. To assess the relative utility of a UAV-based versus walking-based observational survey, FORCE recently developed and conducted a preliminary study using a series of objects randomly distributed along the FORCE beach. This assessment revealed that the UAV performed as well as a walking-based observational survey, but requires less time and human resource to achieve. FORCE also hosts a public reporting tool that allows members of the public to report observations of marine life: mmo.fundyforce.ca

Observations to date

- Harbour porpoise were detected on 98% of days with presence varying due to a number of factors
- Some temporary avoidance during installation and within 200m of a turbine was detected, but no evidence of permanent avoidance within the broader test area

3.3.4 Marine Sound

Marine sound – often referred to as 'acoustics' or 'noise' – monitoring efforts are designed to characterize the soundscape of the FORCE test site. Data collected from these monitoring efforts will be used to test the EA predictions that operational sounds produced from operating tidal stream turbines are unlikely to cause mortality, physical injury or hearing impairment to marine animals (AECOM, 2009).

FORCE convened a working group of experts in passive acoustic monitoring (PAM) data collection and analyses from local academic institutions, industry partners, and other stakeholders in late 2018. The purpose of the workshop was to discuss the challenges and operational limitations inherent with using PAM technologies for marine mammal and sound monitoring in high-flow environments like the FORCE test site and to identify potential solutions to improve environmental effects monitoring capabilities for operational tidal stream energy turbines in the future. The workshop sought to address questions from regulators regarding the integration or corroboration of results from multiple PAM technologies deployed in and around the FORCE test site. The workshop also explored potential future projects to support further environmental monitoring using PAM technologies with the end goal of lending confidence to environmental effects monitoring technologies and approaches used in support of tidal energy devices.

Building on this workshop, FORCE commissioned JASCO Applied Sciences (Canada) Ltd. to conduct a comparative integrated analysis of acoustic data sets collected by various hydrophones (i.e., underwater sound recorders) mounted on and deployed autonomously around the CSTV turbine at the FORCE site (see Appendix IX). This integrated comparative analysis examined near-field sound data collected by hydrophones) located:

- on the CSTV turbine, collecting data since September 4, 2018 (three icListen hydrophones);
- two icListen hydrophones mounted on a Fundy Advanced Sensor Technology (FAST) platform deployed approximately 35 m from the turbine from September 5 – 21, 2018;
- an AMAR (Autonomous Multichannel Acoustic Recorder) deployed approximately 100 m from the turbine from June 29 – November 19, 2018.

In addition, an acoustic Doppler current profiler mounted on the CSTV turbine has collected current data since September 4, 2018. Analyses of the acoustic data revealed that flow noise increased with the height of the hydrophone off the seabed and impacted the hydrophone mounted on the top of the CSTV turbine the most. The least affected hydrophones were those mounted at the 'aft' position on the CSTV turbine and the autonomously deployed AMAR. In fact, flow noise at these locations was low enough to successfully measure the sound from the turbine during the brief period prior to the malfunction of the turbine's rotor in August 2018. Indeed, when the turbine was present (and presumably free spinning prior to this malfunction), the sound levels increased in the 30-1000 Hz band. Details are contained in the report provided as Appendix IX. This comparative analysis provides valuable information about future marine sound monitoring technologies and protocols while building on previous acoustics analysis at the FORCE site.

Results from previous acoustic analyses completed at the FORCE site indicate that the turbine is audible to marine life at varying distances from the turbine, but only exceeded the threshold for behavioural disturbance at very short ranges and during particular tide conditions (Martin et al., 2018). This is consistent with findings at the Paimpol-Bréhat site in France where an OpenHydro turbine was also deployed – data suggests that physiological trauma associated with a tidal turbine is improbable, but that behavioural disturbance may occur within 400 m of a turbine for marine mammals and at closer distances for some fish species (Lossent et al., 2017).

Observations to date

- Turbine sound could be detected during turbine operations in the mid-field under certain conditions
- Integrating multiple datasets will provide the best sound profile of the Minas Passage and operating turbine(s)

3.3.5 Seabirds

FORCE's seabird monitoring program is designed to test the EA prediction that project activities are not likely to cause adverse residual effects on marine birds within the FORCE test area (AECOM, 2009). Over the last several years, FORCE and Envirosphere Consultants Ltd. (Windsor, NS) have collected observational data from the deck of the FORCE Visitor Centre, documenting bird species presence, behaviour, and seasonality throughout the FORCE site (Envirosphere Consultants, 2009, 2017; Stewart and Lavender, 2010; Stewart et al., 2011, 2012, 2013; Stewart et al., 2018). Overall, these surveys have documented the distribution, abundance, and seasonality of water-associated birds in the Minas Passage, but there has been limited opportunity to determine potential effects and test the EA predictions given the short time period with an operational turbine present at the FORCE site.

The non-operational turbine currently deployed at the FORCE site has the potential to serve as a FAD (Wilhelmsson et al., 2006). This could have potential cascading ecological effects for predatory diving seabirds (Wilson and Elliott, 2009; Boehlert and Gill, 2010), and therefore, have indirect consequences for seabird monitoring. Diving seabirds may be drawn to the FORCE site if the abundance of prey species increases as a consequence of the non-operational CSTV turbine (Wilhelmsson et al. 2006; Andersson and Öhman 2010; Boehlert and Gill 2010). Observational surveys under these circumstances contribute neither to effects testing nor to enhancing the seabird baseline. Consequently, FORCE did not conduct observational seabird surveys in 2019, but instead pursued a synthesis of existing baseline data and explored the potential for integration with radar-based monitoring to improve monitoring protocols for the future (see below).

FORCE has begun a collaboration with Envirosphere and Dr. Phil Taylor at Acadia University (Wolfville, NS) to synthesize previous observation-based seabird baseline datasets (2017-2018) and to integrate this information with data from radar-based monitoring (Walker and Taylor, 2018). Radar based monitoring, based on an X-band radar located at the FORCE Visitor Centre has typically been used for flow characterization, but can be used to monitor bird movements throughout and around the FORCE test site. Similar to the observational studies, radar analysis shows a clear seasonal pattern of activity with very few birds present in the winter and peaks during spring and fall migrations (Walker and Taylor, 2018; Appendix III).

This integrated work will help to quantify the risk for seabirds in relation to operating tidal energy turbines at the FORCE site. This work will examine the potential of statistical models to improve the precision and certainty in detecting impacts to seabirds. This work will advance the ability to describe seabird abundance, species composition, spatial and temporal distribution, and seasonality.

Observations to date

- Seasonal peaks associated with known migratory patterns were observed
- Initial results suggest no effect from turbine operations

3.4 Near Field Monitoring

While FORCE completes site-level or 'mid-field' monitoring activities at the FORCE site, near-field monitoring is led by individual berth holders. Like the mid-field monitoring programs, the near-field monitoring plans and reports undergo review by FORCE's EMAC and regulators.

In September 2018, Cape Sharp Tidal (CSTV) confirmed that that its OpenHydro turbine rotor was not spinning. CSTV provided written confirmation to regulators on a monthly basis that the turbine was not operational by monitoring its status during the peak tidal flow of each month.
However, as a result of the insolvency of OpenHydro Technology Ltd., as of March 2019, all reporting activities by CSTV ceased. FORCE now manages and reports data collection from the turbine-mounted ADCPs to regulators to on a monthly basis, to confirm the turbine is no longer spinning. Data is also still being collected from two of the four hydrophones on the CSTV turbine.

As a precaution, FORCE has been taking steps to enhance its near-field monitoring capabilities. In 2018, FORCE deployed multiple Fundy Advanced Sensor Technology (FAST) platforms in proximity to the Cape Sharp Tidal turbine (within 15m – 35m from the turbine) containing hydrophones and ADCPs to measure turbine-produced sound and flow impacts of the turbine respectively. These measurements are being used to inform marine acoustics and also to better understand flow dynamics at the FORCE test site.

FORCE staff also underwent training in 2019 about the use of a near-field monitoring instrument, the Gemini 720is imaging sonar. This training was led by the manufacturer of the Gemini, Tritech International Ltd. (Aberdeen, Scotland) and included an overview of the instrument's capabilities and limitations, best practices for use, and setting optimization for in-situ data recording. The training also incorporated the specialized software used to track marine life targets in the water column. This training will serve to be beneficial for use and testing of the Gemini at the FORCE test site.

As additional near-field, device-specific environmental effects monitoring programs are required and implemented for deployed tidal stream devices, this information will be included as part of FORCE's regular quarterly EEMP reporting to Nova Scotia Environment.

3.5 Additional Science

As mentioned in section 1.1, FORCE's research and monitoring activities are not limited to the EEMP. Briefly, they include:

- The Risk Assessment Program (RAP) for Tidal Stream Energy:
- The Pathway Program (a collaborative effort between FORCE and OERA to identify an effective and regulator approved monitoring solution)
- The Fundy Advanced Sensor Technology (FAST) program (designed to advance capabilities of site characterization, refine environmental monitoring standards and technologies, and enhance marine operating methodologies), including a stable of three sensor platforms
    - FAST-1 (the Vectron: the world's first stand-alone instrument to remotely measure, in high resolution, turbulence in the mid-water column)
    - FAST-2 (targeted monitoring: using a dynamic mounted sonar to track near-field fish turbine interaction)
    - FAST-3 (comparing bottom-mounted vs vessel-mounted fish monitoring)
- Fish tracking in partnership with the Ocean Tracking Network (OTN) to increase knowledge of fish movement within the Minas Passage
- Monitoring of marsh wetlands along Black Rock Beach to chart recovery of area after installation of electrical and data cables.

More information on these activities is available in the 2019 Annual Monitoring Report, available here:
https://fundyforce.ca/document-collection/environmental-effects-monitoring-program-annual-report-2019

4.0 Engagement

Social license for tidal stream technology depends on public and regulator confidence that the effects of tidal devices on marine life and the environment are understood and acceptable.

Since the 2015 EA Addendum, FORCE has significantly enhanced its engagement capacity. FORCE created and hired a full-time engagement coordinator position, expanded outreach efforts in Cumberland County via FORCE's full-time facility manager, and shifted work priorities to be able to meet with over 100 different groups to understand issues, interests, and concerns. Importantly, FORCE's entire staff composition has changed. While FORCE was primarily an electrical, civil, and marine engineering construction project from 2009-2014 as the onshore and offshore facilities were built, FORCE has transitioned into a primarily science-focused research centre. Since the 2015 EA Addendum, FORCE has eliminated its civil engineering position and created five science positions: a director of science, a research assistant, and three ocean technologists. This capacity has enabled FORCE to meet directly with organizations on a semi-regular basis to keep them informed on research activity and monitoring outcomes. This remains a large staff demand.

As part of the Terms and Conditions of the 2009 EA Approval, FORCE established the Community Liaison Committee (CLC) and the Environmental Monitoring Advisory Committee (EMAC). The CLC is a community-based committee including members from the general public, fishers and First Nations and is intended to keep the community updated on FORCE project activities. As well, it provides an opportunity for questions and feedback from the community regarding the project. EMAC, described in section 3, is also an ongoing conduit for participation and advice to FORCE on the design and implementation of its EEMP by representatives from scientific, academic, fishing and First Nations communities.

Polling of Nova Scotians in 2016 (and again in 2018) indicates generally strong support for tidal energy testing (approximately 90% of residents in support, including over-sampling in communities along the Bay of Fundy). Tidal energy also has its critics. As Cape Sharp Tidal prepared to deploy its first two-megawatt turbine in the Minas Passage, representatives from fishers' associations, First Nations bands, and some members of the public expressed strong concerns about potential impacts. Some of their concerns relate to:

- *Financial risk*: e.g. lobster fishers may carry high debt load for license, boat, and equipment, and any change to their catch can have significant implications to their livelihood
- *Displacement*: potential loss of marine space with increased footprint of tidal energy areas
- *Species*: species at risk, and/or species important to food, social, and ceremonial fisheries such as American Eel, Striped Bass, Atlantic Salmon
- *Fish migration*: even if collision risk proves to be low, avoidance behaviour could change migratory routes and therefore impact traditional spots
- *Engagement*: a need to broaden outreach to more groups and wider geography

As mentioned, both EMAC and CLC have representation from the Nova Scotia Mi'kmaq and fishing communities, and FORCE has had ongoing involvement with lobster fishers who work near the test area. However, there is an ongoing need to engage with groups from far outside the direct project site. FORCE expects that need will rise each time a developer's device approaches deployment, as media and therefore public attention increase.

As well, there remains an ongoing need to share information about local content with project developers and opportunities available to Nova Scotia's diverse ocean SME community. In light of OpenHydro's insolvency, there is a need to ensure confidence in the sector's viability and to encourage some SMEs to participate in the sector.

Ultimately, tidal energy needs to co-exist with other users of the marine environment. Tidal stream technology also has the potential to connect maritime communities by protecting marine life from the impacts of climate change – including ocean acidification, erosion, storm surges and population level shifts in the marine ecosystem.

Outreach activities in the most recent years (2019-2020) focused on six key engagement areas:

- Attendance at conferences and events in the fisheries, renewables, and ocean technology sector
- Engagement with First Nations groups/organizations and individual communities
- Education initiatives, including outreach to children, youth, and educators
- Government relations
- Visitor Centre activities, including outreach to the local community in Parrsboro and Cumberland County
- Online reach

4.1 Attendance at Conferences/Events:

Attendance at in-person events, presentations, and meetings was significantly curtailed in 2020 due to the Covid-19 pandemic so much of our engagement work was completely virtually. FORCE's 2019 engagement activities included:

- Asian Wave & Tidal Energy Conference
- Energy Ambassadors Symposium: The Future of Energy in Digby
- Fishermen and Scientists Research Society Annual Conference
- Halifax Field Naturalists meeting
- Innovate Atlantic Conference
- Innovation Fête
- Nova Scotia Community College Industry Showcase
- Atlantic Association for Research in Mathematical Sciences Problem-Solving Workshop
- Atlantic International Chapter of the American Fisheries Society
- Bay of Fundy Ecosystem Partnership Conference
- Canada-China Track II Energy Dialogue
- CORE Energy Conference
- Cumberland Energy Symposium
- Forest Professionals Conference
- International Conference on Ocean Energy
- Marine Renewables Canada Research Forum and Annual Conference
- Offshore Energy Research Association webinar (on radar research)
- Wolfville Newcomers' Club
- Wolfville Rotary Club
- Cumberland Energy Symposium
- G7 Partners Exhibition
- Home to Oversees (H2O) Conference
- Marine Renewables Canada Annual Conference
- Saint Mary's University's Graduate Studies Research Expo
- Community Liaison Committee meetings, including social with FORCE Board of Directors and regular meetings with the Co-Chairs
- Tidal Talks in Parrsboro
- Great Canadian Shoreline Clean-up at Black Rock Beach
- Visitor Centre opening
- Presentations at Marine Affairs, Engineering Law, Coastal Ecology, and Biologging courses at Dalhousie University
- Led a seminar at the International Oceans Institute

- Presentation, and site visit, with the Nova Scotia Community College's Ocean Technology Class
- Booth space shared with the Offshore Energy Research Association at Saint Mary's University's Graduate Studies Research Expo
- Engagement with various Industry Liaison Offices at local universities
- Acadia University's Lifelong Learning Lunch-and-Learn Seminar

4.2 First Nations Engagement

Formally, two Mi'kmaq organizations have input into FORCE's activities:

- The Mi'kmaw Conservation Group (MCG) is a key partner in the Risk Assessment Program for Tidal Energy project
- The Mi'kmaq Rights Initiative/Kwilmu'kw Maw-klusuaqn (KMK) has a representative on FORCE's Community Liaison Committee.

In addition, FORCE holds quarterly meetings with KMK staff engaged on the energy file and has facilitated meetings/introductions with berth holders when requested. FORCE also engages the benefits group at KMK when posting jobs/RFPs online.

Beyond regularly scheduled meetings, FORCE staff have also met with various representatives from Mi'kmaq communities since the 2015 EA addendum, including:

- MCG staff (multiple)
- Atlantic Policy Congress (APC) of First Nations Chiefs (multiple);
- APC annual fisheries conference (multiple)
- APC New Brunswick Fisheries Managers Workshop
- Millbrook staff
- Sipekne'katik staff
- Acadia staff
- Glooscap luncheon
- Millbrook Council
- Sipekne'katik Council
- Maritime Aboriginal Peoples Council
- Glooscap community openhouse
- FORCE also hosted a training session for FORCE staff and partners regarding engagement with the Mi'kmaq. This session was led by the Nova Scotia Office of Aboriginal Affairs
- Led tidal energy sessions with indigenous youth at STEM Fest in cooperation with the Acadia Tidal Energy Institute
- Visitor Centre tour and meeting with the Maritime Aboriginal Peoples Council/Native Council of Nova Scotia

4.3 Education

Since 2018, FORCE has prioritized engagement with students and educators. Connecting with the Department of Energy & Mines-led SaREEN (Sustainable and Renewable Energy Education Network) provided FORCE with connections to other ocean educators and events to engage with children, youth, and teachers. This, in addition to other engagement efforts, has presented opportunities for FORCE staff to present in Cumberland-area schools. FORCE also joined the Canadian Network for Ocean Education (CaNOE). FORCE partnered with the Acadia Tidal Energy Institute (ATEI) to engage children, youth, and adults in a tidal energy demonstration. Using a tank developed by Acadia engineering students, FORCE and ATEI would introduce tidal power in a fun and engaging exercise where students would have to pick a turbine that would produce the highest power and energy curves. This exercise was done at:

- Skills Nova Scotia events for junior and senior high school students (Halifax and Dartmouth)
- Atlantic Science Teachers Conference
- Department of Energy & Mines staff session
- Discovery Centre's Ocean Technology Camp
- Multiple events at STEM Fest, including collaboration with Women In Science and Engineering (WISE) and a day with indigenous youth

4.4 Government Relations

FORCE continues to engage public servants and elected representatives at the municipal, provincial, and federal levels. At the municipal level, ongoing engagement with FORCE's local municipal energy group, the Cumberland Energy Authority, continues to help reach a broad audience in the Cumberland area. In addition, two municipal councillors sit on FORCE's Community Liaison Committee.

At the provincial level, FORCE continues to meet with the Department of Energy and Mines and the Department of Environment on a routine basis, along with Fisheries and Oceans Canada.

Other government department with whom FORCE maintains communication are:

Provincial:

- Economic and Rural Development and Tourism
- Nova Scotia Environment
- Fisheries & Aquaculture
- Labour & Advanced Education
- Natural Resources
- Office of Aboriginal Affairs

Federal:

- Atlantic Canada Opportunities Agency (Atlantic Energy Office)
- Fisheries and Oceans Canada
- Natural Resources Canada
- Transport Canada
- Climate Change and Environment

4.5 Visitor Centre

The Visitor Centre is the most vital part of FORCE's engagement efforts with the public. The Visitor Centre includes interpretive panels, videos, interactive displays, and a direct view of the ocean test site. More than text and image content, however, is face to face interaction. In delivering public programs, each summer FORCE hires two student interpretive assistants and (for the last four years) an ocean technologist intern from NSCC's ocean technology program. Four ocean technologists have found full-time work with FORCE after the summer as part of FORCE's science program.

As of the end of 2020, FORCE has welcomed over 30,000 people to the site. Roughly 60% of visitors are from Atlantic Canada, 25% from Central/Western Canada, 10% from the US (in particular NE states), and roughly 5% from Europe (in particular UK, Germany, Netherlands). Comments from visitors included:

- Generally very positive feelings towards idea of tidal energy
- Less skepticism, more support, than 2018 (when Cape Sharp failed)
- Presence of others companies in area (e.g. Big Moon Power and SME) has been positive – people spoke well of staff, and now understand Cape Sharp is not the only company
- Positive comments on Mi'kmaq history display

4.6 Online Reach

Web presence, including social and traditional media, is a critical part of FORCE's ability to reach audiences and share information about tidal stream energy activity and research. One of the strategic initiatives set for 2019 was to place a greater emphasis on FORCE's research mandate, which included a new website, document library, and user interface for live data (www.fundyforcelive.ca). Social media activity has increased dramatically since the 2015 Addendum. On Facebook, reach has increased by 240% (935 to 2,240 likes); on twitter, an increase of 250% (765 to 1,945); on Instagram, launched in 2017, to 336. Total reach continues to grow, with social media posts receiving over 100,000 views per year.

Ongoing Engagement

In addition to the focus areas listed above, FORCE continues to build relationships with key stakeholder organizations, including World Wildlife Fund-Canada, Herring Science Council, Fishermen and Scientists Research Society, the Bay of Fundy Ecosystem Partnership, the European Marine Energy Centre, OES Environmental, Ocean Tracking Network at Dalhousie University, and other key research bodies locally and internationally.

5.0 Project Amendments

The following summarizes project changes; these are explained in greater detail in the following appendices. These changes have been proposed by project developers, in discussion with the NS Department of Energy and Mines, through their individual project agreements, in the intervening years since the 2015 EA Addendum.

5.1 New technologies:

PLAT-I

Sustainable Marine Energy (SME) plans to supply PLAT-I floating tidal energy systems, with a rated power output of 420kW, to project entity Spicer Marine Energy. This technology is planned for both berth A and berth C. The PLAT-I will be equipped with 6 SIT250 turbines with 4m diameter rotors; these pivot on a turret connected to a two-point mooring spread, and passively aligns with the tidal flow. Each platform will be anchored to the seabed by 4 rock anchors that are mechanically secured into the seabed using a subsea drill rig.

BMP Kinetic Platform

BMP plans to instill an array of eight 05.MW kinetic energy platforms; the design directs the tidal flow into a kinetic wheel chamber through the use of accelerator plates. The accelerator plates increase the volume of water into the kinetic wheel chamber and in turn increases the current flow speed; the intent is to increase torque to generate more electricity. The kinetic platforms will be secured by mooring each platform to a gravity base. The platform swivels 360 degrees to allow the accelerator plates to optimize their position to capture the current flow through the wheel chamber.

5.2 New management:

Berth A + C
These berths (held by Minas Tidal and SME, respectively) are now co-managed by Spicer Marine Energy for a total project scope of 9MW. Ownership of cable C has been transferred to Spicer. The total megawatt capacity remains unchanged from the 2015 EA Addendum, but the technology has changed per above.

Berth B + E
These berths are now co-managed by DP Energy for a total project scope of 9MW. Atlantis Operations Canada is no longer involved. The total megawatt capacity remains unchanged from the 2015 EA Addendum.

Berth D
OpenHydro is now defunct and its technology is no longer in development. The NS Department of Energy has selected a new berth holder – Big Moon Power – and a new technology, per above.

Appendix A.

SUSTAINABLE MARINE ENERGY (SME): Berths A and C

PEMPA'Q TIDAL ENERGY PROJECT

FUNDY OCEAN RESEARCH CENTRE FOR ENERGY (FORCE)

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11 DECEMBER 2020

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1.0 INTRODUCTION

Spicer Marine Energy Inc. (Spicer) is undertaking the Pempa'q Project at Berths A and C at the Fundy Ocean Research Centre for Energy (FORCE) in a phased deployment of 21 PLAT-I 6.40 floating tidal energy converters equipped with SCHOTTEL Instream Turbines (SIT 250).

Spicer, through its engineering, procurement and construction (EPC) contractor Sustainable Marine Energy (Canada) Ltd., intends to install PLAT-I devices in 3 phases between 2020 and 2023 to reach the awarded 9 MW of installed capacity. To accomplish this, project buildout will proceed in a low risk, incremental manner following extensive in-ocean proving of the PLAT-I technology in Nova Scotia. The Grand Passage Project consists of the PLAT-I 4.63 (equipped with 4 turbines with 6.3m-diameter rotors) and the PLAT-I 6.40 (equipped with 6 turbines with 4.0m-diameter rotors) supports the staged approach at the FORCE site. Detailed engineering design for PLAT-I 6.40 was completed in 2019 and informs the various project activities. Project development activities are underway including preparation of project rights assignments, permit applications and ongoing stakeholder engagement.

The substantial work undertaken by Sustainable Marine in Nova Scotia in site characterization, geotechnical analysis, marine operations planning, obtaining an interconnection agreement, environmental and fisheries approvals, building relationships in the local supply chain, indigenous and stakeholder engagement and training of highly qualified people means that much of the work is already significantly advanced or completed.

This project will allow the technology developer to continue its progressive development of small- and utility-scale floating instream energy conversion systems that can be installed, worldwide, in rivers and tidal currents to provide clean, renewable electricity for remote communities and utilities.

The project also includes the use of innovative rock anchoring technology that will be made commercially available to the wider tidal industry and will provide the growing tidal sector in Canada with a new method of anchoring tidal platforms and operations vessels. The technology also has a wide range of potential uses in other marine industries including aquaculture.

The PLAT-I 6.40 technology is described in detail in Section 2.0. Sustainable Marine's ongoing demonstration of the PLAT-I technology at Grand Passage, Nova Scotia is a key part of the technology development plan, providing:

- Proven platform solution: deployed in both Scotland and Nova Scotia with step change technical advances in each phase of the project
- Proven rock-anchoring system: PLAT-I units will be tethered to the seabed using the rock-anchoring system employed for the PLAT-I deployment in Scotland
- Known and manageable costs for all aspects of the proposed project: backed up by in-ocean deployment and operational experience at Grand Passage
- Ability to use smaller, more readily available and cost-effective vessels for installation

Spicer and Sustainable Marine are dedicated to the continued development of viable marine renewable energy technology and helping Nova Scotia realize the economic benefits of this industry, while making a significant contribution to the industry's understanding of environmental impacts. The balance of this document provides details of the project team, the proposed technology and the plan for the project.

1.1 Company Information

Spicer and Sustainable Marine are co-located at Sustainable Marine's Head Office at 95 Symonds Drive in Dartmouth, Nova Scotia with a total of 10 staff, an office building and an operations and assembly building. An additional 3 personnel are located at Sustainable Marine's Operations Centre in Westport on Brier Island, Digby County to operate and service the PLAT-I 4.63 located in Grand Passage. The contact person for Spicer is Mark Savory, President (mark.savory@spicermarine.ca).

2.0 TECHNOLOGY DESCRIPTION

The Pempa'q Project will incorporate many elements and experiences from Sustainable Marine's work to date, and several important new innovative elements with the centrepiece being the PLAT-I floating tidal energy converter that is designed to be installed, maintained and decommissioned utilizing modest, readily available work vessels. From an operational point of view, it is optimized for sites with low to moderate wave exposure such as FORCE, with its robust construction moored via a turret configuration allowing it to passively weathervane with the tide.

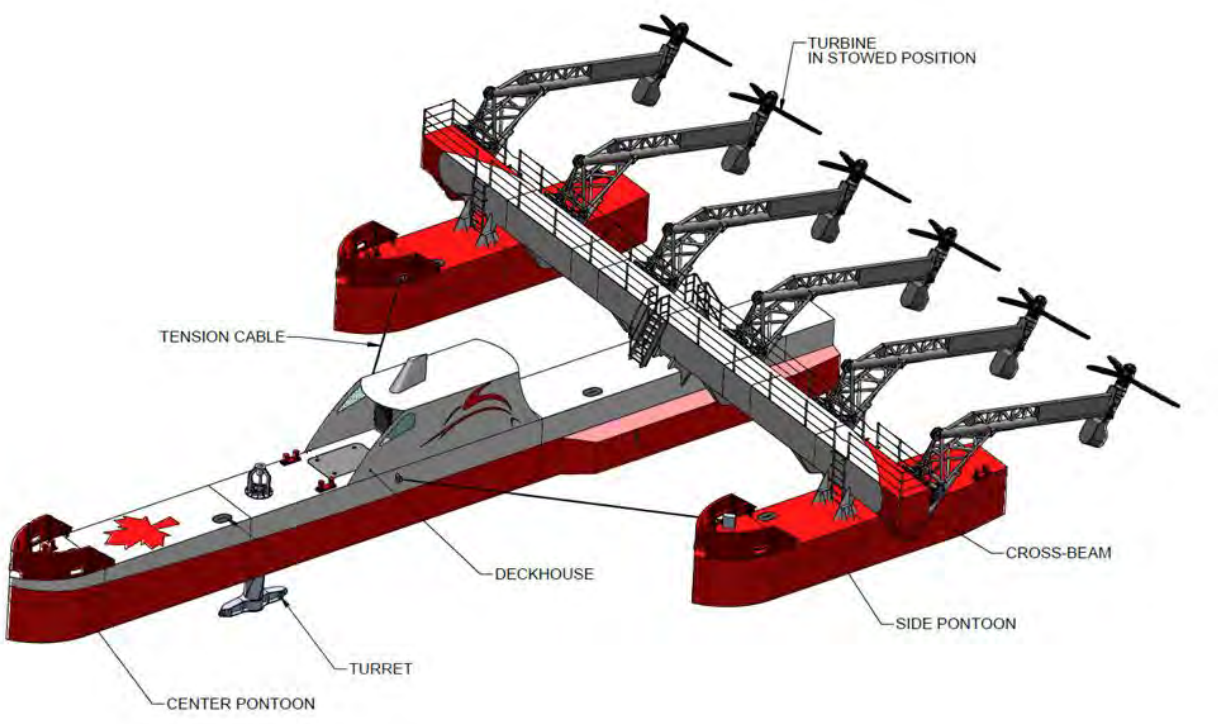


Figure 1: PLAT-I 6.40

The Pempa'q Project will be comprised of the second-generation PLAT-I 6.40 with a nominal generating capacity of 420kW (Figure 1). Like the PLAT-I 4.63 device that is currently deployed at Grand Passage, the PLAT-I 6.40 pivots on a turret connected to a two-point catenary mooring spread and passively aligns with the natural flow of the tidal currents (see Section 3.2). The trimaran design of the platform has been designed to provide low resistance and enhanced stability, as well as full accessibility to the turbines. The structure, largely constructed from high tensile steel, is a fully modular design that allows for worldwide shipping and ease of assembly at site. Each hull unit is based on a standard ISO 40ft container and joined together either on dry land or while afloat.

The PLAT-I 6.40 will be equipped with 6 SIT250 turbines with 4m diameter rotors. Swing-up SIT Deployment Modules (SDMs) will allow easy inspection and maintenance access to the SITs at the water surface. Overload relief allows the turbines to kick-up to reduce loading on the platform and mooring spread in extreme conditions. The same kick-up system allows trapped debris to be cleared and protects the turbines from ice impact.

Electrical power produced by individual turbines will be conditioned in the mid-section of the centre hull. An onboard transformer steps up the voltage before it is exported off the platform via the dynamic export cable running through the centre of the turret to the seabed. A simple slip ring located in the top of the turret allows electrical and fibre optic cables to pass from PLAT-I to the export cable, preventing twisting of the cable as the platform turns with each change of the tide. Technical specifications are provided in Table 1.

Table 1: System Specifications

	System Parameter	Unit
PLATFORM PLAT-I 6.40	Centre Pontoon Length	32.5m
	Outer Pontoon Length	12.0m
	Beam	32.5m
	Centre Pontoon Freeboard (section of hull above surface)	Approx. 1.2m
	Draught in Tow Condition (with turret down)	Approx. 3m
	Draught with Turbines down	Minimum of 5m
	System Mass	140t
	Number of SIT250 Turbines	6
	Rotor Diameter	4.0m
	Rotor Tip Clearance to Surface	Minimum of 1m
	Rotor Tip Clearance to Seabed	Minimum of 4m
	Generating RPM	69 RPM @ 2.9m/s rated speed
SCHOTTEL INSTREAM TURBINE (SIT)	Rated Power	69.2kW @ 2.7 m/s
	Rotor Diameter	4.0m
	Rotor Swept Area	6 x 12.56m² = 75.40m² (40% less than PLAT-I 4.63 at Grand Passage)
	Cut-in Speed	0.5m/s
	Cut-out Speed	5m/s
	Nacelle Weight	1.4t

2.1 Previous Deployments

The Pempa'q Project will include several major innovations, the major technology components of the project have been previously proven in a number of locations around the world. The SIT 250 turbine (and its predecessor the STG) has undergone extensive laboratory testing, field trials, and operational deployments to prove its functionality and efficiency:

- Full-scale tests in Strangford Narrows, Northern Ireland were carried out in 2014 for 260 operating hours according to the International Electrotechnical Commission's (IEC) latest standards. The work was part of the MaRINET testing campaign at the Queens University Belfast tidal test site in Portaferry, Northern Ireland.
- Two turbines were deployed on SME's PLAT-O platform in the Solent, Isle of Wight in 2015.
- A single turbine was installed in 2016 and generated renewable electricity for a sustainable forestry facility in West Papua, Indonesia until late 2017.

The PLAT-I and SIT technologies have been demonstrated in combination through the following projects:

- Four SIT 250 turbines with 4.0m-diameter blades were installed in 2017 on Sustainable Marine's PLAT-I platform at SME's test site near Connel, Scotland.
- Four turbines with 6.3m-diameter blades are currently installed on Sustainable Marine's PLAT-I in Grand Passage, Nova Scotia since late 2018.

As mentioned above, operation and development of the PLAT-I technology is ongoing at Grand Passage.

3.0 PROJECT DESCRIPTION

3.1 Deployment Site

The proposed project will be installed at Berth A (Minas Tidal) and Berth C (Sustainable Marine) at the FORCE tidal energy demonstration site. Figure 2 shows the current layout of berths and proposed projects at FORCE.

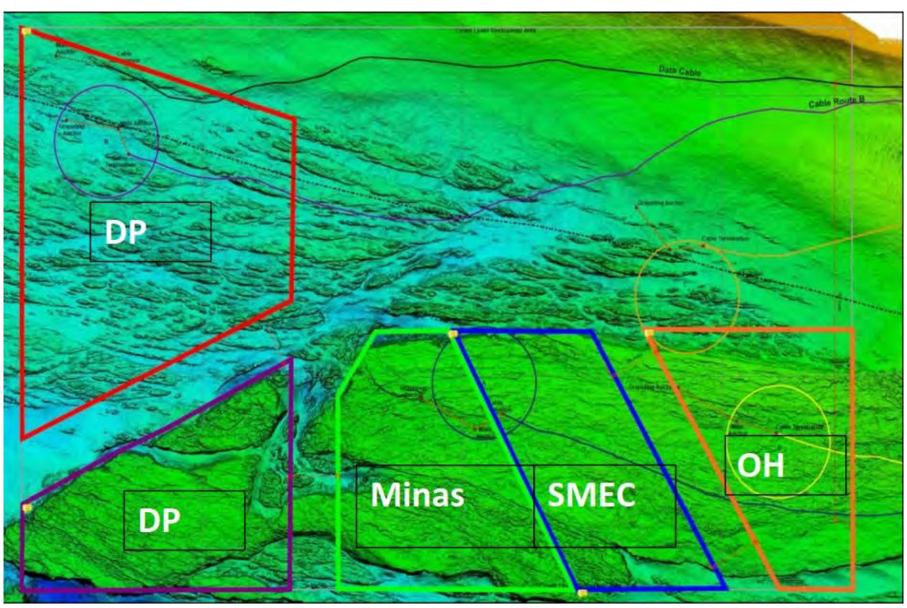
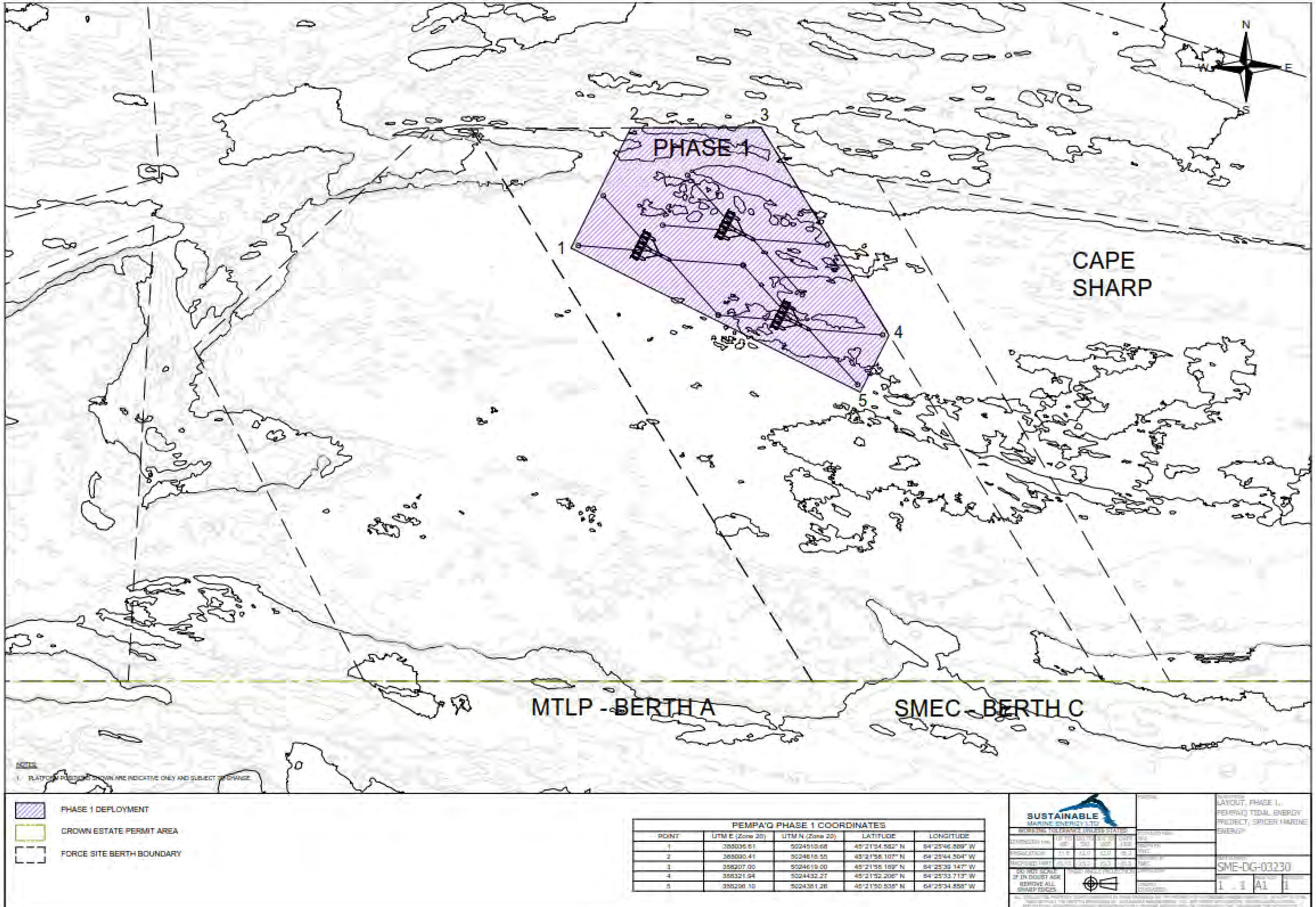


Figure 2: FORCE Berth Layout



PEMPA'Q PHASE 1 COORDINATES				
POINT	UTM E (Zone 20)	UTM N (Zone 20)	LATITUDE	LONGITUDE
1	388036.61	5024510.68	45°21'54.582" N	64°25'46.889" W
2	388090.41	5024616.55	45°21'58.107" N	64°25'44.504" W
3	388207.00	5024619.00	45°21'58.169" N	64°25'39.147" W
4	388321.94	5024432.27	45°21'52.206" N	64°25'33.713" W
5	388296.10	5024361.26	45°21'50.538" N	64°25'34.858" W

Figure 3: Pempa'q Project Phase 1 Site Plan

The final array design (Figure 3: Pempa'q Project Phase 1 Site PlanFigure 3) maximizes power output without comprising navigation of vessels around devices and impacting on the maintainability of the site - for example to ensure access is available to repair a subsea cable. Site bathymetry and geology are key design drivers.

Anchors will be installed on the rock outcrops to avoid unstable cobble areas. Cables will be routed in cable corridors to ensure ease of access and maintenance. Use will made of naturally occurring gullies for the cable corridors where possible.

3.2 Anchoring and Mooring System

Each platform will be anchored to the seabed by 4 rock anchors that are mechanically secured into the seabed at pre-determined positions using a subsea drill rig called the AROV (Anchoring Remotely Operated Vehicle - Figure 4). The equipment was designed and built especially for these operations by SME and has been used on several marine anchoring operations, most recently in Connel, Scotland where 4 x Raptor 420 anchors secured SME's PLAT-I platform in extremely hard basalt and andesite rock.

This anchoring technology has many other potential applications and will be useful to other tidal energy developers, as well as other marine industries such as aquaculture and offshore wind turbines.

The anchor installation system is designed to fit on the deck of a small multicat vessel (sourced locally where practicable, multicats from 23-27m LOA have been utilised thus far) with sufficient space and lifting capabilities for handling the AROV and associated equipment.

Figure 4: SME's Anchoring ROV

The current AROV is powered from a diesel-driven hydraulic power unit situated on the deck of the vessel. The system uses environmentally-friendly, bio-degradable, plant-based hydraulic oil. Anchors are mechanically secured to the seabed via a low-impact and low-noise rotary drilling operation. All drilling operations are carried out and controlled remotely from a control cabin on the deck, which is equipped with a video monitoring system, and a data acquisition and logging system. The AROV is powered and controlled via a simple and robust umbilical which consists of the various pressure tested hydraulic hoses along with the control and camera cables.

The mooring system is catenary mooring system attached to the anchors using shackles (Figure 5). SME's previous deployments using a multicat vessel supported by a dive team has been the most cost-effective way of installing the mooring system. SME is currently completing the design of a remotely operated tool to eliminate the need for divers when connecting mooring chains in deeper water. Following the installation of the anchors the mooring chains are laid on the seabed ready for recovery. Both the forward and aft mooring chains are marked with small buoys that can be quickly and easily recovered to a vessel during connection of PLAT-I.

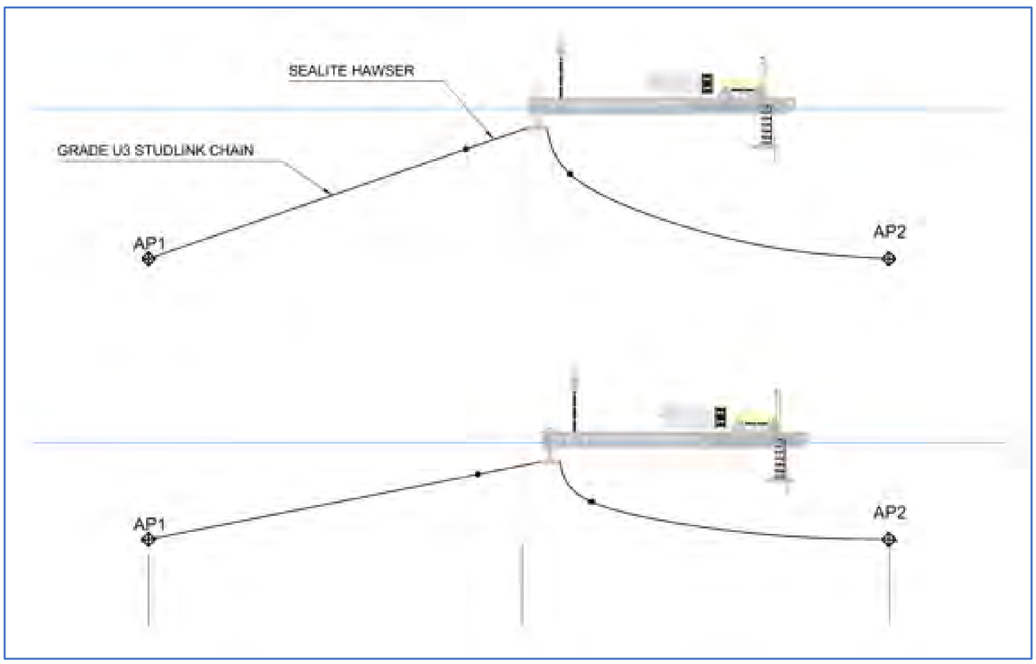


Figure 5: PLAT-I Anchor and Mooring System Arrangement

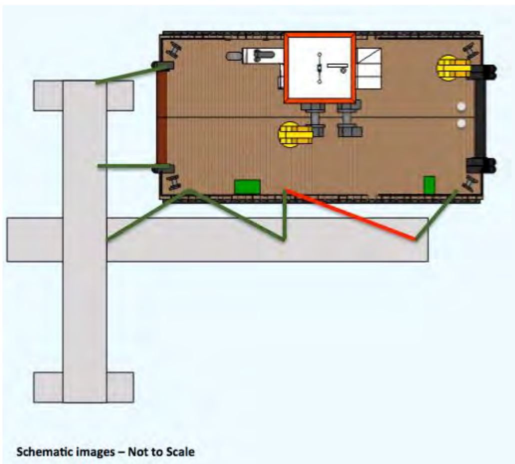
3.3 Installation

The PLAT-I installation process is a simple, efficient and low-cost process that has been conducted successfully for installation of PLAT-I 4.63 in Scotland and Nova Scotia on three occasions (i.e., including reinstallation of PLAT-I at Grand Passage. Once the anchors and mooring chains have been installed, PLAT-I is towed into position and the forward mooring chain is recovered to the surface using the crane of the vessel and line is connected to the forward hawser on PLAT-I using a shackle. The aft mooring is then recovered to the surface and the line is pulled up through the turret and secured. A clacker plate in the turret safely locks the aft mooring chain in position.

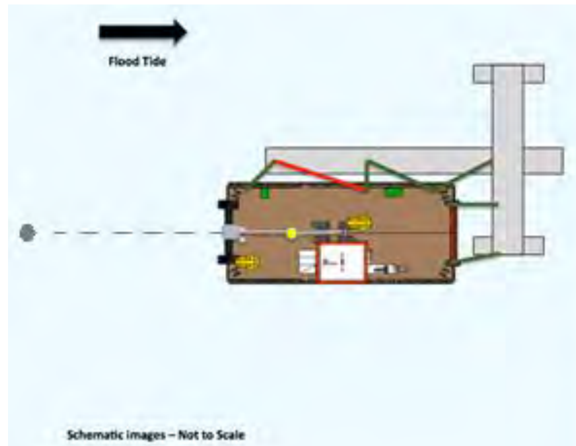
The PLAT-I mooring connection operation has been separated into the follow sections (Figure 6):

Task 1 - Hip up alongside PLAT-I and tow to site
Task 2 - Pick up Variable length bridle, connect synthetic hawser & turret chain
Task 3 - Pick up Fixed length bridle and connect to PLAT-I
Task 4 - Pick up Variable length bridle and connect to PLAT-I
Task 5 - Disconnect Installation Vessel from PLAT-I and depart site

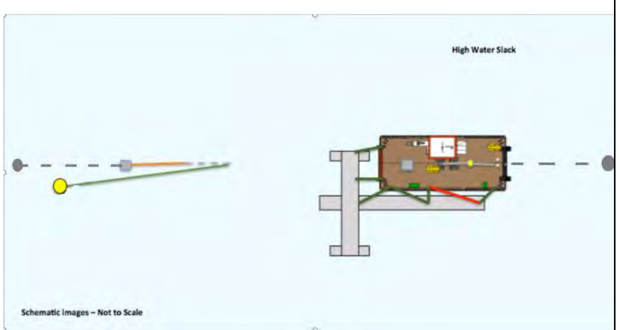
Task 1



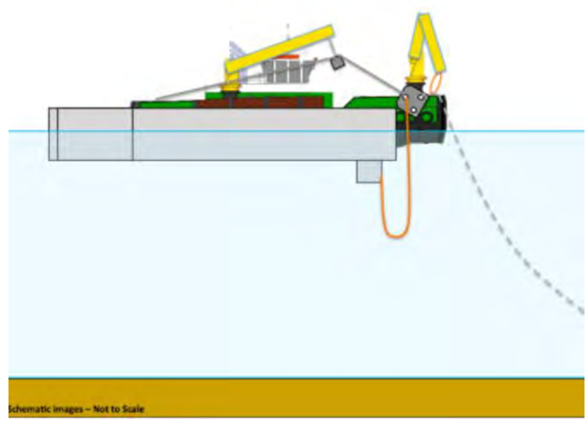
Task 2



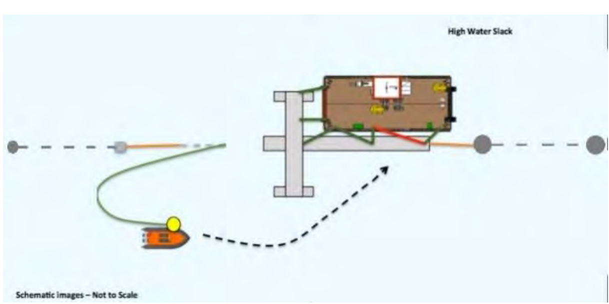
Task 3



Task 4



Task 5



Completion

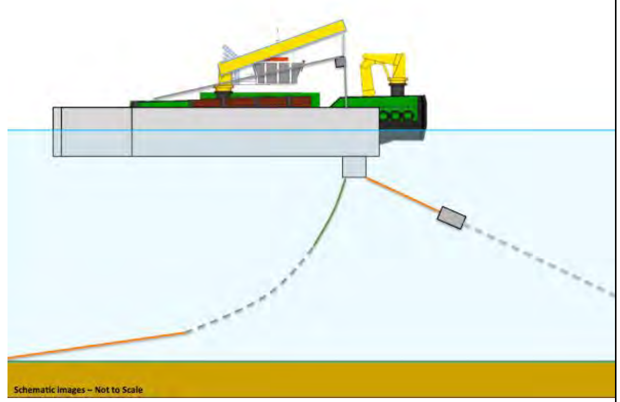


Figure 6: PLAT-I Deployment Method

3.4 Operation and Maintenance

The PLAT-I 6.40 and SITs are designed for low maintenance requirements with minimal annual servicing requirements. The SDMs are designed to be rotated and fixed in the maintenance position to allow access to the turbine using a small maintenance vessel. The SITs are easily removable to enable them to be taken ashore to a workshop for the 5 planned inspections that will be conducted each year, and to carry out any unscheduled repairs.

The platform hull and structures will be inspected and cleaned annually in keeping with typical marine hulls and structure maintenance, with paint repairs and replacement of sacrificial anodes carried out as required. Diver surveys will be conducted periodically to ensure the integrity and condition of the moorings and anchors. It is intended that skilled local tradesmen and engineers will be recruited and trained to form the service teams and carry out the planned maintenance of the PLAT-I platform, turbines and electrical systems. A stock of appropriate spare parts and consumables will be maintained close to the site and will be available to the service teams.

Typical turbine and control system service requirements are as shown in Table 2 and Table 3 below:

Table 2: Turbine Service Intervals

Service level Frequency Tasks

Period	Maintenance Type	Effort
12 months	Regular inspection at site	• Cleaning with steam cleaner • Inspect corrosion protection • Optical inspection of all turbines, blades, etc. • Check lube oil level, magnetic plugs, take samples
5 years	Overhaul	• Workshop inspection and exchange of worn parts Examples: Bearings, dynamic and static sealing, liner • New lube oil filling • Test run after reassembly • Refurbishment of corrosion protection system

Table 3: Electrical System Service Intervals

Service level Frequency Tasks

Period	Maintenance Type	Effort
Continuous	Automatic condition monitoring system	• Automatic data recording • Frequent reports • Alarm if defined threshold values are exceeded
6 Months	Regular inspection at site	• Check ventilation system / changing ventilator mats • Inspect critical electronics installations • Inspection of corrosion • Optical inspection
5 Years	Major inspection	• Inverter inspection and maintenance

3.5 Retrieval Procedure

At the end of the project, the PLAT-I platforms will be removed by the simple process of disconnection from mooring connections and towing to another location. The mooring lines and rock anchors are equipped with retrieval mechanisms that allow complete removal using the same marine assets used for deployment. Subsea cables can be easily lifted and retrieved from the seabed as well.

Decommissioning of the mooring lines, rock anchors and subsea cable will be completed in accordance with the requirements of Nova Scotia Environment, Transport Canada, Environment and Climate Change Canada, Fisheries and Oceans Canada and the Nova Scotia Department of Energy and Mines. Specific requirements will be determined through the relevant permitting processes. While the regulatory requirements will govern these requirements, other factors will be considered within those constraints. These include:

- Results of stakeholder engagement
- Post-project value of the anchors and associated equipment
- Cost of removal and rehabilitation
- Potential value of the mooring spread and subsea cable to future demonstration projects

Two potential scenarios for decommissioning of the mooring lines, rock anchors and subsea cables are leaving some or all the assets in situ for future use, or complete removal of all infrastructure from site.

3.6 Risk Management

Sustainable Marine has identified the following risks to the project plan and has developed mitigation strategies to limit the impact of these risks. A summary is provided in **Table 4**.

Table 4: Risk Management

Description	Type	Risk Level	Mitigation
Timeline challenges with receiving approval under the Fisheries Act	Regulatory	High	Sustainable Marine initiated permitting discussions with DFO at an early stage. Approval to operate platform will be awarded in advance of install. Extensive environmental monitoring and research activities to address uncertainties.
Site permission for deployment	Regulatory	Moderate	Continuing engagement with FORCE, other berth holders and stakeholders. Grand Passage deployments will support and de-risk.
Obtaining sufficient capital	Financial	Low	Required funding is lower than multi-megawatt projects due to lower risk associated with stepwise approach. Proposed device is high TRL (7).
PLAT-I design is not appropriate for Bay of Fundy environment	Technical	Low	Detailed PLAT-I 6.40 design process using operational data from PLAT-I 4.63 deployments and environmental and load data for Bay of Fundy provided by BRTP.
Installation of rock anchors presents technical challenges	Technical	Moderate	Sustainable Marine has initiated the engineering of the AROV to operate in deeper water. Sustainable Marine has contracted qualified geoscientists to assess the type and quality of the bedrock. Installation plan will include contingencies for a variety of potential challenges.
Delays in Marine Operations due to Environmental Conditions and Tides	Technical	Low	Schedule operations during neap tides and monitor weather with assistance of 3rd party where necessary.

Risk that no suitable vessel for the installation is available	Technical	Moderate	Develop new methodologies using local vessels or bring vessel in from abroad.
Lack of future market clarity to attract investment for latter project construction stages	Market	Moderate	Maintain communication with regulators and stakeholders and demonstrate viable technology

3.7 Baseline Project Schedule

Sustainable Marine has developed a baseline project schedule and milestones to deploy 21 PLAT-I 6.40 platforms at FORCE. Construction consists of three phases beginning with a single PLAT-I 6.40 installation in 2020, followed by the rollout of the remaining 20 devices between Q1 2021 and Q1 2023. The baseline schedule for construction is shown in **Table 5**.

Table 5: Project Schedule

Task Name	2019				2020				2021				2022				2023			
	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
Phase 1: 3 PLAT-I 6.40																				
PLAT-I Engineering																				
Licensing & Permits																				
Procurement & Fabrication (PLAT-I #1)																				
1st 6.40 PLAT-I Deployed into FORCE																				
Procurement & Construction (#2&3)																				
Installation at FORCE (#2&3)																				
Commissioning																				
Commercial Operation Date																				
Phase 2: 6 PLAT-I 6.40																				
PLAT-I Engineering																				
Procurement & Fabrication (PLAT-Is																				
Installation																				
Commissioning																				
Commercial Operation Date																				
Phase 3: 12 PLAT-I 6.40																				
PLAT-I Engineering																				
Procurement & Fabrication (#10-21)																				
Installation																				
Commissioning																				
Commercial Operation Date																				

The project milestones and associated timelines are presented in **Table 6**.

Table 6: Project Milestones

Project Activity	Forecast Completion
Phase 1	
PLAT-I Engineering	Complete
Financial Close	Complete
Procurement & Fabrication (PLAT-I #1)	January 31, 2021
Offshore Infrastructure	August 13, 2021
1st 6.40 PLAT-I Deployed into FORCE	August 20, 2021
2nd & 3rd 6.40 PLAT-Is Deployed into FORCE	September 15, 2021
Testing & Commissioning	October 26, 2021
Commercial Operation Date (COD)	October 26, 2021
Phase 2	
PLAT-I Engineering	June 2022
Financial Close	April 1, 2021
Procurement & Fabrication (PLAT-Is #4-9)	March 31, 2022
Anchors and Mooring Systems Complete	June 30, 2022
Deployment of PLAT-I (#1-6) at FORCE Complete	June 30, 2022
Commissioning of Devices	November 30, 2022
Commercial Operation Date	December 20, 2022
Phase 3	
PLAT-I Engineering	September 2022
Financial Close	April 1, 2022
Procurement & Fabrication (PLAT-Is #10-21)	June 30, 2023
Anchors and Mooring Systems	June 30, 2023
Deployment of PLAT-I (#1-3) at FORCE	September 30, 2023
Commissioning of Devices	November 30, 2023
Commercial Operation Date	December 20, 2023

4.0 ENVIRONMENTAL MONITORING

Spicer's approach to environmental monitoring is discussed in this section, including methods employed in previous deployments of the PLAT-I technology, environmental monitoring results from the Grand Passage deployment, and the monitoring plan for the first phase of the Pempa'q Project.

4.1 Approach to Environmental Monitoring

Marine renewable energy holds the potential to contribute to the global effort to counter climate change, by providing clean, renewable energy from an abundant resource. Tidal energy in particular could provide a predictable source of renewable energy that can partly displace thermal baseload sources such as the solid carbon fuel generating plants in Nova Scotia. The possible environmental effects associated with tidal energy need to be better understood before decisions can be made about the future of the technologies. To get this information, effective monitoring measures need to be deployed at operating tidal energy projects.

Several different tidal energy devices have been installed for months or years at a time with no significant environmental effects observed (Copping et al. 2016). However, more monitoring and data collection is required to understand the potential impacts of various turbine designs in different environmental conditions. Internationally, the possibility that fish or marine animals may collide with tidal energy devices is the main concern for the individual or small arrays of devices that currently deployed or planned for deployment. Spicer recognizes that collecting data to further assess the potential for encounters between tidal energy devices and marine life avoidance is an important part of a tidal energy project, especially in relation to Species at Risk.

Spicer will use all reasonable efforts to implement an effective mitigation and monitoring program, while collaborating with stakeholders and leading international marine scientists. In doing so, Spicer will implement a **look, listen, and learn** approach to environmental monitoring, where:

- **Look** includes
  - Marine observation
  - Active acoustic monitoring (echosounder)
- **Listen** includes:
  - Incorporating research by marine scientists
  - Static passive acoustic system (hydrophone and F-POD)
  - Animal Tag monitoring (VEMCO tag receivers)
- **Learn** includes:
  - Understanding of impact of devices and operation on marine animal behaviour

4.2 Previous and Ongoing Deployments

As described previously, the PLAT-I 4.63 device is currently installed and undergoing testing at Grand Passage, in the outer Bay of Fundy. This deployment is providing the opportunity to prove the technical capabilities of the system, collect environmental monitoring data, and test monitoring equipment and techniques. This deployment is providing vital learning which will help to de-risk the Pempa'q Project.

For environmental monitoring in particular, the fact that the PLAT-I is a floating platform provides great advantages in the context of an adaptive management approach:

- Monitoring stations that are part of the PLAT-I infrastructure can be accessed to allow the equipment to be maintained, repaired, upgraded or even replaced with new or different instruments.
- Individual sensors can be moved from one monitoring station to another, allowing sensor performance to be assessed under different environmental conditions, and data to be collected from different locations.
- Third parties such as universities may wish to use PLAT-I as deployment platform for monitoring technologies and data collection.

The environmental monitoring being conducted at Grand Passage continues to inform Spicer's Environmental Effects Monitoring Program (EEMP) by collecting data relating to underwater noise and the presence of fish, seabirds and marine mammals in the vicinity of the PLAT-I. The ways that the information will be used include:

- Spicer will use the information to make decisions about the design of future tidal devices and arrays, and improvements to future EEMPs for PLAT-I deployments, including the Pempa'q Project.
- Indigenous groups, regulators, and other stakeholders will use the information to aid in forming opinions on the Spicer project and other tidal energy projects.

Sustainable Marine has undertaken an industry-leading environmental monitoring system development (EMSD) research program with research partners Fundy Ocean Research Centre for Energy (FORCE) to test optical and acoustic sensors, collect important data on marine life activity, and inform the development of an environmental monitoring system that Spicer will use at the FORCE demonstration site. The EMSD Research Program is divided into 2 separate projects:

1. **Project 1** is comparing the performance of a PLAT-I-mounted hydrophone with that of an identical unit located on a bottom-mounted platform. This project assesses the extent of signal interference from various sources and determine relative performance of PAM devices at surface versus seabed with and without turbine operating, and over various tidal flow conditions.
2. **Project 2** uses echosounders and an imaging SONAR combined with PLAT-I's optical cameras to validate the detection of acoustic targets and determine the utility of these devices for detecting marine life in the vicinity of tidal turbines. This project evaluated which device and mounting configuration provides the best results, and points to a preferred solution for "seeing" underwater at the FORCE site.

The data and knowledge gained through this research will enhance the understanding of sensor performance in high-flow tidal environments and advance knowledge of turbine-marine life interactions.

4.3 Grand Passage Results

PLAT-I 4.63 has been operating at Grand Passage since February 2019 under a Fisheries Act Authorization from DFO. In the summer of 2019, Sustainable Marine provided DFO with a summary report on operations during the term of the authorization, which ended in May 2019. Environmental monitoring activities included dedicated underwater video cameras for each turbine rotor and a hydrophone for recording underwater sound. These sensors were operated at all times during turbine operation. Visual marine animal observations were also made at regular intervals during all operating periods. Conclusions drawn from the mitigation and monitoring activities undertaken during that operating period are presented below.

Underwater Video

- The underwater video recording system performed and functioned well for the duration of the PLAT-I operational period.
- Underwater video provided good quality images of the turbines and the immediate vicinity of the turbines and is a good indicator of encounters with turbines.
- Elevated turbidity levels in Grand Passage occasionally result in poor visibility with the underwater video system.
- Detailed review of underwater video was undertaken covering the full range of tide state, turbine operations (braked, free-wheeling, generating), and time of day (only daylight hours). Observations included:
    - Low levels of animal presence were observed in the reviewed video segments.
    - Only 1 positive fish identification (a smelt), along with several jellyfish observations.
    - Other observations of possible (unidentified) fish were made in the reviewed video.
    - No observations of marine mammals or marine reptiles were made, and only one observation of a confirmed fish (which passed well above the turbine rotor), therefore no opportunity to enumerate, identify, observe behaviour, or note potential harm caused by an operational turbine.

Hydrophone Data

- Assessments of underwater sound produced by PLAT-I were made by Jasco Applied Sciences using data collected from a hydrophone mounted within 3 m of the closed turbine and approximately 20 m from the furthest turbine.
- The hydrophone data gave a good indication of turbine noise and ambient noise in Grand Passage.
- The acoustic data were affected by turbulent flow around the hydrophone and PLAT-I structure.
- The worst case measured sound levels, when weighted for porpoise hearing, were 128 dB re 1 μPa^2, which is 15-20 dB below the sound levels measured for the OpenHydro turbine in Minas Passage, or for typical vessels expected in Grand Passage (i.e., ferries, tugs, fishing and recreational vessels).
- It is highly unlikely that a porpoise could accumulate enough sound exposure for permanent hearing injury, even if they remained within one length of the PLAT-I for an entire day.

- Neither hearing injury nor significant behavioural disturbance of fish is expected based on the measured sound levels.
- Certain acoustic emissions from the turbine are detected by mammal vocalization algorithms as mammal vocalizations, making detection of actual mammal vocalizations difficult. This was corrected during operations in fall 2019, and marine mammal vocalizations can now be recorded and assessed based on the hydrophone data.

Marine Animal Observation

- Observations were made by Sustainable Marine personnel during turbine operation and diligently recorded on data acquisition forms. Observations were made using binoculars from locations with a clear view of PLAT-I and the area within approximately 500m of PLAT-I.
- Data entry spreadsheets were an effective means of capturing the required data during each observation event.
- Results show low levels of marine animal observations. This is likely due to the time of year and the fact that PLAT-I is located in a high-flow channel not frequented by many species. This assessment is consistent with information provided by local residents.
- Sustainable Marine's internal review, augmented by a third-party review by Envirosphere Consultants Limited has provided valuable recommendations for improvements to be integrated in future MAO programs.

General Conclusions

- The measures and standards to avoid and mitigate serious harm to fish and impacts to aquatic species at risk were conducted in general accordance to the conditions of the DFO authorization.
- No contingency measures were required or implemented during the Authorization period.
- No encounters with marine life were observed with the exception of several jellyfish and 1 confirmed fish observed in video footage. None of the animals appears to come into contact with the platform or turbines.
- Testing of PLAT-I is ongoing including further investigate potential environmental effects. Beneficial modifications to mitigation and monitoring measures identified in this first phase of testing have been integrated into the current testing program.

4.4 Pempa'q Project Environmental Monitoring

The PLAT-I 6.40's interaction with the environment is a key aspect of the Pempa'q Project, as well as the overall demonstration of Sustainable Marine's technology. Mitigation and monitoring measures proposed for the Pempa'q Project are a continuation of activities employed in 2019 and 2020 during the initial testing of the prototype PLAT-I 4.63 at Grand Passage, Nova Scotia. The results will play an important role in the evaluation and advancement of tidal energy projects in the Bay of Fundy.

Phase 1 of the Pempa'q Project will include an Environmental Effects Monitoring Program (EEMP) to provide information that will inform an assessment of the measures and standards that will be implemented to avoid the harm of fish or to mitigate the extent of their death in compliance with the anticipated terms and conditions of the Fisheries Act Authorization. Additionally, the EEMP will:

- Collect, analyze, interpret and report data to meet NSE and NSDEM regulatory requirements.
- Collect, analyze and interpret data to help inform internal and sectoral initiatives to assess environmental risks associated with marine renewable energy projects.
- Provide input to ongoing stakeholder communications.

This EEMP will consist of the collection of data via multiple instruments suitable for the site conditions at Spicer Marine Energy Inc.'s deployment site at FORCE.

Mitigation Measures

With respect to marine animals, the most significant risk associated with the PLAT-I deployment in Minas Passage is a direct interaction with a Species at Risk. Mitigation measures implemented in Phase 1 of the Pempa'q Project include the following:

- All PLAT-I functions relevant to potential environmental effects will be controlled remotely via subsea communications cable, with wireless communication as a backup. PLAT-I will not be operated when there is not a direct communication link to the platform control systems.
- All SDMs (the arms on which each turbine is mounted) can be raised from onboard PLAT-I or remotely. All 6 turbines can be raised within a few minutes.
- Each SDM is equipped with a kick-up mechanism that raises the SDM (and therefore the associated turbine) from the water if a large object such as a tree trunk impacts the SDM.

Spicer will maintain records of the implementation of these mitigation measures and undertake the monitoring measures described below to evaluate the effectiveness of the mitigation measures.

Monitoring Measures

Based the experience with environmental monitoring at Grand Passage and in consultation with local and international experts, Spicer has selected a suite of sensors that will collect data to inform the evaluation of mitigation measures and assessment the potential for interactions with marine life (**Table 7**).

Table 7: Monitoring Instruments

Instrument	Make/Model
Hydrophone	icListen RB9 HF HCI-36V Communication Interface GUARD-HD-F-Hydrophone Guard
F-Pod	F-Pod
VEMCO Receiver	VR2 69kHz
Echosounder	Simrad EK80 ES70-18CD transducer x 2 (outer hulls, side facing) WBT Mini x 2 (for ES70) EC150-3C transducer (centre hull, down facing) Processor
GPS Timing Module	TM-20-SER-4F

The rationale for the selection of the monitoring measures is based on:

- **Capability Confidence**: The technologies and methods have either been proven at Grand Passage or have been tested at Grand Passage with promising results and used successfully in other applications. In the case of the echosounder, early results from our Environmental Monitoring System Development research are positive and refinements will be implemented for further testing, and the technology has been successful used in FORCE's monitoring of the FORCE site over the past several years. The passive acoustic instruments are widely used in the marine renewable energy sector around the world and have been used effectively at Grand Passage and/or the FORCE site.

- **Proportionality**: Typically, the level of effort and cost of implementing environmental monitoring measures should be proportional with the perceived risks and the size of the demonstration project. In the case of the proposed monitoring, that level is significantly higher than that undertaken at other tidal energy sites including previous deployments at FORCE.

- **Monitoring coverage**: The combination of monitoring measures provides coverage of the immediate vicinity of rotors and the broader area around PLAT-I.

Given that the PLAT-I technology employs a floating platform, sensors can be easily accessed for maintenance, providing great advantages in the context of an adaptive management approach:

- Monitoring stations that are part of the PLAT-I infrastructure can be accessed to allow the equipment to be maintained, repaired, upgraded or even replaced with new or different instruments. Changes can be proposed by Spicer or requested by the regulator but would always be subject to regulatory acceptance.
- Individual sensors can be moved from one monitoring station to another, allowing sensor performance to be assessed under different environmental conditions.
- Third parties such as universities may wish to use PLAT-I as a deployment platform for monitoring technologies and data collection.

Along with assessing the effectiveness of the mitigation measures, the monitoring measures will endeavour to verify the following hypothesis through the approaches and methods described in **Table 8**.

Table 8: Monitoring Methods

Hypothesis	Approach	Method
Marine animals present avoidance behaviour in the vicinity of the platform when the turbines are spinning	Monitor animal presence in near-field (~100m of platform) when rotors spinning and stationary Monitor animal behaviour regarding collision avoidance	• PAM (VEMCO, hydrophone, F-Pod) detect presence of vocalising animals in near field • PAM results can be compared based on flow speed and turbine operation • AAM (echosounder) monitors animal presence directly upstream from the rotors • Cameras monitor swept area of the rotors, and some distance either side of outer rotors • AAM and camera footage can be compared to determine how animals travel upstream from rotors

Fish are not present at rotor depth when flow speeds are above turbine cut-in speed.	As Assess fish presence in water column based on flow speed and depth-varying velocity Assess the probability of strike for freewheeling rotors below cut-in speed	• Down-facing echosounder monitors fish presence at all water depths • Down-facing echosounder monitors flow speeds at all water depths • Echosounder data can be compared to velocimeter data and rpm to determine fish presence based on flow speeds and rotors speed • Calculated based on fish size, velocity and rpm the probability of strike
Animals present directly upstream from the turbines exhibit avoidance behaviour or pass through the rotor field but the probability of strike/harm is very low.	Monitor animal presence at swept depth upstream from the turbines Assess probability of impact between animals present in this region based on size, behaviour, and other characteristics	• Echosounder and cameras monitor field directly upstream of swept depth, far (echosounder) and close (cameras) • Size and behaviour of species from these methods can determine risk of impact (based on size, flow speed, RPM etc.) and behaviours

Spicer's environmental monitoring and mitigation program will be conducted on the principle of adaptive management, an approach that is widely used in the Marine Renewable Energy sector to evaluate monitoring data and make informed, science-based decisions to modify monitoring programs as deficiencies or opportunities for improvement are identified. Because uncertainties are inherent in the development of new technologies and in collecting data in high-flow tidal environments such as the Minas Passage, this approach allows adjustments and improvements to be made as new information becomes available. Monitoring results and outcomes will be reviewed on a continuous basis with regulators and FORCE, and technologies and methods will be revised based on the accumulated knowledge.

Contingency

Since it is anticipated that the proper operation of the equipment is essential for regulatory compliance, contingency plans will be in place to correct any operating deficiencies in the EEMP systems. In the case of the instrumentation and key system components, this will take the form of replacement equipment in inventory or under contract for quick delivery. Services required to repair or replace the equipment will also be maintained under contract.

Appendix B.

DP ENERGY: Berths B + E

Appendix B. Rio Fundo Operations Canada Limited

Company info

Core Business Products & Services

DP Energy is renewable energy project developer with more than 25 years' experience of developing wind, solar and tidal projects in Europe, Canada and Australia. Since commissioning their first wind farm in Northern Ireland in 1995, DP Energy has developed 314 MW of built and operating assets including the 60 MW Bow Lake Wind Farm in Ontario. The company currently has more than 1 GW of projects in development, ranging from Solar PV in Alberta to hybrid wind, solar and storage projects in Australia. DP Energy has also been one of the leading pioneers in the in-stream tidal energy space. The company has 339 MW of tidal energy projects under development including 9 MW at FORCE in the Bay of Fundy, Nova Scotia. The DP Energy members of the proposed project team have worked through the project development cycle from land acquisition, through consent, construction, commissioning and in operation. This includes the full consenting process for the 30 MW West Islay Tidal Energy Park and the 100 MW Fair Head Tidal Project in Northern Ireland. Both Rio Fundo Operations Canada, Ltd and Halagonia Tidal Energy, Ltd are wholly owned DP Energy companies.

Mission, Goals, Objectives

DP Energy's mission is to develop renewable energy projects which are both sustainable and environmentally benign, conducted in a manner which has the least possible impact on other species.

Physical Offices, Public Contact

DP Energy has offices in Cork, Ireland and Halifax, Nova Scotia Canada to support the development of its tidal turbine project in the Bay of Fundy. Public inquiries should be made to info@dpenergy.com. This email address is monitored regularly, and requests are forwarded to the most relevant employee for a response.

Project Management Team

The Tidal Turbine Project Management team consists of the below personnel:

John Kerr – Commercial Director is a Chartered Surveyor with an extensive background in Canada, the Caribbean and Ireland in the identification and management of property development opportunities, spanning a period of four decades. With a formal business education taken at the University of Limerick and holder of both undergraduate and a Master's degree, John is also an accredited Civil and Commercial Mediator, an Associate of the Chartered Institute of Arbitrators and a Fellow of both the Society of Chartered Surveyors of Ireland and the Royal Institute of Chartered Surveyors.

Damian Bettles – Project Director is the Regional Manager for Canada and has more than 15 years' experience of delivering major projects across a broad range of sectors, especially renewable energy. He has led several strategic projects in Europe and Canada and has experience working with a variety of clients including government, investment funds and individual private investors. Damian is a member of the Institute of Engineering and Technology (MIER). He will be responsible for the project oversight.

Sarah Thomas – Project Manager is the Project Manager for the Uisce Tapa Project and has more than 14 years experience in managing large-scale marine projects. With a robust background in shipbuilding, she transitioned to renewable energy in 2017. Sarah holds both a Bachelor of Science and a Master's degree and is a certified PMP professional. She is responsible for the project management and execution of the Uisce Tapa Project work in Canada.

Key Partner
DP Energy's key partner in the development of Berth E through Halagonia Tidal Energy LTD is Andritz Hydro Hammerfest (AHH). Specifically, we will be using the 1.5 MW AHH Mk1 three-bladed horizontal axis turbine. DP Energy is in discussions with AHH to partner for Berth B development as well.

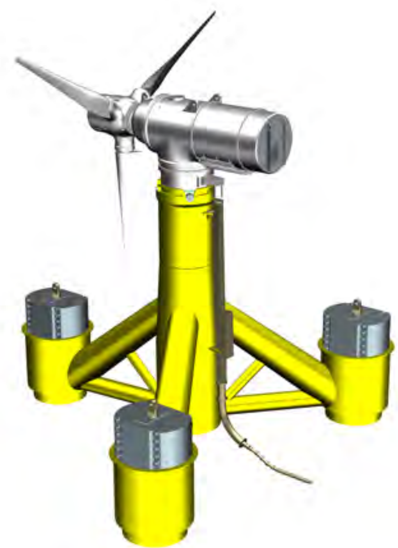


Figure 1: Example Bottom Mounted Turbine, based on AHH Mk 1

Technology description
Design Features/Advantages

The technology for this development will have a rated power of a minimum of 1.5 MW for the prevailing site conditions, is a seabed mounted tidal turbine, with a diameter of less than 20 meters.

The intention of the proponent is to install 3 bottom mounted turbines in the Bay of Fundy using a monopile or ballasted gravity base; the nacelles will be no more than 30 meters above the seabed and each is expected to generate 1.5 WM at the generator terminals at its rated operating point. The turbine will notionally operate at 15 RPM during maximum power generation and a maximum of 18 RPM. If this maximum is reached, failsafe measures would halt operation of the turbine.

The subsea structure will support a vertical spine which routes the cable from the nacelle to the subsea export cable. The nacelle is a single retrievable unit that interfaces with the vertical support spine via a wet-mate connection.

The gravity base foundation, if a ballasted system, will use ballast weight to hold itself in place on the seabed. The footing will be designed to accommodate the site-specific parameters, including levelling tolerances of the turbine. If a monopile on pin pile subsea structure is used, some seabed preparation will be required, including drilling into the bedrock to secure the structure in place.

Functionality

In response to the forces exerted by the moving water, the three bladed rotor, which is exposed to the water forces, absorbs the energy in the form of lift and drag forces. The rotational forces are taken up through the main shaft, gearbox, and high speed shaft into the generator. The generator resistance forces are taken up by the structure inside the nacelle and transferred through the yaw mechanism into the subsea structure to the seabed. All other thrust and moments are taken up by the front plate, transferred through the nacelle into the yaw mechanism, the subsea structure and the seabed. The reaction force in the device is obtained through the subsea structure, ballast weight and footing on the seabed. This provides resistance against any sliding forces and turning forces.

The rotational moment caused by the rotational forces from the water is transformed into electrical energy at the generator inside the nacelle at a three-phase variable frequency voltage of up to 6.6 kV. The power is then transmitted to shore via a subsea cable into a Medium Voltage Converter (MVC) located at the power conditioning site (PCS). The PCS produces a grid compliant power at a constant frequency at a voltage of 6.6 kV. This power is then transmitted to the grid at the metering connection via a cable.

Mooring Description

Any mooring used for turbine installation and recovery will be temporary. There are currently no plans that include permanent moorings for this technology.

Fabrication

The turbines themselves will be manufactured at a proven manufacturing facility in Europe. Assembly and final deployment preparations will be conducted in Canada. The desire is to build the subsea structures in Canada, if suitable facilities can be identified with project constraints.

Project description

Deployment site

Berth B, previously assigned to SME, has been reassigned to RFOCL (Berth C being reassigned to SME). Subsequently, due to the change to the AHH Mk1 bottom mounted turbine, RFOC requested a location change; DP Energy’s two berths, Berth B and Berth E, are now both located on the raised volcanic ridge, as depicted in Figure 2 below.

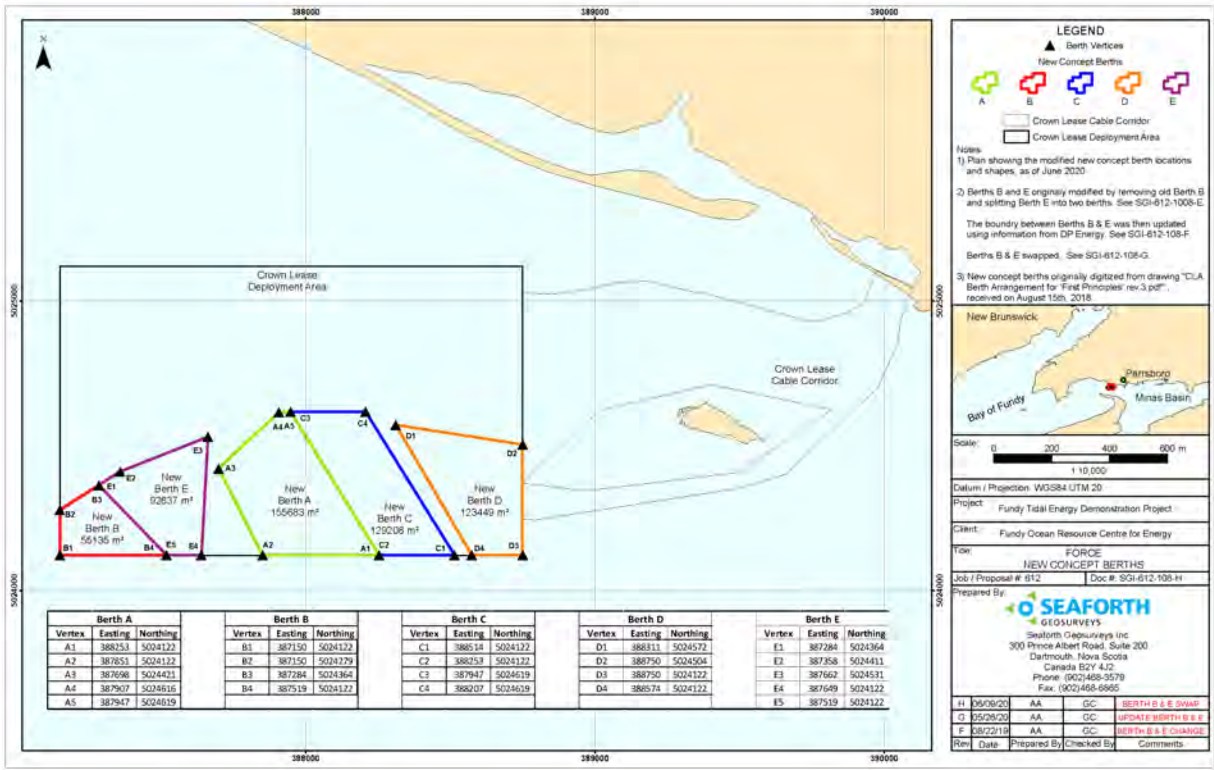


Figure 2: FORCE Crown Lease Area

Deployment method of procedure

Prior to turbine deployment, the subsea cables (one per turbine) will be installed using the appropriate type of vessel. DP Energy is in the initial stages of planning this installation, having discussions with several local marine operators.

The installation methodology will be further detailed in conjunction with the selected marine contractor for the project.

Type of vessel involved

DP Energy is working with experienced operators to finalize the Marine Operations Planning for the project. Two solutions are currently under consideration, the first being a moored vessel deployment, the second using a heavy lift DP vessel or similar.

Ongoing O&M Approach

Tidal turbines typically have a 5-year maintenance cycle. It is envisioned that maintenance will be carried out by the turbine supplier in the first instance with marine operations subcontracted out. In the future, there is the potential for the maintenance to be carried out by a local subcontract under OEM supervision.

The Decommissioning Phase will essentially be a reversal of the installation phase.

Retrieval procedure

The retrieval procedure will be the reverse of the installation procedure.

Project Plan

The project key milestones are detailed below in

Date[1]	**Activity**
Aug 2022	Onshore Electrical Works Completed
Oct – Dec 2022	Subsea Cable Installation Activities
Jul – Nov 2023	Phase 1 Subsea structure installation
Jul – Nov 2023	Phase 1 Turbine installation
Feb 2023	Phase 1 Commissioning activities conclude
Apr 2023	Begin Phase 1 Operations and Maintenance Activities
Jul – Sep 2024	Phase 2 Cable Installation
Sep – Nov 2024	Phase 2 Subsea Structure Installation
Sep – Nov 2024	Phase 2 Turbine Installation
Nov 2024	Phase 2 Commissioning activities conclude

Table 1, subject to regulatory approval.

Date[1]	**Activity**
Aug 2022	Onshore Electrical Works Completed
Oct – Dec 2022	Subsea Cable Installation Activities
Jul – Nov 2023	Phase 1 Subsea structure installation
Jul – Nov 2023	Phase 1 Turbine installation
Feb 2023	Phase 1 Commissioning activities conclude
Apr 2023	Begin Phase 1 Operations and Maintenance Activities
Jul – Sep 2024	Phase 2 Cable Installation
Sep – Nov 2024	Phase 2 Subsea Structure Installation
Sep – Nov 2024	Phase 2 Turbine Installation
Nov 2024	Phase 2 Commissioning activities conclude

Table 1: Project Key Milestones

Environmental Management

RFOC's Environmental Management Plan (EMP) will encompass all environmental and regulatory requirements and commitments made for the Project, including formal conditions of the EA Approval and any subsequent advice or requirements from federal, provincial and/or municipal permitting. The EMP will address both the deployment/installation phase and the operations phase and will be implemented at the start of installation activities.

Monitoring Studies/Testing to Date
DP Energy undertook a noise and vibration analysis of the AHH Mk1 turbine. These results are still being analyzed and the information will be included in future correspondence with regulators as project authorization is pursued. This will be the basis of any further analysis for any additional or modified bottom-mounted turbines at Berth B.

DP Energy is also working with OERA, FORCE and other entities on the Pathway Program. Specifically, DP Energy is responsible for delivering to OERA the reports and data from our efforts to successfully deploy a multi-sensor monitoring platform that has been demonstrated effective in at the FORCE site.

Finally, DP Energy has engaged an experienced company to develop an encounter rate model (ERM) of interactions between the AHH Mk1 turbine at the FORCE test site and a few key species of fish present there. This work is still in the exploratory phase as it has been difficult to collect data to develop a baseline presence model. However, DP Energy is continuing to pursue this analysis and will include progress in future correspondence with regulators as project authorization is pursued. This will be the basis of any further analysis for any additional or modified bottom-mounted turbines at Berth B.

Near-field Monitoring Plans
DP Energy continues to develop its near field Environmental Effects Monitoring Plan (EEMP) through discussions with the regulatory authorities and as additional information is gathered on sensor performance at the FORCE site, on the MeyGen project, and through conversations with other leading experts, including the University of Washington in the US and the University of the Highlands and Islands in the UK. DP Energy has been having discussions with these organizations separate from, as well as participating fully in the Pathway Program.

As a part of its obligations to OERA under the Pathway Program, DP Energy will be deploying a test monitoring platform at the FORCE site in the second half of 2020. The near field EEMP will be informed substantially from this deployment, outside of the Pathway Program's progress.

DP Energy has purchased a variety of sensors to test the performance over the next 9 months. DP Energy has also invested in monitoring infrastructure, including a subsea cable to provide power and fiber op connection to a tethered monitoring platform, intending to monitor the near-field via an independent bottom-mounted device, separate from any installed turbine.

Appendix C.

BIG MOON POWER CANADA: Berth D

Mission, Goals and Objectives

BigMoon Canada Corp is a wholly owned subsidiary of BigMoon Power LLC. BigMoon holds patents on marine renewable energy technologies being tested and demonstrated in the Bay of Fundy, Nova Scotia Canada. BigMoon is also a developer of river energy technology. BigMoon is the owner of the patents on the Kinetic Keel energy system and has legal authority to operate, develop and adapt the technology in any manner.

The mission of the company is to develop and operate technologies that can effectively, efficiently and in an environmentally responsible manner harness the power of moving water for the purpose of generating utility scale electricity. BigMoon has two existing patents and one patent pending to protect the individual proprietary aspects of the technology developed since 2016.

BigMoon also looks for opportunities to develop projects in resource areas that can produce electricity from moving water in tidal flows, ocean currents and river ways. The company works with local regulators and government bodies to permit and negotiate long-term contracts for the sale of electricity onto local grids.

Core Business Products and Services

BigMoon has developed proprietary systems for harnessing utility scale electricity from moving water. Our business model is to develop projects and contracts to sell electricity to local utilities, license technology to other project developers and operate marine energy systems for the purpose of providing renewable energy around the world.

Project Management Team

Lynn Blodgett – Chairman

Lynn started a transaction processing company 35 years ago in a basement with his brother. He became the CEO of a Fortune 500 global services company with over 100,000 employees in over 100 countries with annual revenues of $8 billion. Lynn provided the concepts and the majority of the funding for BigMoon Power.

Andy Jenkins – Chief Executive Officer

Andy has 25+ years of global business experience. He has experience growing global companies from start-ups to $1 billion in annual revenue with a focus in management, sales and project management. Andy lived in Europe for seven years overseeing the European operations for a Fortune 500 company.

Michael Festa – Chief Financial Officer
Michael has over 25 years managing all aspects of global corporate finance with his most recent experience as the CFO of an $8 billion company.

Ernie Blodgett – Chief Engineer

Pioneering software engineer with over 40 years experience developing innovative products such as the first software for pharmacies in the world. Founder, President, CEO and Chairman of Lightspeed Dealer Management Systems, an acknowledged leader in the motor sports and marine industry. Currently President of Heber Center for Advanced Programming.

Corinne Dunow – General Office Manager

28+ years of experience coordinating a wide range of business activities including administration, travel and entertainment, banking, supplier relationships, bookkeeping and accounts payable.

Jeff Blodgett – Vice President of Development

Jeff has overseen the development and testing of the Kinetic Keel since the project was 6 months old. He successfully managed the development and testing of a large prototype kinetic keel in the Minas Basin, leading to BigMoon's acquisition of an 18-year permit and 15-year Power Purchase Agreement with the Province of Nova Scotia.

Joe Fitzharris - Project Manager

Joe has been working in marine operations, safety and operations for over 20 years. Joe has worked on some of the largest projects in Atlantic Canada for some of the country's most well known and respected companies. Joe has managed all aspects of multi-million dollar technology and development projects and has been working with BigMoon Power since 2017.

Jamie MacNeil – Vice President of Government Relations & Canada Country Manager

Jamie has worked extensively with Federal and Provincial Governments at senior levels to champion key initiatives. He has worked successfully as political consultant for multiple years.

Project Partners

Strum Engineering, Dartmouth, Nova Scotia
Strum Engineering has been working with BigMoon on the design and implementation of BigMoon's surface mounted plant to the infrastructure located at FORCE. Richard McCarthy has been the lead engineer working with BigMoon and is responsible to interconnection from the Kinetic Keel to the Nova Scotia Power grid.

Strum Environmental, Bedford, Nova Scotia
Strum Environmental has been working with BigMoon on development of all of our environmental monitoring plans in Nova Scotia for all of our prototype tests. Strum has put together the environmental monitoring plan for this document and has been the lead agency for our public engagement plan for the development of our existing 5MW project in Nova Scotia and will be the lead agency for the public engagement plan for the 4MW project should BigMoon be successful in this procurement.

Stantec, Dartmouth, Nova Scotia
Stantec has been working with BigMoon on all of our prototype testing as well as the development of our demonstration unit for the Bay of Fundy. Stantec has designed the 0.5MW Kinetic Keel that will be fabricated and deployed in the Bay of Fundy for our existing permit and for the 4MW project should BigMoon be successful in this procurement.

E.Y.E Marine Consultants, Bedford, Nova Scotia
EYE has been working with BigMoon since 2016 on all aspects of naval architecture and marine engineering of BigMoon's Kinetic Keel specifically for deployment in the Bay of Fundy. EYE has worked on every prototype deployment for BigMoon in Nova Scotia and is involved in the design and fabrication requirements for the demonstration unit that will be used for BigMoon's existing 5MW project as well as the 4MW deployment if BigMoon is successful in this procurement.

Operational Excellence Consulting Inc, Halifax, Nova Scotia

Operational Excellence will be the agency coordinating and executing the removal and disposal of the abandoned OpenHydro turbine currently sitting in Berth D at FORCE. Operational Excellence has put together a project budget and plan based on their extensive experience working with OpenHydro on past deployment and recovery operations of turbines located at Berth D at FORCE. If BigMoon is successful in this procurement, Operational Excellence will be authorized to begin the project to remove and dispose of the OpenHydro turbine on BigMoon's behalf. The project budget and timetable are attached to this submission.

Glooscap Energy Limited Partnership, Glooscap First Nation, Nova Scotia
BigMoon has entered into an agreement (attached to this submission) with Glooscap Energy Limited for the purpose of mutual benefit for both companies. Glooscap Energy Limited will work with BigMoon to help identify and develop new project opportunities and deploy Glooscap First Nation human and professional resources where appropriate to assist projects. BigMoon will work Glooscap to employ members of Glooscap First Nation wherever possible, help build capacity for Glooscap Energy Partnership to develop as well as work together to establish a Glooscap Culture and Community Fund for the betterment of all members of Glooscap First Nation. A copy of the agreement between Glooscap and BigMoon is available in appendix iv of this submission

Atlantic Towing Ltd., St. John, New Brunswick
Atlantic Towing Limited has been working with BigMoon on marine operations and multiple deployments in the Bay of Fundy. Atlantic Towing has consulted with BigMoon on best marine practices and operational excellence when mobilizing and deploying assets in the Bay of Fundy. Atlantic Towing has assembled resources for BigMoon to assist in project deployment including purchase of supplies, engineering expertise and testing plans for BigMoon prototypes. Atlantic Towing has successfully deployed BigMoon's existing gravity base in the Bay of Fundy and has positioned, towed and berthed BigMoon assets at their facilities in St. John, New Brunswick. Atlantic towing also sold BigMoon a work barge for $1 to assist in our project development.

Poseidon Marine Consultants Ltd., St. John, New Brunswick
Poseidon has worked with BigMoon in conjunction with Atlantic Towing to plan, design and deploy BigMoon's gravity base currently in the Bay of Fundy. Poseidon has worked with BigMoon's engineering team and will continue to work with BigMoon on future gravity base deployments as well as the 4MW project should BigMoon be successful in this procurement process.

Primary Contact and Physical Location

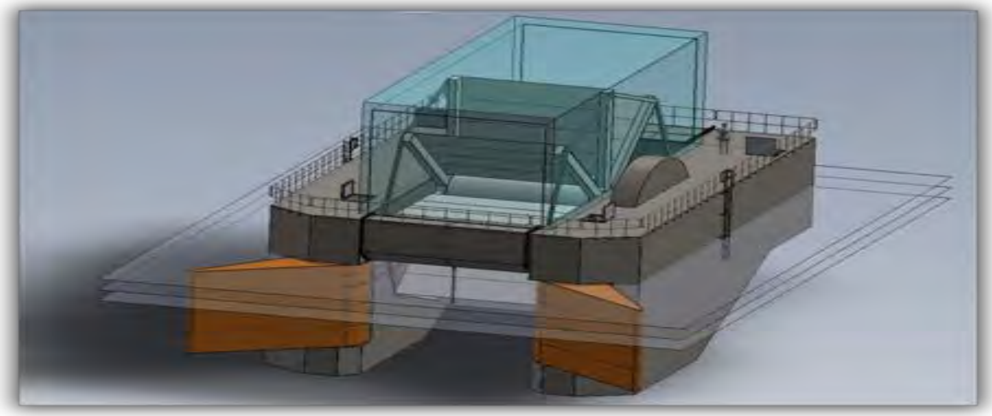
Primary Contact

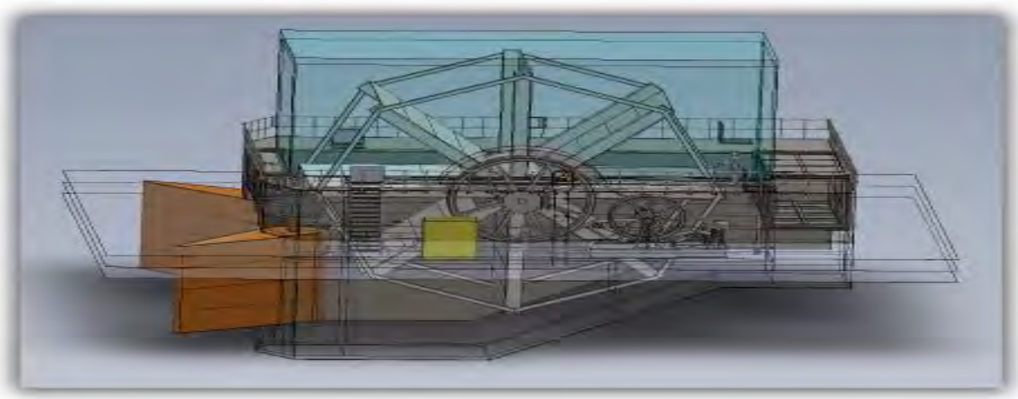
Jamie MacNeil
633 Astral Drive
Dartmouth, NS B2V0B3
902-222-7316

Technology Description

Technology Overview

The BigMoon(BMP) Generator consists of a pontoon hull platform assembly with a kinetic paddle wheel positioned between the two pontoon hulls which forms a chamber that capture the water as it flow by the kinetic wheel and the force of the water makes the kinetic wheel spin.





BMP has created an innovative approach by directing the flow of water into the kinetic wheel chamber through the use of accelerator plates. The accelerator plates will increase the volume of water into the kinetic wheel chamber and in turn increases the current flow speed. This approach will create an increase in torque which will generate more electricity especially at the slower current flow speeds. The BMP generator is a 0.5MW generator and this project will consist of an array of eight 0.5MW Kinetic Energy platforms which will generate a total of 4MW of electricity. The generators will be connected to the existing FORCE subsea cable through a subsea infield array of cables which will consist of a 2 cable splitter from the end of the FORCE cable into two 4 cable connector hubs which will be arrange to provide the shortest cable runs from the platforms to the FORCE cable.. The kinetic platforms will be secured by mooring each platform to a gravity base structure similar to the design created for the 2019 prototype testing. The design of the BMP Kinetic Platform is to allow the platform to swivel 360 degrees through a slip ring designed into the mooring line and cable as they connect to the platform. This swivel action will allow the accelerator plates to always be at the optimum position to capture the current flow through the wheel chamber.

The BigMoon generator is a proprietary technology developed by BigMoon. BMP has two existing patents and one patent pending to protect the individual proprietary aspects of the technology developed since 2016.
Big Moon patent Application No.: US10,458,385 B2
Title: Systems and Methods for Tidal Energy Conversion and Electrical Power Generation using a rotatable drag plate.
Date of Patent: October 29, 2019

Big Moon patent Application No.: US10,378,504 B2
Title: Systems and Methods for Tidal Energy Conversion and Electrical Power Generation
Date of Patent: August 13, 2019

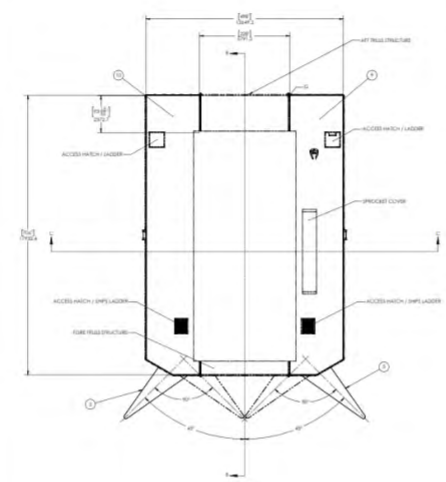
Big Moon patent pending Docket No.: 96542.005
Title: Systems and Methods for Hydro-Based Electrical Power Generation

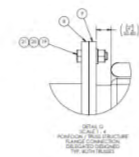
Technology Readiness Level

The BigMoon platform is currently at an API 6 TRL and a DOE 7 TRL based on the level of prototype testing completed between 2018 and 2019. This prototype testing has involved a scaling up of size of the energy platform and has involved the marine operations involved in deploying, operating, and maintaining the platform in the Minus Passage which is in close proximity to the final commercial project location . BigMoon is currently working on fabricating the first commercial device which is planned to be in the water and grid connected by the end of 2020. This first commercial ready device will be at an API 7 TRL and a DOE 8 TRL.

Drawings showing the technical aspects of the Big Moon Kinetic Wheel have been provided in appendix

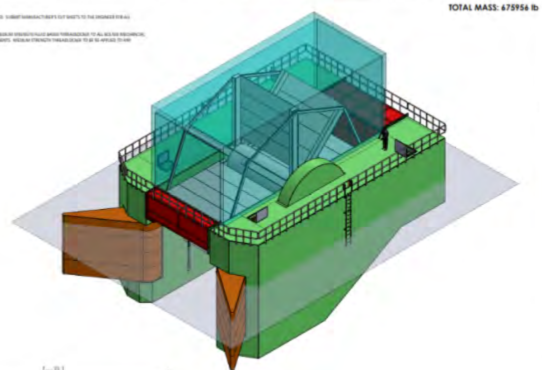
Technical drawings

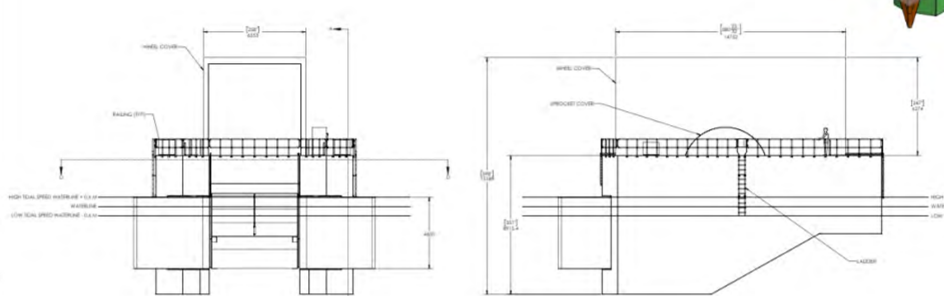




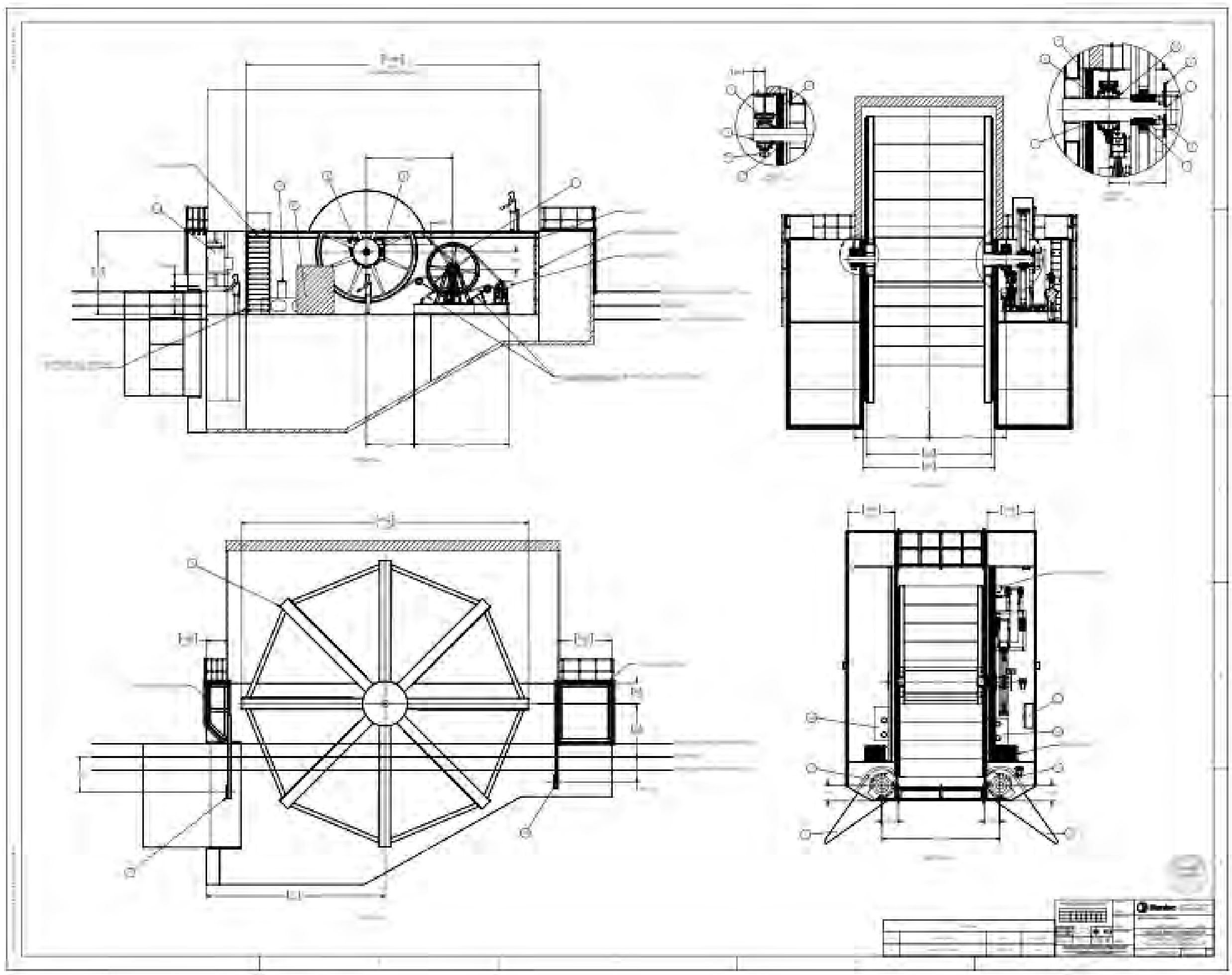
BILL OF MATERIALS					
ITEM NO.	VENDOR	PART NUMBER	DESCRIPTION	QTY	MASS, EACH (lb)
1		31838-002	DRIVE TRAIN ASSEMBLY	1	40826
2	-	31838-003	BRAKE ASSEMBLY	1	174
3		31838-018	BRAKE DISC	1	649
4		31838-025	WATER WHEEL 18 FT	1	166822
5	-	31838-102	ACCELERATION PLATE 18 FT	2	35790
6		31838-100	SHAFT COLLAR - 20"	2	40
7		31838-104	SHAFT COLLAR - 12"	2	26
8	-	S-001 / S-002	TRUSS STRUCTURES (FORE AND AFT) AND WHEEL COVER	1	27880
9	EYE Marine	PONTOON PORT	PONTOON STRUCTURE, PORT SIDE	1	134482
10	EYE Marine	PONTOON STARBOARD	PONTOON STRUCTURE, STARBOARD SIDE	1	134398
11	Cooper Bearings	03 BCP 1200 EX LAB	EXTRA HEAVY DUTY, COMPLETE ONE-PIECE PILLOW BLOCK BEARING, 12" BORE, EXPANSION TYPE, GREASE GROOVE SEALS	1	1932
12	Cooper Bearings	03 BCP 2000 EX LAB	EXTRA HEAVY DUTY, COMPLETE ONE-PIECE PILLOW BLOCK BEARING, 20" BORE, EXPANSION TYPE, GREASE GROOVE SEALS	1	5515
13	TO BE DETERMINED	-	HYDRAULIC ROTARY VANE STEERING GEAR, EFFECTIVE TORQUE REQUIRED = 400 kNm MINIMUM, RUDDER ANGLE = +/- 45 DEGREES, VOLTAGE = 480 VAC, STEERING SPEED LIMITED TO MAX AMPERAGE = 25 A	2	20944
14	TO BE DETERMINED	-	HYDRAULIC POWER PACK FOR STEERING GEAR, VOLTAGE = 480 VAC, 100% REDUNDANCY	2	2071
15	DRYMAX	1200-R	RUDDER SEALING SYSTEM, 12" SHAFT	1	99
16	DRYMAX	2000-R	RUDDER SEALING SYSTEM, 20" SHAFT	1	180
17	ABB	-	690 V GENERATOR DRIVE / INVERTER	1	2006
18	NORTEK	NSAD1100-4	AQUADOPP PROFILER 1 MHz ACOUSTIC DOPPLER CURRENT PROFILER WATER METER	2	5
19	McMaster-Carr	91580A205	HEAVY HEX HEAD SCREW, GALVANIZED, GRADE A325 STEEL, 1"-8, 3-1/2" LONG	TBD	0.15
20	McMaster-Carr	91694A355	HEAVY HEX NUT, GRADE DH, HOT-DIPPED GALVANIZED STEEL, 1"-8	TBD	0
21	McMaster-Carr	98179A028	WASHER, HOT-DIPPED GALVANIZED STEEL, 1" SCREW SIZE, 1.062" ID, 2" OD	TBD	0

TOTAL MASS: 675956 lb



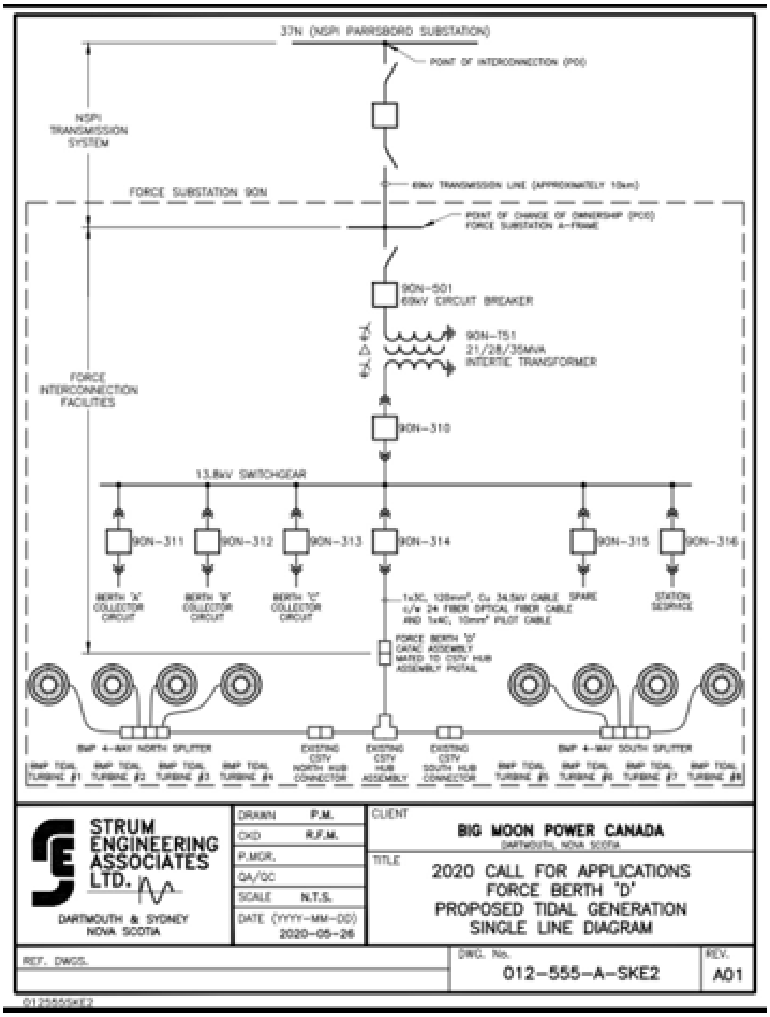


Stantec
BIG MOON POWER
FALCON KEEL GENERATOR
GENERAL ASSEMBLY
FALCON KEEL GENERATOR



Main Collector Elements

The main collector elements are detailed in the Strum Engineering Associates Ltd sketches 012-555-A-SKE1 and 012-555-A-SKE2. Shown below:



Nameplate Capacity and Predicted Performance

The nameplate capacity of the BigMoon Generator is 0.5MW this is based on the BigMoon Power Extraction formula which uses the following rational.

The calculation of power to be extracted from the tidal cycle is based upon determining the amount of power for a given moment in time based upon the conditions at that moment. The Big Moon tidal generator is a fixed size and is stationary, except for pivoting to accommodate a flood vs. an ebb tide flow. Therefore, the only condition that will change naturally is the speed of the water. The other condition that can change is the speed of the wheel blades.

There are two basic formulas involved.

Force

$$Force = \frac{1}{2}\rho C_D A(V_W - V_B)^2$$

The variable conditions are as follows:

ρ Density – The density of seawater, which is 1,029 kg/m3

C_D Drag Coefficient – (See explanation of drag coefficient in a separate document) – This is a fixed value that can be adjusted depending upon the power prediction model used

A Wetted Plate Area – This is the amount of a single blade actually in the water in square meters

V_W Water Velocity – This is the speed of the water (in meters per second) that is hitting the wheel blade

V_B Blade Velocity – This is the speed of the blade (in meters per second) when it is struck by the water. The difference between the Water Velocity and the Blade Velocity is in effect the water speed that is impacting the wheel blade at that moment

To determine the force for any moment in time, the variables are replaced with actual values. The water velocity is used to determine the blade velocity. Initially since the most power extraction from the water is when the blade is 1/3 the speed of the water, then the water velocity is multiplied by 1/3 to determine the blade velocity. Those numbers are then plugged in to the formula and the result is the amount of force (in Newtons) for that moment in time.

Power

$$Power = \frac{1}{2}\rho C_D A(V_W - V_B)^2 V_B$$

The power formula is simply the Force multiplied by the Blade Velocity.

VB Blade Velocity – This is the speed of the blade (in meters per second) when it is struck by the water. The difference between the Water Velocity and the Blade Velocity is in effect the water speed that is impacting the wheel blade at that moment

The power calculation is quite simple, and results in the amount of power (in Watts) for that moment in time.

The Wheel blades are relatively long. In order to improve the accuracy of the predictions, it was decided to take Force and Power measurements at three positions of the blade, since the values could vary significantly at the top of the blade compared to the tip of the blade due to the increased blade speed at the tip, and decreased blade speed at the top. Therefore, the power prediction model calculates Force and Power for the Top, Mid-Plate, and Tip points of the blade for each moment in time.

These are then run through a series of averaging calculations to determine the overall Force and Power for the entire blade at that moment. The wheel produces a given amount of force and power. This must be extracted from the wheel to a power generator to produce electricity. Through a series of gears, the torque and associated power is converted into a specific torque and turning speed of a shaft that is connected to the generator. The gearing ratio will be determined by the generator specifications and the anticipated wheel RPMs at rated values.

The calculated Power now becomes the input power for the generator. Using the specific generator rating and efficiency calculations, the prediction model determines what the output power from the generator, along with the given generator voltage and torque will be for that moment in time. The electrical load placed on the generator is key to maintaining the correct blade speed (1/3 the speed of the water). An attached variable frequency drive/power conditioner allows for constant monitoring of conditions and adjusting the load instantly to adjust the generator torque, which will ultimately affect the blade speed.

The power coming out of the generator must go through the drive/power conditioner, as well as an on-board transformer to prepare the power for transmission from the keel to the shore. This is done via a subsea cable built to accommodate the specific conditions found in the water. It is anticipated there will be some power loss during this journey from the generator to the power grid. A fixed efficiency number is part of the power prediction model to account for this.

Once the net power produced for a given moment in time is determined, it is ready to be converted into measurable power. The amount of time that the given conditions are anticipated to exist (i.e. the water speed stays the same) and determine the number of kilowatt hours (or in this case since water speed measurements at very short intervals are available, kilowatt seconds) produced during that time period.
Predicted water speeds at given points in the target water for an entire year, in 10-minute increments, are available. Therefore, the model calculates the amount of kilowatt seconds produced for each 10-minute increment, considering the changing conditions (i.e. water speed and associated blade speed) throughout the annual period.

These amounts are then summed up to determine the number of kilowatt seconds, kilowatt hours and subsequently megawatt hours the unit is project to produce for the given time period. Part of the prediction model is to be able to set a given target capacity factor, in terms of percentage of time power is produced at a given target nameplate capacity.

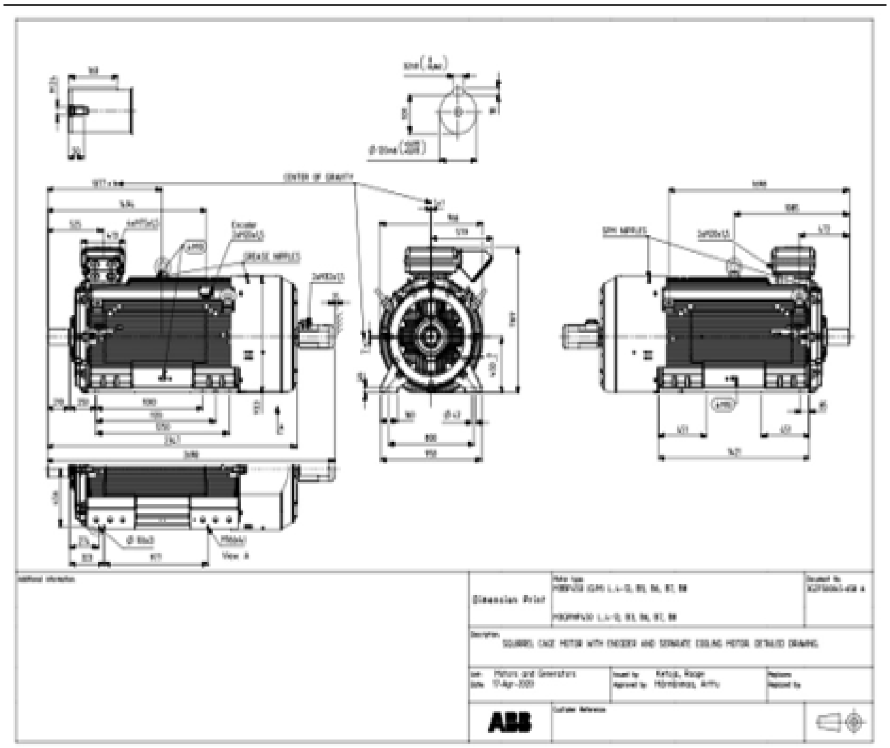
To determine the target capacity, the number of available hours in a year (8,760) is multiplied by the target factor (8,760 * .41). This results in the number of hours in the year (3,591) that are needed at the nameplate to achieve the target capacity factor.

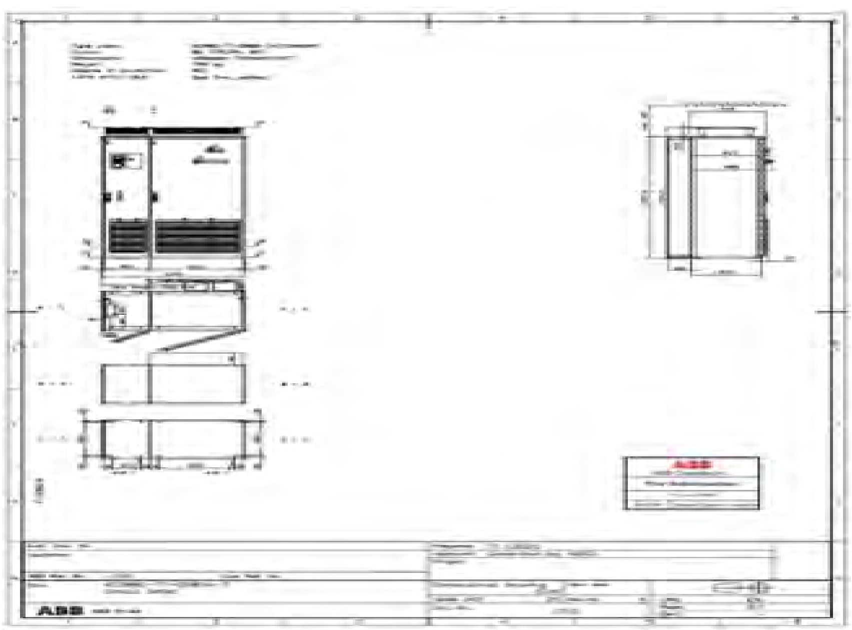
Since power delivered to the grid is usually measured in Megawatt Hours, these targets are converted into Megawatt Hours. The number of target hours is multiplied it by the nameplate of the generator and divide by 1000. This results in the target megawatt hours. The number of megawatt hours projected for the given time period is compared against the target. This gives the percentage of the target factor goal.
There are times when the speed of the water would cause the power produced to exceed the capacity of the generator. When this occurs, the keel has been designed to reduce the flow of water hitting the wheel, thus effectively reducing the speed / force hitting the wheel. This allows the keel to 'spill' excess energy and not overburden the generator and other electrical equipment. This spilling is a key element to the operation of the Big Moon keel. Without spilling the size of the keel required to reach the target capacity factor would have to be much larger. The maximum generator capacity and when spilling will be needed is included in the power prediction model.

The process to project the amount of a power a given Big Moon configuration will produce involves hundreds of thousands of calculations. It is believed that based upon current available data and science, it is a close approximation of expected production. There are some variables that may differ once a production unit is in the water, and adjustments will be made accordingly.

Power Take-off and Energy Conversion System

BigMoon will be using a ABB Power take off which will convert the mechanical energy produced by the kinetic wheel through a set of gears into the ABB Generator (Model M3BP450), the power will then be converted to grid ready electricity through an ABB ACS880-17 Electricity Converter which will transfer the electricity produced by the generator through a variable frequency drive converter at 480V this will then be converted through a transformer on the platform to 13.4KVa which will be fed directly into the FORCE electrical infrastructure at 13.4Kva.





Device Directionality

The BigMoon technology is designed so the platform will allow 360 degrees bi-rotational movement to position the accelerator plates to allow for the optimum current flow through the kinetic wheel chamber. This 360-degree rotation will position the device in the optimum current flow and the accelerator plates will maintain the directionality of the device. Course corrections can be made by adjusting the accelerator plates which act in the same way a rudder works on a ship which will keep the platform in alignment with the current flow.

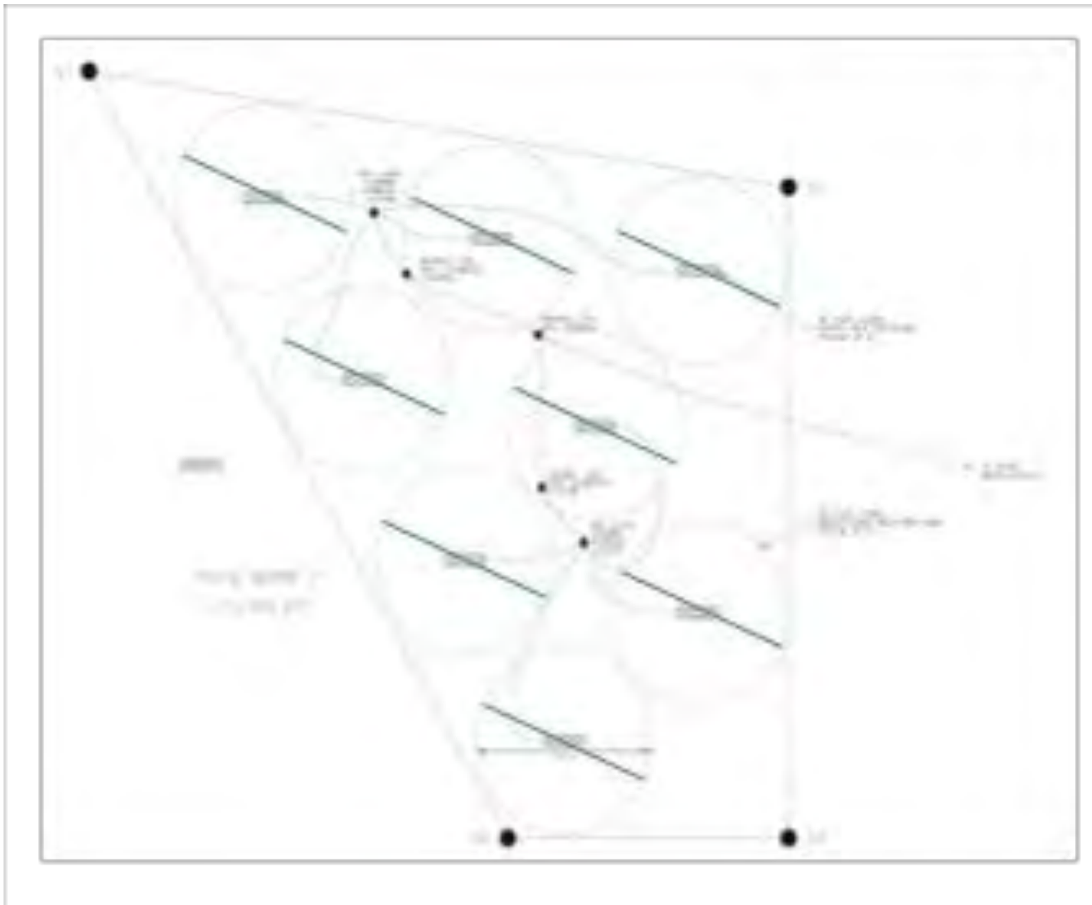
Survivability and Durability of Materials

BigMoon has developed the Kinetic Wheel Platform with the marine environment of the Bay of Fundy in mind. There are 2 main concerns with this environment, marine corrosion, and the abrasive nature of the water due to particulate in the water. BigMoon has conferred with major marine coating manufacturers to ensure the coating applied to all exterior surfaces of the platform and wheel offers the most advance protection against marine corrosion and the abrasive nature of the water in the Bay of Fundy. The engineering companies enlisted by BigMoon have specific knowledge related to working in marine environments and one of the design criteria is to provide equipment and materials designed for a marine environment to ensure that the proper watertight integrity and corrosion resistant are maintained. BigMoon is also requiring that all components are designed for a minimum 25-year life cycle in a marine environment.

- Operation and maintenance plans and schedules, including predicted downtime.

BigMoon had developed the project financial models based on industry norms for Maintenance and down time. The Operation and maintenance are currently in the early stages of development and are based on the manufacture's recommendations for all equipment. BigMoon will also be using the ABS Barge rules for inspection and maintenance cycles for all Platform related components such as hull and wheel coating failure and corrosion and for major non manufactured electrical and mechanical equipment such as shafting and gearing. BigMoon will allow for a maintenance shutdown once per year to complete all major preventive maintenance as required. Monthly maintenance cycles will also be completed to ensure equipment is maintained and inspected to ensure optimal performance.

- Footprint on the seafloor, including cable connectors, moorings, anchors, etc., and any proposed exclusionary areas around the generator.



Generator Certifications

The BigMoon generator is not currently certified. At present there is no regulatory requirement to be certified. BigMoon is however in the process of reviewing the recently released IEC TC-114 Marine Energy – Wave, Tidal, and Other Water Current Converter – Part 4: Standard for establishing qualification of New Technology and using this technical specification to meet the certification requirements of the IECRE once the IEC System for Certification to Standards related to the Equipment for the use in Renewable Energy Applications is develop.

As part of BigMoon's procurement methodology related to the generator components where ever possible the components will be required to have either CSA or UL certification CE certification will also be accepted based on the Supplier being able to provide the testing data to prove compliance with the CSA electrical requirements. Any components in question will be revised by a CSA representative and if it does not meet the requirements it will not be purchased. BigMoon will then have the overall generator system certified to the CSA requirements through a Company approved to provide CSA certification such as QPS.

Description of Previous Tests (lab or in situ),

BigMoon has completed extensive lab and in situ testing over the past 4 years which has greatly contributed to the current Kinetic Wheel Platform technology. BigMoon has maintained a testing lab in Salt Lake City since 2016 with a 40ft x 6ft x 4ft flow tank which has been used to conduct scale model testing off all proposed technology advancements prior to incorporating the into the prototypes tested in situ in lake and Bay of Fundy tests completed over the past 4 years. BigMoon has also worked with DSA Engineering to complete site modelling of the Platform based on their “Proteus” software based on the Richard Karsten’s tidal flow model. This process of scale model testing, Modeling of the Bay of Fundy environment of our platform and the 4 years of in situ testing has been instrumental in the development of the current BigMoon Kinetic Wheel Technology.

Proposed Array

BigMoon is planning on installing an array of eight 0.5MW Kinetic Wheel platforms within the Berth D lease area. Big Moon has completed an initial assessment of the positioning of the devices within the Berth D site as proposed in the layout provided in this document. Based on the preliminary review, and utilizing both laboratory and actual field testing of wake and current recharge requirements in the Minas Channel , there are no wake or turbulence clashes between devices, and both wake and turbulence affects are localized and dissipate to negligible levels inside the 140 meter radius of the platform operating circle. BigMoon retained multiple Marine Architecture Firms based in Nova Scotia, with experience in the Minas Basin to design and review all marine aspects of the device. These firms utilized established sea-state data for the Minas channel and followed appropriate industry standards and safety factors as the basis for the design. Other oceanographic considerations, including bathymetry were reviewed, but no other impacts were identified based on the platform design. As part of the ongoing assessment of the technology water noise levels will be monitored to better understand any cumulative effects as the array is built out. This will be part of the iterative approach BigMoon will be following to determine environmental effects that can only be determined as more devices are deployed.

Interaction of the generators, cabling, equipment, mooring lines,

The BigMoon Platform system, which includes the platform wheel, moorings, and cabling is specifically being designed to ensure that there are no potential for interaction with the different parts of the system such as the cable and the mooring, through the use of a slip ring assembly. It is also being positioned to allow a full 360-degree rotation of each individual platform without coming into the rotational circle of the other platforms. See figure 3.4.7-7 for a diagram of the eight-platform layout and rotational circle.

Connection to the FORCE Subsea Electrical Cable

It is intended that the existing Cape Sharp cable arrangement will be incorporated into the Big Moon infield cable array to connect to the proposed eight 0.5MW platforms. BigMoon will use the existing splitter cable and attach each end of the two splitters cables to a 4-connector hub which in total will allow for connection of the eight individual cables from the platforms through the two 4 hub connectors. From the Cape Sharp splitter the electricity produces will flow through the existing subsea cable arrangement that is currently on the seabed at Berth D. Based on this design the cable requirements from the hub connectors out to the eight platform will be designed based on the 0.5MW produced by the individual generators which will allow for smaller cables than are currently installed at Berth D this will allow for cost saving on the size of the cable from the hubs to the platforms and also a reduction in cost related to marine operations by allow the use of smaller marine assets to carry out the cable installations.

Learnings from the First Installed Generator

BigMoon currently has a Lessons Learned process that has greatly contributed to the progression of the BigMoon technology and has created a corporate culture of continuous improvement through out the organization. This methodology will be continuing to be followed and provide the ability to refine the future installations through the lessons learned from the first installation. The first installation will be broken down to the task level and each task will be evaluated based on the various aspects of each task criteria including, manpower, equipment, methodology, and interaction with other tasks. Theses criterial will be reviewed to determine what improvements or changes can be incorporated to improve on each additional installation.

Fabrication Plan

Fabrication will begin in the first quarter of 2021 and will be completed by East Coast Fabricators in Sydney, Nova Scotia. Generators and power conditioning equipment is currently on order from ABB and other key components to the on board power generation and power distribution system is being handled by Strum Engineering in conjunction with QS Atlantic, Stantec and Strum Environmental.

Project Plan

BigMoon using its proprietary technology will deploy eight (8) 0.5MW units into the existing Berth D at FORCE.. Annual net output in MWh's per MW is 3,579hours annually.. Our Cumulative Net Output for 4 MW's per year equals 14,316 hours for an overall 15 year production of 212,950MWh's.

BigMoon's Kinetic Keels have been and will continue to be designed and refined for each deployment by local engineering partners in conjunction with BigMoon's engineering team. BigMoon has commissioned Operational Excellence Consulting Inc, Halifax, Nova Scotia to act as general contractor for the removal and disposal of the orphaned turbine. A list of the activities in sequence to be undertaken by Operational Excellence is below and a schedule for removal of the CSTV turbine is available in appendix i to this submission.

DATE	ACTIVITY	QTY	RATE	AMOUNT	TAX
03-05-2020	Day Rate:Marine Asset Services Scotia Tide mobilization (Assessment & Readiness)	1	[redacted]	[redacted]	HST NS
03-05-2020	Day Rate:Marine Asset Services Cable Recovery Barge Mobilization	1	[redacted]	[redacted]	HST NS
03-05-2020	Day Rate:Project Management Services Turbine Recovery Operations	1	[redacted]	[redacted]	HST NS
03-05-2020	Day Rate:Marine Asset Services Cable Recovery Barge Demobilization	1	[redacted]	[redacted]	HST NS
03-05-2020	Services:Marine Asset Consulting Scotia Tide Demobilization	1	[redacted]	[redacted]	HST NS
03-05-2020	Day Rate:Project Management Services Site Preparation for Recovery	1	[redacted]	[redacted]	HST NS

03-	Day Rate:Project	1	[redacted]	[redacted]	HST
05-	Management Services				
2020	Turbine Disposal				NS

During the operation to remove the abandoned turbine, BigMoon will work with our preferred fabricators (BigMoon is currently evaluating bids submitted by Nova Scotia fabricators for the construction of our commercial units to be installed in Nova Scotia as part of our existing 5MW project in the Minas Passage) to order the first of 8, 0.5MW units for the fulfillment of this successful procurement. The fabrication will be modular with sections of the plant being fabricated by different fabricators each with a specific skill set. Completed sections will be transported to a common dockside facility. Final assembly of the Kinetic Keel components will be competed using heavy lift cranes from Irving Equipment Limited.

BigMoon's Project Plan for this 4MW project is attached to this submission as appendix x.

BigMoon has followed this process of modular construction, assembly and deployment in Nova Scotia for each of our previous tests in 2016, 2017, 2018 and 2019. All of our staff, as well as our partners, have been through these operations with us including deployment of gravity bases and connection of gravity base to the Kinetic Keel for mooring. BigMoon's operations team have over 18,000 person hour of experience operating Kinetic Keels in the Minas Basin and Minas Passage of Nova Scotia. During these 18,000+ person hours, BigMoon has suffered zero lost time incidents as a result of technical failure or safety issue.

Following dry assembly, BigMoon will have Irving Equipment deploy the unit from the dockside facility into Halifax Harbour.

Following successful deployment, BigMoon will commence pre-commissioning procedures using a neutral, third-party agent. Checklist as follows:

Pre-Commissioning Checklist			
Unit Deployment	Agent Overseeing Deployment		
Name	Agent Company	Agent	
Name	Company	Name	
Address	Company Phone	Agent Address	
Address	Phone	Address	
Date	Title	Agent Phone	
Date	Title	Phone/Fax	
Attested By	Signature	Agent Email	
Attested By		Email	
Item Description	Category	Serial Number	Value
Generator	Category	Serial #	Value

	Power Conditioning	Category	Serial #	Value
	Subsea Cable Components	Category	Serial #	Value
	Pillow Blocks	Category	Serial #	Value
	Wheel Axle	Category	Serial #	Value
	Wheel (blades)	Category	Serial #	Value
	Winches	Category	Serial #	Value
	Environmental Monitoring	Category	Serial #	Value
	Wheel (movement)	Category	Serial #	Value
	Lighting	Category	Serial #	Value
	CPU	Category	Serial #	Value
	Batteries	Category	Serial #	Value
	Housing Unit	Category	Serial #	Value
	Communication	Category	Serial #	Value
	Fire Suppression	Category	Serial #	Value
	Climate Control	Category	Serial #	Value
	PPE/Safety Equipment	Category	Serial #	Value
	Navigation Equipment	Category	Serial #	Value
	Door Seals	Category	Serial #	Value
	Gauges/Monitors	Category	Serial #	Value
	Attested	Signature		

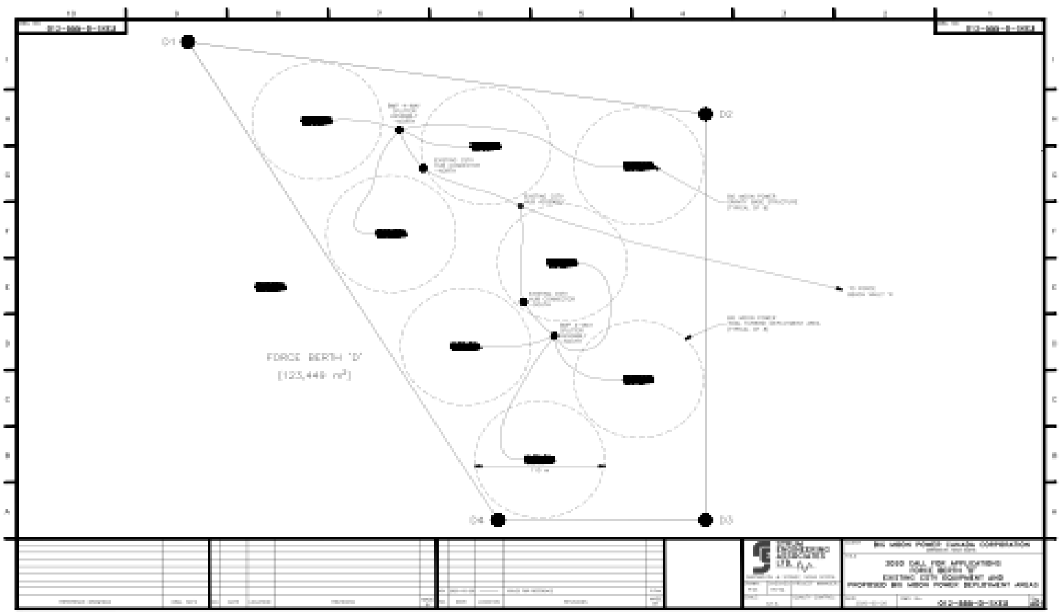
Following successful pre-commissioning procedures, BigMoon will transport the Kinetic Keel to the FORCE location using Atlantic Towing's, Atlantic Beaver. Atlantic Towing will transport the unit from Halifax Harbour around the Southwest tip of Nova Scotia to the Bay of Fundy, through the Minas Passage to the location of FORCE Berth D.

Three months prior to pre-commissioning, BigMoon will begin site preparation for the deployment of a 230 tonne, gravity base at the location of FORCE Berth D. BigMoon has extensive experience designing, assembling and connecting gravity bases in the Minas Passage. To begin with, BigMoon will undergo a bathymetric survey of the area to confirm current data for location of the first unit and subsequent units. Working with Poseidon Marine Consultants, the optimal design, location and harnessing for the 230 tonne gravity base will be completed. This work will be done in conjunction with Atlantic Towing Limited in Saint John, where the gravity base will be built and harnessing and cables attached before being deployed on a work barge owned by Atlantic Towing Limited. The barge with the gravity base and harness attached will be towed to FORCE Berth D using the Atlantic Hemlock or the Atlantic Beaver, to the exact location for the deployment of unit 1.

Gravity Base Deployment

Added as an Attachment to this document

Layout of BigMoon Operations Area in FORCE Berth D using 8 X 0.5MW generators for 4MW.



Interconnection

The following methodologies are proposed for the retrieval and separation of the existing CSTV Submarine Cable Systems:

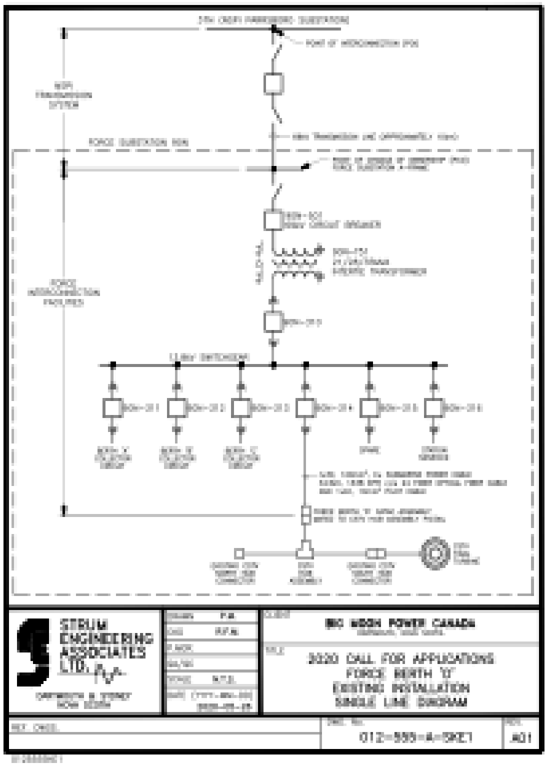
1. Prior to any offshore operation to recover the submarine power cables associated with FORCE Berth 'D", all sources of electrical energy shall be disconnected from the power cores and from the pilot cable and the entire Collector Circuit (Berth 'D') shall be grounded, locked out and tagged.
2. At present the CSTV Turbine Tail Connector assembly is mated with the CSTV Hub Connector – South assembly.
3. It is not stated whether the Clump Weights are still attached to the CSTV Turbine Tail Connector assembly and/or the CSTV Hub Connector – South assembly, but it is assumed that a Clump Weight and Grappling Chain are deployed from the mated Turbine Tail Connector and Hub Connector – South assemblies.
4. Prior to the marine operation to retrieve the mated Turbine Tail Connector and Hub Connector – South assemblies, Blanking Flanges will be required to seal the end of the CSTV Hub Connector – South assembly.
5. It is not stated if the Blanking Flanges, which would have been removed from the end of each connector assembly during initial deployment and connection, are available for reuse or whether new Blanking

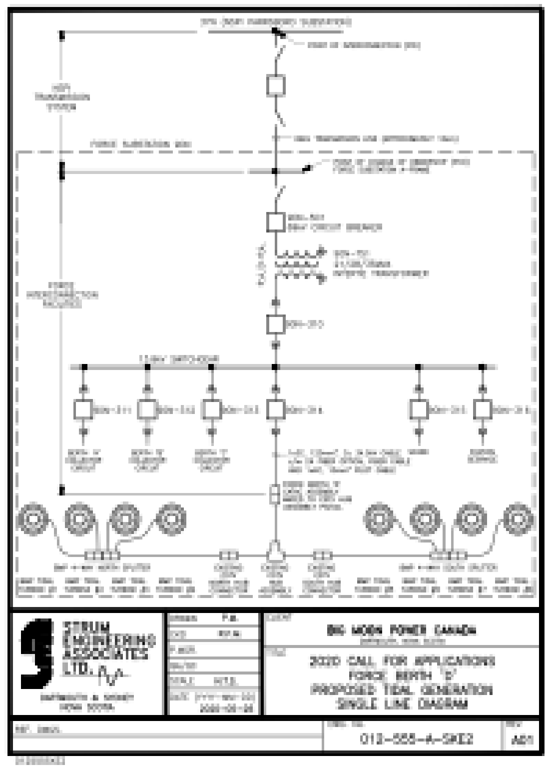
Flanges will be required to be fabricated, to the exact specification of the original Blanking Flanges designed and fabricated by ETA.

6. A marine operation will be undertaken to grapple and retrieve the mated Turbine Tail Connector and Hub Connector – South assemblies.
7. Once onboard the recovery vessel, the Turbine Tail Connector and Hub Connector – South assemblies will be opened and separated.
8. The Blanking Flanges shall be secured to the end of both the Turbine Tail Connector and the Hub Connector – South assemblies and the two separate submarine cable assemblies shall be placed back on the seafloor.
9. Clump Weight and Grappling Chain shall be deployed with each submarine cable assembly.
10. The CSTV Turbine Tail Connector and associated submarine cable will be recovered as part of the removal of the CSTV Tidal Turbine.

The following methodologies are proposed for the deployment and connection of the Big Moon Power Tidal Turbine Submarine Cable Systems:

1. Big Moon Power (BMP) will specify and purchase submarine power cables suitable for deployment at FORCE Berth 'D'.
2. The cable specification will take into account the dynamic forces which exist on the seafloor and, for those cables rising to the floating platforms, the tidal current, wave and catenary/tensile forces which will exist in the water column, between the seafloor and the floating platform.
3. Big Moon Power will design and fabricate a Cable Termination assembly which will mate with the existing Hub Connectors to provide a watertight chamber for the connection of the power cores and, if required, the pilot cable conductors and the optical fiber cable.
4. A marine operation will be undertaken to grapple and retrieve the existing Hub Connector – South and Hub Connector – North assemblies.
5. Once onboard the recovery vessel, the BMP Cable Termination assembly shall be mated to the Hub Connector assembly.
6. The mated BMP Cable Termination assembly and the Hub Connector assemblies shall be lower to the seafloor.
7. Clump Weight and Grappling Chain shall be deployed with each mated BMP Cable Termination assembly and Hub Connector assembly to allow for future retrieval.
8. It is proposed that four (4), 500kW Tidal Turbines be connected to each BMP Cable Termination/Hub Connector assembly in a daisy-chain configuration.
9. A medium voltage slip-ring assembly would be provided for each floating Tidal Turbine platform to allow 360° bi-directional rotation within the deployment area.





Decommissioning

The BigMoon Kinetic Wheel platform systems will be completely decommissioned at the end of the projects lifecycle. BigMoon will commence decommissioning and sight rehabilitation in August 2036. Each platform will be disconnected from the installed mooring system and subsea cable at the end of the project life. The mooring line will have a buoy attached once the Platform is disconnected to allow the mooring cable to be easily recovered during the retrieval operations. The platform will then be towed to a dockside facility and be disassembled and scrapped. The mooring lines and gravity bases from the 8 platforms will all be recovered after the final platform is retrieved. The retrieval of the gravity bases will be completed during one mobilization over eight tidal cycles.

During the retrieval of each individual gravity base and mooring line, the subsea cable will have a buoy and retrieval cable attached. Prior to the gravity base being retrieve the BigMoon cables will be respooled onto the Atlantic Towing tug and the Platform cables, connection hub and splitter cables will be disconnected and removed from the FORCE cable prior to carrying out the gravity base retrieval.

During the installation of each of the BigMoon Kinetic Wheel Systems a 230-ton (minimum) gravity base was placed at the center of each platform operating circle. The gravity base is designed so that that once it has been disconnected from the BMP Platform the same process that was used to deploy the gravity base can be used to retrieve the it. BMP will contract the gravity base retrievals to Atlantic Towing who will use a similar tug to the Atlantic Hemlock or the Atlantic Beaver which will be used to deploy the gravity base. The plan is to mobilize all equipment out of Saint John, New Brunswick. The Atlantic Towing tug will set sail to the FORCE site. The sail from Saint John will take approximately eight hours to reach the site. The arrival of the Atlantic Towing tug at the FORCE site will be coordinated to align with the low tide slack and allowing enough time to arrange the retrieval set up and alignment at the site. The buoy that was attached to the gravity base mooring line, which has been sized based on the weight of the retrieval cable, with enough reserve buoyancy to ensure that the cable will always be accessible during slack tide. The cable and all connecting shackles will be sized to allow for an engineered safety factor. This will ensure that there is no risk of the cable breaking free from the gravity base during the retrieval operations.

When the tidal flow is at or below 2 knots the gravity base mooring line will be grappled for and attached to the same bollard on the tug that was used to deploy the gravity base The operation to retrieve the gravity base will follow the same steps as the deployment but in the reverse order. The gravity base mooring line will be winched back onboard the tug and once the gravity base is pulled up to a draft that will allow the tug to dock once it is back at the pier in St John the vessel will sail back to Saint John and decommission the gravity base and mooring line. The gravity base will be attached to shore-based cranes and lifted out of the water onto the pier for scrapping.

It is assumed that at the end of the project the majority of the equipment on the platform and the gravity base will be outdated and will have no recoverable value. All components will be disposed of based on the local waste management regulatory requirements.

Environmental Monitoring Plan

Added as an Attachment to this document

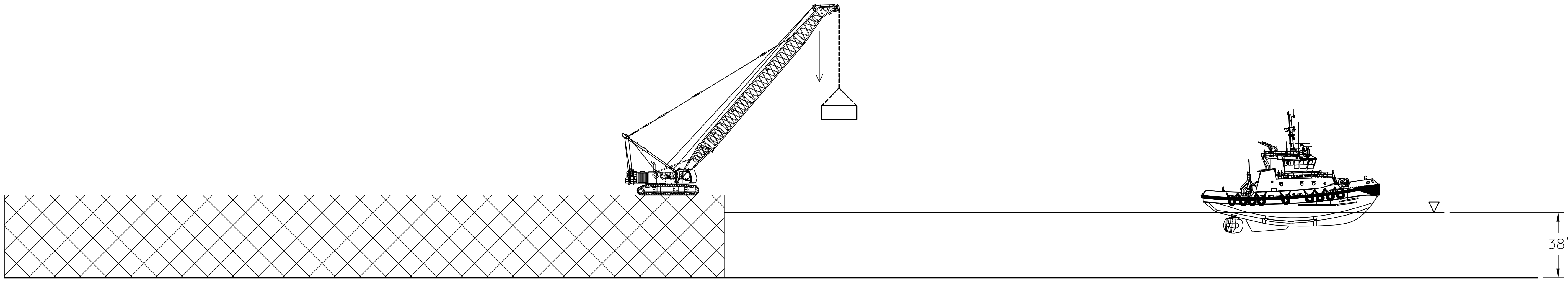
DATE	TBD
TARGET TIME	TBD
STAGE	01A
DESCRIPTION	MOBILIZATION, LOWERING OF CONTAINER ANCHOR AT MOBILIZATION POINT

PROPOSED SEQUENCE:

- MOBILIZE CRANE AND POSITION AT EDGE OF PIER
- SLING CONTAINER ANCHOR WEIGHT
- CONNECT CONTAINER ANCHOR TO CRANE HOOK
- LIFT CONTAINER ANCHOR WEIGHT AND SWING OVER EDGE OF PIER
- BEGIN LOWERING CONTAINER ANCHOR

NOTES & QUESTIONS:

- LOADING OF THE ANCHOR CONTAINER WILL TAKE PLACE AT PIER 20, SAINT JOHN
- WIRE CONNECTED TO CONTAINER ANCHOR WILL BE 300' x $1\frac{1}{4}$" WIRE
- ESTIMATED DEPTH OF CONTAINER DURING TOW IS ~25' BELOW WATERLINE, ~10' BELOW Z-DRIVE UNITS
- MINIMUM WATER DEPTH IN DREDGED AREA ~14 FT AT LOW WATER, WITH BETWEEN 24-28 FT OF TIDE. WILL NEED TO MOBILIZE AT HIGH TIDE



CONCEPT ONLY

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TITLE:

ATLANTIC HEMLOCK
BIG MOON TIDAL STORYBOARD

PROJECT NO.: 19-084	REV: 1
DWG. NO.: 19-084-101	
SCALE/SIZE: NTS / 11x17	
SHEET: 1 OF 7	DATE: 06 JUN 19

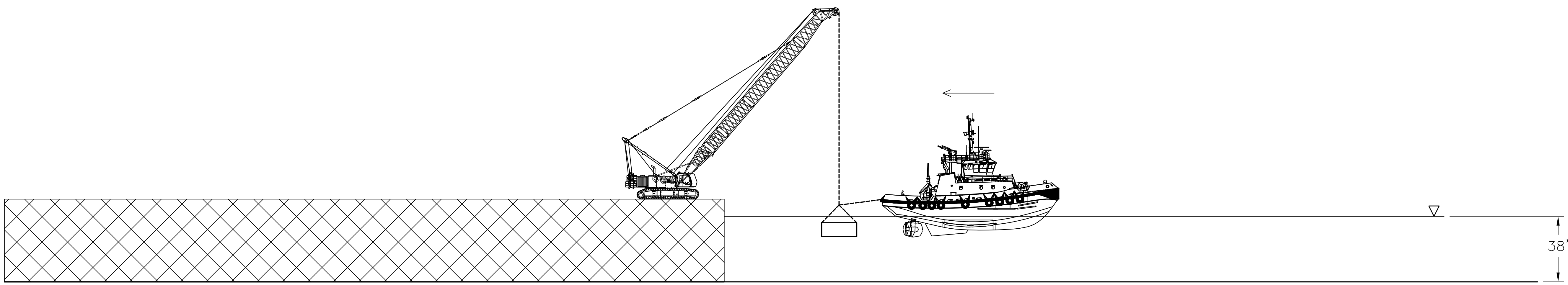
DATE	TBD
TARGET TIME	TBD
STAGE	01B
DESCRIPTION	MOBILIZATION, CONNECTION OF CONTAINER ANCHOR AT MOBILIZATION POINT

PROPOSED SEQUENCE:

- CONTINUE LOWERING CONTAINER ANCHOR UNTIL THE CONTAINER IS SUBMERGED
- WITH THE CONNECTED RIGGING STILL VISIBLE AND THE CONTAINER ANCHOR WEIGHT PARTIALLY DISPLACED, CONNECT A SECOND LINE FROM THE TUG
- TAKE TENSION OF CONTAINER ANCHOR WEIGHT WITH THE TUG

NOTES & QUESTIONS:

- LOADING OF THE ANCHOR CONTAINER WILL TAKE PLACE AT PIER 20, SAINT JOHN
- WIRE CONNECTED TO CONTAINER ANCHOR WILL BE 300' x 1¼" WIRE
- ESTIMATED DEPTH OF CONTAINER DURING TOW IS ~25' BELOW WATERLINE, ~10' BELOW Z-DRIVE UNITS
- MINIMUM WATER DEPTH IN DREDGED AREA ~14 FT AT LOW WATER, WITH BETWEEN 24-28 FT OF TIDE. WILL NEED TO MOBILIZE AT HIGH TIDE



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PROJECT NO.: 19-084	REV: 1
DWG. NO.: 19-084-101	
SCALE/SIZE: NTS / 11x17	
SHEET: 2 OF 7	DATE: 06 JUN 19

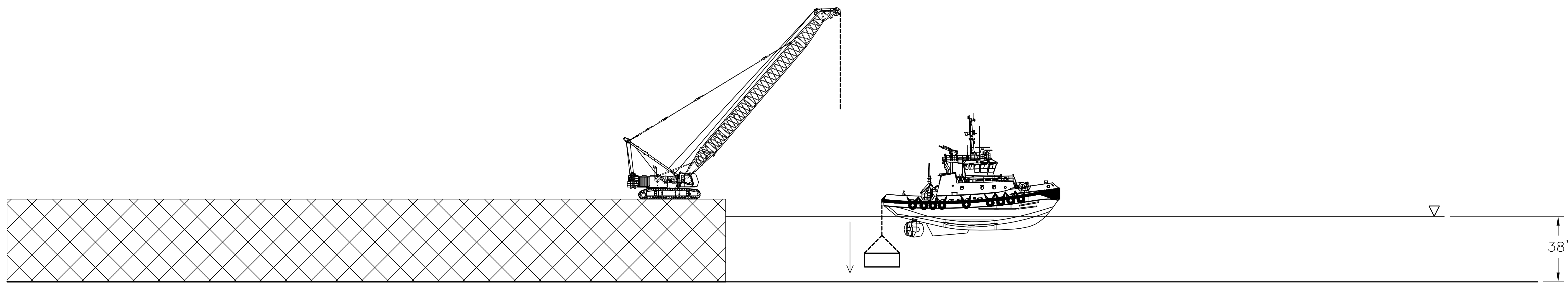
DATE	TBD
TARGET TIME	TBD
STAGE	01C
DESCRIPTION	MOBILIZATION, LIFTING OF CONTAINER ANCHOR AT MOBILIZATION POINT

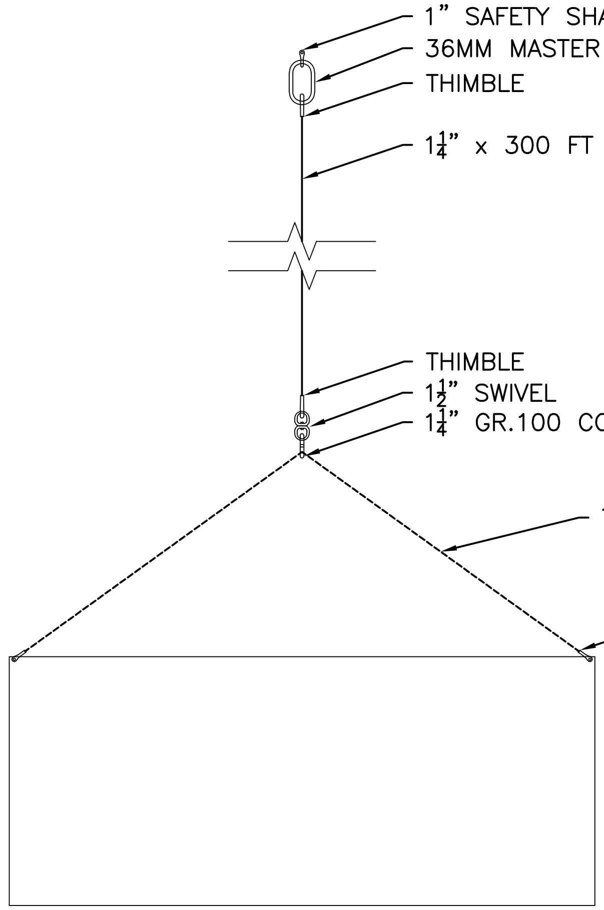
PROPOSED SEQUENCE:

- WITH THE WEIGHT OF THE CONTAINER ANCHOR ON THE TUG WINCH, RELEASE THE RIGGING CONNECTION FROM THE CRANE
- RECOVER THE CRANE HOOK AND RIGGING AND DEMOBILIZE CRANE

NOTES & QUESTIONS:

- LOADING OF THE ANCHOR CONTAINER WILL TAKE PLACE AT PIER 20, SAINT JOHN
- WIRE CONNECTED TO CONTAINER ANCHOR WILL BE 300' x 1¼" WIRE
- ESTIMATED DEPTH OF CONTAINER DURING TOW IS ~25' BELOW WATERLINE, ~10' BELOW Z-DRIVE UNITS
- MINIMUM WATER DEPTH IN DREDGED AREA ~14 FT AT LOW WATER, WITH BETWEEN 24–28 FT OF TIDE. WILL NEED TO MOBILIZE AT HIGH TIDE





CONTAINER CONNECTION DETAIL

SYSTEM SWL: TBD

CONCEPT ONLY

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BIG MOON TIDAL STORYBOARD

PROJECT NO.: 19–084	REV: 1
DWG. NO.: 19–084–101	
SCALE/SIZE: NTS / 11x17	
SHEET: 3 OF 7	DATE: 06 JUN 19

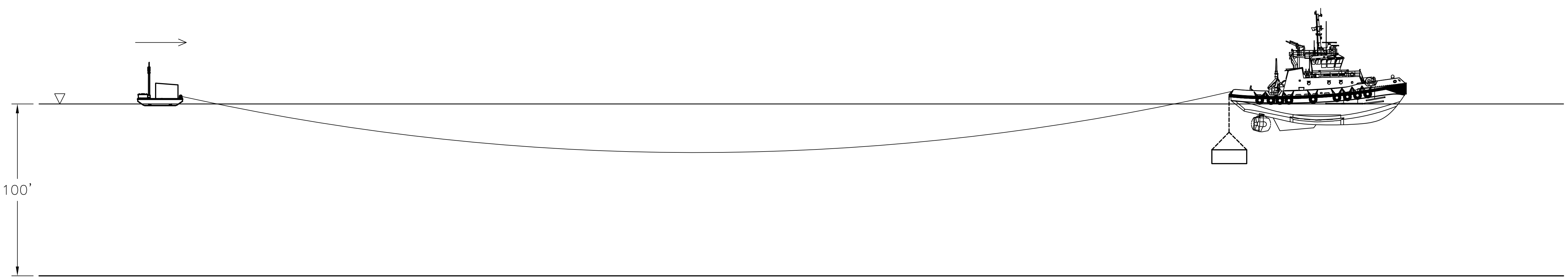
DATE	TBD
TARGET TIME	TBD
STAGE	01D
DESCRIPTION	MOBILIZATION, CONNECTION OF BARGE AT MOBILIZATION POINT

PROPOSED SEQUENCE:

- SECURE CONTAINER ANCHOR IN PLACE
- TRANSIT TO BARGE LOCATION
- POSITION VESSEL IN WAY OF BARGE
- CONNECT TOWLINE TO BARGE
- PROCEED TO TRANSIT

NOTES & QUESTIONS:

- LOADING OF THE ANCHOR CONTAINER WILL TAKE PLACE AT PIER 20, SAINT JOHN
- WIRE CONNECTED TO CONTAINER ANCHOR WILL BE 300' x 1¼" WIRE
- ESTIMATED DEPTH OF CONTAINER DURING TOW IS ~25' BELOW WATERLINE, ~10' BELOW Z-DRIVE UNITS
- MINIMUM WATER DEPTH IN DREDGED AREA ~14 FT AT LOW WATER, WITH BETWEEN 24-28 FT OF TIDE. WILL NEED TO MOBILIZE AT HIGH TIDE
- NOTE THAT THE TUG WILL NOT BE ABLE TO PAY IN OR OUT ON THE BARGE TOW LINE



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PROJECT NO.: 19-084	REV: 1
DWG. NO.: 19-084-101	
SCALE/SIZE: NTS / 11x17	
SHEET: 4 OF 7	DATE: 06 JUN 19

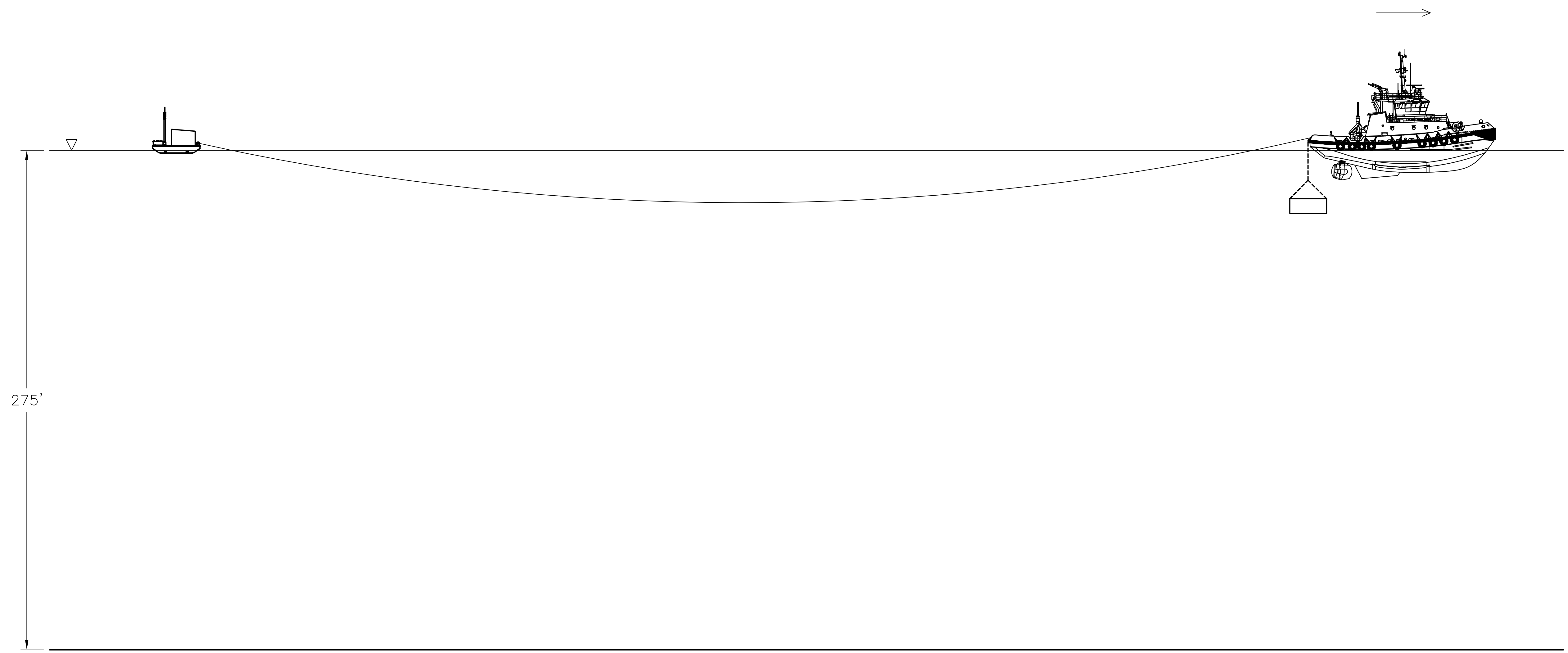
DATE	TBD
TARGET TIME	TBD
STAGE	02
DESCRIPTION	TRANSIT OF TUG, BARGE, AND CONTAINER ANCHOR TO DEPLOYMENT SITE

PROPOSED SEQUENCE:

- TRANSIT FROM MOBILIZATION SITE TO DEPLOYMENT SITE
- DISTANCE OF APPROXIMATELY 600 FT BETWEEN TUG AND BARGE
- ENSURE CONTAINER ANCHOR MAINTAINS POSITION AWAY FROM Z–DRIVE UNITS

NOTES & QUESTIONS:

- DISTANCE FROM LOADING SITE TO DEPLOYMENT SITE?
- MAX. TOW SPEED?
- WEATHER LIMITS?



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SCALE/SIZE: NTS / 11x17	
SHEET: 5 OF 7	DATE: 06 JUN 19

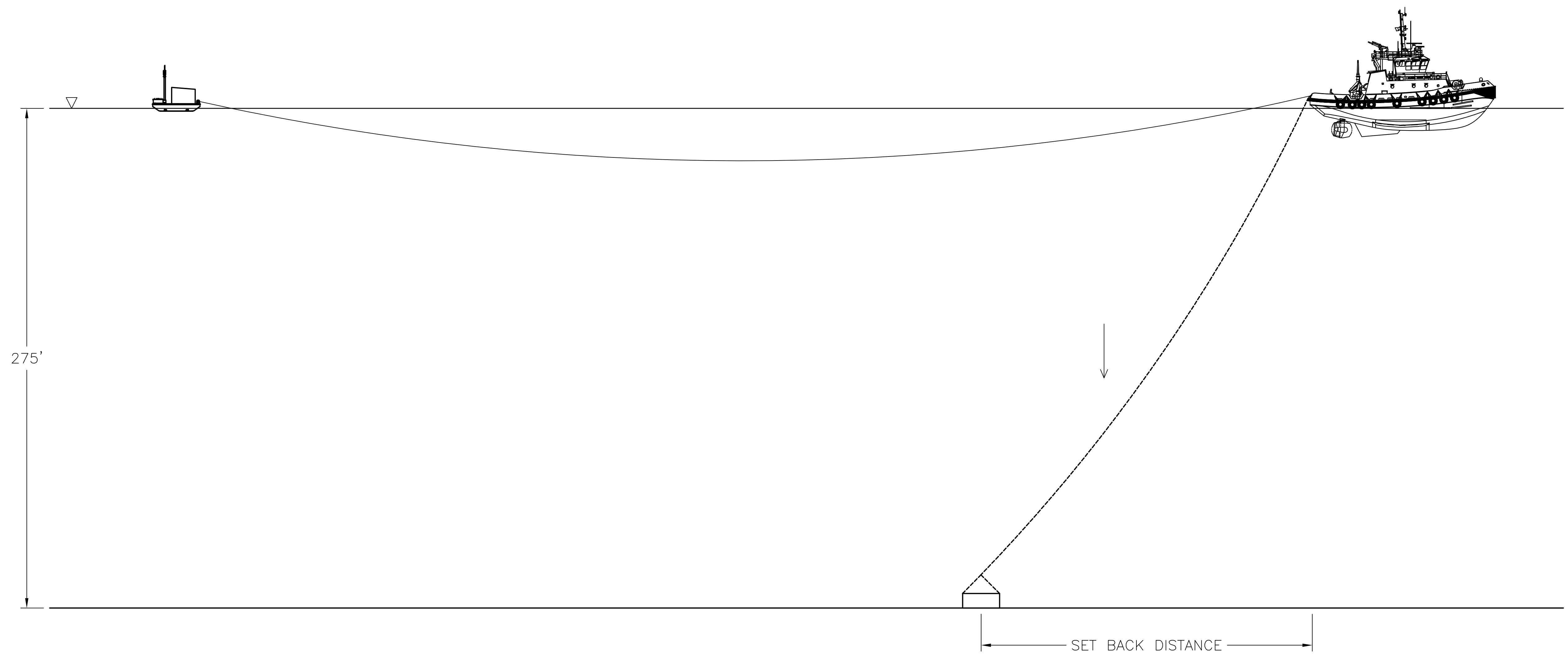
DATE	TBD
TARGET TIME	TBD
STAGE	03
DESCRIPTION	LOWERING OF CONTAINER ANCHOR AT DEPLOYMENT SITE

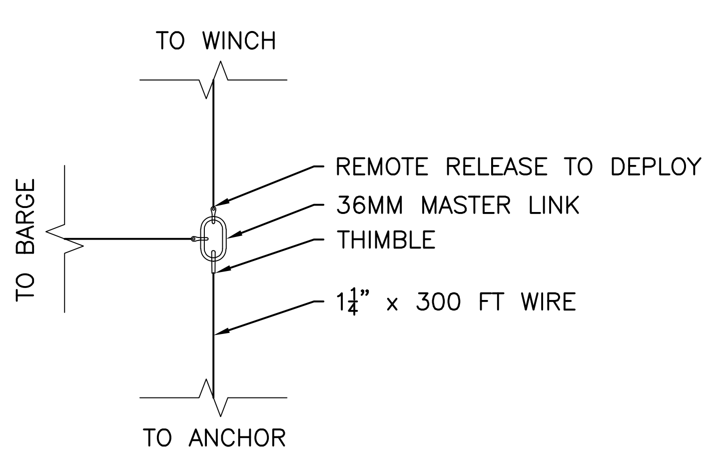
PROPOSED SEQUENCE:

- ARRIVE AT DEPLOYMENT SITE
- ESTABLISH SET BACK DISTANCE FOR CONTAINER ANCHOR DEPLOYMENT
- PAY OUT LINE ON CONTAINER ANCHOR UNTIL FULLY DEPLOYED BUT STILL CONNECTED
- CONNECT BARGE LINE TO CONTAINER ANCHOR LINE
- DEPLOY CONNECTED ENDS

NOTES & QUESTIONS:

- CONTAINER ANCHOR WIRE WILL BE 300' x $1\frac{1}{4}$" WIRE
- DEPLOYMENT WILL BE COMPLETED AT LOW TIDE PRIOR TO EBB
- WHAT IS THE SET BACK OF CONTAINER DUE TO DRAG? BASED ON MAX ALLOWABLE CURRENT OR MINIMUM CURRENT POSSIBLE. EFFECT OF HEAVY CABLE? TO BE CALCULATED





DEPLOYMENT CONNECTION DETAIL

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SCALE/SIZE: NTS / 11x17	
SHEET: 6 OF 7	DATE: 06 JUN 19

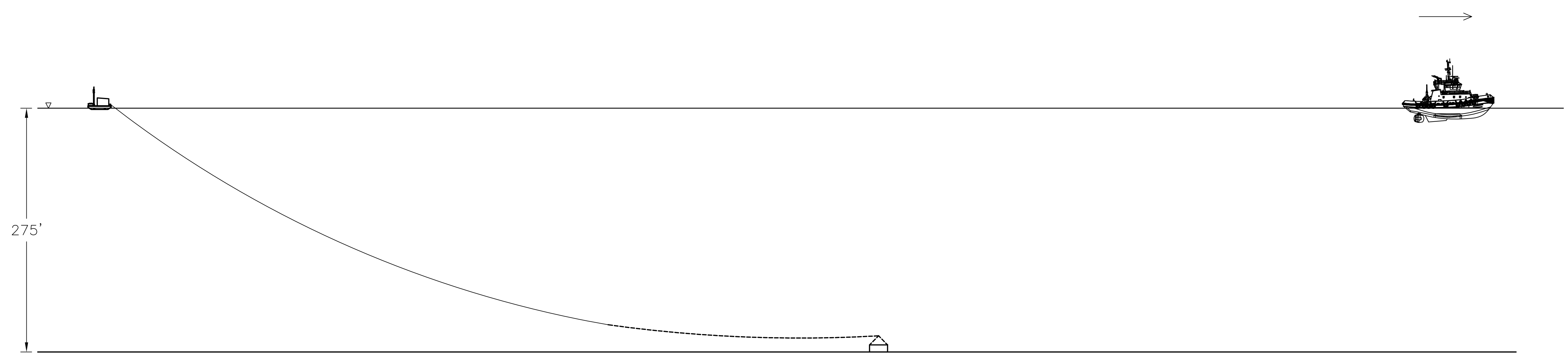
DATE	TBD
TARGET TIME	TBD
STAGE	04
DESCRIPTION	DEPLOYMENT OF SYSTEM, TUG DEPARTS

PROPOSED SEQUENCE:

- AFTER DEPLOYMENT IS COMPLETE, TRANSIT BACK TO PORT

NOTES & QUESTIONS:

- ENTIRE SYSTEM CAN BE RETRIEVED FROM BARGE END CONNECTION IF REQUIRED
- HAS THE BARGE BEEN ASSESSED FOR HAVING SUFFICIENT BUOYANCY TO HANDLE WEIGHT OF WIRE? INCLUDING IN MAX CURRENT WHEN ADDITIONAL CABLE IS LIFTED DUE TO FURTHER SET BACK OF BARGE? TO BE CALCULATED



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