Appendix F

Description of Marine Pipeline Construction

PIPELINE CONCEPTUAL DESIGN AND CONSTRUCTION METHODOLOGY REPORT

Prepared For

NORTHERN PULP

NOVA SCOTIA CORPORATION

A PAPER EXCELLENCE COMPANY

P.O. Box 549, Station Main

New Glasgow, Nova Scotia B2H 5E8

Prepared By

MAKAI OCEAN ENGINEERING, INC.

PO Box 1206, Kailua, Hawaii 96734

MOE Contract No. 36002

January, 2019

TABLE OF CONTENTS

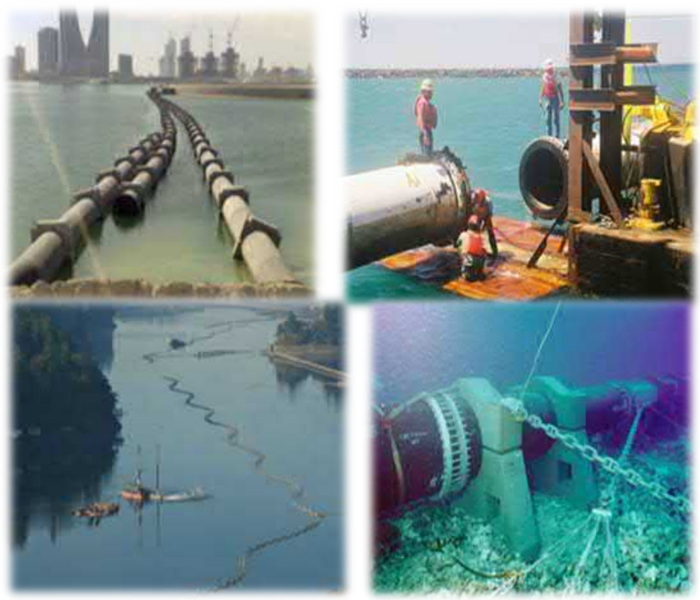
LIST OF FIGURES

INTRODUCTION

PURPOSE OF DOCUMENT

This report describes a preliminary assessment of the construction methodology and routing for the marine portion of the Caribou Harbor outfall system, completed by Makai Ocean Engineering, Inc. (Makai) for Northern Pulp.

The approach presented in this report represents an opinion on possible ways to install the high-density polyethylene (HDPE) pipeline and is based on Makai's extensive past project experience. Makai has designed and been involved in the installation of numerous marine pipeline systems. Throughout the history of our HDPE projects we have provided services ranging from initial feasibility through to construction management and have built up a unique understanding of the complete HDPE process and important lessons learned from 40 years of HDPE pipeline experience; including but not limited to the design and installation of the world's largest deepest HDPE pipelines in Kona, Hawaii; the award-winning Lake Oswego Interceptor Sewer in Oregon; and others (*pictured at right*).



The actual means and methods and construction processes will be the responsibility of the Marine Contractor, and may vary from this approach.

MARINE OUTFALL DESCRIPTION

The marine portion of the outfall system will be constructed from approximately 36" outer diameter (OD) high-density polyethylene (HDPE) pipe. The pipeline will be lightly ballasted with concrete weights, buried along the length of the marine route to the west of the ferry channel, and terminate offshore at a discharge diffuser.

The marine portion of the route starts in the area of the Caribou Ferry Terminal. The diffuser end is located in 20 meters water depth approximately 3.4km northeast from the Ferry Terminal docks; at position 526821W 5067290N (WGS84, UTM Zone 20).

In total, approximately 3.9 km of 36” HDPE pipeline will be laid into a trench and buried. The concrete ballast weights used to sink the pipeline have an estimated dry weight of 1.8 metric tons.

The pipeline will be delivered by standard freight in less than 16.7m (55’) lengths. The pipelines will be stored on-site at the Northern Pulp mill and fused into longer, continuous, sections of approximately 334 meters in length. The pipe weights, made from re-enforced concrete, will be pre-cast off-site and delivered and stored at the same on-site location. The fused pipelines will be pulled into Pictou Harbor. During this process pipe weights will be added onto the pipelines and the pipelines will be fused into longer sections, with lengths possible up to 1km. The fused and ballasted pipelines will be towed to Caribou Harbor and moored until deployment. The pipeline would be towed at several knots, taking 4-8 hours to complete. Alternatively, the pipelines may be towed un-weighted, and pipe weights will be attached via a barge at a Caribou Harbor mooring site. Prior to installation along the outfall route, the seafloor will be dredged to a depth of approximately 3 meters below natural grade. The pipelines will be pulled into position, and controllably submerged into their final position before backfilling and burying.

The remainder of this report presents a more detailed opinion of possible construction means and methods including:

- The onshore staging method and staging sites for the HDPE pipeline and concrete weight materials storage, HDPE pipeline fusion, and initial deployment into Pictou Harbor.
- Pipeline towing from Pictou Harbor to Caribou Harbor.
- Temporary storage of ballasted HDPE pipelines at moorings located in Caribou Harbor.
- Dredging of the pipeline route prior to pipeline installation.
- Fusion of HDPE pipeline segments at the Caribou Harbor mooring, followed by controlled submergence of the pipeline into the pre-dredged alignment.
- Backfill and commissioning of the HDPE outfall system.

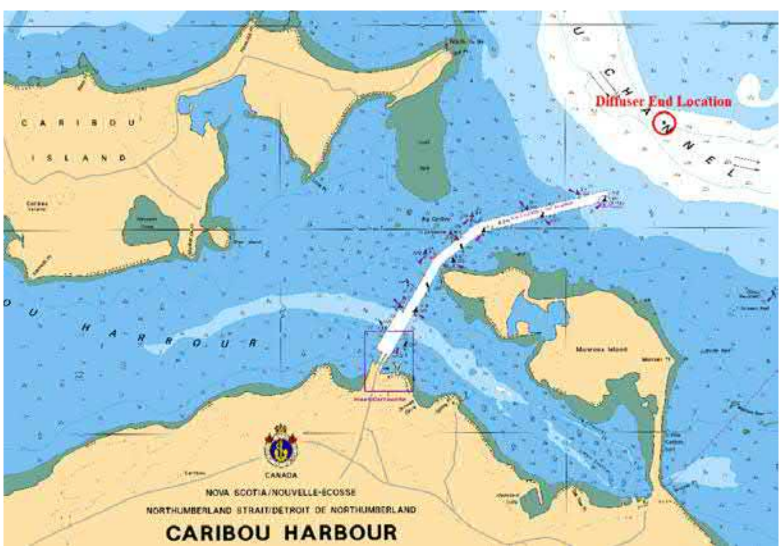


Figure 1. Nautical chart of Caribou Harbor showing proposed location of diffuser end.

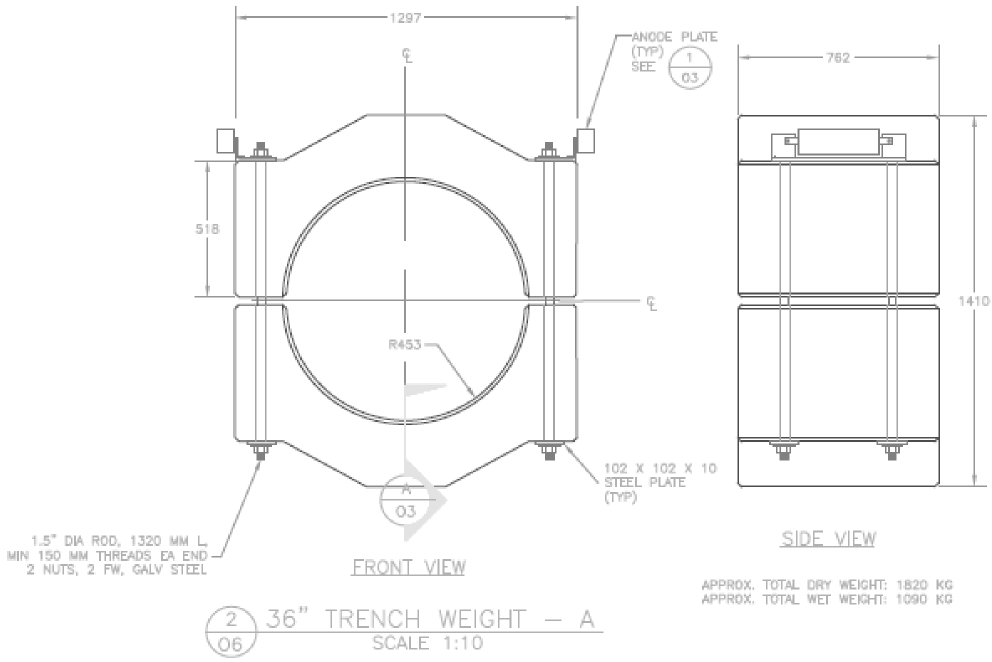


Figure 2. ***Example of 36" HDPE pipe weights for Caribou Harbor Outfall***

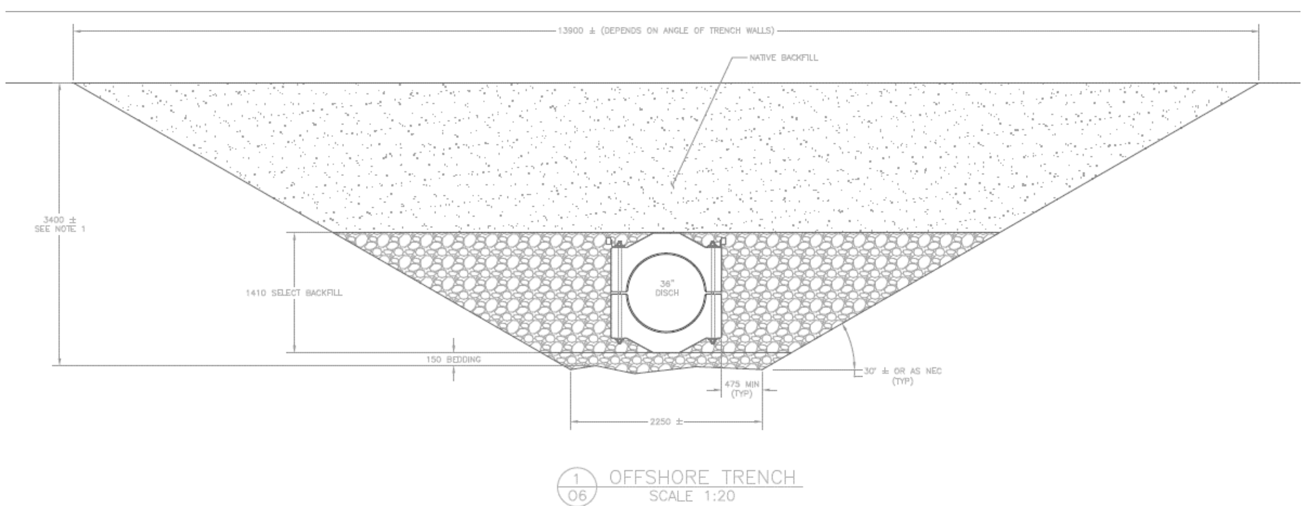


Figure 3. ***Example of dredged trench for 36" HDPE pipeline for Caribou Harbor Outfall, based on 2:1 side wall slope.***

MATERIAL STAGING AND ASSEMBLY SITES

This section describes the staging sites required to support construction. A more detailed step-by-step process for the pipeline deployment follows in later sections.

NORTHERN PULP MILL: PRIMARY STORAGE AND ASSEMBLY SITE

The HDPE pipelines will be delivered by standard freight delivery, via train and truck. Standard lengths of delivered pipe, or "sticks" will be 16.7 meters in length and stacked in cradles. Upon delivery the pipes will be moved, via forklift or crane, onto the primary Northern Pulp Mill staging site shown below in Figure 4. Individual sticks will then be fused together, using HDPE butt fusion machines, to form continuous lengths of approximately 334 meters (20 each 16.7m sticks per fused length). These 334m pipe lengths will then be stored on-site until the contractor is ready for towing them to Caribou Harbor. To deploy the pipes for towing, these lengths may be pulled into the water along a temporary rail system, pipe weights may be attached, and the pipe lengths will be fused into even longer lengths of approximately 1,000 meters (or less).

Pipe weights, similar to those shown in Figure 2, will be constructed at a pre-cast yard, and will be delivered and stored at this primary staging location.

A secondary staging site, shown in Figure 5, will be available to contractors if needed.

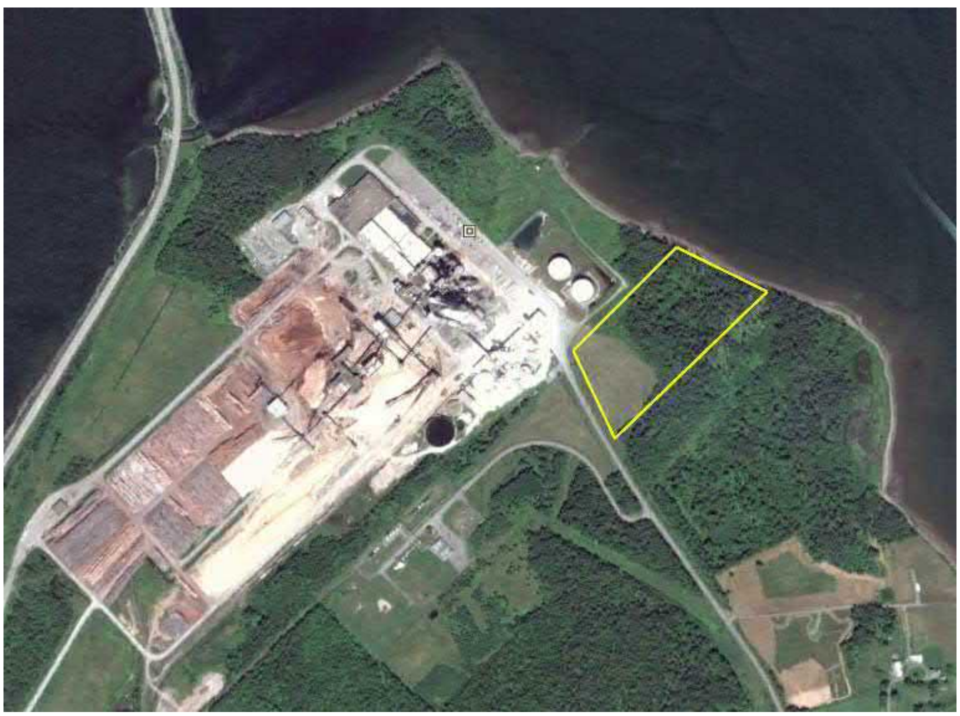


Figure 4. ***Aerial image of the primary staging site on Northern Pulp Mill property.***

Figure 5. Aerial image of the secondary staging site on Northern Pulp Mill property.

DEPLOYMENT AND PIPELINE TOWING IMPACTS

To facilitate deployment of the fused pipelines into Pictou Harbor, where they will be pulled out and towed to Caribou Harbor, a temporary causeway may be built large enough for small work and construction vehicles. As the pipelines are pulled into Pictou Harbor the pipe weights may be attached to the pipelines for ballast, the details of which are described in alter sections.

Alternatively, the pipelines may be pulled in un-weighted and towed to Caribou Harbor. Any pipe weights not installed at the Northern Pulp Mill staging site will be transported to a barge and assembled to the pipelines while floating at a Caribou Harbor mooring.

Figure 6 shows an example of a temporary causeway built in 2009 to support an HDPE pipeline deployment at the Northern Pulp Mill.

Figure 7 shows a view of the same project of the HDPE pipeline being pulled into Pictou Harbor.

Figure 8 shows the layouts and schematics of the pipeline storage, pipe weight storage, and the likely steps for the pipeline deployment into Pictou Harbor.

Previous HDPE pipe installations have taken place at the mill, including a 1500m crossing of the Harbor in 2009. The project used the pulp mill site where HDPE sticks of up to 334m length can be fused together, and deployed via rollers into Pictou Harbor.

Figure 6. Example of temporary causeway built for HDPE pipeline deployment at the Northern Pulp Mill staging site. Photo from 2009 courtesy of Northern Pulp.

Figure 7. Staged pipeline towed into Pictou Harbor from Northern Pulp Mill, 2009, images courtesy of Northern Pulp.

Figure 8. Schematic of primary staging site (yellow box) with 334m pipe sticks (red lines in staging site), pipe weight storage (gray area in staging site), and the initial floating and towing stages for longer 1,000m pipe lengths from Pictou to Caribou Harbor (green lines representing initial deployment, tow hookup, and towing).

CARIBOU HARBOR IN-WATER STAGING SITE

Once towed to Caribou Harbor, pipelines segments of up to 1,000m length will be moored at a temporary site west of the Ferry Terminal and Ferry Channel, as shown in Figure 9. Any pipe weights that still need to be assembled onto the pipeline will be transported over land to barges at the Ferry Terminal and subsequently transported to and assembled onto the moored pipeline segments. Details of this process are described in later sections.

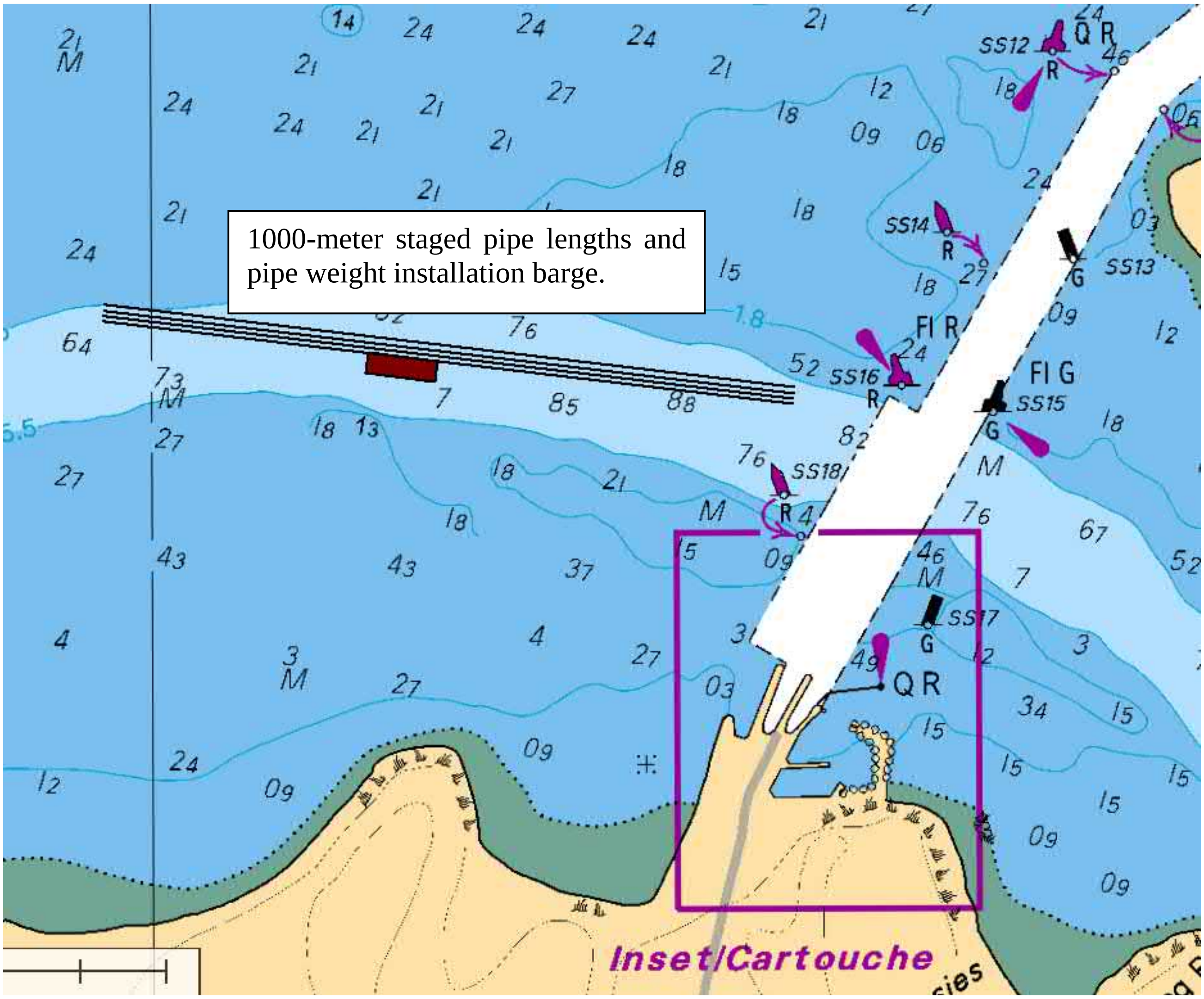


Figure 9. ***Example of in-water staging site for temporary storage and pipe weight installation on 500m to 1000m length pipeline segments; required immediately prior to submergence and installation.***

DREDGING

At the same time that these pipeline assembly and staging activities are taking place, the trenching operations can be underway.

DREDGE METHOD SELECTION

There are multiple factors in Caribou Harbor that significantly narrow down the effective methods for placing the effluent outfall pipe. Chief among these are 1) ice scour and 2) water depth.

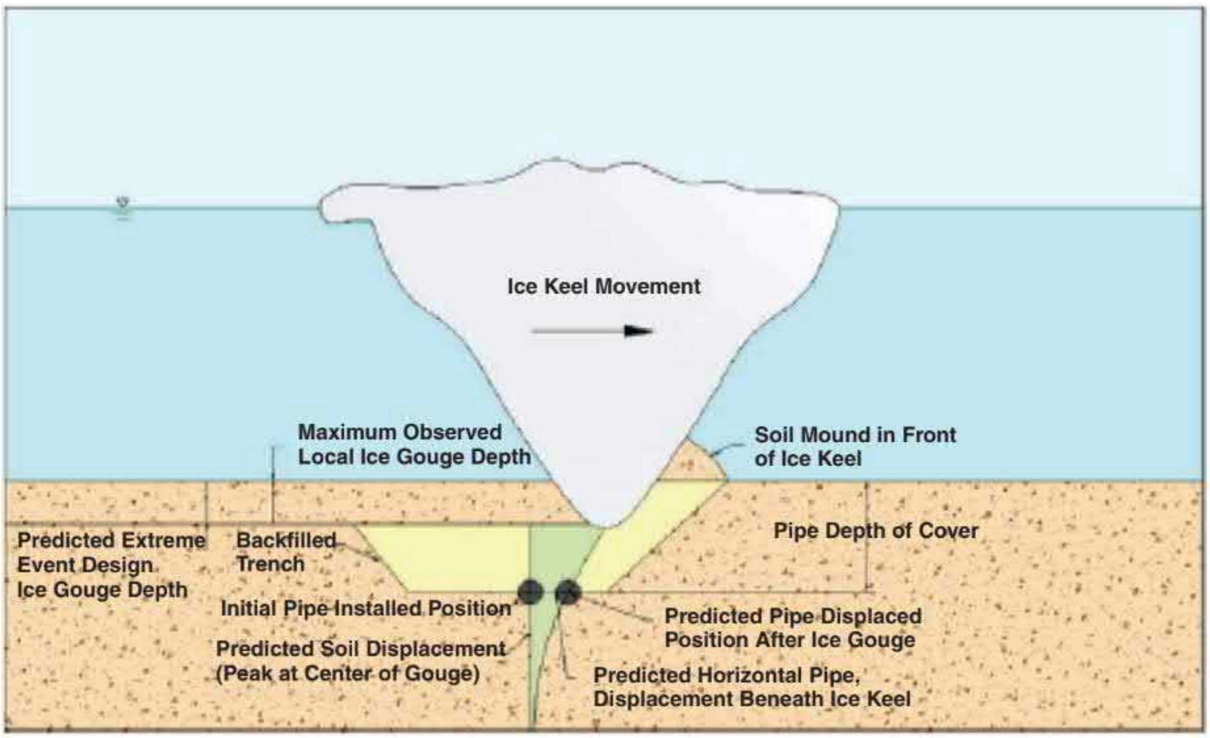


Figure 10. Graphical explanation of ice scour on the seafloor.

Ice scour, illustrated in Figure 10, is the possibility of damage to the pipeline by floating ice, both by direct tearing of the pipeline or by deformation of the pipeline by applied pressure to the soil around it. The real possibility of damage by ice scour requires that the pipeline be protected in order to prevent spillage and environmental damage. The only protection method available that can withstand the forces presented by tons of ice pressure is to bury the pipeline in a trench deep enough that the ice cannot interfere with or directly impact it.

Water depth is a factor in that it limits the trenching and placement methods that can be brought to bear. Some equipment, such as a plow for trenching, is not suitable for shallow water applications.

Water depth and tide range effect the type of barge that can be used and its anchoring methodology (spuds vs towed anchors vs self-powered), as well as the method for moving sediment spoils, as the weight will determine barge draft. Water depth also affects the methods we can use to place pipe, as there is a minimum depth needed to float pipe into place.

The pending marine geotechnical surveys will provide more detailed insight into the exact scour range the pipeline needs to be protected against, but other projects at similar latitudes by the oil industry indicate that the pipeline will require 2 meters of soil protection to prevent damage by marine ice ("*Offshore pipeline protection against seabed gouging by ice: An overview*", P. Barrette). This translates to a trench with a minimum depth of at least 3m in order to accommodate the 1m diameter effluent outfall pipeline. Given the expected angle of repose for the soil of 30 degrees, a trench 3m deep equates an opening at the surface of approximately 9m with a cross-sectional area of 13.5 square meters. This results in an excavated volume of 13,500+ cubic meters per kilometer.

In order to ensure protection for the pipeline, the trenching would be done pre-lay, with the pipeline floated in and placed behind it into the trench. Gravel bedding will provide an approximately 6" thick stable layer below the pipeline. Once placed, the pipeline may be covered by gravel haunching, and to the maximum extent possible the previously excavated spoils. Once the trench is covered in soil, it could either be graded down using a towed grader bar, or left to the elements if local currents and sediment transport is agreeable.

Pipeline Armor: To protect the pipeline from anticipated ice scour the pipeline will have to be buried. The exact depth of burial can be calculated based on existing ice scour marks observed during surveying, as well as historical data. For this document, we are assuming 2 meters of coverage with local soil. Armor stone protection may be considered for sections of the pipeline in the final design.

TRENCHING OPTIONS

Common pipeline trenching methods include conventional excavation, hydraulic suction, ploughing (both pre- and post-lay), water jetting, and mechanical trenching.

Conventional Excavation includes such equipment as hydraulic backhoes, clam-shell bucket dredges, or other similar methods that are used to excavate a pipeline trench in shallow waters. These methods are proven, but more time-consuming methods, generally suitable for areas up to 15m water depth. Clam-shell excavators may be used to side-cast dredge spoils without surfacing any of the dredged materials. This may have benefit in areas where side-casting is allowed, and if so, reduces topside materials handling.

Figure 11 and Figure 12, below, shows a typical clam-shell bucket excavator and mechanical dredger.

Figure 11. Example of typical clam-shell excavator, taken from Manson Construction website, http://www.mansonconstruction.com/andrew/..

Figure 12. Conventional Excavation Dredging

Hydraulic suction dredging works by sucking up a mixture of sediment and water (known as slurry) from the bottom surface and then transferring the mixture through a pipeline to another location. This dredge acts like a giant floating vacuum, removing sediment. The two most common forms of hydraulic dredging used for pipeline trenching are cutter suction dredgers (CSD) and trailing suction hopper dredges (TSHD).

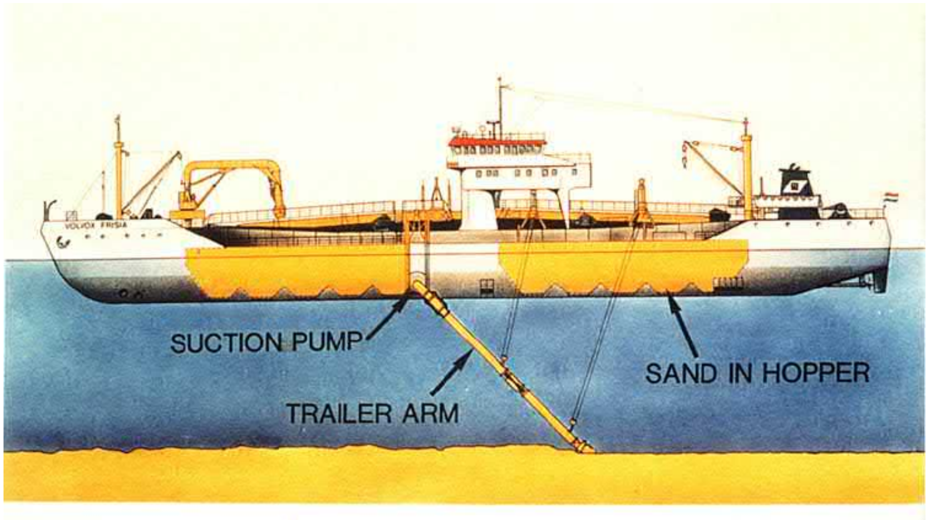


Figure 13. Representation of a Trailing Suction Hopper Dredge

Marine Ploughing is very similar to ploughing on the surface, as the plough is advanced over the seabed by pulling with a large tug or a derrick barge. Ploughing can be done in a single pass, or multiple passes, and can be done pre- or post- placement of the pipeline. Pipeline-trenching ploughs tend to be quite large, approximately 90 to 270 tons dry weight and 9 to 27 m in length.

Figure 14. Subsea plow

Water Jetting involves either pulling a jet sled along the top of a pipeline after it has been installed or flying a jetting ROV along the specified route before or after laying the pipe. Jet sleds and ROV-jetting systems are more generically described as jetters. High-pressure water jets liquefy the soil, and air lift or educator pumps remove it from under the pipeline. To achieve a trench depth of 3 m in most soil conditions, jetting often uses multipass techniques. Jetting would only work in certain soil types and would be ineffective against large boulders and bedrock. Because of the very large fluidized sediment load created, environmental concerns may also be an issue.

Figure 15. Water jet trenching / burial ROV

Mechanical Trenching is used in open water conditions and supported by a large marine vessel. There are two main types of mechanical trenchers: barge-mounted chain cutters; and tracked, crawler-style trenchers. Both of these rely on hydraulic power to operate their cutters and tracks (where appropriate). The barge-mounted mechanical trenchers can be used in water depths of less than 100 m. They often feature high-volume jetting capability for the removal of overburden and a large chain cutter for stiff soils or rock.

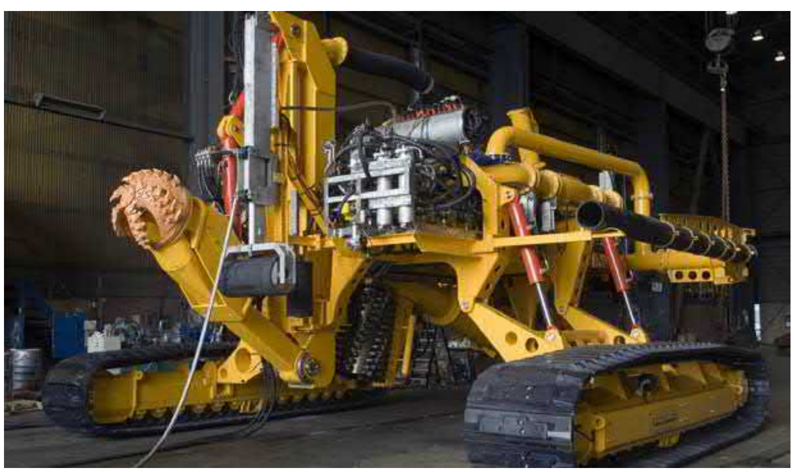


Figure 16. Mechanical Subsea Pipeline Trenching Machine

Recommended Method

Due to the combination of water depth, size of the excavation, desire to limit turbidity, and the desire to side-cast materials, Makai anticipates contractors will use the clam-shell excavator as the primary excavation method. This may require a derrick barge mobilized with a crane and clam-shell bucket excavator. Dredge spoils will be raised out of the trench and side-casted adjacent to the trench, pending permitting approvals of the approach.

The progress of a clam-shell excavator is heavily dependent on a number of factors, including size of the clam-shell bucket, water depth, and more. However, for planning, one could estimate that approximately one lift and side-cast be accomplished every 2 minutes with up to a 10 m^3 bucket. This equates to approximately 300m^3/hour. This excavation rate equates to a trenching rate of roughly 6 days per kilometer of pipeline, assuming 8 productive hours per day, and that additional steps throughout the construction process or use of smaller clam-shell buckets would result in longer dredge schedules.

An excavation rate of 300 cubic meters/hour equates to a trenching rate of roughly **6 days/kilometer of pipeline**, given a trench depth of 3m and an angle of repose of 30 degrees.

In deeper waters, or for other reasons, the hydraulic dredging and trenching technique known as **Cutting Suction Dredging (CSD)** may be used. Clam-shell excavators may be more limited to workable water depths than cutter suction dredging. CSD uses a rotating cutting head connected to hydraulic suction to break up the soil on the seabed and then suck it up onto a spoils barge, as shown in Figure 17.

The CSD excavates the trench with a rotating cutter head on the end of a ladder extended to the seabed. The cutter head breaks the soil, and pumps transport the soil/water slurry through a pipe up the ladder and through a discharge pipe. The end of the discharge pipe is typically located within a couple hundred meters from the dredge and is moved often to prevent excessive dredged spoil from accumulating in one area. Spoil can also be disposed of by discharging into barges, which can then travel to a disposal area. This would have the advantage of limiting the amount of sediment in the water column. Silt curtains have also been used successfully to limit sediment dispersion during soil dumping. Figure 17 shows an image of a typical cutter section dredge.

Figure 17. Cutting Suction Dredge

When using the Cutting Suction Dredge method, the dredge advances by sweeping the cutter head back and forth while advancing longitudinally using spud piles. Because of the sweeping motion of the vessel, the trench tends to be wide, which is what is needed in our specific application.

The progress of a cutting suction dredge is heavily dependent on a number of factors, including size and speed of the cutting head, suction pump power, hose length, spud/barge mechanics, and more. However, for planning, one could estimate a volume acquisition (Ve – volume excavated in cubic meters/hour) of 500 m^3/hour. This excavation rate equates to a trenching rate of roughly 3 to 4 days per kilometer of pipeline.

An excavation rate of 500 cubic meters/hour equates to a trenching rate of roughly **3 to 4 days/kilometer of pipeline**, given a trench depth of 3m and an angle of repose of 30 degrees.

Spoil management for this excavation is directly dependent on local environmental regulations specific to environmental factors such as turbidity, allowable soil transport radius, sediment chemistry (heavy metals, etc), marine habitat, in addition to any governing community factors.

In essence, there are two real possibilities: the dredged soil can be re-used and re-applied in place using a clam-shell excavator which does not breach the surface; the dredged soil must be removed.

Ocean disposal typically requires that sediment be analyzed for TPH, PAHs, metals (including mercury), PCBs, DDT, and grain size. If concentrations are below screening criteria, a permit can then be obtained and material disposed of at designated locations at sea. If dredge material has contaminants above screening criteria, further toxicological testing can be conducted to determine if disposal at sea is permitted. Exceedance of toxicological testing criteria will exclude this disposal method from consideration (EC, 1994).

Historically, in Nova Scotia land-based disposal of dredged material followed best management practices, currently captured in *Guidelines for Disposal of Contaminated Solids in Landfills* (NSE, 2012).

To capture dredge spoils, for either re-use in situ, land-based disposal, or some combination, a spoils barge will be needed. It is possible to have a spoils transport hose of several hundred meters to allow spoils to be deposited on land, but given the length of the planned pipeline, a barge will eventually be needed.

Operations are likely to be conducted in the following sequence:

Route planning and soil testing. The planned pipeline route will be verified with marine surveying (e.g. surface vessel multibeam, side-scan sonar, sub-bottom profiling), and soil testing. Given the planned depth of 3m, soil testing cores will likely be required to go beyond the normal 50cm of depth, and possibly to the full 3m. This will be confirmed during the permitting process.

Soil testing will verify the environmental condition of the soils, which will impact how the dredge spoils will be stored and disposed of. In addition, the soil cores will provide guidance on the exact equipment needed to trench as well as provide input into the anticipated production rate.

Dredging Operations. The dredging equipment will be identified based on the survey and soil conditions. A clam-shell excavator has been identified as the preferred method, due to ability to dredge and side-cast in place during operations, without bringing the majority of dredge spoils to the surface. In the shallow areas, water depth may limit how much of the dredge spoils can be side cast. All spoils will be re-used to the maximum extent possible to re-fill the trench and avoid disposal. The pipe and bedding material will also displace volume that will either need to remain side-casted or be disposed.

Additionally, as an alternate method, cutting suction head dredge is able to dredge in wide swaths and along a broad spectrum of depths, including our anticipated depth range of 1m to 20m along the pipeline length. In this case, a spoils barge would be paired with the dredger to capture the excavated sediment. Depending on the size of the barge – dictated by available equipment and barge freeboard requirements – multiple barges may be cycled back and forth to maintain production.

The dredger will move forward in a single pass, excavating the full trench as it moves forward along the path. At an excavation rate of 300 to 500 cubic meters per hour (depending on the equipment), the anticipated production schedule would be at least 3 days per kilometer.

Trench Backfilling. Once the trench is cut and the pipeline placed, the trench will have to be backfilled. If quality permits, dredge spoils may serve as the main source of fill. Backfill will most likely be placed using mechanical means such as a clam shell. Soil will be placed over the placed pipeline and any haunching in order to fill the trench to original grade, and this will be verified by multibeam survey in a post-lay inspection.

To smooth the placed fill, a grade bar can be towed behind a motor vessel that would drag along the sea floor and push the soil into position.

PIPELINE CONSTRUCTION AND PLACEMENT PROCESS

The overall sequence assembly and installation for an offshore pipeline is presented in this section. The information presented here is based on Makai's experience in construction oversight of several deep seawater intake pipelines. The process described here is not the only one possible; the selected marine contractor should be free to choose an assembly and installation process that best fits his equipment, manpower and technical expertise. It is the job of the construction management team to observe the construction process and ensure that the pipeline is not handled, stored or loaded in ways that are dangerous or damaging to the pipe and its attachments, and follows all final regulatory requirements.

STAGING

A staging site is needed for the fusing, testing, pipe weight installation, and assembly of the pipeline. The staging site locations have been identified and described above. The uses and requirements for the staging area are discussed in more detail below.

Pipe Weights: Pipe weights can be installed onto the pipeline at the required intervals as it is deployed into the water, or similarly by barge. Figure 18 and Figure 19 below shows the staging approach at the mill. The pipelines were pulled into the water by an excavator situated on a temporary jetty.

Pipe Lengths: HDPE pipe will be delivered in pipe lengths that are probably at most 55' (16.7 meters) long due to roadway limits. It is most likely that the pipe is shipped in 40' to 55' lengths and fused into the full deployment length in the staging area. The pipe will be fused on site at the Northern Pulp staging area into approximately 334m long sections, adjacent to a quiet water staging area so that the pipe can be fused and then pulled out into the water from storage – as was the case during the 2009 harbor crossing shown above.

Pipeline Pressure Testing: Fused segments of pipe lengths at the staging site, prior to any pipe weight attachments or deployment, are pressure tested to confirm conformity to HDPE specifications and ratings.

Figure 18. Image of pipeline being pulled into Pictou Harbor, 2009, images courtesy of Northern Pulp.

Figure 19. Image of pipe weights being affixed to HDPE pipeline prior to deployment at Pictou Harbor, 2009, images courtesy of Northern Pulp.

Water Depth: An air-filled 1m (39") high density polyethylene (HDPE) pipe with ballast weights attached will only require about 1m of water depth to remain floating. However, the marine contractor will need to be able to work around that pipeline as well as install the pipe weights. It is possible to install pipe weights right at the shoreline as the pipe sections are buttwelded together and floated into the water, which will allow for continued operation in shallower areas, such as previous operations in 2009, shown above. There needs to be a good passage from the staging area out into the open ocean so that the pipes can be safely towed out and placed, which the transit from the local harbors to Caribou Harbor allows. With proper planning, pipelines with pipe weights can be safely towed several tens of kilometers.

Pipe Towing: The 334m lengths of fused pipe will be pulled out from the on-shore staging site into the adjacent water way. During this process, additional lengths will be fused together to extend the section of floating pipelines being pulled into the water- to a total length of approximately 1,000 meters. As the pipelines are pulled into the water, the concrete ballast weights will be attached.

Pipe Storage Space: When the 1m diameter is fully fused and ready for tow from Pictou Harbor to Caribou Harbor, it may be as much as 1,000m long. With the concrete weights attached, either of these pipes will be formidable obstacles in the water, so they need to be moored in a location away from boat traffic. At the Caribou Harbor in-water staging site, the contractor will put down moorings to hold the pipe in place while he works on them and installs any additional pipe weights.

PIPELINE ASSEMBLY AND INSTALLATION

The following is a conceptual description of the effluent outfall pipeline installation process. The process presented here is preliminary; the final pipeline assembly and deployment plans would be created by the selected pipeline contractor.

Pipeline Configuration and Assembly:

For this description it is assumed that the pipeline will be assembled from individual pipe lengths shipped in 55’ (16.7m) lengths over roads on flat bed hauler trucks. Each pipe length (55’) will weigh around 9,000 lbs (4,100kg). Typically, the contractor would want to unload this pipe on shore and then fuse it together with the fusion machine located some 100’ or so back from the shoreline. A front-end loader would with forklift tines or a crane is used to move the pipe segments around on shore and load them into the fusion machine.

When the pipe segments are fused together a blind flange is connected to the end of the first segment. This segment is directed out into the water as successive pipe segments are fused on the other end forming a longer and longer pipeline. The air-filled pipe easily floats on the water and can be directed and controlled by small boats. It will take a couple weeks to complete the fusion of the entire discharge pipeline. It may be necessary to secure the offshore end of the pipe on a small barge or float, so that the partially assembled pipe can be pulled out to the mooring area when the fusion work is halted at day’s end. The pipe can then be retrieved the next morning, pulled back up onshore and fusion can continue. Figure 20 thru Figure 23 show a series of photos from a 63” pipe being fused into a long length and directed out into the water.

In addition to the offshore pipes, the marine contractor should also be made responsible to fuse the onshore pipes and connect them to the terrestrial pipeline. Once they are fused, they can also be moored in the protected water area of the harbor or stored on land until needed. When ready the on-land pipe can also be towed to the installation site and pulled up the shoreline into the prepared pipe trench. This will make pipe handling much more efficient.

Once the pipe fusion process is complete, the individual pipe sections will be hydrostatically tested. Seawater will be pumped into each pipe and maintained at a specified pressure for a fixed period of time to determine the integrity of the fusion joints. A separate subcontractor is hired to use non-destructive ultrasonic methods to verify the quality of each fusion joint. The hydrostatic test can be conducted with the pipe floating in the lagoon as long as both ends are supported on shore or on a barge. When the testing is complete the water is completely drained from the pipes.

Figure 20. Fusion machine set up to fuse 63" HDPE pipe.

Figure 21. Loading pipe (63") into fusion machine with front end loader.

Figure 22. Roller beds used to move fused pipe down to the water.

Figure 23. Fused pipe (63") entering the water.

Makai assumes that the marine contractor will have constructed the concrete pipe ballast weights at a concrete precast yard and then transported them to the staging area. Pipe weights can be installed either at the shoreline or from a crane barge. The crane barge is usually more convenient as it can be moved along the pipe section while the pipe is moored in the lagoon. An “elevator” apparatus can be installed on the side of the barge that will raise and lower the bottom half of a pipe weight. With the bottom half of a pipe weight placed on the elevator, it can be lowered into the water. Then the floating pipeline can be pulled into position above the pipe weight, and the elevator is raised to allow the pipe to rest in the pipe weight. The top half of the weight is then positioned by the crane, and laborers install the bolts to lock the pipe weight around the pipe. In Figure 24 this process is underway on a 55” pipeline assembled in Hawaii in 2001. Figure 25 shows a better view of the elevator platform looking down from the barge. Notice that the other pipe weights are stored on the flat deck barge adjacent to the crane barge. The air-filled pipeline is able to support all the concrete ballast weights and remain afloat.

Figure 24. Pipe weights being installed on floating pipeline using a crane barge with an elevator mounted on its side.

Figure 25. View of elevator platform mounted on a barge – here used for flange connections on 55” pipe in Hawaii 2001.

PRE-LAY TRENCHING OPERATIONS

The 3m deep burial trench of the entire marine pipeline length can be constructed before or during the pipeline buildup phase is going on. We recommend having the trench in place before pipeline placement (“pre-lay” trenching) in order to reduce the time the pipeline will be moored. Under this scenario, the trench would be cut ahead of time and the pipeline then towed to it and placed directly into the trench. As mentioned above, the preferred methods are the Clam-Shell Excavation or Cutting Head Suction Dredging approach.

The trench across the shore landing location at Caribou Harbor that traverses up onto the shore will allow the contractor to join to the terrestrial placed pipeline, which will have to be excavated. This will be conducted by traditional mechanical excavation, and depending on soil profile, blasting or jackhammering may be required to make construction easier. Figure 26 shows an example of a completed shoreline trench, with a 24” offshore pipeline pulled by a shoreline winch.

Anchors or dead men are needed to connect to bridles that are attached to a holdfast structure mounted on the shore end of the pipe. During pipe deployment, the pipe will have to be slightly tensioned to control alignment. In deeper waters, higher tensions will be required to limit bending during the controlled submergence. These tension loads are applied by a tug boat attached to the offshore end of the pipe. For the effluent outfall pipeline this pull load will be on the order 5-10 tons.

Figure 26. Completed pipe trench with pipe pulled in from offshore by shore winch.

End blind flanges equipped with special pipe fittings are installed on each end of the intake pipe to allow water to be pumped in at the shore end and air to be controllably expelled at the offshore end.

Pumps, manifolds, control valves and flow meters are set up onshore or to pump water into the pipeline during deployment. Electrical power from a diesel genset will be needed to run these pumps.

A second barge is set up with a large winch used to pull on the pipe and lower its end down to the seafloor when the deployment operation is complete. This barge also has compressors and air control equipment on it which will be used to control the discharge of compressed air from the pipeline at it offshore end.

Professional divers arrive in their workboat to assist during the pipeline deployment and in post-deployment anchoring activities.

Detailed deployment plans and calculations are completed by the marine contractor and his engineers and checked by the design engineer to verify that the entire installation operation is well thought-out and understood.

- Once all preparations are complete the prepared effluent outfall pipeline is carefully towed into position for lowering and placement. Figure 27 show a 9000’ long pipe under tow (pipe was painted white for improved visibility).

Figure 27. 55” towed deep-water pipeline immediately after assembly and departing for the deployment site.

- The pipeline is designed for installation by a controlled submergence process, one that has been used for many previous HDPE pipelines that have been deployed under similar conditions to those found in the Northumberland Strait, Nova Scotia. The pipeline deployments occur in one continuous operation lasting up to 12 hours (usually duration of night time) once pipeline flooding begins. For this installation, the pipeline may be installed in sections, with adjacent segments connected via fusion joints. This would require extra steps during construction to mobilize jack-up-barges for the at-sea fusion joints located at approximately every 1,000m.
- Upon arrival at the installation site, the near shore end of the pipeline assembly is attached to the previously prepared anchors that can support the deployment pull loads.
- The pipeline is pulled tight to stretch it out along the surface over planned pipeline route as shown in Figure 27.

Figure 28. *Alignment of a floating 55" deep water pipeline off Keahole, Hawaii.*

- The pump system is connected to the shore end of the pipe. The pumps are capable of delivering water at a rate to allow the pipe to be flooded in less than 8 hours.
- The pipeline is flooded by pumping water in at the near shore end while being tensioned by an offshore pulling tug. It is controllably submerged to the seafloor, always being under control and stable at all times. Air is released at the offshore end during the submerging process. See Figure 29 which shows the pipe shape in the water column and all the critical parameters during the submergence process; applicable for the deeper water and offshore portions of the pipeline path that reach 20m depth.

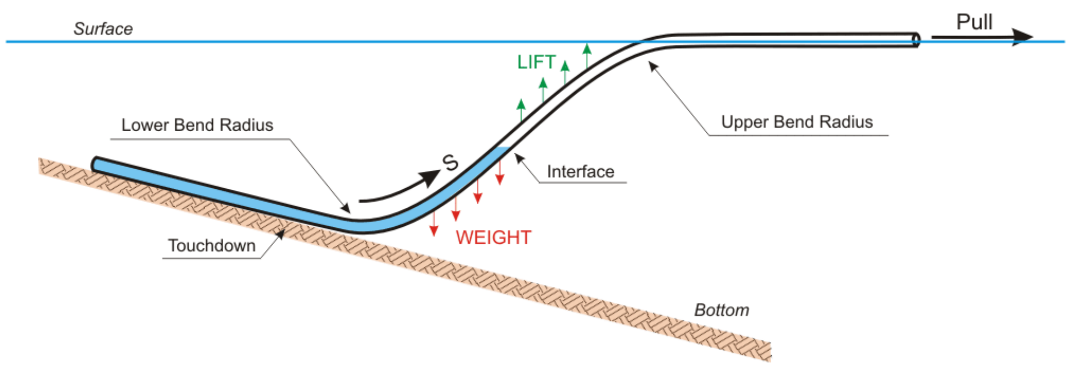


Figure 29. Pipeline shape in the water column during controlled submergence.

- The offshore tug, while maintaining the deployment pull, maneuvers the end of the pipeline to counter alongshore currents as the submergence continues to properly place it on the seabed. The submergence point must be maintained on the path. This is shown in an aerial view of a 40" pipe deployment in Hawaii in Figure 30.
- A diver or ROV inspects the pipeline at the touchdown area at critical points during the deployment.

Figure 30. Deep water pipe deployment – maneuvering to counter cross-currents.

DIFFUSER INSTALLATION AND FINAL INSPECTION

Once the pipeline is completely flooded, the end is lowered to the seafloor (20m depth).

The location and condition of the pipeline is inspected with an ROV or diver, if needed, prior to releasing the pipeline lowering cable. The pipeline can be brought to the surface and repositioned if needed as long as the lowering cable has not been removed. An example diffuser is shown in Figure 31, below.

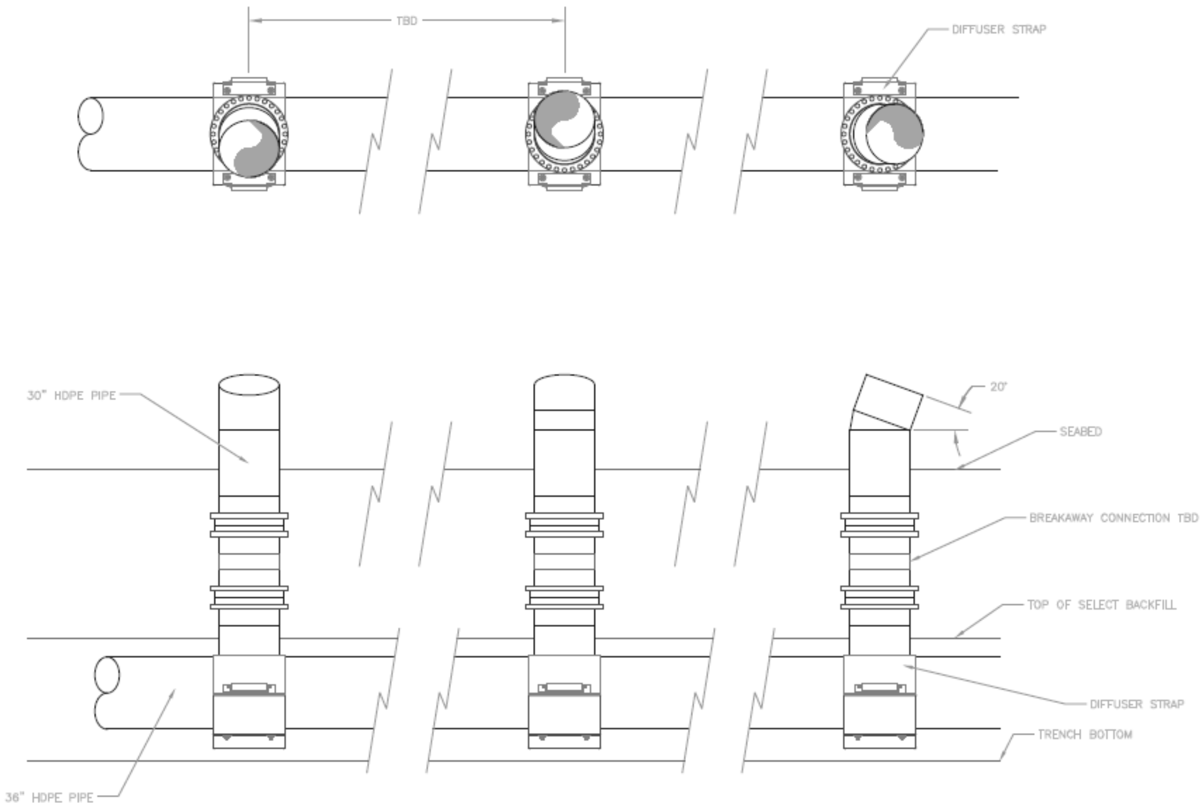


Figure 31. Example of a 3 port diffuser.

SCHEDULE

Impacts to ferry operations and channel navigation have been minimized in the proposed construction approach. Pipelines are staged on-site at Northern Pulp and each towed to Caribou Harbor, in towing operations taking less than 1 day. These tows are commonly done during night-time or planned "off hours when conflicts for use of the channel are lowest. Dredging and mooring of the pipelines in Caribou Harbor will take place to the west of the ferry channel, with movement of barges and support vessels working around the ferry operations. The final installation and deployment of the pipeline segments, each approximately 1km in length, can be expected to occur over only a few hours each, and would be planned to minimize schedule conflicts or impacts to channel navigation.

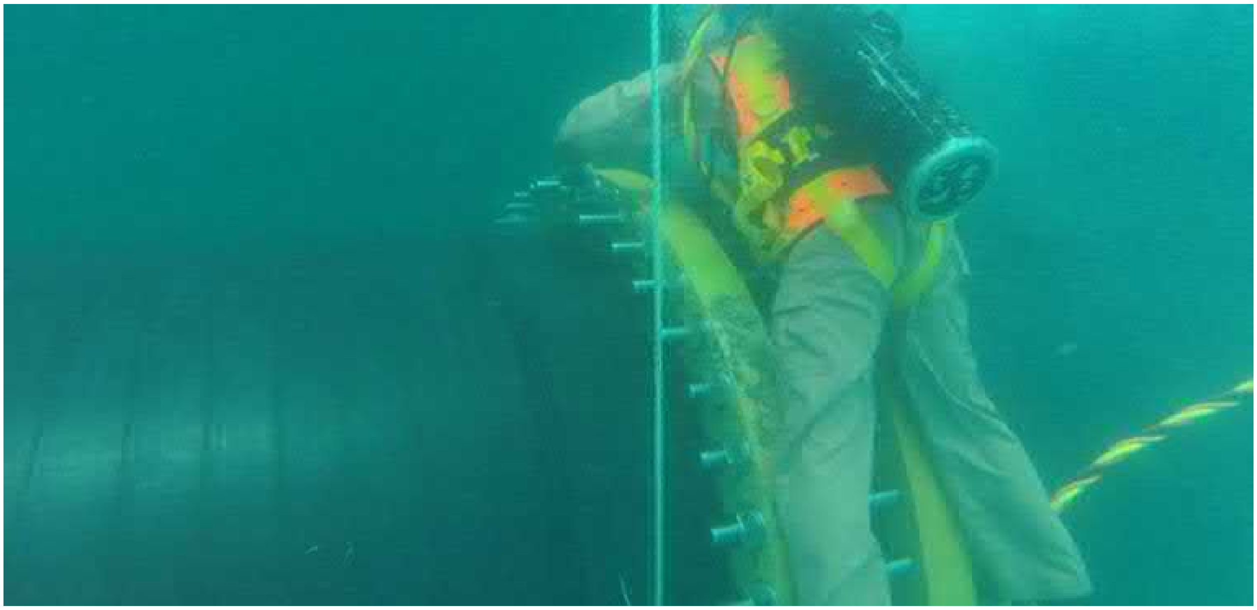


Figure 32. Diver working on HDPE pipeline connection.

FINAL SPOOL-PIECE CONNECTION

Once the pipeline is anchored into place in the trench, the trench will need to be filled back in with preference to use previously excavated side-cast materials. Depending on local environmental regulations, the previously excavated soil can be re-utilized, or fresh soil will have to be brought in on barges and placed. A grader bar can be dragged behind the placement barge to help place, smooth, and compact the soil over the trench.

At the same time that trenches are backfilled, the offshore pipeline is attached to onshore trenched pipe. This connection may have to be accomplished by constructing custom “spool pipe segments” to make the connection between the offshore pipe and onshore pipe for both the intake and discharge. Divers generally assemble a template between the two flanges and then construct a spool piece that exactly matches this template. The spool pieces can be constructed out of HDPE pipe by a skilled fusion technician.

APPENDIX: POTENTIAL FOR HORIZONTAL DIRECTIONAL DRILLING

HDD CONSIDERATIONS

Horizontal directional drilling (HDD) is not planned for the marine portion of the pipeline. However, there exists some potential and possibility that it may be used for shoreline crossings.

The amount of pipeline trenching can be significantly reduced by using horizontal directional drilling (HDD).

HDD has comparatively less environmental impact, as it tunnels underneath all water areas. This means less impact to fishing, marine habitats, water quality, or industry/shipping.

For a pipeline this size and length, the drilling procedure would be a multi-step process. First, as the hole is bored, a steel drill string is extended behind a cutting head while drilling mud is used to cool the cutter and transmitter electronics, to flush excavated soil from the borehole and to lubricate the borehole. Once this first pass is completed and the drill head breaks the surface, the cutting head is then removed and a back-reamer attached. The pipe string is attached to the back-reamer through a swivel device. As the drill string is withdrawn to the drilling rig, the back-reamer enlarges the borehole and the pipe string is pulled into the hole. As with any pipe pulling technique, the movement of the drill string and the pipe string will be monitored. The pulling load on the polyethylene pipe must not exceed the allowable tensile load, or safe pull strength of the pipe.

Once the polyethylene pipe has been pulled through the full length of the drilled bore, then a more traditional trenching and pipe placement will resume until the pipeline reaches it's proper depth. Pipeline weights will note be required for the sections contained in the drill bore.

Horizontal directional drilling (HDD) is a possibility for this project, but it will not be able to cover the entire planned length. It can however, get the pipeline out past the near shore area. The remainder of the pipeline would require trenching.

HDD PROCESS AND REQUIREMENTS

HDD technology is being used for pipeline (water, wastewater) and cable crossings for airports, highways, waterways, and elsewhere around the world.

An HDD crossing, in general, can be broken into multiple steps:

1. The first stage involves drilling a pilot hole of 3" to 10" in diameter from the shoreline along the design centerline of the proposed pipeline. The pilot hole is drilled while bentonite drilling-mud is pumped down the center of the drill rods. In the case of a jetting head, small diameter high pressure jets of bentonite slurry actually cut the soil and facilitate spoil removal by washing the cuttings to the surface where they settle out in a reception

pit. In case of a drill bit, the bit is driven by a down hole mud motor which is located just behind the drill bit and which derives its energy from the pumped drilling fluid. The bentonite also functions as a coolant and facilitates spoil removal.

2. The second stage involves enlarging the pilot hole by ‘reaming out’ the hole during several passes until it reaches the desired diameter. For this project, the drilling would likely start with a 9” or 10” pilot hole, then step-up the diameter size for each successive pass (e.g., 20”, 30”, 38”, 44”, etc). Each successive step will be a small increase in diameter because the total volume of earth that can be removed at a given time is limited. For a 36” HDPE intake pipe the hole may have to be reamed to as much as 52” diameter, but is highly depending on soil conditions and the driller’s evaluation of risk. It would take an HDD contractor multiple passes to get to the diameter hole that is necessary for a 36” pipe (some buffer room is required between the tunnel wall and the pipe).

3. Prior to the pipeline pullback operation, the HDPE pipeline has to be fused together in one full length. The most likely way that the pipeline would be installed into the tunnel is described below:

    a. This pipeline would be fused into one long section of HDPE, filled with air, floated out, and then submerged onto the bottom in-line with the drilled hole. The HDPE pipeline is then pulled back thru the HDD tunnel until it pops out on the shore end.

Examples of a drill rig, reaming device, and other heavy equipment used in HDD are shown the figures below.

Figure 33. HDD drill rig (left) and reaming head (right).

Use of HDD technology will require an onshore area of at least 150’ by 100’ and a source of freshwater for mixing the drill mud. In addition to the drilling rig, this space is used to house a drilling fluid cleaning and recirculation unit, drill pipe trailer, water truck, hoses, pumps, driller’s van, excavator and vacuum pump truck. An aerial view of a site performing HDD, illustrating the space requirements, is shown in the figure below.

Figure 34. Aerial view of HDD in progress.

Ideally, the tunnel would breakout as deep as is possible – as close to the required intake and discharge depths as possible. The breakout depth for tunneling will be deeper than for a trenched pipeline as there is only a small additional cost to extend the tunnel to a deeper depth, and the added depth will provide the advantages of smaller hydrodynamic loads and thus reduced anchoring requirements.

Figure 35. Example of HDPE pipe being placed via Horizontal Directional Drilling.

Appendix G

Proposed EEM Program

ENVIRONMENTAL EFFECTS MONITORING PROGRAM INVESTIGATIONS ASSOCIATED WITH THE NEW PROPOSED TREATED EFFLUENT DISCHARGE CONFIGURATION AT THE NORTHERN PULP NOVA SCOTIA CORPORATION MILL

Report prepared for:

NORTHERN PULP NOVA SCOTIA CORPORATION
260 Granton Abercrombie Branch Rd,
Abercrombie, NS B2H 5C6

Report prepared by:

ECOMETRIX INCORPORATED
6800 Campobello Road
Mississauga, Ontario
L5N 2L8

Ref. 18-2472
January 2019

ENVIRONMENTAL EFFECTS MONITORING PROGRAM INVESTIGATIONS ASSOCIATED WITH THE NEW PROPOSED TREATED EFFLUENT DISCHARGE CONFIGURATION AT THE NORTHERN PULP NOVA SCOTIA CORPORATION MILL

Joseph Tetreault, B.Sc.
Environmental Monitoring Specialist
Principal Investigator

Michael White, Ph. D.
Aquatic Scientist, Reviewer

Brian Fraser, M.Sc.
Aquatic Scientist
Project Principal

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF DEFINITIONS AND ACRONYMS

Plankton – a collection of organisms, including bacteria, algae and animals, that live within the water column that are unable to swim against the current.

Phytoplankton – the autotrophic (i.e., self-feeding) plant-like component of the plankton community, including algae and cyanobacteria, that are the base of the aquatic food chain.

Zooplankton – the heterotrophic (i.e., rely on intake of nutrition from outside sources) component of the plankton community, including many types of weakly swimming animals that may live all or part of their lives in the water column.

Caged Bivalves – Bivalves (e.g., Blue Mussel) that are suspended in frames (or cages) in the water column as used as an "alternative" method to assess fish population health for the purpose of the EEM program. The bivalves are suspended in the frames in areas in close proximity to the effluent discharge and in appropriate reference areas (i.e., areas not influenced by effluent). Measurements of survival, growth and reproduction are used to assess potential effects of effluent exposure.

Benthic Invertebrates – Invertebrates (i.e., organisms without spines), including many species of worms, molluscs and crustaceans, that live in or on the sediment on the seafloor.

Plume Delineation – A study to determine the behavior of effluent that is discharged to the environment. In the study the behavior and spatial extent of the effluent in the environment is assessed.

EA – Environmental Assessment

ETP – Effluent Treatment Plant

NPNS – Northern Pulp Nova Scotia

EEM – Environmental Effect Monitoring

PPER – Pulp and Paper Effluent Regulations

AOX – Adsorbable Organic Halides (AOX)

1.0 INTRODUCTION

1.1 Background Information

Northern Pulp Nova Scotia Corporation (NPNS) operates a northern bleached softwood kraft pulp mill at Abercrombie Point in Pictou County, Nova Scotia. The mill has been in operation since 1967.

The existing effluent treatment plant (ETP) at Boat Harbour will be closed by 2020 in accordance with the *Boat Harbour Act*[1] and a new treatment facility needs to be designed and constructed to allow the mill to continue operations. The main components of the proposed new ETP will be located on NPNS property, adjacent to the mill – that is, effluent treatment will occur on-site. The effluent, once treated and ready for discharge, will be released to the local aquatic environment as it has been since mill operations began. The transmission pipeline will extend approximately 15.2 km from the NPNS facility location in Abercrombie to a marine outfall location in the Northumberland Strait, near Caribou. The pipeline is comprised of approximately 11 km over land and 4 km in water.

In accordance with the provincial *Environment Act*, the design and construction of the new treatment facility is considered a 'modification to an existing undertaking'[2]. Therefore, the design and construction of the new facility has followed the provincial Class 1 Environmental Assessment (EA) process. The EA process was formally initiated in the fall of 2017 and it is expected that NPNS will "register" the EA via the submission of the EA documentation early in 2019.

The purpose of the EA study is to identify constraints and mitigation measures to protect the environment (natural and socio-economic), which will be incorporated into the final design and construction of the ETP. The approval of the EA from the provincial Minister of Environment is required prior to construction and operation.

1.2 Pulp and Paper Effluent Regulations and the Environmental Effects Monitoring Program

In May 1992, Environment Canada (EC), now Environment and Climate Change Canada (ECCC), and the Department of Fisheries and Oceans (DFO) amended the federal Pulp and Paper Effluent Regulations[3] (PPER) under the *Fisheries Act*. The PPER impose various requirements on pulp and paper mills including for example:

---

[1] https://nslegislature.ca/sites/default/files/legc/statutes/boat%20harbour.pdf

[2] https://novascotia.ca/just/regulations/regs/envassmt.htm

[3] http://laws-lois.justice.gc.ca/eng/regulations/SOR-92-269/

- installing, maintaining and calibrating monitoring equipment and keeping records of that equipment;
- monitoring effluent;
- submitting monthly reports containing effluent monitoring results and production information;
- notifying an inspector of a test result that indicates a failure or non-compliance with the Regulations;
- submitting identifying information;
- preparing and updating annually a remedial plan describing the measures to be taken by the operator to eliminate all unauthorized deposits of deleterious substances in the case where effluent fails an acute lethality test;
- preparing an emergency response plan and making it readily available on-site to persons who are to implement the plan;
- providing information related to the reference production rate;
- submitting information on outfall structures and depositing effluent only through those outfall structures;
- complying with requirements for environmental effects monitoring studies;
- keeping records available for inspection;
- requesting an authorization to combine effluents; and,
- providing written reports and additional sampling for the deposit of a deleterious substance in water frequented by fish that is not authorized under the Fisheries Act, which results or may result in detriment to fish, fish habitat or the use of fish by humans.

The amended PPER also prescribed effluent discharge quality criteria that limit the discharge of total suspended solids (TSS), biochemical oxygen demand (BOD) and the acute lethality of effluent. In addition the amended PPER prescribed that all mills were required to participate in an Environmental Effects Monitoring (EEM) program.

The EEM program studies are designed to detect and measure changes in aquatic ecosystems into which treated mill effluents are released (i.e., “receiving environments”). The pulp and paper EEM program is an iterative system of monitoring and interpretation phases that is used to help assess the effectiveness of environmental management measures, by evaluating the effects of effluents on fish, fish habitat and the use of fisheries resources by humans. The EEM program goes beyond end-of-pipe measurement of chemicals in effluent to examine the effectiveness of environmental protection measures directly in aquatic ecosystems. Long-term effects are assessed using regular cyclical monitoring and interpretation phases designed to assess and investigate the impacts on the same parameters and locations. In this way, both a spatial characterization of potential effects and a record through time to assess changes in receiving environments are obtained. EEM studies consist of:

- sublethal toxicity testing of effluent to monitor effluent quality (PPER section [s.] 29); and,
- biological monitoring studies in the aquatic receiving environment to determine if mill effluent is having an effect on fish, fish habitat or the use of fisheries resources (PPER s. 30).

1.3 Environmental Effects Monitoring at the Northern Pulp Nova Scotia Mill

Seven EEM cycles have been completed at the NPNS mill, with the interpretive reports associated with each of the seven EEM cycles submitted to ECCC by 01 April of 1996, 2000, 2004, 2007, 2010, 2013 and 2016, respectively, as required. Since the inception of the EEM program at the mill the EEM studies have comprised various elements including: sublethal toxicity testing of mill effluent; benthic invertebrate community assessments; large- and small-bodied fish population health assessments; caged bivalve exposure assessments; the assessment of chlorinated dioxin and furan concentrations in the edible portion of Blue Mussel tissues; and, the propensity of NPNS effluent to taint lobster flesh. The various in-field components of EEM have been completed within a wide study area in Pictou Road the Northumberland Strait and have focussed on comparison of key biological endpoints for at sites both in the vicinity of the current mill discharge location at Boat Harbour and at appropriate reference locations. Locations of in-field components for the various components of the EEM completed to date are provided in **Figure 1.1**, **Figure 1.2** and **Figure 1.3**. Cumulatively, the results of these studies have indicated little, if any, effluent-associated effects in the Pictou Road area of the Northumberland Strait.

It is noted that each of the seven EEM studies completed at the mill to date was designed and implemented in consideration of the current effluent treatment and discharge configuration at Boat Harbour.

1.4 Objective of the Proposed Work Scope

As indicated above, it has been recommended that the new treated effluent outfall be located in the Northumberland Strait in an offshore area approximately 15.2 kilometers from the mill. Accordingly, should the EA be approved and the design and construction of the new treatment plant and discharge structure move forward as proposed the frame of reference for the EEM program studies will need to be re-visited.

The primary objective of this current report is to describe the work scope that will be implemented in the event that the EA is approved and the design and construction of the new treatment plant and discharge structure move forward as proposed. The work scope has been developed in consideration of the requirements set out in the PPER, as well as those prescribed in the EEM program technical guidance documentation (Environment Canada, 2010).

It is noted that additional proposed monitoring program elements, EA program follow-up monitoring elements, that are not associated with the EEM program are described by in "*Follow-up Studies Associated with the Environmental Assessment Process for the New Treated Effluent Discharge Configuration at the Northern Pulp Nova Scotia Corporation Mill*" (EcoMetrix, 2019).

1.5 Report Format

Following this introductory section, the remainder of this report is organized as follows. In **Section 2.0 (Proposed Scope of Work)**, the proposed EEM program work scope is detailed. In **Section 3.0 (Proposed Work Scope Implementation Schedule)** the schedule for the execution of the proposed EEM program work scope is provided. In **Section 4.0 (References)**, the references cited in preparation of this document are provided.

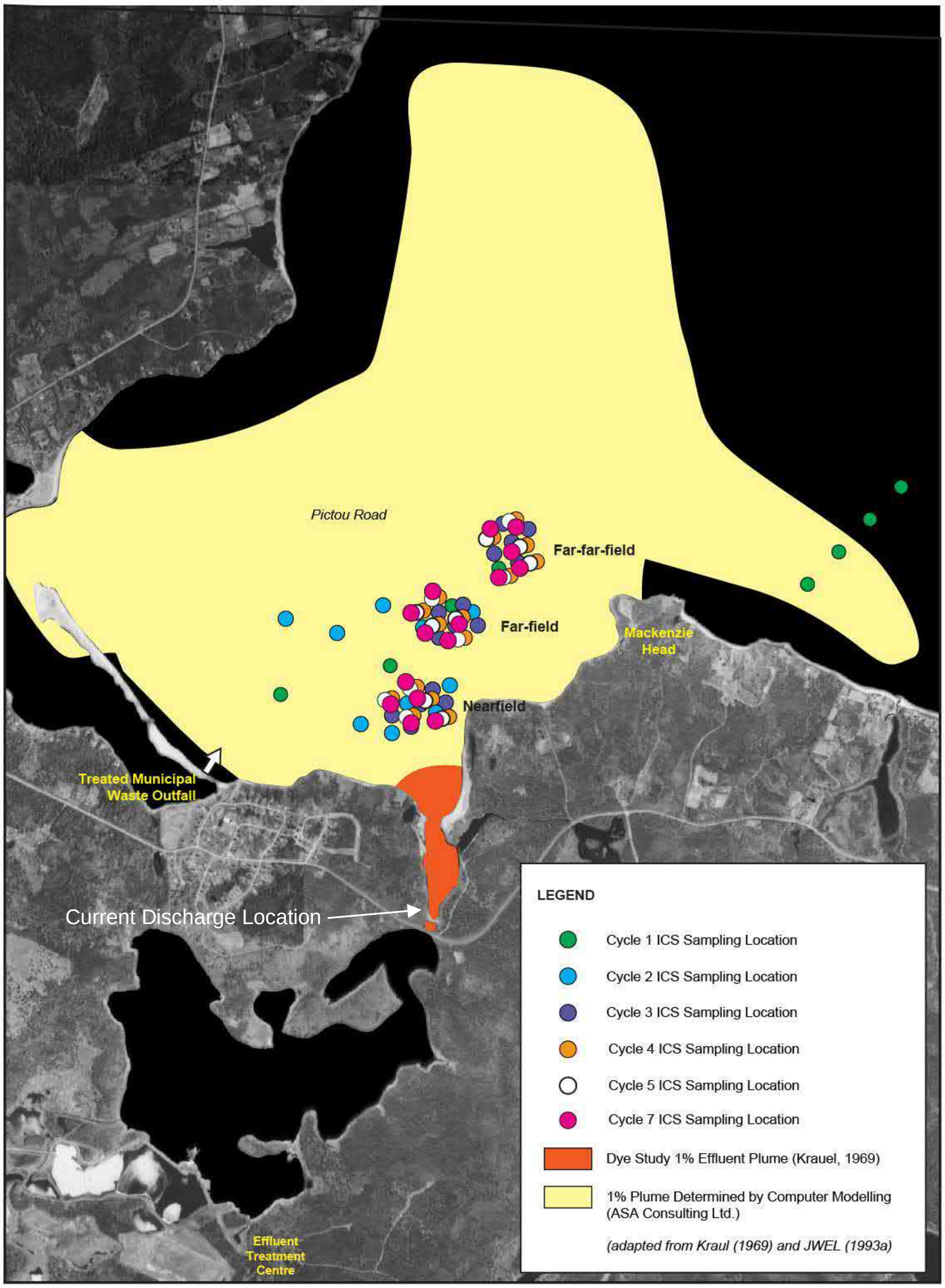


Figure 1.1: Historic EEM Benthic Invertebrate Community Exposure Area Sampling Station Locations

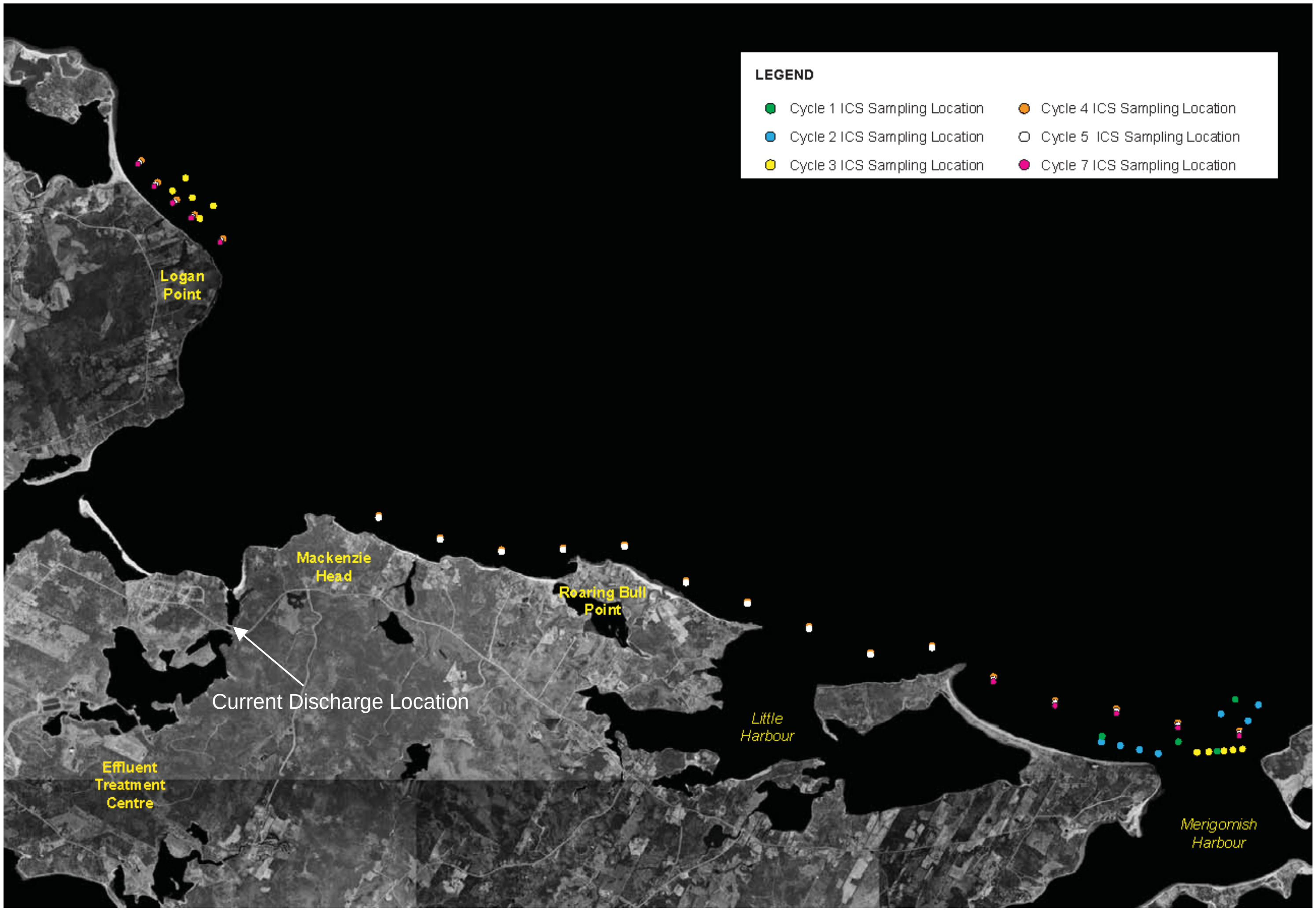


Figure 1.2: Historic EEM Benthic Invertebrate Community Reference Area Sampling Station Locations

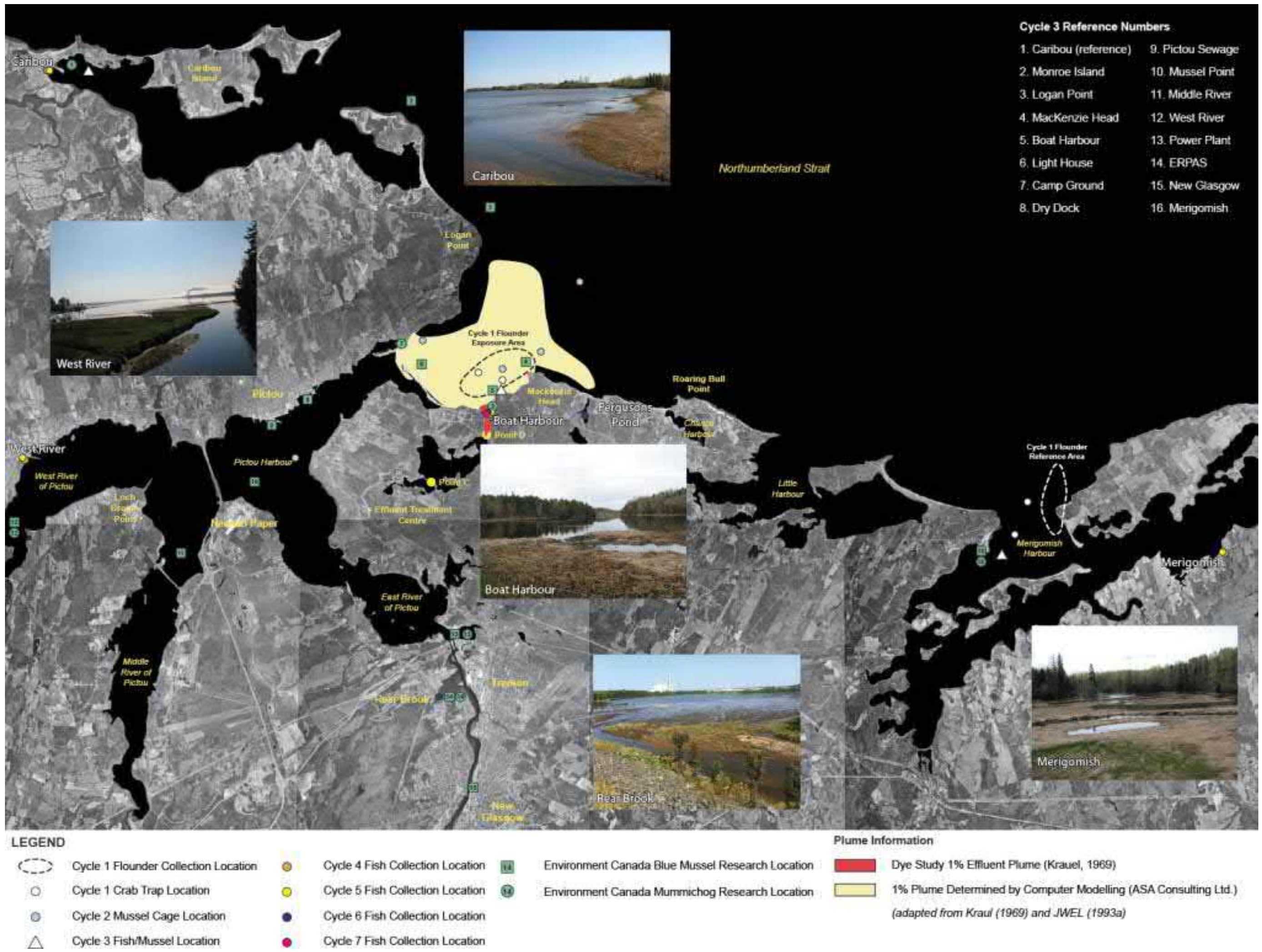


Figure 1.3: Historic Sampling Locations for EEM Fish and Mussel Collections

2.0 PROPOSED SCOPE OF WORK

2.1 Overview

As indicated above, the work scope described herein has been developed in consideration of the requirements set out in the PPER, as well as those prescribed in the EEM program's technical guidance documentation (Environment Canada, 2010). It is noted that Schedule IV.1 of the PPER sets forth the legal minimum requirements for EEM studies. Schedule IV.1 of the PPER is provided as **Appendix A** of this report for reference.

Herein, the focus of the proposed scope of work relates to the field studies that NPNS will implement to fulfill their EEM program obligations. It is assumed for planning purposes that the program will be implemented consistent with the notion that this is the "first" EEM program at the mill (as considered within Schedule IV.1 of the PPER), given the new proposed treatment and discharge systems. It is reasonable to assume that some of the data collected in the previous EEM cycles at the mill can, and will, be used for comparison to any new data that are collected. However, it is understood that new sampling areas will be established that are more geographically relevant to the new discharge location.

The field program elements described herein include the following:

- treated effluent plume delineation studies; and,
- biological monitoring studies to assess;
    - benthic invertebrate community condition,
    - fish population health, and,
    - dioxins and furans levels in fish tissues.

The EEM program also includes provision for biological monitoring via laboratory-based sublethal effluent toxicity testing. Though not specifically addressed as a component of the work scope described in this report, the mill will complete routine testing as prescribed in the PPER. Laboratory tests are conducted twice annually to assess the potential influence of mill effluent exposure on sea urchin fertilization, as well as, the growth of the alga *Champia parvula*. These data are used to assess effluent quality and also to assist in the interpretation of biological field survey data.

2.2 Treated Effluent Plume Delineation

In support of the EA process NPNS has undertaken effluent plume modelling to understand effluent dispersion and potential water quality effects in the receiving environment (Stantec, 2017, 2018). Effluent dispersion analysis was undertaken at alternative outfall locations under conservative ambient conditions using three-dimensional near-field and two-dimensional far-field hydrodynamic models. Based on the results of the modelling it was recommended that the Caribou Harbour site in Northumberland Strait was the most appropriate location to construct the discharge. **Figure 2.1** shows the location of Caribou Harbour, and also shows the locations of current mill infrastructure and other local features.

The effluent dispersion model simulations predict rapid dilution of the effluent in the Strait. The freshwater effluent is buoyant in the marine environment and as a result disperses upwards in the water column following discharge. It is predicted that the effluent reaches the water surface within 25 m of the diffuser and at a dilution ratio of 105:1 (seawater to effluent) and reaches a dilution ratio of 144:1 at the edge of the mixing zone (100 m from the diffuser).

Empirical confirmation of the predicted spatial extent of the effluent plume described by Stantec (2017, 2018) will be needed to support EEM monitoring program design. Empirical confirmation will be achieved via an in-field plume delineation study that will be conducted consistent with the guidance provided by JWEL and NATECH (2003). The study will necessarily be conducted following the initiation of treated effluent discharge at the proposed discharge location.

A detailed study plan for the in-field plume delineation will be developed prior to implementing the field work and would be provided to ECCC, as well as other interested parties as may be appropriate. The overall approach to the in-field plume delineation study is described in brief as follows. A conservative tracer (Rhodamine WT, a fluorescent dye that is not harmful to the aquatic environment) will be injected into the effluent at the ETP and tracked in the Northumberland Strait. Concentrations of dye will be measured in real-time by measuring fluorescence in the water at surface and in vertical profiles. The tracking of the dye would extend outwards from the diffuser location until such time as the 1000:1 dilution limit is determined. The dye would be injected continuously over a sufficient time period (several tidal cycles) to establish an equilibrium concentration in the receiving water. The effluent measurements in the Strait will be taken over the same time period.

Along with the fluorescence measurements a variety of other information will be collected regarding effluent discharge rates, tidal and current conditions, water temperature and salinity, and wind direction and speed so that the fluorescence data can provide an overall spatial perspective on effluent dispersion in the Strait under that specific set of conditions. In addition, water samples for the characterization of water quality parameters that have been used as tracers of mill effluent in past EEM studies at the mill will be collected coincident with the plume delineation study (e.g., see EcoMetrix, 2011). This includes total organic carbon (TOC), dissolved organic carbon (DOC), total Kjeldahl nitrogen (TKN) and colour. Comparison of data for these parameters for areas where effluent is present and where it is not present, confirmed by Rhodamine WT dye fluorescence, will provide useful information for the planning of the EEM biological monitoring programs (see **Section 2.3**).

Subsequent to the field study, some additional numerical modelling may also be conducted. This modelling would provide the means by which the plume measurements could be extrapolated to simulate effluent dispersion over a wider range of environmental conditions than those encountered during the field survey to ensure that the full extent of the mill's effluent plume has been established.

As it concerns the EEM program the in-field plume delineation study helps to delineate appropriate sampling areas. The EEM guidance (JWEL and NATECH, 2003) suggests that the "exposure zone" or "exposure area" be defined in terms of the following considerations:

- the area whose maximum extent reflects the zone within which effluent is periodically detectable at a concentration of 1% or greater; and,
- the area within which the long-term average conditions reflect the zone within which effluent concentrations of 1% or greater, and 0.1% or greater would be regularly detectable.

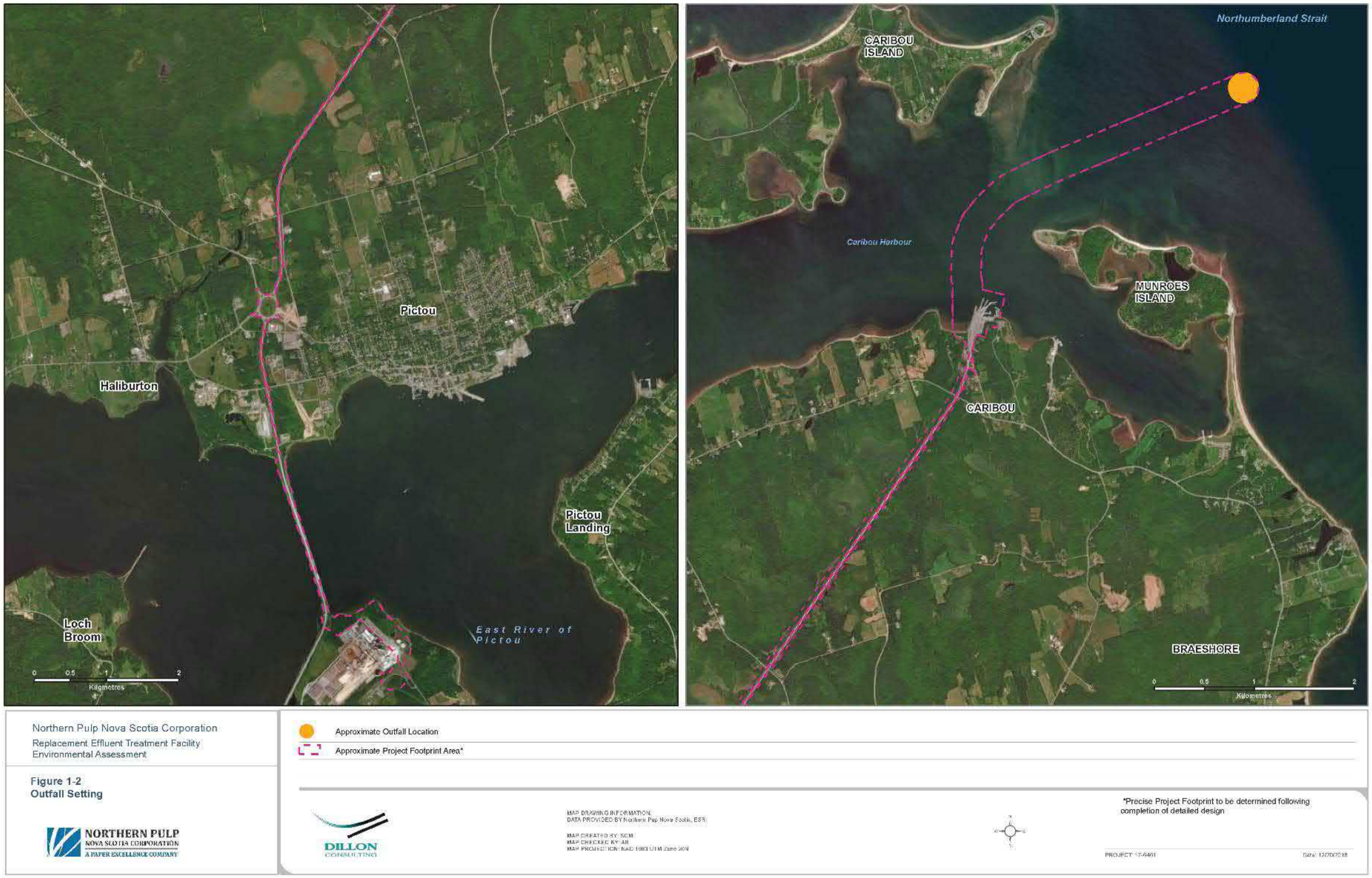


Figure 2.1: Location of the proposed Caribou Harbour outfall (used with permission from Dillon Consulting)

2.3 Biological Monitoring Studies

According to the PPER, biological field monitoring studies consist of evaluations of benthic invertebrate community condition, fish population health, and dioxins and furans levels in fish tissues. In each case, specific conditions are associated with the potential implementation of each component of these. For benthos and fish health, the requirements to conduct field studies are conditional on the spatial extent of the effluent plume in the receiving environment. Specifically Schedule IV.1 of the PPER indicates field studies are required as follows:

- *"A study respecting the benthic invertebrate community, if the concentration of effluent in the exposure area is greater than 1% in the area located with 100 m of a point of deposit of the effluent in water."*

- *"A study respecting the fish population, if the concentration of effluent in the exposure area is greater than 1% in the area located within 250 m of a point of deposit of the effluent in water."*

The requirement to measure dioxins and furans levels in fish tissues is conditional on whether mill effluent contains a measurable concentration of 2,3,7,8-TCDD or of 2,3,7,8-TCDF, within the meaning of the Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations, or an "effect"[4] on fish tissue was reported in the most recently completed EEM study at the mill. The results of the analysis for dioxins and furans in NPNS effluent have been below detection for several years and this is not likely to change with the new treatment system. Therefore, it is not anticipated that testing for dioxins and furans it fish tissue will be required. Annual testing for dioxins and furans in the future treated effluent will continue to be performed as per the requirements set out in the Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations.

2.3.1 Assessment of Benthic Invertebrate Community Condition

An assessment of the benthic invertebrate community serves as a basis to delineate the extent and magnitude of fish habitat degradation, if any, due to organic or nutrient enrichment, or other forms of physical and chemical contamination potentially associated with mill operations. It also provides a basis for an evaluation of the aquatic food resources available for fish communities in the receiving environment.

A detailed study plan for the benthic invertebrate community survey will be developed prior to implementing the field work and would be provided to ECCC, as well as other interested

---

[4] Effect on fish tissue means that the concentration of chlorinated dioxins and furans, expressed as toxic equivalents of 2,3,7,8-tetrachlorodibenzo-para-dioxin, exceeds 15 pg/g wet weight in muscle or 30 pg/g wet weight in liver or hepatopancreas in fish taken in the exposure area.

parties as may be appropriate. The overall approach to the benthic invertebrate community study is described in brief as follows.

The proposed survey will follow a control/impact design. Benthic samples will be collected from three areas – a near field area in close proximity to the discharge, a far field area further from the discharge at the maximum extent where exposure to effluent is likely and in a reference area that is beyond any potential influence of the effluent. Five replicate samples will be collected in each area to meet the statistical power requirements outlined in the EEM technical guidance document (Environment Canada, 2010). Samples will be collected with a petit ponar grab and sieved through 500 micron mesh consistent with past EEM survey at the mill.

Detailed taxonomic identification of the resident benthic taxa in the samples will be undertaken. Invertebrates will be identified to the lowest practical taxonomic level. Raw data will be summarized to express the benthic invertebrate community in terms of metrics of abundance, diversity and community structure. These metrics include those defined as "EEM effect parameters" (Environment Canada, 2010), as well as several others that help to better reveal patterns of invertebrate community structure including:

- total invertebrate density (organisms per m^2 of bottom surface area);
- invertebrate richness (number of discrete taxa);
- Evenness (E) (how equitably taxa are distributed within samples by abundance);
- Bray-Curtis Index (numerical expression of similarity/dissimilarity to a reference condition);
- taxon density (organisms per m^2 of bottom surface area for a given taxon or taxa group); and,
- taxon proportion (relative density [%] for a given taxon or taxa group).

Statistical procedures (e.g., Analysis of Variance [ANOVA]) will be used to compare the benthic invertebrate community metrics to test the null hypothesis that there are no differences among sampling area and by inference that the benthic invertebrate community is not affected by the mill effluent discharge. In addition, historical data collected as part of EEM programs conducted at the mill in the past will be used to assess potential temporal patterns in benthic invertebrate community structure.

Supporting environment data will be collected coincident with benthic invertebrate samples to help interpret any patterns that may be identified in the benthic data. This will include sediment samples that will be characterized for:

- grain size;

- total organic carbon;
- total sulphides;
- Eh; and,
- the carbon to nitrogen ratio.

Water samples will be collected for the measurement of:

- dissolved oxygen levels;
- temperature;
- salinity;
- colour;
- dissolved organic carbon;
- total organic carbon; and,
- Total Kjeldahl nitrogen.

Historically, the benthic surveys for the EEM program at NPNS have been implemented during the fall. This timing would again be preferred so these data and the current data can be used for comparison.

2.3.2 Assessment of Fish Population Health

The objective of fish monitoring in the EEM program is to determine whether or not mill effluent has an "effect" on fish. This assessment is accomplished by evaluating the growth, reproduction, survival and condition of representative fish populations in reference and effluent exposed areas. An effect is defined as a statistical difference between heath endpoints for an exposure area and a reference area, or differences with an exposure area where there are gradually decreasing effluent concentrations (i.e., a dose effect).

Marine discharges, particularly those located offshore as is the case for the proposed discharge at NPNS, are not normally conducive to a standard finfish survey. The level of exposure to effluent for finfish is difficult to assess since they tend to move over large areas, thereby making it difficult to discern potential effluent effects from natural variability in the fish health endpoints that are measured.

Caged bivalves provide a reasonable alternative to finfish to assess the effects of pulp and paper effluent on fish (Environment Canada, 2010). They are sessile and therefore effluent exposure can be controlled. In addition, it is possible to expose bivalves of different maturity (juveniles, adults) simultaneously allowing the measurement of all growth and reproductive endpoints within a single survey. Caged bivalves have been used successfully at NPNS in the past – the site was an original test location for caged bivalves as part of the development of this approach for use in EEM in Canada (St. Jean, 2002). Thus, caged bivalves are an appropriate fish population health survey tool in the current context.

A detailed study plan for the fish population health assessment will be developed prior to implementing the field work and would be provided to ECCC, as well as other interested parties as may be appropriate. The overall approach to the fish population health assessment study is described in brief as follows.

Blue Mussels (*Mytilus edulis*) used for the study will be obtained from a nearby licensed aquaculture facility. Associated mussel testing documentation will be obtained from the aquaculture facility to determine the status of the mussels in relation to certain diseases. Older research indicated that the mill effluent had potential effects on exposed mussels, particularly the development of leukemia. However, more recent work has determined that leukemia in mussels is widespread and was not the result of exposure to mill effluent. If leukemia testing is not part of the normal suite of tests conducted by the aquaculture industry, mussels will be analyzed for leukemia prior to deployment. The proposed survey will follow a control/impact design. Mussels will be deployed in three areas – a near field area in close proximity to the discharge, a far field area further from the discharge at the maximum extent where exposure to effluent is likely and in a reference area that is beyond any potential influence of the effluent. The mussels will be deployed within 60 cm by 60 cm 1¼ inch PVC frames that are suspended at about 30 cm below the surface of the water (low tide).

Five frames of mussels will be deployed in each area. Each frame will contain 30 mussels (20 mature specimens [>4 cm shell length] and 10 juveniles [2 cm shell ± 0.2 cm]). This will yield more than the required 25 male and 25 female mature mussels and juvenile mussels that are needed to have the appropriate statistical power (Environment Canada, 2010). Mussels will be held in place within the frames via mussel socks (10-cm diameter plastic mesh with 5-mm holes). Each mussel sock will hold up to 5 mussels. Mussels will be separated from one another by constricting the mussel sock with a plastic tie wrap between each mussel, but leaving enough space for growth (about 10 cm between ties). The location of each individual mussel will be recorded (area, cage, sock, position in sock) to facilitate repeated (i.e., before and after) measurements of key endpoints.

Mussels will be deployed in early April and collected in late June. Ideally, the mussels should be *in situ* for no less than 90 days, as recommended in Environment Canada (2010). This time period allows for maximum shell and tissue growth and is also ideal for the measurement of reproductive status (Environment Canada, 2010).

Various morphological measurements will be made on individual mussels (shell length, shell width, shell height, whole animal weight wet (WAWW), soft tissue fresh weight, and, gonad somatic index (GSI)) in order to generate measures of key potential effect endpoints, such as reproductive effort, growth, energy storage and survival. This will allow data to be analyzed in a manner consistent with the overall objective of identifying potential differences in mussels exposed to and not exposed to mill effluent.

Supporting environment data will be collected coincident with survey to help interpret any patterns that may be identified in the data. Water samples will be collected for the measurement of:

- dissolved oxygen levels;
- temperature;
- salinity;
- colour;
- dissolved organic carbon;
- total organic carbon; and,
- Total Kjeldahl nitrogen.

2.3.3 Assessment of Effects on Fish Usability (Dioxins and Furans in Fish Tissues)

For the pulp and paper EEM program[5], fish usability is evaluated through the measurement of chlorinated dioxin and furan concentrations in the edible portion of a given fish species. Mills which use or have used chlorine bleaching may be required to conduct these analyses if dioxins and furans are an issue for the receiving environment. The requirement to measure dioxins and furans levels in fish tissues is conditional on whether mill effluent contains a measurable concentration of 2,3,7,8-TCDD or of 2,3,7,8-TCDF, within the meaning of the Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations, or an “effect”[6] on fish tissue was reported in the most recently completed EEM study at the mill. The results of the analysis for dioxins and furans in NPNS effluent have been below detection for several years and this is not likely to change with the new treatment system.

---

[5] Over the first three cycles of EEM, fish usability was also evaluated on the basis of the potential for mill effluents to taint fish. As tainting was not identified as an issue of national concern the requirement for tainting evaluations as part of EEM has been discontinued. It is noted that a tainting evaluation was completed at NPNS using lobster in EEM Cycle 1 (JWEL, 1996).

[6] Effect on fish tissue means that the concentration of chlorinated dioxins and furans, expressed as toxic equivalents of 2,3,7,8-tetrachlorodibenzo-para-dioxin, exceeds 15 pg/g wet weight in muscle or 30 pg/g wet weight in liver or hepatopancreas in fish taken in the exposure area.

Therefore, it is not anticipated that testing for dioxins and furans it fish tissue will be required. Annual testing for dioxins and furans in the future treated effluent will continue to be performed as per the requirements set out in the Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations).

3.0 PROPOSED WORK SCOPE IMPLEMENTATION SCHEDULE

The mill is only required to implement the field survey programs described in **Section 2.0** once it has begun to discharge effluent from the new proposed outfall location. There is no statutory obligation as defined in the PPER to complete field surveys prior to this time.

Nevertheless, and specifically as it concerns the biological monitoring program elements described in **Section 2.0**, EcoMetrix suggests implementation of the biological monitoring program prior to final commissioning of the proposed treatment plant and effluent outfall. The collection of this baseline information will significantly strengthen the interpretive power of the biological monitoring program as a whole. This will allow the biological monitoring program data to be analysed in a BACI (Before-After-Control-Impact) framework so that potential effluent related effects can be considered both spatially (i.e., exposure vs. reference) and temporally (i.e., pre-discharge vs post-discharge).

In consideration of the above, a provisional proposed implementation schedule for the work scope elements described in **Section 2.0** is summarized in **Table 3.1**. It is noted that the schedule only considers the pre-discharge and first post-discharge studies. Subsequent EEM cycle study needs would be refined as appropriate based on the results of these surveys.

Table 3.1: EEM Work Scope Schedule

Activity	Timing
Plume Delineation	The plume delineation will be conducted following the commissioning of the new treatment plant and discharge.
Benthic Invertebrate Community Assessment	• Pre-discharge survey – Not required, proposed only • Post discharge survey – within 24 months of the initiation of discharge from the new outfall location
Fish Population Health Assessment (Caged Bivalves)	• Pre-discharge survey – Not required, proposed only • Post discharge survey – within 24 months of the initiation of discharge from the new outfall location

4.0 REFERENCES

EcoMetrix Incorporated (EcoMetrix). 2005. EEM Cycle 4 Study Design for the Neenah Paper (Pictou Mill) Facility at New Glasgow, Nova Scotia. Submitted to Neenah Paper Inc. and Environment Canada by EcoMetrix.

EcoMetrix Incorporated (EcoMetrix). 2011. EEM Cycle 6 Study Design for the Northern Pulp Nova Scotia Corp. Facility near Pictou, Nova Scotia. Submitted to Northern Pulp Nova Scotia and Environment Canada by EcoMetrix.

EcoMetrix Incorporated. 2019. Follow-up Studies Associated with the Environmental Assessment Process for the New Treated Effluent Discharge Configuration at the Northern Pulp Nova Scotia Corporation Mill. January 2018.

Environment Canada. 2010. 2010 Pulp and Paper Environmental Effects Monitoring (EEM) Technical Guidance Document. Revised April 2013.

Jacques Whitford Environmental Limited (JWEL). 1996. First Cycle Final Report - Aquatic Environmental Effects Monitoring Program - Boat Harbour Wastewater Treatment Facility. Report to the Nova Scotia Department of Supply and Services.

Jacques Whitford Environmental Limited (JWEL) and NATECH Environmental Services Inc. (NATECH). 2003. Revised Technical Guidance on how to conduct effluent plume delineation studies. Report prepared for Environment Canada.

Stantec Consulting Ltd (Stantec). 2017. Preliminary Receiving Water Study for Northern Pulp Effluent Treatment Plant Replacement, Pictou Harbour, Nova Scotia. Report Prepared for KSH Solutions Ltd. August 11, 2017.

Stantec Consulting Ltd (Stantec). 2018. Addendum Receiving Water Study for Northern Pulp Effluent Treatment Facility Replacement Project – Additional Outfall Location CH-B, Caribou Point, Nova Scotia. Report Prepared for NPNS December 19, 2018.

St. Jean, S. 2002. Pictou Harbour Biomonitoring Report: Developing tools for monitoring marine environmental health in and around Pictou Harbour, Nova Scotia. Fisheries and Oceans Canada.

Appendix A Schedule IV.1 of the Pulp and Paper Effluent Regulations

SCHEDULE IV.1

(Subsections 29(1) and 30(1) and (3) and paragraph 35(1)(i))

Environmental Effects Monitoring Studies

Interpretation

1 The following definitions apply in this Schedule.

effect on fish tissue means that the concentration of chlorinated dioxins and furans, expressed as toxic equivalents of 2,3,7,8-tetrachlorodibenzo-para-dioxin, exceeds 15 pg/g wet weight in muscle or 30 pg/g wet weight in liver or hepatopancreas in fish taken in the exposure area. (*effet sur les tissus de poissons*)

effect on the benthic invertebrate community means a statistical difference between data referred to in subparagraph 11(a)(ii) from a study respecting the benthic invertebrate community conducted in

(a) an exposure area and a reference area; or

(b) sampling areas within an exposure area where there are gradually decreasing effluent concentrations. (*effet sur la communauté d'invertébrés benthiques*)

effect on the fish population means a statistical difference between data relating to the indicators referred to in subparagraph 11(a)(i) from a study respecting fish population conducted in

(a) an exposure area and a reference area; or

(b) sampling areas within an exposure area where there are gradually decreasing effluent concentrations. (*effet sur la population de poissons*)

exposure area means all fish habitat and waters frequented by fish that are exposed to effluent. (*zone exposée*)

fish means fish as defined in section 2 of the *Fisheries Act*, but does not include parts of fish, parts of shellfish, parts of crustaceans or parts of marine animals. (*poissons*)

reference area means water frequented by fish that is not exposed to effluent and that has fish habitat that, as far as practicable, is most similar to that of the exposure area. (*zone de référence*)

sampling area means the area within a reference or exposure area where representative samples are collected. (*zone d'échantillonnage*)

Sublethal Toxicity Testing

2 (1) Sublethal toxicity testing shall be conducted by following the applicable methods referred to in subsections (2) and (3) and by recording the results for an invertebrate species and an algal species.

(2) In the case of effluent that is deposited into fresh waters, sublethal toxicity tests shall be conducted by using the following test methodologies, as amended from time to time, as applicable to each species:

(a) [Repealed, SOR/2008-239, s. 11]

(b) in the case of an invertebrate species, *Biological Test Method: Test of Reproduction and Survival Using the Cladoceran Ceriodaphnia dubia* (Report EPS 1/RM/21 Second Edition), February 2007, published by the federal Department of the Environment; and

(c) in the case of an algal species,

(i) *Biological Test Method: Growth Inhibition Test Using a Freshwater Alga* (Report EPS 1/RM/25 Second Edition), March 2007, published by the federal Department of the Environment, or

(ii) *Détermination de l'inhibition de la croissance chez l'algue Selenastrum capricornutum* (Reference Method MA 500-S. cap.2.0), September 1997, published by the *Centre d'expertise en analyse environnementale du Québec*.

(3) In the case of effluent that is deposited into marine or estuarine waters, sublethal toxicity tests shall be conducted by using the following test methodologies, as amended from time to time, as applicable to each species:

(a) in the case of an invertebrate species, *Biological Test Method: Fertilization Assay Using Echinoids (Sea Urchins and Sand Dollars)* (Report EPS 1/RM/27), December 1992, published by the federal Department of the Environment; and

(b) in the case of algal species, one of the following test methodologies, as applicable, namely,

(i) *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Marine and Estuarine Organisms* (Third Edition) (Reference Method EPA/821/R/02–014), October 2002, published by the U.S. Environmental Protection Agency, or

(ii) *Short-term Methods for Estimating the Chronic Toxicity of Effluent and Receiving Waters to West Coast Marine and Estuarine Organisms* (First Edition) (Reference Method EPA/600/R-95-136), August 1995, published by the U.S. Environmental Protection Agency.

Biological Monitoring Studies

3 Biological monitoring studies consist of

(a) a study respecting the fish population, if the concentration of effluent in the exposure area is greater than 1% in the area located within 250 m of a point of deposit of the effluent in water;

(b) a study respecting fish tissue if

(i) since the submission of the most recent interpretive report, the effluent contained a measurable concentration of 2,3,7,8-TCDD or of 2,3,7,8-TCDF, within the meaning of the *Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations*, or

(ii) an effect on fish tissue was reported in the most recent interpretive report; and

(c) a study respecting the benthic invertebrate community, if the concentration of effluent in the exposure area is greater than 1% in the area located within 100 m of a point of deposit of the effluent in water.

Study Design

4 (1) At least six months before the commencement of sampling for biological monitoring studies, a study design shall be submitted to the authorization officer that, subject to subsections (2) to (4), consists of

(a) the site characterization referred to in section 5;

(b) if a study respecting fish population is required under paragraph 3(a), a description of how the study will be conducted, that includes

(i) the information referred to in paragraphs 6(a) to (d), and

(ii) how the study will determine whether the effluent has an effect on the fish population;

(c) if a study respecting fish tissue is required under paragraph 3(b), a description of how the study will be conducted that includes

(i) the information referred to in paragraphs 6(a) to (d), and

(ii) how the study will determine whether the effluent has an effect on fish tissue;

(d) if the study referred to in paragraph 3(c) respecting the benthic invertebrate community is required, a description of how the study will be conducted, that includes

(i) the information referred to in paragraphs 7(a) to (d), and

(ii) how the study will determine whether the effluent has an effect on the benthic invertebrate community;

(e) the dates when any samples will be collected;

(f) a description of the quality assurance and quality control measures that will be implemented to ensure the validity of the data that is collected;

(g) a summary of the results of any previous biological monitoring studies that were conducted respecting the fish population, fish tissue or the benthic invertebrate community; and

(h) if the two most recent interpretive reports indicate the same effect on the fish population, on fish tissue or on the benthic invertebrate community, a description of the magnitude and geographical extent of the effect.

(2) If the most recent interpretive report indicates the magnitude and geographical extent of an effect on the fish population, on fish tissue or on the benthic invertebrate community, or that the cause of the effect has not been identified, the study design shall consist of the following:

(a) the summary of results referred to in paragraph (1)(g); and

(b) a detailed description of the field and laboratory studies that will be used to determine the cause of the effect.

(3) If the most recent interpretive report indicates the cause of the effect on the fish population, on fish tissue or on the benthic invertebrate community, or that the solutions have not been identified, the study design shall consist of a detailed description of the studies that will be used to identify the possible solutions to eliminate the effect.

(4) If the most recent interpretive report indicates the solutions to eliminate the effect, the study design shall consist of the information referred to in subsection (1).

5 (1) The site characterization consists of

(a) a description of the manner in which the effluent mixes within the exposure area, including an estimate of the concentration of effluent in water at 100 m and 250 m, respectively, from each point of deposit of the effluent in water;

(b) a description of the reference and exposure areas where the biological monitoring studies will be conducted that includes a mapped description of the sampling areas and information on the geological, hydrological, oceanographical, limnological, chemical and biological features of those areas;

(c) a description of any anthropogenic, natural or other factors that are not related to the effluent under study and that may reasonably be expected to contribute to any observed effect;

(d) the type of production process and treatment system used by the mill; and

(e) any additional information relevant to the site characterization.

(2) If the information described in subsection (1) was submitted in a previous study design, it may be submitted in summary format, but it shall include a detailed description of any changes to that information since the submission of the most recent study design.

6 The information respecting the fish population and fish tissue studies shall include a description of and the scientific rationale for

(a) the fish species selected, taking into account the abundance of the species most exposed to effluent;

(b) the sampling areas selected;

(c) the sample size selected; and

(d) the field and laboratory methodologies selected.

7 The information respecting the benthic invertebrate community studies shall include a description of and the scientific rationale for

(a) the sampling areas selected, taking into account the benthic invertebrate diversity and the area most exposed to effluent;

(b) the sample size selected;

(c) the sampling period selected; and

(d) the field and laboratory methodologies selected.

Conducting Biological Monitoring Studies

8 (1) Subject to subsection (2), the biological monitoring studies shall be conducted in accordance with the study design submitted under section 4.

(2) If it is impossible to follow the study design because of unusual circumstances, the owner or operator of a mill may deviate from the study design but shall inform the authorization officer without delay of those circumstances and of how the study was or will be conducted.

9 When studies respecting fish population or the benthic invertebrate community are conducted, water samples shall be collected from the sampling areas selected under paragraphs 6(b) and 7(a), and the following information shall be recorded:

(a) water temperature;

(b) depth;

(c) concentration of dissolved oxygen;

(d) in the case of effluent that is deposited into fresh water, pH levels, electrical conductivity, hardness, total phosphorus, total nitrogen and total organic carbon; and

(e) in the case of effluent that is deposited into marine or estuarine waters, salinity.

10 When studies respecting the benthic invertebrate community are conducted, sediment samples shall be collected from the sampling areas selected under paragraph 7(a), and the following information shall be recorded:

(a) particle size distribution and total organic carbon; and

(b) in the case of effluent that is deposited into marine or estuarine waters, the ratio of carbon to nitrogen, redox potential (Eh) and sulphides.

Assessment of Data Collected from Studies

11 The data collected during the biological monitoring studies shall be used

(a) to calculate the mean, the standard deviation, the standard error and the minimum and maximum values in the sampling areas for

(i) in the case of a study respecting the fish population, and if it is possible to obtain data to establish the following indicators — indicators of growth, reproduction, condition and survival that include the length, total body weight and age of the fish, the weight of its liver or hepatopancreas and, if the fish are sexually mature, the egg weight, fecundity and gonad weight of the fish, and

(ii) in the case of a study respecting the benthic invertebrate community — the total benthic invertebrate density, the evenness index, the taxa richness and the similarity index;

(b) to identify the sex of the fish sampled and the presence of any lesions, tumours, parasites or other abnormalities;

(c) to conduct an analysis of the results of the calculations under paragraph (a) and information identified under paragraph (b) to determine if there is a statistical difference between the sampling areas;

(d) to conduct a statistical analysis of the results of the calculations under paragraph (a) to determine the probability of correctly detecting an effect of a pre-defined size and the degree of confidence that can be placed in the calculations; and

(e) to calculate the concentration of chlorinated dioxins and furans in fish tissue taken from the exposure area, which concentration is expressed as toxic equivalents of 2,3,7,8-tetrachlorodibenzo-para-dioxin.

Interpretive Report

12 (1) After biological monitoring studies are conducted in accordance with sections 8 to 10, an interpretive report shall be prepared that, subject to subsections (2) and (2.1), contains the following information:

(a) a description of any deviation from the study design that occurred while the biological monitoring studies were being conducted and any impact that the deviation had on the studies;

(b) the latitude and longitude of sampling areas in degrees, minutes and seconds and a description of the sampling areas sufficient to identify their location;

(c) the dates and times when samples were collected;

(d) the sample sizes;

(e) the results of the data assessment made under section 11 and any supporting raw data;

(f) based on the results referred to in paragraph (e), the identification of any effect on

(i) the fish population,

(ii) fish tissue, and

(iii) the benthic invertebrate community;

(g) if the study design contains the information described in paragraph 4(1)(h), the magnitude and geographical extent of the effect on fish population, fish tissue or the benthic invertebrate community;

(h) the information referred to in sections 9 and 10;

(i) a description of any complaint within the three preceding years to the owner or operator of a mill about fish flavour or odour;

(j) the conclusions of the biological monitoring studies, based on the results of the statistical analysis conducted under paragraph 11(c), taking into account any of the following factors that may have affected those results:

(i) the results of any previous biological monitoring studies,

(ii) the presence of anthropogenic, natural or other factors that are not related to the effluent under study and that may reasonably be expected to contribute to any observed effect,

(iii) any quality assurance or quality control results that may interfere with the reliability of the conclusions, and

(iv) the exposure to effluent of the fish that were sampled;

(k) a description of the impact of the results on the study design for subsequent biological monitoring studies; and

(l) the date of the next biological monitoring studies.

(2) If a study design is submitted under subsection 4(2), the interpretive report shall consist of only the cause of the effect on fish population, fish tissue or the benthic invertebrate community, and any supporting raw data and, if the cause was not determined, an explanation of why and a description of any steps that need to be taken in the next study to determine that cause.

(2.1) If a study design is submitted under subsection 4(3), the interpretive report shall consist of only the studies that were used to identify possible solutions to eliminate the effect and the results of those solutions and, if no solutions were identified, an explanation of the reasons why and a description of any steps that need to be taken in the next study to identify the solutions.

(3) For the purposes of paragraph (1)(f), if a study on the fish population, on fish tissue or on the benthic invertebrate community is not required to be conducted under these Regulations, the effluent is considered to have no effect on the fish population, on fish tissue or on the benthic invertebrate community, respectively.

Appendix H

Proposed Follow Up and Monitoring Program

FOLLOW-UP STUDIES ASSOCIATED WITH THE ENVIRONMENTAL ASSESSMENT PROCESS FOR THE NEW TREATED EFFLUENT DISCHARGE CONFIGURATION AT THE NORTHERN PULP NOVA SCOTIA CORPORATION MILL

Report prepared for:

NORTHERN PULP NOVA SCOTIA
CORPORATION
260 Granton Abercrombie Branch Rd,
Abercrombie, NS B2H 5C6

Report prepared by:

ECOMETRIX INCORPORATED
6800 Campobello Road
Mississauga, Ontario
L5N 2L8

Ref. 18-2472
January 2019

FOLLOW-UP STUDIES ASSOCIATED WITH THE ENVIRONMENTAL ASSESSMENT PROCESS FOR THE NEW TREATED EFFLUENT DISCHARGE CONFIGURATION AT THE NORTHERN PULP NOVA SCOTIA CORPORATION MILL

Joseph Tetreault, B.Sc.
Environmental Monitoring Specialist
Principal Investigator

Brian Fraser, M.Sc.
Aquatic Scientist
Project Principal and Reviewer

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF DEFINITIONS AND ACRONYMS

Plankton – a collection of organisms, including bacteria, algae and animals, that live within the water column that are unable to swim against the current.

Phytoplankton – the autotrophic (i.e., self-feeding) plant-like component of the plankton community, including algae and cyanobacteria, that are the base of the aquatic food chain.

Zooplankton – the heterotrophic (i.e., rely on intake of nutrition from outside sources) component of the plankton community, including many types of weakly swimming animals that may live all or part of their lives in the water column.

Caged Bivalves – Bivalves (e.g., Blue Mussel) that are suspended in frames (or cages) in the water column as used as an "alternative" method to assess fish population health for the purpose of the EEM program. The bivalves are suspended in the frames in areas in close proximity to the effluent discharge and in appropriate reference areas (i.e., areas not influenced by effluent). Measurements of survival, growth and reproduction are used to assess potential effects of effluent exposure.

Benthic Invertebrates – Invertebrates (i.e., organisms without spines), including many species of worms, molluscs and crustaceans, that live in or on the sediment on the seafloor.

Plume Delineation – A study to determine the behavior of effluent that is discharged to the environment. In the study the behavior and spatial extent of the effluent in the environment is assessed.

EA – Environmental Assessment

ETP – Effluent Treatment Plant

NPNS – Northern Pulp Nova Scotia

EEM – Environmental Effect Monitoring

PPER – Pulp and Paper Effluent Regulations

AOX – Adsorbable Organic Halides (AOX)

1.0 INTRODUCTION

1.1 Background Information

Northern Pulp Nova Scotia Corporation (NPNS) operates a northern bleached softwood kraft pulp mill at Abercrombie Point in Pictou County, Nova Scotia. The mill has been in operation since 1967.

The existing effluent treatment plant (ETP) at Boat Harbour will be closed by 2020 in accordance with the *Boat Harbour Act*[1] and a new treatment facility needs to be designed and constructed to allow the mill to continue operations. The main components of the proposed new ETP will be located on NPNS property, adjacent to the mill – that is, effluent treatment will occur on-site. The effluent, once treated and ready for discharge, will be released to the local aquatic environment as it has been since mill operations began. The transmission pipeline will extend approximately 15.2 km from the NPNS facility location in Abercrombie to a marine outfall location in the Northumberland Strait, near Caribou. The pipeline is comprised of approximately 11 km over land and 4 km in water.

In accordance with the provincial *Environment Act*, the design and construction of the new treatment facility is considered a 'modification to an existing undertaking'[2]. Therefore, the design and construction of the new facility has followed the provincial Class 1 Environmental Assessment (EA) process. The EA process was formally initiated in the fall of 2017 and it is expected that NPNS will “register” the EA via the submission of the EA documentation early in 2019.

As part of the EA process NPNS has undertaken an assessment of potential locations from which effluent from the new ETP will be discharged. Stantec Consulting Ltd. (Stantec) prepared a receiving water study to determine the optimal location for the effluent outfall (Stantec, 2017, 2018) Alternative outfall locations were assessed in consideration of effluent dispersion model predictions and the potential effects of the effluent discharge on local environmental and socioeconomic features of importance. Based on the results of the assessment it was recommended that the Caribou Harbour outfall site in Northumberland Strait was the most appropriate location to construct the discharge. **Figure 1.1** shows the location of the Caribou Harbour outfall, the pipeline route from the mill to the Caribou Harbour outfall and the locations of current mill infrastructure and other local features.

The scope of the monitoring program described herein has been developed in consideration of the preferred effluent pipeline and outfall configuration. The purpose of the EA study is to identify constraints and mitigation measures to protect the environment

---

[1] https://nslegislature.ca/sites/default/files/legc/statutes/boat%20harbour.pdf

[2] https://novascotia.ca/just/regulations/regs/envassmt.htm

(natural and socio-economic), which will be incorporated into the final design and construction of the ETP. The approval of the EA from the provincial Minister of Environment is required prior to construction and operation. In consideration of this, the scope of the monitoring program proposed in this report should be considered provisional and subject to revision based on feedback received through the EA process.

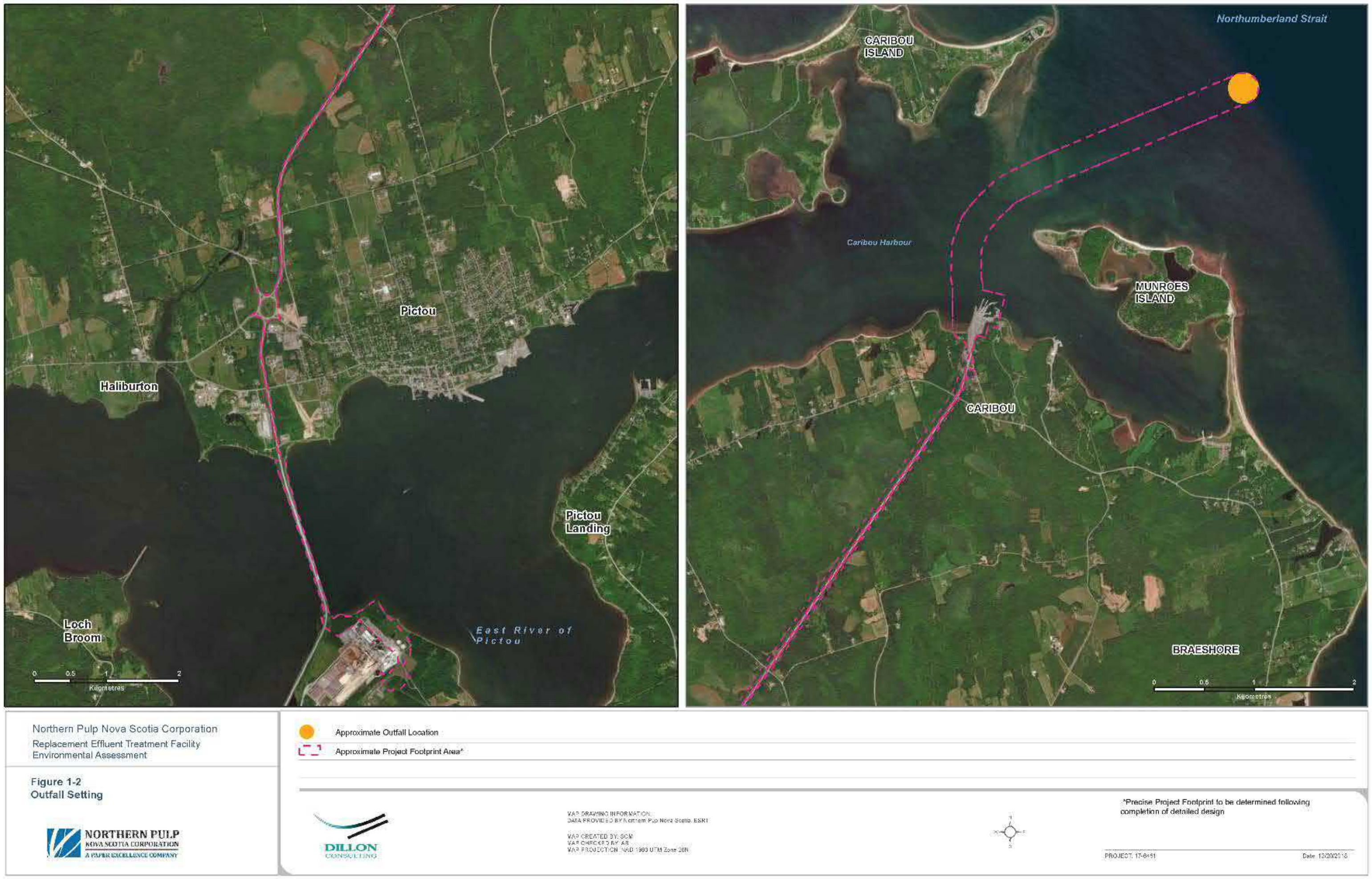


Figure 1.1: Location of the proposed Caribou Harbour outfall, effluent pipeline route, current mill infrastructure and other local features **(used with permission from Dillon Consulting)**

1.2 Objective of the Proposed Work Scope

As indicated above, it has been recommended that the new treated effluent outfall be located in the Northumberland Strait in an offshore area approximately 15.2 kilometers from the mill. Accordingly, should the EA be approved and the design and construction of the new treatment plant and discharge structure move forward as proposed, it will be necessary to test EA-related predictions and assess the expected performance of the ETP and outfall structure.

The primary objective of the current report therefore, is to outline a proposed EA follow-up monitoring program that satisfies baseline information requirements so that EA-related predictions and expected ETP and outfall structure performance can be evaluated.

It should be noted that additional monitoring has also been proposed and is described under separate cover (see EcoMetrix, 2019). This additional monitoring is specific to the mill's obligations for Environmental Effects Monitoring (EEM) as prescribed under the *Pulp and Paper Effluent Regulations* (PPER) under the *Fisheries Act*. The EEM program components are not as inclusive as those proposed in this report, and generally the EEM program focusses effort in the immediate area of the proposed outfall location. The work scope described herein does not duplicate the effort proposed for the EEM program; rather, the two monitoring programs are intended to be complementary. Where appropriate the proposed EEM sampling program as described by EcoMetrix (2019) is referenced.

1.3 Report Format

Following this introductory section, the remainder of the proposal is organized as follows. In **Section 2.0 (Proposed Scope of Work)**, the proposed objectives to be achieved and the scope of work is provided. In **Section 3.0 (Proposed Work Scope Implementation Schedule)** the schedule for the execution of this program is provided. **Section 4.0 (References)**, the references cited in this document are provided.

2.0 PROPOSED SCOPE OF WORK

2.1 Overview

The following sections describe recommendations for the framework upon which the EA follow-up monitoring program will be executed. The follow-up program consists of both baseline environmental sampling (i.e., pre-construction and discharge) and performance monitoring (i.e., post-construction and discharge). The baseline dataset forms the basis upon which the expected performance of the ETP and outfall structure can be assessed.

Further feedback on this plan is anticipated as the EA process proceeds and can be incorporated into the design of the final EA follow-up monitoring program documentation as appropriate.

It is noted that the program described herein is specific to the execution of the baseline sampling program and the first iteration of performance monitoring. The scope of further iterations of the performance monitoring program would be considered with an adaptive management framework – that is, the scope of subsequent iterations would be informed by the results of previous iterations. For example, where monitoring results indicate that either end-of-pipe effluent quality data or receiving environment data deviate from those predicted in the EA the potential consequences (if any) of such deviations would be investigated. In this instance, additional or modified performance monitoring components could be proposed and/or implemented, as appropriate. Alternatively, where EA-related predictions are confirmed reduced monitoring effort may be indicated.

2.2 Toxicity Testing of Treated Effluent

Local and regional fisheries resource users have raised concerns over potential toxicological effects on fisheries resource use as the result of the proposed discharge of effluent. The major concerns are related to the potential effects of the new discharge location on larval lobster and herring eggs, though potential effluent-related effects more broadly within resident aquatic biota are also of concern.

To address the concern, NPNS will commission toxicity testing to determine both potential acute and sublethal effects on immature stages of lobster and herring. Standardized toxicity testing protocols are not available for lobster and herring; however, custom tests have been developed that can be completed using larval lobster and herring embryos. The tests will include Stage I-IV larval lobster and include a live-dead (acute) assessment of the various stages, as well as the assessment of sublethal effects on moulting time and growth. Herring tests on embryos would be similar in that they would assess acute toxicity to eggs, as well as the growth post-hatch for a number of days.

In conjunction with the specialized testing that is proposed, after commissioning of the new ETP, NPNS will be required to conduct the sublethal testing associated with the EEM program to meet its obligations under the PPER. EEM specific testing requirements are described by EcoMetrix (2019).

2.3 Phytoplankton Community Assessment

Phytoplankton forms the basis of the food web and changes to the composition of the phytoplankton community and/or the abundance and distribution of phytoplankton near the diffuser as the result of effluent exposure could have effects on higher trophic levels. Phytoplankton sampling will provide information concerning species composition, abundance and distribution in the study area.

Seasonal phytoplankton sampling is proposed. Phytoplankton will be collected by vertical tows. The plankton net (1 m diameter, 63 micron mesh) will be pulled vertically through the water column over the length of the photic zone. Samples will be sent for analysis by a qualified taxonomist and the phytoplankton will be identified to the lowest practical taxonomic level. As indicated above, the phytoplankton data will be summarized in terms of species composition, distribution and abundance.

Sampling will occur prior to (baseline monitoring) and following (performance monitoring) the construction of the proposed ETP and discharge structure and commencement of treated effluent discharge at the new outfall location (see **Section 3.0**).

2.4 Zooplankton Community Assessment

Zooplankton are a diverse group of organisms that may spend all or part of their life in planktonic form. Important zooplankton groups include the foraminiferans, crustaceans, and molluscs. Many marine fish and shellfish species of commercial, recreational and/or aboriginal importance also have early larval stages that are planktonic and occur throughout the water column. These zooplankton may be exposed to and potentially affected by effluent once discharge commences. Zooplankton sampling, including live-dead assessments, will provide information concerning species composition, distribution and abundance in the study area.

Seasonal zooplankton sampling is proposed, with samples collected coincident with phytoplankton sampling. Zooplankton will be collected by vertical tows. The plankton net (1 m diameter, 300 micron mesh) will be pulled vertically through the water column over the length of the photic zone. Samples will be collected at the same locations as for phytoplankton. Samples will be sent for analysis by a qualified taxonomist and the zooplankton will be identified to the lowest practical taxonomic level. Similar to phytoplankton, the zooplankton data will be summarized in terms of species composition, distribution and abundance.

As indicated above, many marine fish and shellfish species that are of commercial, recreational and/or aboriginal importance have larval stages that occur throughout the water column. With this in mind, more targeted collections are proposed to better characterize the zooplankton community, and in particular to characterize that portion of the zooplankton community that are of local and regional significance.

Seasonal horizontal larval tows at both the surface and mid-depth, including live-dead assessments, are proposed. These samples will provide further data on species composition, distribution and abundance in the immediate vicinity of the proposed discharge location and in the general study area. Either a neuston net or a bongo net will be used to collect samples. The tows will be completed along west-to-east oriented transects approximately 300 m in length. One transect will be located directly over the location of the proposed diffuser and additional transects will be located at defined distances out from the location of the proposed diffuser to provide adequate spatial coverage of the area.

In addition to the seasonal horizontal tows, horizontal tows will also be conducted for the duration of the period over which larval lobster are expected to emerge and exist in their planktonic form. This targeted sampling will aim to collect emerging larval lobster during the start, peak and end of the emergence period. Lobster in particular have been identified as being of local importance and therefore it is proposed that their abundance and distribution in the planktonic form will be assessed using a rigorous design. Larval lobster typically emerge and migrate to the surface of the water column in mid-summer. The pelagic stages of lobster (Stages I to III) last approximately one month with Stage IV lobster also continuing to be pelagic at times for an additional month. Therefore, sampling for larval lobster will commence in mid-July and continue weekly until the end of August. This design will adequately assess the abundance of lobster in the study area. The horizontal tows targeting the larval lobster will be completed by the same methods at the same locations as described above.

All zooplankton samples will be sent for analysis by a qualified taxonomist and the zooplankton will be identified to the lowest practical taxonomic level. As indicated above, the zooplankton data will be summarized in terms of species composition, distribution and abundance.

Sampling will occur prior to (baseline monitoring) and following (performance monitoring) commencement of the treated effluent discharge at the new outfall location (see **Section 3.0**).

2.5 Benthic Invertebrate Community

The benthic invertebrate community may be affected by both construction activities associated with the new proposed effluent pipeline and outfall structure, as well as with the potential exposure to effluent once the discharge of effluent has commenced. Potential exposure related issues are assessed as part of the federal EEM program and a study plan that considers the benthic invertebrate community at, and in the vicinity of the proposed effluent outfall has been proposed in "*Environmental Effects Monitoring Program*

Investigations Associated with the New Proposed Treated Effluent Discharge Configuration at the Northern Pulp Nova Scotia Corporation Mill" (EcoMetrix, 2019).

Herein, it is proposed that sampling efforts will focus on the effluent pipeline corridor so that further baseline information can be obtained. It is noted that benthic habitat and geotechnical information will be collected in 2019 along the in water portion of the proposed pipeline corridor. This information is in addition to the data available from the most recent dredging associated with the Prince Edward Island ferry channel and will include bottom habitat information from a sidescan sonar survey. It is proposed that benthic samples will be collected at 500 m intervals along the in water portion of the pipeline corridor. Conservatively, this would total approximately 8 stations along the corridor. Samples will be collected with a petit ponar grab and sieved through 500 micron mesh. Detailed taxonomic identification of the resident benthic taxa in the samples will be undertaken. Invertebrates will be identified to the lowest practical taxonomic level. Raw data will be summarized to express the benthic invertebrate community in terms of metrics of abundance, diversity and community structure.

Sampling will occur prior to (baseline monitoring) and following (performance monitoring) the construction of the proposed ETP and discharge structure and commencement of treated effluent discharge at the new outfall location (see **Section 3.0**).

Supporting environment data will be collected coincident with benthic invertebrate samples to help interpret any patterns that may be identified in the benthic data. Three representative sediment samples both inside and outside Pictou Harbour will be characterized for:

- grain size;
- total organic carbon;
- total sulphides;
- Eh;
- the carbon to nitrogen ratio;
- Dioxins[3];

[3] - These parameters will be analyzed for the sediments collected along the pipeline corridor as well as the sediment samples collected as part of the EEM Monitoring Program. It should be noted that some of the parameters listed may not be analyzed coincident with the benthic collections but rather the data obtained through the pre-construction assessments conducted by Stantec (2017).

- Furans[3];
- Adsorbable Organic Halides (AOX)[3];
- Metal Scan[3];
- Acid-volatile sulphide[4]; and,
- Low Level Mercury[4].

2.6 Water Quality

There will be ample time to collect baseline (i.e., pre-discharge) water samples during the other components of the aquatic community study. Water samples will be collected for the measurement of:

- dissolved oxygen levels;
- temperature;
- salinity;
- colour;
- pH;
- total suspended solids;
- turbidity;
- dissolved organic carbon;
- total organic carbon;
- total Kjeldahl nitrogen;
- total phosphorus;
- total nitrogen;
- metal scan;
- low level mercury;
- Resin fatty acids;
- BOD_5;

- Dioxins;
- Furans;
- Total phenols; and,
- AOX

2.7 Fish Community and Fisheries Resource Characterization

Fish community and fisheries resource use information has been complied as part of the EA process. Given the level of detail associated with the available information no additional in-field survey programs are proposed.

2.8 Fish and Shellfish Tissue Chemistry Investigations

In conjunction with local fishers and fishery users, NPNS will secure tissue samples from finfish and shellfish species that are important components of the local fishery. Local commercial, recreational and aboriginal fisheries use and sensitivities have been documented (e.g., EcoMetrix, 2005; EcoMetrix, 2011; Stantec, 2017). Based on this information potential species of interest that could be used for this assessment include: lobster, rock crab, scallop, blue mussel, softshell clam, oyster, and locally relevant finfish (e.g., Eel, Smelt, Gaspereau, Striped Bass, Mackerel, Atlantic Herring).

Tissue specimens will be collected from the exposure area (i.e., the area potentially influenced by mill effluent) and up to two reference areas that are beyond the potential zone of influence of the effluent. Overall, it is envisioned that 5 to 8 replicate samples of 3 to 4 species from 2 to 3 sampling areas will be submitted for analysis of the following parameters:

- total phenols;
- total metals contents;
- low level mercury; and,
- resin and fatty acids.

The level of replication proposed will make it possible to statistically compare the concentrations of the aforementioned chemical parameters within individual species among sampling areas with a reasonable level of statistical power.

The data collected as part of this sampling program may be supplemented by the EEM program components detailed by EcoMetrix (2019). The caged bivalves that will be deployed as part of the EEM program study to assess fish population health will also be used for the purpose of assessing tissue chemistry. Tissue samples from the mussels that are deployed for the EEM program will be analyzed for the chemical parameters listed above. Mussels act as semi-permeable membranes in the water column and their tissue chemistry quickly comes to reflect the chemistry of the water in which they are resident.

Dioxin and furan testing in fish or shellfish tissues for EEM is not likely to be required by the PPER based on current and predicted future levels of these constituents in mill effluent and therefore they have not been proposed as part of the suite of parameters in this study. Annual testing of treated effluent for dioxins and furans in the future treated effluent will continue to be performed as per the requirements set out in the Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations.

Sampling of fish tissues will occur prior to (baseline monitoring) and following (performance monitoring) commencement of treated effluent discharge at the new outfall location (see **Section 3.0**).

3.0 PROPOSED WORK SCOPE IMPLEMENTATION SCHEDULE

A provisional proposed implementation schedule for the work scope elements described in **Section 2.0** is summarized in **Table 3.1**. It is noted that the schedule only considers the pre-discharge and first post-discharge studies. Subsequent performance monitoring needs will be refined as appropriate based on the results of these surveys and by stakeholder input, as described in **Section 2.1**.

Table 3.1: Baseline Assessment Schedule

Activity	Associated Date
Effluent Toxicity Testing	• Post discharge survey – within 24 months of the initiation of discharge from the new outfall location o Based on test specimen availability the herring and lobster toxicity can be conducted in the spring (April/May) and fall (August/September), respectively. o Three to four months of lead time is recommended prior to the initiation of the toxicity testing program.
Phytoplankton and Zooplankton	• Pre-discharge survey – 2019 • Post discharge survey – within 24 months of the initiation of discharge from the new outfall location • Plankton surveys will be conducted over multiple seasons to provide a baseline characterization.
Benthic Community	• Pre-construction survey along the pipeline route • Collections of post discharge samples along the pipeline route are not proposed.
Fish and Shellfish Tissue Evaluation	• Pre-discharge survey – 2019, with the timing of collections for individual species selected based on local fishery use patterns and the execution of the EEM caged bivalve survey. • Post discharge survey – Within 24 months of the initiation of discharge from the new outfall location, with the timing of collections for individual species selected based on local fishery use patterns, and the execution of the EEM caged bivalve survey.
Water Quality	• Pre-discharge survey – 2019 • Collections of water quality samples will occur seasonally during the other proposed components of the study.

4.0 REFERENCES

EcoMetrix Incorporated (EcoMetrix). 2005. EEM Cycle 4 Study Design for the Neenah Paper (Pictou Mill) Facility at New Glasgow, Nova Scotia. Submitted to Neenah Paper Inc. and Environment Canada by EcoMetrix.

EcoMetrix Incorporated (EcoMetrix). 2011. EEM Cycle 6 Study Design for the Northern Pulp Nova Scotia Corp. Facility near Pictou, Nova Scotia. Submitted to Northern Pulp Nova Scotia and Environment Canada by EcoMetrix.

EcoMetrix Incorporated. 2019. Environmental Effects Monitoring Program Investigations Associated with the New Proposed Treated Effluent Discharge Configuration at the Northern Pulp Nova Scotia Corporation Mill. January 2019.

Stantec Consulting Ltd (Stantec). 2017. Preliminary Receiving Water Study for Northern Pulp Effluent Treatment Plant Replacement, Pictou Harbour, Nova Scotia. Report Prepared for KSH Solutions Ltd. August 11, 2017.

Stantec Consulting Ltd (Stantec). 2018. Addendum Receiving Water Study for Northern Pulp Effluent Treatment Facility Replacement Project – Additional Outfall Location CH-B, Caribou Point, Nova Scotia. Report Prepared for NPNS. December 19, 2018.