CAPE SHARP TIDAL

Cape Sharp Tidal Venture

Environmental Effects Monitoring Program 2018

July 2018

Acronyms

ADCP	Acoustic Doppler Current Profiler
AMAR	Autonomous Multichannel Acoustic Recorder
CLA	Crown Lease Area
CSTV	Cape Sharp Tidal Venture
DFO	Fisheries and Ocean Canada
EA	Environmental Assessment
EEMP	Environmental Effects Monitoring Program
EMP	Environmental Management Plan
EMAC	Environmental Monitoring and Advisory Committee
FAST-EMS	Fundy Advanced Sensor Technology – Environmental Monitoring System
FORCE	Fundy Ocean Research Center for Energy
MUX/Term-can	Multiplexer and Termination Can
MW	megawatt
NSE	Nova Scotia Environment
OERA	Offshore Energy Research Association of Nova Scotia
SARA	*Species at Risk Act*
SPL	Sound Pressure Level
VECs	Valued Ecosystem Components

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1.0 Introduction

This document provides details for an updated Environmental Effects Monitoring Program (EEMP) (the Program) for Cape Sharp Tidal Venture (CSTV) for 2018. This document is submitted to meet the conditions listed under the Environmental Assessment (EA) Approval granted to the Fundy Ocean Research Center for Energy (FORCE) in 2009 (September 15, 2009) by Nova Scotia Environment (NSE) for effects monitoring, as defined under the Nova Scotia *Environment Act*.

As required by the conditions of the FORCE EA Approval (2009), the EEMP was developed in collaboration with experts in the field of in-stream tidal energy, monitoring and technology developers and with input from government agencies, including Fisheries and Oceans Canada (DFO) and NSE, as well as other in-stream tidal energy interests including the Offshore Energy Research Association of Nova Scotia (OERA), FORCE, and the associated FORCE Environmental Monitoring and Advisory Committee (EMAC).

The 2018 EEMP has been updated from the 2016/2017 CSTV EEMP which was implemented for the first turbine deployment from November 2016 to June 2017 (refer to Section 3).

2.0 Project Description

CSTV, a partnership between Emera Inc. and OpenHydro, a Naval Energies company, is proposing to deploy and operate two in-stream tidal energy turbines at the FORCE test site which is located approximately 10 km west of Parrsboro, in Cumberland County, Nova Scotia. The OpenHydro Open-Centre turbines are 2 megawatts (MW) each and will be joined by an interconnection cable. Power created by the turbines will be transferred to an onshore substation via a subsea cable.

The Project is located in Berth D at the FORCE test site. The coordinates of the Berth D are as follows:

- Latitude: 45 degrees 21' 49.3020"/51.6708"
- Longitude: 64 degrees 25' 21.7933"/19.5247”

The Project will be implemented in a phased approach. During the first phase, a single turbine was deployed in November 2016 and retrieved in June 2017. The next phase of this demonstration project involves the deployment of a single turbine in 2018. The second turbine is planned for deployment at a later date, to be determined, pending monitoring results, operational success and regulatory consent. This is a demonstration project focused on assessing the feasibility of generating tidal energy in an environmentally and economically sustainable way.

The overall purpose of the proposed Project is to gather relevant data to achieve a better understanding of the technology and of the potential near-field (*i.e.*, within 100 m of the turbine) interactions of the OpenHydro Open-Centre in-stream tidal energy device with marine species. The Project will also provide an opportunity to validate the proposed suite of monitoring devices to collect and transmit meaningful data that will be used to increase understanding of the potential effects to the environment and will inform future monitoring programs.

A schedule for 2018 for the Project is provided in Appendix A[1].

2.1 Turbine Technology

The turbine technology is the OpenHydro Open-Centre Turbine which is a shrouded, horizontal axis turbine, with four key components: a horizontal axis rotor; a direct-drive permanent magnet generator; a hydrodynamic duct; and a subsea gravity base type support structure (Figure 1). This simple design uses seawater for both generator cooling and for lubrication. The turbine possesses only one moving part, the rotor, and is bi-directional (i.e., the turbine is capable of extracting energy in both the ebb and the flood flow directions).

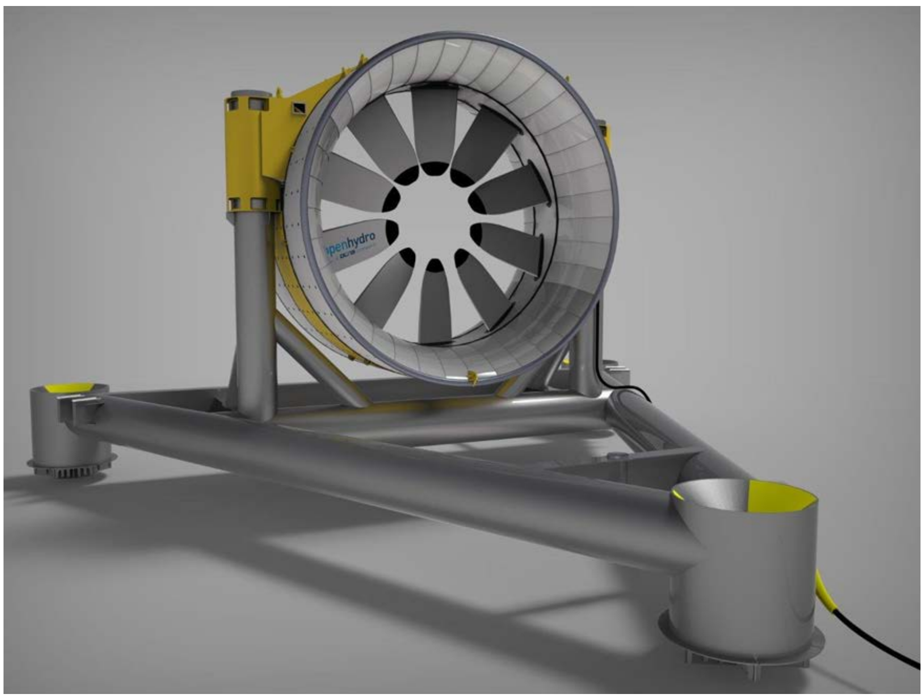


Figure 1. OpenHydro Open-Centre Turbine

[1] The schedule also provides the timeline for the Project Authorization required by DFO under the *Fisheries Act* and *Species at Risk Act*.

3.0 Regulatory Context

3.1 Environmental Assessment Approval

The FORCE test site underwent a joint provincial and federal EA in 2009. The (FORCE) project was approved (September 15, 2009) in accordance with Section 13(1)(b) of the Environmental Assessment Regulations, pursuant to Part IV of the NS *Environment Act*. The requirements for an EEMP are linked to the Terms and Conditions for Environmental Assessment Approval provided to FORCE (the Approval holder) which state, in relation to effects monitoring:

> *The Approval Holder, as part of the project Environmental Management Plan (EMP), must develop and implement an environmental effects monitoring program (EEMP). The EEMP must be developed using relevant baseline data and identify appropriate environmental effects indicators. The plan must be developed and implemented in consultation with the project Environmental Monitoring Advisory Committee (EMAC) and shall consider project effects on, but not limited to, the following:*
>
> - *fish and lobster*
> - *marine birds*
> - *marine mammals*
> - *acoustics*
> - *physical oceanography*
> - *currents and waves*
> - *benthic environment*

The FORCE and CST EEMPs were designed to be complementary in order to address all relevant conditions associated with the FORCE EA Approval, to achieve the most meaningful examination of potential effects, and to avoid repetition. The CSTV EEMP therefore focusses on the near-field environment of the turbine (i.e., < 100 m) while the FORCE EEMP focuses on the mid and far-field (i.e. >100 m).

In November 2016 CST deployed one, 2 MW in-stream tidal energy turbine at Berth D in the FORCE test site. The turbine was deployed for a six-month period and was disconnected from the FORCE subsea cable in April 2017 and retrieved in June 2017. The EEMP for this phase was initiated upon deployment and continued until April 2017 ending with the disconnection of the FORCE subsea cable to prepare the turbine for retrieval.

Following retrieval, the turbine and subsea base were towed to port facilities in Saint John, New Brunswick. While in port a detailed evaluation and inspection of the retrieved turbine and all associated monitoring devices was undertaken. The lessons learned from the first deployment (e.g., operations, turbine functioning, monitoring devices, data collection and management etc.) have been implemented in preparation for the 2018 deployment.

The following reports were provided to regulators during the 2016/2017 deployment and are available on the CSTV website (http://capesharptidal.com/):

- CST EEMP Operational Update (December 7, 2016);
- CST EEMP – Q1 Report (April 1, 2017);
- CST EEMP – Q2 Report (July 1, 2017);
- CST EEMP – Q3 Report (October 1, 2017);
- CST EEMP – Q3 *Revised* Report (October 18, 2017); and
- CST EEMP – Annual (Q4) Report (January 1, 2018).

Based on feedback from regulators, CST and FORCE have integrated the EEMP reporting beginning in 2018. This allows an integration of the data results for the two EEMPs which will be integral to understanding the potential overall environmental effects for the test site.

3.2 Marine Renewable Energy Act

In accordance with Section 31(2) of the *Marine Renewable Energy Act,* administered by the Nova Scotia Department of Energy and Mines and Section 5.0 of CSTV's License No. 2018-001, CSTV must submit an environmental effects monitoring plan to the Minister of Energy and Mines for approval prior to deployment. In addition CSTV is also required to submit regular EEMP reports to the Department of Energy and Mines throughout the term of the Project.

3.3 Fisheries Act and Species at Risk Act

Pursuant to paragraph 35(2) (b) of the *Fisheries Act*, administered by the Fisheries Protection Program of DFO, CSTV also has an Authorization. As per section 74 of the *Species at Risk Act (SARA),* which states that activities resulting in prohibited effects on listed aquatic species at risk can be authorized under other federal legislation, including the *Fisheries Act,* this Authorization also serves as a *SARA* permit for the Project.

3.4 Navigable Waters Protection Act

CSTV applied for an Approval from the Navigable Waters Protection Program under the *Navigable Waters Protection Act* administered by Transport Canada. This Approval was received on August 7, 2015.

4.0 EEMP Strategy

The EEMP is based on an adaptive management approach and has been developed to address the near-field component of the overall FORCE EEMP. The objectives focus on the predictions made in the 2009 EA of the FORCE test site, in relation to specific components identified by DFO. These components are fish, marine mammals and turbine sound.

In addition to addressing the EA predictions, guidance for the Program includes regulatory and policy regimes of Nova Scotia as well as conditions contained in permits, authorizations and approvals from regulatory bodies, including the FORCE EA Approval. Additional guidance includes past experience of CST, DFO feedback on previous monitoring programs completed at the site by FORCE, conversations with the Fisheries Protection Program (at DFO) and feedback from the DFO Canadian Science Advisory Secretariat, as well as with technology and subject experts, academia, and research and published documents.

As part of the strategy for the 2018 EEMP the following elements have informed improvements to the monitoring program as part of the adaptive management process:

- Recommendations of the researcher reports completed for sound, fish and marine mammals for the 2016/2017 deployment;
- Feedback from NSE and DFO from the Annual Report;
- Input from researchers; and
- Technical review of the 2016/2017 EEMP program including device set-up, changes to cabling, and improvements to data collection and transfer.

All research reports will be reviewed by FORCE's EMAC prior to finalization and incorporation into the Annual Report.

Specifications of the EEMP will continue to build upon requests and recommendations provided from discussions, and review and feedback from scientific experts, government regulators and other stakeholders.

CST has established a set of general intentions under the 2018 scope to be met in the development and application of the updated EEMP. These are:

- to develop an updated near-field EEMP for 2018 in consultation with, and to the satisfaction of NSE and DFO prior to deployment;
- to address the predictions of the FORCE EA Registration Document through monitoring of specific environmental components (i.e., fish, marine mammals, and turbine sound);
- to develop and implement a commissioning plan to test devices prior to deployment;
- to develop and field test a contingency environmental monitoring plan that is measurable against the original objectives of the EEMP and to the satisfaction of NSE and DFO;
- to ensure a complementary program scope to that which will be delivered by the FORCE EEMP and allow for integration of near, mid and far-field monitoring results;
- to identify information and data uncertainties and provide plans and timelines, with milestones, to address these uncertainties ;
- to include relevant knowledge gained from discussions with Aboriginal groups and stakeholders;
- to implement improvements identified as part of the technical review of the performance of the environmental sensors;
- to expand the EEMP with supplemental data collection to ensure gaps are addressed; and
- to communicate results to Aboriginal groups and stakeholders using a variety of methods (e.g., newsletters, round table discussions, open house events, media relations, technical reports, plain language summaries, etc.).

4.1 Adaptive Management

An adaptive management approach is used to evaluate data and make informed, science-based decisions to modify and improve monitoring if deficiencies are identified. This approach is necessary due to the unknowns and difficulties inherent with gathering data in tidal environments such as the Minas Passage and allows for adjustments and constant improvements to be made as knowledge is gained about the system and environmental interactions.

Outcomes are reviewed continuously with regulators and FORCE, and, where required, approaches and methodologies are revised on the basis of accumulated experience and observed progress toward achieving the monitoring objectives. This approach will assist with resolving gaps in the knowledge of the potential effects of the Project. The approach will also facilitate the implementation of new or modified monitoring strategies and programs.

4.2 FORCE Monitoring Program

The CST EEMP was designed and is executed in conjunction with the FORCE EEMP for the overall site. As such, key comments from the DFO 2012 feedback on the FORCE monitoring program report were incorporated in the original scope, and remain as key components including:

- the need for monitoring studies in the vicinity of the turbine(s) particularly related to fish interaction or behavior around the devices;
- concerns around inference to the likelihood of direct encounters of fish with a device since the (2009) test device was not operational for a significant amount of time;
- recognition that monitoring methodologies in the immediate vicinity of the turbine(s) in high flow environments are limited and evolving; and
- the need for more effort directed towards gathering monitoring data directly around the turbine (e.g., either a vessel-mounted system or, preferably, an instrumented monitoring platform mounted on the turbine enclosure).

For a comprehensive understanding of the test site, results of the CST and FORCE monitoring programs will be compared and integrated as part of the reporting process. This integration work has already started. FORCE has been collecting baseline sound data, both from bottom-mounted and drifters, since 2008, and collected drifting sound data during the 2016/2017 deployment. Sound data from the 2016/2017 CSTV deployment has been integrated into the sound data collected by FORCE to form a comprehensive and clear description of the sound produced by the turbine relative to ambient (background) sound and other noise sources in the Minas Passage (*e.g.*, vessels). The report was provided as part of the FORCE 2018 Q2 report.

For fish, FORCE is presently collecting fish tagging data, mobile echosounder data, and stationary echosounder data from bottom-mounted platforms. For 2018, CST is planning to collect sonar data both from the subsea base of the turbine (once deployed), as well as additional sonar data from a bottom-mounted platform during peak migration seasons (again once the turbine is deployed). FORCE and CST will work towards integrating all of the fish monitoring data streams in order to spatiotemporally assess fish trajectories and presence at the site in a qualitative manner. For marine mammal presence, FORCE is collecting data using autonomous C-PODs, and CST is collecting data using icListen hydrophones mounted on the turbine's subsea base, and will be adding a supplemental component through the deployment of an autonomous subsea platform during peak presence of harbour porpoise. FORCE and CST will again work towards comparing these data sets in a qualitative manner[2] to provide a cohesive understanding of marine mammal presence and use of the FORCE site.

5.0 EEMP Scope, Goal and Objectives

5.1 Scope

This EEMP has been developed for 2018. The EEMP forms a component of the CSTV Project Environmental Management Plan (EMP). The CST EEMP forms a component of the FORCE EEMP and as such is an integral part of the overall monitoring of the FORCE Crown Lease Area (CLA).

Overall responsibility of environmental monitoring at the FORCE test site is provided by FORCE; however it is important that monitoring information is integrated for a better overall understanding of the test area. The EEMP for CST addresses the near-field environment and results are provided to FORCE for integration with mid and far field monitoring results.

The scope of the 2018 CST EEMP includes the near-field monitoring of three main components which were identified through consultation with regulators and a review of the FORCE EA Registration Document. Those components are:

- Fish;
- Marine Mammals; and
- Turbine Sound.

It should be noted that CSTV recognizes that there are currently two aquatic species that are listed under Schedule 1 of the *Species at Risk Act* (*SARA*) that may use the Minas Passage in the vicinity of CST turbine:

- Inner Bay of Fundy Atlantic Salmon (endangered); and
- Atlantic White Shark (endangered).

Monitoring of these fish species at risk falls under the fish monitoring component of the EEMP (refer to Section 6.1). It is also important to note that during the life of the EEMP there may be additional species listed or Critical Habitat identified. CSTV will continually monitor this potential for new *SARA* listed or potentially listed species that may interact with the Project.

A description of the objectives and methodologies for each component are provided in Section 6. In addition to the specific monitoring objectives for each component, CSTV will also use the EEMP to test

[2] Since the marine mammal data will be collected by different instrumentation (i.e., CPODs versus icListen hydrophones) a direct integration of data results cannot be done. However, data will be compared in a qualitative manner to look at patterns in distribution and abundance.

and validate the monitoring equipment to understand the capabilities of these devices in a tidal environment.

Interim reporting will be completed throughout the year. Final reports, including a full data analysis and interpretation, will be completed and submitted to NSE on December 31st. Details on the reporting schedule are provided in Section 9.0.

5.2 Goal

The CST EEMP is crucial to the successful operation of the Project, a commitment to the protection of the environment, and an essential part of the overall FORCE monitoring program. The overall goal of the CST EEMP, in conjunction with the FORCE EEMP, is to confirm the predictions of the EA for specific components known as 'Valued Ecosystem Components' (VECs) (*i.e.*, fish, marine mammals and turbine sound). In achieving this goal, the CST EEMP will lead to a better understanding of the potential effects and interactions of specific environmental components in the near-field environment with the CST in-stream tidal devices. This understanding will continuously inform future monitoring plans.

The goal will be achieved through specific objectives focused on fish, marine mammals, and turbine sound and supports CST's commitments to understanding potential near-field environmental effects of the Project; collaborating with FORCE on monitoring of the test site; and contributing to a growing body of knowledge about the potential near-field effects of in-stream tidal energy.

5.3 Objectives

The objectives of the 2018 EEMP are designed to test the EA predictions provided in the EA Report, and will focus on the following VECs: fish, marine mammals and turbine sound.

The VECs were identified in the EA process and were established based on a review of the Strategic Environmental Assessment Report and supporting Background Report, formal and informal discussions with provincial/federal regulatory agencies and government scientific authorities, a review of listed species and species at risk found within the Project area, discussions with stakeholders and First Nation/Aboriginal groups and the professional judgment of the EA Study Team (AECOM 2009). The EA process evaluated each VEC for potential interactions with Project activities and provided predictions as to what the potential significance of that effect would be after application of technically and economically feasible mitigative measures. Table 1 provides a summary of this process for each of the VECs that are a focus of the CST EEMP and notes the predictions and any suggested mitigation and/or monitoring identified in the EA.

Table 2 describes the monitoring objectives of the 2018 EEMP that have been designed to address the EA predictions with the aim of increasing knowledge around specific components. As noted above, there are also specific objectives designed to address the capabilities of the monitoring devices. Mitigation measures from the EA that are noted in Table 1 have been implemented into the CST environmental management program.

Details on the EA process are available in the EA Report (AECOM 2009). With the implementation of the proposed mitigation measures provided in the EA Registration Document, including development and implementation of a detailed monitoring plan, adverse residual environmental effects of the Project were predicted to be not significant for all VECs. Specifically the following statements summarized the assessments completed for fish and marine mammals, including species at risk, and turbine sound:

i. Fish: It is anticipated that fish present or migrating through the Project area may experience very limited behavioural changes such as avoidance and evasion, as well as limited mortality and habitat disruption. The extent of these effects is not known given the lack of specific information related to fish interactions with in-stream device components, sound generated by the proposed devices, and the background noise in the Project area. By following existing standard construction practices, available guidelines and associated mitigation measures, Project activities and components are not likely to cause significant adverse residual effects on marine fish within the Project area or vicinity (*i.e.*, Minas Passage and Minas Basin).
Just as important to note however, is that the EA also states that the response of fish to in-stream tidal devices is currently unknown and that this is a critical gap in knowledge. Consequently, building the research knowledge base among the scientific community of the Bay of Fundy represents a valuable asset that will amplify the potential for this region (Jacques Whitford *et. al.*, 2008 in AECOM 2009).
ii. Marine Mammals: By following existing standard construction practices, available guidelines and associated mitigation measures, Project activities and components are not likely to cause significant adverse residual effects on marine mammals within the Project area or vicinity (*i.e.*, Minas Passage). However, it was also noted that a key technical limitation of the EA was the lack of detailed information available on the presence and movements of marine mammals in the Minas Basin and the limited knowledge of the effects of tidal energy technology on marine mammals.
iii. By following existing standard construction practices, available guidelines and associated mitigation measures, Project activities and components will not cause significant adverse residual effects on Marine Species at Risk within the Project area or vicinity (*i.e.,* Minas Passage and Minas Basin).

It is important, however, to note that the EA process did note that there were many unknowns when evaluating the potential environmental effects for the in-stream tidal demonstration projects (see Table 1) and that monitoring must focus on these unknowns in these early research and development stages. As noted above, this has been taken into account in the development of the CST EEMP objectives.

Table 1. Summary of Potential Project Interactions and EA Predictions for CST EEMP Components

VEC/EEMP Component: Marine Fish including Species at Risk	
Reason for VEC designation in EA: • To meet specific regulatory requirements; • Due to the important role that fish populations have on the marine ecosystem and on the stability of fisheries resources • Due to the important ecological roles that marine species at risk play in the Bay of Fundy • Species at risk are important indicators of ecosystem health and regional biodiversity • Species at risk are of public concern and socio-economic importance for the tourism industry in the Bay of Fundy	
Related Legislation/ Policy and Administrators: • *Fisheries Act* (DFO) • Policy for the Management of Fish Habitat (DFO) • *Species at Risk Act (SARA)* (DFO) • NS *Endangered Species Act* [NS Department of Natural Resources (NSDNR)] • NS *Environment Act* (NSE)[a]	
Project Activities with Potential to Cause Effects: • Construction (deployment) and Decommissioning • Operation	
EA Predictions including Marine Fish Species at Risk *(relevant to CST)*	**Recommended Mitigation and/or Monitoring**
Construction/Decommissioning: Direct mortality and injury of marine fish is possible due to modification of fish habitat[b] and interactions with vessels. Activities are likely to be minimal to short time periods. Limited species diversity and low population densities of marine benthic communities in the deployment area means that it is unlikely that large numbers of fish species which rely on such communities for food may be present. Permanent alteration of small areas of fish habitat will occur but the will be minimal (due to the small footprint) in relation to the area of available habitat. Mortality/injury is likely to be minimal with recovery to baseline levels over the short-term.	*Mitigation:* • Minimize time for activities to the extent possible • Work with local fishers to understand fish migration timing and, where possible, avoid these times or prolonged activity during these times • Maintain open communication with fishers to remain updated on changes to catches and review the potential schedule
Construction/Decommissioning: Noise/vibrations from vessels involved in deployment/retrieval activities may have deterrent effect on fish (including lobster), particularly with regard to migratory stocks (*i.e.*, fin fish), that are not currently understood. Activities and vessel traffic are expected to be of short duration and intermittent and will mostly use smaller vessels common to the Minas Passage. Large vessels will be limited in number and duration of use. Noise levels are not expected to be abnormal when compared to ambient (environmental) noise and no adverse effects on adult, juvenile, eggs or larvae of commercial or non-commercial species are expected as noise levels will not exceed the thresholds for damage to marine fish. Construction activities will have no effect on reproducing salmon or bass in freshwater rivers, where the species are most susceptible to anthropogenic disturbance since suitable habitat does not occur within the Project footprint. The only breeding location of striped bass occurs within the Shubenacadie River, and the nearest breeding locations for Inner Bay of Fundy Atlantic Salmon occur at the Diligent and Parrsboro Rivers (COSEWIC 2006 in AECOM 2009).	*Mitigation:* • Minimize time for activities to the extent possible • Work with local fishers to understand fish migration timing and, where possible, avoid these times or prolonged activity during these times • Undertake installation/removal/maintenance activities outside of lobster fishing season, to the extent possible • Where activities are required during lobster season, inform fishers of vessel movements, timing and locations • Operate vessels in specified routes and locations • Maintain open communication with fishers to remain updated on changes to catches and review the potential schedule • Provide fishers with coordinates of subsea cables and turbines as soon as possible following deployment
Construction/Decommissioning: Use of light artificial lighting may result in localized behavioral modifications for certain fish species. Potential effects are anticipated to be low, temporary, reversible and limited in geographic extent.	*Mitigation:* • Minimize time for activities to the extent possible • Work with local fishers to understand fish migration timing and, where possible, avoid these times or prolonged activity during these times • Maintain open communication with fishers to remain updated on changes to catches, movements of fish, abnormal schooling behavior etc. • Use of lighting only for safety requirements on vessels • Direct lighting on vessels away from the water, where possible, to avoid attracting fish to the vessels

Construction/Decommissioning: Activities may disrupt the seabed and remobilize sediments leading to plumes/ increased levels of suspended sediment that could be an issue for filter feeders. Suspended sediment from vessel prop wash and deployment/retrieval of in-stream devices will be limited due to the depth of the water over Berth D. Effects to fish are expected to be negligible, there will not be any long term effects and it is highly unlikely that there will be any direct mortalities. Any sediment plumes will quickly dissipate from the immediate area. Localized disturbance of marine sediment during construction activities could temporarily affect habitat and food sources of salmon and bass, however this temporary localized effect would not be significant.	*Mitigation:* • Minimize time for activities to the extent possible • Work with local fishers to understand timing of migrations and, where possible, avoid these times or prolonged activity during these times • Maintain open communication with local fishers to remain updated on changes to catches
Operations: There is a potential for a "reef effect"[c] that could attract fish to the turbine. The potential for this effect is reduced in the Minas Passage because of high velocities.	*Mitigation:* • Use of anti-fouling paints to minimize the effect that might be an attractant to fish UPDATE: No anti-fouling paint has been used in previous deployments. The potential for a reef effect was evaluated following recovery of the turbine from the 2016/2017 deployment. There was no marine production noted on the turbine or subsea base likely due to currents in Minas Passage
Operations: Turbine generated noise is anticipated to be a continuous source that has the potential to interact with marine fish. Noise generated during turbine operations is unlikely to cause mortality or injury to marine fish and it is anticipated that marine fish present or migrating through the Project area may experience extremely limited behavioural changes (*i.e.*, avoidance and aversion over a few meters).[d] **However, the extent of these effects is not known given the lack of specific information related to sound generated by the turbine, exact migration patterns, and the ambient (natural) noise in the Project area.**	*Monitoring:* • Collection of ambient noise levels in the area of the turbine device(s) • Collection of sound data for each of the turbines during regular operations • Increase knowledge of fish species and migration patterns in the Minas Passage
Operations: Fish mortality could result from collision with the turbine or from sudden pressure drops as the fish proceeds through the device. Fish that move in the mid-water zone are more likely to interact with the device than those moving close to the bottom or those close to the surface. It is also expected that tightly schooling fish may be more vulnerable than solitary ones. In general, high currents and turbulence in the water column are not preferred by most fish. For a smaller percentage of the time, movements may involve passage further from shore, where the fish could be transported past turbines by tidal currents. Thus there is a small likelihood that a small proportion of most pelagic species will encounter turbines at some point while passing through Minas Passage. The fish would also probably be more likely to be in the upper 10 - 20 m of the water column, where they could occasionally encounter turbines, but again the most likely depth distribution is not known. Bottom-associated species will move near bottom where bedrock outcrops may be used for refuge during high tidal currents, and would likely be below depths influenced by the turbines. If the turbines are moving slowly enough (*i.e.*, 6 - 14 rpm) fish kills are minimized. Turbine devices to be utilized in the Demonstration Project will spin slowly (*i.e.*, 6 - 14 rpm), thereby minimizing the likelihood of mortality of marine fish from turbine operation. Also, engine-driven ships move through the water with high velocity, sucking anything nearby towards the propeller, whereas a turbine is stationary, passive and does not create suction. Yet, ships and boats seemingly cause no major mortality of marine fish. In summary, the risk of collision by fish is considered to be extremely low. No effects are likely for Inner Bay of Fundy Atlantic Salmon, striped bass, Atlantic shortnose sturgeon and American eel, since it is highly unlikely that single or multiple individuals of the species would pass through the turbine and be injured by it. Unlike a hydro turbine, the fish have the whole cross section of the Minas Passage to move through, so the likelihood of passing through a single turbine or turbine array is improbable. **However, this is a technology, site, and species-specific interaction requiring further research for each turbine design. With respect to marine fish species at risk, the vertical distribution of salmon (Inner Bay of Fundy salmon) is not well documented and marine habitat requirements are less understood as compared to inland habitat (COSEWIC 2006 in AECOM 2009).**	*Monitoring:* • Increase knowledge of fish behaviour in the vicinity of specific in-stream turbine technologies to better understand the potential for interactions between fish and turbines in the Minas Passage
VEC/EEMP Component: Marine Mammals including Species at Risk including Leatherback Sea Turtles	
Reason for VEC designation in EA: • To meet specific regulatory requirements; • Due to the important role that marine mammals play in the marine ecosystem • These species are also of public concern and of socio-economic importance for the tourism industry in the Bay of Fundy • Due to the important ecological roles that marine species at risk play in the Bay of Fundy • Species at risk are important indicators of ecosystem health and regional biodiversity • Species at risk are of public concern and socio-economic importance for the tourism industry in the Bay of Fundy	

Related Legislation/ Policy and Administrators:

- *Fisheries Act* (DFO)
- *Species at Risk Act (SARA)* (DFO)
- NS *Endangered Species Act* [NS Department of Natural Resources (NSDNR)]
- NS *Environment Act* (NSE)[a]

Project Activities with Potential to Cause Effects:

- Construction (deployment) and Decommissioning
- Operation

EA Predictions for Marine Mammals including Species at Risk including Leatherback Sea Turtles *(relevant to CST)*	**Mitigation and/or Monitoring**
Construction/Decommissioning: Mortality or injury to marine mammals may occur due to vessel strikes during activities in the Minas Passage or during transit to/from the test site from harbour facilities. Vessel collisions with marine mammals/turtles are more likely to occur when vessel speeds are high and with slow moving marine wildlife (*e.g.*, whales, turtles). In the Minas Passage, the most common marine mammal is the harbour porpoise so the potential for collisions are reduced (in the Project area) given that these mammals are fast swimmers and able to swim away or dive. The likelihood of collision can be decreased significantly by vessels maintain constant speed and course while in transit as would be the case in this Project. Additionally, whale species at risk (*e.g.*, right whales and fin whales) primarily inhabit the outer Bay of Fundy, potential for any interaction to occur is low. The area also does not meet suitable habitat requirements to support populations of leatherback sea turtles. Occurrences of the species are more likely incidental indicating it is highly unlikely that the leatherback turtle will be found in the Project area. As such, vessel collisions with turtles are extremely unlikely.	*Mitigation:* • As much as possible, marine vessels will travel at slow constant speeds while in transit to minimize potential for collisions with marine mammals • Maintain constant course and vessel speed under 14 knots • Do not approach whales nearer than 100m nor by greater than 2 vessels at one time • Develop an Environmental Protection Plan (EPP) for protection of marine mammals during transit between Saint John and Minas Passage, with focus on right whales
Construction/Decommissioning: Disturbance caused by vessels (*i.e.*, increased noise levels) during presence installation/retrieval of turbines. If effects (*e.g.*, avoidance, impairment of feeding efficiency and predator detection) were to occur, they would likely be to seals and harbour porpoises as larger marine mammals such as whales are not known to be present in the Minas Passage on a regular basis. Activities are expected to be of short duration and intermittent. Marine vessels produce low-frequency sounds with most acoustic energy below 1kHz. As seals and harbour porpoise are most sensitive to mid-frequency sounds (> 1kHz) much of the acoustic energy produced by vessel traffic will not be audible to these marine mammals. Behavioural effects will subside once activities are complete. Additionally, whale species at risk (*e.g.*, right whales and fin whales) primarily inhabit the outer Bay of Fundy, potential for any interaction to occur is low. **However, there is a relative low confidence level with respect to the occurrence information for marine mammals in the Project area and the spatial distribution in the Minas Basin is not well known.** The area also does not meet suitable habitat requirements to support populations of leatherback sea turtles. Occurrences of the species are more likely incidental indicating it is highly unlikely that the leatherback turtle will be found in the Project area. As such, disturbances to turtles are extremely unlikely.	*Monitoring:* • Increase knowledge on marine mammal occurrence and spatial distribution in the in the Minas Passage
Operations: Fixed structures can be a focus for marine production (*e.g.*, reef effect[c]) which can attract marine life, including mammals. Given the high current velocities this effect is reduced and marine mammals are not expected to be attracted to the turbine(s).	*Mitigation:* • Use of anti-fouling paints to minimize the effect that might be an attractant to fish **UPDATE:** No anti-fouling paint has been used in previous deployments. The potential for a reef effect was evaluated following recovery of the turbine from the 2016/2017 deployment. There was no marine production noted on the turbine or subsea base likely due to currents in Minas Passage.
Operations: Disturbance caused by the presence of turbine(s) including sound/vibration[d] could mask cetacean vocalizations. Also of concern is temporary threshold shifts or hearing impairment, behavioural effects (*e.g.*, avoidance, changes in migration or reproductive and feeding behaviors), or physical injury. Potential underwater noise or vibrations from the turbine could confuse signals and diminish marine mammal capacity to discriminate fixed structures which might result in them striking a turbine	*Monitoring:* • Collection of ambient noise levels in the area of the turbine device(s) • Collection of sound data for each of the turbines during regular operations • Address various components of acoustic emissions, including sound propagation distance • Collection of noise data to determine interference potential with cetacean communication • Increase knowledge of fish species and migration patterns in the Minas Passage
Operations: Mortality or injury to marine mammals may occur due to vessels used in monitoring activities. Vessel traffic during operations is expected to be of short duration and intermittent and will use smaller vessels compared to construction/ decommissioning. Additionally, whale species at risk (*e.g.*, right whales and fin whales) primarily inhabit the outer Bay of Fundy, potential for any interaction to occur is low. **However, there is a relative low confidence level with respect to the occurrence information for marine mammals in the Project area.**	*Mitigation:* • As much as possible, marine vessels will travel at slow constant speeds while in transit to minimize potential for collisions with marine mammals • Maintain constant course and vessel speed under 14 knots • Do not approach whales nearer than 100m nor by greater than 2 vessels at one time

The area also does not meet suitable habitat requirements to support populations of leatherback sea turtles. Occurrences of the species are more likely incidental indicating it is highly unlikely that the leatherback turtle will be found in the Project area. As such, vessel collisions with turtles are extremely unlikely	• Increase knowledge on marine mammal occurrence in the in the Minas Passage
Operations: Mortality/injury due to turbine strikes. There is little evidence that marine mammals come into contact with large stationary objects in the marine environment (Jacques Whitford et. al., 2008 in AECOM 2009). Marine mammals are more likely to contact fishing gear that may be too small to be detected or with moving objects such as vessels. Tidal currents flow through turbines in a helical path through the turbine such that any passive, neutrally buoyant object will follow a path aligned with the rotor blades rather than across them. This occurs because water slows down as it passed through the turbine due to the removal of energy. Furthermore, as water slows down it spreads to occupy a greater cross-sectional area. The rotating turbine blades deflect the current tangentially into helical pathways, at velocities proportional to the distance from the rotational centre of the turbine (CREST Energy Limited 2006 in AECOM 2009). A marine animal approaching a turbine by swimming downstream will tend to follow the helical path (*i.e.*, it will not swim directly through the plane of rotation, but rather will be swept tangentially with the helical movement of the currents). Subsequently, after passing the turbine, the animal would be swept along with the current as the helical flows gradually regain the natural flow (CREST Energy Limited 2006 in AECOM 2009). Marine wildlife has evolved to avoid collisions with natural features and species that favour swimming in strong currents tend to be fast and agile and are expected to be able to avoid fixed objects. Dolphins/cetaceans generally have large eyes, large cornea and large pupils. When approaching the surface, their pupillary opening is constricted rapidly to restrict access of excess light. Underwater, their eyes provide excellent definition and they have the ability to amplify light sensitivity more than 10-fold when diving. These visual characteristics provide dolphins/cetaceans with equally sharp vision above and below water and will help to mitigate the risk of inadvertent collision with underwater turbine structures (CREST Energy Limited 2006 in AECOM 2009). Additionally, whale species at risk (*e.g.*, right whales and fin whales) primarily inhabit the outer Bay of Fundy, potential for any interaction to occur is low for these species. **However, there is a relative low confidence level with respect to the occurrence information for marine mammals in the Project area.** The area also does not meet suitable habitat requirements to support populations of leatherback sea turtles. Occurrences are more likely incidental indicating it is highly unlikely that leatherbacks will be found in the Project area. Leatherbacks are relatively small and individuals and would likely avoid the turbines. The sound emitted by the turbines would also likely discourage leatherbacks from the Project area.	• Increase knowledge on marine mammal occurrence in the in the Minas Passage
Operations: Indirect effects through changes in prey distribution and abundance	*Note: There was no specific monitoring measure related directly to this potential effect. However, given that the most common marine mammal in the Minas Passage is Harbour porpoise (OEER 2008 in AECOM 2009) and that this species is chasing herring schools and other fish, monitoring of potential effects to prey distribution and abundance is captured under the monitoring specific to marine fish (please refer to Table 2)*
VEC/EEMP Component: Turbine Sound	
Reason for VEC designation in EA: • Potential effects to marine fish including species at risk • Potential effects to marine mammals including species at risk	
Related Legislation/ Policy and Administrators: • *Fisheries Act* (DFO) • *Species at Risk Act (SARA)* (DFO) • NS *Endangered Species Act* [NS Department of Natural Resources (NSDNR)]	
Project Activities with Potential to Cause Effects: • Construction (deployment) and Decommissioning • Operation	
EA Predictions for Turbine Sound *(relevant to CST)*	**Mitigation and/or Monitoring**
Operations: Turbine generated noise is anticipated to a be a continuous source that has the potential to interact with marine fish. Noise generated during turbine operations is unlikely to cause mortality or injury to marine fish and it is anticipated that marine fish present or migrating through the Project area may experience extremely limited behavioural changes (*i.e.*, avoidance and aversion over a few meters).[d] **However the extent of these effects is not known given the lack of specific information related to sound generated by the turbine, exact migration patterns, and the ambient (natural) noise in the Project area.**	*Monitoring* • Collection of ambient noise levels and other noise sources (*e.g.*, vessels) in the area of the turbine device(s) • Collection of sound data for each of the turbines during regular operation
Operations: Disturbance caused by the presence of turbine(s) including sound/vibration[d] could mask cetacean vocalizations. Also of concern is temporary threshold shifts or hearing impairment, behavioural	*Monitoring:* • Address various components of acoustic emissions, including sound

effects (*e.g.*, avoidance, changes in migration or reproductive and feeding behaviors), or physical injury. Potential underwater noise or vibrations from the turbine could confuse signals and diminish marine mammal capacity to discriminate fixed structures which might result in them striking a turbine Acoustic disturbance to harbour porpoises are not likely to occur since acoustic productions from the turbine are incidental, unlike those produced for the purpose of discouraging mammals from approaching equipment, and sound emissions are not at the high frequencies (such as those used on harassment devices). Based on previous work examining marine turbine devices, sound pressure and frequency levels are expected to occur at levels considerably below those which cause mortality, physical injury or hearing impairment to marine mammals in general. In past studies[d], at distances beyond 200 m, turbine noise was difficult to identify above ambient tidal water flow noise. As such, behavioural interaction with marine species is considered to be limited to this range. Based on this distance of sound propagation, behavioural interactions would include avoidance rather than injury or mortality. In addition, since some whale species at risk (*e.g.*, right whales and fin whales) primarily inhabit the outer Bay of Fundy, potential for any interaction to occur is low. **However, there is limited information related to the behavioural responses of marine mammals to in-stream tidal devices and a relative low confidence level with respect to the occurrence information for marine mammals in the Project area.** The sound emitted by the turbines would likely discourage leatherbacks from the immediate Project area.	propagation distance • Collection of ambient noise levels and other noise sources (*e.g.*, vessels)in the area of the turbine device(s) • Collection of sound data for each of the turbines during regular operation • Collection of noise data to determine interference potential with cetacean communication

Notes:

a) DFO works in collaboration with NSE to protect fish and fish habitat. As a result all activities that could potentially affect fish and fish habitat must be approved in advance by DFO and NSE.
b) The CST turbine design is gravity based, meaning the turbine and subsea base remain stationary on the sea floor, without the requirement of drilling or modification to the substrate. The CST project therefore does not require any substrate preparation activities (*e.g.*, drilling, blasting).
c) A “reef effect” refers to the fact that underwater fixed and moored structures often become a focus for biological growth which in turn can attract fish.
d) It is important to note that the EA was done on a 1MW OpenHydro device so effects and effect predictions for sound may be different that for a 2MW device.

The monitoring objectives for 2018 are noted below in Table 2. Methodologies noted in Table 2 are detailed in Section 6.

Table 2. CST EEMP Objectives

EEMP Component	Monitoring Related to EA Predictions (refer to Table 1)	2018 Monitoring Objectives	Methodology
Fish including Species at Risk		Validate the capabilities of the Gemini imaging sonar to function in the Minas Passage.	Active Acoustic Monitoring (AAM) with Gemini Imaging Sonar and *SeaTec* software. One Gemini device mounted on the turbine.
	Increase knowledge of fish migration patterns in the Minas Passage	Collect Gemini sonar data to validate the ability to detect and track fish within 50 m and within the viewing angle of the sonar over the duration of the Project	
	Increase knowledge of fish behaviour in the vicinity of specific in-stream turbine technologies to better understand the potential for risk/ interactions between fish and turbines in the Minas Passage	Assess the ability of the Gemini sonar data to provide information on near-field (50 m) trends in fish size-class, abundance and movements over time (days to months) and in relation to day or night, as well as trends associated with tidal stage (ebb, flood, low slack, or high slack), temperature, current speed, and average current direction.	
		Explore the potential to collect additional visual data of fish interactions in the immediate area of the CST turbine rotor. *Note: this is a supplemental element of the EEMP. CST is interested in exploring the abilities of underwater video cameras in the Minas Passage environment to provide additional data on fish behaviour and species identification*	Underwater Video with an SAIS IP-CAM High Definition Ethernet underwater video camera mounted on the subsea platform and facing the rotor.

EEMP Component	Monitoring Related to EA Predictions (refer to Table 1)	2018 Monitoring Objectives	Methodology
Marine Mammals		Validate the capabilities of the icListen hydrophones to function in the Minas Passage.	Passive Acoustic Monitoring (PAM) with hydrophones and implementation of click detector software. Four hydrophones are mounted on the turbine (1) and the subsea base (3).
	Increase knowledge on marine mammal (Harbour porpoise)[a] occurrence and spatial distribution in the Minas Passage	Collect acoustic data to detect the presence of harbour porpoises in the vicinity of the turbine over the duration of the Project.	
		Use the acoustic data to better understand presence/absence of harbour porpoises in the Minas Passage in relation to environmental variables (diurnal, tidal, seasonal cycles).	
Turbine Sound		Validate the capabilities of the Autonomous Multichannel Acoustic Recorder (AMAR) hydrophones in the Minas Passage	Bottom Moored Autonomous Multichannel Acoustic Recorder positioned approximately 100m from the turbine.
	Collection of sound data for each of the turbines during regular operation	Collect sound data in the vicinity of the turbine over the duration of the Project including a period prior to turbine deployment in order to obtain comparative background sound levels. Characterize operational sound of the turbine, and understand how operational sound changes with turbine operating state and tidal flow speeds	
	Address various components of acoustic emissions, including sound propagation distance		
	Collection of noise data to determine interference potential with cetacean communication		

Notes:

a) Harbour porpoise is the marine mammal species that CST will focus monitoring efforts on as baseline studies indicate that this species is the most common marine mammal species in the Minas Passage (OEER 2008 in AECOM 2009). However other vocalizing cetaceans can be detected and, if so, will be reported on. It is anticipated, however, that detection rates for other vocal cetaceans will be too low for detailed analyses of presence in relation to varying physical conditions (e.g. current speed).

6.0 EEMP Approach

6.1 Fish Monitoring Program

Gathering data on the movements of fish in the near-field environment of the turbine is important to improve understanding of year-round presence (migration patterns) and spatial distribution of fish. This information will be helpful for meeting future monitoring objectives related to how fish might interact with an in-stream turbine and data will be useful for the future development of strike risk models.

6.1.1 Scope

The EA noted that the majority of the fish species in the Minas Passage are migratory, and are typically present only at particular times of the year. This includes species such as herring, mackerel, Gaspereau and shad. These species would be present in the Passage on a seasonal basis (while migrating between foraging habitats and spawning grounds) and none of the species identified in the EA are known to spawn in the Passage in the vicinity of CLA (AECOM 2009). While marine and salt tolerant species are expected throughout the year, abundance varies according to many factors including tidal cycles (over small scales) and season (over larger scales). There are both commercial and recreational species present and due to the large number of species which undergo migrations, collectively there will be limited time during the year when there are no fish moving through the Project area (Jacques Whitford *et al.* 2008 in AECOM 2009). Important invertebrates include American lobster, crab and sea scallops. The principal and most valuable fishery in the immediate area of the Project site is for lobster which is included in the inner Bay of Fundy lobster fishing area 35 (LFA 35).

Additional fish species that may be present in the Minas Passage and that have been identified by federal or provincial agencies as being endangered, threatened, rare, of special concern, or otherwise of conservation concern include: Inner Bay of Fundy salmon (*Salmo salar*), Striped bass (*Morone saxatilis*), Porbeagle shark (*Lamna nasus*), Atlantic wolffish (*Anarhichas lupus*), White shark (*Carcharodon carcharias*), and Shortnose sturgeon (*Acipenser brevirostrum*).

CST notes that the inner Bay of Fundy (iBoF) population of Atlantic salmon and White Shark which are currently listed as Endangered on Schedule 1 of *SARA* are known to use this area and have been considered in the development of the EEMP. Since *SARA* applies to impacts on individuals of listed species, the residence of listed species and Critical Habitat identified in a species recovery strategy or action plan are important considerations.

Fish (including fish species at risk and commercial and recreational species) will be monitored throughout the duration of the turbine deployment. This will be accomplished using an acoustic sonar, the Tritech Gemini sonar, mounted on the subsea base and, during specific seasons (*i.e.*, migratory seasons) through a supplement monitoring program using a subsea platform called the Fundy Advanced Sensor Technology – Environmental Monitoring System (FAST-EMS) platform. The FAST-EMS platform will also support a Tritech Gemini sonar and will be positioned approximately 30 m from the turbine to provide a side view, with the objective of gaining additional knowledge of fish interactions in the vicinity of the rotor. A detailed description of the methodology for marine fish monitoring is provided in Section 6.1.3. Details on the supplemental program using the FAST-EMS platform are provided in Section 7.

6.1.2 Objectives

The objectives of the fish monitoring program are to:

1. Validate the capabilities of the Gemini imaging sonar function in the Minas Passage.
2. Collect Gemini sonar data to validate the ability to detect and track fish within 50 m and within the viewing angle of the sonar over the duration of the Project.
3. Assess the ability of the Gemini sonar data to provide information on near-field (50 m) trends in fish size-class, abundance and movements over time (days to months) and in relation to day or night, as well as trends associated with tidal stage (ebb, flood, low slack, or high slack), temperature, current speed, and average current direction.

The results of these objectives will increase understanding of the usage of the test site by fish and could be used to determine patterns and behaviour in the vicinity of the turbine which, will be used to explore avoidance behaviours around in-stream devices. Understanding avoidance behaviours is essential in ensuring the protection of *SARA* listed species that utilize the Minas Passage including iBoF Atlantic salmon and Atlantic White shark.

6.1.3 Methodology

Technology

The fish monitoring will be achieved through Active Acoustic Monitoring (AAM) using the Tritech Gemini Imaging Sonar mounted on the turbine subsea base.

The Tritech Gemini Imaging Sonar (the Gemini) is an active acoustic device which uses high frequency (720 kHz) multi-beam sonar technology to build up a picture of the underwater environment. Although lower frequency fisheries sonars (*e.g.* split and single beam echosounders) have a greater sampling range, this project utilizes the Gemini high-frequency sonar to achieve better resolution (*i.e.*, clearer images) and span a greater area to track fish movements as they approach or depart from the turbine. The Gemini will monitor a 120° wide by 20° deep swathe of water, extending up to 60 m upstream of the turbine (reaching approximately 104 m in width). The Project will use the data collected to provide information on the range at which the detection and tracking capability of the sonar can operate for targets of different sizes in this particular environment.

The Gemini was chosen as the best device for monitoring fish based on monitoring successes of marine mammals and schools of fish. The Gemini *SeaTec* system was launched in 2011 and uses Tritech's industry standard Gemini 720id multi-beam sonar and *SeaTec* target identification and tracking software. This innovative software has been developed from field installations and is designed to identify, track and classify targets (*i.e.*, harbour seals and other marine mammals). Tritech's Gemini range of sonars have also been used as part of the Clever Buoy system from Smart Marine Systems (SMS) in Australia and South Africa, in which a variation of the same *SeaTec* software is used to monitor marine life for beach protection. Individuals (large fish) and shoals of fish are detected and tracked with a view to raise an alarm if any target is evaluated to be greater than 1.5 m and appears to be a shark.

The Gemini will be mounted in a protective frame on the subsea base of the turbine, positioned in front of the rotor to capture images of the water column at hub height, facing into the ebb tide. The device will be positioned to view along a line parallel to the current.

The Gemini has undergone a number of commissioning and capability tests prior to the 2018 deployment. Commissioning tests have taken place on the turbine and in the FORCE test site on the FAST-EMS and have focused on testing the functioning of the unit and improving data transfer and analysis procedures and protocol. Data from the tests was used to further develop and refine the *SeaTec* algorithms and provide researchers with a better understanding of what the subsampling regime will be for data collected from the turbine.

Data Collection

The Gemini is connected to the turbine export cable so that data can be collected and transmitted on a continuous basis. The data will be transferred to a computer in the onshore substation at FORCE and is then automatically transferred to a server (*i.e.*, ftp site) that is accessible by researchers.

The data stream will be uploaded on a daily basis and accessible to researchers. Researchers will download data, review the results and report regularly to CSTV. All updates will be provided to regulators. Details on report content and delivery times is provided in Section 9.0. The frequency of data transfer and quality review by researchers will ensure timely review and regular analysis and will also provide quality assurance by allowing early detection of any problems with the monitoring device or data transmission. If any significant issue are detected, initiation of the CSTV EEMP 2018 Contingency Plan (refer to Section 10.0) will occur.

Data will be collected continuously beginning with the connection of the subsea cable following deployment of the turbine.

Data Processing and Analysis

Once onshore, the data will be accessed by researchers. As part of the EEMP, a specialized software program, *SeaTec*, will be refined to detect and track fish within the near-field of the turbine. The refinement of the algorithms used by *SeaTec* will continue to be validated and improved as more data is collected. Further details on the data management specific to the Gemini sonar is provided in Section 8.0 and in the CSTV Sensor Data Management Plan 2018, provided in Appendix B.

The Gemini cannot currently differentiate between different species but the software will be used to extract moving targets and to perform a classification process using defined criteria to determine if an object is likely to be a fish or other marine wildlife (*e.g.* marine mammal) versus other marine objects (*e.g.*, seaweed, sticks, moving rocks etc.). This determination will be validated by corroborating with expert observations.

Analysis of the Gemini datasets will incorporate the use of the *SeaTec* software for data processing and viewing, which will include:

- automated software detection and classification of targets; and
- human observer assessment of the presence and movement of marine life, including fish, in the

Gemini's field of view for a subset of the Gemini data.

Both methods will be adopted until such time as the Gemini *SeaTec* software can be shown to reliably detect and classify all targets of interest.

Manual data processing of Gemini files requires a trained human observer to view the data files and search for moving objects (targets) that could be marine animals. Data recorded for each target detected will include the time at which it becomes visible and then no longer visible, the corresponding x and y coordinates, and any observations of unusual appearance or behavior. All targets will be counted, measured (sized) using the click-and-drag measurement tool available in the Gemini *SeaTec* software, and assigned size-class categories: < 0.5 m, 0.5 to 1.0 m, and > 1.0 m. If a target appears to be an aggregation of smaller objects (*e.g.*, a school of fish), it will be recorded as such and the longest dimension measured. Observer precision will be tested by re-processing a subset of samples previously examined.

Manual target detection by a human observer is extremely time consuming, and a single 5-minute span of data can take a human observer 15-40 minutes to process, depending on the number of targets present and other variables. For the 2018 deployment, subsamples will include viewing and processing of sub-samples (5-minute data files) at 2-hour intervals over a 24-hr day, every two to three days for the first 4-6 months (N~36 files per week). Thereafter, automated detection, classification and tracking of fish with the *SeaTec* software should be sufficiently developed to reduce the number of manually processed data files to weekly assessments. Before any changes are made to the methodology CSTV will review and discuss with regulators to ensure that they are satisfied that the software has been sufficiently developed to reduce the number of manually processed data files. At this time, a new subsampling methodology will be proposed. Any changes will be reviewed and approved by DFO and NSE prior to implementation. A description of any changes will be discussed in the following relevant quarterly or annual report.

It is important to note also, that throughout the deployment, a certain amount of manual processing will be necessary to validate the results of the automated system, to quantify its error rate relative to a human observer, and to ensure its continued functionality over time. In addition, any extreme or unusual data generated by the automated detection and classification software will also be manually checked.

Current speed data from co-located ADCPs mounted on the turbine structure and /or a hydrodynamic model of the FORCE site will be used to classify each target as occurring during flood, ebb, or slack tide and for assessing the movement direction of targets relative to the flow. Other data of importance in the interpretation of the data includes turbine operating state, water temperature (from onboard sensors) and time of day, noting that fish behaviour is known to exhibit both diel and seasonal patterns, in addition to tidal patterns.

Temporal patterns (*e.g.* tidal, diel, and seasonal) in the presence and movements of marine life, especially fish that come within close proximity to the sonar will be analyzed. Data analyses and reporting will include:

- assessment of trends in marine life abundance within the sampled volume, over short and long-time scales and with respect to tidal stage and current speed;

- characterization of marine life movement with respect to current direction and position relative to the turbine;
- identification and assessment of fish schools vs. individuals; and
- results from the supplemental data collected for fall migration.

6.2 Marine Mammal Monitoring Program

6.2.1 Scope

Gathering data on the movements of harbour porpoise (and other marine mammals) in the near-field environment of the turbine is important to improve understanding of year-round presence and spatial distribution. This information will be helpful for meeting future monitoring objectives related to how harbour porpoise might interact with an in-stream turbine which can be useful for the future development of strike risk models and project and site planning.

The Minas Channel, Minas Passage, and Minas Basin are generally shallow areas and few whales are observed (AECOM 2009, Jacques Whitford 2008). The harbour porpoise (*Phocoena phocoena*) is the only marine mammal species regularly observed in the Minas Passage so, marine mammal monitoring will focus on this species (although other species may also be detected).

A detailed description of the methodology for marine mammal monitoring is provided in Section 6.2.3. Details on the supplemental program using the FAST-EMS platform are provided in Section 7.

6.2.2 Objectives

The objectives of the marine mammal monitoring program are to:

1. Validate the capabilities of the icListen high frequency hydrophones in the Minas Passage.
2. Collect acoustic data to detect the presence of harbour porpoises in the vicinity of the turbine over the duration of the Project.
3. Use the acoustic data to better understand presence/absence of harbour porpoises in the Minas Passage in relation to environmental variables (diurnal, tidal, seasonal cycles).

The results of these objectives will increase understanding of the usage of the Minas Passage by marine mammals which, in the future could be used to explore potential avoidance behaviours around in-stream devices.

6.2.3 Methodology

Technology

Occurrence of harbour porpoise in the Minas Passage appears to be related to feeding behaviour (AECOM 2009). During feeding, harbour porpoises vocalize to locate potential food sources. This vocalization can be picked up by passive acoustic devices that act as microphones and are able to record and process sounds within the marine environment.

The marine mammal monitoring will be achieved through Passive Acoustic Monitoring (PAM) using four icListen high frequency hydrophones mounted on the turbine structure in the following locations:

- One device mounted on the top of the rotor;
- Two devices mounted on the subsea base on either side of the rotor; and
- One device mounted on the apex of the subsea device (positioned on the side facing the flood flow).

The icListen high frequency hydrophone is a suitable instrument for detecting vocalizing marine mammals because of the broadband response, low self-noise and wide dynamic range allowing for high signal quality and long-term stability sensitivity of the instrument. The hydrophone can record the lower frequencies of baleen whales (10-1000 Hz) as well as the upper frequencies of echolocation clicks of harbour porpoise (120-140 kHz) at the same time. The hydrophone can stream and record the information at the shore station allowing for remote access and processing and can record data internally, for backup in case of telemetry faults.

The icListen hydrophone was chosen as the best device for this study due to the successes that this device has had on other similar passive acoustic monitoring systems and that stream and process data at tidal sites, as well as in the Minas Passage:

- Ocean Networks Canada has been using the icListen hydrophones since 2011 throughout the West Coast near and off shore at a variety of locations for underwater acoustic observations including marine mammal monitoring. The data is streamed to shore and recorded from hydrophone arrays in depths over 2000 meters. Multiple classification algorithms have been successfully tested on this recorded data.
- Several icListen hydrophone arrays have been deployed in the Salish Sea to develop The Whale Tracking Network, over the past three years, to detect critically endangered Southern Resident Killer Whales. The hydrophones have been successful in the primary trials in recording many detections of this species throughout the region.
- The SNOPUD project at U of Washington on the US west coast used the icListen for monitoring for sea life, and machinery health. The same team is working in Hawaii with wave energy converters.
- The icListen hydrophones have been used in the Minas Passage for multiple drifting buoy systems. The drifting operations recorded data and used porpoise click detectors on the data. Using a drifting array of two, synchronized icListen hydrophones and porpoise click detectors to determine porpoise arrival times, the study was able to determine the depth distribution of porpoise in the water column. *Coda* (the click detector) was used to detect harbour porpoise clicks in the data and was able to correlate the detections to visual detection data during the drifts.
- The LoVe (Lofoten-Vesterålen hydrophone array has been deployed in Norway for the past four years to study human effects on wildlife in this critical area.

Along with the Gemini, the hydrophones have also undergone a number of commissioning and capability tests prior to the 2018 deployment. Commissioning tests have taken place on the turbine and in the FORCE test site on the FAST-EMS and have focused on testing the functioning of the devices and the ability to function with the Gemini. Data transfer and analysis procedures and protocol have also been improved.

Data Collection

All four hydrophones will be synchronized and are connected to the turbine export cable so that data can be collected and transmitted on a continuous basis. Each of the hydrophones will sample both waveform datasets (WAV) and processed spectral Fast Fourier Transform datasets (FFT). The sampling rate will be 512 kS/s (200 kHz); this rate can be adjusted remotely if required. The data is transferred to the onshore substation at FORCE and then transferred to a server that is accessible for researchers.

It is important to note that Harbour porpoise detection ranges can be within 300 meters of the hydrophones in a slack tide environment but during peak tidal activity the range will be less due to the background noise associated with the tidal flow. Tidal flow noise will therefore have a negative impact on detections of low frequency vocalizations (*i.e.*, baleen whales) as increased tidal noise will decrease detections.

The data stream will be uploaded on a daily basis and accessible to researchers. The researchers will provide a weekly report on data transmission and quality for duration of the project. This continuous process will ensure that the monitoring results are reported on in a timely manner. The frequency of data transfer and quality review by researchers will also provide quality assurance by allowing early detection of any problems with the monitoring device or data transmission and, if any significant issue is detected, initiation of the CSTV EEMP 2018 Contingency Plan (refer to Section 10.0).

Data will be collected continuously beginning with the connection of the subsea cable following deployment of the turbine.

Data Processing and Analysis

Once onshore, the data will be accessed by researchers. The data will be processed using harbour porpoise click detectors on *Lucy* and *Coda* to determine when harbour porpoises were detected in the Minas Passage. Visual inspection, screenshots of spectral data and third octave processing will also be performed. Further details on data management, specific to the hydrophones, is provided in Section 8.0 and in the CSTV Sensor Data Management Plan 2018, provided in Appendix B.

The output of the processes depicted in the flow diagram (Appendix B) will be reviewed and further analyzed for weekly, quarterly and final reports. All raw data will be processed by *Coda* and the low frequency WAV file extractor.

The WAV data is the raw data sampled by the hydrophone in the time series domain. This data is needed to replay the audio part of the recording. FFT is an algorithm that samples a signal over a period of time and divides it into frequency components. This method is used by the hydrophone during initial processing to convert waveform data (time domain) to frequency data (spectrum). The FFT data is a more compact representation of the acoustic soundscape. The hydrophones will store the FFT data in their internal memory.

The substation will store both WAV and FFT datasets with the use of *Lucy*, a PC program that allows researchers to view and interact with acoustic data collected by the hydrophones. *Lucy* is capable of streaming and recording accurate real-time acoustic measurements. The program includes a porpoise click detector that uses intensity to indicate a porpoise click in the data, amongst other user configurable event triggering.

After the automatic processing on the raw data is completed, further data analysis will be done by manual examination of the processed data. The manual examination will include:

1. A review of the processed data to verify automatic processing was performed on the raw data. This is to verify quality is maintained for processed data.
2. Verification of the results from the automatic processing on subsets of the data.
    a. List of Detections and WAV files with Detections – Harbour Porpoise Click Detection: Using the resulting files from *Coda*, a manual search for true positive, false positive and false negative detections will be performed on subsets of the data for each hydrophone.
    b. Low Frequency WAV Files- Low Frequency Event Detection: A manual review of the low frequency WAV files will be done in *Lucy* to search for the presence of vessels and other low frequency events (*e.g.* marine life). The analysis will search for low frequency events such as baleen whales. Signal to noise ratio at the hydrophone will be a factor in detecting low frequency signals. The call signal must be louder than the surrounding noise in the area, so the call can be detected and not masked. As noted above an increase in tidal flow noise will have a negative impact on detecting low frequency events.
    c. Full Bandwidth FFT Data - 7 Day Soundscape Review: *Lucy* will be used to review seven days of spectral data, providing a spectral soundscape overview of the week for each hydrophone. This analysis will provide information on what is seen in the spectral overview of the week, including tidal changes and ship passes.

The data will also be run using the software program *Coda;* this is a click detector software used to locate porpoise clicks in the data and to use matches to identify porpoise click trains. A porpoise click train is series of clicks, described by the time between clicks, the inter-click interval (ICI). The click detectors used a minimum of 3 clicks and an ICI of 0.2 seconds to define a click train. The click train will be used to minimize false positive detections by eliminating single clicks from other sources. Although the *PAMGuard* software is an industry standard for this type of data analysis, lessons learned from the previous deployment in the Minas Passage indicated that the high tidal flow noise and Gemini sonar signals caused many false positive and false negatives, with few true positive detections. *Coda* performed better in the high noise environment, so has been chosen as the preferred program for assessing porpoise presence.

The final data processing step will involve a third octave analysis to provide additional information on soundscape data: flood (loud); and slack (quiet) tides. The third octave analysis is performed to achieve an acoustic overview of the soundscapes around the hydrophones during peak tidal flow, slack tide, and other acoustically significant events such as vessel noise. This is done through as a sound power distribution which splits the power spectrum into adjacent one-third octave frequency bands and presents the acoustic data in a logarithmic frequency scale on the x-axis and sound pressure level on the y-axis of a graph. The third octave analysis is useful because it can be used to understand the broadband sound pressure level and demonstrate frequency dependent propagation characteristics of an environment, over time.

In the event that other vocalizing marine mammals are detected, these events will be reported.

6.3 Turbine Sound Monitoring Program

6.3.1 Scope

Acoustic measurement of tidal turbine operational sound is an important component of understanding the potential effects of turbine operation sound on marine life by understanding the frequency of sound produced and how it changes with the different states of operation and tidal flow. Characterization of operational sound, how it changes with flow speed and how levels compare to the levels of natural noise created in these high energy environments, will allow CSTV to evaluate the potential level of risk to marine life. The results will provide the basis by which future in-stream tidal energy projects can evaluate cumulative effects of turbine sound on the environment.

A detailed description of the methodology for turbine sound monitoring is provided in Section 6.3.3.

6.3.2 Objective

The objectives for monitoring turbine sound are to:

1. Validate the capabilities of the Autonomous Multichannel Acoustic Recorder (AMAR) hydrophones in the Minas Passage.
2. Collect sound data in the vicinity of the turbine over the duration of the Project including a period prior to turbine deployment in order to obtain comparative background sound levels.
3. Characterize operational sound of the turbine, and understand how operational sound changes with turbine operating state and tidal flow speeds.

6.3.3 Methodology:

Technology

To measure sound pressure levels (SPL), a bottom-mounted Autonomous Multichannel Acoustic Recorder (AMAR, JASCO Applied Sciences) will be used. The high flow mooring device was designed by JASCO and the University of New Brunswick. JASCO employs the AMAR recorders for precision acoustic measurements of all kinds and this high-flow mooring has been especially designed for Minas Passage measurements and has been demonstrated to be an effective tool for low-noise measurements in this environment.

The AMAR will be housed in a high-flow mooring device and will be fitted with an M36-V35-100 hydrophone (GeoSpectrum Technologies Inc.), with a nominal sensitivity of −165 dB re 1 V/µPa. The hydrophone will be located near the front, or 'bow' of the high flow mooring.

The device will be deployed approximately 100 m to the side of the planned turbine location with a ground line and clump weight to allow for retrieval. The unit will also have surface floats to assist retrieval.

Data Collection

Each AMAR will be calibrated before deployment and upon retrieval with a pistonphone type 42AC precision sound source (G.R.A.S. Sound & Vibration A/S). The pistonphone calibrator produces a constant tone at 250 Hz at a fixed distance from the hydrophone sensor in an airtight space with known volume. The recorded level of the reference tone on the AMAR yields the system gain for the AMAR and hydrophone. To determine absolute sound pressure levels, this gain is applied during data analysis. Typical calibration variance using this method is less than 0.7 dB absolute pressure.

The device will be deployed approximately 100 m from the turbine on the inner bay side, in line with the centre of the turbine. The proposed coordinates for the location are:

- Latitude: 45.363491
- Longitude: -64.421138

Although both channels will collect data, only the Channel 1 location will be measured – the 2016-17 measurements showed that the data collected on the two channels was virtually identical, and therefore analyzing the data on the second channel is not required. The proposed duty cycle is provided in Table 3 with rationale for the sampling rates. Using this type of duty cycle will allow the AMAR to record for 120 days thereby allowing CSTV to record baseline (ambient) sound and turbine operational sound.

Table 3. Proposed Duty Cycle and Sampling Rate Rationale for Monitoring of Turbine Operational Sound

Sampling Rate	Rationale
64 kHz for 300 seconds	During the 2016/2017 deployment, a 32 kHz sampling rate was used. Using a sampling rate of 64 kHz will allow JASCO to check if the turbine emits any sounds above 10 kHz that have might have been missed during the first deployment.
375 kHz for 60 seconds	This sampling rate is intended for porpoise detection and will supplement the data collected by the icListen hydrophones (refer to Section 6.2).
Sleep for 300 seconds	The sleep period of 300 seconds allows the recorder to preserve memory and battery to last for the full 120 day period.

It is intended that the AMAR will be deployed in late June 2018 and retrieved late September 2018. This will allow for a period of data collection prior to turbine deployment (late July) to inform background sound levels.

Data Processing and Analysis

The data analysis will determine the frequency band affected by flow noise, the frequency band of the sounds emitted by the Open-Center turbine, and will then compare how these bands changed with turbine operating state, current speeds, and measurement technique (drifters vs turbine mounted hydrophones vs autonomous bottom mounted hydrophones).

The acoustic metrics for these analyses are the 1-minute broadband SPL, pressure spectral density and decidecade SPL. The decidecade SPLs will be weighted to provide the high-frequency cetacean and herring-auditory-filter weighted sound pressure levels. The one-minute statistics match the time resolution of the current speed and turbine state data set. One-minute averaging also smooths the random effects of turbulence and sediment movement sounds.

The analysis results will be used to train models that provide the source level of the turbine as it changes with frequency, operating state, and current speed. Generalized Additive Models will be used for the source levels modeling, along with simplified acoustic propagation models.

7.0 EEMP Supplemental Program

CSTV will be implementing a supplemental monitoring program which will involve the deployment of a sensor platform to collect additional environmental data, at specified times, to supplement the data from the monitoring devices on the turbine structure. The proposed setup of the FAST-EMS platform will provide redundancy of the sensors installed on the turbine (two hydrophones and a Gemini sonar).

The FAST-EMS platform is an open triangular, stainless-steel, square tube frame with a low profile and sloped sides housing a suite of passive and active devices. Monitoring devices are fastened to mounting brackets and are placed at selected locations within the frame. The frame is weighted with lead and zinc ballast and the legs are designed to provide grip on the seabed against the current flow. The FAST-EMS platform will be cabled so data transfer can occur continuously. All data will be transferred from the test platform to the FORCE Visitor Center where is will be uploaded to a platform for access by researchers.

The sensor suite will include:

- a Tritech Gemini 720is sonar, mounted on a Kongsberg Dual-axis Pan & Tilt device, that can be remotely adjusted from shore;
- two Ocean Sonics icListen high frequency hydrophones;
- a Nortek 400 kHz AWAC Acoustic Doppler Current Profiler (ADCP)
- a Sculpin HDC – SubC high-definition imaging camera;
- an EMO (McCartney) Multiplexer and Termination Can. (MUX/Term-can.); and.

The MUX / Term-can combo are connected to shore via a double armoured power and data cable with both fiberoptic and copper conductors. The cable connects to a termination box on the beach with a permanent hook-up to the FORCE Visitor Center where the FAST-EMS platform can be operated in real-time.

The first installation of the FAST-EMS platform will take place within two months of turbine deployment after other instruments, in the vicinity of the turbine, have been removed. These additional instruments include three bottom-mounted ADCP's and an AMAR located in close proximity to the turbine which will remain for approximately two months after turbine deployment. Since the proposed location for the FAST-EMS platform (refer to Section 7) is very close to proposed position of one of the ADCP's there is a high risk of losing both instruments through entanglement if both are in position at the same time.

Thereafter, the FAST-EMS platform will be deployed twice a year for the duration of two months each time corresponding to peak fish migration as follows:

- Spring Migration: April 1 – June 1; and
- Fall Migration: September 1 – November 1.

7.1 Location

The FAST-EMS platform will be deployed by the *Nova Endeavor*. Marine operations have taken place in Q2 2018 and established through a number of deployments of the unit.

The proposed location of the FAST-EMS platform will be a position approximately 30 m from the turbine centre and located just off the axis of the face of the generator so that the Gemini sonar is facing across (almost perpendicular to) the face of the rotor (Figure 2).

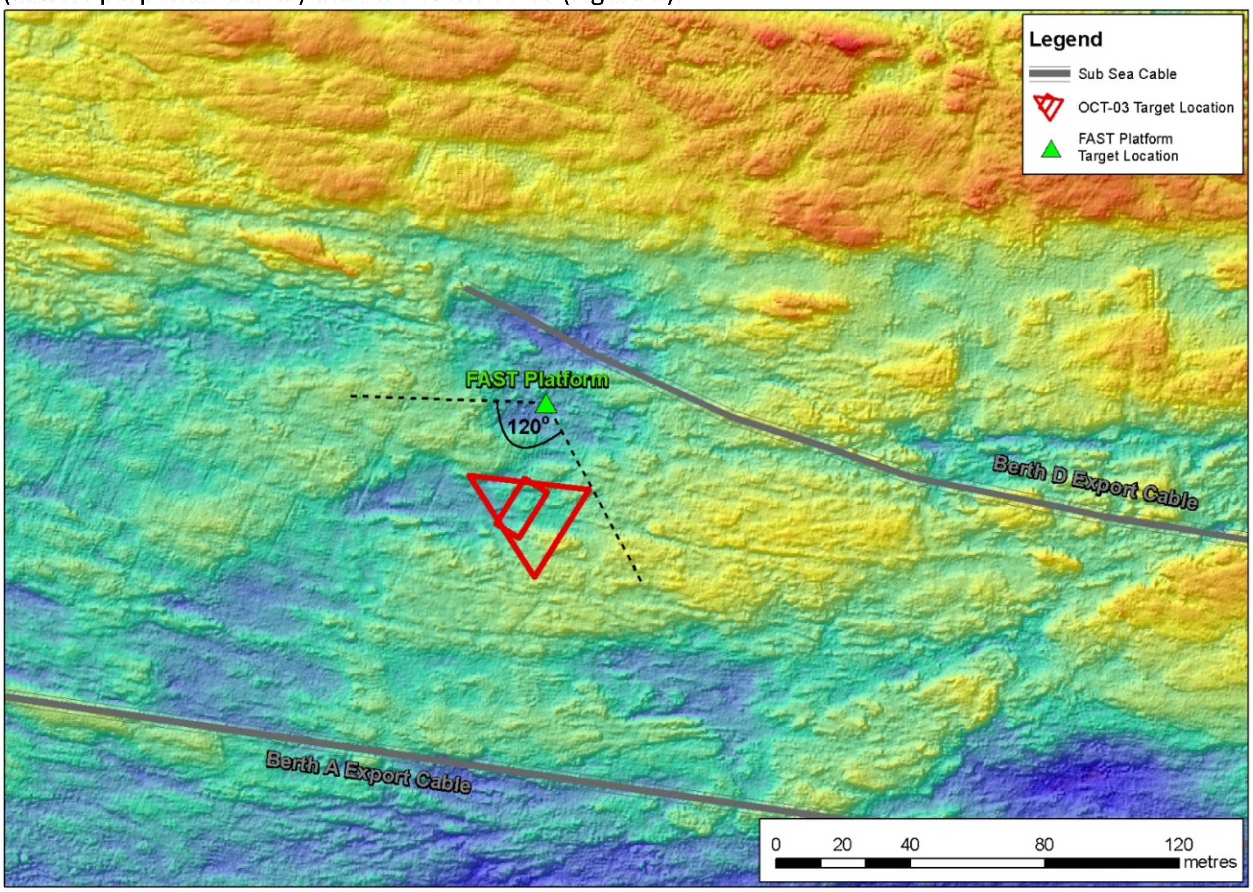


Figure 2. FAST-EMS Platform Location and Viewing Angle

When collecting supplementary data, this position can be used to analyze the tracks of marine life when passing the turbine mounted Gemini sonar, heading towards the turbine. This will provide additional useful data in the vicinity of the turbine to inform the fish and marine mammal objectives.

7.2 Testing and Commissioning

Detailed testing and commissioning was completed for the FAST-EMS platform to ensure that all instruments operated correctly and that the marine operation to deploy the platform complete with cable to shore is well practised. The test and commissioning schedule is summarized in Table 4. A detailed CSTV Environmental Sensor Testing and Commissioning Schedule is provided in Appendix C.

The tests of the FAST-EMS platform have confirmed the correct operation of the sonar, ADCP and pan and tilt device. For the intertidal tests, the sonar was left on the beach near the low water mark. Operation of the devices on the platform was confirmed when the platform was submerged under the high tide with just the Gemini and then again at a water depth similar to Berth D at a location between Black Rock and the shore.

Table 4. Summary of CSTV FAST-EMS Testing and Commissioning

FAST-EMS Platform Sensor Testing	Scheduled Date (dd/mm/yr)
Intertidal test No 1 (sonar and pivot)	11/07/17
Intertidal test No 2 (sonar and pivot)	23/03/18
Deep water test No 1 (sonar and pivot)	24/05/18
Intertidal test No 3 (sonar, pivot and hydrophones)	27/06/18
Intertidal test No 4 (sonar, pivot and hydrophones)	20/07/18
Deep water test No 2 (sonar, pivot and hydrophones)	01/09/18

Following completion of the first deep water test, two icListen hydrophones were added to the platform and the operation of all components were tested onshore before deployment in the intertidal zone for wet tests. The final commissioning test will involve deployment at the turbine site after the turbine is deployed.

7.3 Development of Sonar Data Processing with Data from FAST-EMS Platform Test Deployment

The deep-water test scheduled was initiated on May 26 2018 with the deployment of the FAST-EMS platform at the test location between Black Rock Island and the shoreline. This location will allow for additional validation of marine operation and testing of the Gemini sonar over a minimum period 5 days. The test location was chosen to test the marine operation for deploying the platform with a cable and is expected to have similar presence of fish to that at the turbine site.

In addition to testing of the device, the sonar data collected from the Gemini was used to refine development of parameters specific to the Minas Passage conditions for the marine life detection algorithms. At this stage it is only intended to ensure that the software performs well in the detection and counting of targets. This will ensure that this aspect will perform as expected when the turbine is deployed. If the data is suitable and validation is successful, the algorithm can be applied to the sonar data from future FAST-EMS platform deployments as well as data from the turbine sensors.

All data will be transferred from the FAST-EMS platform to the FORCE Visitor Center via a data cable.

The schedule for activities associated with this is as follows:

- 26th to 1st June — Data collection FORCE-EMS, daily upload from FORCE's visitor's centre
- 7th June to 4th July — Manual review of test data
  Refine algorithm and application to test data
- 5th July to 22nd July — Analysis, reporting, review and issue solving

A description of the full scope of the FAST-EMS program is provided with the CSTV Environmental Sensor Testing and Commissioning Schedule in Appendix C. Subject to receiving good data from the test deployment and verification of the operation of the automated detection and target counting algorithm, this can be put in place to reduce data volumes from the start of the turbine deployment.

8.0 Sensor Data Management Plan 2018

The CSTV Sensor Data Management Plan 2018 has been developed to address the need for reducing the volume of data received from the monitoring devices due to the extremely large amount of data generated from the sensors, while still retaining an appropriate level of detail and ensuring that all relevant data is recorded and analyzed. The CSTV Sensor Data Management Plan 2018 is informed by discussions with the sensor equipment providers and data analysts and is complimentary to the device commissioning and testing.

The data relates to one Gemini sonar and four icListen high frequency hydrophones mounted on the turbine plus a Gemini sonar and two icListen high frequency hydrophones mounted on the independent cabled platform known as the FAST-EMS platform.

The CSTV Sensor Data Management Plan 2018 is provided in Appendix B.

9.0 Reporting

The reporting scope is meant to be intensive and will include a combination of interim reports, quarterly reports and an Annual Report. Details on content and delivery times are provided in the sections below. The timing of report delivery for quarterly and annual reports is also included in the CSTV 2018 EEMP Schedule (Appendix A).

9.1 Interim Reports

Interim reports will include the following:

- Weekly Interim Reports for the first month of deployment; and
- Monthly Interim Reports for the first quarter of deployment.

The Weekly and Monthly Interim Reports will act as quality assurance and will provide:

- confirmation of device operation;
- confirmation that data has been received as expected;
- an update on interference testing and how the results are planning to be integrated;
- any issues or concerns, suggested corrective measures and any effect to the Project program; and
- for the Monthly Reporting, a summary of the month and any early thoughts or interpretation that can be drawn from the results analysis.

The Weekly Interim reports will be submitted to CSTV at the end of each week from researchers. CSTV will submit the reports to regulators on the following Monday for the first month of the Project. Following that CSTV will continue to receive weekly reports and will file the documents. Upon request, these reports can be provided to regulators at any time. The Monthly Interim Reports will be submitted to CSTV on the last day of each month. CSTV will provide these monthly reports to regulators during the first week of the following month for the duration of the Project.

9.2 Quarterly Reports

CSTV will submit three quarterly reports (Q1, Q2, and Q3). These reports will be submitted on the following dates:

- April 1st;
- July 1st; and
- October 1st.

Quarterly Reports will provide the same content as the Interim Reports as well as an operational summary for the turbine and any preliminary data analysis. The Q3 report will also contain the preliminary data results from the supplemental data collected during spring migration. These results and the results from the supplemental data collected for fall migration will be reported on in the Annual Report.

9.3 Annual Report

An Annual Report will take the place of the Q4 report and will be submitted on January 1st. The Annual Report will provide a final data results and analysis for all environmental data collected, including supplemental data, and will discuss the monitoring results as an integrated approach with FORCE data. All research reports will be provided as appendices to the Annual Report.

10.0 Contingency Planning

Contingency planning is necessary to address specific conditions that may occur during the operation of the Project that might lead to a temporary halt of environmental monitoring done by the sensors mounted on the turbine, or a disruption that affects the objectives of the EEMP. An essential element of contingency planning is the preparation of processes and plans that can be activated if these events occur.

The following unexpected events require contingency planning and are discussed further in the following subsections:

- Damage or loss of environmental monitoring devices;
- Gaps (longer than one week) in the collection of monitoring data that are caused by activities related to deployment and/or retrieval operations; and
- Other unexpected events that lead to a disruption in the collection of monitoring data.

Although unexpected problems are not anticipated to occur during operation, CSTV will be prepared to respond to ensure that environmental monitoring can continue in a way that is measurable to the original EEMP objectives at the site, and that will comply with *Fisheries Act* and *SARA*, while the turbine is in place (*i.e.*, that EEMP objectives are met).

The FAST-EMS platform planned for the EEMP Supplemental Program (refer to Section 7) will serve as the primary contingency mechanism in case of any issue with operation or data from the environmental sensors on the turbine. If required, the FAST-EMS platform can be deployed within two weeks of instruction, if it is not already in place as part of the supplementary data collection program.

The proposed location of the FAST-EMS platform will be the same for contingency data collection as for supplementary data collection (refer to Figure 2). The platform will be deployed 30 m from the centre of the turbine with a view across the generator and the area in front of the generator. Data will be collected using identical devices as used on the turbine (*i.e.*, two icListen high frequency hydrophones and a Gemini sonar). Although this is a different configuration to the Gemini that is mounted on the turbine (*i.e.*, horizontal on the FAST-EMS versus parallel to the current on the turbine structure), testing of the FAST-EMS platform prior to deployment will allow for an opportunity for the automated tracking accuracy to be tested for both orientations (refer to Section 7.2). Researchers believe that the proposed location will allow compliance with the objectives of the EEMP.

An MOU is under development and will be in place for this component to define the responsibilities of FORCE and CSTV (OpenHydro).

Further details are provided in the CSTV EEMP 2018 Contingency Plan, provided in Appendix D.

11.0 References

AECOM. 2009. Environmental Assessment Registration Document – Fundy Tidal Energy Demonstration Project. Volume I: Environmental Assessment. June 10, 2009. 247 pp.

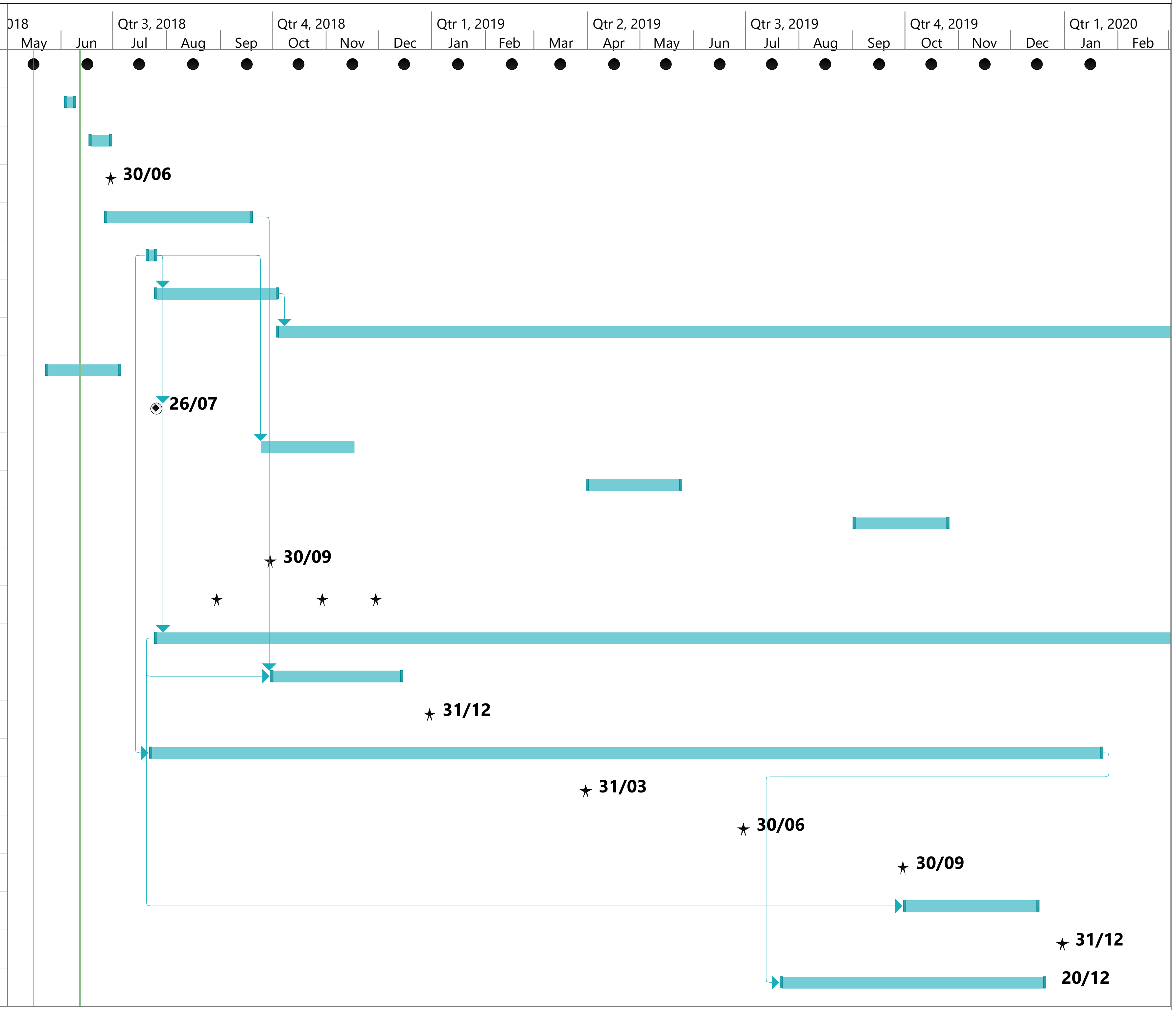
Jacques Whitford. 2008. Background Report for the Fundy Tidal Energy Strategic Environmental Assessment. Completed for Offshore Energy Environmental Research Association. 291 pp.

Appendix A
CSTV 2018 EEMP Schedule

CSTV Schedule EEMP and Authorisation Duration 2018 and 2019

CAPE SHARP TIDAL
An OpenHydro and Emera Company

ID	Task Name
1	Monthly meetings with DFO/NSE
23	Complete monitoring infrastructure improvements at FORCE
24	Pre-deployment testing
25	EEMP 2018 Q2 update report
26	AMAR deployment and recovery
27	Turbine deployment
28	Refining environmental sensor algorithms
29	Enduring sensor operation
30	FAST-EMS development and testing
31	FAST-EMS ready for contingency deployment
32	FAST-EMS supplementary data collection 2018
33	Spring season FAST-EMS supplementary data collection 2019
34	Autumn season FAST-EMS supplementary data collection 2019
35	EEMP 2018 Q3 update report
36	Initial post-deployment monthly reporting
40	Environmental sensor data analysis
41	2018 end of year report preparation
42	EEMP 2018 Q4/End of year report
43	Authorisation duration
44	EEMP 2019 Q1 update report
45	EEMP 2019 Q2 update report
46	EEMP 2019 Q3 update report
47	2019 end of year report preparation
48	EEMP 2019 Q4/End of year report
49	Provisional date for future authorisation application and consideration



Appendix B
CSTV Sensor Data Management Plan 2018

CAPE SHARP TIDAL

Memo

To	CSTV Project Team
From	Kieran O'Malley
Subject	**CSTV Sensor Data Management Plan 2018**
Date	12th June 2018

This memo sets out the latest draft plan for management of environmental data associated with the Cape Sharp turbine planned for deployment in July 2018. The data relates to one Gemini sonar camera and four icListen hydrophones mounted on the Cape Sharp turbine plus a Gemini sonar camera and two icListen hydrophones mounted on an independent cabled platform known as FAST-EMS. The data saved from each hydrophone recording at maximum resolution is approximately 125 GB per day with a similar quantity transmitted from the sonar camera (the sonar camera on the FAST-EMS platform will transmit more data due to greater number of beams) when recording with maximum detail. Therefore, the total amount of data generated, if all instruments are operating at full resolution, is approximately 1,100 GB per day. This is an enormous amount of data for any system to transmit, analyse and store and the purpose of this report is to set out the plan for reducing the volume of data while retaining an appropriate level of detail and ensuring that all relevant data is recorded and analysed. This plan is informed by discussions with the sensor equipment providers and data analysts and is complimentary to the device commissioning and testing which is reported on separately.

Equipment Improvement

There are two elements to the equipment improvement being put in place. The first is an upgrade to the bandwidth available at FORCE for uploading data. This has been completed and there is now a maximum combined upload/download capacity of 100 Mbps from FORCE substation and visitor centre. Cape Sharp only requires approximately 13 Mbps of this new capacity; more than enough to ensure expedient data transfer.

The second element of infrastructure improvement is the installation of a separate third-party computer (separate to the OpenHydro network) at FORCE substation that will take the data from the sensors and that is also accessible to the equipment providers, analysts and researchers. This will permit remote adjustment of the processing software and direct access to the data for the researchers and technology providers. This new process will allow for much faster data transfer to equipment providers, analysis and researchers and is a significant improvement on the current situation where there is no access to the data at the FORCE substation for any 3rd parties due to security concerns regarding access to the computers that are currently being used.

Data Management

<u>Sonar Camera</u>

New data processing software has been implemented for both sonar and hydrophones which will significantly reduce the volume of data archived and transmitted for analysis without compromising the quality of the data – it will record all events where a potential target is detected.

In the case of the sonar camera, when a marine life target is detected all files containing its path are copied to a permanent location. To ensure that the complete path is captured, and able to be analysed by human experts and/or observers, both the previous and subsequent files are also stored. Gemini 720id data files are approximately 3-5 minutes in length and maximum 307MB (data files from the Gemini 720is will be larger due to greater number of beams), so the extra overhead of storing these files is minimum compared to the benefit.

The Rolling Storage Retention mechanism is enabled through general system set up and does not need any ongoing user intervention. Copying files with marine life to permanent locations is based on the classification algorithms mentioned below. Improvements in the classification algorithms mean that the permanently stored data set contains a more accurate representation of the presence of marine life in the sonar's field of view. The fundamental mechanism is already in place in the SeaTec software and has been tested on numerous commercial installations. Data reduction of 95 % has been achieved in other locations. The existing software requires tuning in order to develop classification algorithms specific to the marine life at the site as described below.

CSTV is gathering approximately 5 days of data in May/June 2018 from a sonar mounted on the FAST-EMS platform in a location representative of the turbine location. During this time all data will be collected and used to develop the automatic detection algorithm for site specific detections and to verify the operation of the algorithm with human observation and comparison.

Processing will be carried out in conjunction with the Acadia Centre for Estuarine Research (researchers) and Tritech (equipment suppliers) to develop and verify the operation of the data reduction algorithm. Data will be analysed using existing automatic SeaTec capabilities and cross referenced with human observations. The reduced data from this testing period set will comprise data from times where:

- there are high numbers of automatic detections
- low numbers of automatic detections
- experts anticipate greater numbers of targets
- least number of targets are expected

This comparison should give confidence in the decisions the automatic system has made. It will validate that the collection of permanent files contains a good representation of any marine life in the sonar's field of view. If the data from the FAST-EMS deployment provides suitable data, the automated detection and tracking software and data reduction will be in place by the time the turbine is deployed. If the data is not suitable, this will be carried out from the start of the turbine deployment. The schedule assumes that it is carried out at the later date as a worst case.

Until the sonar data processing algorithms are fully developed and verified to be operating correctly on the turbine, the full sonar data set will be collected, saved and transmitted daily to the researchers. Once validated, the data will still be transmitted daily to the researchers except that the data volume will be significantly reduced. A weekly quality control report on the data will be provided to CSTV to ensure any issues with data collection or quality will be identified, and attempts made to remedy are done in a timely manner.

The data processing algorithms will be developed either with data from the sonar mounted on the FAST-EMS platform or from the sonar mounted on the turbine as described above.

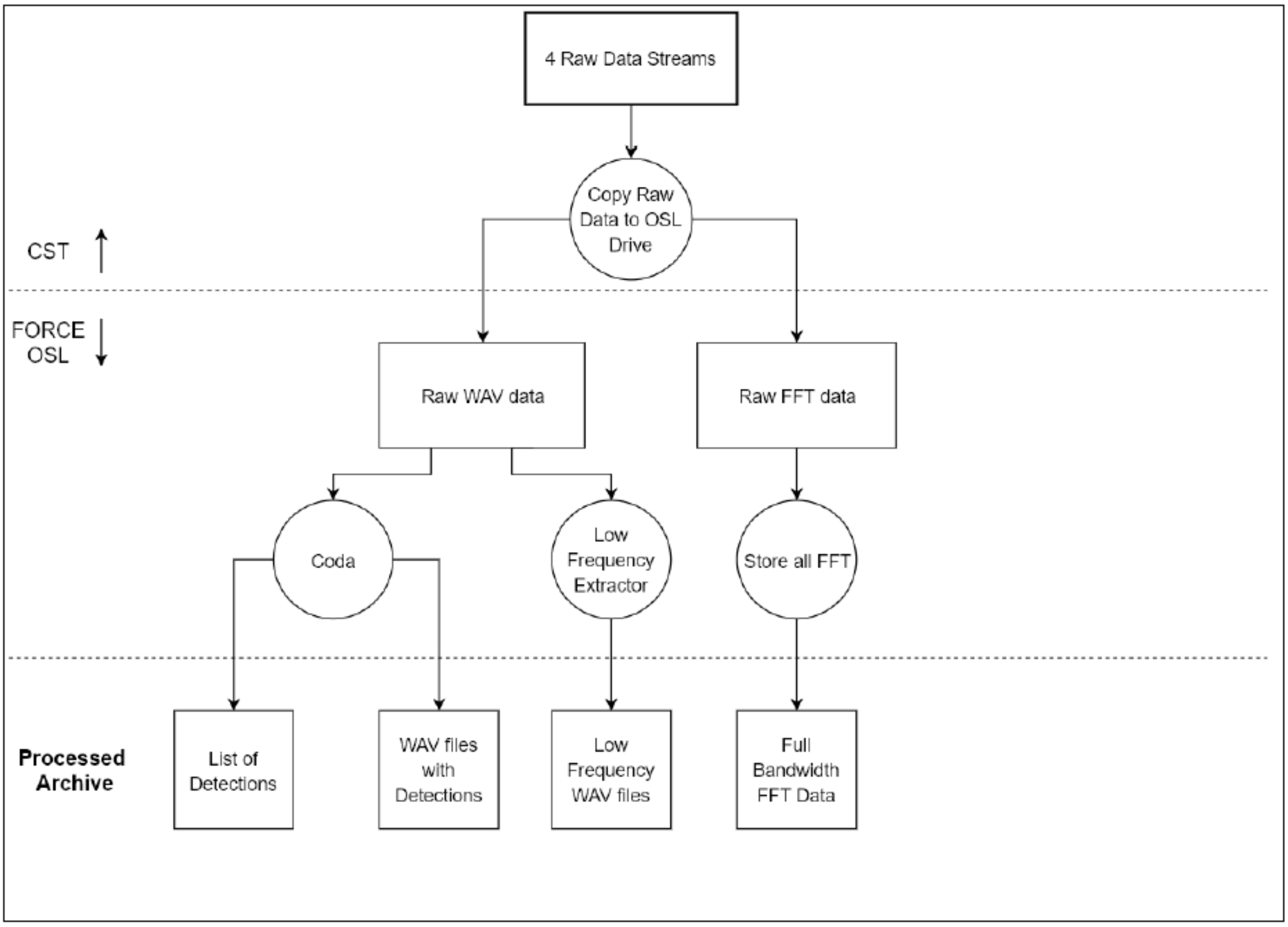
Hydrophones

The volume of data from each of the hydrophones operating at full resolution is similar to that from a sonar camera. As there are four hydrophones mounted on the turbine, the volume of data from the hydrophones is much larger than that from the sonar and it would be challenging, even with the increased bandwidth at the FORCE substation, to transmit all sonar and hydrophone data at full resolution over the internet from the FORCE substation to the FTP site where researchers can access the data.

There are existing data management algorithms already developed for the hydrophone data which will be installed on the 3rd party computer located at the FORCE substation. The four hydrophones will stream the data to the 3rd party computer.

- Full Spectrum FFT will be archived and stored in the hydrophone as well as streamed and recorded at the shore station.
    - Archived output is full spectrum FFT files.
- Full spectrum WAV data will be processed using Coda, the harbour porpoise click detector.
    - Archived output is WAV data with detected clicks.
    - Archive a list of detected clicks with time stamps.
- Extract and store low frequency WAV files from original WAV files, this reduces the quantity of memory required.
    - Archived output is low frequency WAV file.

Data Flow Diagram of Hydrophone Data Processing



The permanent acoustic data archive associated with the processed data will consist of:

1. Full bandwidth processed spectral data (FFT) for all four hydrophones (36 GB/month).
2. Reduced bandwidth low frequency WAV data 4 kS/s for four hydrophones (128 GB/month). This setting may vary over time as turbine noise measuring requirements become better understood.
3. Coda processed data output typically 5 seconds in length (7.7 MB/event).
4. Fish tag event detection output typically 8 seconds in length (12 MB/event).

It is estimated that the average daily volume of data associated with this archive will be approximately 18 GB per day, depending on the number of targets detected. This is well within the bandwidth capacity of the broadband available at the FORCE substation to transmit daily. A weekly quality control report on the data will be provided to CSTV to ensure any issues with data collection or quality will be identified, and attempts made to remedy are done in a timely manner.

Backup Data Collection

The full unprocessed data from all instruments will be saved to hard drives located at the FORCE substation. These will provide backup capacity for approximately 3 weeks of full unprocessed data (based on 10 TB of storage capacity for hydrophone data). This duration can be increased by changing the settings on two hydrophones, for example, which will extend the backup capacity to approximately 6 weeks without compromising the quality of the data to any significant extent. This will ensure that if there is any issue with the data processing or transmission, there is time to get the issue resolved without losing any data. In such a situation, the hard drives will be swapped out before they reach full capacity until the issue is resolved.

Expected Benefits

The proposed solution will provide a number of benefits:

1. Reduction in the volume of data collected and accordingly the data to be analyzed will be focused on relevant 'events'
2. No reduction in the quality of data collected
3. Reduced volume of data combined with increased available bandwidth allows for upload of data direct from FORCE substation
4. Remote access for equipment providers, analysts and researchers to the data coming from the sensors
5. Improved backup facility – the data collected on hard drives is no longer the means of transmitting the information but is a dedicated backup facility allowing for increased capacity and longer fix time if required
6. More efficient and expedient delivery of results from the monitoring equipment.

Appendix C
CSTV FAST-EMS Platform: Sonar Automated Detection Software Testing Scope and Environmental Sensor Testing and Commissioning Schedule

Short-term Sensor Platform (FAST-EMS) Study of Gemini and *SeaTec* Performance

EMS Goal

To verify if the Gemini sonar and *SeaTec* software can reliably detect the presence and abundance of marine life (fish and larger animals) in comparison to a human observer.

Rationale

As manually processing Gemini data files is extremely time consuming, automated *SeaTec* software is required to examine data that is collected continuously over time and must be reliable in comparison with detections by a human observer. This study will seek to verify that the automated detection software for the Gemini (*SeaTec*) can accurately detect marine animals when within view, for a range of field conditions.

Methods

- Pre-turbine deployment of Gemini sonar on FAST-EMS platform:
  - Gemini data collection to be carried out from a cabled FAST-EMS platform deployed north of Black Rock, for 5 days.
  - At the Black Rock site (~20-25 m, noting depth will limit the maximum useable range of the Gemini sonar for this test) and current speeds are up to ~ 2 m/s. At the turbine site, maximum current speeds at turbine hub height reach up to 5 m/s during spring flood tides.
  - Target detection probability and ability to track across multiple pings/frames will be somewhat dependent on direction of target movement relative to the sampled volume. A Gemini sonar aimed parallel to the current, or "with-flow" (facing up or downstream, such as the Gemini positioned on the turbine) may provide different results than one aimed across the current, or "across-flow" (*e.g.* Gemini facing the turbine from the FAST-EMS platform). For this reason, the automated tracking accuracy should be tested for both with- and across-flow orientations, by remotely adjusting the pan and tilt from shore. Orientations should be selected to give good-quality data for testing the *SeaTec* software, *i.e.* without surface or seafloor interference. It is possible that this test site will not be able to provide good-quality with-flow data, and if this is the case, analyses will focus on across-flow data only.

- Data collection:
  - Record Gemini data for 5 days at the Black Rock site. Over this time, a number of fish species are likely to be observed, including Atlantic herring, as they move through the sampled volume (a 120˚x20˚ swathe of water, extending out to 60 m range).
  - The orientations to test (via pan and tilt remote control) are across-flow (perpendicular to shore, facing away from the beach) and with-flow (parallel to shore, in whichever direction provides the cleanest data).
    - Note 1: data collected with-flow may be contaminated by surface or bottom signal, as the Gemini will be oriented across the slope of the shore; if that is the

    - case, all data will be collected across-flow. Training the software is not possible if there is a lot of bottom or surface signal.
    - Note 2: orientation of Gemini may be limited on the platform due to the presence of a roll bar (*i.e.* full 90-degree rotation may not be possible). The limits on Gemini movement will be determined during this test.
  - Record for 24 hours in each orientation, to ensure sampling of both day and night, ebb and flood, under the same orientation conditions. This will provide information on the effect of time of day and tidal stage on target abundance.
  - After 24 hours, switch the Gemini orientation; repeat.
  - Resulting data:
    - 2-3 full days sampling across-flow
    - 2-3 full days sampling with-flow (if possible; if not, result will be 5 full days only of across-flow data)

- Data file processing [Acadia, Tritech]:
  - The human observer (Acadia) will scan through files from each of the datasets and look for periods of time with 0 fish, low fish counts and high fish counts, during periods of low (near slack tide) and peak flow (maximum speed).
  - 5-minute data files are expected to take on average 30 min to view / process (counts) but will be faster/slower depending on the number of fish detected.
  - 10-12 data files will be chosen for processing for each of 2 orientations and for each of 3 abundance categories: 0 fish, low and high fish counts, at both low flow (near slack water) and peak flow. Current speed may affect detection probability, so it is important to compare counts at slower and faster water speeds.
  - Each data file segment will be viewed by the human observer and the number of fish in each file segment recorded. Approximate size of the targets may also be noted, if time allows.
  - The same file times selected for processing by the human observer will be provided to Tritech, and they will return to Acadia the counts the software obtained for each file.
  - The two sets of counts will be compared (Viehman) and the accuracy reported.
  - It would be useful if Tritech processed the full dataset to provide a "full picture". Any extreme or odd fish counts could then be manually checked by the Acadia observer.

- Data Analysis of Counts [Viehman]
  - Manual and automatic counts will be compared for each situation (0 fish, low and high fish density, for low and high flow, in each viewing orientation), and accuracy calculated (*e.g.* percent error)

Example comparison table. A set of 10-12 data files (~5-min each) will be processed for each category below (about 144 files). If more file samples can be processed, we will report % error with a confidence interval, or carry out a linear regression—whichever is more appropriate for the data.

Orientation	Current	Fish density observed	Manual count	Automated count	% Error
Across-stream	Slack	0			
		Low			
		High			
	Peak	0			
		Low			
		High			
With-stream	Slack	0			
		Low			
		High			
	Peak	0			
		Low			
		High			

- Reporting [Viehman, Acadia, Tritech, CSTV]
  - A progress report will be drafted, edited, and circulated to the research team for input prior to finalization
  - The purpose of the report will be to provide an update on the current functional status of the *SeaTec* software capabilities for detecting and classifying fish and provide direction for continued development and testing
  - Report content:
    - Brief background and methods
    - Overview of fish detection algorithm (w/input from Tritech on tracking parameters used)
    - General observations of Gemini performance (w/input from human observer)
    - Counts of fish observed by each method
    - Comparison of software counts to human observer counts (% error; stats if applicable)
    - Conclusions
    - Recommendations for next steps

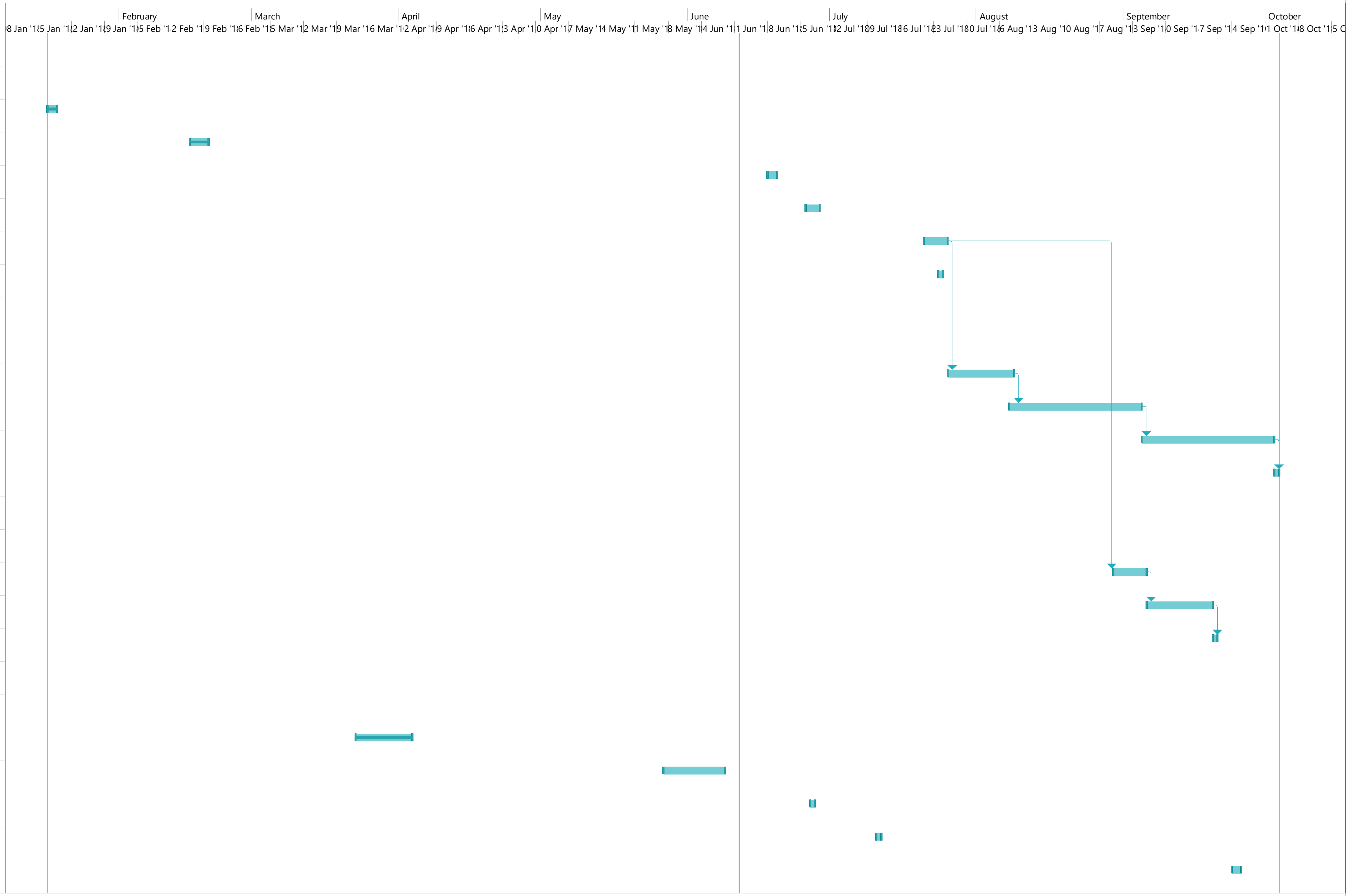
Timeline

- May 2018: Data collection and training
  - Training of two new observers on using the Tritech viewing software and how to consistently identify fish-like targets by eye
- June – July 2018: Data processing of Gemini files collected in May 2018
  - Manual Counts [Acadia]:
    - Identify files of interest [2-3 days]
      - Scan through each dataset and find files with no fish, as well as low/high fish counts
      - Select the series of 5-minute segments for full processing

    - Manually process selected data files [10-14 days]
        - Watch all files and record number of fish in each one
        - ~10 files will be re-counted as a quality check for count consistency
        - Send file times to Tritech for *SeaTec* automatic processing
- Automated Counts [Tritech]:
    - The same files will be processed to allow comparison.
    - If there is time, request that Tritech process the entire dataset to fill in the gaps around the manually processed data. This would allow an examination of temporal and tidal trends, and identification of any spurious detection situations (*e.g.* extremely high counts due to changing environmental factors).
- Data analysis [Viehman]
- Compare the counts from human observer and Tritech, run any stats (depending on sample size)
- Report writing [Viehman, with input from Tritech, Acadia and FORCE)

CSTV Environmental Sensor Testing and Commissioning Schedule

ID	Done	Task Name
1		Turbine Sensor Testing
2		General Testing
3	✓	Bench test
4	✓	IST04
5		IST06
6		IST07
7		Turbine deployment and connection
8		IST08
9		
10		Sonar Processing Refinement
11		Gather test data
12		Detection and tracking algorithm development
13		Detection and tracking algorithm validation
14		Enduring operation
15		
16		Hydrophone Processing Refinement
17		Test with no other acoustic devices
18		Refine and update software
19		Enduring operation
20		
21		FAST-EMS Platform Sensor Testing
22	✓	Intertidal test No 2 (sonar and pivot)
23		Deep water test No 1 (sonar and pivot)
24		intertidal test No 3 (sonar, pivot and hydrophones)
25		intertidal test No 4 (sonar, pivot and hydrophones)
26		Deep water test No 2 (sonar, pivot and hydrophones)



Appendix D
CSTV EEMP 2018 Contingency Plan

Following the retrieval of the turbine on June 15, 2017, Cape Sharp Tidal Venture (CSTV) completed an in-depth root cause analysis of the equipment failures and implemented the necessary mitigations to ensure that the same incidents do not re-occur. However, given the extreme nature of the deployment site, it is possible that equipment failures will occur during the upcoming deployment.

The EEMP contingency plan ensures that the ability of the CSTV Project to detect and monitor fish and marine mammals in the vicinity of the turbine will be maintained in the event of equipment failure on the turbine platform. As a result, the contingency plan will maintain the acquisition of relevant useful high quality data during the turbine deployment. The proposed contingency plan will have the ability to achieve the same goals as the EEMP (turbine mounted equipment). The contingency plan will include the ability to rapidly deploy replacement monitoring instruments including a Gemini sonar and two icListen hydrophones on a stand-alone platform (the FAST-EMS) with a data transmission and power cable connection to shore. Monitoring of turbine sound will be achieved through the deployment of standalone mooring-based hydrophones which will be deployed and retrieved - if there is any issue with the data from this deployment, the unit can be deployed again.

Trigger of the Contingency Plan

The following unexpected events will trigger the implementation of the contingency plan and are described in greater detail below:

- Damage or loss of environmental monitoring devices;
- Gaps (longer than one week) in the collection of monitoring data that are caused by activities related to deployment and/or retrieval operations; and
- Other unexpected events that lead to a disruption in the collection of monitoring data.

Equipment monitoring and the data gathering process (see CSTV Sensor Data Management Plan 2018) from the CSTV turbine-mounted monitoring devices will enable CSTV to identify an interruption in the data stream within a maximum of one week. Following the detection of any such interruption, CSTV will identify the cause of the failure and determine whether it can be remediated within 48 hours. The EEMP contingency program will be implemented immediately if it is determined that the failure cannot be mitigated. The FAST-EMS platform will be mobilised and deployed within 2 weeks of any requirement to deploy (if not already in position as part of supplementary data collection). This will be done in collaboration with regulators and researchers. CSTV will notify regulators immediately upon identification any significant issue with the data stream from the turbine and will agree the proposed course of action with regualtors. In the event of any issue which gives rise to the implementation of the Contingency Plan, CSTV will issue a report detailing the cause of the issue, the efforts to fix the issue and the implementation of the contingency plan within 2 weeks of the contingency plan being implemented for any reason.

Risks

Damage or loss of any environmental monitoring devices

Loss or damage to any of the monitoring devices is possible due to the extreme conditions of the Minas Passage. A number of contingency measures have been incorporated into the monitoring program to address this such as redundancy (more than one device), use of specific materials during manufacturing of the devices, and protective structures to surround devices, where possible.

Contingency during deployment and retrieval operations

Preparatory activities related to turbine retrievals or deployments involve times when a turbine is in place but is disconnected from the electrical supply to the FORCE substation. This may occur if weather conditions do not permit the immediate connection of the subsea cable following deployment or, during retrieval operations, when the subsea cable is disconnected but the turbine is not retrieved immediately. In the event that these situations arise for more than 2 weeks, contingency monitoring will be implemented.

Unexpected events that lead to a disruption in the collection of monitoring data

Once CSTV becomes aware of an unexpected disruption in the collection of monitoring data, this information will be immediately communicated to regulators. CSTV will investigate the cause and determine the appropriate course of action in consultation with regulators, including the deployment of the Contingency Plan. CSTV will implement the necessary measures to ensure that the disruption of the environmental monitoring is minimal.

Program Scope

To maximize the adaptability and flexibility of the program, the contingency plan will involve the deployment of a cabled subsea platform (the FAST-EMS platform) to obtain continuous, long-term, real-time and targeted measurements of turbine-marine life interaction that is measurable to the objectives of the CSTV EEMP. The use of this smaller and more mobile platform will also facilitate deployment and retrieval and will enable CSTV to collect complementary data from different locations around the turbine as necessary. The FAST platform will also allow the program to be adaptive and facilitate the testing and deployment of new, additional or complementary equipment as yet not available.

The contingency program will involve the following aspects:

- FORCE FAST Platform connected to shore
- Monitoring Devices:
  - Gemini Imaging sonar
  - 2 icListen hydrophones
  - ADCP

Timeline

CSTV has secured access to the FAST platform for the duration of the turbine deployment. FORCE will have the platform “deployment ready” at all times, meaning all of the equipment will have been tested and commissioned. Following the decision to implement the Contingency Plan, the FAST platform will be mobilized, quickly re-tested and deployed within two weeks, depending on the weather conditions. Under these circumstances, and taking into account the process described above, the worst-case scenario would result in up to 3 weeks of loss of data (up to 1 week to identify an issue and up to 2 weeks to mobilise and deploy FAST-EMS platform).

Additionally, CSTV is proposing the use of the FAST platform as a supplementary source of data. Under this scenario, the FAST platform would be deployed for periods of approximately 2 months twice a year during ecologically relevant periods of the year (e.g. spring and autumn migration seasons) to collect supplemental data which could help with the assessment of potential interaction of marine fauna with the turbine. This also allows for continuous validation of the FAST-EMS environmental equipment and ensures readiness for contingency requirement. Also, the platform could be already deployed when called upon to provide contingency environmental monitoring, thus eliminating any gap between detecting an issue and implementing the contingency plan.

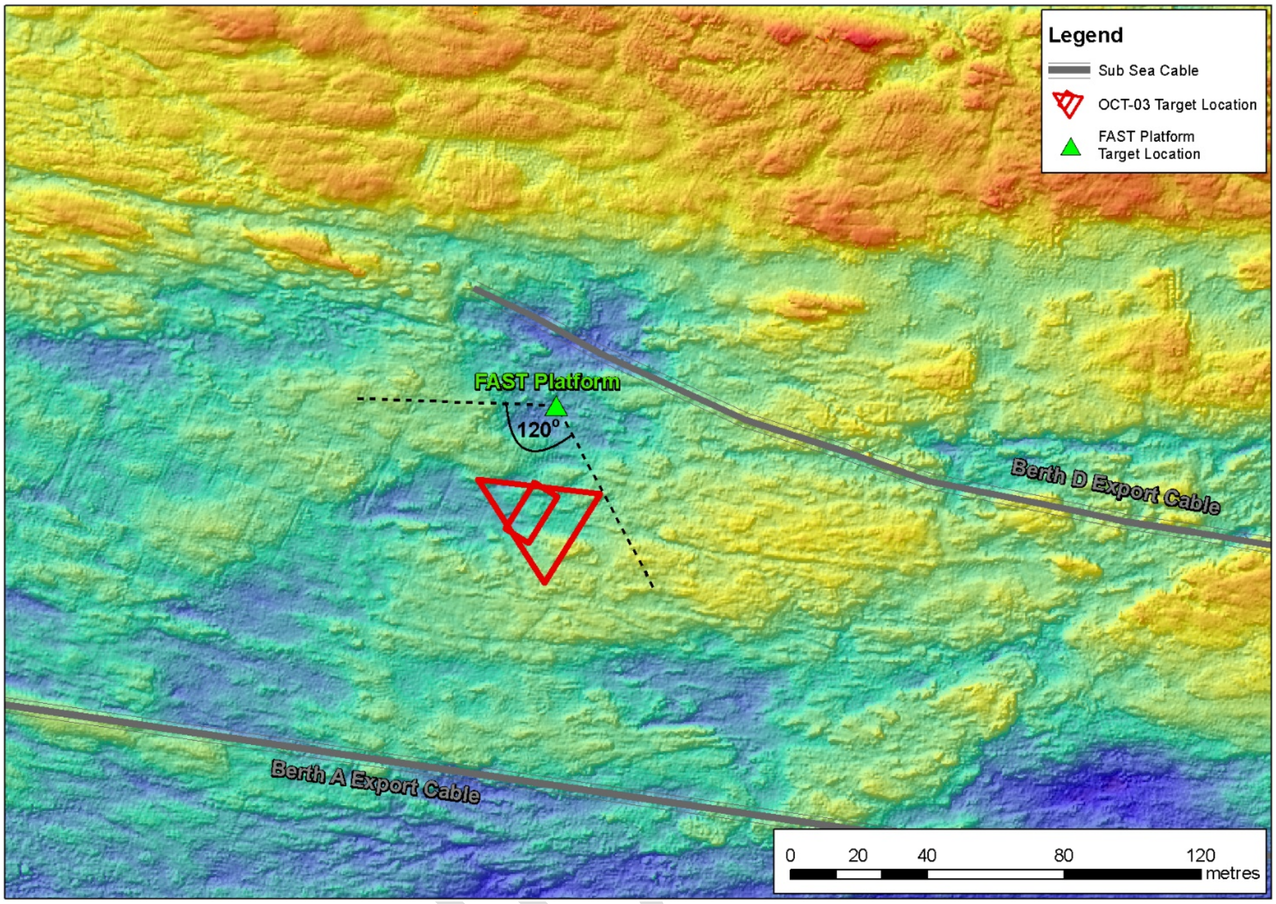
Failure of a piece of equipment on the FAST platform would be identified within one week, and would trigger a recovery of the platform to replace the faulty equipment. Turnaround time for recovery-repair/replacement-redeployment of the FAST platform is anticipated to be in the order of one month depending on the source of the failure and lead times for procuring replacement equipment. Most of the equipment on the platform can be obtained at short notice.

Status of FAST-EMS platform

A testing program has been implemented to ensure that the set-up is successful and operational prior to the 2018 deployment of the turbine. The testing program is provided in the FAST-EMS Platform Overview document.

FAST-EMS platform location

In the case of a contingency deployment of the FAST-EMS platform it is intended to deploy the FAST-EMS platform at a location 30 m from the centre of the turbine with a view across the generator and the area in front of the generator, unless an alternative location is proposed and agreed with DFO and NSE. The illustration below shows the proposed location of the FAST-EMS platform relative to the turbine as well as the viewing angle of the Tritech sonar device. The FAST-EMS platform has a pan and tilt function for the Tritech sonar. The plan viewing angle can be adjusted using the pan function to capture different areas if required. The tilt function will allow changes to be made to the vertical angle of view to capture different areas of the water column, as required.



FAST-EMS Platform Location and Viewing Angle