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Project name **Sediment Mercury Conditions & Sea Water Pipeline Installation**
Project no. **1690008668**
Client **Nordic Aquafarms**
To **Ed Cotter (Nordic Aquafarms)**
From **Richard Wenning**

DRAFT 28 August 2019

Conclusions from this Document

- Total mercury in sediment in the vicinity of Belfast Bay and measured by NAF in the proposed pipeline installation corridor are consistent with sediment results reported elsewhere in coastal Maine. Further, the sediment concentrations in Belfast Bay are below those identified in the scientific literature as potentially posing an environmental hazard.

- Per the proposal in the USACE and State of Maine permit applications, NAF's contractor for installation of the sea water intake and RAS clean water return pipeline is taking adequate precautions to minimize sediment suspension during the in-water work.

- Additional precautionary measures are available, but not warranted, to limit sediment suspension in the water column during the pipeline installation work.

Introduction

Concerns have been raised in the Belfast community regarding the consequences of disturbing sediment in Belfast Bay that may contain mercury. At the request of Nordic Aquafarms Inc. (NAF), Ramboll US Corporation (Ramboll) reviewed the proposed approach to installation of the sea water pipeline supporting the proposed salmon RAS facility and reviewed available information pertaining to the significance of mercury in sediments in the pipeline installation corridor. This memorandum conveys a scientific and engineering supported technical position with respect to the significance of mercury in sediments along the pipeline installation corridor in Belfast Bay, and the approach to installation work envisioned by NAF's contractor to minimize disturbance of the sea floor to the extent practical.

Proposed Sea Water Pipeline Installation

NAF's permit application to the State of Maine[1] includes installation of two sea water intake pipes and a single RAS water return pipe extending for more than 1 mile from the facility to the east in Belfast Bay. The 30-inch diameter intake pipes and 36-inch diameter RAS water return (or outfall) pipes will be buried side-by-side beneath soil from the facility to the high-tide water line at the shore. At the shore,

[1] U.S. Army Corps of Engineers permit application (Section 1.2.1A) describes construction activities relevant to installation of two side-by-side pipelines from the facility to approximately 1 mile offshore. A map illustrating the pipeline installation corridor is found in the State of Maine SLODA permit application (Section 1, pg. 31; and, Section 18, pg. 2).

the pipes will be buried beneath sediment in the offshore subtidal and intertidal zones, extending for approximately 1/2-mile from the high-tide water line to a water depth of approximately 35 feet (ft). Thereafter, all pipes will be anchored just above the sediment surface until reaching the discharge diffusers approximately 1,000-ft from where the pipelines emerge above the sediment surface (water depth of approximately 40-ft). At this point, the sea water intake pipes will continue along the sediment surface to the intake structure approximately 1,700-ft to the east of the discharge diffusers at a water depth of around 50-feet.

As described in NAF's submitted permit materials[2], beginning at the shoreline, an excavator on a floating barge will be used to dig a 10-ft deep, 30-ft wide trench in the offshore subtidal and a 5-10-ft deep, 30-ft wide trench in the intertidal zones for installation of the sea water intake and RAS clean water return pipes. Work will be conducted during low tide conditions. Sediments removed from the trench will be placed alongside the trench, a section of pipe laid in the trench, and the excavated sediment returned to the trench to cover both pipes.

Beyond the location where the pipelines are buried beneath the sediment surface, the pipelines will be anchored in place with drilled concrete collars. No trench will be excavated and sediments will not be disturbed on the sea bed, except as a consequence of the placement of concrete anchors. The pipelines will be secured approximately 6 to 12-inches above the sediment surface.

Buoys will be installed along a specific pre-determined and spatially referenced pipeline installation corridor to demarcate the intertidal, subtidal, and deeper water work area. There are currently no docks, moorings, or buoys that would interfere with construction in the installation corridor. The offshore installation work is anticipated to be completed within a 2-week period, barring inclement weather.

Mercury Levels in Belfast Bay Sediment

Concerns regarding mercury in Belfast Bay largely stem from contamination originating in the Penobscot River, which flows into Penobscot Bay at a distance of approximately 11 miles northeast of Belfast Bay. Though there many sources of mercury in the Gulf of Maine[3], the mercury originating from a chemical manufacturing factory in Orrington is the most significant known potential source to Belfast Bay. A series of environmental investigations and cleanup studies mandated by the federal district court, the State of Maine and United States Environmental Protection Agency (USEPA) reveal how several decades of river flow and tidal flooding have transported some of the mercury from the river at Orrington to the upper reaches of Penobscot Bay by attaching to fine particles of suspended sediment.[4]

A map depicting mercury concentrations measured in sediments from upper Penobscot Bay southward to Belfast Bay between 2006 and 2010 has been published as part of Phase I Study and Phase

[2] Ramboll understands that the specific construction procedures described in the NAF's USACE and SLODA permits is subject to change based on identification of the construction vendor and discussions with USACE and the State of Maine.

[3] See Sunderlund et al. (2012; Environ. Res. 119:27-41) report on results from a New England and Canadian university collaborative study.

[4] The State of Maine DEP references this matter at https://www.maine.gov/dep/spills/holtrachem/index.html; the investigation and cleanup work are described at http://www.penobscotmercurystudy.com/.

II environmental investigations supervised by court-appointed experts representing the U.S. Federal District Court[5].

Hundreds of surface and subsurface sediment samples from have been collected from the Penobscot River and Penobscot Bay over nearly 10 years as part of the Penobscot River Mercury Study. These data provide a good indication of total mercury in sediment extending from the river and into the upper reaches of the bay. Total mercury concentrations in surface and buried sediments in Penobscot Bay southwest of the Penobscot River are much lower (i.e., less than 0.5 parts per million, ppm, in areas southwest of Cape Jellison and Sears Island) than sediments from the depositional areas closer to the river's confluence with the bay (e.g., Mendell Marsh and the Orland River)[6]. Total mercury in 10 surface sediment samples collected in the vicinity of Belfast Bay as part of the Penobscot River Mercury Study ranged from 0.2 ppm to 0.3 ppm[7].

NAF collected sediment cores in 2018 from the proposed pipeline installation corridor and tested two composite samples for total mercury at a well-qualified and highly experienced environmental testing laboratory. Test results were consistent with the concentrations reported in the vicinity of Belfast Bay as part of the Penobscot River Mercury Study. Total mercury was 0.27 ppm in one sediment sample and below measurable detection limits (0.103 ppm) in the other sediment sample[8].

Significance of Sediment-Bound Mercury in Belfast Bay

Total mercury measured in the vicinity of Belfast Bay as part of the Penobscot River Mercury Study and measured by NAF in the proposed pipeline installation corridor are consistent with sediment results reported elsewhere in coastal Maine. Average surface sediment concentrations of total mercury in the central coast of Maine, extending from Casco Bay northward to Narraguagus Bay, are between 0.03 ppm to 0.3 ppm [9,10]. Similar findings are reported in the USEPA National Coastal Condition Assessment (NCCA) sediment dataset for coastal Gulf of Maine[11]. In coastal waters with sediments at these concentrations, neither the State of Maine nor the USEPA impose limits or restrictions on coastal fisheries or consumption of fish. The United States Army Corps of Engineers periodically dredges

[5] See Chapter 1, pg. 522 of the Penobscot River Mercury Study at http://www.penobscotmercurystudy.com/information-repository
[6] See Figure S1 from Section 1 of the Penobscot River Mercury Study
[7] Ibid
[8] Total mercury in 2 sediment samples collected from three different sediment cores obtained along proposed pipeline installation corridor are reported in a Ransom (2019) sediment investigation report. Both samples are composites of surface and subsurface sediment. One sample (B3) is a composite from a 6-ft 5-in depth core and the other is a composite of two cores (A6/A7), one to a depth of 1-ft and the other to a depth of 3-ft 9-in.
[9] See Chapter 17 of the Penobscot River Mercury Study reporting on background concentrations of total mercury in central Maine estuaries. Submitted to Judge Woodcock United States District Court (District of Maine). April 2013.
[10] See Casco Bay Estuary Partnership & Ramboll Environ (2017). Casco Bay Sediment Assessment 1991-2011. Portland, ME: University of Southern Maine, Muskie School of Public Service, Casco Bay Estuary Partnership. http://www.cascobayestuary.org/wp-content/uploads/2018/01/2017-Casco-Bay-Sediment-Report-FINAL-COMPLETE-3-31-17-reduced.pdf
[11] The NCCA is a national coastal monitoring program with rigorous quality assurance protocols and standardized sampling procedures designed to produce national and regional estimates of coastal condition. Data describing total mercury in coastal Maine sediments can be queried at https://www.epa.gov/national-aquatic-resource-surveys/ncca.

sediments from Portland Harbor[12] where total mercury concentrations in surface sediment (0.2 to 0.3 ppm[13]) are consistent with those reported in Belfast Bay.

Total mercury concentrations measured in the vicinity of Belfast Bay as part of the Penobscot River Mercury Study and measured by NAF in the proposed pipeline installation corridor are well below the no-observed-effect concentration for total mercury (3.3 ppm) associated with exposure to aquatic life. This is derived from examination of mercury-specific toxicity testing involving paired testing of benthic invertebrates (crabs, shellfish, worms, and bugs) and the sediments in which they live[14]. Total mercury in sediments in the vicinity of Belfast Bay and the proposed pipeline corridor are one order of magnitude lower than the threshold for toxicity to aquatic life, indicating that total mercury concentrations are highly unlikely to threaten the aquatic life and the fishery in Belfast Bay.

National Oceanic and Atmospheric Administration (NOAA) preliminary screening sediment quality values for total mercury indicate a low effects level of 0.15 ppm and a threshold effect level of 0.13 ppm[15]. These preliminary screening values are widely cited but considered by experts as out of date because NOAA stopped periodic reviews to match the state of the science after 2008. Consequently, US regulatory agencies have been much less reliant on NOAA preliminary screening sediment quality values over the past decade and look to information from regional sediment studies to understand natural or background sediment chemistry conditions[16]. This has been the approach adopted by the State of Maine[17]. For further context, Pelletier et al. (2019) compiled sediment remediations goals from 77 contaminated sites throughout the United States, 21 of which included remediation goals for total mercury. On average, active sediment remediation at those sites occurred in areas where total mercury concentrations exceeded 2.5 ppm, an order of magnitude above the sediment concentrations reported in the vicinity of Belfast Bay or in the proposed pipeline corridor[18].

Minimizing Disturbance of Sediments During In-Water Excavation Work

Minimizing sediment suspension during in-water work is always desirable because it reduces the amount of sediment in the water column and the potential for physical impacts to the natural aquatic habitat and aquatic life that rely on that habitat . Disturbing the sediment can change the bioavailability of substances such as mercury, and thereby change the amount possibly taken up by shellfish and fish.

The US Army Corps of Engineers advocates several management techniques to minimize sediment suspension during dredging and excavation work, including work limits during extreme tides and poor

12 https://govtribe.com/opportunity/federal-contract-opportunity/maintenance-dredging-portland-harbor-portland-me-w912wj13b0006

13 Ibid (Casco Bay Estuary Partnership & Ramboll Environ. 2017. Figure 14)

14 See Conder et al. (2019; Environ. Toxicol. Chem. 34:6-21) report on results of a critical review of mercury sediment quality values for the protection of aquatic invertebrates.

15 From inception in the late 1980s until 2008, NOAA maintained Screening Quick Reference Tables, or SQuiRTs, as a preliminary screening tool to help regulatory agencies to evaluate chemistry results in water, sediment or soil. See https://response.restoration.noaa.gov/environmental-restoration/environmental-assessment-tools/squirt-cards.html

16 See The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments (USEPA 2001) at https://www.epa.gov/sites/production/files/2015-09/documents/slera0601.pdf

17 See the Maine Remedial Action Guidelines (RAGs) for Sites Contaminated with Hazardous Substances (MEDEP 2018) at https://www.maine.gov/dep/spills/publications/guidance/rags/ME-Remedial-Action-Guidelines-10-19-18cc.pdf

18 See Pelletier et al. (2019; Integ. Environ. Assess. Manag https://doi.org/10.1002/ieam.4162) results of a review of US EPA and state cleanup decisions involving sediments containing total mercury and other chemicals.

weather conditions, use of silt curtains and similar particulate suspension control barriers, use of carbon amendments to reduce bioavailability in the water column and sediment after disturbance, and use of removal and placement equipment that minimally upsets the sediment surface during disturbance[19]. These management techniques are not specific to mercury, and there are no technologies specifically aimed at controlling water column suspension of mercury or handling sediment-bound mercury.

Per the proposal in the USACE and State of Maine permit applications, NAF's contractor for installation of the sea water intake and outfall pipelines appears to be taking adequate precautions to minimize sediment suspension during the in-water work.

Three proposed practices support this finding:

First, NAF's contractor is proposing to adopt current, best engineering practices for sediment excavation in the intertidal and subtidal zone. The proposal in NAF's USACE and State of Maine permit applications to use silt curtains has been shown effective for minimizing sediment suspension in the water column[20]. Sediment suspension should be inconsequential outside the silt curtain barrier if work is scheduled when tidal velocities are reliably less than 2 feet per second (ft/s)[21]. At greater than 2 ft/s to as much as 10 ft/s, a robust anchoring system along the bottom of the silt curtain on both sides of the excavation trench will be necessary and should be effective for minimizing particulate suspension in the water column [15]. NAF's contractor is correct to propose work stoppages for inclement weather where wind conditions are >20 knots and silt curtains will be ineffective.

Second, NAF's contractor is proposing to adopt current, best engineering practices for placement of sediment into the pipeline trench after excavation in the intertidal and subtidal zone. The proposal for 'soft placement' of material indicated in the permit applications is intended, appropriately, to fill the trench by slow release of material from the excavator bucket as close to the surface of the trench as possible (as opposed to dumping from a height that itself will encourage a sediment plume in the water column). This is standard industry practice, including in sensitive aquatic environments where precautions are advised to minimizing unnecessary disturbances to habitat and aquatic life[22]. Another 'soft placement' approach indicated in the permit applications involves temporarily placing excavated sediment adjacent to the trench and returning the material to the trench by pushing the material with the excavator bucket. Both approaches aim to reduce sediment suspension in the water column.

And third, NAF's contractor is proposing to minimize sediment disturbance in the deeper water by securing the pipeline just above the surface using concrete anchors at established intervals along the length of the submerged pipeline. Sediment disturbance will be limited to the locations where the concrete anchors will be installed rather than the entire length of the pipeline.

Ramboll Qualifications for Commenting on Mercury Conditions and Sediment Management in Belfast Bay

[19] See Palermo et al. (2008). US Army Corps of Engineers Technical Guidelines for Environmental Dredging of Contaminated Sediments.
[20] See Bridges et al. (2010; Integ. Environ. Assmt. and Mgmt. 6(4):619-630). Dredging processes and remedy effectiveness: Relationship to the 4 Rs of environmental dredging.
[21] Ibid (Palermo et al. 2008)
[22] Ibid (Palermo et al. 2008)

This work was conducted by Derek Pelletier and Richard Wenning from Ramboll (Portland , Maine).

Mr. Pelletier is an expert in sediment risk assessment, and lead author of a recently published scientific study of sediment remediation goals, including for mercury, at US Superfund sites dating back to the 1980s. Mr. Pelletier was the lead author on Ramboll's assessment of sediment chemistry in Casco Bay, Maine, conducted on behalf of the Casco Bay Estuary Partnership[23]. He has studied the consequences of mercury in the Penobscot River, supporting experts assigned to conduct environmental investigations and remediation feasibility studies by the US Federal District Court (Maine).

Mr. Wenning is an expert in aquatic ecotoxicology and sediment risk assessment. He was co-author of a 2002 book on setting sediment quality guidelines and has served since 2004 as editor-in-chief of the peer-review science journal, Integrated Environmental Assessment and Management (IEAM). He has studied the consequences of mercury in the Penobscot River, supporting experts assigned to conduct environmental investigations and remediation feasibility studies by the US Federal District Court (Maine). In 2015, Mr. Wenning co-led with Rice University a 3-year study by a team of experts from 25 US Gulf Coast universities tasked with establishing aquatic baseline conditions prior to the Deepwater Horizon oil spill. At that time, he also completed collaboration work with the US Army Corps of Engineers ERDC scientific group to revise the 30-year old national CWA 404 Inland Testing Manual and MPRSA Section 103 Ocean Testing Manual for dredged material. More recently, he advised the Maine Department of Transportation during a 2-year assignment on navigation channel maintenance and improvement work at the Searsport Terminal.

** END **

[23] See Casco Bay Estuary Partnership & Ramboll Environ (2017). Casco Bay Sediment Assessment 1991-2011. Portland, ME: University of Southern Maine, Muskie School of Public Service, Casco Bay Estuary Partnership. http://www.cascobayestuary.org/wp-content/uploads/2018/01/2017-Casco-Bay-Sediment-Report-FINAL-COMPLETE-3-31-17-reduced.pdf