9.0 Human Health Evaluation

Preface

Presently, there is no regulatory requirement to conduct a human health risk assessment (HHRA) study in association with the NPNS project. The project is currently in a Class 1 EA Process in Nova Scotia that does not specifically require the completion of a HHRA in advance of registration of an EA.

Public and regulatory concerns regarding the potential human health effects of project emissions and treated effluent discharges have been and continue to be raised throughout the project's development period. This has led to a number of discussions with NSE and Health Canada over the past year regarding the potential for project-related human health effects. Whether or not a HHRA study would be required is a provincial decision that would be anticipated when the Province issues conditions of approval for the project. NSE regularly engages Health Canada in an advisory role on projects where human health effects may need to be considered. In discussions/consultation and correspondence between project EA team personnel and Health Canada representatives over the past several months, Health Canada clearly communicated their position that a HHRA of the project would need to be considered.

Thus, in anticipation of a potential regulatory requirement for a HHRA of the project, a human health evaluation (HHE) was conducted (presented herein). The HHE reviews and synthesizes currently available relevant information and sets the stage for a HHRA study, should a HHRA become a regulatory requirement.

9.1 Introduction and Background

Public and regulatory concerns regarding the potential human health effects of project emissions and treated effluent discharges have been raised throughout the project development period, and it is likely that such health-related concerns will continue to be raised during NSE's EA review process.
The project has two main sources of emissions/discharges that may result in potential human exposure to project-associated chemicals:

- The marine treated effluent diffuser; and,
- Air emissions from the replacement ETF and existing NPNS mill due to future planned co-combustion of sludge with hog fuel in the mill power boiler.

Details on the project, and its key components and infrastructure, are previously provided in **Section 5.** Such information is not reproduced within this section.

At this time, effluent chemistry characteristics (including the specific substances present in treated effluent and their anticipated concentrations) will not be known with certainty until the project is operational. Some other current areas of uncertainty include limited recent or current baseline environmental media and marine food item chemistry data, and limited data on traditional marine food item harvesting and consumption patterns within the PLFN community.

PLFN is a key study area community of interest with respect to potential human exposures to project-associated chemicals. PLFN and other community marine recreational patterns in the vicinity of the proposed effluent diffuser location are also largely unknown, though very little to negligible recreational activity would be anticipated at the proposed diffuser location.

While such uncertainties would preclude the ability to conduct a HHRA at this time, a qualitative human health evaluation (HHE) was conducted (and presented herein) which serves as an interim approach to address the potential for human exposure and risk in relation to project air emissions and treated effluent discharges. The HHE was conducted at a scoping level or screening level of effort and utilizes data and study outcomes that are currently available and/or feasible to address at this time.

Essentially, the HHE sets the stage for an anticipated future HHRA study (should one be required) that would be conducted once suitable data are available. The HHE relies in large part on a review and synthesis of compiled historical data and documents (including some historical HHRA studies) that are relevant to locations within the current project study area and/or that relate to the existing NPNS facility and areas that have been influenced by its operation within the past five decades. The HHE also considers identified HHRAs of projects that are similar to the NPNS project (only one such study was identified to date; i.e., Toxikos, 2006). The HHE utilizes the outcomes of the data and document review and synthesis to infer, extrapolate or predict what may be reasonably anticipated with respect to potential human exposure to project-associated chemicals.

It is noted that parallel efforts similar to the HHE have been conducted by consultants retained by NPNS. Relevant aspects of that work have been incorporated herein.

The HHE is structured in accordance with the problem formulation step of the HHRA framework that is commonly used in HHRAs conducted across Canada, as described in Health Canada guidance documentation (i.e., Health Canada, 2010). Thus, the HHE primarily addresses the following HHRA problem formulation items:

- Identifying relevant exposure pathways, routes and scenarios;
- Identifying relevant human receptors; and
- Identifying candidate chemicals of potential concern (COPCs) in the project air emissions and treated effluent.

The HHE does not include quantitative exposure and risk analysis approaches at this time that would typically comprise the HHRA steps of exposure assessment, toxicity assessment and risk characterization. The HHE is not a HHRA, though it does necessarily comprise some elements of a HHRA, as noted above.

Qualitative approaches like the HHE are common and typical for many EA processes across Canada, particularly when a project is at an EA registration stage. In this stage, it is common and expected that there are various project details under development and/or in the process of being refined. With respect to the review and synthesis of historical data and reports, it is noted that a substantial amount of the reviewed historical data were collected from locations outside the current project study boundaries and/or are too old to represent current baseline concentrations of chemicals of interest in air, or in marine environmental media and marine traditional food items. While such data cannot be used to directly assess the potential human health implications of the project, it can be used to inform on candidate chemicals of potential concern (COPCs) that would potentially be evaluated in a HHRA study. Candidate COPCs are addressed further in **Section 9.2.4**.

As noted above, the HHE also considers identified HHRAs of projects that are similar to the NPNS project. Literature review efforts to date have identified only one such study (i.e., Toxikos, 2006). This particular HHRA study predicted potential human exposures and risks associated with a marine treated effluent discharge into Bell Bay, Tasmania, from a proposed elemental chlorine free (ECF) kraft pulp mill that would mainly process hardwood eucalyptus. A key focus of this HHRA involved assessing whether or not the effluent discharge might impact human health due to potential bioaccumulation of effluent chemicals into marine biota species which are consumed by humans. While this HHRA study also evaluated potential recreational sea water contact exposures in a cursory manner (i.e., comparison of predicted concentrations of COPCs in sea water to recreational water quality guidelines), the study authors noted that this exposure pathway is unrealistic and implausible given the location of the proposed effluent diffuser, and its hydrodynamic characteristics (i.e., depth of 25 m, 3 km off shore in a high energy dispersive environment). Furthermore, the applied guidelines are not appropriate for potential transient and infrequent sea water contact events, which is the only plausible sea water contact exposure scenario for a subsea effluent diffuser (this would include splash and spray water contact events as well as someone falling out of a boat).

The Toxikos (2006) HHRA was a highly conservative assessment that substantially overestimated exposure and risk to potential human consumers of fish and shellfish that may be influenced by the effluent diffuser discharge in Bell Bay. The authors concluded that there were negligible risks to human health from consuming any marine food item harvested in the vicinity of the effluent diffuser, for any of the substances that were assessed in the HHRA. This study considered numerous substances, but through a multi-step screening process, ultimately selected only four COPCs for assessment (i.e., cadmium, mercury, selenium, PCDD/F). The Toxikos (2006) screening procedure is addressed further in **Section 9.2.4.2.1**.

It is believed that the assumed effluent chemistry characteristics and composition as well as the effluent diffuser design for the Tasmania project are similar to what is proposed and designed for the NPNS project (KSH Consulting, Personal Communication). Both mill facilities utilize ECF bleaching processes, and this will not change for future NPNS mill operations.

The proposed Tasmania pulp mill was assumed to process mainly hardwood eucalyptus chips. There is some uncertainty regarding how the wood chips processed at the NPNS mill, which are from softwood coniferous species, would compare to eucalyptus chip processing, with respect to potential effluent chemistry differences. However, in the interim, the Toxikos (2006) study may serve as a reasonable indication of what may be expected in relation to project treated effluent composition/characteristics (KSH Consulting, Personal Communication).

It is acknowledged that the Toxikos (2006) HHRA study in Tasmania has not undergone regulatory review by Health Canada at this time, but it appears to be a well conducted and highly conservative study that applied reasonable and standard HHRA approaches and assumptions.

In general, while studies of other pulp and paper mill projects elsewhere in the world (which are subject to different regulatory regimes and requirements than those that prevail in Nova Scotia) may share some similarities to the NPNS project, key aspects of these studies (such as effluent composition, receptors, exposure pathways) cannot be assumed to be directly applicable to the current project, though they may facilitate to some degree the identification of key exposure pathways, receptors and COPCs, and may also inform on certain assessment approaches that could be applied or considered in a HHRA study of the NPNS project.

9.1.1 Health Canada Consultation

Consultation has occurred with Health Canada in relation to the HHE (herein) and a potential HHRA study that could be conducted when key data constraints and uncertainties have been addressed. Key Health Canada expectations with respect to evaluating the human health implications of the project are summarized below:

- Consistency with current Health Canada HHRA guidance documentation.
- Including both baseline and future conditions exposure scenarios.
- Emphasis on potential exposures and risks that may be incurred from the harvesting and consumption of marine food items that could be affected or influenced by the treated effluent diffuser.
- Consideration of potential drinking water impacts.
- Consideration of potential changes in local air quality due to co-burning of sludge in the power boiler.
- A focus on First Nations (i.e., PLFN).
- Requiring the collection of a reasonable number of baseline sea water, sediment and marine food item tissue samples.
- If possible, incorporating at least a rudimentary survey of local harvesting and consumption patterns for marine-based traditional food items among PLFN members.
- Including a reasonably well defined characterization of likely effluent chemistry that represents a conservative prediction of the chemicals that may be present in effluent discharge.

It was also discussed that for EA purposes, a human health study (HHRA or HHE) could potentially be largely qualitative in nature as opposed to quantitative. However, this was acknowledged as being dependent on the identified operable exposure pathways and the availability of relevant chemistry data for such pathways.

With respect to item ix above, there remains uncertainty at this time regarding the specific chemical parameters that will be present in the project's treated effluent (and their concentrations).

9.1.2 Scope of Human Health Evaluation

The HHE applies a standard HHRA problem formulation structure to identify potential human receptors, exposure pathways, exposure scenarios and candidate chemicals of potential concern.
Human health is a public and regulatory concern for the following reasons:

- Chemicals present in treated effluent that is released to the marine receiving environment may come into contact with human receptors in marine sea water or sediments.
- Some of the chemicals present in treated effluent may accumulate within certain marine food items that are harvested by local community members.
- Air emissions of certain contaminants to the atmosphere, during construction and operation (and maintenance) of the project, may present a potential inhalation exposure pathway for human receptors in communities located within the study area.
- As the current proposed pipeline route traverses a drinking water supply area, there is a potential that accidental releases from the effluent pipeline in this area (should they occur) could potentially impact potable water supplies.

The HHE partially relies upon the outcomes of the environmental effects assessment for the atmospheric environment (**Section 8.1**) and groundwater (**Section 8.5**), and also utilizes certain information and outcomes from the assessments of Harbour physical environment, water quality and sediment quality (**Section 8.11)**, marine fish and fish habitat (**Section 8.12**), and marine mammals, sea turtles, and marine birds (**Section 8.13**).

For HHRAs of projects undergoing an EA process, and similar evaluations such as the HHE herein, there are no provincial regulations within Nova Scotia that apply. However, most of these types of studies that are conducted within Canada closely follow HHRA guidance developed by Health Canada (posted at: https://www.canada.ca/en/health-canada/services/environmental-workplace-health/contaminated-sites/guidance-documents.html). As noted above, Health Canada guidance is followed for the HHE.

9.1.3 Spatial and Temporal Boundaries for the HHE

Spatial boundaries for the assessment of human health are a combination of the assessment area for the Atmospheric Environment VEC (**Section 8.1**), the Local Assessment Area (LAA) as described in the Groundwater Assessment (**Section 8.5**), and the potential extent of water quality/sediment interactions and wider area of relevance to migratory or pelagic species (described in **Sections 8.10** and **8.11**). For the area potentially influenced by the marine treated effluent diffuser discharge, the HHE study boundaries are considered to be based on a conservative assessment of the spatial extent of effluent discharge that would exceed background conditions. Consideration is also given to the potential for effluent pipeline construction effects that may generate suspended sediments in localized areas along the pipeline route. Essentially, the marine spatial boundaries of potential relevance to human health are Pictou Harbour (PH; areas near the pipeline crossing only), and the coastal environment of Caribou Harbour and coastal Northumberland Strait near Caribou Island and Munroes Island.

More specifically, the marine study boundary is considered to be a radius of a couple to few hundred metres around the proposed treated effluent diffuser discharge location (i.e., CH-B). The diffuser engineering design work is completed and a 3-port diffuser will be employed that is anticipated to achieve a dilution factor of ~168 x within 100 m of the discharge point.

Temporal boundaries for the assessment of environmental effects are based on the project schedule described in **Section 5.4** and include periods of construction, operation and maintenance, and decommissioning. Construction is estimated to be approximately 21 months, beginning second quarter of 2019, commencing as soon as the EA review has been completed and the applicable permits, approvals or other forms of authorization have been obtained. Operation and maintenance will commence immediately following the construction phase and will continue to operate efficiently and safely for several decades and likely much longer with a well-maintained system. For the purpose of this EA Registration, it has been assumed that the operation and maintenance phase will begin in the fourth quarter of 2020. Decommissioning of the project would occur at the end of mill life following the completion of operations. Once the ETF or pipeline is nearing the end of a useful service life, a decommissioning plan will be developed and will be submitted for a separate review requiring NSE approval.

9.2 Human Health Evaluation

The potential human health impacts of the project are addressed in this section. A HHRA problem formulation structure is used to organize this section with respect to describing potential exposure pathways, exposure routes, exposure scenarios, human receptors, and candidate chemicals of potential concern in project air emissions and treated effluent discharge.

9.2.1 Identification and Potential Exposure Pathways and Routes

People can come into contact with chemicals in a variety of ways, depending on their daily activities and their land/resource use patterns. The means by which a person comes into contact with a chemical in an environmental medium are referred to as exposure pathways. The means by which a chemical enters the body from the environmental medium are referred to as exposure routes. There are three major exposure routes through which chemicals present in environmental media can enter the body: inhalation, ingestion and dermal (skin) absorption. For each of these major exposure routes, there are a number of potential exposure pathways. For example:

- Inhalation of gases, vapours, and dusts/particulate material.

- Ingestion of soils, dusts, drinking water, garden produce, local country food items (e.g., fish, shellfish, game meats, wild berries/plants), grocery store-bought food items, and accidental/incidental ingestion of surface or ground water, and sediments).
- Dermal absorption (i.e., uptake through the skin) from direct skin contact with gases/vapours, soils/dusts, water and other materials.

For the HHE, the identification of potential likely exposure pathways and routes considered the project description, the outcomes of relevant VEC assessments, historical HHRAs conducted in the vicinity of the NPNS pulp mill facility (e.g., Cantox 1997a, 1997b; JWEL/Cantox 1998; JWEL 2004), and numerous historical and current environmental monitoring studies conducted in various areas near the NPNS mill.

The specific exposure pathways and routes that were identified as being relevant for the project are as follows:

- Outdoor air inhalation.
- Incidental contact with sea water/marine sediments.
- Ingestion of traditionally harvested marine food items (by PLFN members) that may accumulate chemicals present in the marine treated effluent discharge.
- PLFN and general public ingestion of commercial fishery and aquaculture products that may be impacted or influenced by residual effluent chemicals present in marine waters.
- Ingestion of drinking water that may be impacted by accidental releases from the effluent pipeline.

With respect to the potential for incidental contact with sea water and sediments, the offshore location (roughly 4 km from shore) of the proposed treated effluent diffuser in an area of high hydrodynamic energy and a >20 m depth would suggest it is implausible that there could be any significant direct human contact with effluent chemicals in sea water or marine sediments in the vicinity of the diffuser. The Stantec (2018a) receiving environment study concluded that water quality will reach ambient conditions within less than 2 m from the diffuser in terms of total nitrogen, total phosphorous, DO, pH, and salinity, and colour will return to baseline conditions within 5 m of the diffuser (see **Section 8.12.3.3**). Water temperature is anticipated to meet compliance for applicable federal water quality guidelines within approximately 2 m of the diffuser and be within 0.1 °C of background at the end of the 100-m mixing zone. It is presumed that other residual chemicals contained in the treated effluent would also diffuse within this mixing zone in a similar manner. Thus, this exposure pathway(s) would likely not be carried forward into a HHRA study.

With respect to PLFN harvesting of traditional marine food items, it is noted in BEAK (2000) and all subsequent EEM cycle reports that PLFN residents traditionally harvest various species including lobster, rock crab, herring and American eel. However, the extent and details of PLFN harvesting and consumption patterns for such species does not appear to have been documented to date. In many areas of Pictou Harbour, Pictou Road and other coastal Northumberland Strait areas, local shellfish harvesting (e.g., native mussels, clams, oysters) has long been and remains prohibited due to faecal coliform bacterial contamination (from municipal and domestic sewage discharges). No harvesting of native bivalve shellfish in prohibited areas would be expected. However, the shoreline areas around Caribou and Munroes Island (near the proposed CH-B effluent diffuser location) are currently open for bivalve shellfish harvesting, such that it is possible local harvesting and consumption of bivalve shellfish from these areas could occur (https://inter-w01.dfo-mpo.gc.ca/Geocortex/Essentials/Viewer/Index.html?viewer=CSSP_Public_En_Site).

With respect to commercial fishery and aquaculture products, there are several active recreational and commercial fisheries in the area and there are also currently four provincially licensed marine shellfish aquaculture operations (all for American Oyster) in the vicinity of Caribou and Munroes Island, which are located relatively near to the location of the proposed effluent diffuser (CH-B).

A few past reports have described local commercial and recreational fisheries (e.g., BEAK 2000; Stantec 2004; Ecometrix 2016; JW 2004; JWEL 1993a, 1993b). In these reports, it was noted that recreational sportfishing focuses mainly on sea run brook trout, Atlantic mackerel, alewife, Atlantic salmon, rainbow smelt and striped bass. The striped bass fishery was closed from the late 1990s to early 2000s, and re-opened in 2013 with two short retention periods in May and August. In 2015 and 2016, the striped bass season was expanded to four short retention periods (May, August, September and October; Ecometrix, 2016). These reports also note that lobster, rock crab, and Atlantic herring are the most important local commercial fisheries. Commercial scallop fishing occurs as well but to a lesser extent than lobster and herring fishing. The local lobster fishing season (DFO Lobster Fishing Area (LFA) 26a) runs from April 30th to June 30th, with harvesting typically occurring close to shore around rocky shoals. Herring are harvested at the approaches to Pictou Harbour, from September to October (Ecometrix, 2016). JW (2005) noted that lobster, rock crab and American eel fishing occurs mainly in Northumberland Strait with occasional fishing within Pictou Road. One of PLFN's main industries is commercial fishing (there are license holders among PLFN for lobster, rock crab, snow crab, mackerel, herring and tuna), and approximately 100 people are employed in this industry annually (Chan et al., 2017).

Exposure pathways and routes other than those listed above do not merit consideration in relation to the project. HHRAs commonly and appropriately exclude exposure pathways and routes that are not relevant to, or not affected/influenced by a given study area, site or project under investigation, or that lack sufficient data to enable their evaluation with a reasonable degree of confidence and/or accuracy. Generally, excluded pathways and routes would be expected to make a negligible contribution to COPC exposures, relative to those that are selected for evaluation.

9.2.2 Identification of Potential Human Receptors and Their Characterization

A human receptor is a hypothetical person (e.g., infant, toddler, child, adolescent, adult) who resides, visits or works in the area being investigated and is, or could potentially be, exposed to the chemicals identified as being of potential concern. General physical/physiological and behavioural characteristics specific to the receptor type (e.g., body weight, breathing rate, food and soil consumption rates, etc.) are used to determine the amount of chemical exposure received by each human receptor. Due to differences in these characteristics between children and adults and between males and females, the exposures received by a female child, a male child, a female adult or a male adult will be different. Consequently, the potential human health risks posed by the chemicals being evaluated will also differ depending on the receptor that is under evaluation.

Since people have varying physical/physiological features, lifestyles and habits, it is not possible to evaluate all types of individuals. However, a HHRA must be sufficiently comprehensive and protective to ensure that those receptors with the greatest potential for exposure to COPCs and/or those that have the greatest sensitivity, or potential for developing adverse effects from such exposures, are evaluated in a HHRA. If no potential health risks are determined/predicted for relevant receptors that are considered to be either the most sensitive, or the most exposed, then it can be assumed that those receptors who are either less sensitive, or who receive lower exposures, would also not be at risk.

Human chemical sensitivity is primarily a function of physiological maturity (life stage) and/or pre-existing biochemical, physiological or medical conditions that may compromise an individual's ability to effectively cope with chemical exposures. For example, infants and young children, being in a state of rapid growth and still immature in terms of development, may be more sensitive than adults to some (though not all) chemicals, and may also experience different types of adverse effects than adults do, when exposed to the same chemical(s) for the same durations. The potentially greater chemical sensitivity in younger age classes (relative to older age classes) is believed to reflect immature or not fully developed biochemical and physiological processes and mechanisms that regulate a chemical's absorption, distribution, metabolism (including detoxification) and elimination, as well as its toxic mode of action. Also, in fetuses, infants and young children, there are known to be certain sensitive developmental stages or windows where chemical exposure may be of greater potential harm relative to other periods in human development and growth.

HHRAs also consider whether or not the identified COPCs and exposure pathways support the assessment of human receptors with known or likely sensitivity/vulnerability (relative to other human receptor types). Often, when evaluating community level exposures and risks, HHRAs assess each human life stage in order to ensure that no potentially highly exposed and/or sensitive/vulnerable human receptor life stage would be inadvertently overlooked. In addition, in HHRAs that evaluate communities, it is often a preferred approach to assess all potential receptors rather than to target only the most sensitive or most exposed receptors. This approach can greatly aid in HHRA transparency and completeness, and in facilitating the communication of potential human health risks.

The following human receptor age classes are therefore anticipated to be considered in a potential HHRA of the project (as per Health Canada 2010; Richardson and Stantec 2013):

- Male and female infant (0 to 11 months);
- Male and female preschool child or toddler (1 to <4 years);
- Male and female child (4 to <12 years);

- Male and female adolescent or teen (12 to <20 years); and
- Male and female adult (≥20 years).

In the event a HHRA of the project is required, the study would refine and justify the human receptors that are ultimately selected for evaluation. Depending on the exposure pathways and receptors that are selected for evaluation, it is considered likely that only a subset of the receptor types noted above would actually require assessment.

It is common that final human receptor selection for HHRA is somewhat dependent on the COPCs and exposure pathways that are identified as being relevant. For example, if some of the COPCs are developmental toxicants, young life stages and female receptors of child-bearing age may warrant evaluation. If there are COPCs that are known to partition to breast milk, lactational transfers to nursing infants may require assessment. HHRAs also commonly assess toddler life stages for non-carcinogenic COPCs. This is partly due to the potentially greater chemical sensitivity of such receptors, as briefly described above, but also reflects their generally higher potential for chemical exposure. For example, toddlers typically receive greater chemical exposures, via all pathways and routes, on a relative body weight basis, when compared to other human receptor classes (i.e., infant, child, adolescent and adult). In other words, toddlers have higher intake rate to body weight ratios than the other human age classes. Toddlers also have certain physiological and behavioural characteristics that tend to increase their chemical exposure relative to other receptors (e.g., tendency to play outdoors for prolonged durations; tendency to ingest soil/dust due to frequent hand-to-mouth behaviour and mouthing of objects; greater potential for dermal contact due to playing and digging in soil).

For COPCs that are carcinogenic, it is common for HHRAs to assess adult receptor life stages or a lifetime receptor that is a composite of all life stages, when assessing carcinogen exposure and risk.

As indicated above, both female and male human receptors are anticipated to be evaluated in a future HHRA of the project. Many HHRAs tend to focus more on female than male receptors though. This is because female receptors tend to weigh less than male receptors and therefore receive higher chemical exposures on a relative body weight basis. While Health Canada HHRA guidance in recent years has moved away from distinguishing between genders for the selection of human receptors, HHRA guidance in other jurisdictions continues to differentiate receptors based on gender. Although differences in body weights (and sometimes intake rates as well) are generally minor between males and females, assessing a female receptor is inherently more conservative, due to the slightly higher intake rate to body weight ratios, relative to male receptors. Furthermore, for a number of chemicals, there is toxicological evidence that females may be more sensitive than males as a function of differences in physiological, endocrine and biochemical parameters. Moreover, in order to be able to evaluate exposures and risks to sensitive human receptors (i.e., the developing fetus, infants/young children), via placental transfer and breast milk ingestion pathways (when warranted), female adult and teen receptors must first be evaluated.

For whichever human receptors are ultimately selected for evaluation, in order to estimate chemical exposures that are received by these receptors, it will be necessary to characterize the key physiological and behavioural characteristics of each receptor type that is evaluated. These characteristics are typically referred to as receptor parameters and exposure parameters and they enable the calculation of exposure estimates for human receptors that are expressed as a received dose (i.e., mg COPC/kg body weight/day). There are a number of published standard regulatory and scientific literature sources of human receptor parameters that are routinely used in HHRAs conducted within North America. It is expected that the following sources would be considered: [Richardson and Stantec 2013; Richardson 1997; Health Canada 2010; U.S. EPA 2008; U.S. EPA 2011; and, selected other information sources from the regulatory and scientific literature, as necessary]. Many of these sources have been used in numerous previous HHRAs that have been accepted by regulatory agencies across Canada and the United States.

As it is expected that a HHRA of the project (if required) would focus on the PLFN community (given their close proximity to the NPNS mill), receptor parameter selection would need to emphasize Indigenous receptors, where possible. Ideally, this would involve the use of surveys to collect PLFN-specific information. However, implementing surveys in Indigenous communities is not always feasible and it is likely that there would need to be some, if not considerable, reliance on literature that describes indigenous receptor and exposure parameters. Some of this information may be able to be sourced from the Atlantic Canada FNFNES study (i.e., Chan et al. 2017).

The Atlantic FNFNES study was conducted in 2014 and reported in 2017. It included participation by PLFN, as well as 10 other Atlantic Canadian First Nations communities. A total of 1025 adult participants across all participating communities took part in the study (670 female; 355 male). Of this total, 89 participants were from PLFN, representing roughly 18% of the on-reserve population for this community (Chan et al. 2017). FNFNES studies have some inherent limitations though. For example, these studies typically target adults and may not adequately represent the age groups that may be more sensitive to chemical exposure, such as young children and elders. In addition, while these studies provide consumption rates and frequencies for various traditional food items, the rates and frequencies are not reported on a community-specific basis.

While it would be considered preferable if a PLFN-specific dietary survey(s) could be conducted to provide realistic and accurate consumption rate and frequency information for the key traditional marine food items harvested by the PLFN community, and the human receptor gender and age classes of interest, it may not be feasible. In that event, the Chan et al., (2017) information on traditional marine food item consumption rates and frequencies could likely be applied in a HHRA, supplemented where possible/necessary with Health Canada and U.S. EPA Indigenous receptor and exposure parameter information. It would likely be possible to develop consumption rates from the information provided in Chan et al., (2017). This study reports consumption frequency for several traditional marine food items that PLFN members may harvest and consume, and also reports mean and 95th percentile portion or serving sizes for a number of traditional food categories, as well as some specific traditional food items. Consumption rates can be developed by integrating the portion/serving size information with consumption frequency information. Chan et al., (2017) reported consumption rate estimates for some traditional food items (expressed as grams food item/person/day) that could potentially be applied or modified for a HHRA of the project.

9.2.3 Selection and Development of Exposure Scenarios

It is important to be able to evaluate potentially different levels of chemical exposure that may occur under different scenarios or conditions. Exposure scenarios are largely defined based on the outcomes of other problem formulation steps. Exposure scenarios essentially combine the outcomes of COPC identification, exposure pathway/route selection, and human receptor selection with key study area or project features to identify the most relevant or most likely means by which people in a given population or community of interest may become exposed to the COPCs. Exposure scenarios are also designed to have approaches and sets of assumptions that represent “reasonable worst case” conditions that are likely to overestimate, and unlikely to underestimate, exposures to COPCs.

Exposure scenarios are also defined and limited by the spatial and temporal boundaries for a given project.

It is also common for exposure scenarios to have various specific subscenarios (e.g., subscenarios for specific communities or locations, subscenarios for different assessment cases or different development/management options). For a HHRA of the project (if required), likely exposure subscenarios would generally mirror the EA assessment cases (e.g., construction, operations and maintenance, cumulative), and would also include a baseline scenario. Not all subscenarios are necessarily assessed quantitatively though. For example, a construction scenario for a project is frequently addressed qualitatively as these scenarios are short term, emissions and impacts tend to be highly localized, and emissions often differ from those anticipated for a project’s operations phase. Cumulative effects and decommissioning scenarios (if addressed) are also commonly assessed in a qualitative manner due to uncertainties regarding future emissions sources and their characteristics, and the fact that operational emissions cease completely when a project is in its decommissioning phase. As previously noted, a decommissioning phase for the NPNS project is not currently envisioned.

It is noted that a baseline scenario would reflect existing study area conditions with respect to human health and would assess baseline levels of exposure and risk to pulp mill-associated chemicals. The NPNS mill has operated for five decades (under various owners) and effects have occurred to various environmental media and biota within the assessment area, to widely varying degrees, both spatially and temporally. There are also other historical and current industrial, commercial and domestic activities within the assessment area that may have impacted assessment area environmental media and biota, both historically and currently. Thus, baseline conditions do not reflect a pristine state that is free of potential impacts from chemical emissions.

It is anticipated that exposure scenarios for accidents, malfunctions and unplanned events would not be assessed in potential future HHRA work. Commonly, such scenarios are addressed by the development of EMPs and EPPs that enable appropriate responses and mitigation for such events. NPNS will develop EMPs and EPPs to address malfunctions, accidents and other unplanned events that may result in the release of chemical substances to local environmental media. See **Section 9** for further details.

Each of the exposure scenarios assessed in a HHRA would evaluate the same receptors, exposure pathways and COPCs and would focus on chronic (long-term) exposures and risks. Acute or short-term exposures and risks may be evaluated as part of specific subscenarios, if deemed necessary. While it is recognized that the consumption of some traditional marine food items may more closely resemble acute or even subacute exposure conditions, HHRAs traditionally focus on chronic exposures and risks, as such exposures and risks are generally of greatest public and regulatory concern and also represent the most conservative exposure condition.

9.2.4 Identification of Candidate Chemicals of Potential Concern

As noted previously, the project has two main sources of emissions/discharges. These sources may result in potential chronic human exposure to project-associated chemicals:

- The marine treated effluent diffuser; and
- Air emissions from the replacement ETF and the existing NPNS mill due to future planned co-combustion of sludge with hog fuel in the facility power boiler.

Chemicals present in treated effluent and in air emissions may pose a potential human health risk if there is significant exposure to the project-associated chemicals. As such, many of the chemicals present in treated effluent and in air emissions are considered to be candidate COPCs at this time.

When identifying chemicals of potential concern, it is a common practice to limit the number of chemicals evaluated to those that represent the greatest potential concern to people that may be present in the area under consideration. This is done because it is impractical to assess every chemical that may occur at measurable concentrations in a particular area. In addition, the concentrations of many chemicals associated with a particular site, study area or project may be similar to chemical concentrations found naturally in the area rather than being the result of predicted, current or former industrial or other anthropogenic activities. It is also preferable in HHRA practice to comprehensively evaluate a smaller number of chemicals which represent the greatest potential human health concern, than it is to conduct a less detailed assessment on a larger number of chemicals that are of lesser potential concern. COPC identification or selection processes are designed to enable a high degree of confidence that chemicals of greatest potential health concern have been identified. Thus, if no health risks are predicted for the chemicals selected for evaluation, then no health risks would be expected for any of the chemicals not included in the evaluation (e.g., those that are present at lower environmental concentrations, those that are of lower toxic potency, those that are emitted/released at lower rates). COPC identification processes are also inherently iterative and allow for chemicals that may have been initially excluded, to be selected for evaluation, should there be scientific justification, or, if public or regulatory concerns suggest that certain chemicals should be assessed, irrespective of their known potential to pose a human health risk. Thus, COPC identification processes are designed to reasonably ensure that no chemicals of potential human health concern are overlooked.

At this time, it is only possible to identify candidate COPCs that may be evaluated should a HHRA of the project be a regulatory requirement. This is due to the fact that chemical process engineering design work is continuing and there is presently uncertainty regarding the likely chemical composition and characterization of the marine treated effluent discharge (including the potential concentrations of substances present in the effluent).

There is a reasonable degree of confidence however, that candidate COPCs in air emissions, as described in **Section 9.2.4.1** below, are likely to be the same COPCs that would be assessed in the event a HHRA of the project is required, with perhaps minor additions or deletions as new or refined project information becomes available.

With respect to marine effluent discharge, and the candidate COPCs identified within the treated effluent, it is expected that a potential HHRA of the project would utilize various screening approaches to refine and reduce the candidate list of COPCs down to a more reasonable and representative set of COPCs that would undergo assessment. The same considerations would apply to the potential assessment of impacted drinking water, in the event the effluent pipeline experiences spills or leaks in the sections that traverse drinking water supply areas. However, accident scenarios are generally not evaluated within HHRAs.

The approaches and considerations that would be expected to be applied in an effort to refine lists of candidate COPCs for HHRA purposes would include the following, likely utilized in a sequential or step-wise process.

- Comparison of current baseline environmental media and biota chemistry data (when sufficient data are collected) to applicable regulatory human health-based environmental quality and tissue residue benchmarks (where such benchmarks exist). For substances and media with suitable benchmarks, it is anticipated that calculations of frequency of detection, and the frequency of exceedance over benchmark values would be important considerations.
- Comparison of current baseline environmental media and biota chemistry data (when sufficient data are collected) to available representative media and biota background concentrations for the parameters of interest. Frequency of exceedance over representative background values would likely be important considerations.
- Physical-chemical and environmental fate and behaviour properties of candidate COPCs (including the potential for a substance to bioaccumulate and biomagnify, persistence, partitioning/fugacity, solubility, volatility, degradation rates). Established screening approaches that utilize such properties would be anticipated to be applied.
- Essential nutrient status of certain inorganic elements.

- Ubiquity of certain substances in environmental media or biota of interest.
- Consideration of local geology (for inorganic elements).
- Spatial distribution patterns of chemical concentrations in environmental media.
- Likely speciation (chemical forms) of candidate COPCs in environmental media of interest.
- Outcomes of NPNS operational and/or performance/compliance monitoring of current effluent quality may also be used to refine initial candidate COPC lists (i.e., if such monitoring consistently shows certain substances are not detectable in the current mill effluent, then the inclusion of such substances as COPCs is unlikely to be warranted, because if they are not present in current mill effluent, they are highly unlikely to be present in future post-project mill treated effluent).

9.2.4.1 Identification of Candidate COPCs in Project Air Emissions

In support of the project EA, Stantec (2019) conducted an air dispersion modelling study which considered air emission sources for both baseline (existing operations) and future operations scenarios. This study also accounted for air emissions from the existing ETF (i.e., Boat Harbour treatment and stabilization lagoons) for the baseline scenario, and accounted for air emissions estimated from the proposed replacement ETF, for the future operations scenario. The co-combustion of sludge with hog fuel in the power boiler was also considered in the future operations scenario. No other potential air emissions sources that relate to the project (which would be minor relative to those considered by Stantec (2019), have been considered at this time. The air dispersion modelling study selected and assessed ten discrete receptor locations that represent the nearest sensitive receptors (residential locations). Details of these locations are provided in Stantec (2019).

The air contaminants considered in the Stantec (2019) study are those that are regulated by the Government of Nova Scotia under the Air Quality Regulations, as amended on October 12, 2017, as well as fine particulate matter (PM2.5), as it is regulated under Northern Pulp's Industrial Approval (2011-076657-A01). The modelled air contaminants were as follows:

- Carbon monoxide (CO).
- Hydrogen sulphide (H_2S).
- Nitrogen dioxide (NO_2).
- Sulphur dioxide (SO_2).
- Total suspended particulate matter (TSP).
- Fine particulate matter ($PM_{2.5}$).

Emissions summaries for these contaminants for the baseline and future operations scenarios are provided in Section 8.1 and in the Stantec (2019) study, and are not reproduced herein.

The considered contaminants modelled in the Stantec (2019) study represent the major NPNS air emissions. Available ambient monitoring for the local airshed and NPNS mill NPRI reporting to date does not indicate that other air contaminants are emitted from the mill at significant rates such that they would merit consideration in relation to the project. As such, the air contaminants listed above are considered to be candidate COPCs in relation to the project.

It is acknowledged that other air contaminants of concern have been evaluated historically. For example, Environment Canada (1996) reported on an ambient air quality study to evaluate the presence of PCDD/F in fogs/mists rising from the BHETF during the summer months. The sampling was undertaken at three locations within PLFN during February 1995 and July 1995. The study concluded that the PCDD/F levels measured were in the background range found at other rural sites across Canada and that there was no measurable difference in PCDD/F concentrations between the February and July sample collection events. The study conclusions were that there were no elevated levels of PCDD/F in the fog coming from the BHETF lagoon or in the ambient air of the Pictou area.

In addition, a recent paper by Hoffman et al. (2017) evaluated ambient air levels of seven volatile organic compounds (VOCs), based on ambient monitoring data reported from the Canadian National Air Pollution Surveillance Network (NAPS). There are two NAPS monitoring stations near the NPNS mill that have historically monitored for VOCs. This paper focused on ambient monitoring data for the following VOCs: chloroform; 1,3-butadiene; vinyl chloride; benzene; carbon tetrachloride; trichloroethylene; and, perchlorethylene. The paper reported that results of the conducted temporal and spatial statistical analyses indicated that 1,3-butadiene, benzene, and carbon tetrachloride air concentrations routinely exceeded EPA air toxics-associated cancer risk thresholds, and that 1,3-butadiene and perchloroethylene levels in air were significantly higher when the prevailing wind direction blew from the northeast and the NPNS mill towards the Granton NAPS site. Conversely, when prevailing winds originated from the southwest towards the mill, higher median VOC air toxics concentrations at the NAPS site, except carbon tetrachloride, were not observed. These outcomes have not been corroborated by regulatory agencies or other parties at this time. The study authors documented a number of limitations of their study but purported that VOC levels were elevated in the community surrounding the NPNS mill. The study authors also noted that study limitations preclude the explicit attribution of ambient air toxic exposures to the risk potential for cancer for community residents. Thus, the study outcomes, given the study design and its inherent limitations, can only be viewed as suggestive. The study design and methods do not enable any causal inferences.

Technical review of this paper reveals some issues that question some of the paper's conclusions.

- These seven VOCs may be emitted in small amounts in stack and fugitive emissions at the NPNS mill but a number of other point and mobile local sources also emit these substances within the local airshed. The study's methods do not enable any VOC source attribution that is scientifically defensible, nor was source attribution among the study's objectives.
- The seven VOCs are not known (based on literature review) to be associated with pulp and paper mill activities and air emissions to any significant extent.
- The authors did not (or could not) estimate annual average air concentrations for the seven VOCs. However, the most appropriate averaging period for comparison to chronic inhalation toxicity reference values (TRVs) (which the authors compared to) is well known to be annual average data. The study authors compared 24 hour average air concentration data (collected on a 1 in 6 day cycle) to chronic inhalation TRVs. This approach biased the assumed potential inhalation exposure

concentrations high as 24 hour average air concentrations are always higher than annual average air concentrations. More appropriate comparisons would have been to available regulatory 24 hour average-based air quality criteria. It should be noted as well that TRVs and air quality criteria are intentionally conservative values for which exceedance does not and cannot imply a human health risk. Rather, exceedance denotes a need for further and more detailed evaluation.

- For the carcinogenic inhalation TRVs that were applied, the authors did not adjust these values from the default USEPA target cancer risk level of 1 in 1 million to the target cancer risk level that is current public health policy in Nova Scotia and most other provinces (i.e., 1 in 100,000). Thus, the TRVs for carcinogens cited in the paper should have been ten times higher than indicated. This correction would alter the conclusions of the study substantially in that for the seven VOCs considered, there would be no to negligible exceedances of the TRVs that were applied.
- When other study uncertainties are considered (including the use of one ambient air station only for study analyses; the use of measured concentrations only with no information provided on data quality review; the lack of modelled data to corroborate potential ground level air concentrations of the VOCs), it must be concluded that there is no current air quality issue with the seven targeted VOCs in the Pictou County area.
- Overall, the Hoffman et al., (2017) paper is not relevant to the current NPNS project and is not considered further at this time.

The outcomes of the assessment of air quality (Section 8.1) are briefly summarized below (from Stantec, 2019). It is likely that the same conclusions would be reached in a HHRA that would assess project air emissions.

- During the construction phase, air emissions are expected to be primarily related to the operation of heavy equipment, trucking, and ETF and effluent pipeline construction activities. Such activities may result in changes in local air quality, primarily related to fugitive dust generation from material movement as well as combustion gas emissions associated with construction equipment used to build the new ETF, and for digging, pipe-laying and infilling activities during the installation of the new effluent pipeline. Such air emissions will be temporary, highly localized (primarily to the Nova Scotia Department of Transportation and Infrastructure Renewal (NSTIR) road right-of-way), transient, and reversible. As such, construction phase air emissions were not considered to merit assessment.
- Based on the modelling results, the predicted concentrations of the air contaminants of concern (i.e., CO, NO_2, SO_2, TSP, $PM_{2.5}$ and H_2S) from the operation of the existing mill and the future mill (with replacement ETF) are both expected to be in compliance with the reference criteria at the representative off-property discrete receptors. (Stantec 2019). Modelled exceedances of H_2S were estimated to occur less than 0.05% of the time, and were determined to be largely an artifact of the model inputs (i.e., meteorological anomalies in the meteorological data used as inputs to the dispersion model).
- Stantec (2019) also reported that ambient air monitoring data for 2015, 2016 and 2017 showed no exceedances of the applicable Nova Scotia regulatory AQC for the air contaminants monitored under

the NPNS approval to operate. However, there were some instances of reported odour occurrences that are associated with H_2S.

Should future emissions source testing and air dispersion modelling indicate that other air emissions merit evaluation, air quality and human health risk assessment may occur at that time to inform appropriate mitigation strategies (if necessary).

9.2.4.2 Identification of Candidate COPCs in Treated Mill Effluent

The identification of COPCs in future treated effluent is necessary in order to characterize potential chemical exposures that may occur via the following exposure pathways that were identified as being relevant to the NPNS project:

- Incidental contact with sea water/marine sediments.
- Ingestion of traditionally harvested marine food items (by PLFN members) that may accumulate chemicals present in the marine effluent discharge.
- PLFN and general public ingestion of commercial fishery and aquaculture products that may be impacted or influenced by effluent chemicals.
- Ingestion of drinking water that may be impacted by effluent pipeline leaks or spills.

Potential exposure to chemicals in treated effluent will not occur during the construction phase or decommissioning phase. The only relevant assessment case for potential exposure to effluent chemicals is the operations phase.

Due to uncertainty regarding effluent composition and approximate concentrations of substances present in the future treated effluent (which will not be verified until the project is operational), the identified candidate COPCs in effluent are considered preliminary at this time. Refinement of the candidate COPCs would be anticipated for a potential HHRA study of the project, should one be required (wherein various screening approaches, as previously described above, would be applied to refine and reduce the candidate list of COPCs down to a more reasonable and representative set of COPCs). The same types of screening considerations apply to the potential assessment of impacted drinking water, in the event the effluent pipeline experiences accidental releases in the sections that traverse drinking water supply areas.

Candidate COPCs in future treated effluent were determined primarily on the basis of:

- A review and synthesis of historical data and reports for areas near the NPNS project, particularly areas that are or were influenced by the NPNS mill current or historical effluent discharges.
- The outcomes of the COPC identification processes that were applied in the Toxikos (2006) HHRA study.
- Selected additional relevant scientific literature.

While diffuser design criteria and the Stantec (2018a) Receiving Water Study (RWS) were also reviewed, the RWS only models and reports bulk parameters (e.g., TSS, AOX) and general water quality parameters (e.g., BOD, COD, temperature, pH, colour, conductivity). These parameters are either not relevant to human health or are not specific enough to evaluate from a human health perspective. AOX, for example, is a bulk measurement of organically bound chlorine and comprises potentially hundreds to thousands of compounds (Hewitt et al. 2006). AOX is non-specific and highly variable in composition and is therefore not a suitable parameter to consider for any risk assessment study.

The reviewed historical data and reports included: environmental monitoring reports on the BHETF; previous risk assessment studies conducted within the local study area near the NPNS mill; aquatic EEM program reports for the NPNS mill; and, previous environmental assessments of options to replace the BHETF. While some of the reviewed historical data were collected from locations outside the current NPNS project study boundaries and/or are too old to represent current baseline concentrations of chemicals of interest in marine environmental media and marine traditional food items, so long as the reviewed data were collected within an area(s) potentially influenced by the current or historical pulp mill activities, it can be used to aid in identifying candidate COPCs.

The Toxikos (2006) HHRA of the proposed pulp mill in Tasmania was reviewed in detail. It is considered likely that the assumed effluent chemistry for the Toxikos HHRA is representative of expected future effluent chemistry for the NPNS project. Both the effluent treatment plant and marine diffuser pipe design for the Tasmania study are similar to what has been proposed for the NPNS project. Also, both mill facilities utilize ECF bleaching processes, and this will not change for future NPNS mill operations. While there are some uncertainties associated with the representativeness of the effluent chemistry characterization presented in Toxikos (2006) to the proposed future NPNS project effluent (as noted above), it is believed that there are sufficient similarities to state that the Toxikos (2006) information can serve as an indication of what may be expected in relation to NPNS project effluent composition/characteristics (KSH Consulting, personal communication).

Review of the Toxikos HHRA has also determined that some of the approaches used/decisions made within this study, with respect to screening and identifying COPCs, may be appropriate to apply in the event a HHRA of the NPNS project is required.

It must be acknowledged that the Toxikos (2006) HHRA study in Tasmania has not undergone regulatory review by Health Canada at this time, although it appears to be a well conducted and highly conservative study that applied reasonable and standard HHRA approaches and assumptions.

Toxikos (2006) Approach to Identify Candidate COPCs in Treated Effluent

As previously noted, it is believed that the assumed effluent chemistry characteristics and composition as well as the effluent diffuser design for the Tasmania project is similar to what is proposed and designed for the NPNS project. Both mill facilities utilize ECF bleaching processes, and this will not change for future NPNS mill operations. While the proposed Tasmania pulp mill was assumed to process mainly hardwood eucalyptus chips, and there is uncertainty regarding how the wood chips processed at the NPNS mill (which are from softwood coniferous species), would compare to eucalyptus chip processing in terms of effluent chemistry differences, the Toxikos (2006) study is considered to provide a reasonable interim indication of what may be expected in relation to NPNS project effluent chemical composition and characteristics (KSH Consulting, Personal Communication).

Toxikos noted the inherent challenge in trying to identify COPCs within effluent that does not yet exist and cannot yet undergo chemical analyses. This challenge is compounded by the fact that thousands of chemicals have been identified in pulp mill effluent over the last two decades, many of which are naturally occurring substances in wood, and in wood degradation products. Effluent constituents and their concentrations are a function of mill-specific differences in process technology and operations and differences in wood types processed.

Thus, Toxikos took a multi-step approach to identify candidate COPCs that could potentially be present in the Tasmania mill's effluent. First, a comprehensive literature search and review was conducted to identify an initial list of substances that have been reported (recently and historically) to be present in pulp and paper mill effluent. They also considered the substances and estimated concentrations of substances in the mill effluent that was conservatively determined by the mill designers (based on mass balance calculations). In combination, these approaches generated an initial 'candidate list of chemicals' that may occur in pulp mill effluents. It was noted by Toxikos that the literature review effort was not necessarily exhaustive but reflected what was available/accessible within the published scientific literature. For any substance where there was uncertainty about its potential presence in pulp mill effluent, it was conservatively assumed that the substance was present. Toxikos also noted that the parameter concentration estimates provided by the designers of the Tasmania mill were substantially and intentionally overestimated. The initial list of candidate COPCs that was determined from literature review and mill design input was as follows:

- Metals and metalloids.
- Selected plant sterols and steroids (phytosterols and phytosteroids).
- Methylphenols and other alkyl-substituted phenols.
- Nitrophenols.
- Phenol.
- Plant-based hydrocarbons such as pinenes, camphenes, carenes, limonene.
- Petroleum hydrocarbons (primarily long chain aliphatic hydrocarbons).
- BTEX (benzene, toluene, ethylbenzene, xylenes).
- Polycyclic aromatic hydrocarbons (PAHs).
- Alkyl and chloro-substituted PAHs.
- Numerous chlorinated volatile organic compounds (VOCs).
- Chlorinated benzenes and methoxybenzenes.
- Dehydrojuvabione.
- Juvabione.
- Furanones (chlorinated and non-chlorinated).
- Hydroxy and/or methoxy chlorinated diones and pyranones.

- Thiolignins.
- Thiosulphates.
- Chloroacetic acids.
- Resin acids (chlorinated and non-chlorinated).
- Fatty acids.
- Various aliphatic and aromatic aldehydes and ketones (chlorinated and non-chlorinated).
- Aniline and chloroanilines.
- Chlorinated anisoles.
- Numerous chlorinated phenolic compounds including chlorinated phenols, catechols, cymenes, guaiacols, guaiacones, vanillins, veratroles.
- Vanillones (chlorinated and non-chlorinated).
- p-Cymene.
- Syringol and syringaldehydes.
- Various aliphatic alcohols.
- Polychlorinated dibenzo-p-dioxins and dibenzofurans (PCDD/F).
- Chloromethyl sulfones.
- Chlorohydroxypyron.
- Thiophenes and chlorinated thiophenes.
- Hexachlorocyclopentadiene.
- Various ions such as ammonia, nitrate/nitrite, chloride, sulphate, hydrogen sulphide, carbon disulphide, chlorate, chlorite.

This initial list was then reduced by applying knowledge of the ECF bleaching chemistry (i.e., where chlorine dioxide is the bleaching agent (which is also the case for the NPNS mill)), and the effluent treatment methods to be used at the proposed new mill, along with further input from the mill design engineers. When pulp mills around the world abandoned chlorine bleaching processes (which occurred gradually throughout the 1990s) in favour of the ECF process that uses chlorine dioxide, the formation of polychlorinated organics during the bleaching process largely ceased. With ECF bleaching processes, there is virtually no formation of PCDD/F and chlorophenolics relative to what used to occur with chlorine bleaching processes (e.g., Luthe et al. 1992; FEI 1996; Sharrif et al. 1996; Strömberg et al. 1996; USEPA 1998; Bright et al. 2003; Guthe 1998).

Based on applied knowledge of ECF bleaching, Toxikos provided rationale for the elimination of the following substances as candidate COPCs.

- All polychlorinated organic compounds (i.e., >trichloro). These substances were eliminated on the basis of the chemistry of the ECF bleaching process, which was noted to not produce appreciable (measurable) quantities of polychlorinated organics greater than dichloro. While this would clearly include PCDD/F, Toxikos carried PCDD/F forward as candidate COPCs due to public and regulatory concerns.

- Chlorate. Toxikos noted that the chlorate ion is effectively converted to chloride in the anoxic zones which precede aerobic effluent treatments. It was also noted that chlorate is generally not detected in biologically treated pulp mill effluents (Strömberg et al. 1996).

The next step involved further reducing the list of candidate COPCs by considering which of the remaining candidate substances potentially present in effluent would have a reasonable likelihood of accumulating in marine fish species that people may harvest and consume. The Toxikos HHRA considered that the consumption of fish harvested from around the effluent outfall was the most plausible means by which the general public could be exposed to substances present in the effluent. Accumulation potential was determined based on literature values for, or modelling (using USEPA EPISuite software) of several physical-chemical, environmental fate and behaviour, and toxicological properties that influence the likelihood for a chemical to be accumulated from marine water or sediments into marine fish that may be harvested by humans. Among the properties considered were log Kow, bioaccumulation and/or bioconcentration factors, and degree of metabolism/excretion in marine fish.

The outcome of the screening approach to identify substances that may accumulate in fish was a greatly reduced list of candidate COPCs. The final COPCs selected in the Toxikos HHRA study were:

- Cadmium.
- Mercury.
- Selenium.
- PCDD/F.

PCDD/F was included due to regulatory and public concerns only, as it was noted there is no technical justification to include PCDD/F as COPCs in effluent from an ECF mill, as the chlorine dioxide bleaching chemistry is not conducive to PCDD/F formation. The small group of final COPCs reflects the fact that many of the organics and chlorinated organics potentially present in mill effluent are unlikely to accumulate due to such factors as high volatility or solubility, rapid degradation, ionisable in sea water, limited tendency to partition to lipid-rich tissues, and rapid metabolism and excretion when taken up by fish. However, the transparency of this screening approach was limited in the Toxikos (2006) HHRA report and technical appendices, such that it is difficult to verify its outcomes.

Review of Pulp Mill Effluent Chemistry: Hardwood Versus Softwood Processing

As noted previously, there is some uncertainty regarding the application of the Toxikos (2006) candidate COPC identification approaches in light of the potential differences in effluent chemistry that may result from hardwood (such as eucalyptus) processing versus softwood conifer processing. Thus, KSH Consulting was retained by NPNS to prepare a technical brief on the identification of candidate COPC's in treated mill effluent, based on available data generated by past and current mill efforts as well as published literature in technical journals and conference abstracts. The following information is extracted from the KSH brief (KSH Consulting, Personal Communication).

Wood material impact on effluent parameters was assessed by comparing the figures for bleaching effluents derived from softwood and hardwood pulp. Softwood pulp effluent has higher COD and colour content than hardwood pulp effluent. The compounds responsible for colour are lignin fragments of high molecular weight (HMW), which represents low biodegradability in the biological treatment (Herstad Svärd et al. 1997). Research has compared effluents from softwood and eucalyptus pulps, through AOX, COD, BOD_5 and colour behaviour of the different kinds of pulp production (conventional bleached pulps and oxygen delignified bleached pulps (Herstad Svärd et al. 1997; Springer 2000; Yousefian et al. 2000). According to the findings, softwood and eucalyptus effluents have the same trend in AOX levels. For both conventional pulps, the AOX levels were higher than the corresponding oxygen delignified pulps.

Moreover, the total COD levels are dependent on the extent of pulp cooking. The COD compositions of eucalyptus and softwood effluents are different, where the effluents from the eucalyptus pulps are more biodegradable. The compounds measured when assessing the extent of pulp cooking in softwood and hardwood (especially eucalyptus) differ as well: in softwood, this measurement is mainly representative of lignin, whereas in eucalyptus, the hexenuronic acids (HexA) are a larger contributor (Teleman et al., 1996; Ventorim et al., 2006). In this regard, the most common way to remove the hexenuronic acids is in the early bleaching stages through hot acid hydrolysis (A) and hot chlorine dioxide bleaching (DH) technologies (Teleman et al. 1996; Colodette et al. 205; Ragnar 2004).

The most important difference, when comparing softwood effluents with the eucalyptus effluents, is the higher lignin content in the former and the hexenuronic acid content in the latter. There has been significant work (Lehtinen 2004; Dahlman et al. 1995; Mounteer et al. 2002) on determining the molecular weight distribution of the components in the effluents. The importance of this determination comes from the fact that significant removal in the biological treatment system is achieved from the low molecular weight (LMW) material. Evidence of this is the increment in the proportion of organic compounds with high molecular weight after biological treatment. Improvements in the removal of high molecular weight material would lead to greater efficiency and improve the effluent quality.

Traditionally, the separation between low molecular weight (LMW) and high molecular weight (HMW) is done at 1,000 dalton (Da, a unified atomic mass unit). Bleach kraft mill effluents have an extended molecular weight distribution; from diverse kinds of monomeric compounds to large and complex molecules with molecular weights between 10,000 and 30,000 g/mol. The molecular weight distribution depends on the raw material and the bleaching process used. For example, the average molecular weight of organic matter in hardwood kraft pulp effluents is lower than in the corresponding softwood effluents (Lehtinen 2004).

The molecular weight fractions in the bleaching filtrates of oxygen delignified eucalyptus pulps were studied. The HMW fraction contributed to approximately 40% of the total effluent load of COD both in softwood and hardwood ECF bleached pulps production, and about 30–40% to TCF (total chlorine free) bleached pulp effluents (Dahlman et al. 1995; Mounteer et al. 2002). Additionally, the most remarkable differences between softwood- and hardwood-derived effluents are in the aromatic region. The aromatic lignin-derived structures such as syringyl and guaiacyl units are not important structural elements in HMW effluent materials from ECF bleaching of oxygen delignified hardwood kraft pulps, but are important in softwood HMW effluents (Mounteer et al. 2002; Souza et al. 2003).

Similarly, the results show that all HMW effluents contained carbohydrates. The carbohydrates found in the examined HMW could have had oligosaccharides, polysaccharides or both present in the effluent, either in dissolved or colloidal form. As can be expected, the HMW hardwood kraft pulps fraction contained more carbohydrates (mainly xylan) than the corresponding samples from softwood kraft pulps. Concerning the presence of carboxylic acids, the HMW samples showed high levels of these groups. They were formed due to the oxidation of lignin structures in the bleaching process (Dahlman et al. 1995; Souza et al. 2003).

The low molecular weight (LMW) compounds can be broadly classified into three main classes: acids, phenolic compounds and neutral compounds. The phenolic compounds and some of the acids are degradation products from lignin, while the resin acids, fatty acids, terpenes, sterols and other neutral compounds are residues of extractives presents in the raw material (Lehtinen, 2004).

KSH concluded from their review and analysis that there are enough similarities regarding the compounds produced during biological treatment of both types of effluent, to consider the Toxikos candidate COPC list as providing an interim indication of what can be expected in relation to NPNS project effluent chemical composition and characteristics.

Consideration of Other Selected Relevant Literature

In an effort to corroborate the candidate COPCs identified and considered by Toxikos (2006), selected other literature was identified and reviewed, though not exhaustively.

Hewitt et al. (2006) conducted a detailed literature review of the environmental effects of pulp and paper mill effluents in Canada, which included chemical characterization of the bioactive organic substances present within pulp and paper mill effluent. Many of the same substances noted by Toxikos (2006) to be candidate COPCs were also reported in Hewitt et al., (2006). These authors noted that pulp and paper mill effluents are extremely complex and variable mixtures of thousands of chemical compounds, many of which have not been identified. The following organic substances were reported by Hewitt et al. (2006) to be commonly measured in pulp and paper mill effluents:

- Terpenes/diterpenes.
- Terpenoids.
- Sterols.
- Phytosterols (including beta-sitosterol).
- Lignin.

- Lignin phenolic residuals (chlorinated and non-chlorinated).
- Juvabione.
- Dehydrojuvabione.
- Trichloropterostilbene (and other chlorinated pterostilbenes and stilbenes).
- Retene (alkylated phenanthrene).
- Manool.
- Chlorophenols [Although, the authors noted that the substitution of chlorine dioxide for chlorine in the pulp and paper making process during the 1990s has markedly reduced the formation of chlorophenols and lowered their levels in effluent considerably].
- Non-chlorinated phenols.
- Chlorinated guaiacols and vanillins.
- PCDD/F.
- Resin acids.
- Fatty acids.
- Chlorinated resin and fatty acids.
- Aliphatic alkane hydrocarbons.
- Chlorinated dimethylsulfones.
- Various other chlorine and other functional group-substituted benzenes, anisoles.
- Flavonoids (e.g., genistein).

In addition, limited focused searches of the published scientific literature confirmed the substances reported by Toxikos (2006) and Hewitt et al. (2006) with respect to the potential chemical composition of bleached kraft mill effluent. Some additional potential bleached kraft mill effluent substances reported in the literature may include the following (Durhan et al. 2002):

- Humic and fulvic acids.
- Butenedioic acids.
- Androstenedione.

While some additional older literature was found that dealt with the potential composition of bleached kraft mill effluent, the effluents tested in those studies reflected elemental chlorine bleaching rather than ECF bleaching processes, and were therefore deemed not relevant to the NPNS mill.

Consideration of Historical Data and Documents for Areas Influenced by the NPNS Mill

Review of various previous risk assessment (HHRA) and environmental monitoring studies and data, which included chemistry data for sea water, sediments (where much of the data collection has focused on the Boat Harbour ASB as well as settling ponds, settling basins and the stabilization lagoon) and selected marine biota (such as mussels, clams, oysters, rock crab, flounder) that relate to current and historical NPNS mill activities and effects, suggests that various substances may merit consideration as candidate COPCs in the future treated effluent.

While effluent quality and composition has changed over time, especially since the mill switched from chlorine to ECF bleaching in the mid to late 1990s and undertook significant in-mill improvements, the review of previous studies and data is still of some value in flagging candidate COPCs. It is acknowledged that the scope of the chemical analyses in these past studies and monitoring programs was often relatively limited and focused. However, many of the same chemicals identified as candidate COPCs by Toxikos (2006) and reported in Hewitt et al., (2006) were addressed in these previous studies and data.

The studies (and/or data) reviewed included: NPNS monitoring data for Point C and D within the Boat Harbour Treatment Lagoon; NPNS PPER compliance monitoring program data; Cantox 1997a, 1997b; Cantox 1994; JWEL 2004; JWEL/Cantox 1998; Walker et al. 2016; JWEL 1997; 2001; 2005; JWEL/BEAK 1992; 1994; Andrews and Parker 1999; Dalziel et al. 1993; Dillon 2012).

The previous HHRA studies (i.e., Cantox 1997a, 1997b; JWEL 2004; JWEL/Cantox 1998) conducted in relation to Boat Harbour and other nearby areas influenced by NPNS and former mill owner's pulp-making activities have not undergone detailed review at this time, as these studies focused on areas and exposure scenarios that are different from those that are relevant to the NPNS project. These previous HHRA studies also had numerous uncertainties and data gaps which resulted in the application of highly conservative assumptions and approaches. All prior HHRA studies concluded no risk to human health under reasonable or realistic exposure scenarios for the COPCs, exposure pathways and receptors that were assessed.

The chemicals that merit consideration as candidate COPCs from the review of previous studies and sediment or sea water data include the following:

- Metals (including mercury) and metalloids – [various metals and metalloids have been measurable or deemed elevated in local marine media and biota, but variably, and with no readily identifiable consistent spatial concentration trends].
- PAHs.
- PCDD/F.
- Phytosterols.
- Resin and fatty acids (non-chlorinated).
- Petroleum hydrocarbons, oils and greases.
- Chlorinated VOCs.
- Chlorinated phenols, catechols, guaiacols, vanillins and veratroles – [only detected in the ASB and other effluent-treatment process lagoons and basins, and primarily during the early 1990s; these compounds have not been detected in the marine receiving environment influenced by the current mill effluent discharge point].
- H_2S and other sulphides.
- Chlorate/chlorite.
- Cyanide.
- Syringaldehydes.

This list of substances is generally consistent with that which was reported by Toxikos (2006), Hewitt et al. (2006), and within the other scientific literature that was reviewed.

Current NPNS Mill Effluent Chemistry

There has been periodic testing of NPNS mill effluent for chemical analyses, which has included a number of the candidate COPCs noted above. This testing has typically occurred in association with EEM Program cycles. While some of the testing events are dated, and the parameters tested for have varied as function of EEM cycle scope and focus, the mill bleaching process today is essentially unchanged from the late 1990s, when ECF bleaching was fully implemented. Chlorine bleaching was 100% converted to chlorine dioxide bleaching by 1998, with the conversion occurring gradually from 1994 to 1997 (BEAK 2000; Stantec 2004).

The NPNS Mill EEM Cycle reports (JWEL, 1996; BEAK, 2000; Stantec, 2004; Ecometrix, 2007; 2010; 2013; 2016) have reported the following observations for current mill effluent chemistry that are useful towards identifying candidate COPCs in future mill effluent (recognizing that some differences are expected due to the proposed change in the effluent treatment process in association with the NPNS project). For example:

- Andrews and Parker (1999) reported the following analytical results for four 1998 effluent samples:
  - Some resin acids were detected (at very low concentrations); most resin acids were present at concentrations <RDLs.
  - Some metals were detected (only Al, Ba, B, Fe, Mn, Sr, V, Zn were measurable; all other metals were present at concentrations <RDLs).
  - Chlorophenolics (which includes chlorinated phenols, catechols, guaiacols, vanillins and veratroles) were below RDLs in all four effluent samples.
- Compliance testing from 1994 to present, conducted during EEM cycles, showed that the dioxin congener, TCDD, was below its RDL in all tested effluent samples and the furan congener, TCDF, was below its regulated limit in all samples and below its RDL in the vast majority of tested effluent samples.
- A 1999 final mill effluent sample reported that PCBs were <RDLs and only one chlorinated phenolic substance was detected (4-chlorocatechol) at a concentration just slightly above its RDL (0.06 µg/L versus a RDL of 0.01 µg/L). A few resin and fatty acids were also measured at trace concentrations in this effluent sample but most of these substances were non-detectable.
- In 2002, PCDD/F test results for a Point D effluent sample showed that all congeners (except OCDD) were <RDLs. The reported measured OCDD concentration was less than the typical RDL for this congener; thus, this analytical result is likely not reliable.
- Limited metals and other inorganics testing was conducted for final effluent (Point D) samples in 2002 and 2003. The only metals and other inorganic parameters that were measurable (>RDLs) were: Al, As, Cu, B, Ba, Ca, Fe, V, Mg , Ni, K, Mn, Pb, Se, Na, Zn, Hg, N compounds (i.e., ammonia, nitrate, nitrite), orthophosphate, sulfate, silica, total phosphorus, hydrogen sulphide, fluoride, and chloride. Metal concentrations in effluent were variable between samples and were generally low. In a 2002 effluent sample, chlorate and chlorite were tested for. Chlorate was measurable in this sample at a low concentration (roughly twice its RDL value) and chlorite was non-detectable. Testing for chlorate

and chlorite in other 2002 and 2003 effluent samples showed non-detectable concentrations of these substances.

- Testing of 2002 and 2003 effluent samples also showed that PCBs, VOCs (chlorinated and non-chlorinated), and PCDD/F were non-detectable (i.e., <RDL results for all parameters). Testing in 2002 also occurred for the chlorophenolics parameter suite (which includes: chlorinated phenols, catechols, guaiacols, vanillins and veratroles). All chlorophenolics parameters were below their RDLs with the exception of a trace measurement of 6-chlorovanillin.
- The 2002 and 2003 effluent samples were also tested for AOX and resin and fatty acids. AOX was measurable in these samples. The following resin and fatty acids were detected at concentrations slightly above their RDLs: abietic, arachidic, dehydroabietic, isopimaric, linoleic, oleic, palmitic, palustric, pimaric, sandaracopimaric.

Recent (i.e., spring and fall of 2018) comprehensive chemical analyses of current treated mill effluent samples (from Points C and D) shows that most candidate COPCs are below detection limits in treated effluent. The only candidate COPCs that were measurable (above RDLs) in the recently tested treated effluent samples (and generally at low concentrations near RDL values or within typical natural ranges in water) were: hydrocarbons, toluene, cyanide, mercury, other metals and metalloids, and trace PAHs (fluoranthene, phenanthrene and pyrene only). The chemical analyses included comprehensive scans for PAHs, chlorinated PAHs, PCBs, PPER parameters (2,3,7,8-TCDD; 2,3,7,8,-TCDF), chlorophenolic and non-chlorinated phenolic parameter suites, VOCs (chlorinated and non-chlorinated), glycols, and various and numerous semi-volatile chlorinated organics.

A recent (2018) sample of untreated mill effluent (collected from Point A) underwent a very similar suite of chemical analyses as the 2018 Point C and D samples. This sample represents worst case effluent chemistry as it was collected at a point prior to the current effluent treatment process. Comprehensive chemical analysis of this sample shows that most candidate COPCs are below detection limits even in untreated mill effluent. The only candidate COPCs that were measurable (above RDLs) in this Point A untreated effluent sample (also generally at low concentrations near RDL values or within typical natural ranges in water) were: hydrocarbons, toluene, cyanide, metals and metalloids, phenol, o-cresol, a phthalate ester compound (likely from pipe materials rather than due to mill processes), chloroform, total trihalomethanes, and trace PAHs (phenanthrene and pyrene only). Mercury was not tested for in this sample, nor was 2,3,7,8-TCDD; 2,3,7,8,-TCDF (as testing of untreated effluent for these dioxin and furan parameters is not required under the PPER).

It is expected that future treated effluent that will be produced as a result of the NPNS project will be of higher quality than the current effluent and will contain fewer candidate COPC substances. For those substances that are present, it is anticipated that they will occur at lower concentrations in the future effluent relative to current effluent.

Since 1995, EEM program cycles have also periodically collected data on certain effluent parameters in marine receiving environment media and biota. These data also provide some information that is helpful towards identifying candidate COPCs in future treated effluent. For example:

- Chlorophenolics were not detected in sea water or sediments at EEM program sampling stations (JWEL, 1996). The EEM stations include areas clearly influenced by the mill and the current location of mill effluent discharge (Point D).
- Resin and fatty acids (non-chlorinated) were tested for in rock crab hepatopancreas and winter flounder liver (JWEL, 1996). Of these substances, only oleic acid was detected above its RDL in crab hepatopancreas and flounder liver samples, from both the EEM study area and a reference area. JWEL (1996) noted that oleic acid is a natural glyceride that occurs in most lipid-rich biota tissues (which is the case for crab hepatopancreas and flounder liver). It was concluded that no effluent-related resin or fatty acids were detected in EEM study area crab hepatopancreas or winter flounder liver samples.
- JWEL (1996) also sampled and analyzed blue mussels collected from the outlet are of Boat Harbour (a composite sample of 10 mussels). The composite sample was analyzed for PCDD/F. The only PCDD/F congener detected was OCDD. This congener was also detected in a reference area composite mussel sample and was present at a higher concentration in the reference area sample. It was concluded that there was no significant uptake of PCDD/F into blue mussels. Mussel (or other marine biota) sampling and analysis was not conducted in subsequent EEM cycles as the mill fully converted from chlorine bleaching to an ECF process (which uses chlorine dioxide bleaching) in 1998. All final mill effluent testing has demonstrated compliance with regulated limits for PCDD/F since the conversion to the ECF bleaching process.

As part of EEM Cycle 2, a caged mussel study was conducted (Andrews and Parker, 1999). Deployed mussels (90 days) at several stations in PH showed no increase in, or detection of, chemicals associated with bleached kraft mill effluent. Chlorophenols were <RDLs in all mussel samples. Resin acids were <RDLs in all but the baseline mussel samples. Phytosterol and metals levels in mussels were all measurable (as these are naturally occurring substances in a marine coastal setting), but there were no significant differences between PH mussel stations and reference area mussel stations.

Candidate COPCs in Treated Effluent Summary and Path Forward

From the preceding sections, it is clear that a complex and diverse set of numerous chemical substances may be present in NPNS project treated effluent. While it is believed that the candidate COPCs identified from Toxikos (2006), Hewitt et al. (2006) and other literature would be similar to what would be anticipated for NPNS project effluent, a number of differences may also be expected. These differences are functions of the differing wood species processed, different mill processes, different technologies (process and treatment) and different mill process and treatment efficiencies.

For potential HHRA purposes it is anticipated that candidate COPCs would undergo a comprehensive and robust screening process that would apply screening approaches that consider the physical-chemical, environmental fate and behaviour and toxicological properties of candidate COPCs. The application of such approaches would be expected to reduce a large list of candidate COPCs down to a smaller, more reasonable and more manageable set of substances that pose the greatest potential for human exposure in relation to the project. The consideration of ECF bleaching chemistry would also likely be a defensible consideration in reducing the list of candidate COPCs. As noted previously, most polychlorinated organic substances could likely be excluded from a HHRA on the basis of ECF process chemistry considerations alone. Such exclusions could likely be well supported with the proposed screening approaches (that would utilize substance physical-chemical and environmental fate and behaviour, and toxicological properties), as well as current and historical field-based evidence (as summarized above) which demonstrates certain candidate COPCs are not detectable, or are rarely detectable in current mill effluent, or in the current marine receiving area media and biota.

While current data constraints regarding future treated effluent composition preclude the identification of final COPCs for a HHRA of the NPNS project at this time, it is expected that the list of final COPCs would be relatively small and would potentially include some metals/metalloids (likely including mercury), some PAH compounds, PCDD/F (likely on the basis of public and regulatory concern only, as there is believed to be little technical justification to consider PCDD/F as COPCs for the project), some resin acid compounds, and perhaps a couple or few chlorophenolic compounds, non-chlorinated phenolic compounds, and chlorinated VOC compounds.

However, the possibility must also be recognized that once there is confirmation of future treated effluent chemical composition, and appropriate screening approaches (as suggested previously) are applied with sufficient scientific rationale and justification, there may be no COPCs identified in project effluent that would warrant evaluation in a HHRA. For example, chemicals that are volatile, soluble, easily degraded in sea water, and that do not bioaccumulate in marine biota would not warrant evaluation in a HHRA of the project. This may be the case for the majority of candidate COPCs. The likelihood of no COPCs being identified is supported by the recent testing of current treated and untreated mill effluent. As noted previously, the tested Point A, C, and D effluent samples contain very few of the candidate COPCs at measurable concentrations, and for those candidate COPCs that were present above RDLs, the concentrations were generally low (near RDL values) and/or within typical natural reference ranges (e.g., metal and metalloid concentrations in effluent). Furthermore, the future effluent that will be generated from the NPNS project is anticipated to be of higher quality than the current mill effluent, and would contain fewer candidate COPCs and/or lower concentrations of candidate COPCs. A demonstrated lack of COPCs in HHRAs of industrial projects is not uncommon; although, public and regulatory concerns may result in some COPCs requiring assessment despite a scientifically defensible basis for their exclusion.

9.3 Next Steps

If the conditions of the approval for the EA of the project require that a HHRA study be conducted, the information presented in the preceding sections would form the basis of a HHRA problem formulation stage.

If HHRA becomes a regulatory requirement for the project, the data constraints described in the preceding sections would need to be sufficiently addressed to enable a defensible HHRA study.

However, regardless of whether or not a HHRA study is deemed a regulatory requirement, or deemed necessary to complete (i.e., if no final COPCs are identified, HHRA would not need to occur), there will likely be environmental monitoring in the marine area influenced by the treated effluent diffuser discharge that addresses potential human exposure to effluent chemicals. It is noted however that HHRAs are useful studies towards informing on the chemicals and species that should be monitored. Typically, human health-based monitoring programs are developed based on the outcomes of HHRA studies.

It is considered likely that marine monitoring, as part of existing and planned marine EEM programs, would enable the collection of data relevant to potential human exposure to effluent COPCs. The EEM framework and future EEM cycle studies would also allow for confirmation of future treated effluent chemistry which could confirm effluent COPCs or a lack thereof.

A proposed EA follow-up and performance monitoring program will be submitted as part of the EA documentation. This will include fish and shellfish tissue chemistry investigations that could be used to support a HHRA, should a HHRA be required. The proposed schedules for baseline and performance monitoring programs would enable assessment of pre-discharge baseline conditions (in the vicinity of the treated effluent discharge) and establish the framework for post-construction/commissioning performance monitoring of the marine aquatic environment. Scoping evaluations have been conducted regarding potential aquatic EEM and marine EA follow-up sampling programs that would occur in the vicinity of the marine treated effluent diffuser. These programs will incorporate any parameters and considerations (such as locations, media, species, sampling event timing and frequency etc.) deemed relevant to potential human exposure pathways to effluent chemicals.

With respect to air emissions, the NPNS mill currently undergoes a source emissions testing program annually, which will continue under the IA. In addition, it is anticipated that a pilot study of the co-combustion of hog fuel and sludge in the power boiler will be conducted. During the pilot study, the power boiler exhaust gas will be tested, and upon receipt of the results the current air dispersion modelling study will be updated if deemed necessary. In addition, the existing ambient air monitoring program will continue under the IA during future operations and will collect data on the concentration of the various air contaminants over time for comparison to the applicable regulatory air quality criteria and the model predictions conducted for the NPNS project.

10.0 Accidents, Malfunctions, and Unplanned Events

This section identifies accidents, malfunctions, or unplanned events that could occur during any phase of the proposed project. The assessment focuses on events that are considered credible based on the project description and the experience of the EA team in assessing similar projects.

Contingency planning is a component of NPNS' approval requirements, and is a key component of NPNS' approach to its operations at the mill. NPNS has developed detailed operational procedures to guide its everyday operations, and has developed contingency and emergency response procedures to quickly address mill upsets or abnormal operating conditions while limiting environmental effects. Various emergency scenarios will be incorporated in planning for operation of the replacement ETF, including potential for failure and repair.

A key consideration is the physical design of the pipe itself, which is proposed to consist of HDPE. HDPE is strong (has greater than 5 cm thickness), is not susceptible to corrosion or decay, does not experience thermal expansion or contraction in the same manner as other materials (e.g., steel) do, and has some flexibility (i.e., can be bent) to adapt to the undulating terrain of the proposed route to Caribou and the ocean bottom profile between Caribou and the outfall location.

In addition, a component of the contingency planning for the replacement ETF is the construction of a spill basin. A new spill basin has been proposed with a capacity of 35,000 m^3 (i.e., 10 to 13 hours storage of effluent at full production). The spill basin will be lined with an impermeable barrier (HDPE). This containment system will serve to provide storage and containment of untreated effluent for a period of time in the event of a mill malfunction that would negatively affect the quality of untreated effluent. For example, while the mill is being shut down or while maintenance is occurring on the ETF components.

NPNS will also develop an EMP to address malfunctions or accidents that may occur at the proposed ETF and outfall during operation and maintenance.

10.1 Approach

The general approach to assessing the potential environment effects of the selected potential accident, malfunction, or unplanned event scenarios involves the following:

- describing the potential accident, malfunction, or unplanned event;
- considering if the potential accident, malfunction, or unplanned event could occur during the life of the project, and during which phase(s) or activity(ies);
- determining with which VECs the potential accident, malfunction, or unplanned event may interact;

- describing the project planning and safeguards established to minimize the potential for such occurrences to happen;
- considering of the contingency or emergency response procedures applicable to the event; and
- in consideration of the above, assessing the residual environmental effects of accidents, malfunctions, and unplanned events on related VECs, and determining the significance of the potential residual environmental effects of these accidents, malfunctions, or unplanned events (and their likelihood of occurrence, as applicable).

Spatial and temporal boundaries for considering residual environmental effects of potential accidents, malfunctions, and unplanned events that may arise as a result of the project are the same as those for each VEC to which they apply, presented earlier in this document. Similarly, criteria used for determining the significance of residual environmental effects with respect to potential accidents, malfunctions and unplanned events are the same as those for each applicable VEC.

10.2 Description of Potential Credible Accidents, Malfunctions, and Unplanned Events

Based on the nature of the project, the study team's knowledge of the environment within which the project is located, as well as the experience of the Proponent and KSH, the following credible accidents, malfunctions, and unplanned events have been selected for this assessment, and are described in greater detail in the following sections.

10.2.1 Accidental Release of a Hazardous Material

An accidental release of fuel or other liquid hazardous materials (e.g., POL) used in vehicles or heavy equipment on-site may occur during refuelling of machinery or trucks as a result of human error or equipment malfunction during construction activities. During operation of the ETF, there is potential for release of chemicals used in the treatment process as well. Such a spill may contaminate soils and groundwater and, through runoff, contaminate watercourses. Contaminants may adversely affect fish and fish habitat and waterfowl. Groundwater contamination may adversely affect nearby water supplies.

10.2.2 Failure of Erosion and Sediment Control Measures

Erosion and sediment control measures during construction prevent exposed soil from mobilizing and entering undisturbed areas as a result of rainfall or runoff. A failure of an erosion and sediment control measure could result in mass wasting of soil or siltation of receiving watercourses.

The discharge of sediment to watercourses during precipitation events or runoff following the failure of an erosion and sediment control measure would be limited to the construction phase of the project.

10.2.3 Accidental Release of Effluent from Land-Based Pipeline or ETF

An accidental release of effluent could occur at the ETF or along the length of the land-based portion of the effluent pipeline during the operation and maintenance phase of the project. An accidental release of effluent may be the result of equipment failure, human error, or material failure. A release of effluent on land at the ETF site or the land portion of the effluent pipeline could affect soil or water quality (groundwater or surface water), as the effluent is treated to guidelines specific to marine or aquatic disposal.

An accident or malfunction of this nature would be limited to the operation and maintenance phase of the project.

10.2.4 Marine Outfall Damage/Fouling

The pipeline leading from the land to the marine outfall location will be buried in the seabed and some sections may be protected by armour stone to protect it against ice scour and wave action in the shallow waters nearshore or from physical damage from anchor drag in deeper waters. Damage to the marine outfall prior to the diffuser location could result in a release of effluent in conditions that might not allow for proper diffusion, as the water depth and degree of mixing may differ from that of the diffuser location.

Another possible malfunction is that the diffuser nozzles may become fouled by marine life or damaged by fishing gear or anchor drag. This could result in the effluent being diffused differently than what is expected.

Marine outfall damage or fouling would be limited to the operation and maintenance phase of the project.

10.2.5 Accidental Release of Off-Specification Effluent

Off-specification effluent refers to effluent that does not meet the PPER before release from the ETF. The cause of off-specification effluent could be the result of an unplanned process change in the pulp mill which in turn could alter the organic or solids loading of the effluent entering the ETF, or a malfunction in the ETF process. A release of off-specification effluent could affect marine sediment, water quality, or marine fish and fish habitat if the effluent does not meet PPER.

An accidental release of off-specification effluent would be limited to the operation and maintenance phase of the project.

10.2.6 Berm Failure

Failure of the berm forming the walls of the spill basin could impact soil and water quality (surface water or groundwater). Berm failure could be in the form of a leak, releasing material over time, or a complete collapse of one or more basin walls.

Berm failure would be limited to the operation and maintenance phase of the project.

10.2.7 Vehicle Accident

A vehicle accident is possible during the construction phase at the ETF site or along the pipeline construction route, or while conveying materials to the construction site(s). A vehicle accident includes a potential collision with other vehicles, pedestrians, wildlife, or structures/objects, and potentially poses a risk to the health and safety of workers, the public, or wildlife and potential for damage to infrastructure. A fire or fuel spill could also occur as a consequence of a vehicle collision, compounding the initial effects by potentially threatening surface water, groundwater, fish and fish habitat, wildlife and wildlife habitat, vegetation, and wetlands. A vehicle accident would be limited to the construction phase of the project, as limited transportation is required for the project during operation and maintenance.

10.2.8 Discovery of a Heritage Resource

Previously undiscovered archaeological resources (i.e., artifacts) could be uncovered during excavation of topsoil and overburden as well as from other earth moving activities on the site during the construction phase.

10.3 Potential Interactions Between Accidents, Malfunctions, and Unplanned Events and Related VECs

Based on the nature of the above credible events and the study team's knowledge of their potential to interact with the environment, the VECs with a reasonable potential to interact with these potential accidents, malfunctions, or unplanned events that could result in residual environmental effects are identified in **Table 10.3-1**.

Table 10.3-1: Potential Interactions of Accidents, Malfunctions, and Unplanned Events with VECs

Accident, Malfunction, or Unplanned Event	Atmospheric Environment	Acoustic Environment	Bedrock and Surficial Geology, Soils	Surface Water	Groundwater	Aquatic Habitat	Wetlands	Terrestrial Habitat and Flora (Plant) Priority Species	Terrestrial Wildlife/Priority Species	Migratory Birds and Priority Species/Habitat	Harbour/Marine Physical Environment and Water/Sediment Quality	Harbour/Marine Fish and Fish Habitat/Priority Fish Species	Socio-Economic Environment	Indigenous Peoples	Heritage Resources	Impacts of the Environment on the project
Accidental release of Hazardous Materials	✓		✓	✓	✓	✓	✓	✓	✓	✓				✓		
Failure of Erosion and Sediment Control Measures			✓	✓	✓	✓	✓	✓	✓					✓		
Accidental release of Effluent from Land-Based Pipeline or ETF			✓	✓	✓	✓	✓	✓	✓	✓				✓		
Marine Outfall Damage/Fouling											✓	✓	✓	✓		✓
Accidental Release of Off-Specification Effluent											✓	✓	✓	✓		
Berm Failure			✓	✓	✓	✓		✓			✓	✓		✓		
Vehicle Accident	✓	✓						✓					✓	✓		
Discovery of a Heritage Resource														✓	✓	

Those accidents, malfunctions, or unplanned events that may result in an interaction with a specific VEC are identified with a checkmark in the table above, and are therefore carried for further assessment below.

Accidents, malfunctions, or unplanned events that are not identified with a checkmark in the table above are not expected to result in an interaction with a specific VEC or VECs. For those accidents, malfunctions, or unplanned events, the residual environmental effects of the project with the VECs for which an interaction was not identified in the above table during all phases are not significant, with a high level of confidence.

10.4 Assessment of Potential Environmental Effects from Accidents, Malfunctions, and Unplanned Events

This section assesses the environmental effects of each of the credible accidents, malfunctions, and unplanned events for which an interaction was identified with a related VEC (or VECs), and identifies mitigation measures to address the potential residual environmental effects. The significance of potential residual environmental effects following the implementation of mitigation or consideration of emergency or contingency response procedures is also discussed.

10.4.1 Accidental Release of Hazardous Materials

The accidental release of a hazardous material through a spill could affect primarily surface water and groundwater, and aquatic habitat, with consequential environmental effects possible to the atmospheric environment, bedrock and surficial geology, soils, wetlands, terrestrial habitat and fauna, terrestrial wildlife, migratory birds, and Indigenous peoples. An accidental spill of hydrocarbons or other substances during construction or operation and maintenance of the project may contaminate air, soils and groundwater and, through runoff, contaminate watercourses. Contaminants may adversely affect both terrestrial and aquatic habitat and migratory birds. Loss of petroleum hydrocarbons, hazardous materials, or other substances may volatilize and adversely affect ambient air quality on a temporary and localized basis.

Chemical or fuel spills may enter a watercourse directly, potentially affecting water quality and fish and their habitat, with the extent of effects depending upon the nature of the material and the quantity released. The effects could range from a small localized spill, which is contained and remediated quickly, to a large release of a highly soluble material that affects the receiving watercourse and downstream watersheds. Possible negative affects to fish and fish habitat could include direct mortality of fish and aquatic organisms that fish feed upon, degradation of surface water quality, and potential injury or death of wildlife in the event of exposure. If natural resources affected by a spill are used for traditional purposes by Aboriginal persons, a consequential environmental effect of a spill could also occur to Indigenous peoples.

Effects on terrestrial habitat and flora from an accidental hazardous materials release could include a physical harm or death of vegetation species, a reduction or loss of wetland function as a habitat for fish and wildlife, or accretion of contaminants in wetland sediments. Contaminants are less likely to move through a wetland system at the same rate as riparian systems due to the low mobility of water and sediments. Contaminants may build up in the sediments and be released into the ecosystem over time, rather than being flushed out over a season as with a riparian system.

10.4.1.1 Mitigation

Key mitigation to prevent an accidental release of a hazardous material is described in **Section 5.7.2** - Standard Mitigation Measures.

10.4.1.2 Potential Residual Environmental Effects

With no storage of liquid hazardous materials on-site during construction, spill containment provided during operation and maintenance, and careful implementation of best practices during refuelling of equipment from mobile tankers on a daily basis, the risk of spills resulting during construction or operation and maintenance of the project is expected to be low. The risk of contamination from spills and leaks during the operation and maintenance phase will be reduced further by preventive measures, contingency planning and spill response and mitigation. With the implementation of mitigation measures, contingency and emergency response procedures, and best practices, the potential residual environmental effects of an accidental release of a hazardous material on the atmospheric environment, bedrock and surficial geology, soils, surface water, groundwater, aquatic habitat, wetlands, terrestrial habitat and flora, terrestrial wildlife, migratory birds, and Indigenous peoples during all phases of the project are not significant, with a high level of confidence.

10.4.2 Failure of Erosion and Sediment Control Measures

Erosion and sediment control measures prevent erosion of surface soils and the resulting surface runoff from directly entering surface water bodies. Failure of an erosion and sediment control measure could be a result of the measures being insufficient to manage a given runoff event (e.g., rainfall or spring runoff exceeding capacity) or the implementation was poorly constructed.

A failure of an erosion and sediment control measure could affect primarily aquatic habitat. The discharge of runoff containing sediment to watercourses during storm events or spring runoff could result in the degradation of adjacent surface water bodies, wetlands, and fish and fish habitat those environments support. The effects on fish and fish habitat could include a temporary reduction in water quality due to increased sediment load. If the release were to occur during spawning, spawning beds could be negatively affected as sediment may cover the gravel beds and suffocate the eggs. Aquatic organisms may be adversely affected by a sediment release, potentially reducing the fish's food supply. Consequential environmental effects could result to bedrock and surficial geology, soils, surface water, groundwater, wetlands, and terrestrial wildlife.

In addition, a failure of an erosion and sediment control measure could affect Indigenous peoples use as a consequential environmental effect. Indigenous communities that practice traditional activities near the project site could be affected if the fish and fish habitat affected by an erosion and sediment control failure were being used for traditional purposes.

10.4.2.1 Mitigation

Key mitigation to prevent a failure of erosion or sedimentation control measures is described in **Section 5.7.2** - Standard Mitigation Measures.

10.4.2.2 Potential Residual Environmental Effects

The installation, maintenance, and monitoring of erosion and sedimentation control structures is a routine activity on construction sites and industrial operations, and is well understood by environmental managers and construction personnel. With daily visual monitoring of erosion and sedimentation control devices, conducting maintenance of them as necessary, periodically removing accumulated sediment, and active water management on-site, the risk of a failure of erosion and sediment control measures occurring is expected to be very low. With the implementation of mitigation measures, contingency and emergency response procedures, and best practices, the potential residual environmental effects of a failure of erosion and sedimentation control measures on aquatic habitat, bedrock and surficial geology, soils, surface water, groundwater, wetlands, terrestrial wildlife, and Indigenous peoples during all phases of the project are not significant, with a high level of confidence.

10.4.3 Accidental Release of Effluent from Land-Based Pipeline or ETF

The project will be designed for the effluent to comply with applicable CCME guidelines as described in **Section 5.6.1**, which require the effluent to meet ambient water quality at the edge of a standard mixing zone in the marine environment. An effluent spill in an environment other than for what the project is designed (i.e., terrestrial or aquatic) could adversely affect bedrock and surficial geology/soils, surface water, groundwater, and aquatic habitat, as well as terrestrial habitat and flora, wetlands, terrestrial wildlife, migratory birds, and Indigenous peoples.

10.4.3.1 Mitigation

Key mitigation to prevent an accidental release of effluent includes:

- The pipe will be constructed of > 50 mm thick HDPE which combines strength and flexibility to withstand stresses as well as being resistant to corrosion;
- The pipeline will be constructed with fusion technology to eliminate most, if not all, jointed sections.
- The ETF design includes a spill basin with a capacity of 35,000 m^3 (10 to 13 hours storage at full production);
- Operation of the ETF will include regular inspection of all piping and tanks for leaks or potential weak points where a leak could occur;

- An inspection program and leak detection will be implemented as described in **Sections 5.3.2.4** and **5.3.2.5**;
- Treated effluent will meet the PPER regulations upon exiting the secondary clarifiers.

10.4.3.2 Potential Residual Environmental Effects

Regular inspection of effluent facilities and pipelines is a standard component of effluent treatment systems to prevent costly and potentially damaging leaks. Identifying potential issues early though an inspection plan allows for repairs or replacement of problem sections before a release occurs. Through the implementation of an inspection plan that includes leak detection, the potential residual environmental effects of an accidental release of effluent on bedrock and surficial geology/soils, surface water, groundwater, aquatic habitat, terrestrial habitat and flora, wetlands, terrestrial wildlife, migratory birds, and Indigenous peoples during all phases of the project are not significant, with a high level of confidence.

10.4.4 Marine Outfall Damage/Fouling

A key concern with a malfunction or an accident involving the marine outfall pipeline and diffuser is that the project is designed so that the effluent is released into an area where the physical conditions will enable mixing and dispersion to meet ambient conditions at the edge of the mixing zone. Currents, temperature, salinity and flow rates of the effluent from the diffuser all affect the ability of the effluent treatment system to meet the applicable CCME guidelines. If an accident or malfunction results in a release in waters where conditions are significantly different from the diffuser location, or flow from the diffuser is adversely affected by fouling or damage, the ability of the system to meet applicable CCME guidelines may be reduced until the situation is reversed. Such a malfunction could affect the harbour/marine physical environment and water/sediment quality, marine fish and fish habitat/priority fish species, the socio-economic environment, and Indigenous peoples.

10.4.4.1 Mitigation

Key mitigation to prevent releases from the marine outfall pipeline damage or diffuser fouling includes:

- NPNS will with work with TC and DFO to establish a no anchoring zone in the vicinity of the marine outfall to reduce the likelihood of anchor drag damaging the pipeline;
- The outfall pipe will be buried in a trench and potentially covered with armour stone to minimize damage from physical impact or ice scour;
- The diffuser will be inspected regularly (by diver or remote operated vehicle) and any marine growth or debris will be removed;
- Upon detection of any marine outfall pipe damage or diffuser fouling, repairs would be promptly performed;
- Given the strong currents of the Caribou Channel at the outfall location significant diffusion is still likely to take place without the diffuser nozzle(s) in place; and
- Treated effluent will meet the PPER regulations upon exiting the secondary clarifiers.

10.4.4.2 Potential Residual Environmental Effects

As with the terrestrial portion of the effluent pipeline, regular inspections and maintenance as required to repair any damage or clear obstructed diffuser valves, combined with embedding the pipe in the substrate and protecting it with armour stone; the potential residual environmental effects of an accidental release of effluent on the harbour/marine physical environment and water/sediment quality, marine fish and fish habitat/priority fish species, the socio-economic environment, and Indigenous peoples during all phases of the project are not significant, with a high level of confidence.

10.4.5 Accidental Release of Off-Specification Effluent

A release of off-specification effluent into the receiving environment could affect the quality of the effluent and, as a result, the ability of the system to meet the PPER requirements until the issue is resolved. Off-specification effluent could adversely affect harbour/marine physical environment and water/sediment quality, marine fish and fish habitat/priority fish species, the socio-economic environment, and Indigenous peoples.

Off-specification effluent could be the result of an unplanned change to the influent to the pulp mill process (e.g., a sudden change in production rate, an accidental release in the mill, or a malfunction of mill equipment). Another possible reason for the effluent is the result of a malfunction in the ETF process or power failure. Regardless of the cause, NPNS personnel monitoring ETF operations would be alerted and take appropriate action as defined in the NPNS ERCP.

10.4.5.1 Mitigation

Key mitigation to prevent an accidental release of off-specification effluent to the receiving environment includes:

- Regular monitoring and testing of incoming influent by trained, full-time operators to identify potential deviations from standard quality;
- Daily monitoring of key performance indicators of the ETF in order to respond to and manage changes;
- Implementation of an EPP and spill response plan to manage spills and minimize upsets; and
- Use of a distributed control system and data historian to identify malfunctions in the pulp mill process or ETF and adjust processing to compensate or initiate a temporary shutdown until the issue is rectified.

10.4.5.2 Potential Residual Environmental Effects

The proposed ETF will be designed to process effluent from the pulp operations of NPNS to meet PPER requirements in the receiving environment. Changes in the composition of influent can be identified prior to it entering the pulp mill system, and, as such, changes to the treatment process can be made to adjust for influent changes to maintain the quality of the effluent. Malfunctions in the pulp mill system or in the ETF will be identified by control systems and necessary actions will be taken ensure that the effluent quality reaching the receiving environment meets PPER requirements.

Therefore, the potential residual environmental effects of an accidental release of off-specification effluent on harbour/marine physical environment and water/sediment quality, marine fish and fish habitat/priority fish species, the socio-economic environment, and Indigenous peoples during all phases of the Project are not significant, with a high level of confidence.

10.4.6 Berm Failure

The spill basin will be used to store untreated effluent from entering the main ETF system when conditions warrant diversion. The effluent would be pumped back into the ETF system to continue treatment as soon as possible.

The spill basin will be constructed from an earthen berm lined with an impermeable barrier. If the berm containing the spill basin were to fail - as a result of erosion or a structural defect - there is potential for a release of untreated or partially treated effluent, which could adversely affect bedrock and surficial geology/soils, surface water, groundwater, aquatic habitat, harbour/marine physical environment and water/sediment quality, marine fish and fish habitat/priority fish species, and Indigenous peoples.

10.4.6.1 Mitigation

Key mitigation to prevent failure of the spill basin berm includes:

- The spill basin design has accounted for the average annual precipitation to accommodate the potential for additional precipitation on top of the maximum effluent in the basin;
- Regular visual inspection of the berm walls for signs of erosion on the exterior walls;
- Encourage grass growth on the exterior surface to maintain slope stability;
- Mowing of the grass to discourage shrubs or trees where roots could lead to seepage of water into the berm;
- A project-specific EPP with defined contingency and emergency response procedures; and
- The standard operating procedure will be to keep the spill basin nearly empty so the full volume is available when needed.

10.4.6.2 Potential Residual Environmental Effects

The spill basin will be designed to industry standards including maintaining a safe freeboard to prevent accidental overtopping of the berms. With thorough design combined with regular inspection, particularly during and immediately following significant precipitation, mitigation measures, contingency and emergency response procedures, and best practices, the potential residual environmental effects of a berm failure at the spill basin on the atmospheric environment, bedrock and surficial geology/soils, surface water, groundwater, aquatic habitat, harbour/marine physical environment and water/sediment quality, marine fish and fish habitat/priority fish species, and Indigenous peoples during all phases of the project are not significant, with a high level of confidence.

10.4.7 Vehicle Accident

A vehicle accident could affect the atmospheric environment, acoustic environment, terrestrial wildlife/priority species, the socio-economic environment, and Indigenous peoples. Consequential environmental effects that could occur from the vehicle accident (i.e., arising from mechanisms other than the collision itself) were assessed under other scenarios above (e.g., accidental release of a hazardous material).

Vehicles will be active across the ETF project site throughout the construction and phase as well as on the pipeline route between Abercrombie Point and Caribou. A vehicle collision has the potential to risk human health and safety and other property such as project infrastructure or private property. This could have an adverse effect on the socioeconomic environment (which includes humans) as well as Indigenous peoples. A vehicle accident could also affect the atmospheric environment, as fires or fuel spills arising from a vehicle accident could result in a temporary and localized reduction in air quality, and the acoustic environment due to the noise generated from the collision itself.

Consequential environmental effects from fuel spills resulting from a vehicle accident could adversely affect soil quality, surface water, groundwater, aquatic habitat, wetlands, or terrestrial habitat/fauna, as surface or groundwater resources may become contaminated by fuel, potentially threatening potable water supplies and fish and fish habitat. Finally, a vehicle accident could have a direct effect on wildlife in the event of vehicle-to-wildlife collision, and an indirect effect in the event of a fuel spill or fire resulting from a vehicle collision.

10.4.7.1 Mitigation

Key mitigation to prevent vehicle accidents is described in **Section 5.7.2.11** – Traffic Management and Roadway Infrastructure.

10.4.7.2 Potential Residual Environmental Effects

Though vehicle accidents may occur with any project, particular attention will be paid to conducting project operations in a careful and safe manner so as to reduce the risk of a serious vehicle accident. With the implementation of mitigation measures, contingency and emergency response procedures, and best practices, the potential residual environmental effects of a vehicle accident on the atmospheric environment, acoustic environment, terrestrial wildlife/priority species, the socio-economic environment, and Indigenous peoples during all phases of the project are not significant, with a high level of confidence.

10.4.8 Discovery of a Heritage Resource

The discovery of a heritage resource would interact with historical, archaeological, and paleontological resources as well as Indigenous peoples.

Any ground breaking or earth moving activity has the potential to uncover previously undiscovered heritage resources. Archaeological resources (i.e., artifacts) tend to be found in surficial soils and when discovered, whereas paleontological resources (i.e., fossils) tend to be found in bedrock. The discovery of these resources can provide valuable information about human activity or use in the distant past (in the case of artifacts), or the presence of wildlife and vegetation in earlier eras (in the case of fossils). With respect to the project, it is possible that previously undiscovered heritage resources in the form of artifacts could be found in the surficial soils (including topsoil and overburden) during construction of the project, or from fossils if they are present.

Based on the early results of the archaeological assessment conducted for the project, the ETF project site generally has a high potential for harbouring archaeological resources. The location of the spill basin has been revised from the previous design to avoid archaeological resources identified in the initial archaeological field investigations. For paleontological resources, given the presence of up to 40 m of till in the general area, the presence of encountering fossils in the underlying bedrock is highly unlikely.

10.4.8.1 Mitigation and Response

Key mitigation measures to minimize the potential for the discovery of a heritage resource include conducting an archaeological assessment consisting of background research, map and model interpretation, a walkover of the project site, and associated shovel test pitting of any areas that are determined through the walkover to have a moderate to high archaeological potential. If archaeological or heritage resources are discovered through the archaeological assessment, further mitigation including archaeological monitoring during construction and operation and maintenance, excavation, or other measures would be considered. Additionally, a project-specific EPP with defined contingency and emergency response procedures in the event of the accidental discovery of a heritage resource will be developed and implemented. The EPP will include contingency and emergency response procedures to be implemented in the event of a chance find of a heritage resource.

In the unlikely event that an archaeological, paleontological, or cultural resource or artifact is discovered during the construction or operation and maintenance phases of the project, the following procedure will be followed, to be updated as part of the development of the EPP:

- The proposed pipeline route utilizes the previously disturbed Highway 106 corridor to avoid potential cultural resources.
- If cultural resources are encountered, work will be immediately stopped, and the area will be marked to prevent further disturbance. An exclusion zone of 100 m surrounding the find will be established.
- The Site Manager will immediately contact the Special Places Branch of the Nova Scotia Department of Communities, Culture and Heritage to notify them of the discovery and establish a mitigation plan.
- No new ground disturbance work will be permitted at the site until approval has been received from the appropriate regulatory agency to resume the work.
- If bones or human remains are found, work in the area must cease, and the Royal Canadian Mounted Police (RCMP) shall be immediately notified.

- No one shall disturb, move or rebury any uncovered human remains.

If the resources are related to Indigenous culture, the OAA and Special Places Branch will be contacted to determine how best to proceed with respect to repatriation of the resources.

10.4.8.2 Potential Residual Environmental Effects

Given the known potential of the ETF project site, the potential to encounter previously undiscovered heritage resource during construction and operation and maintenance of the project is believed to be very moderate to high in the vicinity of the ETF, while the proposed pipeline route is within a heavily disturbed corridor of Highway 106 and the potential for encountering cultural resources is considered to be low. With the implementation of mitigation measures, contingency and emergency response procedures, and best practices, the potential residual environmental effects of a discovery of a heritage resource on historical, archaeological, and paleontological resources as well as Indigenous peoples during all phases of the project are not significant, with a moderate level of confidence. The conduct of an archaeological assessment including walkover and shovel testing (as required) will improve the level of confidence of this prediction.

10.5 Summary

The potential occurrence of accidents, malfunctions, or unplanned events has been considered as part of the project design. The potential for accidents, malfunctions, or unplanned events to occur will be carefully considered during planning for the project, and measures will be developed and implemented such that their potential is reduced. Safeguards will be implemented throughout the construction, operation and maintenance, and decommissioning phases. Contingency and emergency response plans will be developed before any work is initiated on the proposed project so that incidents can be managed effectively. By ensuring that all aspects of the project adhere to applicable codes and standards and implementing the mitigative measures outlined above, the potential for adverse environmental effects arising from accidents, malfunctions, or unplanned events is greatly reduced.

NPNS will also develop an EPP for the management and prevention of such accidents, as well as develop effective response mechanisms for accidents, malfunctions, or unplanned events. To mitigate the potential for releases associated with operation of the ETF and effluent pipeline, an effective operations and maintenance plan will be put in place including routine, scheduled maintenance and inspection of the various components of the facility. Existing contingency and communication plans in case of emergencies, will be updated to include the new ETF. Plans include notification of NPNS and emergency response personnel and appropriate actions to be undertaken for various emergency scenarios. Given the nature of the project and the credible accident and malfunction scenarios, their low likelihood of occurrence, and proposed mitigation and contingency response planning, the potential residual environmental effects of all identified project-related accidents, malfunctions, and unplanned events on the all affected VECs as assessed above during all phases of the project are rated not significant, with a moderate to high degree of confidence.

11.0 Summary of Residual Adverse Effects and Environmental Effects

The environmental effects assessment of the VECs described throughout **Section 8** of this report concluded that there would be no significant adverse residual environmental effects from the project during all phases assessed and in consideration of normal activities of the project, as planned. The potential residual environmental effects of accidents, malfunctions, and unplanned events were also found to be not significant. Follow-up or monitoring initiatives have been developed to verify the predictions of this EIA Registration or to verify the effectiveness of mitigation.

Overall, based on the results of this EA Registration, it is concluded that, with planned mitigation through project design and the implementation of best practices to avoid or minimize adverse environmental effects, the residual environmental effects of the project during all phases are rated not significant. This includes the effects of the environment on the project and effects from accidents, malfunctions and unplanned events.

11.1 Summary of Residual Adverse Effects and Environmental Effects

The following **Table 11.1-1** summarizes the environmental effects assessment for each VC (refer to **Section 8** for details) and for each identified potential accident, malfunction or unplanned event (refer to **Section 10** for details). A summary of project phase(s) and potential interactions, identified mitigation, and significance of residual effects that were identified are provided in the tables below.

Table 11.1-1: Summary of Residual Adverse Effects and Environmental Effects

Project Phase(s)	Potential Environmental Effects	Mitigation	Significance of Residual Environmental Effects
Atmospheric Environment (refer to Section 8.1)			
Construction, Operation and Maintenance	• Dust and airborne particulate generation and deposition; • Contribution to degradation of air quality; • Nuisance effects; and • Potential for perception by nearby receptors at times	In addition to the standard mitigation measures and best management practices, the following mitigative measures will be employed: • Application of dust suppressants via water truck during dry periods when appropriate; • Instituting and following a non-idling policy; • Vehicles and equipment will be maintained in proper working order; • Operation of the facility will follow regulatory requirements; • Continuous solids removal from clarifiers to mitigate odour potential by preventing sludge from turning septic; • Subsurface air injection in the AS to mitigate odour potential; • Indirect effluent cooling (heat exchangers) to mitigate odour potential; and • Combustion of sludge in the power boiler, may reduce Mt CO2eq emissions through displacement of other fuels.	No significant residual environmental effects identified. Confidence level: High Magnitude: Low Geographic Extent: Local to Regional Duration: Short term (Construction) to Long Term (Operation/Climate) Reversibility: Reversible (Air Quality), Irreversible (Operation/Climate)
Acoustic Environment (refer to Section 8.2)			
Construction, Operation and Maintenance	• Noise at nuisance levels to local residences/ businesses.	In addition to the standard mitigation measures and best management practices, the following mitigative measures will be employed: • Utilize construction scheduling restrictions when possible to ensure noise from construction activities does not occur during nighttime; • Vehicles and equipment shall be maintained in good working order with quality mufflers; • Ensure workers have adequate hearing protection; • Include requirements in tenders clauses that assure minimization of noise; • Have regular discussions with workers and contractors on noise minimization practices; • Following timing windows in relation to migratory bird sensitivities (see Section 8.10). • Ensure drivers know the designated vehicle routes, parking locations, idling policy, normal delivery hours and use of engine brakes policy; and • Utilize existing mill communication channels to communicate with the public related to noise.	No significant residual environmental effects identified. Confidence level: High Magnitude: Low Geographic Extent: Local (PFA) Duration: Short term Reversibility: Reversible
Soils and Geology (refer to Section 8.3)			
Construction, Operation and Maintenance	• Potential for acidic drainage from local acidic rock bedrock types; • Potential for increased levels of suspended solids in surface water due to erodibility of soils based on surficial geology; • Potential to encounter contaminated soil or sediment and; • Potential adverse effects on bedrock, surficial geology or soils, most likely from maintenance activities involving ground disturbance	In addition to the standard mitigation measures and best management practices, the following mitigative measures will be employed: • Underlying Pictou Group bedrock is not known to produce ARD. Bedrock may not be disturbed depending upon the results of geotechnical investigations; • Soil types in the project area not considered highly erodible; • Soil and sediment sampling will be conducted prior to excavation in terrestrial environment if potential contaminants are identified and appropriate mitigation meeting regulatory requirements; and • Effects from sedimentation from both terrestrial and marine sediment will be prevented or will be mitigated in accordance with the appropriate guidelines documented in the EPP and Sediment and Erosion Control Plan developed for the project.	No significant residual environmental effects identified. Confidence level: High Magnitude: Negligible Geographic Extent: Local (PFA) Duration: Short term (Construction) Reversibility: Reversible

Project Phase(s)	Potential Environmental Effects	Mitigation	Significance of Residual Environmental Effects
Surface Water (refer to Section 8.4)			
Construction, Operation and Maintenance	• Degradation of water quality; • Alteration of natural surface water flow patterns; • Alteration of a stormwater drainage channel and; • Changes to stormwater runoff and potential impact to water quantity to nearby watercourse/ wetlands	In addition to the standard mitigation measures and best management practices, the following mitigative measures will be employed: • Comply with NSE conditions of approval for clearing within 30 m of watercourses; • Implementation of EPP, which shall include erosion and sediment control, buffer zones, stormwater management plan, and spill prevention and emergency response plan; • Environmental Inspector will monitor the implementation of the EPP mitigation during all critical phases of construction and repair, if warranted; • Maintain drainage across the construction ROW during all phases of construction; and not cause ponding of water or unintentional channelization of surface water flows; • Restrict the removal of riparian plants to appropriate setbacks from surface waters; • Relocation of the drainage and meeting NSE requirements; • Ensure all necessary approvals, licences and permits required for a particular activity are obtained prior to the commencement of the activity; • An erosion and sediment control plan for the project to be developed and erosion and sediment control measures to be implemented including those in Section 5.7; and • Avoid crossing NSE defined watercourses.	No significant residual environmental effects identified. Confidence level: High Magnitude: Low Geographic Extent: Local (within 500 m of watercourse crossings) Duration: Short term (Construction) to long term (Operation) Reversibility: Reversible WC2 - Irreversible
Groundwater (refer to Section 8.5)			
Construction, Operation and Maintenance	• Excavation may expose additional points of entry to the aquifer; • Damage to existing monitoring wells; • Groundwater discharge; • Groundwater in the vicinity of a wetland will be affected during spill pond construction; • Excavation may expose additional points of entry to the aquifer and; • Potential for surface water contaminants to enter local groundwater	In addition to the standard mitigation measures and best management practices, the following mitigative measures will be employed: • No potable wells near ETF site; • Conduct post construction groundwater monitoring; • If a monitoring well is in the way, recommend decommissioning to avoid creating a conduit; • If monitoring well is out of the way, place barriers around monitoring wells for protection; • If minor damage occurs, have monitoring wells repaired as necessary; • Dewatering to confirm groundwater quality if discharge to the environment occurs and undertake appropriate mitigation including disposal at approved facility if applicable. • The wetland alteration will be conducted under an NSE approval with appropriate compensation (see Section 8.7); • Conduct pre- and post-construction monitoring to ensure no alterations to groundwater from the construction process; • The pipeline will be constructed within the road shoulder gravel fill (no bedrock excavation anticipated); • Use mechanical mowing only; • Appropriate erosion and sediment control as noted for water quality; and • Surface water quality mitigation as noted in Section 8.4.	No significant residual environmental effects identified. Confidence level: High Magnitude: Negligible to Low Geographic Extent: Local (PFA) Duration: Short term Reversibility: Reversible
Freshwater Fish and Fish Habitat (refer to Section 8.6)			
Construction, Operation and Maintenance	• Indirect loss of fish habitat - suspended sediment generation and other water quality effects; • Indirect effects in relation to hydrological changes and; • Direct Loss of Fish Habitat (WC2).	In addition to the standard mitigation measures and best management practices, the following mitigative measures will be employed: • Avoid watercourse crossings where possible (conduct crossings on causeway or suspended from bridges, use HDD or other boring methods underneath watercourses); • Comply with NSE watercourse alteration conditions of approval for clearing within 30 m of watercourses; • Conduct fish rescue under DFO permit for areas of direct habitat loss; • Comply with DFO Authorization conditions of approval for work in fish bearing watercourses including approved offset and effects monitoring; and • Project team and contractors will be educated to recognize SAR species that may occur within the project area.	No significant residual environmental effects identified with planned and standard mitigation implementation, authorization, and environmental protection measures Confidence level: High Magnitude: Low Geographic Extent: Local (site specific within PFA) Duration: Short term (Construction) Reversibility: Reversible WC2: Irreversible

Project Phase(s)	Potential Environmental Effects	Mitigation	Significance of Residual Environmental Effects
Wetlands (refer to Section 8.7)			
Construction, Operation and Maintenance	• Direct loss of wetland area or function; • Indirect loss of wetland function via reduced surface water quality and; • Nutrient loading affecting wetland vegetation communities and potentially introducing invasive species	In addition to the standard mitigation measures and best management practices, the following mitigative measures will be employed: • Wetland alteration approval and compensation plan to achieve 'no net loss' of wetland area or function developed in conjunction with NSE; and • Following the contractors' EPP and applicable guidelines and regulations and use the NS Highway Seed Mix, unless otherwise approved.	No significant residual environmental effects identified with planned mitigation, authorization (with compensation), and environmental protection measures Confidence level: Moderate. Additional delineation of affected wetland features and evaluation of wetland function and follow-up, monitoring will improve the confidence of this prediction. Magnitude: Low Geographic Extent: Local (PFA) Duration: Short term (Construction) to Permanent Reversibility: Irreversible

12.0 Cumulative Environmental Effects Assessment

The potential cumulative environmental effects that could arise from the project in combination with other past, present, or reasonably foreseeable future projects or activities are assessed in this section.

12.1 Scope

Cumulative environmental effects are the residual environmental effects that are likely to result from a project in combination with the environmental effects of other projects or activities that have been or will be carried out (also referred to as past, present, and reasonably foreseeable future projects or activities) (CEA Agency 2014).

An assessment of cumulative environmental effects is warranted if:
- the project is assessed as having residual environmental effects on one or more VECs, whether those residual environmental effects are significant or not; and
- the residual environmental effects of the project on the identified VECs could act cumulatively (or overlap, spatially and temporally) with the residual environmental effects of other past, present, or reasonably foreseeable future projects or activities.

The existing environment conditions described for each of the VECs in **Section 8** generally reflect the cumulative environmental effects of past and present project activities; however, there is also a need to assess the potential for additional project-related cumulative environmental effects, particularly with respect to potential interactions with other pending projects that are in advanced planning stages, or existing ones that may be subject to modifications or expansion. In such cases, a cumulative environmental effects assessment is completed to determine if there is potential for substantive interaction with such projects or activities. The residual cumulative environmental effects are then evaluated.

The cumulative environmental effects assessment methodology undertaken for the project, and as presented in this section, generally conforms (at a high level) to the approach recommended in the Canadian Environmental Assessment Agency's (CEA Agency) publication titled "Assessing Cumulative Environmental Effects under the *Canadian Environmental Assessment Act, 2012* – Interim Technical Guidance" (CEA Agency 2018). According to CEAA's guidance document, a cumulative environmental effects assessment should accomplish the following:
- determine if the project will have a residual environmental effect on a VEC;
- determine if the incremental effect acts cumulatively with the effects of other past, existing, or future actions; and

- determine if, after mitigation, the combined environmental effects may cause a significant change in the VEC.

12.1.1 Spatial and Temporal Boundaries

The spatial boundaries for the assessment of cumulative environmental effects are defined by a regional assessment area that is common for all VECs. The **regional assessment area (RAA)** is defined as the area within which potential cumulative environmental effects are assessed. For the purpose of this cumulative environmental effects assessment, the RAA for this project includes the entirety of Pictou County in Nova Scotia as well as an area of the Northumberland Strait adjacent to the project footprint area (PFA, defined in **Section 5.1.1**) and boundaries of the County, and north to Prince Edward Island's south coast (**Figure 12.1-1**). This RAA has been selected because it encompasses the PFA and local assessment areas of all VECs assessed for the project, and because it covers an area within which project-related environmental effects may overlap or accumulate with the environmental effects of other projects or activities that have been or will be carried out. Specifically, it also accounts for discharges to and uses of the marine environment from projects and activities on the northern coast of Nova Scotia and the southern coast of PEI.

Temporal boundaries for the assessment of cumulative environmental effects are the same for each VEC as identified in **Section 8** of this EA Registration document. These temporal boundaries encompass periods of construction, and operation and maintenance of the project.

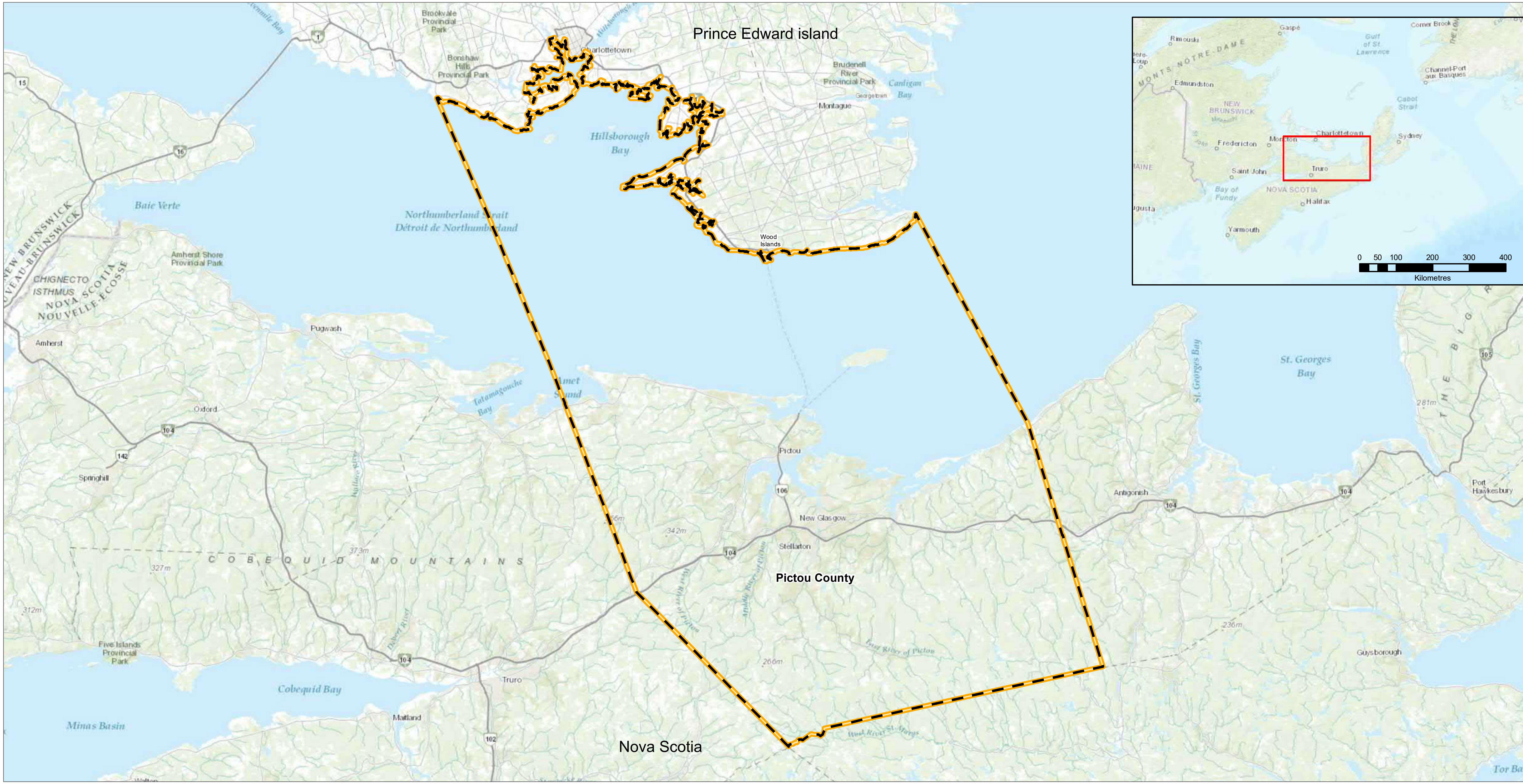
12.1.2 Significance Criteria

The significance of cumulative environmental effects is determined based upon specified significance criteria. Thresholds of significance for the assessment of cumulative environmental effects are the same as for each applicable VEC, as identified in **Section 8**.

12.1.3 Description of Other Projects or Activities

Future projects or activities were considered if the study team considered them to be "reasonably foreseeable", as follows:

- they have been publicly announced with a defined project execution period and with sufficient project details available publicly that allow for a meaningful environmental effects assessment;
- they are currently undergoing an environmental assessment, either federally or provincially, and information on those environmental assessments is available publicly; or
- they are currently in a known permitting process.



Northern Pulp Nova Scotia Corporation
Replacement Effluent Treatment Facility
Environmental Assessment

Cumulative Effects Regional Assessment Area
Figure 12.1-1

NORTHERN PULP NOVA SCOTIA CORPORATION A PAPER EXCELLENCE COMPANY

Cumulative Effects Regional Assessment Area

DILLON CONSULTING

MAP CREATED BY: SCM
MAP CHECKED BY: AB
MAP PROJECTION: NAD 1983 UTM Zone 20N

0 5 10 20 30 40
Kilometres

PROJECT: 17-6461
Date: 2019-01-30

A review of the websites of Nova Scotia Environment (NSE; https://novascotia.ca/nse/ea/projects.asp), Prince Edward Island's Department of Communities, Land and Environment (PEICLE; https://www.princeedwardisland.ca/en/topic/communities-land-and-environment), and the Canadian Environmental Assessment Agency (CEA Agency; http://www.ceaa-acee.gc.ca/050/index-eng.cfm) conducted on January 4, 2019 revealed that there are three projects within the RAA that may result in residual environmental effects that might overlap those of the project to cause cumulative environmental effects. All three projects are land-based and are located within Pictou County, Nova Scotia. **Table 12.1-1** describes the reasonably foreseeable future projects or activities that might overlap with the proposed project.

Table 12.1-1: Reasonably Foreseeable Future Projects or Activities with Environmental Effects that Might Overlap Those of the Proposed Project

Name of Potential Project or Activity	Location	Description
Fifteen Mile Stream Gold Project	Sunnybrae, Pictou County, NS, located approximately 30 km south of PFA	Atlantic Mining NS Corp, a wholly owned subsidiary of Atlantic Gold Corporation, is proposing the construction, operation, decommissioning and reclamation of an open-pit gold mine. As currently proposed, the project would include open pits, stockpiles, materials storage, crushing and concentrator facilities, water management and treatment infrastructure, mine haul roads, and an above-ground tailings management facility. Ore would be crushed and concentrated on-site to produce a gold concentrate that would be hauled to the Touquoy Mine for final processing, a distance of 76 kilometres, on existing public roads.
Highway 104 Twinning Project	Sutherland's River, Pictou County, NS to Brierly Brook, Antigonish County, NS, located approximately 20 km east of PFA	The proposed project involves the twinning of a section of the Highway 104 alignment. It will involve twinning approximately 28 kilometres of existing highway, in addition to the construction of a new four-lane highway section (approximately 10 kilometres). Project construction may commence in 2019 and is expected to be completed within 5 years.
MacLellans Mountain Quarry Expansion	MacLellans Brook, Pictou County, NS, located approximately 15 km southeast of PFA	The proposed undertaking is anticipated to expand the existing MacLellans Mountain Quarry. This project encompasses expansion of the existing quarry over an expected 50-year period, across an expansion area of 32.8 hectares. Future rate of aggregate production (~250,000 tonnes annually) and associated quarry activities at the MacLellans Mountain Quarry are expected to remain consistent with current quarry operations. Quarry expansion was

Name of Potential Project or Activity	Location	Description
		to commence in August 2018, pending approval.

In addition to the potential future projects or activities with environmental effects that might overlap those of the proposed project identified in **Table 12.1-1**, the study team identified five broad categories of past, present, or reasonably foreseeable future activities with which the residual environmental effects of the project will be assessed, but for which no specific project is currently proposed nor for which a specific location is necessarily identified—they are intended to be generalized, generic activities that may be taking place anywhere in the RAA to overlap with the environmental effects of the project. These broad categories of activities have been selected based on the nature of the residual environmental effects of the project that may overlap those of other activities, as well as the study team's knowledge of current activities taking place in the region. The broad categories of past, present, or reasonably foreseeable future physical activities that have been identified as having the potential to result in residual environmental effects that may act cumulatively with those of the project are described in **Table 12.1-2** below.

Table 12.1-2: Past, Present, or Future Activities with Environmental Effects that Might Overlap Those of the Proposed Project

Name of Past, Present, or Future Activity	Description
Industrial Development and Land Use	Industrial facilities located within the immediate vicinity of the PFA are limited to the existing NPNS mill facility directly associated with the project. Industrial activities in nearby areas (<5 km from PFA) include Nova Scotia Power Inc.'s Abercrombie Ash Management Site, the Pictou County Solid Waste Management Facility, the Michelin Tire Canada manufacturing facility, Nova Scotia (formerly Pictou) Advocate Printing, Pictou Waste Water Treatment Plant and the Aecon Atlantic Industrial Inc. Pictou Pipe and Modulation Fabrication Yard and Pictou Shipyard. A former chlor-alkali facility, currently operated as a sodium hydroxide transfer site, owned by Canso Chemicals Ltd. is also located immediately to the south of the ETF. Other large industrial activities in the RAA include the Nova Scotia Power Inc. Trenton Generating Station in Trenton, NS (approximately 7 km southeast of the PFA), and the Stellarton Surface Coal Mine owned by Pioneer Coal Ltd., located in Stellarton, NS (approximately 10 km southeast of the PFA). There are various pits and quarries within the RAA, including the MacLellans Mountain Quarry (located approximately 15 km southeast of the project), which is the largest supplier of aggregates within Pictou County and provides material to NSTIR, government agencies and other contractors and private sector projects. It is also noted that the Town of Pictou is currently planning for future commercial development on lands adjacent the Pictou Roundabout. According to the websites of NSE, PEICLE, and the CEA Agency, other than projects listed in Table 12.1 above, no new planned industrial developments have been identified based on a review of registered projects (as of January 4, 2019).

Name of Past, Present, or Future Activity	Description
	Given the potential for interaction between the project and existing and future industrial development and activities in the RAA, and the potential for the environmental effects of the project to overlap with those of past, present or future industrial development and land use, this activity is carried forward in the cumulative environmental effects assessment.
Linear Facilities	The major existing linear features in the vicinity of the PFA include the existing road network (notably Highway 106), overhead electrical transmission lines, pipelines, water and wastewater infrastructure, and buried utility corridors. Within the broader RAA, existing large linear development features include the Trans-Canada Highway Route 104, a natural gas pipeline corridor owned and operated by Heritage Gas Limited, the Cape Breton and Central Nova Scotia Railway (including spurs connecting Stellarton to Trenton and New Glasgow to Trenton), and Bell Aliant's fibre optic telecommunications cable spanning the Northumberland Strait from Caribou, NS to Wood Islands, PEI. TC's marine shipping channel which crosses the Northumberland Strait is also located adjacent to the marine portion of the PFA. Project construction traffic is likely to use Highway 104, Highway 106, and arterial roadways. Generally, linear developments contribute to habitat fragmentation due to the large amount of edge habitat that they produce relative to the area disturbed. However, the project will contribute less to habitat fragmentation than in previously undisturbed landscapes, as the vast majority of the route follows existing linear developments. There is no known planned major road or linear infrastructure work managed by NSTIR or private utility companies that may overlap with project construction. However, given the proximity of the project to other linear infrastructure, and the potential for the environmental effects of the project to overlap with those of existing linear developments, linear facilities are carried forward in the cumulative environmental effects assessment.
Commercial Fisheries and Aquaculture	The Northumberland Strait, including Caribou Harbour, supports life and well-being for many individuals and coastal communities. Commercial fishing and aquaculture activities within the RAA are an important economic driver in both Pictou County and for coastal communities in PEI. For example, DFO estimates that approximately seven thousand people participate in the commercial lobster harvest in the Gulf Region (DFO 2017). These activities are described in more detail in the marine fish and fish habitat VEC (**Section 8.12**). Through conversations with stakeholders (such as fishing industry representatives), Indigenous fishermen, and other available records (e.g., DFO), many active fisheries have been identified that intersect the RAA. These include: lobster, herring, rock crab, oyster, scallop, quahogs, eels, mackerel, smelt, and oysters. Twenty-three Nova Scotia licensed marine shellfish aquaculture sites, dozens of aquaculture lease areas in PEI, and numerous marinas, docks, and harbours are also located within the RAA. Given the amount of fishing activity in the Northumberland Strait, and the potential for the environmental effects of the project to overlap with those of past, present, or future commercial fisheries and aquaculture operations, this activity is carried forward in the cumulative environmental effects assessment.

Name of Past, Present, or Future Activity	Description
Commercial Shipping	Within the RAA, there are two defined shipping lanes, including one for entry to Caribou Harbour and one for departure from Caribou Harbour. One lane is predominantly used by Northumberland Ferries Limited for a vehicle and passenger ferry connecting Caribou, NS to Wood Islands, PEI. A second ferry lane connects Caribou to Pictou Island. These shipping lanes are regulated and maintained (where required) by TC. Other commercial shipping in the Northumberland Strait in the RAA includes shipping of agricultural, petroleum, and aggregate products from various harbours in Nova Scotia and PEI, as well as forestry products from Pictou, NS. Cruise ships will also use the Strait, particularly to access Charlottetown, PEI during the summer and fall, and occasionally smaller tourist vessels will visit Pictou, NS. Given the regular vessel traffic in the Northumberland Strait, and the potential for the environmental effects of the project to overlap with those of past, present, or future commercial shipping activities, this activity is carried forward in the cumulative environmental effects assessment.
Recreational Use	Recreational use in the RAA consists of both land and water-based activities. Through comments received during this project (see **Section 6**), community members report valuing access to the lands and water for recreation and social value for swimming, by various types of boating, or walking trails and coastlines. Recreational and subsistence hunting and fishing, as well as harvesting edible plants such as berries, is common in Pictou County. Freshwaters throughout Pictou County, including lakes and rivers are active traditional, subsistence, and recreational fishing areas. There are fishing grounds for American eel, smelt and gaspereau and, in the past (currently closed) blue mussel and soft shell clam. Recreational fishing of Atlantic salmon, striped bass, brown trout, and brook trout may occur as well. The RAA is home to many outdoor recreational opportunities. There are many hiking, cycling, and walking trails throughout the area, as well as many public and private beaches used for recreation, beachcombing, and kayaking. The Trans-Canada Trail network also passes through Pictou County within close vicinity of the PFA (under Highway 106 near the north end of the Pictou Causeway). Munroes Island and Caribou Island form the headlands which bound the opening to Caribou Harbour. Much of these headlands are protected as Provincial Parks and Nature Reserves, including: Caribou-Munroe Island Provincial Park and Campground, MacKenzie Beach Provincial Park, Waterside Beach Provincial Park and the Caribou Rivers Nature Reserve. These natural assets are important for community use and in supporting the local tourism industry. Recreational vessels make use of the harbours, docks and marinas along Pictou County's coastline and along PEI's southern shore within the RAA (including a small craft harbour located to the west of the Northumberland Ferries marine terminal). Given the high tourism and outdoor opportunities in the RAA, and the potential for the environmental effects of the project to overlap with those of past, present, or future recreational use, recreational use is carried forward in the cumulative environmental effects assessment.

12.2 Identification of Potential Cumulative Environmental Effects Interactions

Based on the assessments presented in **Section 8**, the following ten VECs are anticipated to have residual environmental effects that might overlap those of other projects or activities that have been or will be carried out, and for which cumulative environmental effects assessment was therefore undertaken:

- atmospheric environment;
- acoustic environment;
- wetlands;
- flora/floral priority species;
- terrestrial wildlife/priority species;
- migratory birds and priority bird species/habitat;
- harbour physical environment, water quality and sediment quality;
- marine fish and fish habitat;
- marine mammals, sea turtles and marine birds; and
- socio-economic environment.

Interactions between the project and soils and geology, surface water, groundwater, freshwater fish and fish habitat, marine archaeological resources, terrestrial heritage resources, or Indigenous Peoples use of land and resources VECs are not anticipated to result in cumulative residual environmental effects with any other project or activity listed in **Table 12.2-1**, for the following reasons:

- **Soils and Geology VEC:** Provided the recommended mitigative measures are implemented (to be addressed by the EPP), it is not anticipated that the project will result in significant adverse residual environmental effects on bedrock geology, surficial geology, or soils. There are no expected residual environmental effects on geology, particularly ARD as acid producing rock is not found within the PFA. In the unlikely event that acid producing rock is discovered through geotechnical investigations, these can be mitigated through appropriate techniques. Given that there are no residual environmental effects on soils and geology, this VEC is not carried forward in the cumulative environmental effects assessment.
- **Surface Water VEC:** During the construction phase, watercourses (as defined by NSE) encountered along the pipeline route will be crossed either above the existing road culvert, or if required, crossing will occur underneath the watercourse using a trenchless technology such as HDD or boring such that there are no residual environmental effects on surface water. Potential changes in water quality due to erosion and/or sediment generation will be mitigated by standard erosion and sediment control measures, and a construction monitoring program. Operation and maintenance activities at the proposed ETF facility will be similar to existing NPNS activities and storm water runoff during operation will be monitored as part of follow-up and within the Mill Monitoring Network. Operation and maintenance activities along the proposed roadside pipeline will reflect existing highway maintenance activities undertaken by NSTIR and no significant interaction is anticipated with the project. Given the nature of the project which will not interact directly with watercourses, and with the implementation of mitigation measures, the residual environmental effects of the project on surface water during all phases of the project are not likely to be substantive, and this VEC is not carried forward in the cumulative environmental effects assessment.

- **Groundwater VEC:** The ETF is greater than 500 m away from the closest residential well; a watershed divide intersects the far eastern portion of the site (near the eastern side of Landfill 3) in a general north-south direction; and groundwater flow east of the divide is in a southeasterly direction towards the East River. Therefore, it is unlikely that groundwater from the PFA would affect residential water supplies. In consideration of the above, the nature of the project, its environmental setting, and planned mitigation, the residual environmental effects of the project on groundwater during all phases of the project are not likely to be substantive, and groundwater is thus not carried forward in the cumulative environmental effects assessment.
- **Freshwater Fish and Fish Habitat VEC:** During construction, watercourses (as defined by NSE) encountered along the pipeline route will be crossed either above the existing road culvert, or if required, crossing will occur underneath the watercourse using a trenchless technology such as HDD or boring such that there are no residual environmental effects on freshwater fish and fish habitat. Any potential impacts to on-site surface waters will most likely be a result of erosion, sediment transport or from storm water runoff. Direct fish habitat loss will occur at WC2 which will be mitigated by obtaining and complying with a watercourse alteration approval and/or an authorization under the federal *Fisheries Act* (with appropriate offsetting), as required by NSE and DFO. Given the nature of the project which will not interact directly with watercourses, and with implementation of offsetting measures as mitigation for direct loss of fish habitat, the relocation of fish from within the PFA, and the implementation of other mitigation measures aimed at reducing or minimizing environmental effects on fish and fish habitat, the residual environmental effects of the project on freshwater fish and fish habitat during all phases of the project are not expected to be substantive. Once the project is operational, no environmental effects are anticipated to freshwater fish and fish habitat. This VEC is thus not carried forward in the cumulative environmental effects assessment.
- **Indigenous Peoples' Use of Land and Resources VEC:** The construction of the land-based portion of the PFA is not anticipated to interact with Indigenous traditional uses, given that the NPNS property has been actively used as an industrial site since the 1960s. Additionally, installing the pipeline in the road shoulder of Highway 106 is not likely to interact with Indigenous Peoples' use of land and resources, since few (if any) resources would likely be collected in the road shoulder. Although construction of the marine portion of the pipeline may interfere with the harvesting of marine resources by Indigenous Peoples due to the presence of construction vessels and movement of construction materials, timing of construction will be staged to minimize disruption to marine traffic and key fishing seasons. During operation and maintenance, there are no project features expected to result in substantive interactions with Indigenous Peoples' use of land and resources given the likely limited scope, frequency, and duration of such activities. With mitigation measures in place, residual environmental effects of the project on Indigenous Peoples' use of land and resources during construction or operation and maintenance are not expected to be substantive, and as such this VEC is not carried forward in the cumulative environmental effects assessment.
- **Marine Archaeological Resources VEC:** Project-related seabed disturbance activities during the construction and operation and maintenance phases have the potential to adversely affect marine archaeological resources by altering the resource, if present. Since the only way that the project could

result in environmental effects on marine archaeological resources is via direct disturbance of such resources if present, environmental effects of the project on marine archaeological resources would be limited to the PFA. Additionally, for cumulative environmental effects to occur from other projects or activities, the environmental effects of other projects or activities would need to overlap spatially with those of the project, within the PFA. The Nova Scotia government requires mitigation of all potential effects to historical, archaeological, palaeontological and ecological resources within the Marine PFA/LAA prior to construction. Marine ARIA and mitigation measures will be completed prior to any seabed disturbing activities. Based on the determination that potential environmental effects to marine archaeological resources will be mitigated (through avoidance or SDR as appropriate) in accordance with Provincial legislation, and since there are no known projects or activities that would be conducted in the marine portion of the PFA with environmental effects that overlap those of the project, this VEC is not carried forward in the cumulative environmental effects assessment.

- **Terrestrial Heritage Resources VEC:** As with the marine archaeological resources VEC, project-related environmental effects on terrestrial heritage resources could only occur via direct disturbance of such resources if present, and as such, environmental effects of the project on terrestrial heritage resources would be limited to the PFA. Additionally, for cumulative environmental effects to occur from other projects or activities, the environmental effects of other projects or activities would need to overlap spatially with those of the project, within the PFA. Based on the preliminary results of the ARIA conducted for the project, the PFA is generally thought to have low archaeological potential, with the exception of a few areas to be avoided and others having a higher archaeological potential that have been recommended to be subjected to shovel testing prior to construction. No interactions with palaeontological or built heritage resources are anticipated. As a result, the potential for terrestrial heritage resources to be present within the PFA is considered low; therefore, substantive unmitigated interactions between the project and terrestrial heritage resources during any phase of the project are unlikely to occur. Since there are no known projects or activities that would be conducted in the PFA with environmental effects that overlap those of the project, this VEC is not carried forward in the cumulative environmental effects assessment.
- **Human Health:** Following an approach developed in consultation with Health Canada, a human health evaluation was completed for the project. NPNS is the only industrial activity of its nature in the region and its emissions and discharges are unique to its operations. The air quality assessment completed for this project demonstrated no change above baseline conditions, and no other projects or activities, past or present, will release effluent at the planned outfall location (CH-B).

Table 12.2-1 highlights the potential for interactions between the VECs resulting in residual environmental effects of the project and the overlapping reasonably foreseeable future projects and broad categories of past, present, or reasonably foreseeable future activities identified.

Table 12.2-1: Potential Cumulative Effects Interactions Among Valued Environmental Components and Past, Present, or Future Projects and Activities

Past, Present, or Future Project or Activity	Valued Environmental Components (VECs)									
	Atmospheric Environment	Acoustic Environment	Wetlands	Flora/Floral Priority Species	Terrestrial Wildlife/Priority Species	Migratory Birds and Priority Bird Species/Habitat	Harbour Physical Environment, Water Quality and Sediment Quality	Marine Fish and Fish Habitat	Marine Mammals, Sea Turtles and Marine Birds	Socio-economic Environment
Fifteen Mile Stream Gold Project	-	-	-	-	-	-	-	-	-	-
Highway 104 Twinning Project	-	-	-	-	-	-	-	-	-	-
MacLellans Mountain Quarry Expansion	-	-	-	-	-	-	-	-	-	-
Industrial Development and Land Use	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Linear Facilities	✓	✓	✓	✓	✓	✓	-	-	-	✓
Commercial Fisheries and Aquaculture	✓	-	-	-	-	-	✓	✓	✓	✓
Commercial Shipping	✓	✓	-	-	-	-	✓	✓	✓	✓
Recreational Use	-	-	-	-	-	-	✓	-	-	✓

Legend: √ Potential for cumulative environmental effects to occur on the VEC; further analysis is provided below.
- Cumulative environmental effects are not likely to occur on the VEC; cumulative environmental effects on the VEC are rated not significant and are not discussed further.

Past, present and future projects or activities that have been identified in **Table 12.2-1** as having a potential for overlapping environmental effects with those of the project, for one or more VECs, have been carried forward in the cumulative environmental effects assessment. Those past, present, or future projects or activities for which no interaction was identified for any VEC in **Table 12.2-1** are not carried forward in the cumulative environmental effects assessment, either because they do not overlap spatially or temporally with the environmental effects of the project, or in light of very low magnitude residual environmental effects of the project or other projects or activities that would result in negligible cumulative environmental effects. A justification for those projects or activities that were identified as not having an interaction with any VEC in **Table 12.2-1** is provided below.

The Fifteen Mile Stream Gold Project is planned to be located approximately 30 km south of the PFA, at a site that has been used for mining and exploration activities for over 100 years. The proposed project will involve construction, operation, decommissioning and reclamation of an open-pit gold mine. As currently proposed, the project would include open pits, stockpiles, materials storage, crushing and concentrator facilities, water management and treatment infrastructure, mine haul roads, and an above-ground tailings management facility. Ore would be crushed and concentrated on site to produce a gold concentrate that would be hauled to the Touquoy Mine for final processing, a distance of 76 km on existing public roads. The mine would process approximately two million tonnes of gold-bearing ore per year. The planned start date for construction for the project is May 2020, with a scheduled start-up for 2021. The Fifteen Mile Stream Gold Project will be entirely land-based and located close to 30 km south of the project.The project is currently undergoing a federal environmental assessment, and project timelines are subject to change. The Fifteen Mile Stream Gold Project is not likely to act cumulatively with the Project, as there are not expected to be overlapping interactions with any of the VECs listed in **Table 12.2-1**, given the large distance between the projects. As there is no spatial overlap expected between the environmental effects of the project and those of the Fifteen Mile Stream Gold Project such that there would be any interaction with any of the VECs listed in **Table 12.2-1**, the Fifteen Mile Stream Gold Project is not carried forward in the cumulative environmental effects assessment.

The Highway 104 Twinning Project will link the existing twinned Highway 104 east of Sutherland's River to the existing twinned Highway 104 west of Antigonish, NS, a distance of approximately 38 km. The project will involve twinning of existing lanes (approximately 28 km), construction of a new four-lane highway section (approximately 10 km) and approximately 25 structure additions or modifications, including interchanges and large watercourse crossings. The incorporation of infrastructure to permit wildlife passage in key areas is also included in this highway twinning project. It is anticipated that construction will be completed between spring 2020 and fall 2024. The highway twinning project will be entirely land-based and located close to 20 km east of the project. The twinning project is currently undergoing a provincial environmental assessment. It is not likely that the Highway 104 Twinning Project will act cumulatively with the project, as there are not expected to be overlapping interactions with any of the VECs listed in **Table 12.2-1**. As there is no spatial overlap expected between the environmental effects of the project and those of the Highway 104 Twinning Project such that there would be any interaction with any of the VECs listed in **Table 12.2-1**, the Highway 104 Twinning Project is not carried forward in the cumulative environmental effects assessment.

The MacLellans Mountain Quarry is owned and operated by S.W. Weeks Construction Ltd. The proponent plans to expand its existing quarry to continue to have quarry reserves for the local market. The proposed project area includes and expansion footprint of 32 ha over a minimum 50-year time period. While the proposed quarry expansion aims to increase reserves, the proponent does not intend to increase the rate of production. The timing and rate of quarry expansion and development is based on market need for local aggregate. However, current production rates are expected to remain consistent as the quarry expands. If a large project was to occur in the local service area, the proposed development plans could vary if an increased need of aggregate is required at that time. Presently, there are no anticipated changes to the current operations within the quarry including the amount and frequency of blasting, quarry hours of operation, and number and frequency of haul trucks collecting aggregate from the site. The quarry project is currently undergoing a provincial environmental assessment. It is anticipated that quarry expansion activities could begin as early as 2019. The MacLellans Mountain Quarry Project is not likely to act cumulatively with the project, as there are not expected to be overlapping interactions with any of the VECs listed in Table 12.3. The quarry expansion will be entirely land-based and located close to 15 km southeast of the project, and there is limited potential for the two projects to overlap spatially in any meaningful way in the RAA that would cause overlapping cumulative environmental effects on any VEC. As there is no substantive spatial or temporal overlap expected between the environmental effects of the project and those of the MacLellan's Mountain Quarry Project such that there would be any interaction with any of the VECs listed in **Table 12.2-1**, the MacLellan's Mountain Quarry Project is not carried forward in the cumulative environmental effects assessment.

In summary, those past, present, or future activities for which no interaction with a VEC was identified in **Table Table 12.2-1**are not expected to overlap spatially or temporally with the environmental effects of the project for any VEC, and are not carried forward in the cumulative environmental effects assessment. The cumulative environmental effects of the project in combination with those of the Fifteen Mile Stream Gold Project, the Highway 104 Twinning Project, and the MacLellans Mountain Quarry Expansion, for all phases of the project and for all VECs affected, are rated not significant and are not further discussed in this assessment.

12.3 Assessment of Cumulative Environmental Effects

Past or present projects or activities that have been or are being carried out have influenced the baseline conditions for the assessment of project-related environmental effects, as documented in the existing environment section of each preceding VEC section (**Section 8**). Since the environmental effects of past or present projects or activities are largely encompassed within existing environmental conditions for each VEC, the environmental effects of other projects or activities that have been or are being carried out (i.e., past and present environmental effects) in combination with the environmental effects of the project are considered in the assessment of the residual environmental effects of the project and are thus not duplicated below. The focus of the discussion below will be on the cumulative environmental effects of the project in combination with those of reasonably foreseeable future projects or activities.

It is important to note that the discussion that follows only considers those projects or activities that were identified in **Table 12.2-1**as having a potential interaction with the particular VEC being assessed.

12.3.1 Cumulative Environmental Effects on the Atmospheric Environment

12.3.1.1 Residual Project Environmental Effects Summary

As detailed in **Section 8.1**, the residual environmental effects of the project on the atmospheric environment during construction include fugitive dust and emissions from equipment. Environmental effects from equipment are expected to be short-term and very localized when applying standard and site-specific mitigation. Residual environmental effects of the project on the atmospheric environment during decommissioning will be similar, but less, to those arising during construction since some of the project components will be abandoned in place (e.g., pipeline).

GHGs for the future operating scenario are not anticipated to be materially different from the existing facility emissions, with the overall change being immaterial in the context of regional emissions.

During operation and maintenance, emissions of the regulated air contaminants are predicted to be below the provincial maximum permissible GLCs for all contaminants except H2S, where one exceedance was predicted at a receptor immediately east of the project, with an estimated frequency of exceedance of less than 0.05%, a single exceedance in the modelling domain that is likely an artifact of the model inputs (i.e., meteorological data anomalies—see Section 7.1.3 of Stantec [2019]). It is also noted that the source of the exceedance is the new replacement ETF, which is based on conservative estimates and that actual GLCs are likely to be lower than the model results suggest.

12.3.1.2 Cumulative Environmental Effects during the Construction Phase

During construction, past and present industrial operations, commercial fisheries and aquaculture, shipping activities, and use of linear facilities (particularly roadways) in the RAA are expected to be ongoing and similar to past and present activities in terms of contribution to air quality and GHGs, whose environmental effects are encompassed in existing conditions for the atmospheric environment.

In consideration of available standard mitigation practices and the relatively limited duration of construction, project-related releases of air contaminants are unlikely to cause exceedances of air quality standards, and are unlikely to act cumulatively with other projects and activities. Similarly, because of the relatively small footprint and duration of construction, project-related releases of GHGs during construction will not measurably contribute to provincial and national GHG totals.

The environmental effects of industrial activities and land use, commercial shipping, commercial fishing and aquaculture activities, and use of linear facilities in the RAA are therefore not expected to result in a substantive overlap with the environmental effects of the project on the atmospheric environment during the construction phase of the project.

12.3.1.3 Cumulative Environmental Effects during the Operation and Maintenance Phase

During project operations, past and present industrial operations, commercial shipping, commercial fishing and aquaculture, and use of linear infrastructure in the RAA are expected to be ongoing and similar to past and present activities in terms of contribution to air quality and GHGs, whose environmental effects are encompassed in existing conditions for the atmospheric environment. GHGs for the future operating scenario are not anticipated to be materially different from the existing facility emissions, with the overall change being immaterial in the context of regional emissions. Other future projects or activities would also be subject to approvals and permits which would determine the acceptability of their environmental effects and prescribe any required mitigation.

As noted above, emissions of the regulated air contaminants are predicted to be below the provincial maximum permissible GLCs for all contaminants except H2S, where one exceedance was predicted at a receptor immediately east of the project, with an estimated frequency of exceedance of less than 0.05% (though likely an artifact of the model inputs) . Though other reasonably foreseeable future activities may also release emissions of air contaminants to the environment, their contribution to the airshed in combination with those of the project are unlikely to result in an exceedance of ambient air quality standards or objectives, except for possibly H2S, for which none of the other reasonably foreseeable projects or activities are not expected to be a substantive source of H2S emissions, given their nature. As such, substantive overlapping cumulative environmental effects to the atmospheric environment during operation and maintenance are unlikely.

The environmental effects of industrial activities, commercial shipping, commercial fishing and aquaculture, and linear facilities in the RAA are therefore not expected to result in a substantive overlap with the environmental effects of the project on the atmospheric environment during the operation and maintenance phase of the project.

12.3.1.4 Summary of Cumulative Environmental Effects on the Atmospheric Environment

In light of the above, overlapping cumulative environmental effects on the atmospheric environment during project construction and operation and maintenance are not anticipated. Other future projects or activities would be subject to approvals and permits which would determine the acceptability of their environmental effects and prescribe any required mitigation. Cumulative environmental effects of the project in combination with those of other past, present or future activities (industrial operations, commercial shipping, commercial fishing and aquaculture, and linear facilities) on the atmospheric environment during all phases of the project are therefore not expected to be substantive.

12.3.2 Cumulative Environmental Effects on the Acoustic Environment

12.3.2.1 Residual Project Environmental Effects Summary

As detailed in **Section 8.2**, the residual environmental effects of the project on the acoustic environment are expected to be primarily related to operation of heavy equipment and related construction activities.

During the construction of the new replacement ETF and the effluent pipeline, sources of noise are expected to be primarily related to operation of heavy equipment and related construction activities. Construction related activities have the potential to result in changes in local noise levels due to the operation of construction equipment. Noise levels associated with construction activities are expected to be localized, short-term, and reversible.

Given that the replacement ETF will be constructed on an operating pulp facility mill and given the project site's relative distance to the nearest residential receptor (approximately 750 m), the potential for construction-related noise emissions to adversely affect nearby receptors is expected to be minimal.

The predicted noise levels from the operation of the replacement ETF or pipeline are not expected to exceed the NSE Noise Guidelines during the day or evening at any of the four discrete receptors where baseline noise monitoring was conducted, nor at night provided that intrusive construction activities are limited during that period.

12.3.2.2 Cumulative Environmental Effects during the Construction Phase

During construction, noise emissions from past and present industrial operations, commercial shipping activities, and the use of linear facilities in the RAA are expected to be ongoing and similar to past and present activities in terms of their contribution to noise. The environmental effects arising from past and present activities are encompassed in existing conditions for the acoustic environment.

The nature and underlying physics of noise propagation and dissipation is such that noise levels decrease with increasing distance from the source, with noise levels from a source typically not distinguishable from background levels within about 1 km from the source. As such, for a substantive overlap to exist between noise levels from the project and those from other reasonably foreseeable activities, the noise producing sources would have to be located roughly within 1 km or less of each other; otherwise, noise levels would not be expected to act cumulatively in any substantive way.

Use of large equipment and vehicles during the construction phase of the project will emit sound. Noise will be concentrated predominantly on NPNS property during construction of the replacement ETF and initial section of the pipeline, and within the NSTIR Highway 106 ROW during installation of the land-based portion of the pipeline. Because of the linear progression of pipeline construction, it is anticipated that any given nearby residence or sensitive receptor will be exposed to potentially increased noise levels for less than a week at any given time (given the transient nature of the activity). In the marine environment, noise will be limited to the immediate vicinity of the marine portion of the PFA. Intrusive construction activities will be scheduled during daytime hours, when possible, in areas with nearby residences to lessen noise disturbance.

Given the limited spatial and temporal extent to which the environmental effects of the project's construction activities will overlap those of other reasonably foreseeable projects or activities, the environmental effects of industrial activities, commercial shipping, and use of linear facilities (particularly roadways) in the RAA are not expected to result in a substantive overlap with the environmental effects of the project on the acoustic environment during the construction phase of the project.

12.3.2.3 Cumulative Environmental Effects during the Operation and Maintenance Phase

During project operation and maintenance activities, noise emissions from past and present industrial operations, commercial shipping, and use of linear facilities in the RAA are expected to be ongoing and similar to past and present activities in terms of their contribution to noise levels. The environmental effects of those past and present activities are encompassed in existing conditions for the acoustic environment.

Once operational, there are no features of the operation of the replacement ETF or pipeline (including their physical presence) that would be expected to contribute materially to ambient noise levels. Periodic maintenance activities may result in some sound emissions. The frequency, duration and geographic extent of the maintenance activities would not be expected to have a substantive overlap with noise emissions from other potential future projects or activities occurring within the zone of influence for noise (i.e., within approximately 1 km of the project activities).

As such, the environmental effects of industrial activities, commercial shipping, and linear facilities in the RAA are therefore not expected to result in a substantive overlap with the environmental effects of the project on the acoustic environment during the operation and maintenance phase of the project.

12.3.2.4 Summary of Cumulative Environmental Effects on the Acoustic Environment

In consideration of the residual environmental effects of the project on the acoustic environment and the very limited number of other likely projects or activities in the RAA that would generate noise that would act cumulatively with that of the project, the potential cumulative environmental effects of the project in combination with those of other past, present or future activities on the acoustic environment during all phases of the project are not expected to be substantive.

Other future projects or activities would be subject to approvals and permits which would determine the acceptability of their environmental effects and prescribe any required mitigation.

12.3.3 Cumulative Environmental Effects on Wetlands

12.3.3.1 Residual Project Environmental Effects Summary

As detailed in **Section 8.7**, the potential residual environmental effects of the project on wetlands will primarily be from vegetation clearing and wetland loss, introduction of invasive species, and a reduction in surface water quality during construction.

Unavoidable direct wetland loss is anticipated for those wetlands located within the replacement ETF footprint. This is an unavoidable loss which will occur during construction and persist through the life of the project. However, since the pipeline will be constructed largely within the cleared portion of the road shoulder of Highway 106, no direct loss of wetland area is anticipated for any wetlands located adjacent the pipeline ROW. The project has been designed and developed to minimize the area of disturbance of the PFA to that which is required to meet the project objectives and to minimize the net loss of wetland area and function. Wetland alteration will be undertaken within the context of NSE approval requirements and fulfillment of compensation obligations for “no net loss of wetland function”.

The regular removal of wetland vegetation from the highway shoulder for maintenance purposes is anticipated to occur on a schedule consistent with Nova Scotia Series 1 highways. During this work, there exists the potential for the spread of exotic and/or invasive species into wetlands.

The construction of project infrastructure and long-term maintenance of project infrastructure, throughout the lifespan of the project, may lead to minor ground disturbance and subsequent erosion, leading to sedimentation of adjacent wetlands. However, the potential ground disturbance associated with maintenance activities of pipeline infrastructure will be smaller in magnitude, than during initial construction, and will be localized in nature.

There are no substantive residual environmental effects of the project on wetlands during the operation and maintenance phase that were not initially introduced during construction, thus cumulative environmental effects are not expected during this phase and not discussed further in this section.

12.3.3.2 Cumulative Environmental Effects during the Construction Phase

During construction, there will be unavoidable and permanent wetland loss for those wetlands located within the replacement ETF footprint. This loss of wetland area will persist for the life of the project. No direct loss of wetland area is anticipated for any wetlands located adjacent the pipeline ROW as it will be constructed largely within the disturbed road shoulder of Highway 106. The project has been designed and developed to minimize the area of disturbance of the PFA to that which is required to meet the project objectives and to minimize the net loss of wetland area and function. Construction of project infrastructure may also lead to minor ground disturbance and subsequent erosion, leading to sedimentation of adjacent wetlands. However, this effect will be largely avoided through implementation of mitigation measures as outlined in **Sections 5.6** and **8.7.3.2**.

Future industrial and/or linear development projects are likely to result in similar environmental effects on wetland communities, but it is unlikely that their environmental effects would overlap spatially or temporally with those of the project (i.e., their environmental effects occurring at the same time as those of the project, and with footprints that affect the same wetlands as those of the project), though the extent of spatial and temporal overlap with those of the project would determine whether cumulative environmental effects might occur. However, these potential developments are unlikely to result in substantive overlap with the environmental effects on wetlands in such a manner as to cause a measurable change from existing conditions that would affect the ongoing viability of wetland habitats in the RAA.

12.3.3.3 Summary of Cumulative Environmental Effects on Wetlands

In consideration of the limited residual environmental effects of the project on wetlands, the ecological context of the project, including its generally disturbed and fragmented nature, and the very limited number of other likely projects or activities in the RAA or the low likelihood that their environmental effects would overlap spatially and temporally with those of the project, the potential cumulative environmental effects of the project in combination with those of other past, present or future activities (industrial and linear facility developments) on wetlands during all phases of the project are not expected to be substantive.

12.3.4 Cumulative Environmental Effects on Flora/Floral Priority Species

12.3.4.1 Residual Project Environmental Effects Summary

As detailed in **Section 8.8**, it is anticipated that the potential residual environmental effects of the project on flora/floral priority species will primarily be from alteration of site drainage, vegetation clearing and re-vegetation.

Construction activities with ground disturbance components have potential to result in direct loss of vegetation and/or changes in the vegetation composition. Disturbance to vegetation would be both temporary in some areas, and permanent in other areas. Priority plant species were not identified within the ETF footprint area. Potential habitat for priority plants was preliminarily identified within the road shoulder where the pipeline will be constructed; however, the likelihood for priority plants within the pipeline footprint area is generally very low. The likelihood of priority plants within adjacent habitat was identified as low to moderate. In order to confirm that impacts can be mitigated, additional plant surveys for the pipeline footprint area are proposed prior to construction (**Section 8.8.5**).

Indirect environmental effects to plant species may result due to sediment generation, change in habitat due to hydrology impacts or other water quality pathway to downgradient habitats or from microclimate changes in adjacent habitat related to vegetation clearance. As noted above, priority plants are not expected within the ETF footprint area. There was identified potential for priority plants in the PFA in adjacent downgradient habitats, such as wetlands.

Operation and maintenance activities associated with the project are not expected to interact with the plants VEC beyond existing interactions related to the continuation of vegetation maintenance along Highway 106.

12.3.4.2 Cumulative Environmental Effects during the Construction Phase

Although construction of the project would result in both temporary and permanent loss of vegetation communities, it is not expected to contribute to habitat fragmentation as project facilities are generally in fragmented habitat and/or on a disturbed footprint, and there is no interior forest within the PFA. With mitigation and revegetation on NPNS property following pipeline installation, most of this disturbance will result in a change (such as species composition), but not a permanent loss in vegetation communities. Existing forested areas on NPNS property will likely be converted to shrub or regenerating/sapling aged forests to allow for continued maintenance of the pipeline corridor.

For cumulative environmental effects to occur on the plants VEC, the environmental effects of other projects or activities would need to overlap those of the project spatially, since environmental effects on plants are generally limited to those that arise from direct physical disturbance. It is unlikely that new industrial developments and land uses will occur in close proximity to the vegetated areas disturbed by the project along the Highway 106 corridor and TC property adjacent Caribou Harbour. Thus, no spatial overlap with the environmental effects of the pipeline portion of the project on flora is expected during the construction phase.

Future industrial and/or linear development projects are likely to result in similar environmental effects on vegetation communities. The extent of spatial and temporal overlap with those of the project would determine whether cumulative environmental effects might occur. These potential developments are unlikely to result in substantive overlap with the environmental effects of the project on flora. There would be no measurable change from existing conditions that would be above regulatory thresholds or that would affect the ongoing viability of vegetation communities and habitats during the construction phase of the project.

12.3.4.3 Cumulative Environmental Effects during the Operation and Maintenance Phase

Once operational, there are no features of the operation of the replacement ETF or pipeline (including their physical presence) that would be expected to contribute materially to further environmental effects on the flora/floral priority species VEC. There would be no overlapping environmental effects with other projects or activities as a result, and thus no cumulative environmental effects.

During the project's operation and maintenance phase, routine maintenance of linear facilities (e.g. Highway 106 road edges and pipeline ROW through NPNS property), including vegetation maintenance, are expected to be ongoing and similar to past and present activities in terms of contribution to vegetation removal, and those environmental effects are encompassed in existing conditions for the flora/flora priority species, as described in **Section 8.8**. Since the land-based portion of the PFA is located almost exclusively on property owned by NPNS, NSTIR, and TC, it is unlikely that new industrial developments and land uses will occur in close proximity to the vegetated areas disturbed by the project and thus no spatial overlap with the environmental effects of the project is expected.

Future industrial and/or linear development projects are likely to result in similar environmental effects on vegetation communities, though the extent of spatial and temporal overlap with those of the project would determine whether cumulative environmental effects might occur. However, these potential developments are unlikely to result in a substantive overlap with the environmental effects of the project on flora, unless those other developments occur in the same footprint as that of the project. It is not expected that there will be a measurable change from existing conditions that would be above regulatory thresholds or that would affect the ongoing viability of vegetation communities and habitats during the operation and maintenance phase.

12.3.4.4 Summary of Cumulative Environmental Effects on Flora/Floral Priority Species

In summary, the cumulative environmental effects assessment considered the residual environmental effects of the project on flora/floral priority species, the ecological context of the project, and the very limited number of other likely projects or activities in the RAA that would have environmental effects that overlap those of the project spatially and temporally. The potential cumulative environmental effects of the project in combination with those of other past, present or future activities (industrial and linear facility developments) on flora/floral priority species during all phases of the project are therefore not expected to be substantive.

12.3.5 Cumulative Environmental Effects on Terrestrial Wildlife/Priority Species

12.3.5.1 Residual Project Environmental Effects Summary

As detailed in **Section 8.9**, it is anticipated that the potential residual environmental effects of the project on terrestrial wildlife/priority species will be limited to habitat alteration through vegetation clearing, primarily as a result removal of immature and mature forested and hayfield vegetation within the ETF construction footprint. This will result in a temporary and permanent disturbance to wildlife habitat within the PFA.

Noise related to construction activities is expected to be largely within the current baseline conditions and interaction with priority wildlife is not anticipated. Along the pipeline route, loss of vegetation and associated wildlife habitat will be consistent with existing road maintenance activities as the pipeline will be constructed predominantly within the road shoulder.

There are no substantive residual environmental effects of the project on terrestrial wildlife/priority species during the operation and maintenance phase that were not initially introduced during construction, thus cumulative environmental effects are not expected during this phase and therefore not addressed further in this section.

12.3.5.2 Cumulative Environmental Effects during the Construction Phase

Although construction of the project would result in both temporary and permanent loss of terrestrial wildlife habitat, particularly through the removal of vegetation, it is not expected to contribute to habitat fragmentation as project facilities are generally located in fragmented habitat and/or on a disturbed footprint. Vegetation clearing does increase wildlife mortality risk through a number of mechanisms including the removal of nests, dens, burrows and hibernacula, as well as through vehicular collisions. With mitigation measures implemented and re-vegetation of cleared areas on NPNS property following pipeline installation, most of the disturbance to wildlife and wildlife habitat will be temporary in nature. Existing forested areas on NPNS property that presently provide suitable wildlife habitat will likely be converted to shrub or regenerating/sapling aged forests in the longer term. Since the vast majority of the land-based portion of the PFA is located within disturbed areas, owned by either NPNS, NSTIR, or TC, future projects with potential to considerably alter wildlife habitat is not anticipated.

Future industrial and/or land-based linear development projects are likely to result in similar environmental effects on vegetation communities and associated terrestrial wildlife populations. The extent of spatial and temporal overlap with those of the project would determine whether cumulative environmental effects might occur. These potential developments are unlikely to result in substantive overlap with the environmental effects of the project on wildlife habitat in such a manner as to cause a measurable change from existing conditions that would that would affect the ongoing viability of populations and habitats during the construction phase of the project.

12.3.5.3 Summary of Cumulative Environmental Effects on Terrestrial Wildlife/Priority Species

Due to the abundant availability of undisturbed habitats elsewhere in the RAA and surrounding areas and the reduced suitability of habitats within the PFA because of their proximity to the existing NPNS facility and the Highway 106 corridor and the associated sensory disturbance, wildlife species that may potentially use the PFA are not expected to be restricted by a lack of suitable habitat available.
The cumulative environmental effects assessment considered the residual environmental effects of the project on terrestrial wildlife/priority species, the ecological context of the project, including the high level of disturbance associated with existing industrial and linear development in the PFA, and the very limited number of other likely projects or activities in the RAA. The potential cumulative environmental effects of the project in combination with those of other past, present or future activities (industrial and linear facility developments) on terrestrial wildlife/priority species populations during all phases of the project are therefore not expected to be substantive, and are rated not significant.

12.3.6 Cumulative Environmental Effects on Migratory Birds and Priority Bird Species/Habitat

12.3.6.1 Residual Project Environmental Effects Summary

As detailed in **Section 8.10**, the potential residual environmental effects of the project on migratory birds and priority bird species/habitat will primarily be from vegetation clearing and habitat alteration and loss within the PFA. Noise related to construction activities is expected to be largely within the current baseline condition and substantive interaction with priority birds is not anticipated.

Development of the project will result in some minimal vegetation clearing and the permanent loss of some forested and managed grassland (lawn) habitat in the immediate ETF footprint area. The loss of vegetation and associated bird habitat (if it occurs) within the pipeline footprint area along the road shoulder will be consistent with existing road maintenance activities and thus, will not result in any additional loss of bird habitat.

Other than the observed cliff swallows collecting nesting materials, the ETF footprint area was not identified as preferred or critical habitat for any other priority species. It is not anticipated that the loss of the lawn habitat will negatively impact the nesting cliff swallows as there are many other, managed and un-managed, grassland habitats nearby from which they can gather nesting materials.

For the pipeline portion of the project, potential habitat for priority birds was identified for the general surrounding area. However, construction and installation of a buried pipeline within an existing road shoulder is not anticipated to permanently alter the existing conditions or habitat for these species or result in any increased habitat fragmentation. Potential for interaction with nesting birds is mitigated by conducting clearing operations outside of the breeding season for birds, where possible.

Noise at the NPNS facility as a result of the operation of the proposed replacement ETF is expected to be largely within the current baseline conditions and a substantive negative interaction with the birds VEC is not anticipated. Both the spill basin and clarifiers may attract waterfowl and other waterbirds, but their incidental presence at these locations where effluent may be present is not expected to adversely affect birds in any substantive way.

12.3.6.2 Cumulative Environmental Effects during the Construction Phase

Construction of the project would result in both temporary and permanent loss of bird habitat, specifically from vegetation clearing activities conducted predominantly on NPNS property for ETF construction and the initial portion of the pipeline. Potential for interaction with nesting birds is mitigated by conducting clearing operations outside of the breeding season for birds wherever possible. It is also noted that portions of the forested areas cleared on NPNS for pipeline construction will be restored and converted to shrub or regenerating sapling aged forests following the construction phase.

The loss of vegetation and associated bird habitat within the pipeline footprint area along the road shoulder (if it occurs) will be consistent with existing road maintenance activities along Highway 106 and thus, will not result in any additional loss of bird habitat. Construction related noise levels are also expected to be largely within the current baseline conditions and substantive interaction with priority birds is not anticipated. Since the vast majority of the land-based portion of the PFA is located within disturbed areas, owned by either NPNS or NSTIR, future projects with potential to considerably alter migratory and priority birds and their habitats is not anticipated.

Future industrial and/or linear development projects are likely to result in similar environmental effects on bird habitat, though the extent of spatial and temporal overlap with those of the project would determine whether cumulative environmental effects might occur. However, these potential developments are unlikely to result in a substantive overlap with the environment effects of the project on birds and their habitats during the construction phase of the project.

12.3.6.3 Cumulative Environmental Effects during the Operation and Maintenance Phase

During the project's operation and maintenance phase, routine maintenance of linear facilities (e.g. Highway 106 road edges and pipeline ROW through NPNS property), including vegetation maintenance, are expected to be ongoing and similar to past and present activities. No new clearing of mature vegetation would be completed during this phase. Associated environmental effects are encompassed in existing conditions for migratory birds and priority bird species/habitat, as described in **Section 8.10**.

Future industrial and/or linear development projects are likely to result in similar environmental effects on birds and their habitat, though the extent of spatial and temporal overlap with those of the project would determine whether cumulative environmental effects might occur. While future infrastructure development activities and linear facility developments in the RAA may result in similar environmental effects to birds and their habitats, the project is located in a fragmented landscape with considerable existing disturbance. Above ground facilities associated with the project are also very minimal and would have very limited interaction with migratory birds and priority bird species. Potential developments are unlikely to result in a substantive overlap with the environmental effects on migratory birds and priority bird species/habitat during the operation and maintenance phase of the project.

12.3.6.4 Summary of Cumulative Environmental Effects on Migratory Birds and Priority Bird Species/Habitat

Due to the availability of habitats elsewhere in the RAA and surrounding area and the reduced suitability of habitats within the PFA because of their proximity to the existing NPNS facility and the Highway 106 corridor and the associated sensory disturbance, bird species that may potentially use the PFA are not expected to be restricted by a lack of suitable habitat.

The residual environmental effects of the project on migratory birds and priority bird species/habitat, the ecological context of the project, and the very limited number of other likely projects or activities in the RAA were considered. The potential cumulative environmental effects of the project in combination with those of other past, present or future activities (land-based industrial and linear facility developments) on migratory birds and priority bird species/habitat during all phases of the project are therefore not expected to be substantive.

12.3.7 Cumulative Environmental Effects on Harbour Physical Environment, Water Quality and Sediment Quality

12.3.7.1 Residual Project Environmental Effects Summary

As detailed in **Section 8.11**, it is anticipated that potential residual environmental effects of the project on harbour physical environment, water quality and sediment quality may occur during the initial site preparation, construction and installation of the marine-based portion of the pipeline, and during pipeline operation and maintenance activities within the marine environment.

Construction Phase

On-land activities and site preparation at the shoreline have the potential to cause sedimentation and runoff to enter the marine environment. With the implementation of site-specific mitigation measures (i.e., Erosion and Sediment Control Plan), the risk of sedimentation causing a change in water or sediment quality in the marine environment is considered low and, in the unlikely event that such a change did occur, it would be localized.

In-water activities could result in a change in water and sediment quality by disturbing contaminated sediments (if present). However, based on the results of previous sediment sampling in Caribou Harbour (see **Section 8.11.2.5**), sediments in and around the LAA are not expected to be contaminated and there is little risk of resuspension of deleterious substances during project activities.

With respect to project construction activities involving seabed disturbance (e.g. pipeline installation), although there may be temporary and localized increases in turbidity, TSS levels are expected to dissipate to background levels within a matter of hours or days (depending on grain size and the level of wave and current action in the area).

Although unlikely to be required, if marine blasting is required in the marine environment, potential effects will be temporary, short in duration, and infrequent. The high currents in the Northumberland Strait will aid in the dispersion of re-suspended sediments. Compliance with the DFO *Guidelines for the Use of Explosives In or Near Canadian Fisheries Waters* (Wright and Hopky 1998) will minimize environmental effects due to blasting activities, if required.

Operation and Maintenance Phase

The discharge of treated effluent from the replacement ETF into the water column has the potential to cause a change in water and sediment quality. The effluent discharge quality for adsorbable organic halides (AOX), total nitrogen, total phosphorus, colour, BOD, COD, TSS, DO, pH, water temperature, and salinity are anticipated to meet applicable water quality guidelines at the end of the mixing zone.

Water quality parameters of concern in the treated effluent include total nitrogen, total phosphorus, colour, TSS, DO, pH, water temperature and salinity. Water quality at the end of the mixing zone for the three-port diffuser will reach ambient conditions within less than 2 m from the diffuser in terms of total nitrogen, total phosphorus, TSS, DO, pH, and salinity; colour will return to ambient conditions within 5 m of the diffuser (Stantec 2018 **Appendix E**). Water temperature is anticipated to meet compliance for applicable federal water quality guidelines within approximately 2 m of the diffuser and be within 0.1 °C of background at the end of the 100-m mixing zone. Any effects due to the discharge of treated effluent would be localized at the diffuser as the implementation of a three-port diffuser and the high currents present in the Northumberland Strait will aid in dispersion of treated effluent. Thus, significant residual environmental effects to water quality or sediment quality as a result of treated effluent discharge are not likely.

Elevated levels of TSS, and settlement of suspended sediment, could cause a change in sediment characteristics such as sand and silt size fractions and/or a change in chemical composition of sediments. Any increases in TSS, or changes in composition of sediments would be highly localized near the effluent diffuser due to the use of the three-port diffuser and the buoyant nature of the effluent.

The residual environmental effects characterizations provided above for the construction phase may also be generally applicable for the operation and maintenance phase if project maintenance activities require the presence and operation of project vessels or equipment, seabed disturbance (e.g., for pipeline retrieval or reburial). However, any potential residual change in water and/or sediment quality associated with project maintenance would generally be expected to be relatively more localized in spatial extent, lower in magnitude, shorter in duration and limited to the operation and maintenance phase, and less frequent than the potential residual environmental effects associated with project construction.

12.3.7.2 Cumulative Environmental Effects during the Construction Phase

The environmental effects of projects and activities on the marine physical environment, water quality and sediment quality have the potential to interact cumulatively with the project through localized increased sedimentation, specifically in the nearshore environment, and increased turbidity (TSS levels) if activities overlap spatially and temporally with those of the project.

During construction, the environmental effects of past and present commercial shipping, commercial fisheries and aquaculture, industrial development activities, and recreational use activities in the RAA are expected to be ongoing and similar to past and present activities in terms of changes to the marine physical environment, water quality and sediment quality. Those changes are encompassed in the existing conditions for the harbour physical environment, water quality and sediment quality, presented in **Section 8.11**.

The Northumberland Ferries service, commercial shipping, commercial fishing and aquaculture, and recreational uses of Caribou Harbour and the Northumberland Strait could have a cumulative environmental effect when combined with project construction activities. Increased marine traffic from construction, combined with ongoing marine-based activities in the RAA, may result in increased suspension of sediments within localized areas. Once installation of the pipeline and outfall is complete, no further project-related increases to turbidity in the marine environment are anticipated during the construction phase.

There could be a cumulative environmental effect on the harbour physical environment, including water quality and sediment quality, if maintenance dredging of the shipping channel or other harbour areas is completed by TC or DFO during or around the same time period that in-water pipeline installation activities are occurring. The cumulative environmental effects could include temporary changes to sediment through resettlement, such as sand and silt size fractions and/or a change in chemical composition of sediments, and water quality, including heightened TSS levels in the local area. Such a spatial and temporal overlap with project activities, however, is unlikely to occur.

The environmental effects of commercial shipping, commercial fisheries and aquaculture, industrial development activities, and recreational use activities in the RAA are therefore not expected to result in a substantive overlap with the environmental effects of the project on the harbour physical environment, water quality and sediment quality during the construction phase of the project.

12.3.7.3 Cumulative Environmental Effects during the Operation and Maintenance Phase

During the operation and maintenance phase of the project, the environmental effects of past and present commercial shipping, commercial fisheries and aquaculture, industrial development activities, and recreational use activities in the RAA are expected to be ongoing and similar to past and present activities in terms of changes to the harbour physical environment, water quality and sediment quality. Those conditions are encompassed in the existing conditions for the harbour physical environment, water quality and sediment quality, presented in **Section 8.11**. Future such operations would be expected to continue as they presently do.

Similar to, but to a lesser extent than during the construction phase, there could be a cumulative environmental effect on the harbour physical environment, including water quality and sediment quality if maintenance dredging of the shipping channel or other harbour areas is carried out during or around the same time period that maintenance work (e.g. excavation for pipe inspection) on the pipeline or diffuser is occurring. The cumulative environmental effects could include temporary changes to sediment through resettlement and change in chemical composition of sediments and water quality, including heightened TSS levels in the local area. However, given the likely limited extent and frequency of maintenance activities of the pipeline and their likely lack of spatial and temporal overlap with those of other projects or activities, substantive cumulative environmental effects during the operation and maintenance phase are unlikely to occur.

The discharge of treated effluent into the water column at the outfall has the potential to cause a localized change in water quality or sediment quality. Parameters of concern in the treated effluent include total nitrogen, total phosphorus, colour, TSS, DO, pH, water temperature and salinity. Water quality at the end of the mixing zone for the three-port diffuser will reach ambient conditions within less than 2 m from the diffuser in terms of total nitrogen, total phosphorus, TSS, DO, pH; colour will return to ambient conditions within 5 m of the diffuser (Stantec 2018; **Appendix E**). Water temperature is anticipated to meet compliance for applicable federal water quality guidelines within approximately 2 m of the diffuser and be within 0.1 °C of background at the end of the 100-m mixing zone. No past or present activities or planned future projects are expected to occur within close proximity to the outfall location, and the discharge of treated effluent would be localized at the diffuser, with environmental effects similar to background conditions beyond 5 m of the diffuser. Thus, given the likely lack of spatial overlap at this location, significant cumulative residual environmental effects to water quality or sediment quality as a result of treated effluent discharge are not likely.

The environmental effects of commercial shipping, commercial fisheries and aquaculture, industrial development, and recreational use activities in the RAA are therefore not expected to result in a substantive overlap with the environmental effects of the project on the harbour physical environment, water quality and sediment quality during the operation and maintenance phase of the project.

12.3.7.4 Summary of Cumulative Environmental Effects on Harbour Physical Environment, Water Quality and Sediment Quality

The residual environmental effects evaluated included those of the project on the harbour physical environment, and water quality and sediment quality, the ecological context of the project, including the present level of disturbance associated with existing commercial shipping, commercial fishing and aquaculture, and recreational use in the marine portion of the RAA; no other known marine projects or activities are planned in the RAA. The potential cumulative environmental effects of the project in combination with those of other past, present or future activities during all phases of the project are therefore not expected to be substantive, and are rated not significant.

12.3.8 Cumulative Environmental Effects on Marine Fish and Fish Habitat

12.3.8.1 Residual Project Environmental Effects Summary

As detailed in **Section 8.12**, it is anticipated that potential residual environmental effects of the project on marine fish and fish habitat may occur during the construction and installation of the pipeline, and during pipeline operation and maintenance activities.

Construction Phase

During construction in the marine environment, the risk of mortality of marine fish will be increased. This would occur in a localized area where infrastructure is placed and there is potential for sediment deposition. Slow-moving and sessile invertebrates such as sea stars and sea anemones are the most vulnerable to harm from physical disturbance because they are unable to avoid burial or crushing. The setting of anchors by project vessels involved with construction activities may also result in the mortality of sessile or slow-moving demersal fish and invertebrates.

Any bottom lay construction of the pipeline in the marine environment will result in a permanent alteration from a soft-bottomed benthic community to a hard-bottomed benthic community in the trench excavation area, which will likely result in higher biodiversity of species and overall productivity.

Elevated concentrations of suspended sediments associated with bottom lay and trenched pipeline construction will likely be localized within the PFA. However, the strong currents in the Northumberland Strait will cause dispersion of suspended sediment. Once construction is complete, concentrations of TSS in the water column is expected to return to background levels within a relatively short period from several hours to a day.

The construction is likely to result in a temporary net loss of productivity in marine fish populations, including habitat-forming vegetation, with potential residual environmental effects on fish species including those associated with CRA fisheries. Physical disturbances to the seabed are typically followed by a temporary reduction in species abundance, population density, and biomass of benthic organisms in the affected area (Gilkinson et al. 2005; Newell et al. 1998).

Sessile benthic invertebrates such as anemones and sponges will colonize the in-water structures once installation is complete. Marine plants, which are important components of habitat for lobster and other commercially important species, will also colonize the hard substrate of in-water structures. This recolonization will attract other mobile species (e.g., marine fish) for feeding and refuge, ultimately creating a “reef effect”, thereby increasing fish biomass (Stantec 2012). As discussed in **Section 8.12**, recolonization and restoration of benthic invertebrates in the impacted area is anticipated to naturally occur within six months of completion of pipeline installation, thus representing a temporary alteration. If an adverse environmental effect to marine fish and fish habitat that supports a CRA fishery is considered “serious harm” by DFO, it will be addressed through a *Fisheries Act* Authorization and the application of offsetting measures.

The area immediately around the installation of marine infrastructure for the project is subject to sound levels that would have the potential to cause physiological harm or behavioural change of fish during the construction phase. However, the brief period of in-water works, the localized area of potential environmental effects, and the ability of fish to actively move away from intense sounds reduce the risk of adverse environmental effects on fish populations due to underwater noise.

If marine blasting is required, potential effects associated with blasting will be temporary, short in duration, and infrequent. The risk of direct explosion-induced physical injury or mortality to marine fish will be highly localized around the marine PFA and, with the implementation of the *DFO Guidelines for the Use of Explosives In or Near Fisheries Waters* (Wright and Hopky 1998), is considered low since marine fish species are generally expected to avoid the immediate area where project activities take place. In the case of slow-moving or sessile species, blasting could result in physical injury or mortality.

Operation and Maintenance Phase

Effluent quality will necessarily comply with all federal and provincial permit conditions and regulatory requirements such as PPER. The operation and maintenance of the pipeline will cause elevated levels of TSS in the immediate vicinity of the effluent diffusers. Any localized effects of TSS during operation and maintenance will occur within less than 2 m from the diffusers based on modelling (Stantec 2019, **Appendix E**). It was determined in the receiving water study (Stantec 2019; **Appendix E**) that water quality at the end of the mixing zone for the three-port diffuser will reach ambient conditions within less than 2 m from the diffuser in terms of total nitrogen, total phosphorous, DO, pH, temperature, and salinity. Colour will return to baseline conditions within 5 m of the diffuser. Thus, any potential environmental effects on water quality during the operation and maintenance phase will be highly localized.

In response to concerns expressed by lobster harvesters in the Pictou region about the potential environmental effects of the discharge of treated effluent on lobster, and as discussed in **Section 8.12**, a review of existing scientific literature on the effect of bleached Kraft mill effluent on the American lobster was done. It was determined that lobster larvae will be within the water column and could come into contact with the proposed treated effluent plume. Previous scientific studies suggest that lobster larvae are not expected to be affected by the proposed treated BKME within 2 m of the diffuser due to the predicted dilution rate at this distance. (Clarke 2018, **Appendix R**).

Infrastructure inspection (e.g., ROV surveys of the pipeline and diffuser) will occur as needed. Any increase in vessel traffic related to maintenance of the pipeline will be negligible compared to current activity in Caribou Harbour and the Northumberland Strait. Noise emissions from vessels during maintenance activities may cause fish to move out of the affected areas close to the source; however, it is generally accepted that low-level underwater sound has little to no likelihood of causing any significant physical effects on marine fish populations. If in-water activities and seabed disturbance are required during maintenance, the potential environmental effects on marine fish populations would be similar to, though lower than, those during the construction phase.

12.3.8.2 Cumulative Environmental Effects during the Construction Phase

The environmental effects of projects and activities on marine fish and fish habitat have the potential to interact cumulatively with the project through increased acoustic emissions, increased TSS, artificial light, and habitat alteration, disruption or destruction if activities overlap spatially and temporally with those of the project.

Ferry service and commercial shipping and fishing activities across Caribou Harbour and the Northumberland Strait could have a cumulative environmental effect when combined with project construction activities. Increased marine traffic and temporary benthic habitat disturbance during construction may result in marine fish avoidance within the PFA, and a temporary loss of habitat proximal to construction activities. Once installation of the pipeline and outfall is complete, no more project-related marine traffic is anticipated during construction. Benthic habitat is also expected to stabilize and be recolonized by marine organisms after construction.

There could be a cumulative environmental effect on marine fish and fish habitat between future dredging activities at Caribou Harbour in support of maintenance of TC's shipping lanes and project-related in-water construction. The cumulative environmental effects could include vessel underwater noise, potential collisions with fish, potential increases in TSS and turbidity, and potential pollution from bilge water and the accidental release of hydrocarbons. Most fish species, however, will likely avoid construction activities and the PFA because of project-related noise, and thus direct environmental effects are likely to be minimal for a short period of time while construction is taking place. The likelihood of dredging activities being conducted at the same time as construction of the project Is low, thus there is little potential for temporal or spatial overlap with the environmental effects of the project.

Acoustic emissions from ongoing marine traffic (commercial fishing and shipping vessels, and recreational vessels) in Caribou Harbour and surrounding marine areas may act cumulatively with acoustic emissions from vessels serving the project. Overall, however, the contribution of acoustic emissions from project activities are not likely to have adverse cumulative environmental effects on marine fish because of the relatively short period of pipeline construction and the relatively low speed of project vessels.

Commercial fishing is ongoing within the RAA and can also result in mortality of marine fish species. These activities have potential to cumulatively interact with project-related effects to increase the risk of changes in fish populations. Recreational fishing likely poses less of a risk to fish species in the RAA due to their relatively low intensity in comparison to commercial fishing.
Fishing activity also contributes to the effects of acoustic noise on fish species, and increases the risk of potential for collisions with marine species. As noted above, the acoustic emissions from project

activities are not likely to have cumulative environmental effects on fish species because of the relatively short duration of in-water work and the relatively low speeds of project vessels. The potential for fishing vessel collisions with fish species is expected to be low given the expected speeds and relatively small size of the vessels.

The environmental effects of industrial activities and land use, commercial shipping, and commercial fishing and aquaculture activities in the RAA are therefore not expected to result in a substantive overlap with the environmental effects of the project on marine fish and fish habitat during the construction phase of the project.

12.3.8.3 Cumulative Environmental Effects during the Operation and Maintenance Phase

During the operation and maintenance phase of the project, the environmental effects of past and present commercial shipping, commercial fisheries and aquaculture, and industrial development activities in the RAA are expected to be ongoing and similar to past and present activities in terms of changes to marine fish and fish habitat. Those conditions are encompassed in the existing conditions for marine fish and fish habitat, presented in **Section 8.12**. No planned future operations are currently known that would contribute to changes to marine fish and fish habitat in the RAA.

No past or present activities or known future projects are expected to occur within the immediate proximity to the outfall location, and the residual environmental effects from the discharge of treated effluent would be localized at the diffuser, with environmental effects similar to background conditions beyond 5 m of the diffuser. Water quality at the end of the mixing zone for the three-port diffuser will reach ambient conditions within less than 2 m from the diffuser in terms of total nitrogen, total phosphorous, DO, pH, temperature, and salinity. Colour will return to baseline conditions within 5 m of the diffuser. Thus, any potential environmental effects on water quality that could affect marine fish and fish habitat during the operation and maintenance phase will be highly localized. Given the likely lack of spatial overlap at this location, significant cumulative residual environmental effects to fish and fish habitat as a result of treated effluent discharge are not likely.

Presently, there are various point and area sources along the shorelines of Pictou County and southern PEI, as well as in the Northumberland Strait that are releasing treated effluent to the Strait. These include public municipal sources such as wastewater treatment plants and other industrial sources (such as treated effluent releases from the existing BHETF, the Trenton coal-fired power plant, and other industrial sources). These sources have no demonstrated substantive effect on marine fish populations that affect any species at a population level in the RAA.

Given the likely limited spatial extent and frequency of maintenance activities of the pipeline and their likely lack of spatial and temporal overlap with those of other projects or activities in the RAA, substantive cumulative environmental effects during the maintenance phase are unlikely to occur. If in-water activities and seabed disturbance are required during maintenance activities, the potential environmental effects on marine fish populations would be similar to, though lower than, those during the construction phase.

12.3.8.4 Summary of Cumulative Environmental Effects on Marine Fish and Fish Habitat

Project-related construction and operation and maintenance activities may result in adverse environmental effects which could result in changes to marine fish habitat and fish populations in the PFA. It is not anticipated that changes would extend beyond the PFA. Changes in fish habitat would persist over the life of the project. The potential change in fish populations is attributable to direct and indirect disturbance/change of habitat and increased mortality risk. With the implementation of proposed mitigation and environmental protection measures, and given the lack of substantive effects arising from existing releases of treated effluent to the Northumberland Strait from other sources, the environmental effects of a change in marine fish and fish habitat is predicted to be not significant.

Considering the limited overlap between the project and other existing projects and activities, combined with the proposed mitigation measures, the residual cumulative environmental effects of a change in marine fish populations is not anticipated to be substantive.

Overall, any potential cumulative environmental effects on the marine environment from interaction between the environmental effects of the project and those of other projects and activities within the RAA for all project phases are not expected to be substantive.

12.3.9 Cumulative Environmental Effects on Marine Mammals, Sea Turtles and Marine Birds

12.3.9.1 Residual Project Environmental Effects Summary

As detailed in **Section 8.13**, it is anticipated that potential residual environmental effects of the project on marine mammals, sea turtles and marine birds may occur during the construction and installation of the pipeline, and during pipeline operation and maintenance activities.

<u>Change in Risk of Injury or Mortality</u>

Injury or mortality of marine mammals and sea turtles can occur from vessel strikes or entanglement in anchor lines. Although there are no known concentration areas for marine mammals near the LAA, it is possible that groups of foraging marine mammals may be encountered in the area, particularly during summer months. However, the relatively slow speed of vessel movement during pipeline trenching and installation operations (i.e., <5 knots) will increase the ability of marine mammals, sea turtles and marine birds to avoid potential collisions with project vessels and equipment.

Project vessels may operate up to 24 hours a day, 7 days a week during construction. Marine vessel lighting will be required for navigational aids and illumination of work areas during nighttime vessel operations. Although operation of project vessels and equipment will have a deterrent effect on most marine species, there is potential for nocturnally migrating marine birds to be attracted and disoriented by artificial night lighting. Disoriented birds may fly into vessel lights or infrastructure, injuring themselves and becoming stranded. This risk will be further reduced through the application of mitigation measures specific to vessel lighting and the handling of stranded birds, as outlined in **Section 8.13.3.2**.

Discharges from project vessels are expected to be temporary, localized, non-bio-accumulating, non-toxic, and will be subject to dilution; organic matter will be quickly dispersed and degraded by bacteria.

If blasting is required, potential effects associated with marine blasting in the Northumberland Strait and/or blasting on land at the Pictou Causeway will be temporary, short in duration, and infrequent. The risk of direct explosion-induced physical damage from blasting will be highly localized around the marine portion of the PFA and is considered very low since marine species are generally expected to avoid the immediate area where project activities are taking place. However, auditory injury from blasting could occur within a larger spatial extent. Although the risk of permanent or temporary threshold shifts for marine mammals may extend beyond the LAA, the avoidance of marine blasting within 500 m of a marine mammal or sea turtle will substantially reduce or eliminate this risk such that only temporary behavioural effects are expected. In the unlikely event that a diving marine bird remains in the area despite the presence and operation of project vessels and equipment and the use of bird deterrent devices prior to marine blasting, it is expected that any potential effects would be at least somewhat attenuated by the water prior to reaching the bird. Thus, a residual change in risk of injury or mortality for marine mammals, sea turtles and marine birds from blasting (if required) is unlikely to occur.

The residual environmental effects characterizations provided above for the construction phase may also be generally applicable for the maintenance phase if project maintenance activities require the presence and operation of project vessels or equipment, seabed disturbance (e.g., for pipeline retrieval or reburial), and/or marine blasting. However, any potential residual change in risk of injury or mortality associated with project maintenance would generally be expected to be relatively more localized in spatial extent, lower in magnitude, shorter in duration and limited to maintenance activities, and less frequent than the potential residual environmental effects associated with project construction. If project maintenance activities do not require the presence and operation of project vessels or equipment, seabed disturbance, or marine blasting, no residual change in risk of injury or mortality is predicted to affect marine mammals, sea turtles, or marine birds.

Change in Habitat Quality and Use

With respect to project construction activities involving seabed disturbance, although there may be temporary and localized increases in turbidity, levels of TSS are expected to dissipate to background levels within a matter of hours or days (depending on grain size and the level of wave and current action in the area). Sediment disturbance and associated increases in TSS are predicted to be relatively higher in the intertidal/nearshore zone portion of the LAA (since a gravel access causeway/bridge will be constructed and excavation of marine sediments will be required) and relatively lower in the portion of the LAA between the intertidal/nearshore zone and the outfall location.

Sensory disturbance to marine species from the presence and operation of project vessels and equipment and blasting (if required) could lead to behavioural responses in marine mammals, sea turtles and marine birds, such as temporary habitat avoidance/displacement or attraction and temporary changes in movements, communications, feeding, or activity state. Sensory disturbance also has potential to disrupt reproductive, foraging and feeding, and/or migratory behaviour for marine mammals, sea turtles and marine birds if the availability of important habitat areas, including the special areas illustrated on **Figure 8.13-2**, is affected. However, such disruptions are considered unlikely to occur given the short-term, transient and relatively localized nature of anticipated project-related sensory disturbances, and with the implementation of mitigation measures.

The residual environmental effects characterizations provided above for the construction phase may also be generally applicable for the operation and maintenance phase if project maintenance activities require the presence and operation of project vessels and equipment, seabed disturbance (e.g., for pipeline retrieval or reburial), and/or marine blasting. However, any potential residual change in habitat quality and use associated with project maintenance would generally be expected to be relatively more localized in spatial extent, lower in magnitude, shorter in duration and limited to the operation and maintenance phase, and less frequent than the potential residual environmental effects associated with project construction.

The plume from the effluent outfall diffuser is expected to reach the surface water approximately 25 m from the diffuser but is not expected to be visible at the surface. In consideration of these modelling results, any potential change in habitat quality and use for marine mammals, sea turtles or marine birds associated with routine discharges from the diffuser would be expected to be negligible in magnitude and highly localized in spatial extent. However, the residual environmental effect will occur continuously during the operational life of the project.

The presence and operation of project vessels and equipment (including associated emissions and discharges), seabed disturbance, and marine blasting (if required) during the construction phase (and potentially also during the operation and maintenance phase, depending on the nature of maintenance requirements), as well as treated effluent discharges during the operation and maintenance phase, have potential to adversely affect marine mammals, sea turtles, and marine birds by causing a change in risk of injury or mortality and/or a change in habitat quality and use. The environmental effects assessment in **Section 8.13.3.3** describes these interactions and proposes mitigation measures to reduce anticipated potential adverse environmental effects.

12.3.9.2 Cumulative Environmental Effects during the Construction Phase

The environmental effects of other projects or activities on marine mammals, sea turtles and marine birds and their habitat have the potential to interact cumulatively with those of the project through increased acoustic emissions, increased TSS, artificial light, and habitat alteration, disruption or destruction if activities overlap spatially and temporally with those of the project.

The Northumberland Ferries service and commercial shipping and fishing activities in Caribou Harbour and the Northumberland Strait could have a cumulative environmental effect when combined with project construction activities. Increased marine traffic and temporary benthic habitat disturbance during construction may result in marine fish avoidance within the PFA, and a temporary loss of habitat proximal to construction activities. Once installation of the pipeline and outfall is complete, no more project-related marine traffic is anticipated during construction. Benthic habitat is also expected to stabilize and be recolonized by marine organisms after construction.

There could be a cumulative environmental effect on marine mammals, sea turtles and marine birds and their habitat between future dredging activities at Caribou Harbour in support of maintenance of TC's shipping lanes and project-related in-water construction activities. The cumulative environmental effects could include underwater noise from vessels, potential collisions with marine species, and potential pollution from bilge water and the accidental release of hydrocarbons. Most marine mammal, sea turtle, and marine bird species, however, will likely avoid construction activities and the PFA because of project-related noise and activities, and thus direct environmental effects are likely to be minimal for a short period of time while construction is taking place.

Acoustic emissions from ongoing marine traffic (commercial fishing and shipping vessels, and recreational vessels) in Caribou Harbour and surrounding marine areas may act cumulatively with acoustic emissions from vessels serving the project. Overall, however, the contribution of acoustic emissions from project activities are not likely to have cumulative environmental effects on marine mammals, sea turtles and marine birds because of the relatively short period of pipeline construction and the relatively low speed of project vessels.

Commercial fishing is ongoing within the RAA and can also result in mortality of marine mammals, sea turtles and marine birds. These activities have potential to cumulatively interact with project-related effects to increase the risk of changes in species populations. Recreational fishing likely poses less of a mortality risk to these marine species in the RAA due to their relatively low intensity in comparison to commercial fishing and shipping operations.

Fishing activity also contributes to the effects of acoustic noise on marine mammals, sea turtles and marine birds, which can increase the risk of potential for collisions with marine species. Increased artificial light from project vessels operating at night can also affect visibility and result in heightened risk of potential for collisions. As noted above, the acoustic emissions from project activities are not likely to have cumulative environmental effects on marine mammals, sea turtles and marine bird species because of the relatively short duration of in-water work and the relatively low speeds of project vessels. The potential for fishing vessel collisions with fish species is expected to be low given the expected speeds and relatively small size of the vessels.

The environmental effects of industrial development and land use, commercial shipping, and commercial fishing and aquaculture activities in the RAA are therefore not expected to result in a substantive overlap with the environmental effects of the project on marine mammals, sea turtles and marine birds during the construction phase of the project.

12.3.9.3 Cumulative Environmental Effects during the Operation and Maintenance Phase

During the operation and maintenance phase of the project, the environmental effects of past and present commercial shipping, commercial fisheries and aquaculture, and industrial development activities in the RAA are expected to be ongoing and similar to past and present activities in terms of their interactions with marine mammals, sea turtles and marine birds and their habitats. Those conditions are encompassed in the existing conditions for marine mammals, sea turtles and marine birds, presented in **Section 8.13**. No planned future operations are currently known that would contribute to changes to these existing conditions in the RAA.

As previously noted, there are various point and area sources along the shorelines of Pictou County and southern PEI, as well as in the Northumberland Strait, that are releasing treated effluent to the Strait. These include public municipal sources such as wastewater treatment systems, and industrial sources (such as treated effluent releases from the existing BHETF, the Trenton coal-fired power plant, and other industrial sources). These sources have no demonstrated substantive effect on marine mammals, sea turtles and marine bird populations that affect any species at a population level in the RAA.

No past or present activities or known future projects are expected to occur within the immediate proximity to the outfall location, and the environmental effects arising from the discharge of treated effluent would be localized at the diffuser, with environmental effects similar to background conditions beyond 5 m of the diffuser. Water quality at the end of the mixing zone for the three-port diffuser will reach ambient conditions within less than 2 m from the diffuser in terms of total nitrogen, total phosphorous, DO, pH, temperature, and salinity. Colour will return to baseline conditions within 5 m of the diffuser. Thus, any potential environmental effects on water quality during operation and maintenance will be highly localized. The plume from the effluent outfall diffuser is expected to reach the surface water approximately 25 m from the diffuser but is not expected to be visible at the surface. In consideration of these modelling results, any potential change in habitat quality and use for marine mammals, sea turtles or marine birds associated with treated effluent discharges from the diffuser would be expected to be negligible in magnitude and highly localized in spatial extent. Marine mammal, sea turtle, and marine bird species, however, will likely avoid the immediate area of a diffuser, and thus a direct environmental effect is anticipated.

Given the likely limited spatial extent and frequency of maintenance activities associated with the operation of the pipeline, and their likely lack of spatial and temporal overlap with those of other projects or activities (industrial development and land use, commercial shipping, and commercial fishing and aquaculture activities), substantive cumulative environmental effects during maintenance activities are unlikely to occur. If in-water activities and seabed disturbance are required during maintenance activities, the potential effects, on marine mammals, sea turtles and marine birds and their habitats, such as risk of injury or mortality, would be similar to, though considerably lower than, those during the construction phase.

12.3.9.4 Summary of Cumulative Environmental Effects on Marine Mammals, Sea Turtles and Marine Birds

Project-related construction and operation and maintenance activities may result in adverse environmental effects which could result in changes to habitat of marine mammals, sea turtles and marine birds in the PFA. It is not anticipated that changes would extend beyond the PFA. Changes in habitat would persist over the life of the project; however, they would be concentrated during the construction phase of the project. The potential change in marine species populations is attributable to direct and indirect disturbance/change of habitat and increased mortality risk.

Considering the limited overlap between the project and other existing projects and activities, combined with the proposed mitigation measures, the residual cumulative environmental effects of a change in populations of marine mammals and birds, and sea turtles, are not likely to be substantive.

The residual environmental effects of the project on marine mammals, sea turtles and marine birds considered the ecological context of the project, including the high level of disturbance associated with existing commercial shipping and commercial fishing in the PFA, and the very limited number of other likely projects or activities in the marine portion of the RAA. In this light, the potential cumulative environmental effects of the project in combination with those of other past, present or future activities (particularly marine-based activities) on populations of marine mammals, sea turtles and marine birds during all phases of the project are not expected to be substantive.

12.3.10 Cumulative Environmental Effects on the Socio-economic Environment

12.3.10.1 Residual Project Environmental Effects Summary

As detailed in **Section 8.14**, it is anticipated that the potential residual environmental effects of the project on the socio-economic environment will be limited to the construction phase, and primarily be from short-term road, trail, and marine traffic restrictions, as well as short term nuisance (e.g., noise, dust) to local residents, particularly in the vicinity of Caribou where residences are located along Highway 106.

Construction effects on land and water use will be limited to the construction duration and to the project footprint as defined by the PFA. The PFA is limited to lands compatible with the activity, by being constructed on lands generally previously disturbed from other infrastructure projects. Short-term interruptions in traffic during construction may occur, but the potential for delays will be minimized through the completion of a traffic impact study to inform construction staging. The project will provide advance signage and appropriate traffic control methods to maintain traffic flow.

Short term and periodic delays to marine users, including commercial fishing vessels, in Caribou Harbour and along the marine portion of the PFA may occur during the installation of the marine-based pipeline portion and outfall. Given the width of the entrance to Caribou Harbour and the anticipated work area, delays are only anticipated during some stages of marine-based portion of the pipeline construction. Delays will be further mitigated by timing construction activities outside of peak fishing seasons (e.g., during lobster season), and in coordination with the Northumberland Ferry as possible. Advance notice and safety protocols will be developed for mariners in coordination with TC. No interruptions to aquaculture operations in the RAA are anticipated.

Given the mitigation measures described above, the residual environmental effects of the project on the socio-economic environment will be temporary and not significant in nature. These include the potential for:

- Short-term interruption to Jitney Trail use while construction occurs in that vicinity;
- Potential for periodic, short-term delays to marine traffic including the NS-PEI Ferry and commercial fisheries vessels leaving the marinas east of Caribou Ferry Terminal during the construction stage where the pipe route is anticipated to cross the navigational channel;
- Potential short term traffic delays during peak (e.g. commuter hours) periods; and
- Potential for short term nuisance (noise, dust) to local residents from construction activities, particularly in the vicinity of Caribou where residences are along Highway 106.

The construction of the project will require an estimated 100,000 person-hours of effort. Construction will be completed by third party contractor; however, additional staff is expected to be hired to carry out the project activities as discussed in **Section 5.5** Labour Requirements. Further, the construction of the project will have increased economic spin-off from the construction workforce staying in the area and the local procurement of goods and services. The completion of the project will allow for the continued operation of NPNS mill, which since its construction in 1967 has been a significant contributor to the local communities, providing employment and contributing to the provincial economy.

There are no substantive residual environmental effects of the project on the socio-economic environment during the operation and maintenance phase that were not initially introduced during construction, thus cumulative environmental effects are not expected during this phase and not discussed further.

12.3.10.2 Cumulative Environmental Effects during the Construction Phase

During project construction, commercial fisheries (including aquaculture operations), commercial shipping, use of linear facilities, recreational use and industrial development activities in the RAA are expected to continue.

The project will result in a temporary increase in demand in the local labour force and accommodations, and a minimal residual environmental effect on transportation and the use of linear facilities in the PFA. The project labour requirements are considerable during the planned 21 month construction period. However, competition for labour or a decline in the availability of and access to public services are unlikely to cause a significant environmental effect on the socio-economic environment, even in combination with other present activities such as commercial fisheries and aquaculture, commercial shipping, recreational use, linear facilities, and industrial development.

It is expected that many of the workers for both land-based and marine-based project activities during the construction phase will be residents of Pictou County and the surrounding areas. Other workers would be temporary residents to the RAA, requiring accommodations and other local services. Local options for temporary accommodations are abundant within the RAA, and any decline in the availability of local accommodations is therefore unlikely to cause a significant environmental effect on the socio-economic environment, even in combination with other local projects and activities.

For land-based portions of the project, there will be limited increases in passenger vehicles and large commercial trucks transporting workers, and project-related materials and equipment during the construction phase. Traffic volumes, however, are not anticipated to be of concern. In consideration of the short-term and transient nature of the planned construction activities, as well as planned mitigation, there will be no noticeable increase in the overall traffic volumes in the RAA. Short-term interruptions in traffic patterns along Highway 106 during installation of the pipeline in the road shoulder, however, may occur. It is expected that the potential for delays will be minimized through working with NSTIR to determine traffic patterns to inform construction staging. The project will provide advance signage and appropriate traffic control methods to maintain traffic flow.

For the marine-based portion of the project, the project in combination with future commercial fisheries and aquaculture, and recreational use activities may result in a negative effect to the local economy as these activities may disrupt fishing activities through the temporary presence of navigational hazards and interference with access to fishing grounds. Commercial shipping and recreational activities may also be disrupted through the temporary presence of navigational hazards. Construction within the marine environment, however, would be short in duration. To the extent feasible, efforts would be made to schedule marine-based construction activities to avoid overlap with commercial fishing seasons in the RAA, and marine vessel (e.g., ferries) movement within the shipping channel.

More general development that occurs incrementally over longer periods of time, such as economic growth, population increase and infrastructure expansion has resulted in the current patterns of land

and resource use throughout the RAA. It is unlikely that the project will substantially contribute to a cumulative change in overall land and marine use patterns since the replacement ETF, pipeline and associated facilities will be sited either immediately adjacent to existing linear infrastructure developments, on disturbed private properties (e.g., ETF on NPNS property) or within regulated marine areas. Although existing NPNS infrastructure and linear facilities have permanently changed the use of some land (areas are now paved or inaccessible), land availability is not considered constraining in this part of the province, and land and resource use can generally be accommodated in conjunction with these developments.

The project will not be displacing any established businesses, and will not interfere with access to local businesses or tourism locations. The project is expected to generate revenue for the area through direct expenditures by construction workers and personnel. Therefore, anticipated cumulative socio-economic environmental effects of the project are expected to be generally positive.

If there are future industrial and commercial development activities that overlap temporally with construction, a positive cumulative environmental effect may result in labour and economy, as there would be increased employment opportunities, and direct, indirect, and induced revenues for project-related goods and services, as well as generating income and sales tax revenues for governments.

Based on the above assessment, the environmental effects of commercial fisheries and aquaculture operations, commercial shipping, use of linear facilities, recreational use and industrial development activities in the RAA are therefore not expected to result in a substantive overlap with the environmental effects of the project on the socio-economic environment during the construction phase of the project.

12.3.10.3 Summary of Cumulative Environmental Effects on the Socio-Economic Environment

In summary, while there may be occasional short-term overlapping environmental effects of the project with those of other projects or activities that have been or would be carried out, given the nature of the project and RAA, it is unlikely that those overlapping environmental effects would cause a significant cumulative environmental effect. Therefore, cumulative environmental effects of the project in combination with those of other past, present or future activities on the socio-economic environment during all phases of the project are not expected to be substantive.

12.4 Summary and Determination of Significance

Overall, the vast majority of the land-based portion of the PFA is located on either disturbed industrial land (i.e., NPNS property) or within the developed portion (i.e., road shoulder) of NSTIR’s Highway 106. This will reduce residual project and cumulative environmental effects. Past industrial development and land use, commercial fisheries and aquaculture, commercial shipping, recreational land uses (including tourism), and existing linear facilities have affected the existing landscape in the RAA; however, those alterations were considered in, and encompassed within, the baseline conditions used to assess the residual environmental effects of the project.

The project would result in some environmental effects on VECs that may potentially overlap with similar environmental effects on those VECs from other past, present, or reasonably foreseeable projects or activities in the area. However, in all cases, these cumulative environmental effects are similar to the residual project environmental effects presented in this EA Registration, though in most cases having limited temporal or spatial overlap. Residual environmental effects from all project activities were predicted to be not significant. It is understood that other projects or activities in the RAA would be required to reduce potential environmental effects through compliance with government standards and permit stipulations, further reducing the potential for cumulative environmental effects; there are no projects currently registered that will have environmental effects that overlap those of the project in a substantive way. Cumulative environmental effects during all phases on all affected VECs are not expected to be substantive, and no additional mitigation is recommended.

Given the limited residual environmental effects of the project and planned mitigation, the cumulative environmental effects of the project in combination with those of other activities that have been or would be carried out (including commercial and industrial operations, commercial fisheries and aquaculture, commercial shipping, recreational use, and existing linear facilities) during all phases of the project on all affected VECs are rated not significant.

13.0 Follow-up and Monitoring Summary

This section summarizes the follow-up and monitoring measures recommended for the VECs presented in **Sections 8.1 through 8.17**.

Throughout this section, “follow-up” is defined as *“a program for (a) verifying the accuracy of the environmental assessment of a project, and (b) determining the effectiveness of any measures taken to mitigate the adverse environmental effects of the project”*. Though additional monitoring or other requirements may apply to the Project to verify compliance with environmental legislation (e.g., compliance monitoring) or to achieve other goals, such requirements are not considered to be part of a formal follow-up program. There are several circumstances, however, where monitoring activities are identified in this EARD, and these are also summarized below, for convenience.

A follow-up program is required where the limitations in, or scientific certainty of, the environmental effects predictions need to be verified, or where the effectiveness of mitigation requires confirmation. Follow-up measures are proposed where the environmental effects assessments have identified a need to confirm the predictions of the EA (e.g., when the level of confidence in the significance prediction is low or moderate), or where the effectiveness of mitigation needs to be verified (e.g., for non-standard mitigation or where new technology is being proposed). Conversely, monitoring is generally carried out to measure compliance with the requirements of environmental laws or regulations, or the conditions of permits, approvals or authorizations issued under such laws or regulations, or to otherwise measure the environmental performance of a project. The central goal of monitoring programs is generally to demonstrate compliance.

It is noted that the elements of the follow-up or monitoring programs described herein are conceptual and presented in this report at a relatively high level. As the project advances through detailed design, permitting, construction, and into operation, and as follow-up or monitoring programs are carried out, the methodology for each program will be documented and adjusted as necessary to meet the environmental protection requirements or commitments.

In this section, follow up and monitoring includes:

- formal follow-up measures to verify the environmental effects predictions of this EARD or the effectiveness of mitigation;
- monitoring to enable the collection of additional baseline data to confirm and expand upon data gathered through existing sources and field surveys conducted to date;
- monitoring programs to demonstrate compliance with regulatory and permit requirements during the construction and operation and maintenance phases; and

- contingency plans and environmental protection plans developed to protect the environment, the public and project personnel, and the project during construction and operation and maintenance phases.

13.1 Follow-up and Monitoring Summary

The follow-up or monitoring programs that were recommended in each of the VECs in this EARD are summarized in **Table 13.1-1** below. Further scoping and refinement of the follow-up or monitoring program elements (including specific methodologies, monitoring locations, monitoring timeframes and frequencies, parameters of concern, and the like) will be carried out during the permitting phase and in response to conditions of approval.

Table 13.1-1: Summary of Follow-Up and Monitoring

VEC	Recommended Follow-up or Monitoring
Atmospheric Environment	• Follow up and monitoring using the mill's current regulated source emission testing program will verify the environmental effects predictions and the effectiveness of mitigation. The facility currently undergoes a source emissions testing program annually, which will continue as per the Industrial Approval. Pulp and paper mill sludges are considered, in most jurisdictions, a standard fuel with no requirements for additional monitoring outside of the source emissions testing program; and, • The existing ambient air monitoring program is expected to continue during future operation and will collect data on the concentration of the various air contaminants over time for comparison to the Nova Scotia *Air Quality Regulation* Maximum GLCs and the model predictions conducted for the project.
Acoustic Environment	• Periodic noise monitoring may be conducted as spot-checks to ensure compliance with noise guideline levels and/or in response to noise complaints; and, • Though not a formal follow-up or monitoring measure, NPNS will periodically liaise with the local community and/or groups during construction.
Soils and Geology	• Geotechnical investigations have already been undertaken at the ETF site. Geotechnical investigations will be conducted within the causeway portion of the pipeline and in conjunction with non-intrusive excavation (such as HDD) at wetlands or watercourses (if undertaken); • A contingency plan will be developed for the project and will specify that if acid rock, karst or contaminants are encountered, follow-up monitoring will be undertaken to meet regulatory requirements; and, • Soil stabilization practices and erosion control measures will be monitored and maintained until slopes have stabilized.

VEC	Recommended Follow-up or Monitoring
Surface Water	• A surface water monitoring program will be developed and maintained over the life of the project in accordance with requirements stipulated by NSE; and, • Baseline monitoring will be performed prior to project commencement. Refer to **Section 8.4.3.5** for details.
Groundwater	• The existing network of monitoring wells associated with the NPNS monitoring program has been and will continue to be used to monitor groundwater at the NPNS site before and after the ETF is constructed; • The groundwater table may be confirmed using piezometers or shallow monitoring wells prior to project initiation if required for construction of the clarifiers at the ETF site; and, • NPNS will develop a surface water monitoring program to monitor runoff within the pipeline footprint both during and subsequent to construction in areas where surface water can infiltrate to groundwater. Refer to **Section 8.5.5** for details.
Freshwater Fish and Fish Habitat	• Field verification of fish habitat within watercourses in the vicinity of the project footprint prior to construction; • Baseline, compliance and effects monitoring of surface water quality as described in **Section 8.4** (surface water); and, • Follow-up effects monitoring of fish habitat offset, if required, to meet DFO requirements. Refer to **Section 8.6.5** for details • Follow-up as required to meet regulatory approvals requirements if in-stream crossing methods considered.
Wetlands	• Additional work will be undertaken in the spring and summer of 2019 to confirm the location and sensitivities of wetlands located adjacent to the proposed pipeline footprint; and, • Follow-up will be conducted to assess the success of wetland compensation for the proposed wetland alterations. Refer to **Section 8.7.5** for details.
Flora/Floral Priority Species	• Follow-up surveys will be conducted to verify the effects predictions or the effectiveness of mitigation, consisting of a field investigation of the pipeline footprint area during spring and summer of 2019 to confirm the information obtained from desktop sources; • Monitoring will be conducted to confirm the regrowth of vegetation following construction activities and to assess the potential for invasive plant species to have been introduced, during the first year following the completion of construction; and, • The pipeline footprint area will be inspected to identify areas where vegetation re-establishment has not been successful. Refer to **Section 5.7** for details.

VEC	Recommended Follow-up or Monitoring
Terrestrial Wildlife/Priority Species	• Completion of field investigations in the pipeline footprint area to confirm the existing conditions information obtained from secondary (desktop) sources, specifically - follow-up turtle surveys to be conducted May to June prior to construction activity within the pipeline project footprint; • Re-establishment and monitoring of monarch forage milkweed and; • Follow-up studies as required to verify the environmental effects predictions.
Migratory Birds and Priority Bird Species/Habitat	• A comprehensive field migratory survey and breeding bird survey of the pipeline footprint area will be conducted in spring/summer 2019 as a follow-up measure to confirm the desktop information, as a follow-up measure to confirm the resulting effects prediction; • NPNS will review the SAR list during construction and modify monitoring accordingly. • Enforce existing NPNS wildlife policies, including do not feed birds or wildlife on NPNS property.
Harbour Physical Environment/Marine Fish and Fish Habitat/Marine Mammals Sea Turtles and Birds	• A project-specific environmental effects monitoring program will be undertaken to confirm the prediction of effects and demonstrate compliance with regulatory and permit requirements during the operation and maintenance phase; and,
Socio-economic Environment	• Follow up studies and monitoring programs developed for other VECs will address issues which affect the Socio-economic VEC; • Sectors of the fishing industry are anticipated to be engaged with the follow-up and monitoring program identified in the marine environment through their ongoing relationship with DFO in reporting observations, and landings; and, • The existing Community Liaison Committee will continue to provide advice and facilitating two-way communication between the local community and NPNS. Refer to **Section 8.14.6** for details.
Indigenous Peoples' Use of Land and Resources	• Completion of the expanded MEKS prior to construction will be carried out as a follow-up measure to verify the effects predictions; and, • Follow-up or monitoring conducted for other VECs (particularly for fish and fish habitat, and human health) may assist in further defining and limiting environmental effects on Indigenous Peoples' use of land and resources. Refer to **Section 8.15.5** for details.
Marine Archaeological Resources	• Completion of the ARIA to determine areas of elevated marine archaeological potential; and, • Archaeological monitoring during construction if avoidance of areas of elevated potential is not feasible. Refer to **Section 8.17** for details.

VEC	Recommended Follow-up or Monitoring
Terrestrial Heritage Resources	• Shovel testing of any areas of elevated terrestrial archaeological potential that may be disturbed prior to construction; and, • Archaeological monitoring will be conducted during construction in areas of elevated archeological potential. Refer to **Section 8.18** for details.

14.0 Assessment Summary and Conclusion

This environmental assessment (EA) registration document has described, and provided an environmental effects assessment of, the proposed construction and operation of a replacement effluent treatment facility (ETF) and pipeline for the existing Northern Pulp Nova Scotia (NPNS) Corporation pulp mill located at Abercrombie Point, Pictou County, Nova Scotia (the project). The project requires a formal registration for a Class 1 Environmental Assessment under the *Environmental Assessment Regulation of the Nova Scotia Environment Act.*

The project is required in order to replace the existing Boat Harbour Effluent Treatment Facility (BHETF) which currently treats effluent from the NPNS mill. The project is fundamental to the continued operation of the NPNS mill. The *Boat Harbour Act*, which received Royal Assent on May 11, 2015, will prohibit the use of the provincially-owned BHETF for the receipt and treatment of effluent from NPNS after January 31, 2020. In order for NPNS to remain operational, a replacement ETF is required to treat and dispose of effluent. The continued operation of the NPNS mill is essential to meet global market demands and to support the local and provincial forestry sector, a major component of Nova Scotia's economy.

The proposed project will consist of the construction and subsequent operation and maintenance of a new replacement ETF, a transmission pipeline that will carry treated effluent overland to Caribou Harbour, and then out into the marine environment ultimately discharging into the Northumberland Strait at a diffuser (marine outfall). The replacement ETF will be located on NPNS property, adjacent to the mill, and will employ an AnoxKaldnes Biological Activated Sludge (BAS™) process, which combines Moving Bed Biofilm Reactor (MBBR) technology with conventional Activated Sludge (AS). Once the effluent is treated, it will be directed to the marine environment at Caribou Harbour through a pipeline, with an overall length of approximately 11.4 km, which follows the Highway 106 right-of-way (ROW) within the existing road shoulder, and reaches Caribou Harbour adjacent to the Northumberland Ferries marine terminal. This includes a 4.1 km section of pipeline in the marine environment through Caribou Harbour to the Northumberland Strait, reaching an engineered marine outfall and three-port diffuser.

In accordance with the requirements the *Environmental Assessment Regulation*, this EA Registration document has provided project-related information available at this stage of its design, and has assessed the environmental effects of the project. The key findings of this report are as follows:

- Based on the needs highlighted above and the treatment and discharge requirements, the alternative chosen is justified for this application.
- The project will create disturbances through its construction, and operation and maintenance. The proposed approach to environmental planning and management of the project was described to manage project-related emissions and wastes. Standard mitigation measures (i.e., mitigation by design) to minimize or avoid environmental effects have been described.

- To obtain an understanding of the effects of the project activities, public, regulatory, and Indigenous engagement activities were undertaken for the project, from initial project concept to conceptual design.
- The assessment of potential environmental effects of the project on each valued component (VEC) of relevance and importance to this EA was provided. Eighteen VECs were identified as relevant and important to the EA of the project.
- Potential environmental effects were identified in the absence of mitigation. Mitigation measures to avoid or reduce environmental effects so that they are not significant were identified, and residual environmental effects were evaluated in consideration of defined boundaries and significance criteria.
- The potential considerations for evaluating human health risks were presented.
- Credible accidents, malfunctions, and unplanned events were also assessed.
- Cumulative environmental effects of the project in combination with other projects or activities that have been or will be carried out were assessed.
- Where applicable, follow-up or monitoring measures to verify the environmental effects predictions of this EA or to verify the effectiveness of mitigation were identified.
- A summary of residual environmental effects and mitigation was presented.
- A summary and conclusion of the environmental assessment was provided.

Project interactions with all VECs were analyzed to determine potential environmental effects associated with Project components and activities. The environmental effects assessment for each VEC was carried out for all Project phases as well as for potential accidental and/or unplanned events and the effects of the environment on the Project. The analysis used qualitative and, where possible, quantitative information available from existing knowledge and appropriate analytical tools, as well as considering identified mitigation measures. To eliminate or reduce anticipated environmental effects, mitigation measures were incorporated into the Project design.

14.1 Predicted Residual Environmental Effects

Residual environmental effects were predicted for VECs following the application of planned mitigation measures. The residual environmental effects of each Project phase were evaluated as either not significant (“NS”), significant (“S”, with likelihood of occurrence identified in such cases), or positive (“P”), based on thresholds of significance previously defined. The significance of residual environmental effects, as determined for each of the VECs, is summarized in **Table 14.1-1** below.

Table 14.1-1: Summary of the Significance of Project Related Residual Environmental Effects

Valued Environmental Component (VEC)	Project Phase		Accidents, Malfunctions, and Unplanned Events	Project Overall
	Construction	Operation and Maintenance		
Atmospheric Environment	NS	NS	NS	NS
Acoustic Environment	NS	NS	NS	NS
Soils and Geology	NS	NS	NS	NS
Surface Water	NS	NS	NS	NS
Groundwater	NS	NS	NS	NS
Freshwater Fish and Fish Habitat	NS	NS	NS	NS
Wetlands	NS	NS	NS	NS
Flora/Floral Priority Species	NS	NS	NS	NS
Terrestrial Wildlife/Priority Species	NS	NS	NS	NS
Migratory Birds and Priority Bird Species/Habitat	NS	NS	NS	NS
Harbour Physical Environment, Water Quality and Sediment Quality	NS	NS	NS	NS
Marine Fish and Fish Habitat	NS	NS	NS	NS
Marine Mammals, Sea Turtles, and Marine Birds	NS	NS	NS	NS
Socio-Economic Environment	NS	NS	NS	NS
Indigenous Peoples' Use of Land and Resources	NS	NS	NS	NS
Marine Archaeological Resources	NS	NS	NS	NS
Terrestrial Heritage Resources	NS	NS	NS	NS
Effects of the Environment on the Project	NS	NS	NS	NS

Notes:
NS = Not Significant Residual Environmental Effect Predicted.
S = Significant Residual Environmental Effect Predicted.
L = Residual Environmental Effect is Likely to Occur.
U = Residual Environmental Effect is Unlikely to Occur.
P = Positive Residual Environmental Effect Predicted.

The environmental effects assessment concluded that, for all VECs, there would be no significant adverse residual environmental effects from the project during all phases assessed and in consideration of normal activities of the project as planned. Effects of the environment on the project were predicted to be not significant due to the nature of the project and design features that incorporate factors of safety and other mitigation to minimize the likelihood of a significant adverse effect of the environment on the project. The potential residual environmental effects of accidents, malfunctions, and unplanned events were also found to be not significant. Cumulative environmental effects of the project in combination with other projects or activities that have been or will be carried out were also found to be not significant. A follow-up program has been proposed to verify the environmental effects predictions of this EA Registration or to verify the effectiveness of mitigation.

Overall, based on the results of this EA Registration, it is concluded that, with planned mitigation and the implementation of best practices to avoid or minimize adverse environmental effects, the residual environmental effects of the project, including the effects of accidents, malfunctions and unplanned events as well as cumulative environmental effects, during all phases are rated not significant.

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