Jody McCaffree
Individual/ Executive Director
Citizens For Renewables/
Citizens Against LNG
PO Box 1113
North Bend, OR 97459

October 28, 2019

Andrew Stamp, Hearings Officer
Coos County Planning Department
225 N. Adams St.
Coquille OR 97423

RE: Rebuttal Comments under Coos County File No. HBCU-19-003

Dear Hearing Officer Stamp:

Please accept these rebuttal comments into the record on behalf of Citizens for Renewables and Jody McCaffree an Individual. This Application proposes the following new developments and activities:

- A meteorological station in the 4-CS zone;
- An industrial wastewater pipeline in the IND zone;
- A concrete batch plant in the IND zone;
- A safety, security, and emergency preparedness, management and response center in the IND zone;
- A helipad in the IND zone;
- Corporate and administrative offices in the IND zone;
- Temporary workforce housing in the IND zone;
- A wastewater treatment facility in the IND zone;
- A park and ride in the IND zone;
- Temporary construction laydown uses and activities in the IND, 6-WD, 3-WD, and 3-NWD zones;
- A temporary barge berth in the 6-DA zone;
- Shoreline stabilization within the 5-WD zone;
- Pile dike rock apron in the 5-DA zone;
- Provision of primary access to the LNG Terminal in the 6-WD zone (driveway confirmation);
- Temporary dredge transport lines in the 6-DA, 7-NA, 13B-NA, and 14-DA zones;
- Gas processing in the 6-WD zone; and
- A fire station in the 6-WD zone.

The application should have been deemed incomplete due to lack of data and information that was provided. A hearing was held on September 30, 2019. On October 14, 2019 Jordan Cove submitted nothing but exhibits and most of these exhibits were available to Jordan Cove far in advance of the filing of their application and ALL BUT ONE WERE AVAILABLE TO THEM PRIOR TO THE HEARING. At the hearing Jordan Cove provided NO REBUTTAL and said that they would provide that on October 14th which they DID NOT PROVIDE. They are not only making a mockery of the entire land use process they are prejudicing citizens' substantial rights to a fair and unbiased land use process. The Planning Director should have made Jordan Cove supply the information prior to the application being deemed complete.

Jordan Cove filed 5,506 pages of Exhibits on October 14, 2019. These were not made available to citizens prior to October 17th at 3:01 p.m. (***See Exhibit 1***) Jordan Cove's exhibits and their completion dates are as follows: (*Dates are provided if they were made available. All sub-exhibits may not be listed*)

Exhibit 16 - Traffic Impact Analysis dated **December 2017** ("TIA"):
Exhibit 18 - Geotechnical Data Report is dated **April 21, 2017**
Exhibit 19 - Geotechnical Report dated **April 23, 2018**:
Exhibit 20 - Geotechnical Data Report, 2018 Subsurface Investigation Program dated **August 22, 2019**:

- Page 342 of exhibit 20 has the following report:
  PRESENTATION OF SITE INVESTIGATION RESULTS Jordan Cove LNG – Final; Prepared for: Geotechnical Resources, Inc.; ConeTec Job No: 18-52120; Start Date: 20-Aug-2018; End Date: 05-Oct-2018; **Report Date: 20-Oct-2018**

Exhibit 21 - Airport Elevation Profile and Plot Plan: dated **10-11-2019**
Exhibit 22 - FERC Resource Report 3: dated **September 2017**:

- Page 153 of Exhibit 22 (Electronic page 4435) has a Jordan Cove Fisheries Report dated **October 2006** with Figure Revisions **February 2013**
- Page 271 of exhibit 22 (Electronic page 4553) has the following report:
  Wildlife Assessment and Survey Report **– January 2013**
- Page 346 of exhibit 22 (Electronic page 4628) has the following report:
  Appendix 1: Herpetological Consultation for Jordan Cove LNG Proposal, Coos Bay, Oregon Prepared by Don Ashton for LBJ Enterprises, Eureka, CA DRAFT – **February 13, 2005**
- Page 351 of exhibit 22 (Electronic page 4633) has the following report:
  Appendix 2: Birds detected during wildlife surveys in the Jordan Cove area, **June, 2005 to November, 200**6.
- Page 367 of exhibit 22 (Electronic page 4649) has the following report:
  Appendix 3. Tetrapod vertebrates detected during LBJ site visits to Jordan Cove, Coos Bay, Oregon, **June, 2005, to November, 2006**.
- Page 370 of exhibit 22 (Electronic page 4652) has the following report:
  Appendix 4. Jordan Cove Project Track Plate Study, Coos Bay, Oregon, LBJ Enterprises.
- Page 372 of exhibit 22 (Electronic page 4654) has the following report:
  Appendix 5. USFWS Species List
- Page 375 of exhibit 22 (Electronic page 4657) has the following report:
  Appendix 6. BLM Table
- Page 378 of exhibit 22 (Electronic page 4660) has the following report:
  Botanical Resources Assessment Report – **May 2013**
- Page 411 of exhibit 22 (Electronic page 4693) has the following Table:
  Appendix A - Species List - Table A-1; 2011 /20130514-BotanicalResRpt

- Page 419 of exhibit 22 (Electronic page 4701) has the following Table: Appendix B - Vegetation Impacted – Table B-1; 2011 /**20130514-**BotanicalResRpt
- Page 428 of exhibit 22 (Electronic page 4710) has the following: Appendix C - Vegetation Association Photos; **2005**
- Page 434 of exhibit 22 (Electronic page 4716) has the following APPENDIX E.3 - **2017** Noxious Weed Policy and Classification System (ODA) Exhibit
- Page 448 of exhibit 22 (Electronic page 4730) has the following: APPENDIX F.3 - Oregon Invasive Species Council Action Plan 2017-2019 ; **Updated Feb 14, 2017**
- Page 473 of exhibit 22 (Electronic page 4755) has the following report: APPENDIX G.3 - Report on Zooplankton Sampling Adjacent to the Proposed Jordan Cove LNG Terminal (Shanks et al. **2011**)
- Page 503 of exhibit 22 (Electronic page 4785) has the following report: APPENDIX H.3 - USFWS Final Recovery Plan for the Western Snowy Plover **8-13-2007**

Exhibit 23 - Dredged Material Management Plan (Electronic page 5075): Dated **9-20-2017**

- Page 64 of Exhibit 23 (Electronic page 5138) - APPENDIX A REGULATORY OVERVIEW
- Page 68 of Exhibit 23 (Electronic page 5142) - APPENDIX B MATERIAL CHARACTERIZATION
- Page 78 of Exhibit 23 (Electronic page 5152) - APPENDIX C BORINGS – **Oct 2016**
- Page 114 of Exhibit 23 (Electronic page 5188) - APPENDIX D NAVIGATION RELIABILITY IMPROVEMENTS **9-1-2017**
- Page 124 of Exhibit 23 (Electronic page 5198) - APPENDIX E BENEFICIA USE EXAMPLES
- Page 127 of Exhibit 23 (Electronic page 5201) - APPENDIX F SITES IDENTIFIED AND ELIMINATED FROM FURTHER CONSIDERATION
- Page 140 of Exhibit 23 (Electronic page 5214) - Attachment F: Portland Sediment Evaluation Team (PSET) Letters
- Page 203 of Exhibit 23 (Electronic page 5277) - Attachment F: Portland Sediment Evaluation Team (PSET) Letters **November 22, 2011**

Exhibit 24 - Dredging Pollution Control Plan for Navigation Alterations / Kentuck /APCO sites dated **4-8-2019**
Exhibit 25 - Technical Memorandum dated **June 10, 2019**:
Exhibit 26 - JCEP Response to Removal-Fill Comments Version 2.0 dated **August 30, 2019**:

Jordan Cove's October 14 cover letter states that "JCEP will offer additional argument based upon this evidence before the close of the local record." What if all us citizens did was just dump in a bunch of exhibits into the record without a narrative. This is about not a process when an applicant is allowed to do this and then citizens are given less than two weeks to respond.

1. Environmental contamination on the Jordan Cove property is not fully being evaluated and considered.

JCEP Oct 14 electronic page 5,079 (Exhibit 23 page 5) has the following dredging diagram and text:

Table 1: Preferred Material Management Alternative for Construction Activities

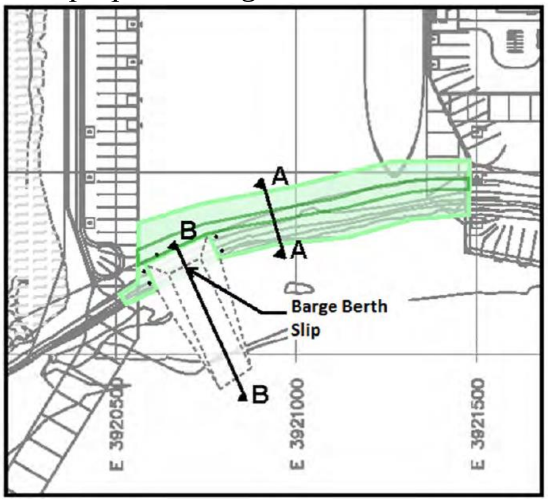
Area	Construction Phase	Volume (mcy)	Placement Location
Freshwater Dredging Phase 1			
Slip	Land-Based Excavation	1.40	LNG Terminal Site
Slip	Dredging in Pocket Behind Berm	2.40	LNG Terminal Site and Roseburg Site
Saltwater Dredging Phase 2			
Access Channel	Dredging from Bay	1.40	LNG Terminal Site and Roseburg Site
Slip	Dredging Natural Earthen Berm	0.20	LNG Terminal Site
		0.30	Kentuck Project Site
TOTAL		**5.70**	
Eelgrass Mitigation Dredging		0.04	APCO Site 1 and 2
Navigation Reliability Improvements		0.59	APCO Site 1 and 2

> *For the slip and access channel, periodic maintenance dredging will consist primarily of silt and clay material, with some sand. The estimated frequency and volume of maintenance dredging is 3 years, with an estimated volume of 115,000 cy per dredging event for the initial 10 years, and an estimated 160,000 cy every five years thereafter. Maintenance dredged material from the access channel, slip and the navigation reliability improvements (a total of between 0.98 and 1.20 mcy over a 30 year planning horizon) would be placed at the upland APCO sites, using a clamshell dredge with either hydraulic or mechanical offloading. However, disposal at the upland APCO sites will require raising the elevations above the existing grade by between 37 and 49 feet.*

It is still not clear as to whether the Oregon International Port of Coos Bay and Jordan Cove have made enough dredge disposal site allowance needed for maintenance dredging as was indicated in a June 8th 2009 and an August 18, 2015 comment letter(s) that were sent to the FERC from the United States Environmental Protection Agency, REGION 10, Seattle, WA 98101-3140.[1] (***See Exhibit 58*** *for the August 2015 letter*.)

[1] http://elibrary.FERC.gov/idmws/file_list.asp?accession_num=20090617-0016 and http://elibrary.FERC.gov/idmws/file_list.asp?accession_num=20150901-0057

JCEP Oct 14 electronic page 5091 (Exhibit 23 page 17) has the following Figure 3-4 of Jordan Cove's proposed Barge Berth:



The barge berth would dredge approximately 45,000 cy of material, which would be permanent as this would eventually become a part of the proposed LNG marine slip.

Jordan Cove Oct 14 electronic page 5096 (Exhibit 23 page 22) states the following:

> ***3.3 Material Characteristics***
> *3.3.1 Slip and Access Channel*
> *Historical boring logs in the vicinity of the slip and access channel were evaluated to provide a preliminary dredged sediment characterization. The available historic subsurface exploration was performed by GRI for Nucor Steel in 1997 (GRI 1997). Additional subsurface exploration was performed by GRI in 2005 and 2007. A more detailed description of the material characterization, boring logs and grain size analyses are provided in Appendix B and Appendix C, respectively.*
>
> *The 1997 boring logs indicate that the material to be dredged consists of medium to very dense sand, fine grained with some gravel (reducing with depth) and trace silt. Borings in 2005 indicate a similar material, with Cone Penetration Tests (CTP) indicating a sand to silty sand. The 2007 borings and CPTs also indicate a similar type of material. Silty to organic / peat lenses were observed in both the 2005 and 2007 site investigations.*
>
> *A comprehensive sediment sampling and analysis plan (SAP) was completed by SHN (SHN, 2007) to characterize dredged sediments within the access channel for physical and chemical parameters. The material was indicated to consist of homogeneous native sands and* ***no areas of visibly contaminated sediments were present.*** (Emphasis added)

THIS IS NOT TRUE as we previously explained in our Oct 14, 2019 comments and also in more detail below.

JCEP October 14 Electronic page 5228 to 5229 (Exhibit 23 page 154 to 155) states the following

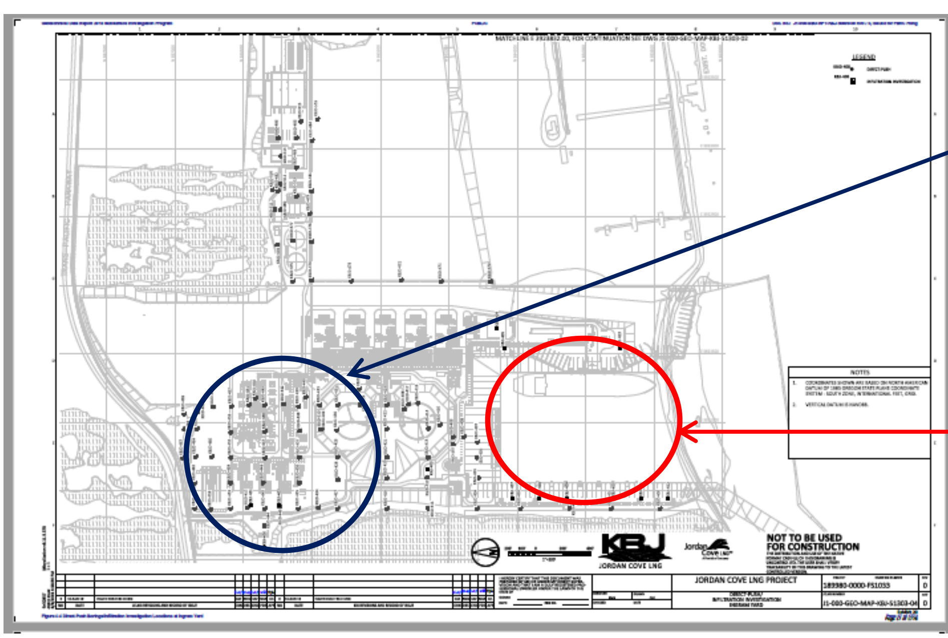
> **JCLNG Sediment Characterization.**
> *In-Bay Sampling, Access Channel and Marine Slip – In October 2006, SHN Consulting Engineers & Geologists, Inc. (SHN) sampled the bayward, estuarine sediments and subsurface sediments (physical characterization only) in the footprint of the JCLNG access channel and outer part of the marine slip. Twenty-one samples (representing approximately 1.9 mcy) were analyzed for grain size and total volatile solids (TVS); the samples were stratified throughout the berth and access channel). The sand content in all 21 samples was >99%; TVS ranged from 0.50 to 2.74% (SHN, 2007). Based on the physical results,* ***no chemical testing was required by the RMT, as documented in their 24 April 2007 suitability determination memorandum****.* (Emphasis added)

JCEP October 14 Electronic page 5226 (Exhibit 23 page 152) states:

> *The northern third of the Ingram Yard site contains ash and sludge with concentrations of polychlorinated biphenyls (Aroclors) detected at up to 89 µg/kg. Phthalates were also detected at concentrations* ***well above the SEF marine SLs*** *(e.g., bis-2-ethylhexyl-phthalate concentrations ranged from 2.7 to 4.9 mg/kg; the SEF marine SL is 1.3 mg/kg) (CH2MHill, 1996).*

Please note where testing was done below:

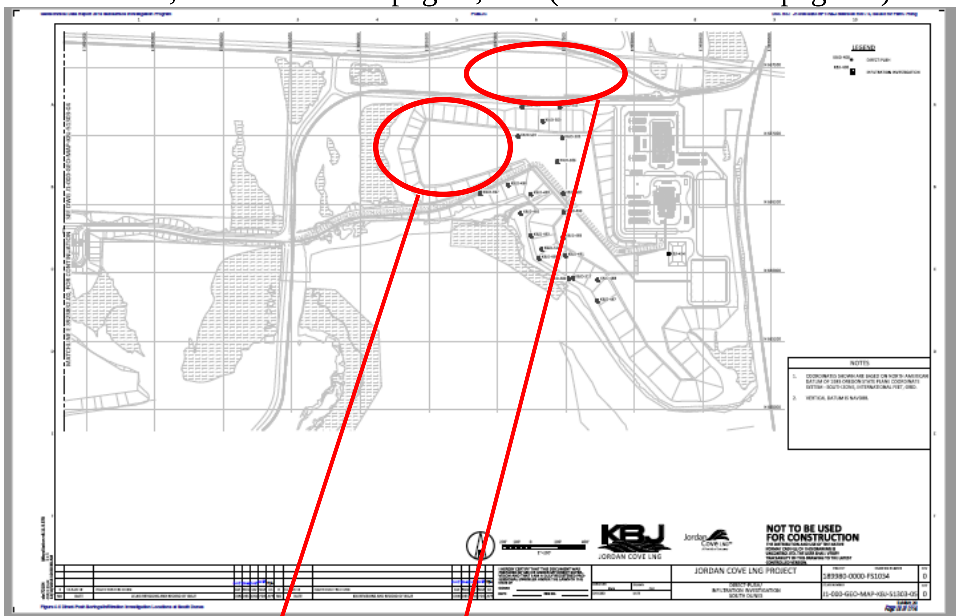
JCEP Oct 14. 2019 electronic page 2,520: (JCEP Exb 20 page 17):



As noted above, contaminated soils were found here in this area where basically no dredging is slated to occur in this area.

No contaminated soils appear to be tested for or found here in this area where 5.7 mcy of dredging is being proposed for JCEP's marine slip. Note the lack of in-depth testing on soils overall.

JCEP Oct 14, 2019 electronic page 2,521: (JCEP Exhibit 20 page 18):



Below are known contaminated landfill sites on the (Weyerhaeuser) Jordan Cove South Dunes property where their proposed worker camp is planned: (***See Exhibit 75***)

What Pembina has planned would be nothing short of another Love Canal for their workers and a death sentence for our Coos Estuary. See Jordan Cove Oct 14 electronic page 5236 (Exhibit 23 page 162) which states:

> ***Existing site grades will be raised a minimum of 3 ft with clean structural fill consisting of sand from the new slip to be excavated on the Ingram Yard property****.* *Development over the existing mill wastewater system settling basins will require over-*

> *excavation of geotechnically unsuitable (highly organic) sludge in the basins and replacement with clean, compacted structural fill. Areas where structures will be seismically designed to minimize settlements will require ground improvement to a depth of about 35 ft below existing site grades to increase the density of the loose to medium dense sand fill. Methods of ground improvement have not been selected, **but could include dynamic compaction or vibro compaction**.* (Emphasis added)
>
> *Material from the onsite settling basins will be dewatered and transported to an open area in the Cell 3 landfill for temporary disposal. the Cell 3 landfill will be covered with a minimum 18 in. of clean sand as an interim measure pending final closure of the landfill. The surface of the solids cake area will be sloped to drain away from the center of the landfill. Spoil from the ground improvement activities in the lowerator and mineral release area will be managed as petroleum-contaminated soil and transported off-site to an approved DEQ-regulated facility. For asbestos containing material (ACM), a minimum of 3 ft of clean sand will be placed over the area with ACM. Any ground improvement completed in the ACM area will likely be completed with dynamic compaction with wet working area; Any ACM excavated will be double bagged in accordance with DEQ asbestos regulations and temporarily disposed of as allowed by permit in landfill Cell 3, or transported to an approved off-site facility. ACM placed in Cell 3 will be covered with a minimum 18 in. of clean sand as an interim measure pending final closure of the landfill.*

Jordan Cove **mistakenly thinks that the Ingram Yard sand is somehow "clean**" when NOTHING COULD BE FURTHER FROM THE TRUTH! As explained previously in testimony submitted on October 14, 2019, a December 16, 2014 letter from Barbara Gimlin, (***See Exhibits 5 & 6***) former Environmental Lead for the Jordan Cove project, addressed to Jeff C. Wright, Director, Office of Energy Projects, at the Federal Energy Regulatory Commission, exposes the fact that the Ingram yard site is contaminated and **proper environmental studies are not being done on the property**. In March 2014, Barbara had been named as the acting Environmental Inspector (EI) for the JCEP Kiewit $15 million exploratory test program conducted at the LNG terminal site on the North Spit of Coos Bay. Work done by Jordan Cove at the Ingram yard site during 2014 under DEQ's, "General NPDES 1200-C Permit for Construction Storm Water Discharges for Pile Test and Ground Improvement Testing Programs," involved clearing done on the property, road building and other work that was extensive and clearly impacted the current ecological environment at the Ingram Yard site. A video clip of contamination that leached into the nearby Henderson Marsh was noted during this time: http://citizensagainstlng.com/wp/wp-content/uploads/2014/12/Henderson-Marsh-on-North-Spit-5-18-2014-MVI_6925.mov

The Ingram Yard property where the Jordan Cove Project is being proposed contains dredging spoils that were dumped there many years ago. When DEQ proposed a "No Further Action" letter for the site they made it clear that there were residual contaminants in the dredge spoils on the land surface, and that it was inappropriate for the material to be placed in waters of the state, and inappropriate to be disposed elsewhere in an unrestricted fashion. If it ever comes to the point where they are actually dredging the material, DEQ will have a roll in approving/disapproving the ultimate fate of where the excavated sediments go. As part of that approval process, DEQ will want to know about the quality of the sediments and where they are planning to put them. There was no testing as to the deeper levels of residual contaminants by DEQ that I am aware of.

Jordan Cove Oct 14 electronic page 5226 (Exhibit 23 page 162) states the following:

> *Roseburg Forest Products (RFP) operates a marine terminal on the north side of the Coos Bay at channel mile 7.9, directly upstream of the proposed JCLNG marine slip and access channel. RFP's berth was evaluated in 1997; concentrations of semi-volatile organic compounds (SVOCs) and tributyltin (TBT)* ***exceeded the regional sediment quality guidelines*** *...*
>
> *... The berth was tested in 2009 and* ***TBT was detected above the SL1*** *in the west part of the berth; discrete re-sampling did not detect TBT and dredging was restricted to the eastern portion of the berth.*

This is the only place in Jordan Cove's Oct 14, 2019 filing that I could even find a reference to tributyltin (TBT) was in the above statements. These compounds were NOT tested for nor were others that are highly likely to be found in Ingram Yard.

CONTAMINATED SOILS WOULD NOT BE A PROPER USE AS FILL FOR THE LNG STORAGE TANKS or THE POWER PLANT or THE GAS PROCESSING FACILITY or THE PROPOSED MANCAMP or THE TRANSPACIFIC PARKWAY REALIGNMENT. These soils are likely to leach contamination into the Bay thus harming marine life and the bay's biological function. WHERE IS THE OVERSIGHT AND ENFORCEMENT THAT WOULD PROTECT THE BAY since it obviously did not occur during the stormwater permitting process? Empty promises by the applicant are no longer good enough.

Past shipping contaminants including Tributyltin (TBT), arsenic, copper, lead, mercury, nickel, zinc, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs) **could be re-suspended into the Coos Bay** harming marine life and businesses that depend on that marine life. (***See McCaffree-CFR Oct 14, 2019 Exhibit 12***) Tidal muds need to be tested prior to any Coos County approval and Jordan Cove's sedimentation plan MUST CONTAIN TESTING FOR ALL POTENTIAL CONTAMINANTS AND CURRENTLY DOESN'T

In 2010, Clausen Oyster Company was hit with a $25,000 fine from the Oregon Department of Environmental Quality for wastewater violations. Clausen maintained that no oyster meat was entering the wash water - just mud that it was washing off the oyster that had just been taken out of the bay. "The mud comes out of the bay; it goes back in the bay," said Lilli Clausen. (***See Exhibit 33***) Despite the fact that the mud had just come out of the bay it was still considered a Clean Water Act violation.

The same scrutiny and oversight should be imposed with respect to the Jordan Cove Project and their proposed placement of fill and/or sedimentation in Waters of the State due to the negative impacts those sediments could have on fishing and recreation.

This should be of particular concern due to the fact that Jordan Cove has ALREADY been sited by the DEQ for violations with respect to their Project for work they were doing on May 8, 2014, at the Jordan Cove Ingram Yard site (***See Exhibit*** 68)

JCEP Oct 14 electronic page 4322 - 4323 (Exhibit 22 page 40 – 41 states):

> * * * *
>
> *3.1.4.5 Chemical and Hydrocarbon Contamination*
>
> *During construction, spills or leaks of hazardous liquids such as fuel or oil associated with construction equipment have the potential to reach surface waters including Coos Bay. Potential effects from a fuel spill would likely be short-term, but could be detrimental to aquatic species within localized spill areas within the estuarine analysis area*
>
> * * * *
>
> *The operation of the LNG Terminal will not require or produce large quantities of hazardous materials.*
>
> * * * *
>
> *In the unlikely event that an accidental spill of LNG were to occur, no effects on marine life are anticipated. LNG is not toxic and, if spilled on water, will vaporize when exposed to the warmer atmosphere and this vapor, being lighter than air, will rise. LNG is not soluble, does not mix with water and will not result in effects to marine life.*
>
> *During the operation of the LNG Terminal, LNG carriers calling on the LNG Terminal could have accidental releases of fuels or other contaminants found on all ships. Since there is no planned bunkering (loading of fuel oils) for the LNG carriers, these spills would be limited to small inadvertent spills of petroleum-based fuels and lubricants from equipment onboard that will be managed according to the carrier's oil spill response plan. These products are kept in relatively small quantities on ships and therefore would not result in the types of volumes associated with a spill from an oil tanker. Depending on the timing, weather conditions, and the efficiency of the response and cleanup, localized adverse impacts may still occur depending on the proximity to aquatic habitat.*
>
> * * * *
>
> *The closest wildlife refuge to the LNG carrier transit route are the islands near Cape Arago located outside the marine analysis area. These islands are part of the Oregon Islands NWR, which extends down the coast south of the Coos Bay harbor entrance. This area is approximately 3 miles from the anticipated LNG carrier transit route and impacts are not anticipated on this area.*

The STATEMENTS ABOVE ARE INCORRECT for several reasons explained in more detail further below:

Jordan Cove Oct 14 electronic page 5128 (Exhibit 23 page 54) shows placement of contaminated soils coming from the proposed Barge Berth and Marine terminal dredging project:

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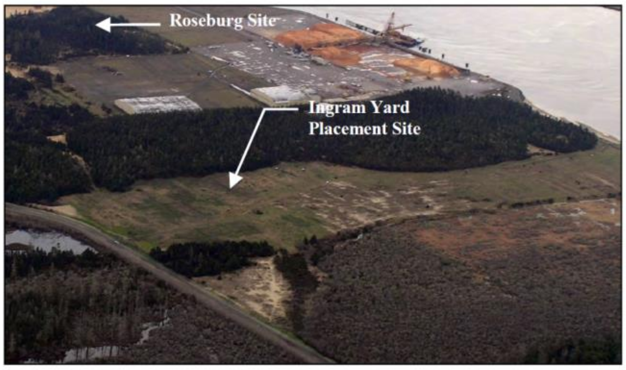


Figure 4-8: Existing Conditions at the Ingram Yard Site

Jordan Cove Oct 14 electronic page 5143 (Exhibit 23 page 69) shows the following examples of borings that have been done on the Jordan Cove property in the area of the proposed marine slip.

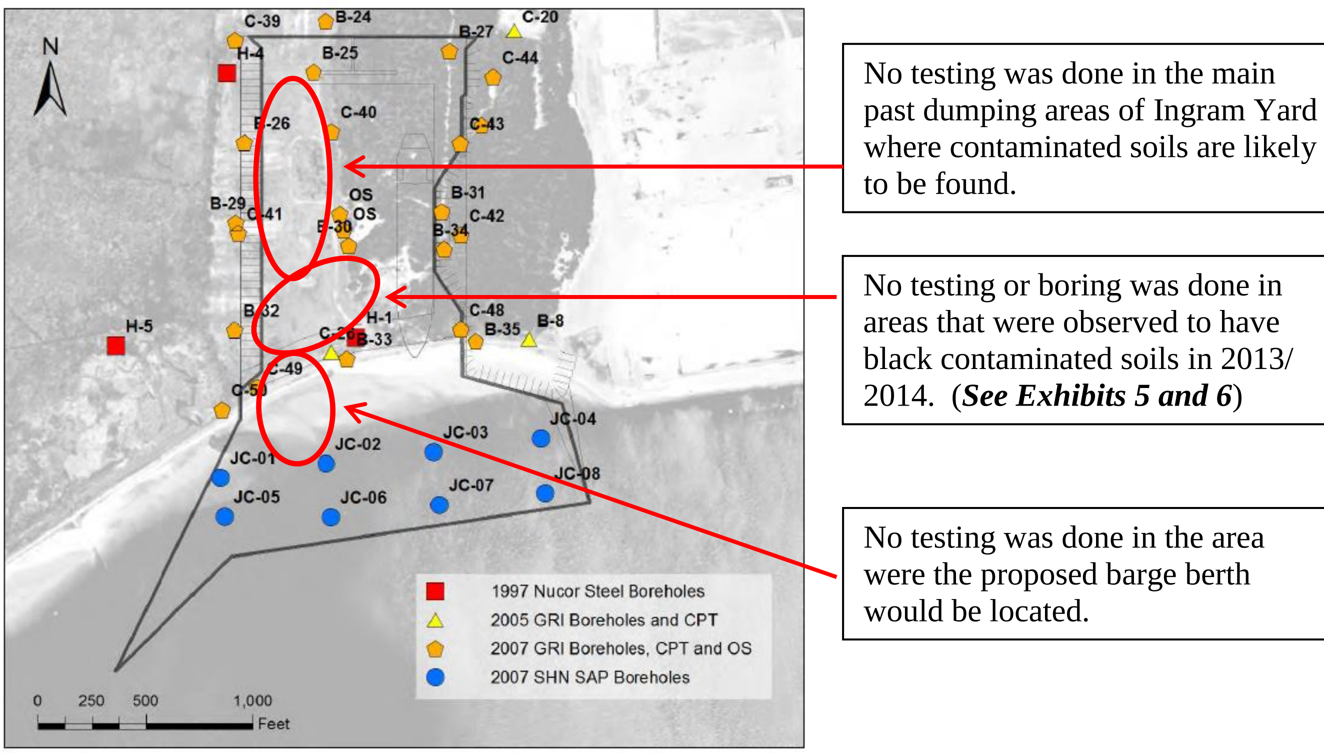


Figure B-1. Historic and Project Geotechnical Sampling Locations (Image Source: USDA, 2012)

The boring that has been done on the property was specific to grain size of the sand found and DID NOT test for a full range of possible contaminates despite contaminated soils being observed on the property in 2013/2014. Nothing was ever done about these soils and no testing has been done as SHOULD BE required and necessary before any dredging or soil removal occurs. ***See Exhibit 6 which states:***

> *The DEQ issued a **partial no further action** letter for both sites on September 15, 2006. Residual contamination remains at the former main mill complex and Ingram Yard sites and the DEQ approved leaving contamination based on the determination that the site*

will remain in commercial/industrial use. For Ingram Yard, the following requirements were noted:

- ***While surface soils at the Ingram Yard site meet human health and ecological screening criteria, they contain low levels of potentially bioaccumulating chemicals and must not be placed in waters of the state.*** *Soils and/or sediments containing residual contamination must be managed or disposed of in accordance with DEQ rules.*

Additional testing, evaluation, and coordination with the DEQ is needed to ensure placement of fill removed from Ingram Yard or any other potentially contaminated sites within the project footprint consists of only clean fill that has been properly tested, due to the project's proximity to Coos Bay. ***The potential release of contaminants into Coos Bay through improper placement of contaminated fill and subsequent release through stormwater or by washing into the bay due to a tsunami would expose fish and marine life to bioaccumulating toxins that would be devastating not only to the fish and marine life, but to humans who could potentially consume them.***

Jordan Cove's Oct 14, 2019 submittal on electronic page 5236 (Exhibit 23 page 162) clearly states:

> *However, while surface soils at the Ingram Yard site meet human health and ecological screening criteria, they contain low levels of potentially bioaccumulating chemicals and must not be placed in waters of the state.*
>
> *The log yard sort debris will be managed as permitted non-hazardous solid waste. The debris will be excavated and removed by truck to the Mill Site landfill Cell 3 for temporary disposal. Sludge at the Ingram Yard will be managed as permitted non-hazardous solid waste. The sludge in the area of the slip and below the footprint of planned industrial facility on and adjacent to Ingram Yard will be excavated and placed in a new soil berm to be constructed adjacent to the rail line along the northernmost portion of Ingram Yard. The sludge in the soil berm will be capped with a minimum of 2 ft of clean sand from the slip excavation. Any excess sludge will be relocated by truck back to the Mill Site landfill Cell 3 for temporary disposal and capped with a minimum 18 in. of clean sand as an interim measure pending final closure of the landfill.*

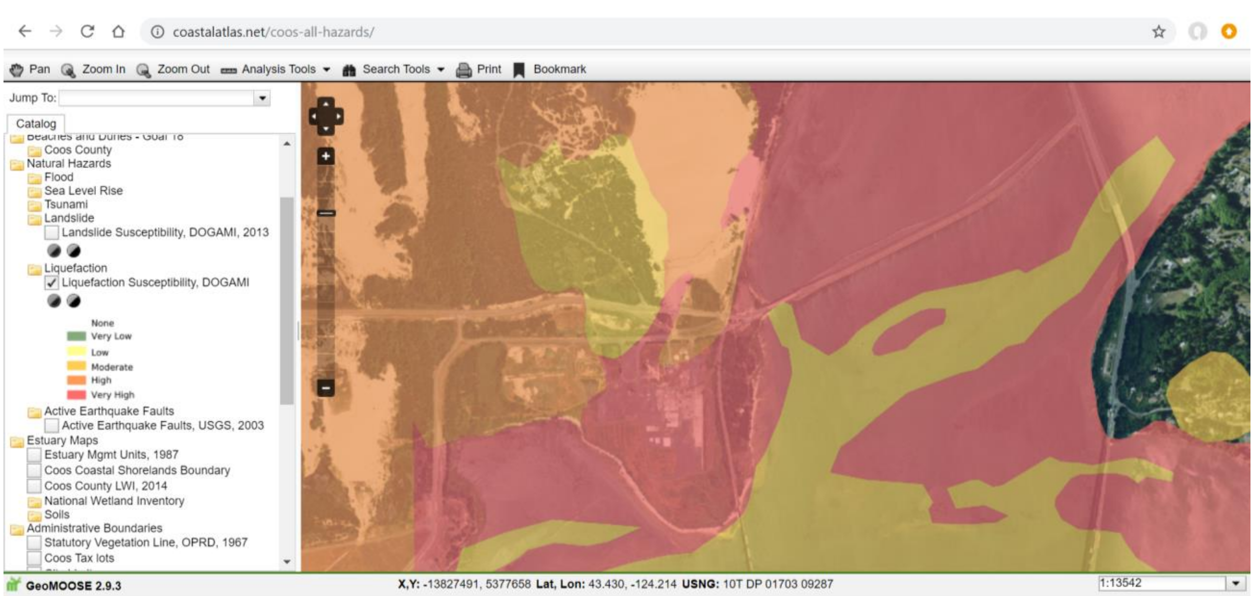
They know the Ingram Yard and South Dunes sites are contaminated below the surface soils but how do they plan to do what they are proposing and keep sediments from going into the water either by wind (airborne) or stormwater runoff? Previously Jordan Cove had plans to remove the contaminated soils to an appropriate land fill site somewhere offsight that has been designed to handle these kinds of bioaccumulating chemical contaminations. I do not see where Jordan Cove has any such plans currently and do not know **how they can have a worker mancamp in an same area where they plan to dump more contaminated soils**? Who will be looking out for the Coos Estuary in this case?. In July of 1999, Nucor Corporation withdrew from purchasing 575 acres of land on the North Spit from Weyerhaeuser in the Ingram Yard area. Nucor purportedly backed out because Weyerhaeuser insisted on transferring all potential liability for past contamination of the property to the buyer.

How can the resource productivity of the Coos Estuary be maintained with this terribly FLAWED AND INADEQUATE DREDGE DISPOSAL PLAN? Findings are not sufficient for this permit to be issued, period!

2. Jordan Cove's Geological Assessment did not consider fill that would be placed on the property prior to facility construction.

The following song comes to mind… *The wise man built his house upon a rock but the foolish company proposed their LNG facility on nothing but sand.* Jordan Cove's Geological Assessments showed no evidence of bedrock. Jordan Cove's Geological Assessments are also based on current static land conditions on the property before any removal-fill. These assessments DO NOT CONSIDER seismic conditions AFTER the proposed placement of fill on the property. This makes the assessments inadequate with respect to earthquake, tsunami and liquefaction conditions with respect to CCZLDO 5.11. In addition, no geological testing was done at all in the area of the propose cement batch plant. I do not see where these reports give Jordan Cove a green light. They must be reviewed by an independent geologist and expert. The Oregon Department of Geology and Mineral Industries has ALREADY questioned Jordan Cove with respect to their project being acceptable in these natural hazard areas. **(*See Exhibit 65*)**

Current Coos County hazard mapping shows very high to high liquefaction hazards at the Ingram Yard and South Dunes property. Jordan Cove's proposed power plant and extremely hazardous liquefaction trains and gas processing facility would not only be built on fill, it would be built in an unacceptable natural hazard location. This violates the spirit and intent of Statewide Planning Goal #7 which prohibits the building of hazardous facilities in known natural hazard areas.



3. Jordan Cove has underestimated hazards and would NOT be in the Public Interest.

In our testimony that was submitted on October 14, 2019, we showed that LNG gas processing facilities and power plants such as is being proposed by Jordan Cove are very hazardous facilities. (***See McCaffree-CFR October 14 Exhibit 11 and 24***) Accidents can and have occurred with rather direr consequences. According to Professor Havens, computer modeling used to predict the Jordan Cove Energy Project (JCEP) LNG export terminal vapor cloud explosion hazards **<u>have not been approved</u>** for predicting explosion overpressures by the U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA). Havens expressed concerns to both the FERC and to the PHMSA that the Government is failing to adequately provide for the risks of potentially devastating Unconfined Vapor Cloud Explosions (UVCEs) of heavier-than-methane hydrocarbons at the proposed Jordan Cove Export Terminal site. **Those hazards appear to be seriously underestimated. (*See McCaffree-CFR October 14 Exhibit 3 and also Oct 14 Exhibits 4 to 10*)**

> *The new Draft Environmental Impact Statement (DEIS) for the Jordan Cove Export Terminal, just issued, **<u>continues to seriously underestimate vapor cloud explosion overpressures (damage) that could occur following credible releases of heavy hydrocarbons at the JCET site</u>**. The latest predictions that I am aware of appear to be an order of magnitude lower than are indicated by physical evidence of numerous documented UVCEs that have occurred worldwide with the potential to cause injuries and deaths to persons and result in destruction of the facility.*
> Jerry Havens, PhD, April 1, 2019 (Emphasis added)

While the FLACS Model used by JCEP designed to predict dispersion has been approved by the PHMSA, the FLACS Model used by JCEP designed to predict vapor cloud explosion overpressures has **<u>not been approved</u>** for such use. The FLACS-Fire Model used by JCEP to calculate fire radiation intensity to ensure that the prescribed radiation limits do not extend beyond the property values **<u>has also not received such approval</u>**. (***See McCaffree-CFR Oct 14 Exhibit 3***)

4. Oysters, Clams, Crabs and Fish would be negatively impacted by the Jordan Cove/Pacific Connector Project

As explained in earlier testimony submitted on October 14, 2019, both Clausen Oysters[2] and Coos Bay Oyster Company[3] (***See Exhibit 7***) have expressed concerns in the past about the potential for turbidity and loss of their commercial oysters from Jordan Cove's dredging activities. Commercial oysters would be at risk as well as populations of Olympia oysters which are protected and not harvested. Page 13 of Jordan Cove's Oct 2017, 404 Application states under item #4 that *"…dredging associated with the navigation reliability improvements and eelgrass mitigation site, will be performed during the ODFW in water work window (October 1 to February 15)*." Electronic page 123 of Jordan Cove's DSL application ALSO states the same thing (See Page 28 of David Evans and Associates Technical Memorandum). **October is the height of the Olympia oyster reproductive cycle[4] and would mean that Olympia oyster spat would be at risk of massive die-off** should dredging occur during this time.

The Oregon DEQ's Integrated Report identifies the Coos Bay Estuary status as Category 5, water quality limited, 303(d) list (in CWA), and Total Maximum Daily Load (TMDL) is needed due to elevated fecal coliform measurements. (ODEQ 2012d).[5] This is also the case for several of the tributaries and rivers that are upstream of the Coos Estuary. On March 11, 2019, Oregon DEQ requested additional information form Jordan Cove which included among other things that the project conduct a benthic macroinvertebrate assessment to comply with the Biocriteria water quality standard (Oregon Administrative Rule 340-0410-0011) (***See Exhibit 3***) On May 6, 2019 the DEQ denied Jordan Cove's application for 401 Water Quality Certification. (***See Exhibit 4***). The Oregon Department of State Lands has also requested additional information from Jordan Cove and recently extended their final decision until Jan. 31, 2020 subject to receiving additional information from the applicant by Oct. 20, 2019.[6] (***See Exhibit 2***)

The Clam Diggers Association of Oregon have already found high levels of contaminants in clams coming from the Coos Bay [7] (***See Exhibit 8***) and Commercial oysters are currently not always able to be harvested due to elevated fecal coliform measurements within the Coos Bay.

Sylvia Yamada, a marine ecologist who has studied native crabs and the European green crab in Oregon and Washington for over 20 years, submitted comments into the DSL record where she stated the following: (***See Exhibit 9***)

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[2] FERC Motion to Intervene Out-of-Time of Clausen Oysters and Lilli Clausen, as in individual and owner, under CP13-483, et. al.: http://elibrary.FERC.gov/idmws/file_list.asp?accession_num=20141015-5087

[3] FERC Motion to Intervene and update Contact Information of Coos Bay Oyster Company / Jack Hampel under CP13-483, et. al.: http://elibrary.FERC.gov/idmws/file_list.asp?accession_num=20150302-5065

[4] "*Settlement Preference and the Timing of Settlement of the Olympia Oyster, Ostrea Lurida, In Coos Bay, Oregon"*, by Kristina M. Sawyer, A Thesis, Presented to the Department of Biology and the Graduate School of the University of Oregon in partial fulfillment of the requirements for the degree of Master of Science, September 2011.

[5] https://www.deq.state.or.us/wq/assessment/rpt2012/results303d12.asp

[6] https://www.oregon.gov/dsl/WW/Pages/jordancove.aspx

[7] Motion to Intervene Out-of-Time Clam Diggers Association of Oregon under CP13-483., et. al.: http://elibrary.FERC.gov/idmws/file_list.asp?accession_num=20140221-5118

…Not only will the turbidity during the construction phase be of concern to the ecological community, the on-going dredging to maintain the berth and shipping channels will continue be a disturbance to the ecosystem. It will result in habitat loss for native species, including the valuable Dungeness crab. In one study between 45 to 85 % of the Dungeness crabs died during a simulated dredging operation (Chang and Levings, 1978). Marine habitat modification by construction of the Jordan Cove Energy Project could impact the important Oregon Dungeness fishery.[8]

JCEP Oct 14 electronic page 5093 (Exhibit 23 page 19)

The Eelgrass Mitigation Site is approximately 9.34 acres in size and is located in the bay at the west end of the Coos Bay-North Bend Airport runway. The proposed mitigation site is located south of the airport's runway extension project, which took place in the 1980s. The proposed mitigation site for the Project is illustrated in Figure 3-6.

5. Mitigation Insufficient / Temporary Dredge Pipeline would impact Eelgrass and other habitat areas.

Jordan Cove's proposed dredging and temporary pipeline would impact eelgrass areas in the lower Coos Bay and natural aquatic areas in the 7-NA and 13B-NA zones. It would also impact zoning districts 6-DA and 14-DA. Jordan Cove has yet to prove a need for their dredging project that outweighs the negative impacts to fishing, recreation and navigation. They have provided no plans to mitigate habitat areas and marine life that would be destroyed in the lower bay by their proposed dredging plans. Jordan Cove's proposed eelgrass mitigation site also lacks sufficient proof that it would be successful and not harm other already productive eelgrass areas.

A March 2019 letter by the Shon Schooler, Ph.D., Research Coordinator with the South Slough National Estuarine Research Reserve states: (***See Exhibit 10***)

We are particularly concerned with the potential impacts to eelgrass (Zostera marina) populations as eelgrass is an important habitat for many estuarine species and improves estuarine water quality. The following comments fit under CBEMP Policy 4: Resource Capability Consistency and Impact Assessment. Eelgrass habitat in the Coos Estuary has experienced a net loss since 2005 (from mapping/GIS methods) and abundance has declined more recently since 2016 (from intertidal field surveys).

[8] Comments of Sylvia B Yamada, Ph.D. in FERC Docket for Jordan Cove – PF-17-4 ;http://elibrary.FERC.gov/idmws/file_list.asp?accession_num=20170622-0008

6. Jordan Cove's Turbidity Modeling Is Flawed

Jordan Cove did not actually do test of the static tidal action with respect to sedimentation transport; they used computer modeling that is obviously severely flawed. The modeling methodology used by Moffatt & Nichols (the contractor hired to do the modeling) is fundamentally flawed for a number of reasons. The most important reason is they treat Coos Bay as a 2D problem when it is in fact 3D due to vertical variability in temperature, salinity, and sediment concentrations in the water column. This will affect how and where suspended sediment is transported by the currents in the bay, it will also affect the concentration of the suspended sediment.

Their flawed modeling makes it look like the sediments will only go a short distance out from the dredging activity when that would NOT be the case. In addition, deepening of the tidal channels actually increases estuarine circulation and suspended sediment concentration (SSC). **(*See Exhibit 59*)**

At what point is a critical amount of dredging performed which raises deposition levels beyond an acceptable criterion? The negative impacts from dredging can sometimes last for many months and even in some cases years (***See Exhibits 60, 61 and 62***)

A covering of less than 50 microns (1/500th of an inch) is enough to impair the attachment of O. lurida larvae to hard substrate. It has long been known that a thin layer of sedimentation impairs the attachment of oyster larvae to hard substrate. According to the U.S. Army Corps of Engineers:

> U.S. Army Corps of Engineers (December 1998) "Technical Note DOER-E2: Environmental Windows Associated with Dredging Operations."
>
> *"Although a thin layer (several mm) of sediments may not be fatal to adult oysters, it may affect reproduction. Because larval oysters require hard substrata for settlement, the presence of even a few millimeters of sediment covering an oyster reef may inhibit larval recruitment (Galtsoff 1964; McKinney et al.1976)."*[9]

Since the resource capabilities of the estuarine zoning districts would be compromised the proposed dredging should NOT BE ALLOWED to occur. There is no mitigation for all these negative impacts and the extent of contaminated soils that Jordan Cove has no plans whatsoever to deal with properly could and most likely would cause irrevocable damage to the Coos Estuary. This would greatly harm impacts to fishing and recreation which is not in compliance with CBEMP Policies 4, 4a, 5 and 5a, among several other CBEMP policies.

7. Jordan Cove did not address Issues with Noise adequately

JCEP Oct 14 electronic page 4321 (Exhibit 22 page 39) states:

3.1.4.4 Acoustic Effects

[9] U.S. Army Corps of Engineers (May 2005) "Sedimentation: Potential Biological Effects of Dredging Operations in Estuarine and Marine Environments."

> *Acoustic effects on marine animals can result from general construction and specific activities such as pile driving and dredging, and these noises can be both in air and in the water…*
>
> *… General construction activities will not produce airborne noises that will exceed the current NMFS regulatory guidance for impacts to marine animals, for example, 100 decibels ("dB") for most marine mammals or 90 dB for harbor seals in air (re: 20 micro(μ)Pascal) (NMFS 2017a), and would likely not even be perceived by those marine mammals that expose their ears to airborne sounds (e.g., seals or sea lions).*

JCEP Oct 14 electronic page 4322 - 4323 (Exhibit 22 page 40 – 41) states:

> *Concurrent with the "in the dry" excavation of the slip, approximately 3,600 pilings and nearly 12,000 sheet piles will also be installed. Nearly all pilings will be separated from the bay by sufficient distance to avoid transfer of excessive noise to either the air or water to affect marine animals*

A 2017 study published in the journal PLOS ONE found that even though oysters do not have ears they react to noise pollution. The oysters in the study reacted most strongly to noises between 10 and 1000 hertz, showing the most sensitivity to sounds between 10 and 200 hertz. As Douglas Quenqua at The New York Times reports, those lower frequencies are often produced by cargo ships, seismic research, wind turbines and pile driving. Higher frequencies created by jet skis and small boats, however, did not seem to bother the animals. (***See Exhibit*** 70)

Marine mammals are particularly sensitive to noise pollution because they rely on sound for so many essential functions, including communication, navigation, finding food, and avoiding predators. An expert panel has now published a comprehensive assessment of the available science on how noise exposure affects hearing in marine mammals, providing scientific recommendations for noise exposure criteria that could have far-reaching regulatory implications.[10] (***See Exhibit 71***)

Once in operation the LNG facility would be extremely noisy also. Each LNG train would have the potential of emitting 124 dBA [11] (***See Exhibit 78***) and there are 5 trains in all not to mention other components of the facility that would be emitting noise. These issues and the impacts that they would have on the surrounding area and habitat have not been properly addressed properly by the applicant.

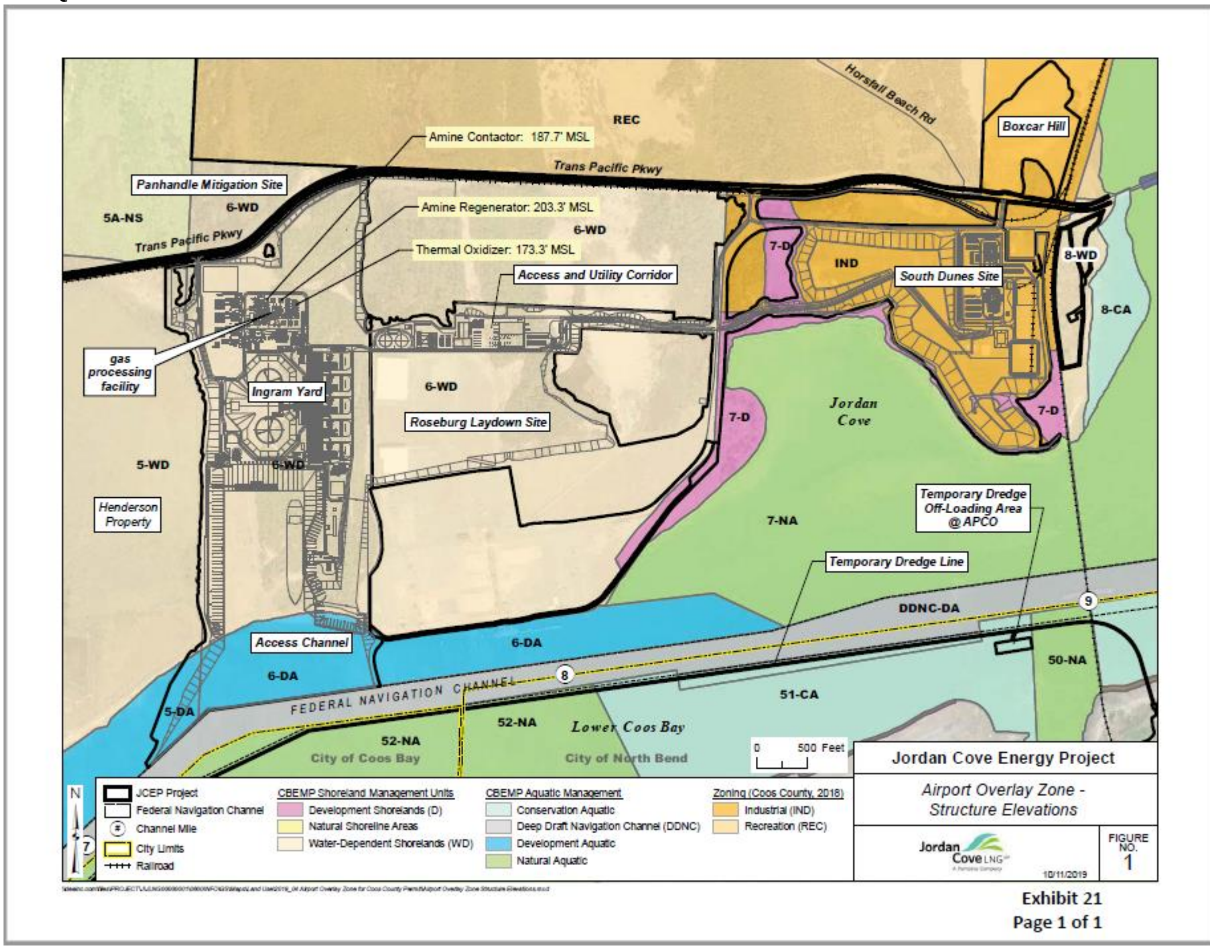
Jordan Cove has provided NO noise assessment into the record with respect to their construction or their proposed facility AFTER it is built.

[10] *Review of noise impacts on marine mammals yields new policy recommendations* https://www.sciencedaily.com/releases/2019/03/190313143307.htm

[11] Report: PNG LNG Project - LNG Facilities - Environmental Noise Impact Assessment 1-15-2009 (See page 27) https://pnglng.com/media/PNG-LNG-Media/Files/Environment/EIS/eis_appendix19.pdf

8. Jordan Cove's Critical Airport Overlay Diagram is Inadequate

JCEP Oct 14, 2019 electronic page 4382 (Exhibit 21) has a diagram that Jordan Cove states is of their Airport Overlay Zone Structure Evaluations. This diagram DOES NOT MEET THE REQUIREMENTS of **CCZLDO SECTION 4.11.400**



JCEP's Oct 14. 2019 diagram above does NOT even show the airport overlay zones and does not provide the information that is required:

CCZLDO SECTION 4.11.400 Southwest Oregon Regional Airport:

***   *   *   ***

CCZLDO SECTION 4.11.420 Definitions:

These definitions only apply to Sections 4.11.400 through 4.11.450, the following words and phrases shall mean:

1. *"Airport" means the Southwest Oregon Regional Airport (also referred to as North Bend Municipal) Airport.*
2. *"Airport direct impact area" means the area located within 5,000 feet of an airport runway, excluding lands within the runway protection zone and approach surface.*
3. *"Airport elevation" The most current and approved North Bend Municipal Airport master plan, airport layout plan, defines the highest point of the airport's usable*

landing area. The 2002 Airport Layout Plan has established the airport elevation as 17.1 feet above mean sea level (reference datum is NAVD 88).

4. *"Airport imaginary surfaces" means imaginary areas in space and on the ground that are established in relation to the airport and its runways. Imaginary areas are defined by the primary surface, runway protection zone, approach surface, horizontal surface, conical surface and transitional surface.*
5. *"**Airport noise impact boundary" means areas located within 1,500 feet of an airport runway or within the most current, established noise contour boundaries exceeding 55 Ldn**. 4. "Airport secondary impact area" means the area located between 5,000 and 10,000 feet from the airport's runways.*

* * * *

CCZLDO SECTION 4.11.425

*Imaginary surface and noise impact boundary delineation: The airport elevation, the airport noise impact boundary, and the location and dimensions of the runway, primary surface, runway protection zone, approach surface, horizontal surface, conical surface and transitional surface is delineated for the airport by the most current, and approved North Bend Municipal Airport master plan and airport layout plan, the airport master plan along with the associated maps and documents are made part of the official zoning map of the city of North Bend and Southwest Oregon Regional Airport Surface (NB/AS) Inventory Map for Coos County. **All lands, waters and airspace, or portions thereof, that are located within these boundaries or surfaces shall be subject to the requirements of this overlay zone**.*

CCZLDO SECTION 4.11.440 Procedures:

An applicant seeking a land use approval in an area within this overlay zone shall provide the following information in addition to any other information required in the permit application:

*1. **A map or drawing showing the location of the property in relation to the airport imaginary surfaces**. The airport authority shall provide the applicant with appropriate base maps upon which to locate the property*

*2. **Elevation profiles and a plot plan, both drawn to scale, including the location and height of all existing and proposed structures, measured in feet above mean sea level (reference datum NAVD 88).***

(Emphasis added)

As we have already stated, Jordan Cove's proposed Amine Contractor, Amine Regenerator and Thermal Oxidizer would place a **CONSIDERABLE HAZARD IN THE FLIGHT PATH OF THE AIRPORT and no one is considering this hazard.**

According to Wikipedia:

Most direct-fired thermal oxidizers operate at temperature levels between 980 °C (1,800 °F) and 1,200 °C (2,190 °F) with air flow rates of 0.24 to 24 standard cubic meters per second.[1]

CCZLDO SECTION 4.11.345 Conformance Requirement:

> ***<u>All structures and uses within the Airport Operations District shall conform to the requirements of Federal Aviation Agency Regulation FAR-77 or its successor, and to other Federal and State laws as supplemented by Coos County Ordinances regulating structure height, steam or dust, and other hazards to flight, air navigation or public health, safety and welfare</u>***.

The FAA has also stated that it is the County's responsibility to deal with airport hazards such as these. (*See Exhibit 74*)

On May 7, 2018 the FAA released 13 determinations of PRESUMED AIRPORT HAZARD with respect to the proposed Jordan Cove Project.[12] Jordan Cove **<u>has not resolved these issues</u>** and they do not appear that they are <u>able to be mitigated</u>. See more information about this further below. (***See Exhibit 11***) Presumed Airport Hazards included but are not limited to the following:

- Amine Regenerator - 2017-ANM-5389-OE
- Oxidizer - 2017-ANM-5388-OE

CCZLDO SECTION 4.11.435 Height limitations on allowed uses in underlying zones:

All uses permitted by the underlying zone shall comply with the height limitations in this section.

*1. **<u>A person may not construct an object or structure that constitutes a physical hazard to air navigation, as determined by the Oregon Department of Aviation in coordination with the governing body with land use jurisdiction over the propert</u>**y.*

2. Subsection (1) of this section does not apply:

a. To construction of an object or structure that is utilized by a commercial mobile radio service provider; or

b. If a person received approval or submitted an application for approval from the

Federal Aviation Administration or the Energy Facility Siting Council established under ORS 469.450 to construct an object or structure that constitutes a physical hazard to air navigation. A variance application will not be required if such application was made.

SECTION 4.11.445 LAND USE COMPATIBLITY REQUIRMENTS:

Applications for land use or building permits for properties within the boundaries of this overlay zone shall comply with the requirements of this section as provided herein:

* * * *

*4. Industrial Emissions. No new industrial, mining or similar use, or expansion of an existing industrial, mining or similar use, shall, as part of its regular operations, **<u>cause emissions of smoke, dust or steam that could obscure visibility within airport approach surfaces</u>**, except upon demonstration, supported by substantial evidence, that mitigation measures imposed as approval conditions will reduce the potential for safety risk or incompatibility with airport operations to an insignificant level. **<u>The review authority</u>***

[12] See Part 8 of Jordan Cove response filing with the FERC that includes the 13 FAA documents: http://elibrary.FERC.gov/idmws/file_list.asp?accession_num=20180510-5165

<u>shall impose such conditions as necessary to ensure that the use does not obscure visibility</u>.

There has been **no thermal plume study provided nor drawings of project components detailed enough to be able to make the above determinations**. We do know that the Amine thermal oxidizer is not only too tall but would be emitting large volumes of emissions as will also the gas flares necessary for safety measures of the Jordan Cove gas processing facility. These gas processing processes are also very noisy but Jordan Cove has not provided any noise impact assessment.

On January 21, 2015, the FAA put out a Memorandum concerning a "*Technical Guidance and Assessment Tool for Evaluation of Thermal Exhaust Plume Impact on Airport Operations.*" [13] (***See Exhibit*** 34)

Pilots in Troutdale, Oregon, have pointed out the hazards of such "heat" plumes in front of airport approach surfaces. An article that came out on April 22, 2015 in the Willamette Week entitled, "*Hot Air*" stated the following: [14] (***See Exhibit 35***)

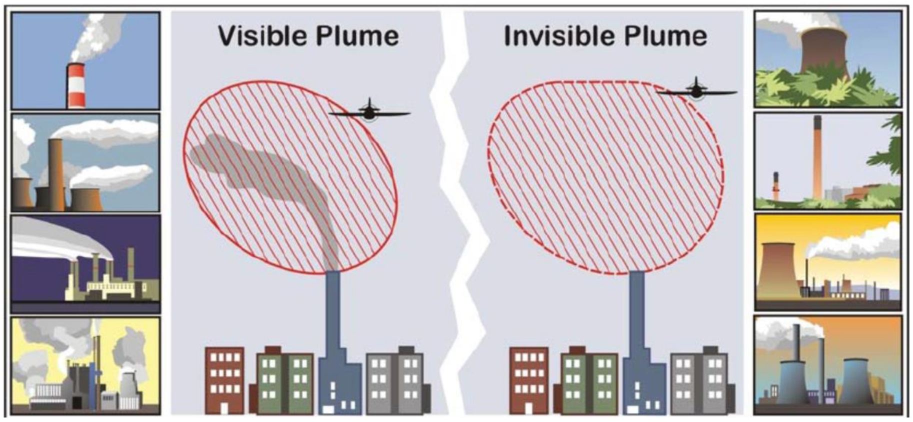
> *…Initially, pilots worried that a power plant at Troutdale would hamper visibility. Gas-fired generating plants work by boiling water to produce steam that drives turbines. When the water is cooled, the steam roiling out of the plant's cooling towers could fog pilots' flight paths and create a hazard.*
>
> ***<u>But the bigger concern now is heat</u>***.
>
> *Earlier this year, the Federal Aviation Administration directed Troutdale users to an independent consulting firm to analyze the potential impact of the invisible plume of hot air that the combustion of gas by the plant would produce.*
>
> *"You're putting a known but invisible hazard right into the path that pilots using Troutdale must fly," says Mary Rosenblum, a Canby resident and president of the Oregon Pilots Association.*
>
> ***<u>Rosenblum says modeling shows the plume could suddenly lift one wing and flip a plane upside down</u>***.
>
> *"This would happen when the plane is 1,000 feet or less off the ground," Rosenblum says. "At that altitude, you cannot recover."*
>
> ***<u>The FAA consultant's initial analysis in March found that the invisible plumes could cause as many as a dozen planes to lose control and crash annually—with fatal consequences. A second run of the same model earlier this month found it could happen even more often</u>***.
> *Risk modeling done for the Troutdale Energy Center in 2013 found no such danger….*

[13] https://www.faa.gov/airports/environmental/land_use/media/Technical-Guidance-Assessment-Tool-Thermal-Exhaust-Plume-Impact.pdf

[14] http://www.wweek.com/portland/article-24594-hot_air.html

(Emphasis added)

FIG 7–5–2
Plumes



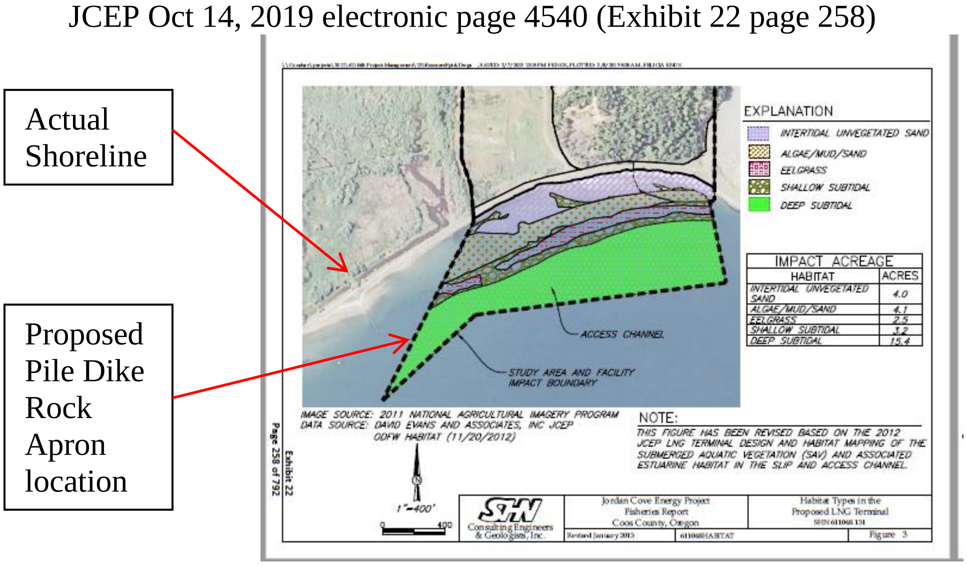
(***See Exhibits 36 and 37***)

The FAA has already determined these gas processing structures **<u>are presumed airport hazards</u>** and since they have clearly stated this to be the case and have also stated that decisions concerning thermal plumes are to be made at the local planning level fully considering their bulletins, there is no other option for the County except to deny the application for safety reasons and for violations of the Coos County Ordinance with respect to airport safety.

In addition, the feed gas for Jordan Cove's proposed gas processing facility would cross directly in the path of the airport approach overlay and due to the high pressure of the proposed Pacific Connector pipeline would have a hazard radius of 800 to 1,000 feet, which clearly would impact the airport transitional zone. (***See Exhibit 64***)

9. Pile Dike Rock Apron and Barge Berth removal-fill would harm Habitat areas, Navigation, Fishing and Recreation.

JCEP Oct 14, 2019 electronic page 4540 (Exhibit 22 page 258)



The proposed Pile Dike Rock Apron **would not be shoreline stabilization** as Jordan Cove has suggested and Jordan Cove has NOT proven that it would not *adversely impact the wetland drainage in the southwest shoreline portion of the district* as required under the 5-DA zoning district. This area as previously shown in our October 14, 2019 testimony is a high habitat area.

JCEP Oct 14, 2019 electronic page 4620 (Exhibit 22 page 338 to 339) states:

> ***Winter Waterfowl***
> *Coos Bay is the largest estuary wholly within Oregon and supports thousands of waterfowl in winter. On average, nearly 6,000 geese, swans, and ducks are recorded annually on the Coos Bay Christmas Bird Count (Table 6). The primary potential impact of the Project on wintering waterfowl would be associated with a marine accident in which a large quantity of oil is spilled. As the LNG ships are not oil tankers and carry only those quantities of oil for fueling the engines, the likelihood of impacts from LNG shipping is remote.* ***Creation of the slip and turning basin actually would increase potential habitat for diving ducks and other deep-water species***

Table 6. Ten-year average numbers of waterfowl on the Coos Bay Christmas Bird Count, 1996-2005. Data obtained from http://audubon2.org/birds/cbc/hr/count_table.html.

Species	Individuals
Greater White-fronted Goose	1.2
Emperor Goose	0.1
Snow Goose	0.7
Brant	9.4
Cackling Goose*	16.5
Canada Goose**	388.8
Tundra Swan	0.6
Wood Duck	22.6
Gadwall	159.1
Eurasian Wigeon	2.1
American Wigeon	1,358
Mallard	441.3
Blue-winged Teal	0.1
Cinnamon Teal	0.1
Northern Shoveler	38.2
Northern Pintail	320.9
Green-winged Teal	395.7
Unidentified duck	267.3
Canvasback	33.7

Species	Individuals
Redhead	2.5
Ring-necked Duck	34.4
Greater Scaup	159.1
Lesser Scaup	63.5
Unidentified scaup	99.5
Harlequin Duck	9.5
Surf Scoter	484.3
White-winged Scoter	94
Black Scoter	8.9
Unidentified scoter	33.5
Long-tailed Duck	3.2
Bufflehead	914.1
Common Goldeneye	15.9
Barrow's Goldeneye	0.3
Hooded Merganser	16.5
Common Merganser	2.6
Red-breasted Merganser	50.2
Ruddy Duck	154
All species combined	5,602.4

*Cackling Goose is a two-year average, 2004-2005.
**Canada Goose numbers before 2004 include Cackling Goose.

> ***Wading Birds and Shorebirds***
>
> *The estuarine habitats on and adjacent to the project area are used consistently by a wide variety of species in this guild. Dredging and development of shoreline and tidal mudflats for the project would eliminate some habitat for these species and, while insignificant on their own, would contribute to cumulative effects. The removal of 5.6 acres of intertidal unvegetated mud flat and 6.1 acres of algal flats (12 acres of mudflat)*

would be a direct impact that would need to be considered. ***A mitigation plan has been developed by the Port of Coos Bay to compensate for the loss of this habitat***

* * * *

The LNG terminal site will have limited habitat remaining on the property that will be attractive to migratory bird species. This lack of favorable habitat likely will not cause migratory species to be attracted to the LNG terminal site, further reducing the likelihood of interaction with the LNG storage tanks (the tallest structures at the terminal)….

….The LNG storage tanks will not be illuminated with high-intensity lighting. The intensity and number of lights will be limited to what is required for security and operations. Due to the limited amount of suitable habitat present on the LNG terminal site, the lack of scientific literature reporting birds striking storage tanks, and the low-intensity lighting to be used, the likelihood of adverse effects on migratory birds from collisions with the LNG storage tanks is probably low.

JCEP Oct 14, 2019 Exhibit 22 Page 342 states:

Migratory Bird Treaty Act
The MBTA prohibits the killing of any native bird from the egg stage onward. Thus, active nests of native birds are protected and project implementation may not destroy nests directly or cause nest failure indirectly without mitigation. The construction phase of the project represents by far the greatest risk of violating this law.

Jordan Cove has not followed these rules previously concerning this issue of harming migratory birds so why would we believe that they would follow these rules now? Jordan Cove has already harmed migratory birds and their habitat and did not follow their own *Draft Migratory Bird Conservation Plan* that was uploaded to the FERC on February 13, 2015 under FERC Docket CP13-483-000 and submittal 20150213-5269 [15]

On May 18, 2014, contaminated water was observed leaching into the Henderson Marsh wetlands on this day [16] during the same time Jordan Cove was out on their property doing soil testing work, road building and various other clearing and construction activities under a DEQ 1200C stormwater permit. This 1200C stormwater permit was issued prior to the FERC Draft EIS and the release of the Draft Migratory Bird Conservation Plan for the Jordan Cove/Pacific Connector Project. On Feb 13, 2015 when Jordan Cove finally did filed their "***Draft Migratory Bird Conservation Plan,***" under FERC Docket CP13-483-000, the plan stated among many other things that:

*"**Direct mortality of adult birds, juveniles and eggs can occur when ground disturbances including shrub and tree removal occur during the nesting period**. Mechanical operations such as mowing, tilling, seeding, and harvesting are well-known sources of direct bird mortality in agricultural fields... ...**Mortality of forest-nesting***

[15] http://elibrary.ferc.gov/idmws/file_list.asp?accession_num=20150213-5269

[16] http://citizensagainstlng.com/wp/wp-content/uploads/2014/12/Henderson-Marsh-on-North-Spit-5-18-2014-MVI_6925.mov

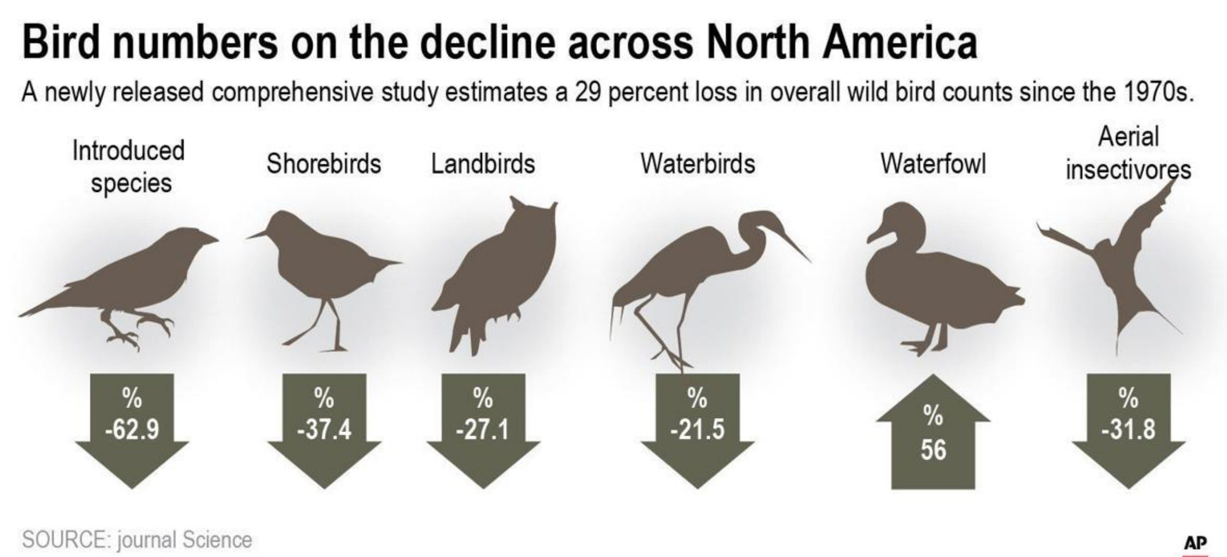
species has been estimated due to logging during breeding periods *(Hobson et al., 2013)."* [17] (Emphasis added)

Unfortunately, this very activity was allowed to occur in a migratory bird habitat area during the months of April - June of 2014 under a general 1200C stormwater permit that was issued to Jordan Cove. Also according to Jordan Cove's 2-13-2015 Draft Migratory Bird Conservation Plan:

> "*all vegetation clearing at the LNG terminal would be conducted* ***prior to*** *March 1 or after August 31* ***to ensure that most, if not all nesting birds have fledged***." (page 42) (Emphasis added)

This is a prime example of why FERC should not be allowing Jordan Cove and Pacific Connector to submit applications for various other permits and certifications prior to the completion of the EIS process and the issuance of a formal record of decision by the FERC which would complete the NEPA process. We requested this in December of 2012 but our letter was ignored.[18] As our 2012 letter explains, while the preparation of a new EIS is underway, FERC has specific responsibilities under NEPA relating to actions by the applicant during the interim.

According to a new study birds have been disappearing at an alarming rate including shorebirds. Experts say **habitat loss was the No. 1 reason for bird loss**. (***See Exhibit 69 and Exhibit 76***)



According the American Bird Conservancy:[19]

> *To put it another way, we've lost a more than a quarter of our birdlife since 1970. These findings were reported in the world's leading scientific journal, Science, by researchers at seven institutions, including American Bird Conservancy….*

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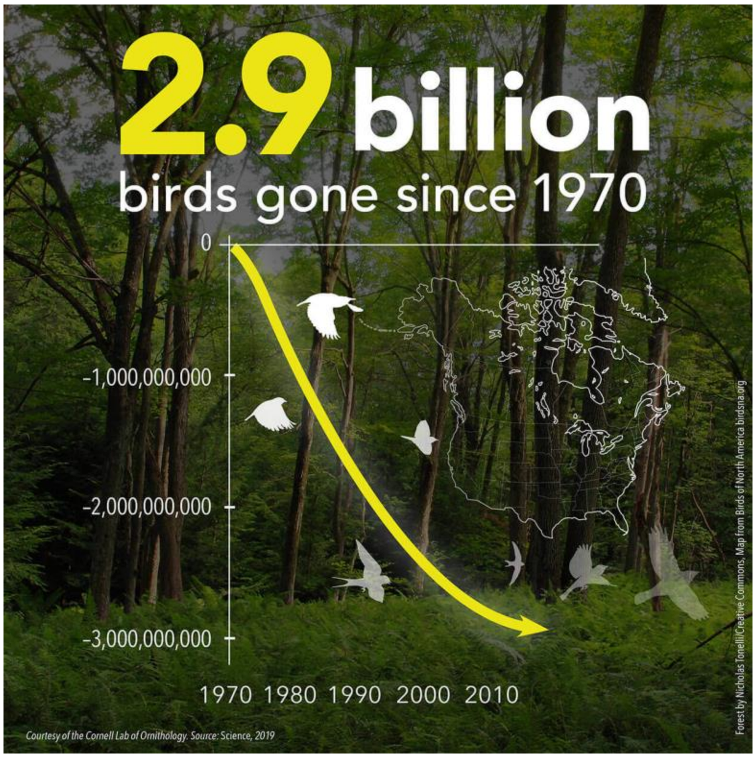
[17] http://elibrary.FERC.gov/idmws/file_list.asp?accession_num=20150213-5269 - page 34
[18] http://elibrary.ferc.gov/idmws/file_list.asp?accession_num=20121218-0008
[19] https://abcbirds.org/3-billion-birds/#homepage



A number as big as 2.9 billion is hard to fathom. It can help to view it as a balance sheet. Each year, many birds produce young while many others die. But since 1970, on balance, many more birds have died than have survived, resulting in 2.9 billion fewer breeding birds today.

Some ecosystems show steeper losses than others. For example:

- *Forests alone have lost 1 billion birds since 1970.*
- *Grassland birds are also hard hit, with a 53% reduction in population — more than 720 million birds.*
- *Aerial insectivores — birds like swallows, nighthawks, and flycatchers — are down by 32%, or 160 million.*
- ***Coastal shorebirds, already at dangerously low numbers, lost more than one-third of their population.*** (Emphasis added)
- ***The volume of spring migration, measured by radar in the night skies, has dropped by 14% in just the past decade***. (Emphasis added)

There is a growing need to restore these bird habitat areas NOT destroy more of them. On October 14, 2019 we showed photo evidence of clams and sand shrimp that **are not being properly mitigated** in the area of Jordan Cove's proposed Pile Dike Rock Apron, barge berth and marine terminal.

In addition, this area is one of the best areas for fishing and crabbing areas in the entire estuary as was explained in our October 14, 2019 comments. Hundreds of recreational boaters can be seen in this area at certain times of the year. (***See Exhibits 38 and 42***)

10. Cement Batch Plant and Boxcar Hill Camping Area problems remain

In response to Todd Goergen's comments submitted on Oct 14, 2019 concerning the location of the Oregon Dunes Sand Park, LLC. Mr. Goergen confirms the statements made at the hearing by Steve Miller concerning the location of Jordan Cove's proposed cement batch plant and laydown area would destroy the current Boxcar hill campground area. Obviously Mr. Goergen has finally signed agreements with Jordan Cove for an undisclosed amount of dollars for the takeover of the current Boxcar hill campground area. (***See Exhibit 43***) Jordan Cove's submittal into the North Bend land Use proceeding referenced by Steve Miller at the hearing also shows the exact location of what Jordan Cove is proposing. (***See Exhibit 79***) Mr. Goergen makes the following statement in his Oct 14, 2019 comments:

> *ODSP intends to relocate and expand campground facilities up to a total of 277 campsites on a portion of our lands lying north of the proposed Boxcar Laydown Area. Please see attached Coos County Planning Zoning Compliance Letter # 19-306.*

Goergen's letter **proves** that Jordan Cove's proposed polluting and noisy cement batch plant would not be a compatible use as is required under CCZLDO 4.3.220:

CCZLDO Section 4.3.220 *Additional Conditional Use Review Standards for uses, development and activities listed in table 4.3.200*

* * * *

(6) Industrial (IND) and Airport Operations (AO)

* * * *

(f) Conditional Use Review Criteria - The following criteria only apply to Use, Activity or Development identified as a conditional uses in the zoning table:

> *i. COMPATIBILITY: The proposed USE, ACTIVITY OR DEVELOPMENT **is required to demonstrate compatibility with the surrounding properties** or compatibility may be made through the imposition of conditions. **Compatibility means that the proposed use is capable of existing together with the surrounding uses without discord or disharmony**. The test is where the proposed use is compatible with the existing surrounding uses and not potential or future uses in the surround area.*

It is unclear why Mr. Goergen did not provide a zoning compliance letter for his proposed sand park under ACU-17-009 (***See McCaffree-CFR Oct 14 exhibits 21 and 2***2) In any event Jordan Cove's proposed laydown area and cement batch plant would harm recreational opportunities for thousands of tourist and recreation enthusiast who visit the Dunes National Recreation Area all throughout the year. (***See Exhibit s72 and 73)***

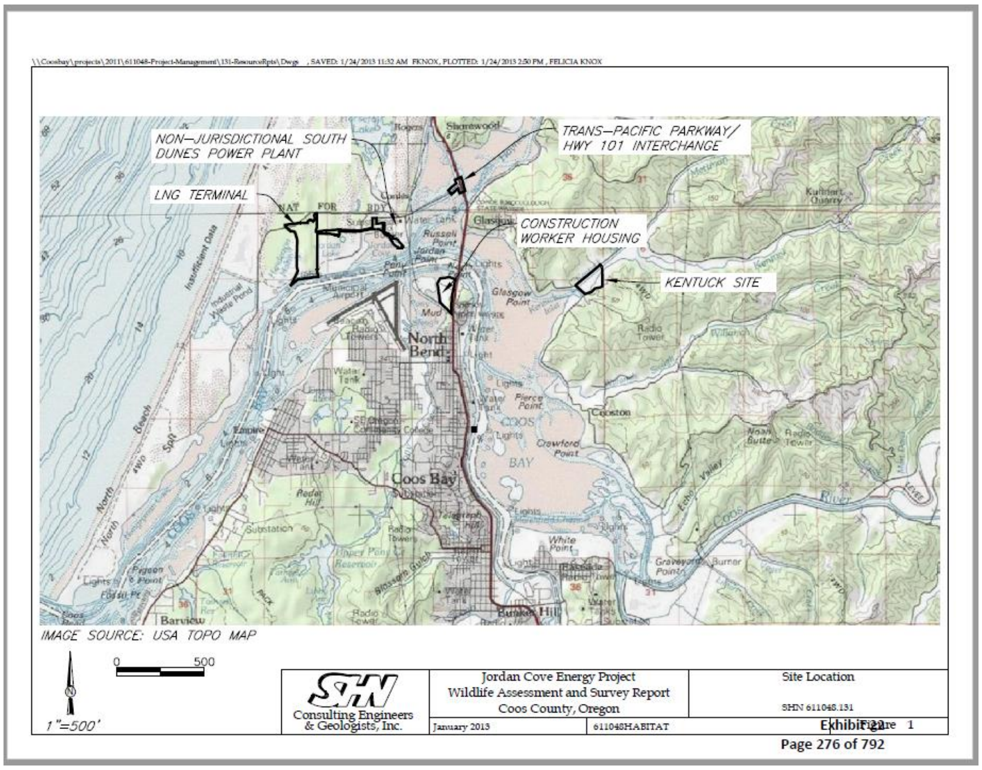
Tourism spending accounted for 3,300 jobs in Coos County in 2017[20]. Those jobs would be negatively impacted as would also jobs in fishing, clamming, crabbing and oyster growing by the Jordan Cove project. (***See Exhibits 38 to 42***) For more details on this please see the comments that we submitted on Oct 14. 2019.

[20] http://www.deanrunyan.com/doc_library/ORImp.pdf

11. Inconsistencies and/or lacking data

In addition, Jordan Cove's Botantical Resources Assessment Reports and tables do not include Jordan Cove's proposed Cement Batch Plant or Boxcar Hill laydown area for impacts.

JCEP Oct 14, 2019 electronic page 4558 shows workforce housing back under the bridge in North Bend and a power plant in the area of the proposed Safety and Resource center or very close to it ? …?



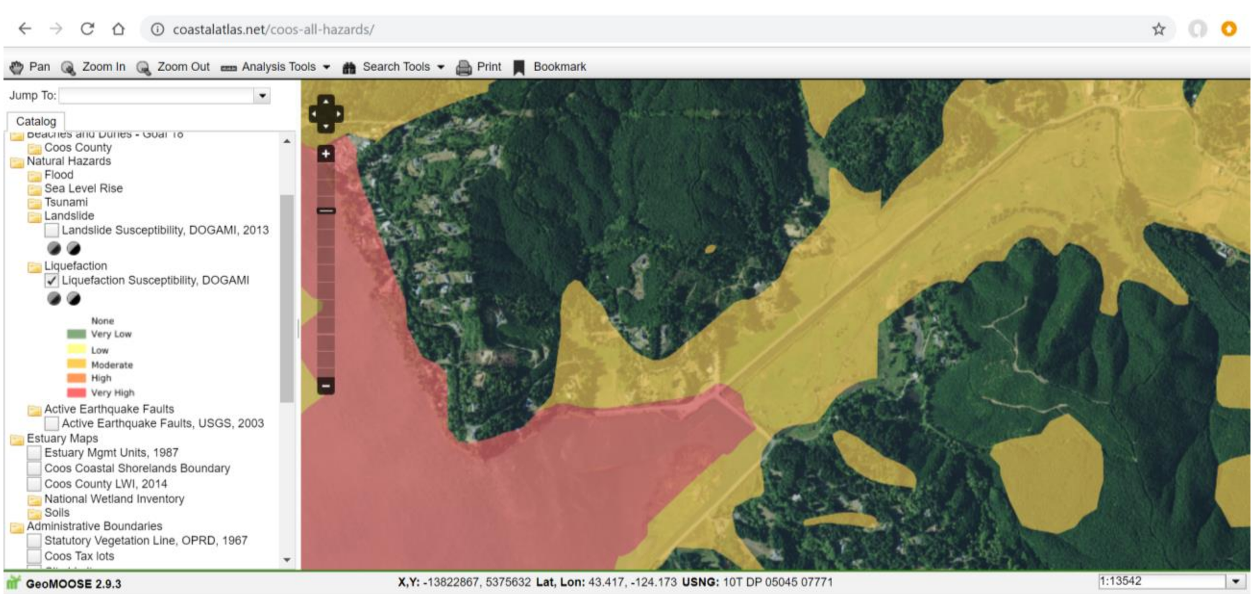
The Diagram dated January 2013 show Jordan Cove's man camp under the bridge in North Bend and their Power plant where their Safety and Security center is currently planned or very close to it. Why is it that the applicant is allowed to continually use incomplete and possibly outdated data and we are scolded when we do? If this is not outdated data then WHY hasn't Jordan Cove been honest about their plans since they would have known about them **since 2013**? Why have they not shown us the elevation drawings that are required for compliance with the Southwest Oregon Regional Airport? This should have been filed AT THE TIME OF THE APPLICATION not as their Rebuttal comments when we will have not chance to respond. This makes a complete mockery of the land use process.

Jordan Cove proposed Worker mancamps would negatively impact housing, medical and public safety services. Rent and housing prices would increase along with negative impacts on are already stretched thin medical and public services. Residents in North Bend have already been forced to pay an additional $30 per month on their monthly waterbill in order to pay for necessary local public services of police and fire. Housing is already a problem in the area with a clear lack of sufficient affordable housing. Jordan Cove would only make that problem worse. (***See Exhibits 49 to 51***)

12. Kentuck Mitigation Plan – dumping of dredging spoils impacts

Jordan Cove's Oct 14 2019 submittal page 5313 (Exhibit 24 page 32) has a diagram of all the plans Jordan Cove has for the former Kentuck golf course property. Barbara Gimlin in the past has pointed out that improper hydrology studies were being done by Jordan Cove and their dumping and flooding project would be highly likely to cause increased flooding in the inlet. (***See Exhibit 66***) At the hearing on December 18, 2015, Barbara Gimlin, former Jordan Cove Environmental lead, testified as to the flooding issues **that are already occurring on Kentuck Slough** to the North of the East Bay Drive due to Main Rock's placement of fill next to the Slough without proper hydrology studies and approvals. Jordan Cove's Feb 2, 2014 Supplement to Technical Memorandum – Tsunami Hydrodynamic Modeling report (***See Exhibit 67***) clearly shows the upland stream impacts from placing fill on the North Spit property. Fresh water wetlands and habitat already existing at the Kentuck Golf course mitigation site would be lost along with existing habitats currently located there. These impacts are not being mitigated properly. By the looks of the diagram on Jordan Cove's Oct 14 submittal electronic page 5319 (Exhibit 24 page 38) there is a lot of fill that is going to be placed on the Kentuck property. Who determines if this fill is actually free of contaminants or if this fill would stay in the places where they are proposing to place it with the continually ingress and egress of the tidal cycle? There needs to be an independent review by a hydrologist in order to determine if Jordan Cove's continually plans for this Kentuck property are even viable and if the flooding could cause increased flooding up the inlet.

What about liquefaction impacts in the inlet when Cascadia subduction event occurs off our Coastline? Where are the geological studies showing the proposed fill would not liquefy?



13. Jordan Cove LNG Project has Not Proven that a Need exists for their LNG project.

As was explained in detail in comments submitted on October 14, 2019, the Jordan Cove project has provided no sign contracts showing a contractual need for their project. Gas Industry

Reports do now show that the project has an international need. (***See Exhibit McCaffree-CFR Oct 14, 2019 Exhibit 28***) (***See also Exhibit 56***) Pembina is all about using the Jordan Cove LNG project to get their Canadian gas to the world as Oregonian's expense and hazard risk. (***See Exhibit 54***) There are other better suited siting locations for LNG terminals up in Canada that could have better meet their needs. Jordan Cove DID NOT consider other locations for their LNG terminal or other locations for their gas processing facility since these processes are not necessarily water dependent. (***See Exhibit 53***) The U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration ("PHMSA"), in coordination with the Federal Railroad Administration ("FRA"), has published a notice of proposed rulemaking ("NPRM") to authorize the transportation of LNG by rail in DOT-113 specification tank cars. (***See Exhibit 77***) LNG could be made at a safer location away from populated areas and transported by rail thus eliminating the need for a pipeline and for impacts to the Coos Estuary and the Coastal Zone. If Jordan Cove was allowed to proceed the project would be the state's largest CO_2 polluter. (***See Exhibit 55)*** Raising atmospheric CO_2 levels has all kinds of negative impacts on our fishing, crabbing and oyster growing industries. (***See Exhibits 44 to 48***) Jordan Cove does not properly address these impacts that would directly affect the resource productivity of the Coos Estuary.

Conclusion

For the reasons discussed above and those detailed previously, please deny the Jordan Cove application.

Sincerely,

/s/ Jody McCaffree

Jody McCaffree

Index for Exhibits

October 28, 2019
McCaffree / Citizens For Renewables / CALNG
For Jordan Cove / Pacific Connector
HBCU-19-003

<u>Exhibit 1</u>: October 17, 2019 e-mail notice from Coos County Planning Dept.

<u>Exhibit 2</u>: April 10, 2019 DSL *Overview of Decision Process and Need for Additional Information request* issued to Jordan Cove Re: DSL Removal-Fill Permit Application No. 60697-RF. **NOTE**: *On Sept. 13, DSL received a request for an extension from Jordan Cove LNG to extend the DSL permit decision date to Jan. 31, 2020. DSL responded to the applicant approving the extension, subject to receiving additional information from the applicant by Oct. 20, 2019 per* https://www.oregon.gov/dsl/WW/Pages/jordancove.aspx

<u>Exhibit 3</u>: March 11, 2019, Oregon DEQ request for additional information from the Jordan Cove Project which included, among other things that the project conduct a benthic macroinvertebrate assessment to comply with the Biocriteria water quality standard (Oregon Administrative Rule 340-0410-0011).

<u>Exhibit 4</u>: May 6, 2019 News Release of the DEQ denial of Jordan Cove's application for 401 Water Quality Certification.

<u>Exhibit 5</u>: December 16, 2014 Public Comment by **Barbara Gimlin** on Jordan Cove Energy Project, L.P., Draft Environmental Impact Statement expressing concerns with respect to **contaminated soils on the Jordan Cove property** under CP13-483-000 via CP07-444-000.

<u>Exhibit 6</u>: February 13, 2015 Public Comment by **Barbara Gimlin** on Jordan Cove Energy Project, L.P., DEQ Water Quality permit process under FERC CP13-483-000.

<u>Exhibit 7</u>:

- Oct 15, 2014 Motion to Intervene Out of Time by **Clausen Oyster Company and Lilli Clausen** expressing concerns with **pipeline and sediment impacts to their Oysters**
- Feb 28, 2015 Motion to Intervene Out of Time by **Coos Bay Oyster Company and Jack Hampel** expressing concerns with **pipeline and sediment impacts to their Oysters**.

<u>Exhibit 8</u>: Feb 21, 2014 **Motion to Intervene Out of Time by Clam Diggers Association of Oregon** expressing concerns with LNG project **sedimentation and estuary impacts on clams**

<u>Exhibit 9</u>: ***Potential Impact of Jordan Cove LNG Terminal construction on the Nursery Habitat of Dungeness crab*** by Sylvia Yamada Ph.D. January 2019 for DSL and oral comment outline provided on January 15, 2019 under APP0060697 at Salem Hearing.

<u>Exhibit 10</u>: Letter from Shon Schooler, Ph.D., Research Coordinator with the South Slough National Estuarine Research Reserve concerning Eelgrass (March 2019)

<u>Exhibit 11</u>: May 7, 2018 the Federal Aviation Administration (FAA) issued 13 NOTICES OF PRESUMED HAZARD on components of the Jordan Cove LNG project

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Exhibits 12 to 32 were included in with former comments filed on October 14, 2019

Exhibit 33: ***DEQ hits Clausen Oysters with $25,000 fine*** By Gail Elber, Staff Writer Aug 25, 2010https://theworldlink.com/news/local/deq-hits-clausen-oysters-with-fine/article_9fb57e0c-b070-11df-8cc0-001cc4c03286.html

Exhibit 34: FAA Memorandum Re: "***Technical Guidance and Assessment Tool for Evaluation of Thermal Exhaust Plume Impact on Airport Operations";*** January 21, 2015

Exhibit 35: ***"Hot Air"*** Pilots say the Port of Portland's plans to sell land for a power plant next to the Troutdale Airport include a fatal flaw; April 22, 2015; Willamette Week http://www.wweek.com/portland/article-24594-hot_air.html

Exhibit 36: *"**Position Paper - Safety Concerns of Exhaust Plumes**"* -Prepared by: Federal Aviation Administration - Airport Obstructions Standards Committee Working Group; July 8, 2014

Exhibit 37: Potential Flight Hazards 8-22-13 AIM: *"7-5-15. **Avoid Flight in the Vicinity of Thermal Plumes (Smoke Stacks and Cooling Towers)"***

Exhibit 38: September 6, 2014 Newspaper **Ad announcing the 15th annual Coos Basin Salmon Derby** in Coos Bay, Oregon Sept 13 & 14th 2014

Exhibit 39: South Coast Basin - **Flow Restoration Priorities** for Recovery of Anadromous Salmonids in Coastal Basins

Exhibit 40: September 15, 2015 Jordan Cove Final EIS under CP13-483-000 et al pages 4-370 to 4-739 having to do with **Ballast Water**

Exhibit 41:

- North Spit listing in"**Top 10 Beach Strolls**" Sunset Magazine, Vol. 219, Issue 4, October 2007
- Coos Bay, Oregon listing in **50 Best Places to Live National Geographic Adventure Magazine** - September 2008

Exhibit 42: ***After a year of planning, Coos Bay has new marine patrol boat dock*** by KCBY; Wednesday, March 16th 2016; https://kcby.com/news/local/after-a-year-of-planning-coos-bay-has-new-marine-patrol-boat-dock

Exhibit 43: June 24, 2015 Letter from attorney's Motschenbacher and Blattner LLP concerning **Jordan Cove leasing the Boxcar Hill Campground**.

Exhibit 44: Study outlines threat of ***ocean acidification to coastal communities in the U.S***.; Oregon State University; Feb 23, 2015 http://today.oregonstate.edu/archives/2015/feb/study-outlines-threat-ocean-acidification-coastal-communities-us

Exhibit 45: ***Vulnerability and adaptation of US shellfisheries to ocean acidification****;* By Julia A. Ekstrom; Lisa Suatoni; Sarah R. Cooley; Linwood H. Pendleton; George G. Waldbusser; Josh E. Cinner; Jessica Ritter; Chris Langdon; Ruben van Hooidonk; Dwight Gledhill; Katharine Wellman; Michael W. Beck; Luke M. Brander; Dan Rittschof; Carolyn Doherty; Peter Edwards; and Rosimeiry Portela; Perspective in Nature Climate Change; Published on-line – Feb 2015

Exhibit 46: ***Oysters on acid: How the oceans's declining pH will change the way we eat*** ; By H. Claire Brown; November 28th, 2017; https://newfoodeconomy.org/ocean-acidification-oysters-dungeness-crabs/

Exhibit 47: -Omitted-

Exhibit 48: Williams CR, Dittman AH, McElhany P, et al. ***Elevated CO2 impairs olfactory-mediated neural and behavioral responses and gene expression in ocean-phase coho salmon (Oncorhynchus kisutch)***. Glob Change Biol. 2018;00:1–15. https://doi.org/10.1111/gcb.14532 November 2018

Exhibit 49: "***Northwest B.C.'s LNG boom is already a bust for some***" (with video) *Heated economy drives up prices and drives out tenants;* By Gordon Hoekstra, Vancouver Sun November 5, 2014
http://www.vancouversun.com/business/energy/Northwest+boom+already+bust+some/10326811/story.html?__lsa=0882-6c5e

Exhibit 50: ***"B.C. LNG work camps concern for northern towns, say mayors"***
Two northern B.C. mayors share their city's struggle with the impending influx of temporary workers; By Radio West, CBC News Posted: Feb 02, 2015
http://www.cbc.ca/news/canada/british-columbia/b-c-lng-work-camps-concern-for-northern-towns-say-mayors-1.2938393

Exhibit 51: *Dark side of the Boom"* By Sari Horwitz; The Washington Post; Sept 28, 2014
http://www.washingtonpost.com/sf/national/2014/09/28/dark-side-of-the-boom/

Exhibit 52: November 12, 2014 notice from the Brotherhood of Electrical Workers 932 that covers proposed Jordan Cove subsistence fees for workers.

Exhibit 53: Alternative LNG terminal locations

Exhibit 54: ***Pembina Pipeline's new purpose: Get Canada's oil and gas to the rest of the world*** ;By Claudia Cattaneo; February 16, 2018;
http://business.financialpost.com/commodities/energy/pembina-pipelines-new-purpose-get-canadas-oil-and-gas-to-the-rest-of-the-world

Exhibit 55: ***Jordan Cove LNG and Pacific Connector Pipeline Greenhouse Gas Emissions Briefing***; Oil Change International; Jan 2018;

http://priceofoil.org/2018/01/11/jordan-cove-lng-and-pacific-connector-pipeline-greenhouse-gas-emissions/

Exhibit 56: Select pages from ***IGU 2018 World LNG Report*** - 27th World Gas Conference Edition

Exhibit 57: ***Current Removal-Fill Permit Applications*** in Coos County – Not a complete listing

Exhibit 58: August 18, 2015 **letter from United States Environmental Protection Agency Region 10** - concerning maintenance dredging disposal availability.

Exhibit 59: *The impact of channel deepening and dredging on estuarine sediment concentration* D.S. vanMaren n, T.vanKessel, K.Cronin, L.Sittoni - Coastal and Marine Systems 95(2015)1–14 Deltares, Delft, the Netherlands

Exhibit 60: ***The effects of marine gravel extraction on the macrobenthos: Results 2 years post-dredging*** A.J. Kenny, H.L. Rees ; Marine Pollution Bulletin ; Volume 32, Issues 8–9, August–September 1996, Pages 615-622
https://www.sciencedirect.com/science/article/pii/0025326X96000240?via%3Dihub

Exhibit 61: ***Seagrasses, Dredging and Light in Laguna Madre, Texas, U.S.A.***
Christopher P. Onuf - National Biological Survey, National Wetlands Research Center, Campus Estuarine, Coastal and Shelf Science; Volume 39, Issue 1, July 1994, Pages 75-91
https://www.sciencedirect.com/science/article/pii/S027277148471050X?via%3Dihub

Exhibit 62: ***Dredging related metal bioaccumulation in oysters***
L.H. Hedge , N.A. Knott, E.L. Johnston; Marine Pollution Bulletin; Volume 58, Issue 6, June 2009, Pages 832-840
https://www.sciencedirect.com/science/article/pii/S0025326X09000472?via%3Dihub

Exhibit 63: ***Shell shock*** , June 14, 2010, By Nate Traylor, Staff Writer - The World
http://theworldlink.com/news/local/shell-shock/article_389a9be8-77dc-11df-9127-001cc4c03286.html

Exhibit 64:
***A MODEL FOR SIZING HIGH CONSEQUENCE AREAS ASSOCIATED WITH NATURAL GAS PIPELINES** - TOPICAL REPORT* Prepared by Mark J. Stephens,
C-FER Technologies, Oct 2000

Exhibit 65:
November 6, 2017 **DOGAMI comments related to Geologic Hazards** and the Proposed Jordan Cove LNG terminal and Pacific Connector Gas Pipeline.

Exhibit 66:
January 11, 2015 Public Comment by Barbara Gimlin, ***Intertidal Flats Mitigation Proposed for Kentuck Slough*** - Jordan Cove Energy Project Joint Permit Applications
U.S. Army Corps of Engineers/Oregon Department of State Lands

Exhibit 67:
Supplement to Technical Memorandum - ***Jordan Cove LNG Facility Tsunami Hydrodynamic Modeling*** – January 24, 2014

Exhibit 68: June 25, 2014 DEQ Warning letter issued to Jordan Cove for violations that occurred at the Ingram Yard property on May 8, 2014, along with the follow-up that also occurred.

Exhibit 69: ***Where have the wild birds gone? Study counts 3 billion fewer than 1970, stunning scientists*** By Seth Borenstein and Christina Larson AP Science Writers
Sep 19, 2019 https://theworldlink.com/news/science/where-have-the-wild-birds-gone-study-counts-billion-fewer/article_a626eed1-2063-52e5-9e5e-a6c7a903f593.html

Exhibit 70: *Even Without Ears, Oysters Can Hear Our Noise Pollution* Study shows that certain frequencies of noise cause oysters to clam up; By Jason Daley; smithsonian.com; October 27, 2017; https://www.smithsonianmag.com/smart-news/earless-oysters-can-still-hear-our-noise-pollution-180966990/

Exhibit 71: *Review of noise impacts on marine mammals yields new policy* Review of noise impacts on marine mammals; March 13, 2019 ;
https://www.sciencedaily.com/releases/2019/03/190313143307.htm

Exhibit 72: Oregon Dunes National Recreation Area map and guide
https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd595822.pdf

Exhibit 73: *UTVs to 'takeover' Box Car Hill this weekend* NICHOLAS A. JOHNSON - The World Jun 27, 2019

Exhibit 74: Communications with the FAA.

Exhibit 75: Diagram of Weyerhaeuser Land Fill areas on South Dunes property.

Exhibit 76: BIODIVERSITY LOSS Decline of the North American avifauna
Kenneth V. Rosenberg1,2*, Adriaan M. Dokter1, Peter J. Blancher3, John R. Sauer4, Adam C. Smith5, Paul A. Smith3, Jessica C. Stanton6, Arvind Panjabi7, Laura Helft1, Michael Parr2, Peter P. Marra8; SCIENCE 366, 120–124 (2019) – Oct 4, 2019

Exhibit 77: *PHMSA Proposes LNG Transportation by Rail Rule* Posted on Oct 23, 2019 by LNG Law Blog: https://www.lnglawblog.com/2019/10/phmsa-proposes-lng-transportation-by-rail-rule/

Exhibit 78: Select pages from the Papua New Guinea Liquefied Natural Gas P NG LNG Project LNG Facilities Environmental Noise Impact Assessment - January 15, 2009
https://pnglng.com/media/PNG-LNG-Media/Files/Environment/EIS/eis_appendix19.pdf

Exhibit 79: Page 2,435 from Jordan Cove's Rebuttal submitted to the City of North Bend on 6-10-2019 under File No. FP4-19/CBE 5-19 Concurrent Land Use Application.

Revised Index for Exhibits

For October 14, 2019 filing
McCaffree / Citizens For Renewables / CALNG
For Jordan Cove / Pacific Connector
HBCU-19-003

NOTE: Exhibits 1 to 11 were inadvertently uploaded from another file and do not coincide with the Oct 14, 2019 Index but do apply with respect to CBEMP Policy 5 Public Interest determination.

Exhibit 1: Ref for Index for Exhibits submitted by McCaffree-CFR on July 9, 2019

Exhibit 2: May 10, 2018 Coast Guard Letter of Recommendation (LOR) for the Jordan Cove LNG Project under CP17-495.

Exhibit 3: Testimony and Exhibits submitted by Professor Jerry Havens to the PHMSA and FERC

Exhibit 4: Communication with the Coast Guard concerning LNG hazards.

Exhibit 5: Highlights of United States Government Accountability Office, Report to Congressional Requesters, Maritime Security; "*Public Safety Consequences of a Terrorist Attack on a Tanker Carrying Liquefied Natural Gas Need Clarification*", February 2007; GAO-07-316: http://www.gao.gov/new.items/d07316.pdf

Exhibit 6: U.S. Department of Energy "*Liquefied Natural Gas Safety Research* "Report to Congress May 2012; http://energy.gov/sites/prod/files/2013/03/f0/DOE_LNG_Safety_Research_Report_To_Congre.pdf

Exhibit 7: SANDIA REPORT "*Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water"*; Mike Hightower, Louis Gritzo, Anay Luketa-Hanlin, John Covan, Sheldon Tieszen, Gerry Wellman, Mike Irwin, Mike Kaneshige, Brian Melof, Charles Morrow, Don Ragland; SAND2004-6258; Unlimited Release; Printed December 2004;

Exhibit 8: "*Understanding the Stoll Curve*"; Oberon 2005; http://csaz462.ca/data/1/rec_docs/102_Oberon_WP_Understanding_the_Stoll_Curve.pdf

Exhibit 9: "*An Assessment of the Potential Hazards to the Public Associated with Siting an LNG Import Terminal in the Port of Long Beach"* - Dr. Jerry Havens, September 14, 2005

Exhibit 10: *"LNG and Public Safety Issues – Summarizing Current Knowledge about Potential Worst Case Consequences of LNG spills onto water"*. Jerry Havens, Coast Guard Journal Proceedings, Fall 2005

Exhibit 11: *WILLIAMS COMPANIES FAILED TO PROTECT EMPLOYEES IN PLYMOUTH LNG EXPLOSION* The natural gas company eyeing other Northwest projects has a history of unsafe work conditions. Author: Tarika Powell; June 3, 2016

Exhibit 12: May 21, 2010 and **Sept 17, 2007 testimony from Ron Sadler** placed into Jordan Cove and Pacific Connector Conditional Land Use Permit processes in Coos County concerning **sedimentation impacts in the Coos Estuary**.

Exhibit 13:

- ODFW – **Threatened / Endangered Species List** http://www.dfw.state.or.us/wildlife/diversity/species/threatened_endangered_candidate_list.asp
- **NOAA – Oregon Coast Coho protected species:** http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/salmon_and_steelhead_listings/coho/oregon_coast_coho.html
- **NOAA - Green Sturgeon protected species:** http://www.westcoast.fisheries.noaa.gov/protected_species/green_sturgeon/green_sturgeon_pg.html
- **NOAA – Pacific Eulachon protected species** http://www.westcoast.fisheries.noaa.gov/protected_species/eulachon/pacific_eulachon.html
- **ESA listed Marine Mammals** http://www.westcoast.fisheries.noaa.gov/protected_species/marine_mammals/esa.html
- **ESA listed Sea Turtles** http://www.westcoast.fisheries.noaa.gov/protected_species/sea_turtles/marine_turtles.html
- **Point Reyes bird's-beak** – Oregon Dept of Agriculture - Endangered http://www.oregon.gov/oda/shared/Documents/Publications/PlantConservation/CordylanthusMaritimusPalustrisProfile.pdf

Exhibit 14:

- Evidence of Shell's Sakhalin II LNG project in Russia and the Environmental Impacts to Avina Bay along with devastating upland impacts.
- Pipeline Impacts from Shell's Sakhalin II LNG project in Russia
- Fortune article "Shell shakedown" By Abrahm Lustgarten, Feb 1, 2007

Exhibit 15:

- Nation & World - ***Ocean salmon seasons in jeopardy off southern Oregon;*** Originally published March 5, 2018; The Associated Press https://www.seattletimes.com/nation-world/ocean-salmon-seasons-off-southern-oregon-coast-in-jeopardy/
- ***West Coast senators join call for salmon disaster declaration****;* Saphara Harrell - The Umpqua Post; Jun 13, 2017 http://theworldlink.com/news/local/west-coast-senators-join-call-for-salmon-disaster-declaration/article_3690f87f-44b8-5f19-a385-7557776543b0.html

<u>Exhibit 16</u>: **Oregon Shorebird Festival Bird List** Compiled from all field trips August 26-28, 2011

<u>Exhibit 17</u>: ***7,500 songbirds killed at Canaport gas plant in Saint John*** - Migrating birds, some possible endangered species, flew into gas flare CBC News Posted: Sep 17, 2013 http://www.cbc.ca/news/canada/new-brunswick/7-500-songbirds-killed-at-canaport-gas-plant-in-saint-john-1.1857615

<u>Exhibit 18</u>: The Irish Times - ***Gas flaring at Corrib plant 'frightening', says resident*;** Jan 1, 2016 ; By Lorna Siggins; http://www.irishtimes.com/news/ireland/irish-news/gas-flaring-at-corrib-plant-frightening-says-resident-1.2482377

<u>Exhibit 19</u>: Zoning Information for JCEP proposed dredging / fill sites within the Coos Estuary

<u>Exhibit 20</u>: November 27, 2017 Oregon LUBA-No. 2016-095 *Oregon Shores vs Coos County* Final Opinion and Order

<u>Exhibit 21</u>: March 9, 2017 Coos County file No. ACU-17-009 application for extended RV park at Boxcar Hill camping area.

<u>Exhibit 22</u>: Coos County File No. ACU-17-009 Notice of Decision and Staff Report for extended RV park at Boxcar Hill camping area.

<u>Exhibit 23</u>: Dec 4, 2018 letter to the FERC under Docket Nos. CP17-494-000 and CP17-495-000 adding to Service list Natalie Eades, Manager, Environment, Jordan Cove Energy Project L.P. Pacific Connector Gas Pipeline, L.P**.** **/** contact NEades@pembina.com

<u>Exhibit 24</u>:

- Articles about the 2004 LNG Explosion in the Algeria Liquefaction Industrial Zone.
- Five killed in Connecticut power plant blast February 7, 2010 10:06 p.m. EST

<u>Exhibit 25</u>: ***Geology of the Coos Estuary and Lower Coos Watershed*** from Partnership for Coastal Watersheds Report https://www.partnershipforcoastalwatersheds.org/geology-of-the-coos-estuary-and-lower-coos-watershed/

<u>Exhibit 26</u>: ***13-Year Cascadia Study Complete – And Earthquake Risk Looms Large*** http://oregonstate.edu/ua/ncs/archives/2012/jul/13-year-cascadia-study-complete-%E2%80%93-and-earthquake-risk-looms-large

<u>Exhibit 27</u>: Select pages from ***The Oregon Resilience Plan Reducing Risk and Improving Recovery for the Next Cascadia Earthquake and Tsunami***; Report to the 77th Legislative Assembly from Oregon Seismic Safety Policy Advisory Commission (OSSPAC); Feb 2013

<u>Exhibit 28</u>: Industrial Energy Consumers of America "***Excessive Liquefied Natural Gas (LNG) Exports To NFTA Countries Are Not In The Public Interest And Increase Natural Gas And Electricity Prices To Consumers***" - January 30, 2019

<u>Exhibit 29</u>: ***Limitations of the Haynes Inlet sediment transport study*** by Tom Ravens, Ph.D., Professor, Dept. of Civil Engineering University of Alaska, Anchorage

<u>Exhibit 30</u>: U.S. Coast Guard ***July 1, 2008, Water Suitability Assessment (WSA) Report*** for the Jordan Cove project.

<u>Exhibit 31</u>: ***Coos Bay Harbor Safety Plan*** by Coos Bay Harbor Safety Committee, February 2018

<u>Exhibit 32</u>: ***Coos Bay Channel Entrance - Distances and Buoy Markings***. Proximity of Channel Buoys to the Shoreline.

<u>Exhibit 49</u>: "***Northwest B.C.'s LNG boom is already a bust for some***" (with video) *Heated economy drives up prices and drives out tenants;* By Gordon Hoekstra, Vancouver Sun November 5, 2014
http://www.vancouversun.com/business/energy/Northwest+boom+already+bust+some/10326811/story.html?__lsa=0882-6c5e

<u>Exhibit 50</u>: ***"B.C. LNG work camps concern for northern towns, say mayors"***
Two northern B.C. mayors share their city's struggle with the impending influx of temporary workers; By Radio West, CBC News Posted: Feb 02, 2015
http://www.cbc.ca/news/canada/british-columbia/b-c-lng-work-camps-concern-for-northern-towns-say-mayors-1.2938393

<u>Exhibit 69</u>: ***Where have the wild birds gone? Study counts 3 billion fewer than 1970, stunning scientists*** By Seth Borenstein and Christina Larson AP Science Writers
Sep 19, 2019 https://theworldlink.com/news/science/where-have-the-wild-birds-gone-study-counts-billion-fewer/article_a626eed1-2063-52e5-9e5e-a6c7a903f593.html

<u>Exhibit 70:</u> *Even Without Ears, Oysters Can Hear Our Noise Pollution* Study shows that certain frequencies of noise cause oysters to clam up; By Jason Daley; smithsonian.com; October 27, 2017; https://www.smithsonianmag.com/smart-news/earless-oysters-can-still-hear-our-noise-pollution-180966990/

<u>Exhibit 71</u>: *Review of noise impacts on marine mammals yields new policy* Review of noise impacts on marine mammals; March 13, 2019 ;
https://www.sciencedaily.com/releases/2019/03/190313143307.htm

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<u>Exhibit 73</u>: *UTVs to 'takeover' Box Car Hill this weekend* NICHOLAS A. JOHNSON - The World Jun 27, 2019

<u>Exhibit 74</u>: Communications with the FAA.

Exhibit 75: Diagram of Weyerhaeuser Land Fill areas on South Dunes property.

Exhibit 76: (Also filed as Exhibit 3) Testimony and Exhibits submitted by Professor Jerry Havens to the PHMSA and FERC on

Exhibit 77: (Also filed as Exhibit 11) *WILLIAMS COMPANIES FAILED TO PROTECT EMPLOYEES IN PLYMOUTH LNG EXPLOSION* The natural gas company eyeing other Northwest projects has a history of unsafe work conditions. Author: Tarika Powell; June 3, 2016

From: Crystal Orr – Coos County Planning Dept
Sent: Tuesday, October 15, 2019 8:56 AM
To: mccaffrees@frontier.com
Cc: Planning Department
Subject: RE: HBCU-19-003 filing

Jody,

You are correct ☺ Those are the exhibits that made it prior to the deadline. See you later today.

Thank you,

Crystal Orr

Crystal Orr, Planning Specialist
Coos County Planning Department
225 N. Adams (physical address)
250 N. Baxter (mailing address)
Coquille, OR 97423

Exhibit 1

From: Crystal Orr – Coos County Planning Dept
Sent: Thursday, October 17, 2019 3:01 PM
To: 'Jody McCaffree'
Subject: Hello

Jordan Coves submittal is online now.

Thank you,

Crystal Orr

Crystal Orr, Planning Specialist
Coos County Planning Department
225 N. Adams (physical address)
250 N. Baxter (mailing address)
Coquille, OR 97423

Exhibit 2

Oregon
Kate Brown, Governor

Department of State Lands
775 Summer Street NE, Suite 100
Salem, OR 97301-1279
(503) 986-5200
FAX (503) 378-4844
www.oregon.gov/dsl

State Land Board

Kate Brown
Governor

Bev Clarno
Secretary of State

Tobias Read
State Treasurer

April 10, 2019

RL600/60697
JORDAN COVE ENERGY PROJECT, L.P.
ATTN DERIK VOWELS
111 SW 5TH AVE, STE. 1100
PORTLAND OR 97204

Re: DSL Removal-Fill Permit Application No. 60697-RF
Jordan Cove Energy Project, Multiple Counties

Dear Mr. Vowels:

The Oregon Department of State Lands' (Department) 60-day public review period has closed for the above-referenced permit application. Public comments submitted and other investigative work by the Department have raised various issues for which the Department needs additional information.

Overview of Decision Process and Need for Additional Information

Specific applicable portions of the Department's Oregon Administrative Rules (OAR) in the narrative below in order to help Jordan Cove Energy Project, L.P. (Jordan Cove) understand the Department's permit decision process and why the additional information is needed.

OAR 141-085-0550 addresses the level of documentation used by the Department to make decisions:

- Section (4) provides that "The applicant is responsible for providing sufficient detail in the application to enable the Department to render the necessary determinations and decisions. The level of documentation may vary depending upon the degree of adverse impacts, level of public interest and other factors that increase the complexity of the project."
- Section (7) provides that "The Department may request additional information necessary to make an informed decision on whether or not to issue the authorization."

The Department analyzes a proposed project using the factors and determination criteria set forth in Oregon Revised Statute (ORS) 196.825 and OAR 141-085-0565. The applicant bears the burden of providing the Department with all information necessary for the Department to consider the factors and make the determinations.

- Section (1) of the OAR provides that "The Department will evaluate the information provided in the application, conduct its own investigation, and consider the comments submitted during the public review process to determine whether or not to issue an individual removal-fill permit."

- Section (2) of the OAR provides that "The Department may consider only standards and criteria in effect on the date the Department receives the complete application or renewal request." This application was deemed complete for public review and comment on

December 6, 2018. OAR 141 Division 85 contains the standards and criteria that will be considered throughout the review of this application.

- Section (3) of the OAR provides that "The Department will issue a permit if it determines the project described in the application:
  - (a) Has independent utility;
  - (b) Is consistent with the protection, conservation and best use of the water resources of this state as specified in ORS 196.600 to 196.990, and
  - (c) Would not unreasonably interfere with the paramount policy of this state to preserve the use of its waters for navigation, fishing and public recreation."

- Section (4) of the OAR provides that "In determining whether to issue a permit, the Department will consider all of the following:
  - (a) The public need for the proposed fill or removal and the social, economic or other public benefits likely to result from the proposed fill or removal. When the applicant for a permit is a public body, the Department may accept and rely upon the public body's findings as to local public need and local public benefit;
  - (b) The economic cost to the public if the proposed fill or removal is not accomplished;
  - (c) The availability of alternatives to the project for which the fill or removal is proposed;
  - (d) The availability of alternative sites for the proposed fill or removal;
  - (e) Whether the proposed fill or removal conforms to sound policies of conservation and would not interfere with public health and safety;
  - (f) Whether the proposed fill or removal is in conformance with existing public uses of the waters and with uses designated for adjacent land in an acknowledged comprehensive plan and land use regulations;
  - (g) Whether the proposed fill or removal is compatible with the acknowledged comprehensive plan and land use regulations for the area where the proposed fill or removal is to take place or can be conditioned on a future local approval to meet this criterion;
  - (h) Whether the proposed fill or removal is for stream bank protection; and
  - (i) Whether the applicant has provided all practicable mitigation to reduce the adverse effects of the proposed fill or removal in the manner set forth in ORS 196.600."

- Section (5) of the OAR provides that "The Department will issue a permit only upon the Department's determination that a fill or removal project is consistent with the protection, conservation and best use of the water resources of this state and would not unreasonably interfere with the preservation of the use of the waters of this state for navigation, fishing and public recreation. The Department will analyze a proposed project using the criteria set forth in the determinations and considerations in sections (3) and (4) above (OAR 141-085-0565). The applicant bears the burden of providing the Department with all information necessary to make this determination."

Summary of Substantive Public Comments

DSL has reviewed all the comments received concerning Jordan Cove application for a removal-fill permit. The Department's summary of the substantive comments (below) is not exhaustive. Jordan Cove should review and address the substantive comments that relate directly to the proposed removal and fill or that relate to the potential impacts of the proposed removal and fill. All substantive comments received are provided here.

Jordan Cove failed to demonstrate the project is in the public interest, Jordan Cove failed to demonstrate a public need. (ORS 196.825(3)(a)): Comments received on this topic stressed that the Department must affirmatively determine that the project would address a public need consistent with *Citizens for Resp. Devel. In the Dalles v. Walmart* 295 Or App 310 (2018). With a privately-sponsored project of this scale and complexity, the Department must consider public need in a transparent and comprehensive analysis that weighs all the relevant impacts and alleged benefits of the project.

Jordan Cove failed to demonstrate the project is consistent with the protection, conservation, and best use of Oregon's waters. (ORS 196.825(1)(a)): Commenters are concerned that the project would likely do unnecessary harm and damage to water quality in Oregon and suggest the applicants have failed to demonstrate that the project is consistent with the protection, conservation and best use of the water resources of this state. The proposed project will likely impair designated beneficial uses, threatening drinking water supplies and fish habitat. It will also likely further degrade stream segments in which water quality is already impaired for temperature, dissolved oxygen, pH, turbidity, mercury, and sedimentation.

The project does not conform to sound policies of conservation and will likely interfere with public health and safety (ORS 196.825(3)(e)): The Department received comments with concerns that the applicant has failed to demonstrate that the project will not interfere with public health and safety. Potential risks to public health and safety include natural hazards, such as floods, tsunamis, wildfires, landslides, and earthquakes, identified under Statewide Planning Goal 7. The potential for high-flow events that expose the pipeline or inadvertent drilling fluid releases (frac-outs) during construction at proposed stream crossings may result in increased risks to public health and safety. Failure at any of the major waterbody crossings claiming avoidance by using either Hydraulic Directional Drill (HDD) method, conventional bore or direct pipe method would have detrimental impacts to waters of the state and potentially contaminate state waters. Several risks to public health and safety were raised during public review that need to be addressed by the applicant, such as the list provided below. Please address these adverse impacts of this project:

- An accidental explosion of a fully loaded Liquefied Natural Gas (LNG) ship or at the terminal, including the worst-case scenario for the immediate area;
- How are the Federal Aviation Administration (FAA) presumed hazard determinations being addressed by Jordan Cove;
- Tsunami risks increasing from the project dredging activities;
- Improper facility siting, Society for International Gas Tanker and Terminal Operators (SIGTTO) standards not followed (i.e., on the outside bend of the navigation channel, near other terminal users, near population centers);
- Impacts on municipal drinking water sources, private wells, irrigation sources and agricultural uses;
- Increased wildfire risks as construction season coincides with the in-water work period which also coincides with fire season; and
- Impacts of massive scale clearing and grubbing with pipeline installation on water quality, land stability, erosion and turbidity of doing these activities during the rainy winter seasons, all water flows downhill.

The project would interfere with navigation, fishing, and public recreation: Comments received on this topic addressed that the Department must conduct a weighing of the public benefits of the project against interference with factors including navigation, fishing, and public recreation (See *Citizens for Resp. Devel. In the Dalles v. Walmart,* 295 Or App 310 (2018)). As part of this weighing of public benefits, the Oregon Legislature has clearly demonstrated that it is the State's "paramount policy" to preserve Oregon waters for navigation, fishing, and public recreation. ORS 196.825(1).

The comments indicate that the applicant has failed to demonstrate that the project will not unreasonably interfere with navigation, fishing, and public recreation in this application. Potential conflicts include but are not limited to:

- Crabbing, fishing and all types of recreational uses in and around Coos Bay;
- Safe bar passage issues/LNG tanker bar crossings only at high tides conflict with recreational fishers and the commercial fleets that also cross the bar at high slack tides for safety reasons should be evaluated;
- Exclusion zones required around LNG tankers while the LNG tanker is in transit will impact the recreating public crabbing via the ring method. This is reportedly the most common recreational crabbing method in Coos Bay. High slack tides are optimum for crabbing and if an LNG tanker must transit only at high tides, given the security and exclusion zones, there is interference with existing recreational uses within Coos Bay; and
- Impacts on the commercial fisheries uses of Coos Bay and adjacent ocean resources.

Jordan Cove failed to demonstrate independent utility (OAR 141-085-0565(3)(a)): Commenters assert that the project is connected to the Coos Bay Channel Modification (CBCM) Project. The applicant would be the primary benefactor from the proposed widening and deepening of the federal navigation channel as part of the CBCM project or similar efforts to expand the navigation channel. Further, there are serious questions about the feasibility of LNG vessels transiting the federal navigation channel under the dredging currently proposed as part of this application. Oregon Department of Fish and Wildlife (ODFW) contends that the Jordan Cove Energy Project and Port of Coos Bay Channel Modification project are connected actions and should be evaluated that way. The applicant has failed to demonstrate that the project has independent utility as required under OAR 141-085-0565(3)(a)**.**

Jordan Cove failed to demonstrate a comprehensive analysis of alternatives to the project (OAR 141-085-0550(5), ORS 196.825(3)(c) and (d)): Commenters outline that the applicant has failed to demonstrate a comprehensive analysis of alternatives to the project, and therefore, the Department does not have the information to consider the availability of alternatives both for the project and for proposed fill and removal sites. Also, the Department was not able to determine that the project is the practicable alternative with the least adverse impacts on state water resources. Comments detail that through a flawed, overly-narrow purpose and need statement, the resulting biased alternative analysis prevents the Department from considering a reasonable range of alternatives to the project.

Navigation Reliability Improvements (NRI) Dredging: Comments indicate that there is no documented need for the 590,000 cubic yards to dredge the four corners outside the existing Federal Navigation Channel (FNC). Comments also state that Jordan Cove can export 99.5% of the anticipated annual output of the LNG facility (7.8 million tons) without the NRI dredging, which leaves the question, is there a 'need' to excavate 590,000 cubic yards of material for a nominal gain in transport capacity to allow Jordan Cove to travel at higher wind speeds than the current channel configuration could safely allow. Comments further suggest this minor economic benefit to only Jordan Cove does not equate to a 'need' to impact trust resources of the State of Oregon. The adverse impacts are understated or not explained in terms of the salinity impacts and hydrologic changes that will result from widening the existing navigational channel. The potential tsunami run-up impacts are not well explained either, nor are any hydrodynamic changes that would likely result or any analysis on potential increases to bank erosion adjacent to the proposed NRI channel improvements. The need should be substantiated, and a robust alternatives analysis prepared to address these issues and justify the dimensions and depths needed with supporting documentation in the form of simulation modelling showing that the current channel is insufficient for Jordan Cove.

Pile Dike-Rock Apron: Comments raised concerns that no alternatives were presented regarding the proposed 6,500 cubic yards (cy) of rock riprap proposed to protect the existing pile dike against erosion from the slip and access channel location, depth and dimensions. With no alternatives presented on the dimensions or design alignment of the slip and access channel, no reasonable range of alternatives can be considered. There is no discussion on impact avoidance, minimization, and/or mitigation to offset any adverse impacts to waters of the state. Please address:

- Why 6,500 cy?
- Why not more?
- Why not less?
- Why any at all?

Dredged Material Disposal (DMD) transfer of materials to APCO 1 & 2 from the NRI dredging: Comments received raised the following questions, please answer:

- How will the rock be excavated and transferred to the DMD site? Vague alternatives analysis presented, leaves more questions than answers.
- What types of equipment will be used to excavate the NRI's?
- Which works best in what type of materials (bedrock, rock, sand or silts), which has least environmental impacts depending on the material encountered?
- How will the rock be dredged? Different equipment?
- Can rock be transferred to a DMD site via slurry line as the application states? Inadequate discussion on alternatives, leaving the details to the contractor is insufficient.

Slip and Access Channel: Comments raised the concern of a lack of discernable alternative analysis for the precise dimensions and location of the slip and access channel. The slip and access channel are designed for a ship class of 217,000 cubic meters, yet the Coast Guard Waterway Suitability Analysis recommends allowing ships no larger than 148,000 cubic meters. Please answer the following questions and concerns:

- Why design a slip to accommodate a ship class that is not currently allowed nor physically capable of navigating into Coos Bay given the constraints of the Coos Bay bar and currently authorized limitations of the federal navigation channel?
- The application claims the stated depth needed for the slip and access channel is to maintain 'underkeel clearance' while an LNG ship is at dock. This is misleading as an LNG ship can only safely navigate the current channel at a high tide advantage, above 6ft tides to get through the channel to the slip before the tide recedes which would strand the vessel if it is not safely docked in the slip. Any LNG ship, 148,000 cubic meter class ship, would not be able to transit Coos Bay except periods of high tide, there would be no way for a ship to exit the slip at any lower tidal elevation as the ships draft would exceed navigational depth of the channel which could pose huge safety concern in the event of a tsunami.
- Water quality concerns from the 'sump effect' of having the proposed 45ft Mean Low Low Water (MLLW) deep slip and access adjacent to and on the outside bend of the 37ft MLLW navigation channel need to be addressed.
- What are the sedimentation impacts, salinity impacts, temperature and dissolved oxygen impacts that would likely result from a deep-water pocket created for the slip?

Questions were raised over whether the access channel dimensions can change, as no alternatives discussion exists, it is just one option, take it or leave it. Any reduction in the size of the slip or access channel would reduce water impacts and reduce the required mitigation. Any reduction in size or depth would also reduce adverse impacts associated with this project. The need should be substantiated, and a robust alternatives analysis prepared to address these issues.

DMD Alternatives: Commenters would also like to know why Jordan Cove will move 300,000 cubic yards of sand to the Kentuck site when other alternatives exist that would have less impact than transferring a line all the way across Coos Bay to Kentuck slough. The log spiral bay could accommodate more than 300,000 cubic yards, it is much closer to the dredge sites and would have significantly less impacts than the Kentuck proposal, yet it is dismissed. Please explain more thoroughly the alternatives that were considered and why those alternatives were dismissed within the greater DMD plan.

APCO DMD Site: Commenters have concerns over the capacity of the APCO site. Does this site have the capacity for the initial dredging and maintenance dredging over the lifespan of this project? Commenters also have site stabilization and liquefaction concerns over a mountain of sand piled up adjacent to Coos Bay in an earthquake and tsunami zone. There is safety, engineering, project feasibility, and water resources concerns that must all be addressed.

The project does not conform with existing land use laws (ORS 196.825(3)(g)):
Commenters indicate that the applicant has failed to demonstrate that the project conforms with existing land uses designated in the applicable comprehensive plan and land use regulations. They also mentioned that the applicant has failed to provide the Department with the information necessary to make the determinations required by ORS 196.825(3)(g) that the applicant's proposed fill or removal is compatible with the requirements of the comprehensive plan and land use regulations for the area in which it will take place. Current, up-to-date Land Use Consistency Statements are required for all parts of this project in all jurisdictions with an explanation of the current status, pending or resolved local issues, processes, or appeals status.

Further, commenters are concerned the applicant has failed to obtain land use permits for the project in Coos Bay. Because of the reasons adopted by the Land Use Board of Appeals (LUBA) in remanding the prior land use application are directly related to the inconsistency of the proposed dredge and fill in wetlands and in the Coos Bay Estuary with the Coos Bay Estuary Management Plan, the project cannot be conditioned on a future land use approval to meet this criterion.

In January 2019, the Douglas County Circuit Court Judge reversed the Douglas County extensions from December 2016 and 2017 that approved the Pacific Connector Gas Pipeline as a conditional use. Because the pipeline will require a new application for conditional use permit and utility facility necessary for public service, the applicant has not met its burden to demonstrate to the Department that the project conforms to Douglas County's acknowledged comprehensive plan and land use regulations.

The comments received indicate that the applicant has not met their burden to demonstrate to the Department that the project conforms to Jackson County's acknowledged comprehensive plan and land use regulations.

Insufficient Mitigation-Kentuck Compensatory Wetland Mitigation (CWM) Site: Concerns were raised about the lack of a discernable alternative analysis on many components of the Kentuck mitigation proposal to see what alternatives were considered and on what basis were rejected. The mitigation proposal itself is the largest wetland impact in this project proposal. Please answer the following questions:

- Why import 300,000 cubic yards of sand?
- Why not more or less materials?
- Why not use more suitable materials native to the area?
- Why sand vs. native cohesive clay soils for use as fill?
- What are the alternatives to move the sand to the site?
- Why were upland routes dismissed without reasonable justification?
    - Trucking the materials is a viable option with no impact to waters of the state.
- What other mitigation sites or options have you looked at addressing the following concern?
- The Kentuck site is already a freshwater wetland and has increased its functions in the past 10 years to the point that the current mitigation strategy might be inappropriate to offset functional losses. Please answer these questions as well:
    - Why is the dike so big, long, and wide?
    - Why is there no justification given to support dimensions of the proposed dike?
    - Why are there no alternatives are presented to evaluate the adverse effects of the dike and mitigation strategy?
    - Address the landowner concerns regarding the Kentuck Mitigation proposal and the Saltwater Intrusion impacts on adjacent lands.
    - Further address the concerns of flooding and impacting agricultural activities and existing farm uses.
    - Why is the pipeline proposed under a proposed mitigation site?
    - Where is the avoidance and/or impact minimization, especially given that each impact reduces the overall size of the mitigation project, therefore diminishing its potential function and values? Concerns were raised about the suitability of having a pipeline under the mitigation site that is supposed to be protected in perpetuity.

Insufficient Mitigation-Eelgrass CWM Site: Comments raised concerns about the lack of a discernable alternative analysis on many components of the eelgrass mitigation proposal. The CWM citing was found not to be in-kind or in proximity mitigation which would replace similar lost functions and values of the impact site. Disturbing existing mudflats and adjacent eelgrass beds is likely to have additional adverse impacts from construction. The proposal is inconsistent with ODFW Habitat Mitigation Policy. Alternatives should be considered, in consultation with ODFW, that favor impact avoidance to adjacent high value habitats (mudflats and adjacent eelgrass beds) and seek out appropriate in-kind, in proximity mitigation. The project impacts are to eelgrass beds adjacent to deep water habitats, while the proposed mitigation is near the airport runway and in shallow water habitats a considerable distance from deep water habitats. There are likely unforeseen FAA issues with the proximity of the mitigation site to the airport runway, this should be explored in detail with the FAA. The location of the eelgrass CWM site is situated in a portion of the Coos Bay Estuary classified as “52-Natural Aquatic” in the Coos Bay Estuary Management Plan where dredging is not allowed. This issue needs to be clarified by Coos County with respect to land use consistency.

Insufficient Mitigation-Stream Impacts: Comments assert that the project will impact many waterways’ beneficial uses, water quantity and quality will be further impaired from construction of this project. Potential impacts include but are not limited to increased water temperatures, dissolved water oxygen, turbidity, etc. from riparian shade removal in 303(d) listed waterways and other waters. Disruption of fluvial processes, increased erosion and downstream sedimentation and turbidity from construction activities, impacts on spawning and rearing habitats, impacts on fish migration and passage.

Many people have raised concerns that Federal Energy Regulatory Commission (FERC) procedures are vague and will not provide assurances that water quality/quantity standards will be protected. Stream risk analysis, alternative ways to avoid and minimize impacts for each water crossing are not possible on properties with denied access. How are any reasonable alternatives considered if access is denied and unattainable without a FERC Order granting condemnation authority? Alternatives are not fully explored or explained to avoid and minimize impacts at every opportunity.

ODFW Habitat Mitigation Policy Inconsistencies: Commenters expressed that the applicants should work with ODFW to appropriately categorize each wetland and waterway impact from start to end along the proposed pipeline route. Once the appropriate habitat category has been assigned in agreement with ODFW, appropriate mitigation can be discussed based on resources impacted. Currently, temporary impacts mitigation is insufficient and inconsistent with the ODFW Habitat Mitigation Policy for streams and wetlands crossed by the pipeline.

Fish Passage-Coastal Zone Management Act (CZMA) and Non-CZMA Streams: Comments expressed concern that fish passage has not been addressed by the applicant. According to ODFW, applications for fish passage have not been submitted and this is critical to the Department for impact analysis determinations yet to be made. Fish passage applications may need to include a contingency method for crossing each waterway. For instance, if any of the HDD's fail, what is next, certainly not open trench, wet cut methods that are not currently being evaluated as alternative crossing methods under consideration.

Wetland Delineations/Concurrence: Public comments point out that some of the wetland delineation reports have either expired or are about to expire, see C4, C5, C9 and C10 of the application.

Additional Information Requested by the Department

Delineation-status for JCEP/PCGP: To allow adequate review time of the wetland delineation report in order to meet the decision deadline, please submit the following data requests by the dates requested.

1) By April 17, 2019: GIS shape files of the new routes and re-routes so DSL can finish the initial review and provide any additional review comments in time to address this summer (involving additional field work, if needed);
2) End of April 2019: Responses to the initial delineation review questions and delineation maps (prototype subset of each map series for completeness review);
3) June 7, 2019: Responses to GIS review questions;
4) Last week of June 2019: Site visits (possible); and
5) August 9, 2019: Everything due: responses to all remaining requests for information based on site visits, GIS review responses and follow-up review requests, all final delineation maps, and all supporting materials for the concurrence.

Bonding Requirements: Prior to any permit issuance, a performance bond should be negotiated and put in place for the Eelgrass and Kentuck CWM projects. Bonds are required for non-public agencies that have permanent impacts greater than 0.2 acre. Proposed financial instruments need to demonstrate consistency with OAR 141-085-0700.

Administrative Protections Required for Eelgrass and Kentuck CWM projects: Administrative protection instruments need to demonstrate consistency with OAR 141-085-0695.

Oregon Department of State Lands, Land Management Issues: Any proposed uses or activities on, over, or under state owned lands requires Department proprietary authorizations.

Extensive Comments-Detailed response requested. The Department requests that the applicant respond to all substantive comments. Certain commenters provided extensive, detailed comments. The Department would like to call these comments to the applicant's attention to ensure that the applicant has time to sufficiently address them.

- Mike Graybill;
- Jan Hodder;
- Rich Nawa, KS Wild;
- Stacey Detwiler, Rogue Riverkeepers;
- Jared Margolis, Center for Biological Diversity;
- Jodi McCaffree, Citizens Against LNG;
- Walsh and Weathers, League of Womens Voters;
- Wim De Vriend;
- The Klamath Tribes, Dawn Winalski;
- Tonia Moro, Atty for McLaughlin, Deb Evans and Ron Schaaf;
- Regna Merritt, Oregon Physicians for Societal Responsibility;
- Oregon Women's Land Trust;
- Sarah Reif, ODFW;
- Margaret Corvi, CTLUSI;
- Deb Evans and Ron Schaaf;
- Maya Watts; and
- Steve Miller.

All comments received during the public review of this application were previously provided to Jordan Cove by the Department via Dropbox and should be responded to as well. Please submit any responses to the Department and copy the commenting party if contact information was provided.

The Department asks that any responses be submitted in writing within 25 days of the date of this letter to allow adequate time for review prior to making a permit decision. If Jordan Cove wishes to provide a response that will take more than 25 days to prepare, please inform me as soon as possible of the anticipated submittal date.

The Department will make a permit decision on your application by September 20, 2019, unless Jordan Cove requests to extend that deadline. Please call me at (503) 986-5282 if you have any questions.

Sincerely,

Robert Lobdell
Aquatic Resource Coordinator
Aquatic Resource Management

RL:jar:amf

Exhibit 3

Oregon
Kate Brown, Governor

Department of Environmental Quality
Western Region Eugene Office
165 East 7th Avenue, Suite 100
Eugene, OR 97401
(541) 686-7838
FAX (541) 686-7551
OTRS 1-800-735-2900

March 11, 2019

Derik Vowels
Jordan Cove LNG, LLC
Consultant, Lead Environmental Advisor
111 SW 5th Ave.,
Suite 1100,
Portland OR 97204

Re: Additional Information Request – Waterbody Crossings
Jordan Cove Energy Project (FERC Project No. CP17-494)
Pacific Connector Gas Pipeline (FERC Project No. CP17-495)
U.S. Army Corps of Engineers (Project No. NWP-2017-41)

Dear Mr. Vowels:

The Oregon Department of Environmental Quality is currently reviewing an application from Jordan Cove LNG, LLC for Clean Water Act Section 401 water quality certification for a Section 404 permit from the U.S. Army Corps of Engineers necessary for construction of the Jordan Cove Energy Project and Pacific Connector Gas Pipeline.

Section 401 of the Clean Water Act bars federal agencies from issuing a license or permit for an action that may result in a discharge to Oregon waters without first obtaining water quality certification from DEQ. DEQ anticipates Jordan Cove's construction and operation will require authorizations from multiple federal agencies, including but not limited to a Section 404 permit from the U.S. Army Corps of Engineers and authorizations from the Federal Energy Regulatory Commission pursuant to the Natural Gas Act. DEQ is conducting a comprehensive section 401evaluation of the project's direct, indirect and cumulative effects on water quality. DEQ expects to develop a single certification decision based on this comprehensive evaluation of the project that will apply to the Corps and FERC decisions on the project.

DEQ is processing the applications pursuant to Section 401 of the Clean Water Act, 33 United States Code §1341, Oregon Revised Statutes 468B.035 through 468B.047, and DEQ's certification rules found in Oregon Administrative Rules 340, Division 048. To certify the project, DEQ must have a reasonable assurance that the proposed project, as conditioned, will comply with Sections 301, 302, 303, 306 and 307 of the Clean Water Act, Oregon water quality standards, and any other appropriate requirements of state law.

DEQ is reviewing the application submitted Feb. 6, 2018, by David Evans and Associates, Inc. on behalf of Jordan Cove. The information described in the attachments to this correspondence is necessary to complete DEQ's analysis of the project's compliance with applicable standards. Please provide a schedule for a complete response to this additional information request. Please forward your responses to:

Christopher Stine
Oregon Department of Environmental Quality 165
East 7th Avenue, Suite 100
Eugene, Oregon 97401

You may reference previously submitted documents to support your responses to the requests in Attachment A.

DEQ may request additional information as necessary to complete its analysis and fulfill its obligations under state and federal law.

If you have any questions, please contact me directly at 541-686-7810, or via email at stine.chris@deq.state.or.us.

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FERC Dockets: CP17-494-000, CP17-495-000

ATTACHMENT A

Jordan Cove Energy Project / Pacific Connector Gas Pipeline Additional Information Request

Horizontal Directional Drilling

1. In September 2017, Pacific Connector submitted Horizontal Directional Drilling Feasibility Analysis reports for the proposed Coos Bay East Crossing and Coos Bay West Crossing. According to the reports, the "conclusions should be considered preliminary pending completion of a subsurface exploration program." Please provide a status update on geotechnical drilling and a schedule for finalizing the reports.
2. Pacific Connector describes two options (i.e., single Horizontal Directional Drilling Option and a Dual Horizontal Directional Drilling Option) to accomplish the Coos Bay East Horizontal Directional Drilling crossing. DEQ expects the design criteria supporting the selected procedure will be presented in the final design report. DEQ requests Pacific Connector address the following considerations in determining their proposed methodology.

   <u>Single Horizontal Directional Drilling Option</u>

   a) The single option places the bottom tangent at elevation -190 feet mean sea level. Pacific Connector expects the underlying geology at this depth will consist of competent bedrock, which is deemed critical to the feasibility of the single option. Please describe whether alternate design measures would allow use of the single option if the geotechnical investigation concludes the underlying geology does not consist of competent bedrock.

   <u>Dual Horizontal Directional Drilling Option</u>

   A final Horizontal Directional Drilling design report that proposes the Dual Horizontal Directional Drilling Option should address the following issues.

   b) The dual option relies on a shared tie-in workspace located in a tidal flat area south of Glasgow Point. Describe how the workspace will be isolated from open water during Horizontal Directional Drilling installation.

   c) The likelihood of inadvertent surface returns of drilling fluid is highest near entry points where drilling pressures can exceed the shear strength and pressure from overburden soils. Describe what special contingency measures will be employed to contain drilling fluids in this inter-tidal environment.

   d) What is the proposed final depth below surface of the installation at the tie-in location? What measures, if any, are proposed to ensure the pipeline remains buried for the life of the project?

   e) Describe the scope of open-water activities such as inter-tidal dredging for barge access to the shared tie-in workspace.

   f) Describe what procedures Pacific Connector will employ to avoid, minimize, or mitigate the effects of this option on water quality.

3. The Horizontal Directional Drilling Mud Contingency Plan states a berm may be built around the drilling site and hay bales or silt fences may be placed on the river side of the drilling area. Because inadvertent surface returns may reasonably be expected near entry locations, Pacific Connector should identify measures that will be employed and maintained to contain fluids during installation.
4. Inadvertent fluid returns to surface waters are unacceptable. Pacific Connector must develop and implement an Horizontal Directional Drilling plan to continuously monitor engineering conditions during installation and provide for a rapid response in the event fluid loss is confirmed or suspected. The plan should establish procedures to monitor drilling pressure, fluid circulation, pilot hole location, axial loads, visual monitoring or other parameters deemed appropriate to interpret formational or surface loss of drilling fluid.

Waterbody Crossing Plans

The effects of pipeline construction across waterbodies can affect the physical, biological and chemical integrity of the aquatic environment. Pacific Connector will utilize dry open cut methods (fluming, dam and pump, or diverted open cut) on most of the proposed 326 waterbody crossings. Open cutting of streambeds can have direct, indirect and cumulative effects on water quality, habitat and stream hydrology. Changes to channel geometry may cause streams to reestablish equilibrium. These actions can increase sedimentation, reduce water quality, decrease habitat complexity and modify channel hydrology. Because, the effects of open trench waterbody crossings can propagate upstream, downstream, and laterally these impacts, may not be confined to the project area.

Waterbody crossing plans must describe site-specific construction procedures that Pacific Connector will undertake at each proposed crossing. The plans should identify the proposed crossing methodology, dewatering procedures, dewatering discharge sites, spoils placement locations, mobilization and demobilization, and monitoring procedures. The plans should be developed in consideration of local characteristics such as anticipated flow, local, geology, gradient, sensitive environmental conditions, slope stability at dewatering discharge points or other environmental factors that may influence the design and implementation of waterbody crossings. Pacific Connector should describe procedures for crossings that may require unique or challenging procedures (e.g., blasting consolidated rock). Last, site-specific crossing plans must address the removal of dams, dewatering locations, temporary bridges, or other temporary construction elements and include procedures to avoid or minimize sediment mobilization or turbidity

Waterbody crossing plans must also describe site-specific plans to restore each of the proposed waterbody crossings. Each plan must include sufficient local-scale information to provide an accurate baseline assessment of pre-construction environmental and ecological conditions to guide the design of the post-construction restoration. Each stream restoration plan must contain site-specific designs and specifications to ensure PCGP fully mitigates the impact of open cut trenching in each stream and protects the beneficial uses. The data generated from the information requested below will support the development of site-specific waterbody crossing plans.

To develop a waterbody crossing plan for each open trench cut stream crossing, Pacific Connector must document and use the site-specific field data described below.

Hydraulic Assessment

Pacific Connector must conduct a hydraulic analysis on each proposed waterbody crossing. Site-specific information of local discharge is required to demonstrate that proposed pumping and fluming designs can adequately bypass anticipated flows. Pre-development local hydrology must also be characterized to inform stream restoration actions.

Pacific Connector should conduct the analysis using one of the following methods:

- Rational Method (for drainages up to 200 acres)
- NRCS Peak Flow Method using HydroCAD (for drainages larger than 200 acres)
- USGS StreamStats for Oregon

The hydraulic analysis should provide the following information:

- Drainage area above each proposed crossing
- Peak flow estimate at the time of construction
- Bankfull width, stage, and corresponding discharge
- Average gradient within the temporary crossing easement
- Mean two-year, five-year and 10-year discharge and velocity at the proposed crossing

Based on the hydraulic conditions at each crossing, Pacific Connector should confirm the design pumping capacity of the proposed fluming or pumping bypass system can sufficiently transfer maximum anticipated flows around the work area. Pacific Connector should further describe alternate or contingency methods in the event field conditions prevent successful dewatering. Waterbody crossing plans must include engineering data to support design criteria of proposed conveyance structures based on gradient, bypass length and anticipated flow.

Pacific Connector must also measure bankfull width, stage, and corresponding discharge at each crossing. Recognizing the bankfull width at each crossing is critical in designing and implementing restoration plans that maintain the geomorphological function of the stream segment.

Topographic Survey of Stream Channel
Restoring a stream's natural form and function requires a topographic survey of the pre-construction stream channel and floodplain form.[1] Pacific Connector provided this information for the South Umpqua Number 2 River crossing. However, this information is lacking for other crossings involving open trench cutting. This survey information will assist in the reconstruction of the natural stream channel. At minimum, Pacific Connector should include in each topographic survey a longitudinal survey of the stream profile, top and bottom of banks, and the top and bottom floodplain slopes. This topographic information should also include geometric data downstream and upstream of the pipeline crossing to assist the restoration design and to identify potential interactions with adjacent reaches.

Stream Function Assessment
Trenched waterbody crossings can alter stream function in ways that negatively affect aquatic habitats and ecosystems. Potential effects may include modified stream channel geometry, reduced habitat complexity, reduced streambank stability, impaired benthic production and increased sedimentation.

Pacific Connector must conduct a pre-construction ecological assessment of each waterbody crossing using the methodology presented in Stream Function Assessment Method for Oregon Version 1.0.[2] SFAM was developed jointly by EPA and Oregon Department of State Lands. The method provides a scientifically supported rapid assessment tool for gathering information on the functions and values associated with wadeable streams that may be subject to regulatory jurisdiction under Section 404 of the Clean Water Act and Oregon's Removal-Fill Law.

The assessment is needed to establish a pre-development ecological baseline and to inform site-specific practices necessary to mitigate the environmental effects of the action. Pacific Connector can also use this assessment method for post-construction monitoring of Pacific Connector's stream restoration actions over time.

More information can be found at:
https://www.oregon.gov/dsl/WW/Pages/Resources.aspx#assessment.

Biological Assessment
Oregon water quality rules prevent discharges to waters of the state that may reduce support for beneficial uses or cause changes in residential biological communities. To establish pre-construction conditions, Pacific Connector must conduct a benthic macroinvertebrate assessment to comply with the Biocriteria water quality standard (Oregon Administrative Rule 340-0410-0011). Benthic communities form the basis for food webs that support aquatic life and are susceptible to changes in sedimentation. Oregon DEQ has developed procedures to characterize

[1] Yokum, S.E. 2018. Guidance for Stream Restoration. Technical Note TN-102.4. National Stream Aquatic Ecology Center. USDA Forest Service

[2] Stream Function Assessment Method for Oregon Version 1.0. June 2018. U.S. Environmental Protection Agency and Oregon Department of State Lands. EPA 910-D-18-001.

the health of benthic communities to comply with this standard. Using procedures found in Methodology for Oregon's 2018 Water Quality Report and List of Water Quality Limited Waters,[3] Pacific Connector must perform pre-development benthic surveys using to the PREDictive Assessment Tool for Oregon (PREDATOR). The results of the PREDATOR surveys will enable DEQ to evaluate the direct, indirect, and cumulative effects of the action caused by stream channel modification, habitat loss, sedimentation or other potential project effects.

Streambed Material Assessment

Pacific Connector must characterize bed material composition at each trenched waterbody crossing. Substrate composition is critical to stream hydrology and provides interstitial refuge for egg incubation. Characteristics can vary considerably based on gradient, stream channel geometry, watershed hydrology and other factors. For this reason, site-specific knowledge of local bed material characteristics are necessary to inform restoration and mitigation actions following construction.

For streambeds characterized by unconsolidated substrates, Pacific Connector must conduct a pre-construction quantitative assessment of substrate material. The assessment should address the particle size, sorting, vertical variability and distribution of material.

Open cut trenches in bedrock-dominated stream channels are susceptible to upstream propagation of knickpoints created by joints in the stream's bedrock.[4] Knickpoint propagation in bedrock-dominated streams can cause changes in stream geomorphology and, potentially, barriers to fish migration. Pacific Connector should describe in detail how bedrock-dominated stream channels will be restored to prevent the creation of a joint in the bedrock that leads to the formation and propagation of a knickpoint in these channels.

Habitat Assessment

Naturally occurring material such as large wood and boulders provide gravel recruitment, cover for juvenile fish, thermal refugia, and hydraulic control. Pacific Connector must conduct a detail inventory of aquatic habitat features within the project area of each proposed crossing. Habitat features identified during this predevelopment inventory should be used to ensure restoration efforts result in no net loss of habitat function or complexity. In its Stream Crossing Risk Analysis document, Pacific Connector provides only general descriptions to address, for example, the reinstallation of boulders to maintain an existing bed profile and cascade/pool morphology during the stream restoration process. However, Pacific Connector's habitat assessments must capture such habitat features as noted above in sufficient design detail so that the construction contractor has clear direction in site-specific drawings to restore these habitat

[3] Methodology for Oregon's 2018 Water Quality Report and List of Water Quality Limited Waters, November 2018. Oregon Department of Environmental Quality: https://www.oregon.gov/deq/FilterDocs/ir2018assessMethod.pdf.

[4] Selander, Jacob. 2004. Processes of Knickpoint Propagation and Bedrock Incision in the Oregon Coast Range. Department of Geologic Sciences. University of Oregon

features during the stream restoration process.

Water Quality

Site-specific water body crossing plans should address the following water quality issues at each crossing proposed:

- Oregon DEQ may issue a section 401 water quality certification that allows the numeric turbidity criteria to be exceeded provided all practicable turbidity control techniques have been applied. Please identify what engineering controls (e.g., settling, filtration, flocculation, etc.) are proposed to reduce turbidity in streams during mobilization and removal of construction equipment.

- Describe procedures to backfill trenches in a manner that maintains predevelopment streambed material and habitat function. For example, backfilling procedures must clearly address how Pacific Connector will prevent the restored stream flow from moving completely into the subsurface of restored streambed material and creating a fish passage barrier. Additionally, crossing plans should clearly describe how fill material will be placed to prevent streambed and bank scour, sedimentation, and channel modification.

- For trench dewatering structures, please identify how sediment and fines removed from the isolated work area will be permanently managed following work completion.

Comments

1. Appendices C.2 and D.2 (Stream Fluming Procedures, Dam and Pump Procedures) of Resource Report 2 state, "Turbidity sampling will be conducted during all . . . crossings in accordance with the Stormwater Pollution Prevention Plan." DEQ cannot find the Stormwater Pollution Prevention Plan in Pacific Connector's application submittal to evaluate the proposed turbidity sampling.
2. Fluming and dam and pump procedures rely on upstream and downstream dams to isolate temporarily work areas during construction activities. Oregon's fish passage requirements found in Oregon Revised Statute 509.585 prevent activities that impede the volitional movement of fish. Pacific Connector should describe how proposed fluming and dam and pump procedures will comply with Oregon fish passage law.
3. Stream Classifications in Table A.2-2 in Resource Report 2 reference methods established by Oregon Department of Forestry and the Northwest Forest Plan. DEQ's biologically based numeric criteria are based on fish distribution maps developed by Oregon Department of Fish and Wildlife. Please consult with ODFW to identify fish use and classifications at the proposed waterbody crossing locations.
4. Appendix C.2 of Resource Report 2 (Fluming Procedures) indicates that scrap metal pipe may be used to construct flumes and that pipes may be steam-cleaned to remove oil and grease. Please identify on the crossing plans where Pacific Connector will discharge this wash water. DEQ expects that Pacific Connector will apply for and obtain coverage under the appropriate permit (i.e., either Water Pollution Control Facility or National

Pollutant Discharge Elimination System) based on the proposed activity.

5. Figure 8 of Appendix C.2 of Resource Report 2 (Fluming Procedures) illustrates procedures to divert stormwater runoff from the construction easement into the isolated stream section. Please note that NPDES 1200-C General Permit does not authorize the discharge of stormwater to waterways. Pacific Connector must control runoff from upland work areas to prevent discharge to stream channels.

Exhibit 4

DEQ issues a decision on Jordan Cove's application for 401 Water Quality Certification

May 06, 2019

Statewide, OR—Today the Oregon Department of Environmental Quality issued a decision on Jordan Cove's application for a Section 401 Water Quality Certification. The certification is required for the U.S. Army Corps of Engineers to issue permits for the project.

DEQ's decision is to deny the requested certification at this time. However, DEQ's action is being made "without prejudice." This means that the applicant may reapply for the certification, and submit additional information that could result in a different decision.

If Jordan Cove resubmits an application along with information addressing DEQ's concerns, DEQ will work to keep the timing of its review in line with the overall federal schedule for the project, but this will depend on the applicant submitting the requested information in a timely manner.

DEQ had expected to make its decision on certification in September of this year. However, DEQ has accelerated the schedule and is making a decision now in order to ensure that we do not unintentionally waive Oregon's authority to review the water quality impacts of the proposed project. The U.S. Army Corps of Engineers initially instructed DEQ to complete its review by May 7, 2019. However, in fall 2018 the U.S. Army Corps of Engineers extended that date to Sept. 24, 2019 following the applicant's withdrawal and resubmittal of its application. Recent federal court and agency decisions have raised significant questions about whether this extension was valid. As a result, DEQ is making a decision by the date initially provided by the Corps – May 7, 2019.

DEQ is denying the requested water quality certification at this time because there is insufficient information to demonstrate compliance with water quality standards, and because the available information shows that some standards are more likely than not to be violated. Through further analysis, and possibly through project changes and mitigation, the applicant may be able to show the standards for certification will be met, but the current record does not allow DEQ to reach that conclusion today.

DEQ's specific concerns, among others, include:
• Expected effects of the construction and operation of the proposed pipeline and associated road and work areas on water temperature and sediment in streams and wetlands
• The risk of release of drilling materials from the construction of the proposed crossing of the Coos Bay estuary

DEQ requested additional information from Jordan Cove in September 2018, December 2018 and March 2019 relevant to the project's effect on water quality. Jordan Cove has provided some, but not all, of the information requested.

The proposed project calls for a liquefied natural gas export facility in Coos Bay and would include a 229-mile, 36-inch diameter pipeline from Malin in Klamath County to the facility in Coos Bay. Under Section 401 of the Clean Water Act, DEQ has the authority to certify whether federally permitted activities that may result in a discharge to state waters comply with applicable water quality standards.

Visit **https://www.oregon.gov/deq/wq/wqpermits/Pages/Sect... (https://www.oregon.gov/deq/wq/wqpermits/Pages/Section-401.aspx)** to learn more about the 401 Water Quality Certification.

Visit **https://www.oregon.gov/deq/Programs/Pages/Jordan-C... (https://www.oregon.gov/deq/Programs/Pages/Jordan-Cove.aspx)** to view the denial letter, evaluation report and other information on Jordan Cove. Other documents, including previous information requests and Jordan Cove's responses are also available on this webpage.

Contacts: Katherine Benenati, DEQ, 541-600-6119, **benenati.katherine@deq.state.or.us (mailto:benenati.katherine@deq.state.or.us?subject=RE:%20)**

Attachments

Categories:

Environment & Energy

Exhibit 5

Barbara Gimlin, P.O. Box 1527, North Bend, OR 97459

(541) 404-0355 — bgimlin@charter.net

December 16, 2014

Jeff C. Wright, Director
Office of Energy Projects
Federal Energy Regulatory Commission
888 First Street N.E.
Washington, DC 20426

RE: Public Comment on Jordan Cove Energy Project, L.P., Draft Environmental Impact Statement; FERC/EIS-0223F; Docket No. CP07-444-000; LNG Terminal Facility

Dear Mr. Wright,

I am sincerely concerned about soil contamination issues at the proposed site for a liquefied natural gas (LNG) terminal facility for the Jordan Cove Energy Project (JCEP) in North Bend, Oregon. I am a biologist and environmental specialist with a 30-year professional background that includes working as an educator and contract biologist, in addition to working 15 years for the Federal Emergency Management Agency (FEMA) as an environmental specialist from 1998 to 2013. At FEMA I specialized in writing Environmental Assessments and ensuring compliance with the National Environmental Policy Act (NEPA) for FEMA-funded projects. My knowledge and awareness related to JCEP site contaminants comes from firsthand experience working for the JCEP while employed by SHN Consulting Engineers & Geologists, Inc. (SHN) in Coos Bay as a biologist and environmental compliance specialist from March 2013 to April 2014.

I was initially hired by SHN to revise JCEP Resource Report 3 for Vegetation, Wildlife and Fish. I have also assisted in writing Exhibits P (Fish and Wildlife Habitat) and Exhibit Q (Endangered Species) for the Oregon Energy Facility Siting Council (EFSC) application for the JCEP South Dunes Power Plant (SDPP) portion of the project. In between writing these reports, I have spent a considerable amount of time at the various JCEP sites associated with the terminal facility. I have participated in and written reports for numerous habitat-related surveys and studies for the project. In March 2014, I was named as the acting Environmental Inspector (EI) for the JCEP Kiewit $15 million exploratory test program conducted at the LNG terminal site on the North Spit of Coos Bay.

During my time at SHN I struggled at times with the resistance by others working on the JCEP, both inside and out of the company, to respond to what is required for environmental compliance. It was understandable on some levels (it's all in education), but not understandable when substantial environmental issues were discovered.

What I experienced while working as the acting EI for the JCEP Kiewit test program led me to submit a resignation letter to SHN on April 21, 2014, as a matter of professional integrity. When considerable contaminated soils and sediments were exposed during the test program, I was repeatedly told the issues were "being taken care of" and that I didn't need to be involved, even although I was the acting EI. What occurred during the test program did not follow the Unanticipated Hazardous Waste Discovery

Plan written for the JCEP in Resource Report 7. This plan is referred to in the JCEP Draft Environmental Impact State (DEIS) as the process that would be implemented for any construction activities. Instead of management allowing me to further assess the situation and develop an action plan for the contamination issues discovered, I became the problem. I was bluntly told more than once that my job as the acting EI was to not to delay the test program construction being conducted.

I was, and still am, very concerned about site contamination and had hoped the issues I brought to the forefront would be acknowledged and addressed in the DEIS. They have not been. In addition, the contaminant issues I drafted for EFSC Exhibit Q were left out of that exhibit and ignored.

To back up a bit, questioning practices at the JCEP terminal site first began when I found out months after the fact that Southern Oregon University Laboratory of Anthropology (SOULA) archaeologists had discovered contaminated black soils along the JCEP shoreline during cultural resources surveys conducted in September 2013. The soils were discovered at the approximate site of the proposed barge berth. SOULA archaeologists stopped their surveys in the area because of black soils that they deemed to be contaminated (allegedly arsenic) and unsafe to work in. At the time, they notified Steve Donovan, my former boss at SHN, who is an environmental engineer.

When I found out about the soils in February during a meeting with SOULA, I asked if the Oregon Department of Environmental Quality (DEQ) had been informed. I was met with a type of subdued hostility from Steve Donovan and was told it was being taken care of, that it was going to be filled anyway, and that it was not my concern. At the time I thought to myself, not before workers go in there and move the stuff around. And why not report it to DEQ immediately and address it? Since there was a window where it could eventually be addressed, I sufficed in my mind that I would just watch and make sure it was taken care of properly. It was clear from the response I received from my initial queries that further discussion was not welcome. Of note, the site is included as a borrow site to be used as fill for the SDPP. To the best of my knowledge, no further action has been taken to have the soils tested and addressed.

Fast forward to the Kiewit exploratory test program conducted in the spring of 2014 at the proposed LNG terminal site, which includes Ingram Yard and parts the dune forest. As the acting EI, I attended the pre-construction meeting and was introduced by Kiewit as the person who would oversee environmental considerations at the site. As unidentified contaminated soils and sediment surfaced during excavations conducted in Ingram Yard, during my research I came across DEQ Environmental Site Cleanup Information (ESCI Site #4704) online for the 80-acre Ingram Yard property. Previously, I had been repeatedly told it was all “clean fill” from dredging conducted by the U.S. Army Corps of Engineers (USACE) in the 1970s. That was not the complete case at all. It had been used as a log sorting yard and had been authorized as a mill waste dump site by the DEQ following the placement of fill by the USACE. There have also been allegations by locals that the site was used as a dump site outside of mill waste. Limited and inadequate testing has been done post-closure at the site to determine the full extent of the contaminants, and the testing has been limited primarily to the northern half of the site.

In my efforts to ensure the contaminated soils uncovered were addressed appropriately, I provided a copy of the Unanticipated Hazardous Waste Discovery Plan for the JCEP to Steve Donovan at SHN along with Kiewit personnel, West Coast Contractors personnel (a subcontractor hired by Kiewit), and to the archaeological monitor for the test program. As more contaminants were discovered during excavations, the protocol for site assessment, testing procedures, and compliance with regulations in place under the plan were not being followed. Although I pressed for compliance, I was precluded from any involvement in the matter as the EI. Instead, I was told it was being handled and that I didn't need to be involved. It became clear I was a figurehead EI. That worries me regarding how the future JCEP EI position will be managed.

Potential contaminates exposed by the Kiewit excavations conducted at the site included numerous black soils (north to south in Ingram Yard, including near the shoreline), bright yellow granulated/powder found in clumps of varying sizes, gray gummy material found in clumps (likely related to hydraulic drilling conducted by GRI), and the exposure of an underground concrete storage tank punched through by heavy equipment with unknown liquid inside. The underground tank was located within 15 feet of a temporary office trailer placed for workers at the site near the shoreline and was proclaimed to be an abandoned septic tank by Steve Donovan at SHN, without being tested or researched. There was no apparent smell and the liquid looked gray and foamy. The tank opening was covered by plywood and workers continued to park next to it and walk over it until I asked that it be cordoned off until tests were conducted.

To add to my growing alarm, the archaeologist hired to monitor Kiewit construction activities throughout the site reported his work boots were falling apart due to the seams disintegrating. Initially, he included reports of the potential contaminants he encountered during his monitoring for cultural resources. Under pressure he stopped including the information, as he's an employee who self proclaims he "rides for the brand." Additional information on the contaminants he encountered beyond his initial weekly reports can now only be found in his handwritten journals turned in for the project that are likely stuffed away in some box.

As the contaminant issues mounted, I stressed with my boss at SHN, Steve Donovan, that the Oregon DEQ needed to be contacted and that their policies and regulations needed to be followed. Instead, my hands were kept tied in terms of fulfilling my role as the acting EI and my attempts to initiate action were initially ignored (he was so busy) and then met with subdued hostility. Steve Donovan's standard line, similar to his response about the SOULA concerns with black soils, was to say that it was being taken care of and that I didn't need to be involved. When pressed, Steve Donovan would say he had contacted the DEQ but he wouldn't provide any details when asked for the sake of the administrative record. It was frustrating, to say the least.

While the potential contamination continued to be untested, I became the problem instead. When I repeatedly reported concerns about ongoing discoveries and the process that needed to be followed, my efforts were repeatedly ignored most of the time, or I was told I didn't need to be involved. I was restricted from taking any action that I felt would make the project not only compliant with environmental policies and regulations in place, but ultimately would assist the project as it continues to move forward. After submitting my resignation I contacted the primary DEQ contact for the environmental cleanup site at Ingram Yard, Bill Mason, and learned he had not been informed of any of the contaminant issues being exposed by the Kiewit test program.

The DEQ should have been contacted immediately when the black soils were discovered by SOULA archaeologists in September 2013, and again when the contaminated soils were uncovered during the Kiewit test program. Instead of taking action as the acting EI, I was restrained and told several times I needed to stop acting like a regulator. I have never been a regulator, but I do know the environmental laws and the ones I don't know I research when needed. There was a process that needed to be followed, but wasn't. And it was clear project managers did not want to hear about it from me.

I'm a supporter of the JCEP but am deeply concerned by the incidents that led me to sever my ties with SHN and the project. There is not a commitment to ensure regulatory compliance and, henceforth, accountability, transparency, and integrity for the project. I don't want to believe that the top project managers condone what has transpired. However, when I contacted Bob Braddock, JCEP Vice President and Project Manager, this past summer about my continued concerns, his short response was that he would take my concerns up with SHN. My response was, "therein lies the problem." I never heard back.

In the DEIS the Ingram Yard soils are repeated referred to as clean fill and as being free of contaminants. What little is mentioned as testing having been conducted does not address the limited areas tested and the concerns raised by the DEQ in 2006, including that there are bioaccumulating toxins that would be extremely harmful to marine life if released into the waters of Coos Bay (e.g., via stormwater during transportation, relocation, and use as filtration for stormwater management). The JCEP plans to excavate and transport approximately 2.3 million cubic yards of the upland soils from the terminal site for use as 20-30 feet of fill for the shoreline SDPP site.

The transparency of the JCEP has become a huge concern of mine since the implementation of the Kiewit test program. In addition to the large amounts of potential contaminants exposed during the test program that were not dealt with, I had repeatedly pointed out early in the design stage back in January that the access road along the shoreline was not paved during weekly conference calls with David Evans and Associates (DEA). It was not ever corrected in the NPDES permit submitted to the DEQ by DEA for the test program, or addressed by DEQ-required conditions for the permit, even though substantial improvements were conducted on this road. In addition, a staging area was constructed within 150 feet of the shoreline in Ingram Yard, ignoring standards established by the National Marine Fisheries Service. The approach of "let's wait and see if it comes out in the public comment period" proclaimed by Sean Sullivan, the DEA lead, for the NPDES permit didn't settle well with me. Vast improvements were made during the Kiewit test program to the shoreline dirt road, without any specifications or requirements by the DEQ for the work at that location because no one at the DEQ checked for site plan accuracy. Would other permits or authorizations have been required for work so close to the shoreline? That's what an environmental professional asks and I did. But only internally, as my comments were discounted by both SHN and DEA.

As the acting EI position for the Kiewit test program, I asked repeatedly that the correct process be followed, stressing transparency was paramount. I tried many times (oral, hand-delivered, phone messages, emails) to communicate this and either did not receive a response or was reprimanded. Despite my concerns raised, with not only SHN but with supervisors at the site, the process wasn't being followed. Prior to resigning from SHN, I learned of additional contaminants being exposed on Friday night of April 18, 2014. I went into work on Saturday morning and alerted all key personnel by email that the Unanticipated Hazardous Waste Discovery Plan for the JCEP needed to be implemented and the protocol followed. The message was tagged as urgent and I emphasized the plan needed to be implemented before workers returned to the site on Monday. I included a personal commitment to assist in addressing the potential issues as expeditiously as possible.

I did not receive one response or phone call in return. When I went into work Monday morning, I was greeted by Steve Donovan who told me I had gotten myself in trouble with Bob Braddock and that I had gone too far. He sternly told me I had gotten off on the wrong foot, that I needed to focus on the "birds and the bunnies," that I had been very disruptive for the Kiewit test program, and that my job with SHN was not to delay the construction occurring at the time. I learned that nothing would be done, construction at the site was commencing without interruption, and there was no plan to deal with the potential contaminants. At that point, after 2-1/2 weeks of trying to resolve the matter, I felt I had no choice and turned in my letter of resignation.

I have a good rapport with the various resource agencies in Oregon from my work for FEMA, and also from when I have worked on my own as an independent environmental consultant. My professional name and integrity was put at stake when I was told my job was to stand back, thereby restricting me from ensuring the proper environmental response was carried out. Within my discipline there is a strict code of ethics (or should be) and I chose not to turn my back on doing the right thing. Transparency, due diligence, and integrity are very important to me. I have not felt they have been important for the JCEP decision makers at hand during the critical moments when a response could have been initiated.

I support the JCEP. I do not support what has recently transpired and sincerely hope it is a reflection of bad judgment on those firms (SHN, DEA) tasked with ensuring this project is transparent and committed to ensuring laws will be followed, including commencing with environmental cleanup as necessary that is coordinated with the Oregon DEQ. The JCEP has inherited property that has issues. These issues can and should be addressed immediately as they arise, and as spelled out by the DEQ. It would be a huge endorsement for the project that they are committed to doing the right thing. Handled correctly, it does not need to be covered up and people like me do not need to be treated as obstacles.

I felt as if I made a strong point by resigning. I had hoped that SHN and DEA would present and address the issues exposed and that the appropriate analysis would be included in the FERC DEIS. Instead, once the DEIS was released I saw that my concerns were excluded and that the Ingram Yard contaminated fill is instead repeatedly referred to as clean and plans are proceeding to use it as fill for the proposed SDPP shoreline site. And no mention is made of the proposed barge berth site, also a borrow site for the SDPP, being contaminated (SOULA, 2013)

The DEIS refers to the DEQ as issuing a "No Further Action" for the environmental clean-up at the terminal site (DEQ, 2006), but if you look at DEQ's website it is listed as a "Partial No Further Action" and is based on the premise that contaminants at the site excavated during future site activities or development must be properly managed and disposed of in accordance with DEQ regulations and policies. Much more testing is needed at the site, due to the much larger extent of contaminated soil exposed during the Kiewit test program. The contamination occurs well outside of the range of where the previous testing was conducted in only the northern portion of the site. Black soils were found all the way to the shoreline at Ingram Yard, along with the additional forested shoreline site to the east encountered by the SOULA archaeologists. And I can't help but wonder if the underground storage tank was ever properly tested and analyzed. It certainly isn't mentioned in the DEIS. Very little regarding this whole issue is included in the DEIS, except for the misrepresentation of the fill being tested and as being free of contaminants.

In addition, the only stormwater management plan referred to in the DEIS is the one included in Resource Report 2, and it is far from adequate. A stormwater management plan needs to be individually developed for the site which clearly takes into account the contaminants at the site and ensures they are not transported to the shoreline SDPP site, where stormwater currently will be transported through a series of ditches and swales for release in the slip and access channel created for the project. Treatment is briefly mentioned as being included as needed, but there is no clear, site-specific plan included in the DEIS and there should be.

The narrative, plans and figures presented in the DEIS are substantially incomplete regarding the contaminant issues encountered by the project so far. It does not present or address these issues. Much more testing is needed and potentially hazardous materials need to be transferred off-site to a DEQ-approved facility for disposal, not transferred to the SDPP site for use as fill along the Coos Bay estuary. The matter is being swept under a rug and the project has set a very disconcerting precedence regarding how issues encountered at the terminal site will be managed. By not clearly and adequately analyzing the affected environment in the DEIS, the potential environmental consequences of the project are not being addressed. Therefore, cumulative effects and conclusions drawn from the misrepresentation of the site are inadequate.

The ongoing issues at the JCEP terminal site needs to be addressed, including corrective actions that will be taken to minimize potential adverse effects. This needs to be clearly spelled out in the Final EIS before a Record of Decision is issued; otherwise the NEPA process is not being followed.

I would be happy to answer any questions you may have and to steer you to the relevant reports that back up my allegations.

Sincerely,

Barbara Gimlin[1]

[1] electronic signature

cc: Ken Phippen, Branch Chief, Oregon Coast Habitat Branch, National Marine Fisheries Service (NMFS)
Brent Norberg, Office of Protected Resources, NMFS Northwest Region
Shawn Zinszer, Portland District Regulatory Branch Chief, USACE Portland District Regulatory Branch
Teena Monical, Eugene Section Chief, USACE Eugene Field Office
Tyler Krug, Project Manager, USACE North Bend Field Office
Patty Burke, District Manager, BLM Coos Bay District Office
Jennifer Sperling, Botanist, BLM Coos Bay District Office
Dennis McLerran, Administrator, U.S. Environmental Protection Agency (EPA), Region 10
Anne Dalrymple, Enforcement Coordinator, EPA Office of Compliance and Enforcement, Region 10
Laura Todd, Field Supervisor, Newport Field Office, U.S. Fish and Wildlife Service

Dick Pedersen, Director, Oregon Department of Environmental Quality (DEQ)
Sara Christensen, 401 Water Quality Certification Coordinator, Oregon DEQ
Bill Mason, Senior Groundwater Hydrologist, DEQ Western Region Office, Eugene
Steve Nichols, Permitting/Compliance Specialist, DEQ Coos Bay Office
Mary Abrams, Director, Oregon Department of State Lands (DSL)
Bob Lobdell, Resource Coordinator, Oregon DSL
Mike Gray, ODFW District Fish Biologist, Charleston Field Office
Stuart Love, ODFW District Wildlife Biologist, Charleston Field Office
Christopher Claire, ODFW Habitat Protection Biologist
Patti Evernden, Coos County Planning Department
Juna Hickner, Coastal State-Federal Relations Coordinator, Oregon Department of Land Conservation and Development
Crystal Shoji, Mayor, City of Coos Bay
Thomas Leahy, Councilor, Coos Bay City Council
Rick Wetherell, Mayor, City of North Bend
David Koch, Chief Executive Officer, International Port of Coos Bay
John Souder, Executive Director, Coos Watershed Association

Warren Brainard, Chief, Confederated Tribes of Coos Lower Umpqua and Siuslaw Indians (CTCLUSI)
Howard Crombie, Director, Department of Natural Resources, CTCLUSI
Bob Garcia, Chairman, CTCLUSI
Don Ivy, Chief, Coquille Indian Tribe
Brenda Meade, Chairperson, Coquille Indian Tribe

Exhibit 6

TOPIC	REQUESTED ACTIONS INCLUDING COMMENTS/QUESTIONS
Inconsistencies in Project Information That Have the Potential to Effect the Review of the DEQ WQC	The project information included in permit applications and authorization requests submitted to local, state and federal agencies by the Jordan Cove Energy Project (JCEP) varies, making it imperative that the Oregon Department of Environmental Quality (DEQ) coordinate with other respective agencies to ensure they are approving the same actions before approving the DEQ Water Quality Certification (WQC) for the project. Complete investigation and analysis is needed due to the substantial inconsistencies between what is presented to various agencies. There are significant lapses in portraying what the full scope of work for the project will entail and how potential adverse effects will be addressed. By not having a complete and consistent scope of work to evaluate, it makes it difficult for the DEQ to fully conduct the proper review and analysis needed for impacts to water quality.
Soil Contamination at the LNG Terminal Facility Site	The site of the LNG terminal (Ingram Yard) was the location of a livestock ranch until 1958. After it was acquired as part of the Menasha mill complex in 1961, the tract was occasionally used for log sorting activities. In 1972-1973, the U.S. Army Corps of Engineers spread materials dredged during maintenance of the Coos Bay navigation channel on the site. From the late 1970s through the early 1980s sand, boiler ash, and wood debris from milling operations were placed on the property. Weyerhaeuser, which acquired the mill in 1981, spread decant solids from its wastewater treatment facility at the site between 1985 and 1994. In addition to mill waste, it is common local knowledge that Ingram Yard was a dumping site used by other entities that found it a convenient place to dump waste of unknown origins. Following closure of the mill site in 2003, it was listed as an environment cleanup site by the DEQ (ECSI #1083) and included Ingram Yard (ECSI #4704). Both sites have undergone a series of limited environmental site assessments to determine the nature and extent of contaminants that occur. Contaminants detected during investigative work over the years have included: mineral spirits, hydraulic oil, diesel, heavy-oil-range petroleum hydrocarbons (total petroleum hydrocarbons, of "TPH"), heavy metals, butylated tin compounds, polynuclear aromatic hydrocarbons, polycholorinated biphenyls, and dioxins. The DEQ issued a **<u>partial</u> no further action** letter for both sites on September 15, 2006. Residual contamination remains at the former main mill complex and Ingram Yard sites and the DEQ approved leaving contamination based on the determination that the site will remain in commercial/industrial use. For Ingram Yard, the following requirements were noted: • **While surface soils at the Ingram Yard site meet human health and ecological screening criteria, they contain low levels of potentially bioaccumulating chemicals and must not be placed in waters of the**

TOPIC	REQUESTED ACTIONS INCLUDING COMMENTS/QUESTIONS
	state. Soils and/or sediments containing residual contamination must be managed or disposed of in accordance with DEQ rules. Additional testing, evaluation, and coordination with the DEQ is needed to ensure placement of fill removed from Ingram Yard or any other potentially contaminated sites within the project footprint consists of only clean fill that has been properly tested, due to the project's proximity to Coos Bay. **The potential release of contaminants into Coos Bay through improper placement of contaminated fill and subsequent release through stormwater or by washing into the bay due to a tsunami would expose fish and marine life to bioaccumulating toxins that would be devastating not only to the fish and marine life, but to humans who could potentially consume them.** During the implementation of a $15 million JCEP exploratory sheet pile and ground penetration test program at Ingram Yard and the dune forest to the east during the spring of 2014, contaminated soil was exposed virtually everywhere excavation occurred in Ingram Yard , all the way to the shoreline. This includes contaminated soils exposed during excavation of a 150'x150' staging area to approximately 4' depth in the northern portion of Ingram Yard and along the road improvements conducted in Ingram Yard from the Trans Pacific Parkway all the way to the shoreline. In addition, during archaeological surveys conducted in the southern portion of the dune forest along the Coos Bay shoreline (also mapped as a borrow area for project fill), archaeologists stopped surveys in the immediate vicinity due to dark black soils that they felt were too contaminated to safely proceed. The soils in this area have not been tested during previous site closure evaluations and the additional contamination issues exposed need to be taken seriously. It is now known that contamination at the JCEP terminal site occurs well outside of the range of where the previous testing was conducted. Much more testing is needed at the overall site to fully understand the extent. While the types of contaminants are somewhat understood, their extent is not. It is extremely important that all pertinent facts regarding potential contaminants be presented for consideration and evaluation prior to placement of fill anywhere within the project footprint. In the Draft Environmental Impact State (EIS) prepared for the project, the JCEP plans to excavate and transport approximately 2.3 million cubic yards of the upland soils from the terminal site (known as Ingram Yard) for use as fill for the shoreline South Dunes Power Plant (SDPP) site. This does not include additional sites along the forested shoreline where other contaminants have been exposed, and other potential sites within the project footprint on the North Spit of Coos Bay. Since the DEQ WQC application is not available for public review (at

TOPIC	REQUESTED ACTIONS INCLUDING COMMENTS/QUESTIONS
	least that I could find), my comments are based on what's presented regarding the use of the fill in the Draft EIS The Draft EIS states 20-30 feet of fill will be used at the South Dunes Power Plant (SDPP) site. However, in the JCEP's application to the Oregon Department of Energy (DOE) for the Energy Facility Siting Council, it states 40-46 feet of fill will be used and it will go right up to the shoreline along Jordan Cove. Regardless of the amount of fill, **due to the fact that it will be excavated from a site known to be a mill dumpsite with bioaccumulating toxins**, there should be a clear plan in place for how the extensive contamination will be managed, handled, and disposed of. It is not acceptable to use contaminated soils as fill anywhere within the project boundaries when the potential for stormwater runoff and/or being washed into the bay from a tsunami presents a very real concern to the marine and natural environment of Coos Bay. All contaminated soil needs to be hauled offsite, with Best Management Practices (BMPs) to ensure construction equipment and vehicles handling it do not result in the further spread of these contaminants into the bay. A testing and monitoring plan needs to be developed and approved by the DEQ prior to approval of the WQC to ensure any fill transferred within the project footprint for use as fill for elevation of the project is free of potential contaminants. By not clearly and adequately analyzing the contaminated soils throughout the JCEP North Spit site and at the Kentuck mitigation site, the effects to water quality have the potential to have significant adverse effects to fish and marine life in Coos Bay.
Unanticipated Hazardous Waste Discovery Plan and Need for Third Party Monitoring	The Unanticipated Hazardous Waste Discovery Plan developed by the JCEP sounds good, but I can tell you from firsthand experience as the acting Environmental Inspector for project's $15 million exploratory test program conducted at the LNG terminal site in the spring of 2014 that this plan was not followed in the least. Instead, I was ordered to not do my job, to not follow the plan, to not contact the DEQ, and to not delay the ongoing construction activities being conducted at the time**. It is essential that third-party environmental monitors are in place to ensure this doesn't happen again on a much larger scale.**
General Stormwater Management	Potential contaminants in stormwater need to be addressed in the development and implementation of a stormwater management plan that meets DEQ National Pollutant Discharge Elimination System (NPDES) permit requirements to reduce the potential impacts to fish and marine species, whether listed as threatened or endangered for not. The only stormwater management plan referred to in the Draft EIS is the one included in Resource Report 2, and it is far from adequate. A stormwater management plan needs to be individually developed for the site which

TOPIC	REQUESTED ACTIONS INCLUDING COMMENTS/QUESTIONS
	clearly takes into account the contaminants at the site and ensures they are not transported to the shoreline SDPP site or anywhere else inside the project footprint along the shoreline of Coos Bay. As stated in the Draft EIS, stormwater currently will be transported through a series of ditches and swales for release in the slip and access channel created for the project. Treatment is briefly mentioned as being included as needed, but there is no clear, site-specific plan included in the Draft EIS and there should be. For the Oregon Department of Energy site application with EFSC, a Conceptual Stormwater Management Plan for the JCEP (Document No. 142488-0000-DS0300) dated October 24, 2014, was included. It did not bring up or address the ongoing contamination issues at the site and the BMPs it proposes to not begin to properly address the real and relevant concerns. If anything, it is alarming as it states placement of what they refer to as “sand fill” throughout the plan (from Ingram Yard) will create approximately 2,512,300 square feet of exposed slopes along the SDPP shoreline. It also states monitoring and testing of the stormwater outfalls will be developed as the stormwater design is finalized. This is not good enough. If this issue is not fully evaluated and a stormwater management plan is approved by DEQ prior to issuing a WQC, there is no guarantee an adequate plan will be in place to address the ongoing issues. In addition, the proposed scope of work states the work will be conducted during the Oregon Department of Fish and Wildlife’s work window for Coos Bay, which occurs during the months with the highest monthly averages of precipitation (November, December and January). This makes it imperative that extensive BMPs and policies are in place to ensure potential contaminants exposed during excavation at the site are not released into the bay via stormwater. In addition to ensuring ANY potential site contaminates are properly managed and disposed of, **a monitoring and testing program needs to be clearly spelled out in the WQC** in order for the DEQ to fully review and analyze the soil contamination issue and ensure the potential effects to the human and natural environment are minimized and mitigated.
Additional Contaminant Concerns Related to Stormwater	Stormwater management for the project plays on increasingly important role in determining the potential effects to coho salmon and other fish and marine species in Coos Bay. Potential concerns have been elevated in recent years regarding even trace amounts of contaminants (i.e., copper, zinc, PAHS, etc.) that may be discharged into waterways. Although limited studies have been conducted to date, it is theorized that depending on their reaction to water quality and activity within the mixing zone, coho salmon may have migration delays, may move into less-protected habitat, or may become more susceptible to predation.

TOPIC	REQUESTED ACTIONS INCLUDING COMMENTS/QUESTIONS
	Pollution reduction and treatment for stormwater runoff needs to clearly address how stormwater will be contained and/or transported from all contributing impervious areas within the project footprint to ensure contaminants harmful to fish and marine life are adequately controlled.
Intertidal Flats Mitigation Proposed for Kentuck Slough	Per the joint Public Notice by the DEQ and the U.S. Army Corps of Engineers (Corps), the JCEP proposes to mitigate for other estuarine aquatic resource impacts through the enhancement of 14.33 acres of freshwater wetland habitat, restoration of 1.88 estuarine wetland habitat and reestablishment of historic tidal flows to approximately 45.1 acres of wetland habitat (converting freshwater wetland to unvegetated tidal mudflat channels) at the former Kentuck Golf Course (Kentuck Slough Mitigation Site), east of North Bend. The estuarine intertidal flats mitigation proposed for Kentuck Slough by the JCEP has not undergone the serious environmental and hydrologic evaluation needed to ensure the mitigation will not result in contamination of the Coos Bay estuary due to the site's use as a golf course for over four decades, flooding of adjacent and upstream property owners, and a potential mosquito infestation that would affect area residents. Much more input is needed from hydrologists, engineers, natural resources scientists, and planners to fully understand and design a plan for the site that will address current and future site-specific conditions on the ground, including upstream of the site. There are substantial inconsistencies in the various compensatory mitigation plan versions floating around in the regulatory system for the Kentuck mitigation proposed by the JCEP. The lack of consistency is an indicator that the project warrants close and interactive scrutiny by the local, state and federal agencies that are authorized to review and approve the project. Each authorizing agency needs to ask tough questions, to coordinate with other respective agencies to ensure they are approving the same actions, and to expect complete investigation and analysis before approving any action. These inconsistencies, together with the lack of appropriate studies and associated documentation, is alarming. As it stands, there is a significant potential for substantial adverse effects from the mitigation proposed at Kentuck to water quality. My public comment to FERC submitted on February 12, 2015, provides substantially more information regarding this issue and I encourage the DEQ to review it (FERC Comment No. 20150212-5018).
State Endangered Plant Species (Point Reyes Bird's Beak) Occurrence Along the Jordan Cove Shoreline and North Point Workforce Housing Project Slough	The Point Reyes bird's-beak (*Chloropyron maritimum* ssp. *Palustre*, formerly *Cordylanthus maritimus* ssp. *palustris*) is an annual gray-green and purple-tinged herbaceous species with pinkish to purplish red flowers that grows 4 to 16 inches tall and has few branched stems. It is listed as endangered by the State of Oregon. In Oregon, the species is restricted to Netarts Bay, Yaquina Bay, and Coos Bay, with the majority of known occurrences located along the Coos Bay shoreline (ORBIC 2013). As required by the Oregon Department of Agriculture (ODA) under OAR 603-073-0090(5)(d)(A)-(E), the project needs to document that it has made a

TOPIC	REQUESTED ACTIONS INCLUDING COMMENTS/QUESTIONS
	reasonable effort to ensure that construction and operation of the project will not result in a population loss or decline of the Point Reyes bird's-beak at the locations where it is found on adjacent shorelines. Focused botanical surveys were conducted during July and August of 2013 during the appropriate blooming period to document occurrences of Point Reyes bird's-beak in or near the JCEP project footprint. Multiple occurrences of substantial populations were detected along the shoreline of Jordan Cove, near Wetland J at the SDPP site, on the shoreline east of the SDPP site boundary, and along the North Point Slough entrance at the proposed North Point Workforce Housing site. It is essential that appropriate Best Management Practices (BMPs) and mitigation measures are implemented to ensure the species is preserved and protected. Although the JCEP states appropriate mitigation measures will be developed and implemented through consultation with the ODA to ensure that suitable habitat for the Point Reyes bird's-beak will not be impacted by construction of the project, the lack of documentation of this actually happening is missing. While employed by SHN Consulting Engineers & Geologists, Inc. (SHN) for the JCEP, I initiated consultation with the ODA–but much more follow-up is needed. The project has dropped the ball on this one. The Point Reyes bird's-beak populations documented warrant further evaluation and site plans need to clearly document the potential impact to the species. At the North Point Slough location, current site plans call for a bridge to connect the two portions of the site on each side of the slough entrance and this action will involve the "take" of this species. Prior to approval of the WQC, the DEQ, as a state agency, needs to ensure mitigation measures developed in coordination with the ODA will be implemented to ensure that impacts to Point Reyes bird's-beak are avoided and minimized. A conservation and mitigation plan that includes monitoring needs be developed and approved by the ODA prior to issuance of the WQC by the DEQ to ensure the project is not likely to cause a significant reduction in the likelihood of survival or recovery of the species.
Tsunami Hazards	In a 13-year study completed by Oregon State University in 2012 (published online by the U.S. Geological Survey; Professional Paper 1661-F), **the study concluded that there is a 40 percent chance of a major earthquake in the Coos Bay region during the next 50 years due to its location along the Cascadia Subduction Zone**. The study determined such an earthquake could approach the intensity of the Tohoku quake that devastated Japan in March of 2011. This extensive study not discussed or considered in the risk evaluation by the JCEP. In addition, a multi-state mitigation project of the National Tsunami Hazard Mitigation Program (NTHMP) published Seven Principles for Planning and Designing for Tsunami Hazards in March 2001. Participants includes

TOPIC	REQUESTED ACTIONS INCLUDING COMMENTS/QUESTIONS
	the National Oceanic and Atmospheric Administration (NOAA), U.S. Geological Survey, Federal Emergency Management Agency, National Science Foundation and the states of Alaska, California, Hawaii, Oregon, and Washington. Funding for this project was provided by NOAA. This valuable study was not used either in determining the tsunami risks for the JCEP. The DEQ needs to review the findings of these two well researched reports in their decision-making process, as the potential for contaminants to be washed into the bay during a tsunami event becomes a very real concern to water quality.
Transparency and Integrity Issues	During my time working for the JCEP under SHN from March 2013 to April 2014, I encountered serious transparency and integrity issues with the management of both SHN and another primary consultant, David Evans and Associates. From inaccurate site plans submitted with permits to failing to address issues as they arose, the standard operating procedures of “let’s wait and see if it comes out in public comment” is not the proper response to issues. Hence my public comment.

Exhibit 7

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMSSION

IN THE MATTERS OF

Jordan Cove Energy Project, L.P.	**)**	**Docket No. CP13-483-000**
Pacific Connector Gas Pipeline, L.P.	**)**	**Docket No. CP13-492-000**

MOTION TO INTERVENE OUT OF TIME OF CLAUSEN OYSTERS AND LILLI CLAUSEN, AS AN INDIVIDUAL AND OWNER

Pursuant to Rule 214 of the Commission's Rules of Practice and Procedure, 18 C. F. R., 385.214, I, Lilli Clausen, an individual and owner of Clausen Oysters, respectfully move to intervene out of time in the May 21, 2013, application of the Jordan Cove Energy Project, L.P. and the June 6, 2013, application of the Pacific Connector Gas Pipeline, L. P. in the above-captioned dockets.

I. Identity and Contact Information

I ask that all communication in regards to this motion be addressed to the following:

Lilli Clausen
Clausen Oysters
66234 North Bay Road
North Bend, Oregon 97459
[redacted]

II. Declaration of Interest

On May 21, 2013, Jordan Cove Energy Project, L.P. filed in FERC Docket No. CP13-483-000 an application under section 3 of the Natural Gas Act (NGA) and Parts 153 and 380 of the Commission's regulations, seeking authorization to site, construct and operate a natural gas liquefaction and liquefied natural gas (LNG) export facility on the bay side of the North Spit of Coos Bay in Coos County, Oregon, directly across from the Cities of North Bend, Coos Bay and the Southwest Oregon Regional Airport. The LNG Terminal would be capable of receiving natural gas via the Pacific Connector Gas Pipeline, liquefying it, storing it in its liquefied state in two cryogenic storage tanks, and loading the LNG onto ocean going vessels.

On June 6, 2013, Pacific Connector Gas Pipeline, L. P. filed an application under CP13-492-000 with FERC to construct and operate the Pacific Connector Gas Pipeline (PCGP) Project, a new 231.82-mile, 36-inch diameter interstate natural gas transmission system and related facilities. The proposed PCGP system will extend from the proposed Jordan Cove Liquefied Natural Gas (LNG) Terminal, being developed by Jordan Cove Energy Project, L.P. (JCEP), to interconnects with two interstate natural gas pipelines near Malin, Oregon. The PCGP is the proposed supply pipeline for the proposed Jordan Cove Terminal.

We continue to get conflicting information about the proposed route of the Pacific Connector Gas Pipeline and have been very concerned about the proposed route of the pipeline through Haynes Inlet and the West side of Coos Bay. As we understand it, the line is proposed to run between Silverpoint 1 and Silverpoint 3 oyster beds. The route going under the Highway 101 Bridge would be very detrimental to our oyster business for several reasons:

We need access to the three oyster beds: Silverpoint 1, 7 and 8, depending on the different tide levels, at various times of the day or night. The harvest crew goes out with the boats at low tide. The large barge is taken out at high tide to bring in the full nets. The channel between Silverpoint 1 and 3 is narrow. We couldn't fill orders if big equipment is being used to dig the trench for the pipeline, preventing us from going through.

Also, we need access to our three oyster beds, Silverpoint 1, 7 and 8, at all times. All the Silverpoint oyster beds: 1, 3, 5, 6, 7, 8 & 9, may be affected by mud or fines in the water which might prevent us from harvesting the oysters according to Dept. of Agriculture regulations. We are also storing our "re-beds" on S 1 for more grow out time. We bring them in as they are ready. Another problem would be the new seed placed around S 1 could potentially be affected by the fines suspended in the water.

When a pipeline is constructed in the water, mud and sand are suspended in the water, especially on windy days. It could drift over our one, two and three year old oysters in the bay. Oysters are filter feeders. They seine out the tiny plankton from the seawater to feed on. Mud, sand or fines could clog the gills of countless oysters. I would hate to have a repeat of the New Carissa oil spill effect. It took 4 years and 9 months before we were paid for the damage!

Another worry is the 250 foot construction right of way in the Bay! Any kind of hole or ditch dug in the mudflats takes years before the ground above it solidifies. One example is at the foot of the boat ramp next to us. A five foot diameter hole left by someone was like quicksand, and one couldn't walk across it for several years!

The line between Silverpoint 1 and 3 could cause problems when accessing the oyster beds, especially at night. Usually the boats are parked in shallow water close to the area to be harvested. I would hate for our guys to get stuck there. And the channel is very narrow! Since the original Silverpoint oyster beds were established in 1890 in Coos Bay and over the years have been worked by various oyster companies, we feel that this resource should be maintained and not jeopardized.

Due to the fact that the Pacific Connector Gas Pipeline's current proposed route could destroy our oyster business, I move to intervene out of time in this proceeding. No other party has been willing or is able to adequately represent our interest in this proceeding and it is for this reason I wish to be made a party to this proceeding, with all the rights attendant to such status. The decision by FERC to allow this Motion/Notice of Intervention Out of Time would be in the public interest.

Dated this 15th day of October 2014.

Lilli Clausen, Clausen Oysters

CERTIFICATE OF FILING

I certify that on the 15th day of Oct 2014, I filed by electronic filing the original document, Motion to Intervene Out of Time electronically with:

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

Dated this 15th day of Oct 2014

Lilli Clausen, Clausen Oysters

CERTIFICATE OF SERVICE

I certify that on the 15th day of Oct 2014 I served electronically or by first class mail this Motion to Intervene Out of Time to each person designated on the official service list compiled by the Commission in the above-captioned proceedings.

Dated this 15th day of Oct 2014

Lilli Clausen, Clausen Oysters

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMSSION

IN THE MATTERS OF

Jordan Cove Energy Project, L.P.	**)**	**Docket No. CP13-483-000**
Pacific Connector Gas Pipeline, L.P.	**)**	**Docket No. CP13-492-000**

MOTION TO INTERVENE OUT OF TIME OF COOS BAY OYSTER COMPANY AND JACK HAMPEL, AS AN INDIVIDUAL AND OWNER

Pursuant to Rule 214 of the Commission's Rules of Practice and Procedure, 18 C. F. R., 385.214, I, Jack Hampel, an individual and owner of Coos Bay Oyster Company, respectfully move to intervene out of time in the May 21, 2013, application of the Jordan Cove Energy Project, L.P. and the June 6, 2013, application of the Pacific Connector Gas Pipeline, L. P. in the above-captioned dockets.

I. Identity and Contact Information

I ask that all communication in regards to this motion be addressed to the following:

Jack Hampel
Coos Bay Oyster Company
PO Box 5478
Charleston, Oregon 97420
[redacted]

II. Declaration of Interest

On May 21, 2013, Jordan Cove Energy Project, L.P. filed in FERC Docket No. CP13-483-000 an application under section 3 of the Natural Gas Act (NGA) and Parts 153 and 380 of the Commission's regulations, seeking authorization to site, construct and operate a natural gas liquefaction and liquefied natural gas (LNG) export facility on the bay side of the North Spit of Coos Bay in Coos County, Oregon, directly across from the Cities of North Bend, Coos Bay and the Southwest Oregon Regional Airport. The LNG Terminal would be capable of receiving natural gas via the Pacific Connector Gas Pipeline, liquefying it, storing it in its liquefied state in two cryogenic storage tanks, and loading the LNG onto ocean going vessels.

On June 6, 2013, Pacific Connector Gas Pipeline, L. P. filed an application under CP13-492-000 with FERC to construct and operate the Pacific Connector Gas Pipeline (PCGP) Project, a new 231.82-mile, 36-inch diameter interstate natural gas transmission system and related facilities. The proposed PCGP system will extend from the proposed Jordan Cove Liquefied Natural Gas (LNG) Terminal, being developed by Jordan Cove Energy Project, L.P. (JCEP), to interconnects with two interstate natural gas pipelines near Malin, Oregon. The PCGP is the proposed supply pipeline for the proposed Jordan Cove Terminal.

On December 18, 2014, I met with Representative Caddy McKeown and Michael Hinricks of the Jordan Cove Energy Project where I learned about the plans of the Pacific Connector Gas Pipeline and the close proximity of the proposed pipeline to our Silverpoint oyster beds. As we understand it, the line is proposed to run up the channel between ours (Silver point 3) and Clausen Oysters (Silver point 1) oyster beds.

Our concern is the effect that the construction of the Pacific Connector Gas Pipeline will have on our oysters along the proposed route through the Haynes Inlet on Coos Bay.

Our oysters are planted at the minus tide lines to utilize the mud flats as close to the channel as we can get. At certain minus tides, the channel may only be 100-200 feet wide. With the amount of mud and sand sediment that would be created within the close proximity of our beds, I believe we could suffer a devastating dead loss.

In the summer months, we set oyster larvae on shell and place them on pallets in bags that keep them up about a foot off the mud flats. This is done to keep them out of any silt or sediment while letting them grow through fall and winter for planting in the spring.

These larvae, when first set, are very small and very vulnerable. (Twelve million larvae equal about the size of a tennis ball).

When the oyster spat are planted in the spring (March-June), by removing them from the bags and pallets and cast directly onto the mud flats, they are approximately ¼ to ½ inch in diameter, and if you cover them with sediment, they will die!

I am also concerned about the bay water quality in this area during the construction time. The Oregon Department of Agriculture will surely be testing this water and if they have any concerns during this period, they will shut our harvesting down.

We need continual access to these beds both day and night. We work on the tides and they change daily.

Due to the fact that the Pacific Connector Gas Pipeline's current proposed route could destroy our oyster business, I move to intervene out of time in this proceeding. No other party has been willing or is able to adequately represent our interest in this proceeding and it is for this reason I wish to be made a party to this proceeding, with all the rights attendant to such status. The decision by FERC to allow this Motion/Notice of Intervention Out of Time would be in the public interest.

Dated this 28th day of February 2015.

__*/s/ Jack Hampel*______________________
Jack Hampel, Coos Bay Oyster Company

Exhibit 8

Clam Diggers Association of Oregon

Chuck Erickson, Director
2727 Stanton Street
North Bend, OR 97459

William Lackner, President
P.O. Box 746
Newport, OR 97365

February 21, 2014

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street NE
Washington, DC 20426

RE: Motion to Intervene Out of Time submitted by the Clam Diggers Association of Oregon on February 20, 2014, for FERC Dockets CP13-483-000 and CP13-492-000

Dear Secretary Bose:

After submitting our *Motion to Intervene Out of Time* yesterday it was brought to our attention that we had the wrong date listed under our Certificate of Service portion of that Motion. Please accept this corrected version of our *Motion to Intervene Out of Time* that corrects this error. The original Motion was served to everyone in the FERC Service List for FERC Dockets CP13-483-000 and CP13-492-000 on February 20, 2014, and this corrected *Motion to Intervene Out of Time* will also be served to everyone in the Service List for the Jordan Cove / Pacific Connector Project.

Sincerely,

Chuck Erickson
William Lackner

UNITED STATES OF AMERICA
DEPARTMENT OF ENERGY
FEDERAL ENERGY REGULATORY COMMISSION

IN THE MATTERS OF

Jordan Cove Energy Project, L.P.) **Docket CP13-483-000**

Pacific Connector Gas Pipeline, L.P.) **Docket CP13-492-000**

CLAM DIGGERS ASSOCIATION OF OREGON MOTION TO INTERVENE OUT OF TIME

Pursuant to 18 C.F.R. 385.214, the Clam Diggers Association of Oregon, hereby respectfully moves to intervene in the Jordan Cove Energy Project and the Pacific Connector Gas Pipeline applications submitted to the FERC on May 21, 2013 and June 6, 2013.

I. Identity/Contact Information

We ask that all communication in regards to this motion be addressed to the following:

Chuck Erickson, Director
Clam Diggers Association of Oregon
2727 Stanton Street
North Bend, OR 97459
[redacted]

William Lackner, President
Clam Diggers Association of Oregon
P.O. Box 746
Newport, OR 97365
[redacted]

II. Declaration of Interest

On May 21, 2013, Jordan Cove Energy Project, L.P. filed an application under section 3 of the Natural Gas Act (NGA) and Parts 153 and 380 of the Commission's regulations, seeking authorization to site, construct and operate a natural gas liquefaction and liquefied natural gas (LNG) export facility (Liquefaction Project) on the bay side of the North Spit of Coos Bay in unincorporated Coos County, Oregon, to the north of the Cities of North Bend and Coos Bay.

On June 6, 2013, Pacific Connector Gas Pipeline, L.P. filed an application with FERC for approval to construct, own and operate a natural gas transmission pipeline in southern Oregon. The Pacific Connector pipeline would deliver approximately 1 billion cubic feet of natural gas per day to the Jordan Cove Energy Project export terminal at Coos Bay Oregon. There the natural gas would be cooled to form LNG for export from Jordan Cove's proposed export terminal.

The proposed LNG export project would require extensive dredging of the Coos Bay, including but not limited to; Channel Deepening and Widening, an LNG Marine Terminal Slip Dock and Access Channel ; and the construction of the Pacific Connector Gas Pipeline through the Coos Bay Estuary and Haynes Inlet. Due to contamination that has been found in Coos Bay sediments, this dredging will negatively impact clams in the Coos Bay both indirectly and directly as described below.

III. **Basis for Intervention**

My name is Chuck Erickson and I am the Director of the Clam Diggers Association of Oregon and have been a resident of Oregon for 58 years. We recently received records from my Oregon Public Records Request we made to Oregon International Port of Coos Bay and Oregon Department of Environmental Quality. Port released documents to us in 2014.

The following information has recently come to light.

In December 2, 1998 EPA and Oregon DEQ entered into a deferral agreement that non-compliance would be reported to the EPA concerning the clean-up of Charleston sediment contamination of hazardous substances (Tributyltin, metals, PAHs, PCBs) in Coos Bay near the proposed Jordan Cove Energy site.

In 2001 EPA Superfund Record of Decision 12.0 clearly states that bioaccumulation test were to be done two years after cleanup and annual monitoring of the sediments for five years. When this was completed the sediment quality was to be monitored at five year intervals.

In the public records emails we received from the Oregon International Port of Coos Bay and their agents, they clearly state that the annual and the five year tests were never done. The Port did not supply the bioaccumulation test results and we assume those were also never done. The Oregon Department of Environmental Quality failed to contact the EPA that the Port was non-compliant with their cleanup agreements. Emails I received late 2013 from Eugene DEQ stated they have never received any test results from Oregon International Port of Coos Bay. These facts also show that DEQ was also non-compliant with the Superfund Deferral agreement.

The records request we received included emails from the Port which show that Coos Bay sediment testing was finally done in 2012.The test results were provided to the Port in October 2013 by Geosyntec consultants. The Port did not release these documents to us until 2014.

These documents indicate heavy metals exceeding minimum requirements in the sediment composite test. The single samples tested were near maximum allowed for heavy metal. These test results also show the following contaminates: tributyltin, antimony, chromium, copper, mercury, nickel and zinc are still present in the sediments sampled. In these same requested emails there were references being made of using samples from other areas of the bay in order to close this matter.

Through our website and members we have learned that Geoduck clams have been taken by commercial and sport harvesters in Coos Bay. Pictures were posted on our website showing a Geoduck harvested. Through our research we found that these clams were present in historical times. Our organization contacted the Oregon Department of Fish and Wildlife Director Roy Elicker to list the Geoduck clams as threatened or endangered species. These clams are only found in limited numbers in Coos Bay and Netarts Bay. ODFW refused our request to list these last remaining stocks of clams. We believe that the planned facility at Jordan Cove LNG export is the reason for their refusal to take action to protect these resources. These remaining Coos Bay Geoduck clams may be the last surviving Geoducks in the State of Oregon.

The President of the Clam Diggers Association of Oregon, William Lackner, was shown pictures of clams by an Oregon Department of Fish and Wildlife employee at the Charleston Field Office. These pictures clearly showed deformed clams from Coos Bay. Mr. Lackner contacted the ODFW employee by email for copies of these photographs. The Charleston ODFW employee refused the request for copies of the photographs and stated they were his personal property.

Mr. Lackner has repeatedly made requests to Newport Oregon Department of Fish and Wildlife to implement an Invertebrate Species Plan for Oregon bays. The Clam Diggers association of Oregon has members along the entire coast of Oregon. Our members have observed clam die offs and crab die offs. When these were reported to the State of Oregon we were told the die offs were natural or they don't have people available to investigate.

Clam Diggers Association of Oregon has contacted the State of Oregon to report sewage spills in Oregon bays. The Oregon Department of Agriculture in Salem has refused to implement the sewage spill notification system to which they agreed. The State excuse is they do not have enough money.

Through our recent request for information from Eugene Oregon Department of Environmental Quality we have learned that DEQ sampling of Coos Bay 1995 dredging samples for contaminates were done incorrectly. Because DEQ did not know how to collect the samples correctly, contaminates like tributyltin could not be tested and all 14 loads of dredged materials failed to detect (TBT) tributyltin. Tributyltin is a known human health risk and can bio-accumulate in shell fish and finned fish.

We also learned from documents and recent communications that DEQ did not use scientific proven methods for detecting contaminates in Coos Bay sediments. DEQ failed to do tissue sampling on clams before and after dredging took place in Coos Bay. Because clams bio-accumulate toxic contaminates they are the litmus test if contaminates are present in sediments. This sample method is used worldwide by scientists who study the effects of environmental pollution in sediments. In other words, clams are the canaries of the coal mine.

DEQ did some limited testing of clams for contaminates in Coos Bay. From DEQ documents and communications we have learned that their sampling methods were less than scientific. DEQ never sampled the original 1970's area where baseline for contaminates were established. When DEQ did test, they never tested the same area again even though contaminates were present in high numbers for the clams sampled. DEQ did not follow scientific protocol by using baseline methodology for their tissue contaminates studies. It was also learned that the clams samples were not all sent to the testing lab as whole shell clams. The larger gaper clams were dissected and not sent whole. It was learned that some internal parts of the clam were not sent for testing. This may explain why the Gaper clams tested much lower than the softshell clams. This methodology of using two systems for sampling is less than scientific and could result in errors.

DEQ has informed the Clam Diggers Association that non source point benzo(a)pyrene levels have risen since the 1979 EPA study. This increase is noted in the Coos Bay Toxics Study. The sediment studies for Jordan Cove LNG have not included tissue sampling for clams. The methodology used by the Jordan Cove studies may contain errors for contaminates in Coos Bay sediments.

Due to the recent findings described above showing that sufficient studies have not been completed to date, and in an effort to protect Coos Bay clams, clam diggers and the interest of any and all citizens who may potentially ingest clams coming from the Coos Bay, the Clam Diggers Association of Oregon respectfully request to be made a party to this proceeding and be permitted to intervene in this proceeding with all the rights attendant to such status. No other party will or can adequately represent the Clam Diggers Association of Oregon and no prejudice to, or additional burdens would occur to existing parties as a result of the FERC permitting this intervention. Participation of the Clam Diggers Association of Oregon in this proceeding would be in the public interest.

CERTIFICATE OF SERVICE

We hereby certify that notice of this Motion to Intervene Out of Time will be served electronically or by first class mail to each person designated in the official service list compiled by the Commission in the above-captioned proceedings.

Sincerely,

Chuck Erickson
William Lackner
Dated this 20th day of February 2014

Exhibit 9

Potential Impact of
Jordan Cove LNG Terminal construction on
the Nursery Habitat of the Dungeness crab.

Salem, Oregon, January 14, 2019

Sylvia Yamada Ph.D.
yamadas@science.oregonstate.edu

The **Dungeness crab** (***Cancer magister***) supports an important commercial and sport fishery from Alaska to California. Total annual landings in recent years exceeded 25,000 tons (55 million pounds) (FAO statistics, 2012). In Oregon, the 2014 Dungeness fishing season yielded 14.4 million pounds, $50 million to crabbers and an estimated $100 million to the Oregon economy (Oregon Dungeness Crab Commission in Fisherman's News On line). *The Dungeness fishery is the most valuable commercial fishery in Oregon (Rasmusen 2013).*

The life cycle of Dungeness crab is complex, depending on both estuarine and near-shore habitats. Typically, mating occurs in shallow water, and females migrate offshore to brood and hatch their eggs. The early larval stages feed and rear in the near-shore water column, after which the final larval stage rides tidal currents back to shore and settles out in shallow estuarine habitats. The final larval stage molts into a ~5 -7 mm wide first crab stage. *The highest densities of juvenile Dungeness crabs are found in estuaries, which provide warm water, high biological productivity and protection from predators. Sand substrate and eelgrass beds are preferred habitat for these young crabs, which bury in the sand and hide in the eelgrass to escape predators.* Size measurements of crabs trapped at Russell Point in Coos Bay (below the Highway 101 McCullough Bridge) show that Dungeness crabs in their first two years of life (100 mm carapace width and smaller) are extremely abundant in the mid-to low intertidal areas such as pools and eelgrass beds (Figure 1).

In my research documenting the status of the non-native European Green crab in Coos Bay, I encounter young Dungeness crabs in all my study sites. I selected a sub-set of my sites closest to the proposed Jordan Cove Energy Project: the north and south sides of Trans Pacific Lane and the beach adjacent to the Roseburg Forest Product watchman's booth. The results from over 600 trap-days, show that young Dungeness crabs are consistently abundant from 2002 to 2014 at all sites, with an average catch of 15 per trap (Table 1). *These trapping results confirm the findings by Emmett and Durkin (1985) that estuaries are important nursery habitats for Dungeness crabs. This fact has to be kept in mind when a trench is dug In Haynes Inlet, the Trans Pacific Parkway is to be expanded and an upland area is cut out to create a berth for ocean-going vessels. Not only will the turbidity during the construction phase be of concern to the ecological community, the on-going dredging to maintain the berth and shipping channels will continue to be a disturbance to the ecosystem. It will result in habitat loss for native species, including the valuable Dungeness crab. In one study between 45 to 85 % of the Dungeness crabs died during a simulated dredging operation (Chang and Levings, 1978).*

Sylvia Yamada is a marine ecologist who has studied native crabs and the invasive European green crab in Oregon and Washington for over 20 years.

References:

Chang, B., Levings, C. 1978. Effects of burial on the heart cockle *Clinocardium nuttalii* and the Dungenes crab *Cancer magister*. *Estuarine, Coastal and Shelf Sci*ence. 7, 4009-412.

Emmett, R.L. and Durkin, J.T. 1985. The Columbia River Estuary: An Important Nursery for Dungeness Crabs, *Cancer magister*. *Marine Fisheries Review*. 47(3), 21-25.

Fisherman's News On line Sept 24, 2014 http://fnonlinenews.blogspot.com/2014/09/oregons-crabbers-riding-market-value.html

Rasmuson, L.K. 2013. The Biology, Ecology and Fishery of the Dungeness crab, *Cancer magister*. In Michael Lesser, editor: *Advances in Marine Biology*, Vol 65, Burlington: Academic Press, pp. 95-148. ISBN: 978-0-12-410498-3 Elsevier Ltd. Academic Press.

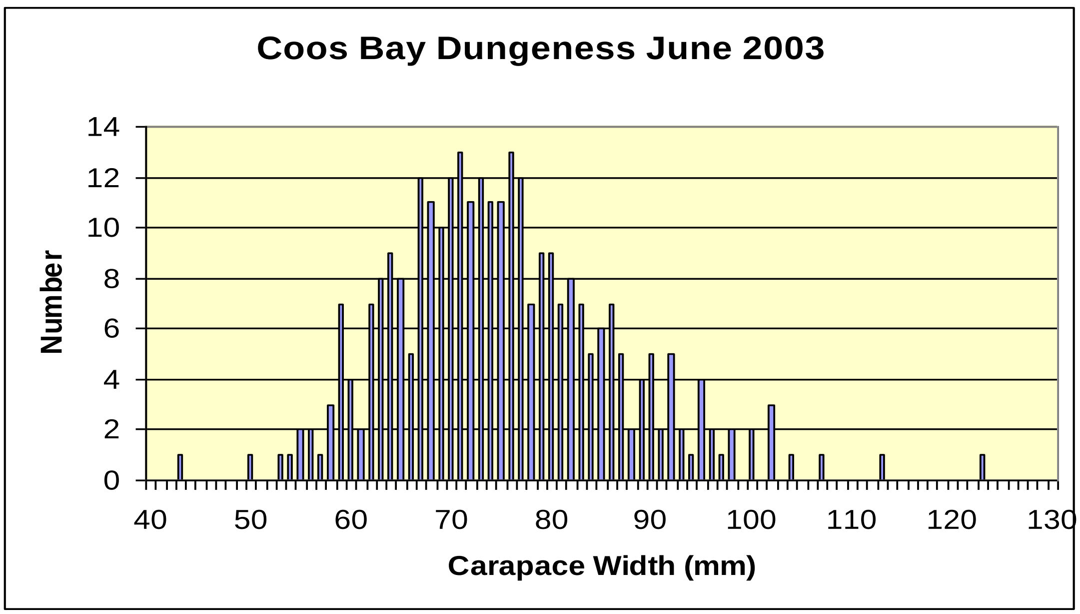


Figure 1. Size frequency distribution of Dungeness crabs trapped in pools and eelgrass at Russell Point, below the Highway 101 McCullough Bridge, in June 2003. Adult crabs are greater than 100 mm in carapace width. It is estimated that the first 2 year classes are represented.

Table 1. Trapping Data for study sites along Trans Pacific Lane and Roseburg Forest Product causeway from 2002-2014.

	Date	Trap Type	Zone	European green crab *Carcinus maenas*	Hairy shore crab *Hemigrapsus oregonensis*	Purple shore crab *Hemigrapsus nudus*	Dungeness crab *Cancer magister*	*Cancer magister* (Recruits <50mm)	Red rock crab *Cancer productus*	stag-horn sculpin	# Traps
Roseburg Lumber	6/25/2002	Fish	Site	0	0	0	45	0.5	0.1	0	10
Roseburg Lumber	6/16/2003	Fish	*low*	0	0	0	12.2	0	0.7	1.5	10
TransPacific S	7/10/2005	Fish	*low*	0	0	0	6.14	1.14	0	1.86	7
North	7/10/2005	Fish	*low*	0	0	0	0	5.7	0	1.1	10
South	3/25/2005	minnow	*Mid*	0	0	0	0	0	0	2.4	10
North	7/10/2005	minnow	*mid*	0	0.2	0	0	0.6	0	0.8	5
South	7/10/2005	minnow	*mid*	0	0	0	0	0.4	0	0.6	5
Trans-Pacific Bridge	9/1/2005	Fish	*Low*	0	0	0	6.6	0	3	1	5
	9/1/2005	Minnow	*high*	0	0	0	0.2	0	0	0.4	4
Trans-Pacific Ln.	6/8/2006	Fish	*Low*	0	0	0	4.9	0	0	2.6	10
	9/13/2006	Fish		0	0.4	0	0.2	0	0	0.2	5
	6/8/2006	Minnow	*high*	0	0	0	0.7	0	0	2.3	10
Trans Pacific Br.	9/13/2006	Minnow		0.2	0	0	0	0	0	0.2	5
TransPacific Ln. N	5/25/2007	Fish	Mid	0.5	0.2	0	1	0.1	0	0.8	10
	7/14/2007	Fish		0.4	1.47	0	23.53	0	0	0.2	15
	9/26/2007	Fish		0	0	0	4.75	0	0	0	8
TransPacific Ln. S	5/25/2007	Fish	Mid	0.09	0	0	0.82	0	0	0.36	11
	7/14/2007	Fish		0.27	0.07	0	9	0	0.07	1	15
	9/26/2007	Fish		0	0	0	2.71	0	0	0.14	7
TransPacific Bridge	5/25/2007	Fish	Mid	0	0	0	1.33	0	0	0	6
	9/25/2007	minnow	high	0	0	0	1.6	0	0	0.4	5
TransPacific Ln. N	6/18/2008	Fish	Mid	0.1	0.2	0	7.4	0	0	7.8	10
	6/19/2008	Fish		0	0	0	1.75	0	0	3.25	8
	9/18/2008	Fish		0	0.1	0	23.4	0	0	0.7	10
TransPacific Ln. S	6/18/2008	Fish	Mid	0.5	0	0	17.2	0	0	2.2	10
	6/19/2008	Fish		0.37	0	0	17.63	0	0	1.37	8
	9/18/2008	Fish		0.1	0	0	22.6	0	0	0.3	10
TransPacific Ln. N	7/8/2009	Fish	Mid	0.13	0	0	9.88	0	0	0.38	8

	7/9/2009	Fish		0.1	0.2	0	11.3	0	0	0.3	10
	07/0/09	Fish		0.1	0	0	11.7	0	0	0.5	10
TransPacific Ln. S	7/8/2009	Fish	Mid	0	0	0	24.38	0	0	0.25	8
	7/9/2009	Fish		0.1	0	0	30.2	0	0	0.9	10
	7/10/2009	Fish		0.4	0	0	16.6	0.1	0	0.5	10
	7/11/2009	Fish		0.4	0	0	13.1	0	0	2.7	10
TransPacific Ln. N	3/19/2010	Fish	Mid	0	0.4	0	0.7	0	0	0	10
	3/20/2010	Fish		0	0.1	0	0.1	0.2	0	0	10
	3/21/2010	Fish		0	0.3	0	0.3	0.4	0	0	10
	6/25/2010	Fish		0	0	0	35.7	0	0	1.1	9
	6/26/2010	Fish		0	0	0	75.9	0	0	0.4	10
TransPacific Ln. S	3/19/2010	Fish	Mid	0	0	0	1.9	0.9	0	0	10
	3/20/2010	Fish		0.1	0	0	1.7	0	0	0	10
	3/21/2010	Fish		0	0	0	2.5	0.1	0	0	10
	6/25/2010	Fish		0	0	0	90.6	0	0	0	10
	6/26/2010	Fish		0	0	0	69.9	0	0	1.6	20
TransPacific Ln. N	7/17/2011	Fish	Mid	0	0.6	0	4.73	0.27	0	0.73	15
	10/17/2011	Fish		0	0	0	5.3	0	0	0.2	10
TransPacific Ln. S	7/16/2011	Fish	Mid	0.03	0.09	0	1.5	0.06	0	1.53	34
	7/17/2011	Fish		0	0.13	0	2.07	0.47	0	1.2	15
TransPacific Ln. N	6/27/2012	Fish	Mid	0	0	0	89.2	0	0	0.4	5
TransPacific Ln. S	6/25/2012	Fish	Mid	0	0	0	9.75	0	0	0.75	12
	6/27/2012	Fish		0.11	0	0	5.2	0	0	0.67	9
TransPacific Ln. S	3/22/2013	Fish	Mid	0	0	0	1.75	0	0	0	20
	3/23/2013	Fish		0	0	0	6.79	0	0	0	19
	7/12/2013	Fish		0	0	0	7.37	0	0	1.6	30
	7/13/2013	Fish		0	0	0	5.24	0	0	1.48	25
TransPacific Ln N	7/12/2014	Fish		0	0	0	40.33	0	0	0.5	12
	7/13/2014	fish		0	0	0	24.9	0	0	0.4	12
TransPacific Ln. S	7/12/2014	Fish		0	0	0	47.27	0	0	0	15
	7/13/2014	fish		0	0	0	23.83	0	0	0	12
Average				0.068	0.075	0	14.955	0.067	0.065	0.874	
Total # Traps											649

Impact of Jordan Cove LNG Terminal

by Sylvia Yamada

Salem, Oregon January 15, 2019

- I have been studying crabs in Oregon estuaries, including Coos Bay, for over 20 years.
- I am concerned that the construction of the Jordan Cove Energy Project could impact important habitats for native species, including the Dungeness crab.
- The Dungeness crab fishery is the most valuable commercial fishery in Oregon. In a good year, landings yield 100 million $ to the Oregon economy.
- The highest numbers of juvenile crabs are found in soft sediments and eel grass beds of estuaries. This is where the young crabs find food and shelter from predators.
- In my study site along Trans Pacific Parkway, I have consistently trapped an average of 15 young Dungeness crabs per trap.
- The importance of this nursery habitats has to be kept in mind when
  - a trench is dug In Haynes Inlet,
  - the Trans Pacific Parkway is expanded and
  - an upland area is cut out to create a berth for ocean-going vessels.
- Not only will the turbidity during the construction phase be of concern to the ecological community, the on-going dredging to maintain the berth and shipping channels will continue to be a disturbance to the ecosystem.
- In a study, designed to simulated a dredging operation, between 45 to 85 % of the Dungeness crabs died.
- In summary, construction and maintenance of the Jordan Cove LNG Terminal will result in habitat loss for native species, including nursery habitat for the valuable Dungeness crab.

Exhibit 10

Oregon
Kate Brown, Governor

Department of State Lands
South Slough National Estuarine Research Reserve
P.O. Box 5417 | 61907 Seven Devils Road
Charleston, Oregon 97420
(541) 888-5558
FAX (541) 888-5559
www.oregon.gov/dsl/ss

RE: Questions and recommendations regarding the application for Coos Estuary Navigation Reliability Improvements (AM-18-011/RZ-18-007/HBCU-18-003 Jordan Cove Energy Project L.P)

To whom it may concern:

We understand that the application is for rezoning portions of 3 parcels of subtidal estuarine property (59-CA, 2-NA, 3-DA) to DDNC-DA in order to dredge for improved ship navigation.

We are particularly concerned with the potential impacts to eelgrass (*Zostera marina*) populations as eelgrass is an important habitat for many estuarine species and improves estuarine water quality. The following comments fit under CBEMP Policy 4: Resource Capability Consistency and Impact Assessment. Eelgrass habitat in the Coos Estuary has experienced a net loss since 2005 (from mapping/GIS methods) and abundance has declined more recently since 2016 (from intertidal field surveys).

Regarding our concerns we have questions and recommendations.

First, we have two questions regarding clarification of parcels in question.

1) Three parcels are listed in the narrative but four are shown in the maps. Why is 52-NA not included in the application narrative for rezoning?
2) Throughout the narrative the parcels are listed as 59-CA, 2-NA, 3-DA. However, on page 16 in the Response the parcels are listed as 59-CA, 3-NA, and 2-DA. Presumably this is a typo, but should be corrected.

Second, we are concerned about the potential presence of eelgrass in the areas to be dredged. The application classifies the areas to be dredged as "deep subtidal habitats" (exhibit 4: page 12) and cites Jefferts 1977 when stating that the substrate is mostly sand (exhibit 4: page 7). This survey is more than 40 years old and no source information for Jefferts 1977 is given in the application. It is unlikely that this survey applies directly to the specific areas intended for dredging. We do know that subtidal areas are important habitat for eelgrass and to our knowledge there have been no recent eelgrass surveys of the intended dredge or dredge-line areas (approximately 36.2 acres combined). Eelgrass is known to occur from depth ranges of 1.4 m to below -5.0 m MLLW in Pacific Northwest Estuaries (Puget Sound, Thom et al. 2008) and occurs in the primary channels of the South Slough estuary. Our examination of the selected sites using GIS indicates depth range starting from -5.5 to below -8.0 MLLW, suggesting eelgrass could be present within these sites. We recommend these areas be surveyed for eelgrass and the survey data be included in the application before this application for rezoning is considered. This could be done rapidly and cost effectively using an underwater camera and focusing on the shallowest areas and a number of randomly selected locations.

Third, the temporary dredge line will cross eelgrass habitat as it approaches APCO site 2 (inset Figure 1.3-1, Exhibit 5, page 2). We appreciate that the plan intends to reduce impact to eelgrass by constructing a temporary structure to span above the eelgrass beds (Exhibit 4: page 2). However, this includes driving 5-6 piles within the eelgrass beds and then removing them at the completion of the project, which would cause additional ongoing disturbance during the 3 years allotted to the project. Eelgrass is known to be sensitive to increases in turbidity and sediment, due to light requirements for photosynthesis (Thom et al., 2008). The application states that the location was chosen in the narrowest location in the eelgrass bed (Exhibit 4: page 2). This is obviously not correct as the figure itself shows decreased eelgrass to the west along the railroad (Figure 1.3-1, Exhibit 5, page 2). We recommend that this disturbance be prevented entirely by simply running the pipe alongside the Trans Pacific Railroad Bridge or choosing an alternative disposal site. If the route cannot be altered, we recommend considering methods for reducing impacts on eelgrass due to the disturbance from pile installation and removal and damage incurred during positioning and stabilization of the barge used for pile installation and removal.

Thank you for considering these clarifying questions and recommendations for project improvement.

Sincerely,

Shon Schooler, Ph.D.
Research Coordinator
South Slough National Estuarine Research Reserve
PO Box 5417
Charleston, OR 97420

Reference:

Thom, R.M., Southard, S.L., Borde, A.B., and Stoltz, P., 2008. Light requirements for growth and survival of eelgrass (*Zostera marina* L.) in Pacific Northwest estuaries. Estuaries and Coasts 31:969-980.

Federal Aviation Administration

« OE/AAA

Interim Cases for OR

Records 1 to 13 of 13 Page 1 of 1

Case Number	City	State	Latitude	Longitude	Site Elevation	Structure Height	Total Height
2017-ANM-5386-OE	North Bend	OR	43° 25' 48.88" N	124° 16' 00.87" W	23	219	242
2017-ANM-5387-OE	North Bend	OR	43° 25' 53.61" N	124° 16' 01.16" W	23	219	242
2017-ANM-5388-OE	North Bend	OR	43° 25' 59.24" N	124° 16' 00.87" W	42	131	173
2017-ANM-5389-OE	North Bend	OR	43° 26' 01.57" N	124° 16' 03.43" W	42	126	168
2017-ANM-5418-OE	North Bend	OR	43° 25' 40.52" N	124° 15' 57.06" W	10	199	209
2018-ANM-4-OE	North Bend	OR	43° 23' 49.37" N	124° 16' 56.55" W	12	199	211
2018-ANM-5-OE	North Bend	OR	43° 24' 07.84" N	124° 16' 41.25" W	12	199	211
2018-ANM-6-OE	North Bend	OR	43° 24' 32.44" N	124° 16' 38.26" W	12	199	211
2018-ANM-7-OE	North Bend	OR	43° 24' 55.79" N	124° 16' 29.14" W	12	199	211
2018-ANM-8-OE	North Bend	OR	43° 25' 07.71" N	124° 16' 17.62" W	12	199	211
2018-ANM-718-OE	North Bend	OR	43° 23' 36.85" N	124° 17' 04.51" W	12	199	211
2018-ANM-719-OE	North Bend	OR	43° 25' 20.59" N	124° 15' 48.27" W	12	199	211
2018-ANM-720-OE	North Bend	OR	43° 25' 13.85" N	124° 16' 09.31" W	12	199	211

Rows per Page: 20

Records 1 to 13 of 13 **Page: 1** Page 1 of 1

Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2018-ANM-720-OE

Issued Date: 05/07/2018

Drew Jackson
Jordan Cove LNG
5615 Kirby Dr
Houston, TX 77005

**** NOTICE OF PRESUMED HAZARD ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	LNG Carrier Vessel - Stack, Transit Point 6
Location:	North Bend, OR
Latitude:	43-25-13.85N NAD 83
Longitude:	124-16-09.31W
Heights:	12 feet site elevation (SE)
	199 feet above ground level (AGL)
	211 feet above mean sea level (AMSL)

Initial findings of this study indicate that the structure as described exceeds obstruction standards and/or would have an adverse physical or electromagnetic interference effect upon navigable airspace or air navigation facilities. Pending resolution of the issues described below, the structure is presumed to be a hazard to air navigation.

If the structure were reduced in height so as not to exceed 155 feet above ground level (167 feet above mean sea level), it would not create a substantial adverse effect and a favorable determination could subsequently be issued.

Any height exceeding 155 feet above ground level (167 feet above mean sea level), will result in a substantial adverse effect and would warrant a Determination of Hazard to Air Navigation.

See Attachment for Additional information.

NOTE: PENDING RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE, THE STRUCTURE IS PRESUMED TO BE A HAZARD TO AIR NAVIGATION. THIS LETTER DOES NOT AUTHORIZE CONSTRUCTION OF THE STRUCTURE EVEN AT A REDUCED HEIGHT. ANY RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE MUST BE COMMUNICATED TO THE FAA SO THAT A FAVORABLE DETERMINATION CAN SUBSEQUENTLY BE ISSUED.

IF MORE THAN 60 DAYS FROM THE DATE OF THIS LETTER HAS ELAPSED WITHOUT ATTEMPTED RESOLUTION, IT WILL BE NECESSARY FOR YOU TO REACTIVATE THE STUDY BY FILING A NEW FAA FORM 7460-1, NOTICE OF PROPOSED CONSTRUCTION OR ALTERATION.

If we can be of further assistance, please contact our office at (206) 231-2990, or paul.holmquist@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2018-ANM-720-OE.

Signature Control No: 357210193-364494235 (NPH)
Paul Holmquist
Specialist

Attachment(s)
Additional Information

Additional information for ASN 2018-ANM-720-OE

ASN 2018-ANM-720-OE

Abbreviations

AGL - above ground level
AMSL - above mean sea level
RWY - runway
VFR - visual flight rules
IFR - instrument flight rules
NM - nautical mile
ASN- Aeronautical Study Number
CAT - category aircraft
MDA - minimum descent altitude
DA - decision altitude
Part 77 - Title 14 Code of Federal Regulations (CFR) Part 77, Safe, Efficient Use and Preservation of the Navigable Airspace

Our aeronautical study has disclosed that the proposed 199-foot AGL (211-foot AMSL) liquid natural gas carrier vessel (ship stack) shipping channel transit point location associated with the proposed Jordan Cove Liquid Natural Gas Terminal penetrates 14 CFR Part 77 protected airspace surfaces at Southwest Oregon Regional Airport (OTH) in North Bend, OR. The OTH airport elevation is 17 feet AMSL.

The proposed structure would exceed the following Part 77 surfaces:

Section 77.19(a): Horizontal Surface-a height exceeding a horizontal plane 150 feet above the established airport elevation. The proposed structure would exceed the OTH Horizontal Surface by 44 feet.

Additionally, the proposed structure would exceed the OTH VFR traffic pattern airspace in the Part 77 VFR Horizontal Surface feet as defined in FAA JO 7400.2L, 6-3-8, Evaluating Effect on VFR Operations.

This proposed structure would exceed the OTH VFR Traffic Pattern Horizontal Surface by 44 feet. The not-to-exceed height of 155 feet AGL (167 AMSL) will avoid penetrating the Horizontal Surface.

The OTH Airport Master Record, http://www.gcr1.com/5010web/airport.cfm?Site=OTH, states there are 36 single engine, eight (8) multi-engine, one (1) jet, and six (6) helicopter aircraft based there with 18,277 total operations for the 12 months ending 31 December 2013 (latest information). RWY 31 is designated Right Traffic.

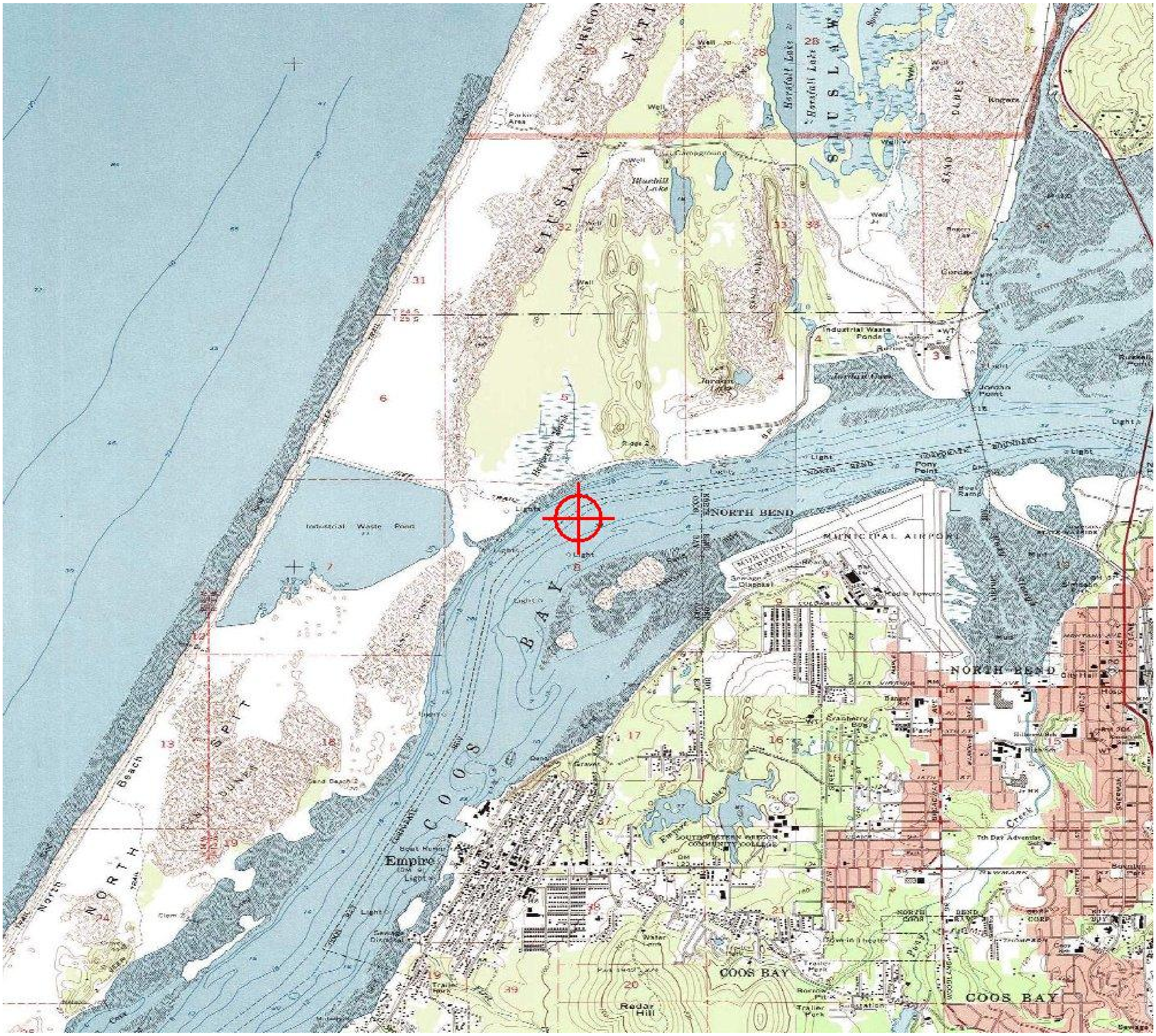
Your options and conditions for this proposal are as follows:

1. You must resolve the 44 foot VFR Traffic Pattern Airspace penetration by lowering the structure height, with all appurtenances, to a maximum height at 155 feet AGL (167 AMSL). If you agree to limit the structure height to 155 feet AGL (167 AMSL), the FAA can then withdraw this objection to the proposed structure as it would not exceed obstruction standards and a favorable determination could be subsequently issued.

2. You can terminate the proposal at this location.

Please email me within 60 days of the date of this letter at Paul.Holmquist@faa.gov with your intentions and any questions you might have regarding this aeronautical study.

Close Print


NORTH BEND
MUNICIPAL AIRPORT
Industrial Waste Pond
Industrial Waste Ponds
COOS BAY
Empire
Radar Hill
NORTH SPIT
SOUTHWESTERN OREGON COMMUNITY COLLEGE
Horsfall Lake
Bluebill Lake
Jordan Point
Pony Point

Mail Processing Center Federal Aviation Administration Southwest Regional Office Obstruction Evaluation Group 10101 Hillwood Parkway Fort Worth, TX 76177	Aeronautical Study No. 2018-ANM-719-OE

Issued Date: 05/07/2018

Drew Jackson
Jordan Cove LNG
5615 Kirby Dr
Houston, TX 77005

**** NOTICE OF PRESUMED HAZARD ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	LNG Carrier Vessel - Stack, Transit East Point
Location:	North Bend, OR
Latitude:	43-25-20.59N NAD 83
Longitude:	124-15-48.27W
Heights:	12 feet site elevation (SE)
	199 feet above ground level (AGL)
	211 feet above mean sea level (AMSL)

Initial findings of this study indicate that the structure as described exceeds obstruction standards and/or would have an adverse physical or electromagnetic interference effect upon navigable airspace or air navigation facilities. Pending resolution of the issues described below, the structure is presumed to be a hazard to air navigation.

If the structure were reduced in height so as not to exceed 155 feet above ground level (167 feet above mean sea level), it would not create a substantial adverse effect and a favorable determination could subsequently be issued.

Any height exceeding 155 feet above ground level (167 feet above mean sea level), will result in a substantial adverse effect and would warrant a Determination of Hazard to Air Navigation.

See Attachment for Additional information.

NOTE: PENDING RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE, THE STRUCTURE IS PRESUMED TO BE A HAZARD TO AIR NAVIGATION. THIS LETTER DOES NOT AUTHORIZE CONSTRUCTION OF THE STRUCTURE EVEN AT A REDUCED HEIGHT. ANY RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE MUST BE COMMUNICATED TO THE FAA SO THAT A FAVORABLE DETERMINATION CAN SUBSEQUENTLY BE ISSUED.

IF MORE THAN 60 DAYS FROM THE DATE OF THIS LETTER HAS ELAPSED WITHOUT ATTEMPTED RESOLUTION, IT WILL BE NECESSARY FOR YOU TO REACTIVATE THE STUDY BY FILING A NEW FAA FORM 7460-1, NOTICE OF PROPOSED CONSTRUCTION OR ALTERATION.

If we can be of further assistance, please contact our office at (206) 231-2990, or paul.holmquist@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2018-ANM-719-OE.

Signature Control No: 357209466-364496207 (NPH)

Paul Holmquist
Specialist

Attachment(s)
Additional Information

ASN 2018-ANM-719-OE

Abbreviations

AGL - above ground level	AMSL - above mean sea level	RWY - runway
VFR - visual flight rules	IFR - instrument flight rules	NM - nautical mile
ASN- Aeronautical Study Number	CAT - category aircraft	
MDA - minimum descent altitude	DA - decision altitude	

Part 77 - Title 14 Code of Federal Regulations (CFR) Part 77, Safe, Efficient Use and Preservation of the Navigable Airspace

Our aeronautical study has disclosed that the proposed 199-foot AGL (211-foot AMSL) liquid natural gas carrier vessel (ship stack) shipping channel transit point location associated with the proposed Jordan Cove Liquid Natural Gas Terminal penetrates 14 CFR Part 77 protected airspace surfaces at Southwest Oregon Regional Airport (OTH) in North Bend, OR. The OTH airport elevation is 17 feet AMSL.

The proposed structure would exceed the following Part 77 surface:

Section 77.19(a): Horizontal Surface-a height exceeding a horizontal plane 150 feet above the established airport elevation. The proposed structure would exceed the OTH Horizontal Surface by 44 feet.

Additionally, the proposed structure would exceed the OTH VFR traffic pattern airspace in the Part 77 VFR Horizontal Surface feet as defined in FAA JO 7400.2L, 6-3-8, Evaluating Effect on VFR Operations.

This proposed structure would exceed the OTH VFR Traffic Pattern Horizontal Surface by 44 feet. The not-to-exceed height of 155 feet AGL (167 AMSL) will avoid penetrating the Horizontal Surface.

The OTH Airport Master Record, http://www.gcr1.com/5010web/airport.cfm?Site=OTH, states there are 36 single engine, eight (8) multi-engine, one (1) jet, and six (6) helicopter aircraft based there with 18,277 total operations for the 12 months ending 31 December 2013 (latest information). RWY 31 is designated Right Traffic.

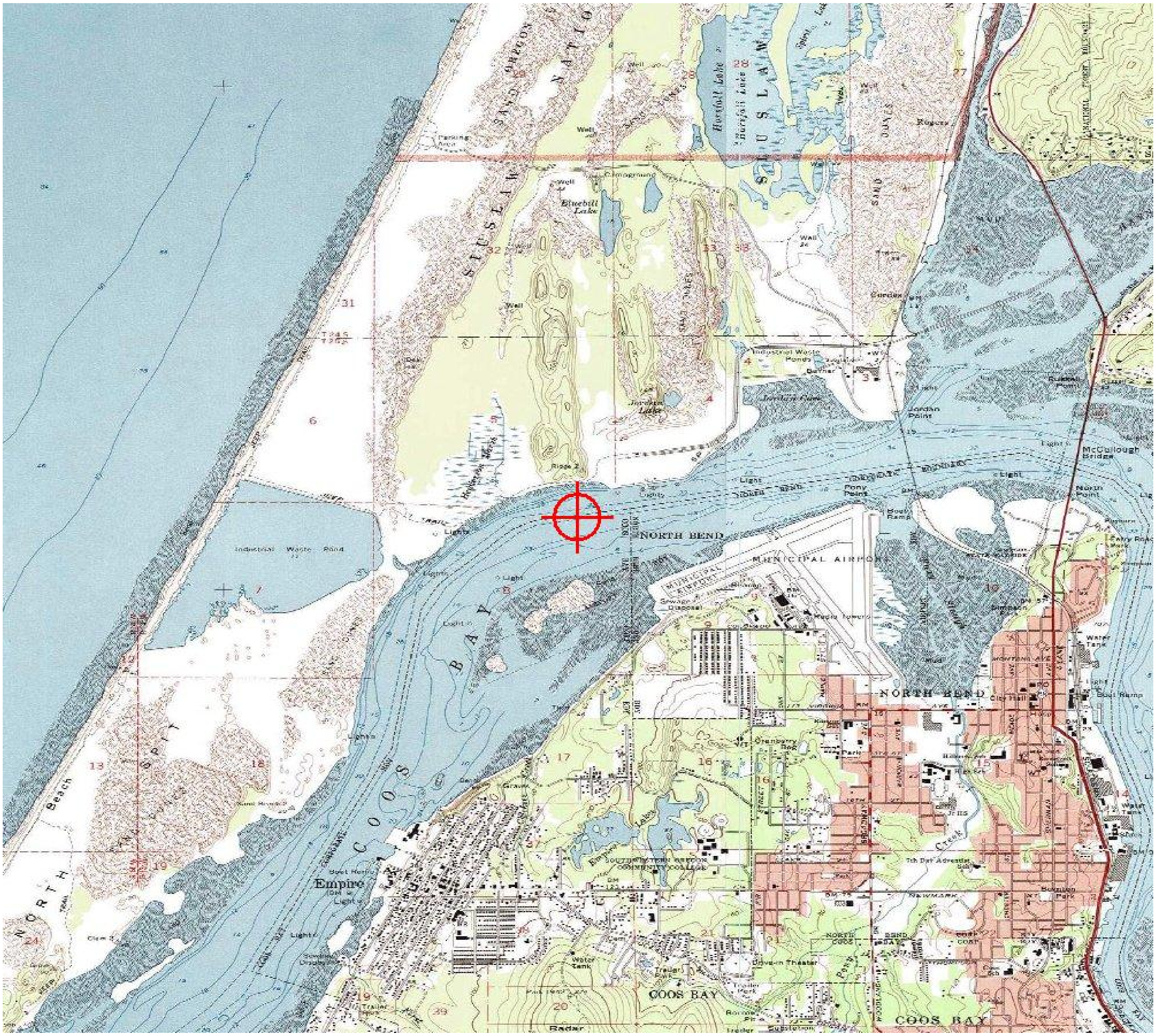
Your options and conditions for this proposal are as follows:

1. You must resolve the 44 foot VFR Traffic Pattern Airspace penetration by lowering the structure height, with all appurtenances, to a maximum height at 155 feet AGL (167 AMSL). If you agree to limit the structure height to 155 feet AGL (167 AMSL), the FAA can then withdraw this objection to the proposed structure as it would not exceed obstruction standards and a favorable determination could be subsequently issued. Further FAA study for any height greater than 155 AGL / 167 AMSL is not an option.

2. You can terminate the proposal at this location.

Please email me within 60 days of the date of this letter at Paul.Holmquist@faa.gov with your intentions and any questions you might have regarding this aeronautical study.

Close Print



NORTH BEND
MUNICIPAL AIRPORT
COOS BAY
Empire
SOUTHWESTERN OREGON COMMUNITY COLLEGE
Bluebill Lake
Jordan Lake
Horsfall Lake
McCullough Bridge
Industrial Waste Pond
North Point
Pony Point
Jordan Point

Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2018-ANM-718-OE

Issued Date: 05/07/2018

Drew Jackson
Jordan Cove LNG
5615 Kirby Dr
Houston, TX 77005

**** NOTICE OF PRESUMED HAZARD ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	LNG Carrier Vessel - Stack, Transit West Point
Location:	North Bend, OR
Latitude:	43-23-36.85N NAD 83
Longitude:	124-17-04.51W
Heights:	12 feet site elevation (SE)
	199 feet above ground level (AGL)
	211 feet above mean sea level (AMSL)

Initial findings of this study indicate that the structure as described exceeds obstruction standards and/or would have an adverse physical or electromagnetic interference effect upon navigable airspace or air navigation facilities. Pending resolution of the issues described below, the structure is presumed to be a hazard to air navigation.

If the structure were reduced in height so as not to exceed 155 feet above ground level (167 feet above mean sea level), it would not create a substantial adverse effect and a favorable determination could subsequently be issued.

To pursue a favorable determination at the originally submitted height, further study would be necessary. Further study entails distribution to the public for comment, and may extend the study period up to 120 days. The outcome cannot be predicted prior to public circularization.

If you would like the FAA to conduct further study, you must make the request within 60 days from the date of issuance of this letter.

See Attachment for Additional information.

NOTE: PENDING RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE, THE STRUCTURE IS PRESUMED TO BE A HAZARD TO AIR NAVIGATION. THIS LETTER DOES NOT AUTHORIZE CONSTRUCTION OF THE STRUCTURE EVEN AT A REDUCED HEIGHT. ANY RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE MUST BE COMMUNICATED TO THE FAA SO THAT A FAVORABLE DETERMINATION CAN SUBSEQUENTLY BE ISSUED.

IF MORE THAN 60 DAYS FROM THE DATE OF THIS LETTER HAS ELAPSED WITHOUT ATTEMPTED RESOLUTION, IT WILL BE NECESSARY FOR YOU TO REACTIVATE THE STUDY BY FILING A NEW FAA FORM 7460-1, NOTICE OF PROPOSED CONSTRUCTION OR ALTERATION.

If we can be of further assistance, please contact our office at (206) 231-2990, or paul.holmquist@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2018-ANM-718-OE.

Signature Control No: 357209465-364496843 (NPH)

Paul Holmquist
Specialist

Attachment(s)
Additional Information

Additional information for ASN 2018-ANM-718-OE

ASN 2018-ANM-718-OE

Abbreviations

AGL - above ground level	AMSL - above mean sea level	RWY - runway
VFR - visual flight rules	IFR - instrument flight rules	NM - nautical mile
ASN- Aeronautical Study Number	CAT - category aircraft	
MDA - minimum descent altitude	DA - decision altitude	

Part 77 - Title 14 Code of Federal Regulations (CFR) Part 77, Safe, Efficient Use and Preservation of the Navigable Airspace

Our aeronautical study has disclosed that the proposed 199-foot AGL (211-foot AMSL) liquid natural gas carrier vessel (ship stack) shipping channel transit point location associated with the proposed Jordan Cove Liquid Natural Gas Terminal penetrates 14 CFR Part 77 protected airspace surfaces at Southwest Oregon Regional Airport (OTH) in North Bend, OR. The OTH airport elevation is 17 feet AMSL.

The proposed structure would exceed the following Part 77 surface:

Section 77.19(a): Horizontal Surface-a height exceeding a horizontal plane 150 feet above the established airport elevation. The proposed structure would exceed the OTH Horizontal Surface by 44 feet.

The OTH Airport Master Record, http://www.gcr1.com/5010web/airport.cfm?Site=OTH, states there are 36 single engine, eight (8) multi-engine, one (1) jet, and six (6) helicopter aircraft based there with 18,277 total operations for the 12 months ending 31 December 2013 (latest information). RWY 31 is designated Right Traffic.

Your options for this proposal are as follows:

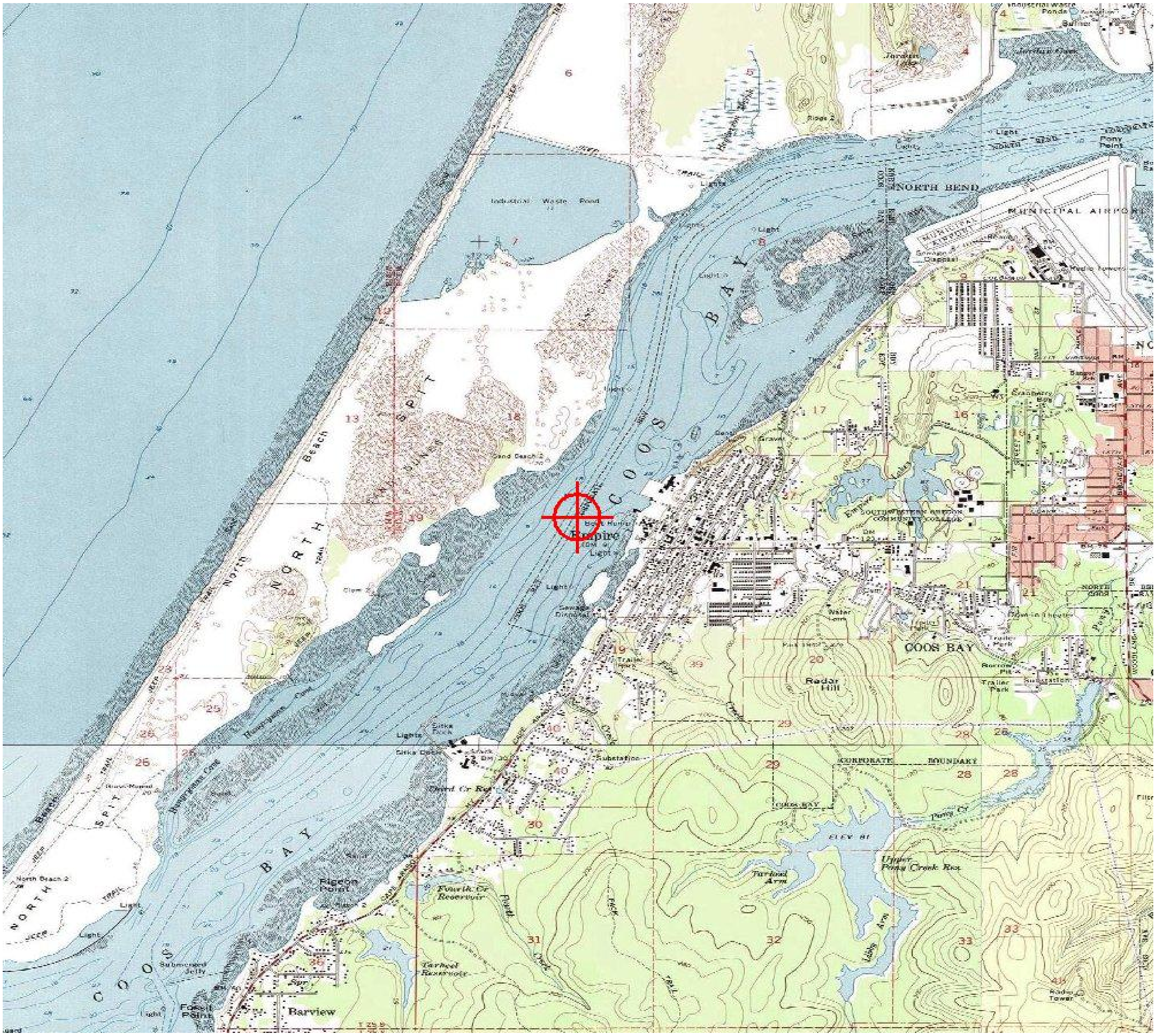
1. If you agree to limit the structure height to 155 feet AGL (167 AMSL), the FAA can then withdraw this objection to the proposed structure as it would not exceed obstruction standards and a favorable determination could be subsequently issued.

2. You can terminate the proposal at this location.

3. You can request further FAA study of the structure at the originally requested height. Further study will include a public notice circularization and 37-day comment period where the outcome cannot be predicted.

Please email me within 60 days of the date of this letter at Paul.Holmquist@faa.gov with your intentions and any questions you might have regarding this aeronautical study.

Close Print


NORTH BEND
MUNICIPAL AIRPORT
COOS BAY
NORTH SPIT
Industrial Waste Pond
Empire
SOUTHWESTERN OREGON COMMUNITY COLLEGE
Radar Hill
CORPORATE BOUNDARY
Upper Pony Creek Res.
Pigeon Point
Fossil Point
Barview
Tarheel Reservoir
Fourth Cr Reservoir
Sitka Dock
Trailer Park
Sewage Disposal

Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2018-ANM-8-OE

Issued Date: 05/07/2018

Drew Jackson
Jordan Cove LNG
5615 Kirby Dr
Houston, TX 77005

**** NOTICE OF PRESUMED HAZARD ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	LNG Carrier Vessel - Stack, Transit Point 5
Location:	North Bend, OR
Latitude:	43-25-07.71N NAD 83
Longitude:	124-16-17.62W
Heights:	12 feet site elevation (SE)
	199 feet above ground level (AGL)
	211 feet above mean sea level (AMSL)

Initial findings of this study indicate that the structure as described exceeds obstruction standards and/or would have an adverse physical or electromagnetic interference effect upon navigable airspace or air navigation facilities. Pending resolution of the issues described below, the structure is presumed to be a hazard to air navigation.

If the structure were reduced in height so as not to exceed 155 feet above ground level (167 feet above mean sea level), it would not create a substantial adverse effect and a favorable determination could subsequently be issued.

Any height exceeding 155 feet above ground level (167 feet above mean sea level), will result in a substantial adverse effect and would warrant a Determination of Hazard to Air Navigation.

See Attachment for Additional information.

NOTE: PENDING RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE, THE STRUCTURE IS PRESUMED TO BE A HAZARD TO AIR NAVIGATION. THIS LETTER DOES NOT AUTHORIZE CONSTRUCTION OF THE STRUCTURE EVEN AT A REDUCED HEIGHT. ANY RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE MUST BE COMMUNICATED TO THE FAA SO THAT A FAVORABLE DETERMINATION CAN SUBSEQUENTLY BE ISSUED.

IF MORE THAN 60 DAYS FROM THE DATE OF THIS LETTER HAS ELAPSED WITHOUT ATTEMPTED RESOLUTION, IT WILL BE NECESSARY FOR YOU TO REACTIVATE THE STUDY BY FILING A NEW FAA FORM 7460-1, NOTICE OF PROPOSED CONSTRUCTION OR ALTERATION.

If we can be of further assistance, please contact our office at (206) 231-2990, or paul.holmquist@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2018-ANM-8-OE.

Signature Control No: 352163129-364497466 (NPH)

Paul Holmquist
Specialist

Attachment(s)
Additional Information

ASN 2018-ANM-8-OE

Abbreviations

AGL - above ground level	AMSL - above mean sea level	RWY - runway
VFR - visual flight rules	IFR - instrument flight rules	NM - nautical mile
ASN- Aeronautical Study Number	CAT - category aircraft	
MDA - minimum descent altitude	DA - decision altitude	

Part 77 - Title 14 Code of Federal Regulations (CFR) Part 77, Safe, Efficient Use and Preservation of the Navigable Airspace

Our aeronautical study has disclosed that the proposed 199-foot AGL (211-foot AMSL) liquid natural gas carrier vessel (ship stack) shipping channel transit point location associated with the proposed Jordan Cove Liquid Natural Gas Terminal penetrates 14 CFR Part 77 protected airspace surfaces at Southwest Oregon Regional Airport (OTH) in North Bend, OR. The OTH airport elevation is 17 feet AMSL.

The proposed structure would exceed the following Part 77 surface:

Section 77.19(a): Horizontal Surface-a height exceeding a horizontal plane 150 feet above the established airport elevation. The proposed structure would exceed the OTH Horizontal Surface by 44 feet.

Additionally, the proposed structure would exceed the OTH VFR traffic pattern airspace in the Part 77 VFR Horizontal Surface feet as defined in FAA JO 7400.2L, 6-3-8, Evaluating Effect on VFR Operations.

This proposed structure would exceed the OTH VFR Traffic Pattern Horizontal Surface by 44 feet. The not-to-exceed height of 155 feet AGL (167 AMSL) will avoid penetrating the Horizontal Surface.

The OTH Airport Master Record, http://www.gcr1.com/5010web/airport.cfm?Site=OTH, states there are 36 single engine, eight (8) multi-engine, one (1) jet, and six (6) helicopter aircraft based there with 18,277 total operations for the 12 months ending 31 December 2013 (latest information). RWY 31 is designated Right Traffic.

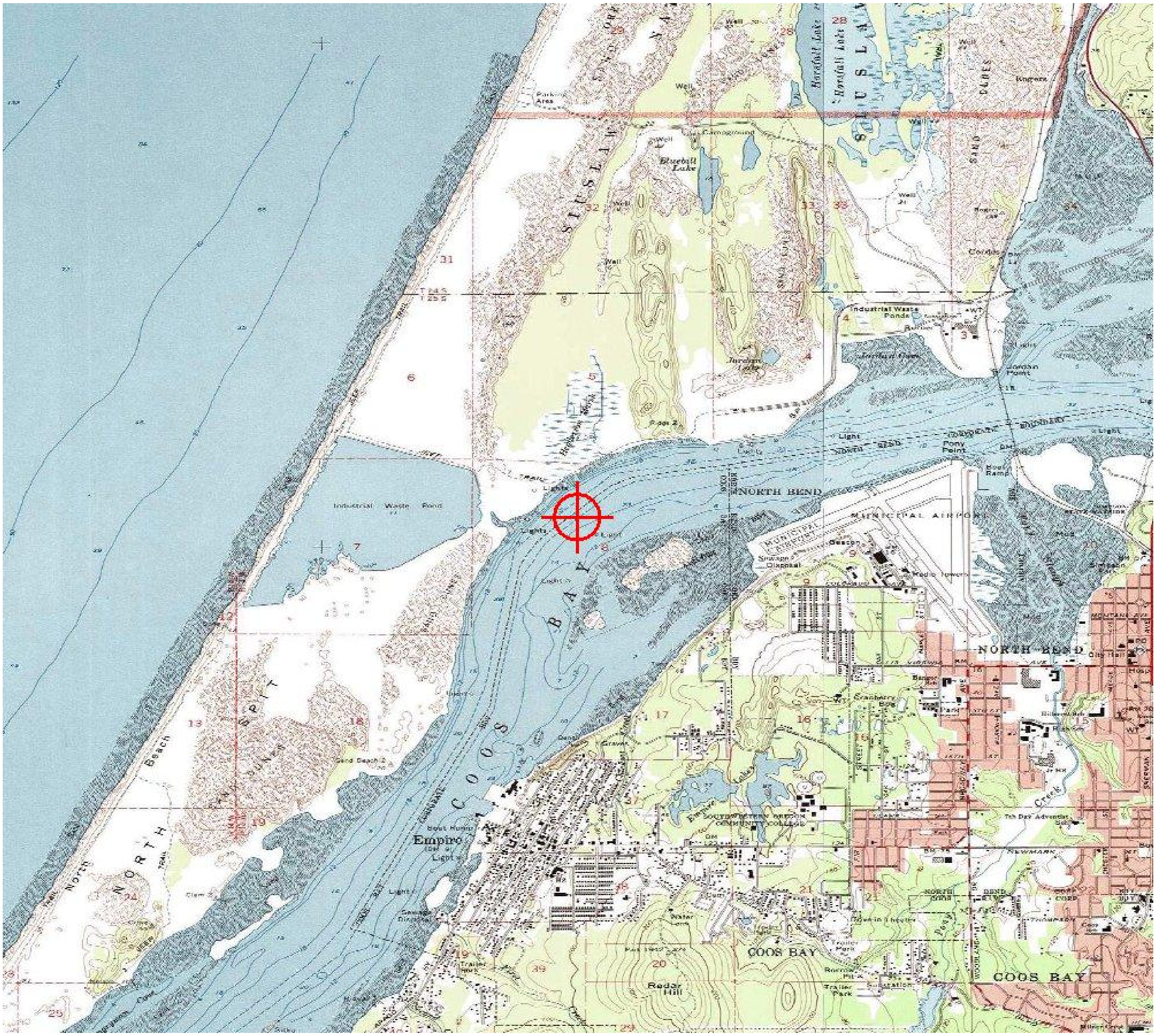
Your options and conditions for this proposal are as follows:

1. You must resolve the 44 foot VFR Traffic Pattern Airspace penetration by lowering the structure height, with all appurtenances, to a maximum height at 155 feet AGL (167 AMSL). If you agree to limit the structure height to 155 feet AGL (167 AMSL), the FAA can then withdraw this objection to the proposed structure as it would not exceed obstruction standards and a favorable determination could be subsequently issued. Further FAA study for any height greater than 155 AGL / 167 AMSL is not an option.

2. You can terminate the proposal at this location.

Please email me within 60 days of the date of this letter at Paul.Holmquist@faa.gov with your intentions and any questions you might have regarding this aeronautical study.

Close Print


NORTH BEND
MUNICIPAL AIRPORT
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Jordan Point
Pony Point
SOUTHWESTERN OREGON COMMUNITY COLLEGE
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Radar Hill
Bluebill Lake
Horsfall Lake
Industrial Waste Ponds

Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2018-ANM-7-OE

Issued Date: 05/07/2018

Drew Jackson
Jordan Cove LNG
5615 Kirby Dr
Houston, TX 77005

**** NOTICE OF PRESUMED HAZARD ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	LNG Carrier Vessel - Stack, Transit Point 4
Location:	North Bend, OR
Latitude:	43-24-55.79N NAD 83
Longitude:	124-16-29.14W
Heights:	12 feet site elevation (SE)
	199 feet above ground level (AGL)
	211 feet above mean sea level (AMSL)

Initial findings of this study indicate that the structure as described exceeds obstruction standards and/or would have an adverse physical or electromagnetic interference effect upon navigable airspace or air navigation facilities. Pending resolution of the issues described below, the structure is presumed to be a hazard to air navigation.

If the structure were reduced in height so as not to exceed 155 feet above ground level (167 feet above mean sea level), it would not create a substantial adverse effect and a favorable determination could subsequently be issued.

Any height exceeding 155 feet above ground level (167 feet above mean sea level), will result in a substantial adverse effect and would warrant a Determination of Hazard to Air Navigation.

See Attachment for Additional information.

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If we can be of further assistance, please contact our office at (206) 231-2990, or paul.holmquist@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2018-ANM-7-OE.

Signature Control No: 352163128-364497902 (NPH)

Paul Holmquist
Specialist

Attachment(s)
Additional Information

Additional information for ASN 2018-ANM-7-OE

ASN 2018-ANM-7-OE

Abbreviations

AGL - above ground level
AMSL - above mean sea level
RWY - runway
VFR - visual flight rules
IFR - instrument flight rules
NM - nautical mile
ASN- Aeronautical Study Number
CAT - category aircraft
MDA - minimum descent altitude
DA - decision altitude
Part 77 - Title 14 Code of Federal Regulations (CFR) Part 77, Safe, Efficient Use and Preservation of the Navigable Airspace

Our aeronautical study has disclosed that the proposed 199-foot AGL (211-foot AMSL) liquid natural gas carrier vessel (ship stack) shipping channel transit point location associated with the proposed Jordan Cove Liquid Natural Gas Terminal penetrates 14 CFR Part 77 protected airspace surfaces at Southwest Oregon Regional Airport (OTH) in North Bend, OR. The OTH airport elevation is 17 feet AMSL.

The proposed structure would exceed the following Part 77 surface:

Section 77.19(a): Horizontal Surface-a height exceeding a horizontal plane 150 feet above the established airport elevation. The proposed structure would exceed the OTH Horizontal Surface by 44 feet.

Additionally, the proposed structure would exceed the OTH VFR traffic pattern airspace in the Part 77 VFR Horizontal Surface feet as defined in FAA JO 7400.2L, 6-3-8, Evaluating Effect on VFR Operations.

This proposed structure would exceed the OTH VFR Traffic Pattern Horizontal Surface by 44 feet. The not-to-exceed height of 155 feet AGL (167 AMSL) will avoid penetrating the Horizontal Surface.

The OTH Airport Master Record, http://www.gcr1.com/5010web/airport.cfm?Site=OTH, states there are 36 single engine, eight (8) multi-engine, one (1) jet, and six (6) helicopter aircraft based there with 18,277 total operations for the 12 months ending 31 December 2013 (latest information). RWY 31 is designated Right Traffic.

Your options and conditions for this proposal are as follows:

1. You must resolve the 44 foot VFR Traffic Pattern Airspace penetration by lowering the structure height, with all appurtenances, to a maximum height at 155 feet AGL (167 AMSL). If you agree to limit the structure height to 155 feet AGL (167 AMSL), the FAA can then withdraw this objection to the proposed structure as it would not exceed obstruction standards and a favorable determination could be subsequently issued. Further FAA study for any height greater than 155 AGL / 167 AMSL is not an option.

2. You can terminate the proposal at this location.

Please email me within 60 days of the date of this letter at Paul.Holmquist@faa.gov with your intentions and any questions you might have regarding this aeronautical study.

Close Print


NORTH BEND
MUNICIPAL AIRPORT
COOS BAY
Empire
NORTH BEND
COOS BAY
Industrial Waste Pond
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Pony Point
Jordan Point

Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2018-ANM-6-OE

Issued Date: 05/07/2018

Drew Jackson
Jordan Cove LNG
5615 Kirby Dr
Houston, TX 77005

**** NOTICE OF PRESUMED HAZARD ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	LNG Carrier Vessel - Stack, Transit Point 3
Location:	North Bend, OR
Latitude:	43-24-32.44N NAD 83
Longitude:	124-16-38.26W
Heights:	12 feet site elevation (SE)
	199 feet above ground level (AGL)
	211 feet above mean sea level (AMSL)

Initial findings of this study indicate that the structure as described exceeds obstruction standards and/or would have an adverse physical or electromagnetic interference effect upon navigable airspace or air navigation facilities. Pending resolution of the issues described below, the structure is presumed to be a hazard to air navigation.

If the structure were reduced in height so as not to exceed 125 feet above ground level (137 feet above mean sea level), it would not create a substantial adverse effect and a favorable determination could subsequently be issued.

Any height exceeding 125 feet above ground level (137 feet above mean sea level), will result in a substantial adverse effect and would warrant a Determination of Hazard to Air Navigation.

See Attachment for Additional information.

NOTE: PENDING RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE, THE STRUCTURE IS PRESUMED TO BE A HAZARD TO AIR NAVIGATION. THIS LETTER DOES NOT AUTHORIZE CONSTRUCTION OF THE STRUCTURE EVEN AT A REDUCED HEIGHT. ANY RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE MUST BE COMMUNICATED TO THE FAA SO THAT A FAVORABLE DETERMINATION CAN SUBSEQUENTLY BE ISSUED.

IF MORE THAN 60 DAYS FROM THE DATE OF THIS LETTER HAS ELAPSED WITHOUT ATTEMPTED RESOLUTION, IT WILL BE NECESSARY FOR YOU TO REACTIVATE THE STUDY BY FILING A NEW FAA FORM 7460-1, NOTICE OF PROPOSED CONSTRUCTION OR ALTERATION.

If we can be of further assistance, please contact our office at (206) 231-2990, or paul.holmquist@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2018-ANM-6-OE.

Signature Control No: 352163127-364500875 (NPH)
Paul Holmquist
Specialist

Attachment(s)
Additional Information

ASN 2018-ANM-6-OE

Abbreviations

AGL - above ground level
AMSL - above mean sea level
RWY - runway
VFR - visual flight rules
IFR - instrument flight rules
NM - nautical mile
ASN- Aeronautical Study Number
CAT - category aircraft
MDA - minimum descent altitude
DA - decision altitude
Part 77 - Title 14 Code of Federal Regulations (CFR) Part 77, Safe, Efficient Use and Preservation of the Navigable Airspace

Our aeronautical study has disclosed that the proposed 199-foot AGL (211-foot AMSL) liquid natural gas carrier vessel (ship stack) shipping channel transit point location associated with the proposed Jordan Cove Liquid Natural Gas Terminal penetrates 14 CFR Part 77 protected airspace surfaces at Southwest Oregon Regional Airport (OTH) in North Bend, OR. The OTH airport elevation is 17 feet AMSL.

The proposed structure would exceed the following Part 77 surfaces:

a. Section 77.17(a)(3) -- A structure that causes less than the required obstacle clearance within a terminal obstacle clearance area, including an initial approach segment, a departure area, and a circling approach area resulting in increases to an IFR terminal minimum altitude. The high point on the LNG carrier vessel (stack) would have the following effects on IFR operations at OTH:

Obstacle penetrates OTH RWY 22 40:1 departure surface in the Initial Climb Area (ICA) 73 feet, increases climb gradient from standard and 200 feet per NM to 300-1 or standard with 423 feet per NM to 400 then as published. The height at or below that avoids this effect: 138 AMSL (126 AGL).

OTH RWY 4 ILS or LOC: ILS or LOC RWY 4, S-ILS 4* not authorized (NA). Obstacle penetrates Vertical Guidance Surface (VGS) 23 feet. The height at or below that avoids this effect: 188 AMSL (176 AGL).
At 188 AMSL, increase S-ILS 4* DA from 216 AMSL to 473 AMSL. The height at or below that avoids this effect: 153 AMSL (141 AGL).
OTH RWY 4 ILS or LOC RWY, S-ILS NA. Obstacle penetrates Vertical Guidance Surface (VGS) 23 feet. The height at or below that avoids this effect: 188 AMSL (176 AGL).
At 188 AMSL, increase S-ILS 4 DA from 278 AMSL to 473 AMSL. The height at or below that avoids this effect: 153 AMSL (141 AGL).
Increases S-LOC 4 MDA from 400 AMSL to 520 AMSL. The height at or below that avoids this effect: 139 AMSL (127 AGL).
Penetrates 34:1 Visual Area Surface 56 feet, increase visibility from 1/2 to 3/4 mile. The height at or below that avoids this effect: 155 AMSL (143 AGL)

OTH RWY 4 COPTER ILS or LOC NA, obstacle penetrates Vertical Guidance Surface (VGS) 23 feet. The height at or below that avoids this effect: 188 AMSL (176 AGL).
At 188 AMSL, increase H-ILS 4 DA from 216 AMSL to 473 AMSL. The height at or below that avoids this effect: 153 AMSL (141 AGL).
Increases H-LOC 4 MDA from 400 AMSL to 520 AMSL. The height at or below that avoids this effect: 139 AMSL (127 AGL).

Penetrates 34:1 Visual Area Surface 56 feet, increase visibility from 1/2 to 3/4 mile. The height at or below that avoids this effect: 155 AMSL (133 AGL).

OTH RWY 4 RNAV (GPS) Y, LPV DA NA, obstacle penetrates Vertical Guidance Surface (VGS) 23 feet. The height at or below that avoids this effect: 188 AMSL (176 AGL).
At 188 AMSL, increases LPV DA from 319 AMSL to 513 AMSL. The height at or below that avoids this effect: 154 AMSL (142 AGL).
Penetrates 34:1 Visual Area Surface 56 feet, increase visibility from 1/2 to 3/4 mile. The height at or below that avoids this effect: 155 AMSL (143 AGL).
LNAV/VNAV NA, obstacle penetrates the VGS 24 feet. The height at or below that avoids this effect: 187 AMSL (175 AGL).
At 187 AMSL, no IFR effect.
LNAV, penetrates 34:1 Visual Area Surface 56 feet, increase visibility from 1/2 to 3/4 mile. The height at or below that avoids this effect: 155 AMSL (143 AGL) .

OTH RWY 4 RNAV (RNP) Z, RNP 0.11 DA* NA, obstacle penetrates the VGS 27 feet. The height at or below that avoids this effect: 184 AMSL (172 AGL).
At 184 AMSL, increases RNP 0.11 DA* from 309 to 444. The height at or below that avoids this effect: 137 AMSL (125 AGL).
Penetrates 34:1 Visual Area Surface 56 feet, increase visibility from 1/2 to 3/4 mile, The height at or below that avoids this effect: 155 AMSL (133 AGL).
RNP 0.30 DA# NA, obstacle penetrates the VGS 27 feet. The height at or below that avoids this effect: 184 AMSL (172 AGL).
At 184 AMSL, increases RNP 0.30 DA# from 477 AMSL to 489 AMSL. The height at or below that avoids this effect: 168 AMSL (156 AGL).

RNP 0.30 NA, obstacle penetrates the VGS 27 feet. The height at or below that avoids this effect: 184 AMSL (172 AGL).

The MDA/DA is the minimum altitudes to which an aircraft may descend while on the instrument approach to the airport during periods when reduced visibility and/or low cloud ceiling conditions exist. If the pilot cannot achieve visual reference to the ground upon reaching the MDA/DA, the approach must be abandoned. This results in the aircraft having to proceed to an alternate airport or waiting in a holding pattern for improved weather conditions. Any increase in the MDA/DA would have a significant adverse effect on the benefits derived from the instrument procedures.

b. Section 77.19(a): Horizontal Surface-a height exceeding a horizontal plane 150 feet above the established airport elevation. The proposed structure would exceed the OTH Horizontal Surface by 44 feet.

c. Section 77.19(d) -- Approach Surface - an area designated to protect aircraft during the final approach phase of flight at an airport: The proposed structure would exceed the existing OTH Approach Surface by 102 feet and would exceed the OTH Approach Surface plan on file by 122 feet.

Additionally, the proposed structure would exceed the OTH VFR traffic pattern airspace in the Part 77 VFR Horizontal Surface and the Approach Surface (plan on file) as defined in FAA JO 7400.2L, 6-3-8, Evaluating Effect on VFR Operations.

This proposed structure would exceed the OTH VFR Traffic Pattern Horizontal Surface by 44 feet. The not-to-exceed height of 157 feet AGL (167 AMSL) will avoid penetrating the Horizontal Surface. This proposed structure would exceed the OTH VFR Traffic Pattern Approach Surface (plan on file) by 11 feet. The not-to-exceed height of 188 feet AGL (200 AMSL) will avoid penetrating the Approach Surface (plan on file).

The FAA Technical Operations Branch found the proposal has a physical and/or an electromagnetic radiation effect upon the Visual Approach Slope Indicator (VASI) serving OTH RWY 04 as it penetrates the surface given in the siting standard, Order 6850.2. The proposal will affect the quality and/or availability of the VASI visual guidance signal (service). The effect can be eliminated by lowering the proposal to 145 ft AMSL (132 AGL).

The OTH Airport Master Record, http://www.gcr1.com/5010web/airport.cfm?Site=OTH, states there are 36 single engine, eight (8) multi-engine, one (1) jet, and six (6) helicopter aircraft based there with 18,277 total operations for the 12 months ending 31 December 2013 (latest information). RWY 31 is designated Right Traffic.

Your options and conditions for this proposal are as follows:

1. You must resolve the 74 foot OTH RWY 4 RNAV (RNP) Z, RNP 0.11 DA* penetration by lowering the structure height, with all appurtenances, to a maximum height at 125 AGL (137 AMSL). This would also resolve our objection to the 44 foot VFR Traffic Pattern Airspace penetration which requires lowering the structure height, with all appurtenances, to a maximum height at 167 feet AGL (179 AMSL). If you agree to lower the maximum height to 125 AGL, the FAA can then withdraw this objection to the proposed structure as it would not exceed obstruction standards and a favorable determination could be subsequently issued.

2. You can terminate the proposal at this location.

Please email me within 60 days of the date of this letter at Paul.Holmquist@faa.gov with your intentions and any questions you might have regarding this aeronautical study.

Close Print


NORTH BEND
MUNICIPAL AIRPORT
COOS BAY
Empire
NORTH SPIT
Industrial Waste Pond
Industrial Waste Ponds
Bluebill Lake
Jordan Lake
Pony Point
Jordan Point
Radar Hill
COOS BAY
CORPORATE BOUNDARY
Sewage Disposal
Sitka Dock
Trailer Park
Filtration Plant

Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2018-ANM-5-OE

Issued Date: 05/07/2018

Drew Jackson
Jordan Cove LNG
5615 Kirby Dr
Houston, TX 77005

**** NOTICE OF PRESUMED HAZARD ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	LNG Carrier Vessel - Stack, Transit Point 2
Location:	North Bend, OR
Latitude:	43-24-07.84N NAD 83
Longitude:	124-16-41.25W
Heights:	12 feet site elevation (SE)
	199 feet above ground level (AGL)
	211 feet above mean sea level (AMSL)

Initial findings of this study indicate that the structure as described exceeds obstruction standards and/or would have an adverse physical or electromagnetic interference effect upon navigable airspace or air navigation facilities. Pending resolution of the issues described below, the structure is presumed to be a hazard to air navigation.

If the structure were reduced in height so as not to exceed 124 feet above ground level (136 feet above mean sea level), it would not create a substantial adverse effect and a favorable determination could subsequently be issued.

Any height exceeding 124 feet above ground level (136 feet above mean sea level), will result in a substantial adverse effect and would warrant a Determination of Hazard to Air Navigation.

See Attachment for Additional information.

NOTE: PENDING RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE, THE STRUCTURE IS PRESUMED TO BE A HAZARD TO AIR NAVIGATION. THIS LETTER DOES NOT AUTHORIZE CONSTRUCTION OF THE STRUCTURE EVEN AT A REDUCED HEIGHT. ANY RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE MUST BE COMMUNICATED TO THE FAA SO THAT A FAVORABLE DETERMINATION CAN SUBSEQUENTLY BE ISSUED.

IF MORE THAN 60 DAYS FROM THE DATE OF THIS LETTER HAS ELAPSED WITHOUT ATTEMPTED RESOLUTION, IT WILL BE NECESSARY FOR YOU TO REACTIVATE THE STUDY BY FILING A NEW FAA FORM 7460-1, NOTICE OF PROPOSED CONSTRUCTION OR ALTERATION.

If we can be of further assistance, please contact our office at (206) 231-2990, or paul.holmquist@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2018-ANM-5-OE.

Signature Control No: 352163126-364502142 (NPH)
Paul Holmquist
Specialist

Attachment(s)
Additional Information

ASN 2018-ANM-5-OE

Abbreviations

AGL - above ground level	AMSL - above mean sea level	RWY - runway
VFR - visual flight rules	IFR - instrument flight rules	NM - nautical mile
ASN- Aeronautical Study Number	CAT - category aircraft	
MDA - minimum descent altitude	DA - decision altitude	

Part 77 - Title 14 Code of Federal Regulations (CFR) Part 77, Safe, Efficient Use and Preservation of the Navigable Airspace

Our aeronautical study has disclosed that the proposed 199-foot AGL (211-foot AMSL) liquid natural gas carrier vessel (ship stack) shipping channel transit point location associated with the proposed Jordan Cove Liquid Natural Gas Terminal penetrates 14 CFR Part 77 protected airspace surfaces at Southwest Oregon Regional Airport (OTH) in North Bend, OR. The OTH airport elevation is 17 feet AMSL.

The proposed structure would exceed the following Part 77 surfaces:

a. Section 77.17(a)(3) -- A structure that causes less than the required obstacle clearance within a terminal obstacle clearance area, including an initial approach segment, a departure area, and a circling approach area resulting in increases to an IFR terminal minimum altitude. The LNG carrier vessel stack high point would have the following effects on IFR operations at OTH:

Obstacle penetrates OTH RWY 22 40:1 departure surface in the Initial Climb Area (ICA) 38 feet, increases climb gradient from standard and 200 feet per NM to 200-1- 1/4 or standard with 324 feet per NM to 400 then as published. The height at or below that avoids this effect: 173 AMSL (161 AGL).

OTH RWY 4 ILS or LOC: increases S-LOC 4 MDA from 400 AMSL to 480 AMSL. The height at or below that avoids this effect: 188 AMSL (176 AGL).

OTH RWY 4 RNAV (RNP) Z: increases RNP 0.30 DA# from 477 AMSL to 526 AMSL. The height at or below that avoids this effect: 136 AMSL (124 AGL).

OTH RWY 4 COPTER ILS or LOC: increases H-LOC 4 MDA from 400 AMSL to 480 AMSL. The height at or below that avoids this effect: 188 AMSL (176 AGL)

The MDA/DA is the minimum altitudes to which an aircraft may descend while on the instrument approach to the airport during periods when reduced visibility and/or low cloud ceiling conditions exist. If the pilot cannot achieve visual reference to the ground upon reaching the MDA/DA, the approach must be abandoned. This results in the aircraft having to proceed to an alternate airport or waiting in a holding pattern for improved weather conditions. Any increase in the MDA/DA would have a significant adverse effect on the benefits derived from the instrument procedures.

b. Section 77.19(a): Horizontal Surface-a height exceeding a horizontal plane 150 feet above the established airport elevation. The proposed structure would exceed the OTH Horizontal Surface by 44 feet.

Additionally, this proposed structure would exceed the OTH VFR traffic pattern airspace in the Part 77 Conical Surface as defined in FAA JO 7400.2L, 6-3-8, Evaluating Effect on VFR Operations. The VFR Conical

Surface is defined in Part 77 Section 77.19(b) as a surface extending outward and upward from the periphery of the VFR Part 77 Horizontal Surface at a slope of 20:1 for a horizontal distance of 4,000 feet .

This proposed structure would exceed the OTH VFR Traffic Pattern Conical Surface by 25 feet. The not-to-exceed height of 186 feet AGL (198 AMSL) will avoid penetrating the Conical Surface.

The FAA Technical Operations Branch found that while the proposal is laterally beyond the standard ? 10? visual slope approach indicator (VASI) obstacle clearance surface (OCS), however, it is within ? 15? of the extended runway centerline and above the VASI OCS. The proposal may be within the lateral limits of the visible light beam of the VASI serving OTH RWY 04. The height at or below that avoids this effect is 187 AMSL

The OTH Airport Master Record, http://www.gcr1.com/5010web/airport.cfm?Site=OTH, states there are 36 single engine, eight (8) multi-engine, one (1) jet, and six (6) helicopter aircraft based there with 18,277 total operations for the 12 months ending 31 December 2013 (latest information). RWY 31 is designated Right Traffic.

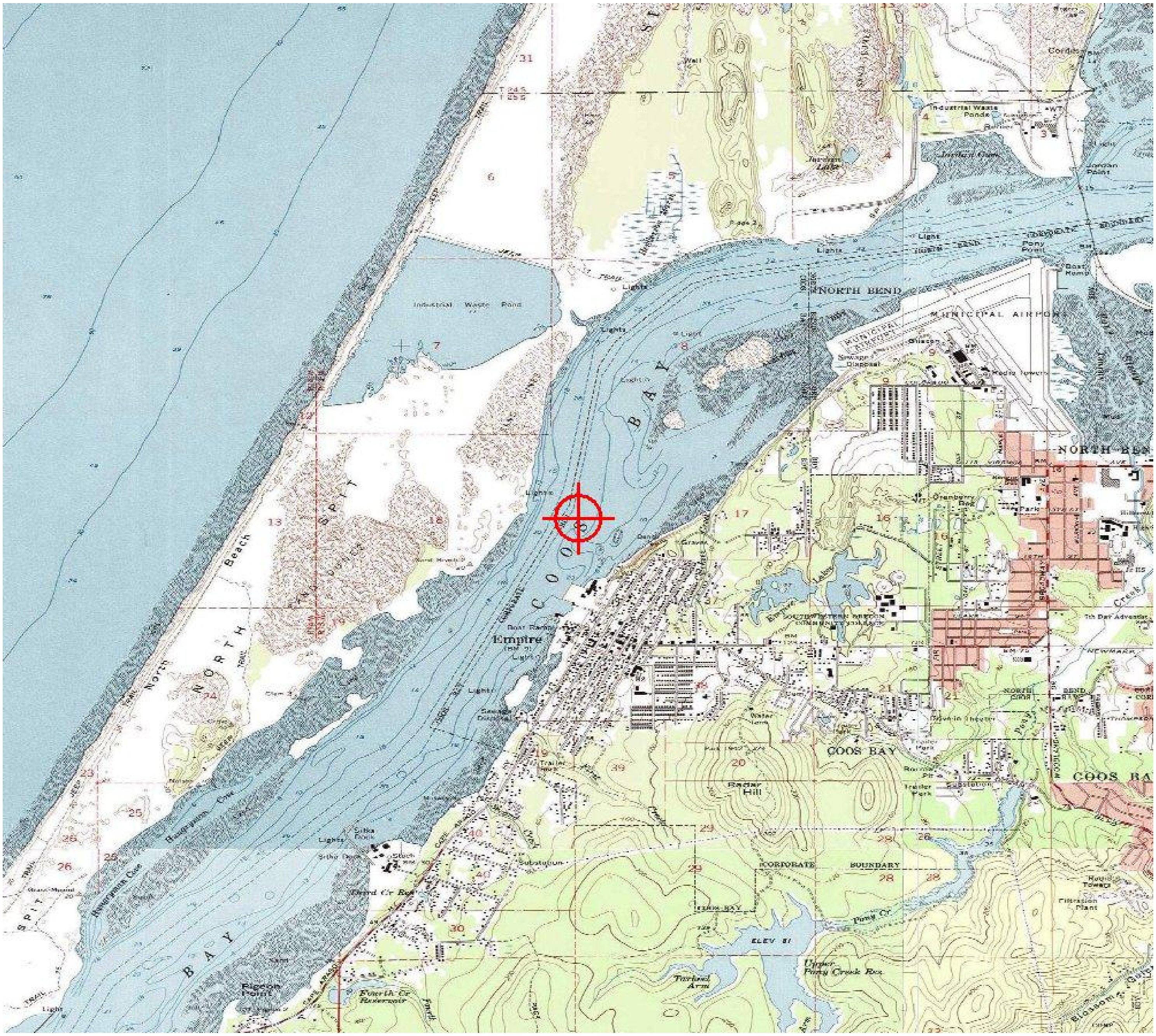
Your options and conditions for this proposal are as follows:

1. You must resolve the 75 foot OTH RWY 4 RNAV (RNP) Z DA penetration by lowering the structure height, with all appurtenances, to a maximum height at 124 AGL (136 AMSL). This would also resolve our objection to the 25 foot VFR Traffic Pattern Airspace penetration which requires lowering the structure height, with all appurtenances, to a maximum height at 174 feet AGL (186 AMSL). If you agree to limit the structure height to 124 feet AGL (136 feet AMSL), the FAA can then withdraw this objection to the proposed structure as it would not exceed obstruction standards and a favorable determination could be subsequently issued. Further FAA study for any height greater than 124 AGL/ 136 AMSL is not an option.

2. You can terminate the proposal at this location.

Please email me within 60 days of the date of this letter at Paul.Holmquist@faa.gov with your intentions and any questions you might have regarding this aeronautical study.

Close Print


NORTH BEND
MUNICIPAL AIRPORT
COOS BAY
Empire
Radar Hill
CORPORATE BOUNDARY
Industrial Waste Pond
Pigeon Point
Upper Pony Creek Res.
Drive-in Theater
Trailer Park
Substation
Sitka Dock
Boat Ramp
Sewage Disposal
Jordan Point
Pony Point
Coos Bay
BAY
NORTH SPIT
North Beach

Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2018-ANM-4-OE

Issued Date: 05/07/2018

Drew Jackson
Jordan Cove LNG
5615 Kirby Dr
Houston, TX 77005

**** NOTICE OF PRESUMED HAZARD ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	LNG Carrier Vessel - Stack, Transit Point 1
Location:	North Bend, OR
Latitude:	43-23-49.37N NAD 83
Longitude:	124-16-56.55W
Heights:	12 feet site elevation (SE)
	199 feet above ground level (AGL)
	211 feet above mean sea level (AMSL)

Initial findings of this study indicate that the structure as described exceeds obstruction standards and/or would have an adverse physical or electromagnetic interference effect upon navigable airspace or air navigation facilities. Pending resolution of the issues described below, the structure is presumed to be a hazard to air navigation.

If the structure were reduced in height so as not to exceed 155 feet above ground level (167 feet above mean sea level), it would not create a substantial adverse effect and a favorable determination could subsequently be issued.

Any height exceeding 167 feet above ground level (179 feet above mean sea level), will result in a substantial adverse effect and would warrant a Determination of Hazard to Air Navigation.

See Attachment for Additional information.

NOTE: PENDING RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE, THE STRUCTURE IS PRESUMED TO BE A HAZARD TO AIR NAVIGATION. THIS LETTER DOES NOT AUTHORIZE CONSTRUCTION OF THE STRUCTURE EVEN AT A REDUCED HEIGHT. ANY RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE MUST BE COMMUNICATED TO THE FAA SO THAT A FAVORABLE DETERMINATION CAN SUBSEQUENTLY BE ISSUED.

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If we can be of further assistance, please contact our office at (206) 231-2990, or paul.holmquist@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2018-ANM-4-OE.

Signature Control No: 352163125-364503672 (NPH)

Paul Holmquist
Specialist

Attachment(s)
Additional Information

Additional information for ASN 2018-ANM-4-OE

ASN 2018-ANM-4-OE

Abbreviations

AGL - above ground level	AMSL - above mean sea level	RWY - runway
VFR - visual flight rules	IFR - instrument flight rules	NM - nautical mile
ASN- Aeronautical Study Number	CAT - category aircraft	
MDA - minimum descent altitude	DA - decision altitude	

Part 77 - Title 14 Code of Federal Regulations (CFR) Part 77, Safe, Efficient Use and Preservation of the Navigable Airspace

Our aeronautical study has disclosed that the proposed 199-foot AGL (211-foot AMSL) liquid natural gas carrier vessel (ship stack) shipping channel transit point location associated with the proposed Jordan Cove Liquid Natural Gas Terminal penetrates 14 CFR Part 77 protected airspace surfaces at Southwest Oregon Regional Airport (OTH) in North Bend, OR. The OTH airport elevation is 17 feet AMSL.

The proposed structure would exceed the following Part 77 surfaces:

a. Section 77.17(a)(3) -- A structure that causes less than the required obstacle clearance within a terminal obstacle clearance area, including an initial approach segment, a departure area, and a circling approach area resulting in increases to an IFR terminal minimum altitude. The LNG carrier vessel stack high point would have the following effects on IFR operations at OTH:

OTH RWY 4 RNAV (RNP) Z: increases RNP 0.30 DAs from 477 AMSL / 569 AMSL to 584 AMSL. The height at or below that avoids this effect is: 179 AMSL (167 AGL)

The MDA/DA is the minimum altitudes to which an aircraft may descend while on the instrument approach to the airport during periods when reduced visibility and/or low cloud ceiling conditions exist. If the pilot cannot achieve visual reference to the ground upon reaching the MDA/DA, the approach must be abandoned. This results in the aircraft having to proceed to an alternate airport or waiting in a holding pattern for improved weather conditions. Any increase in the MDA/DA would have a significant adverse effect on the benefits derived from the instrument procedures.

b. Section 77.19(a): Horizontal Surface-a height exceeding a horizontal plane 150 feet above the established airport elevation. The proposed structure would exceed the OTH Horizontal Surface by 44 feet.

The OTH Airport Master Record, http://www.gcr1.com/5010web/airport.cfm?Site=OTH, states there are 36 single engine, eight (8) multi-engine, one (1) jet, and six (6) helicopter aircraft based there with 18,277 total operations for the 12 months ending 31 December 2013 (latest information). RWY 31 is designated Right Traffic.

Your options and conditions for this proposal are as follows:

1. You must resolve the 32 foot OTH RWY 4 RNAV (RNP) Z penetration by lowering the structure height, with all appurtenances, to a maximum height at 167 AGL (179 AMSL)

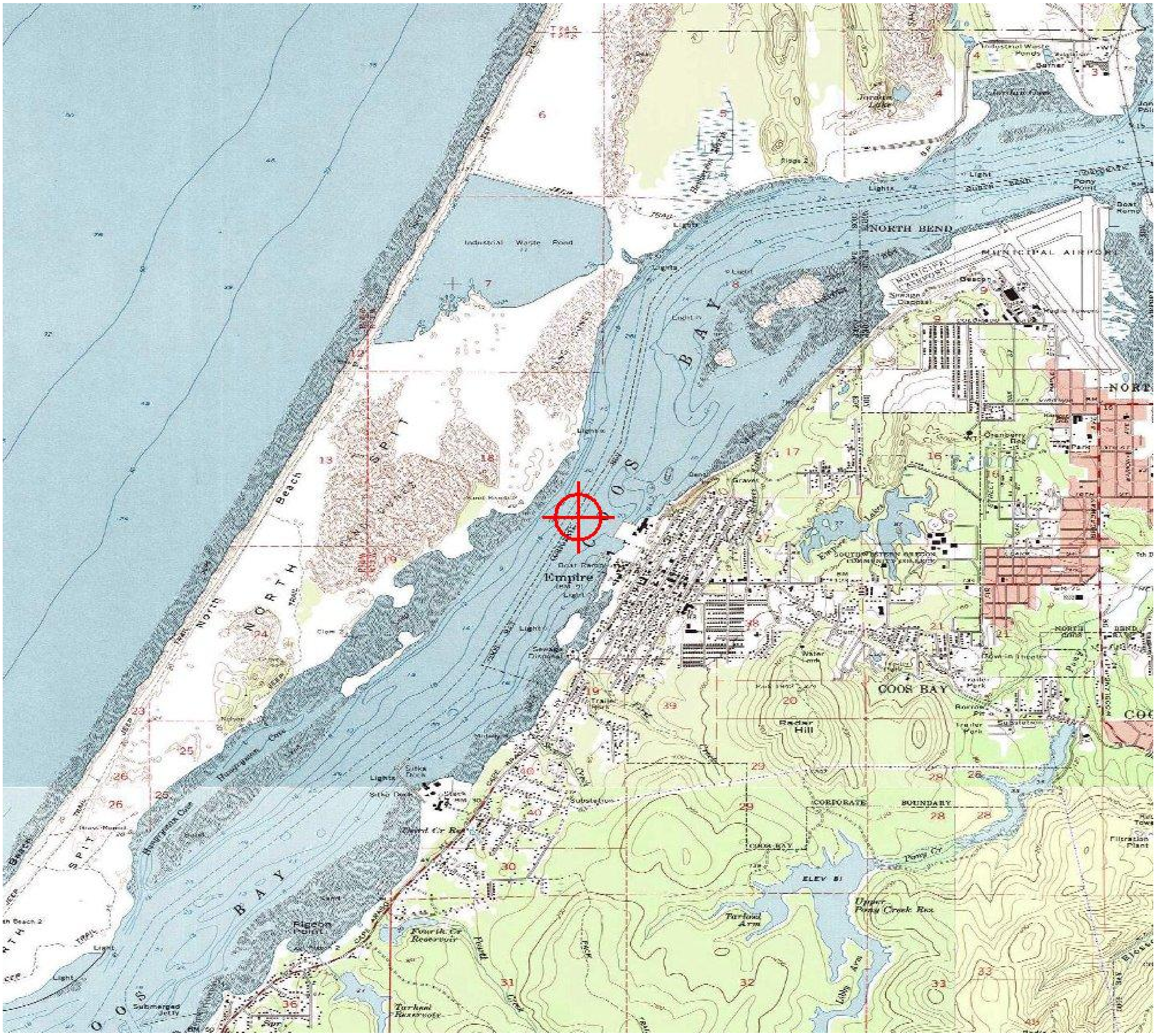
2. If you agree to limit the structure height to 155 feet AGL (167 AMSL), the FAA can then withdraw this objection to the proposed structure as it would not exceed obstruction standards and a favorable determination could be subsequently issued.

3. You can terminate the proposal at this location.

3. You can request further study for any height between 155 AGL and 167 AGL. Further study will include a public notice circularization and 37-day comment period where the outcome cannot be predicted. Further FAA study for any height greater than 167 AGL (179 AMSL) is not an option.

Please email me within 60 days of the date of this letter at Paul.Holmquist@faa.gov with your intentions and any questions you might have regarding this aeronautical study.

Close Print


NORTH BEND
MUNICIPAL AIRPORT
Industrial Waste Pond
BAY
COOS
Empire
COOS BAY
Radar Hill
CORPORATE BOUNDARY
Upper Pony Creek Res
Pigeon Point
NORTH SPIT
Beach

Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2017-ANM-5418-OE

Issued Date: 05/07/2018

Drew Jackson
Jordan Cove LNG
5615 Kirby Dr
Houston, TX 77005

**** NOTICE OF PRESUMED HAZARD ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	LNG Carrier Vessel - Stack
Location:	North Bend, OR
Latitude:	43-25-40.52N NAD 83
Longitude:	124-15-57.06W
Heights:	10 feet site elevation (SE)
	199 feet above ground level (AGL)
	209 feet above mean sea level (AMSL)

Initial findings of this study indicate that the structure as described exceeds obstruction standards and/or would have an adverse physical or electromagnetic interference effect upon navigable airspace or air navigation facilities. Pending resolution of the issues described below, the structure is presumed to be a hazard to air navigation.

If the structure were reduced in height so as not to exceed 157 feet above ground level (167 feet above mean sea level), it would not create a substantial adverse effect and a favorable determination could subsequently be issued.

Any height exceeding 157 feet above ground level (167 feet above mean sea level), will result in a substantial adverse effect and would warrant a Determination of Hazard to Air Navigation.

See Attachment for Additional information.

NOTE: PENDING RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE, THE STRUCTURE IS PRESUMED TO BE A HAZARD TO AIR NAVIGATION. THIS LETTER DOES NOT AUTHORIZE CONSTRUCTION OF THE STRUCTURE EVEN AT A REDUCED HEIGHT. ANY RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE MUST BE COMMUNICATED TO THE FAA SO THAT A FAVORABLE DETERMINATION CAN SUBSEQUENTLY BE ISSUED.

IF MORE THAN 60 DAYS FROM THE DATE OF THIS LETTER HAS ELAPSED WITHOUT ATTEMPTED RESOLUTION, IT WILL BE NECESSARY FOR YOU TO REACTIVATE THE STUDY BY FILING A NEW FAA FORM 7460-1, NOTICE OF PROPOSED CONSTRUCTION OR ALTERATION.

If we can be of further assistance, please contact our office at (206) 231-2990, or paul.holmquist@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2017-ANM-5418-OE.

Signature Control No: 350680505-364504065 (NPH)

Paul Holmquist
Specialist

Attachment(s)
Additional Information

Additional information for ASN 2017-ANM-5418-OE

ASN 2017-ANM-5418-OE

Abbreviations

AGL - above ground level
AMSL - above mean sea level
RWY - runway
VFR - visual flight rules
IFR - instrument flight rules
NM - nautical mile
ASN- Aeronautical Study Number
CAT - category aircraft
MDA - minimum descent altitude
DA - decision altitude
Part 77 - Title 14 Code of Federal Regulations (CFR) Part 77, Safe, Efficient Use and Preservation of the Navigable Airspace

Our aeronautical study has disclosed that the proposed 199-foot AGL (209-foot AMSL) liquid natural gas carrier vessel (ship stack) docking location associated with the proposed Jordan Cove Liquid Natural Gas Terminal penetrates 14 CFR Part 77 protected airspace surfaces at Southwest Oregon Regional Airport (OTH) in North Bend, OR. The OTH airport elevation is 17 feet AMSL.

The proposed structure would exceed the following Part 77 surface:

Section 77.19(a): Horizontal Surface-a height exceeding a horizontal plane 150 feet above the established airport elevation. The proposed structure would exceed the OTH Horizontal Surface by 42 feet.

Additionally, the proposed structure would exceed the OTH VFR traffic pattern airspace in the Part 77 VFR Horizontal Surface feet as defined in FAA JO 7400.2L, 6-3-8, Evaluating Effect on VFR Operations.

This proposed structure would exceed the OTH VFR Traffic Pattern Horizontal Surface by 42 feet. The not-to-exceed height of 157 feet AGL (167 AMSL) will avoid penetrating the Horizontal Surface.

The OTH Airport Master Record, http://www.gcr1.com/5010web/airport.cfm?Site=OTH, states there are 36 single engine, eight (8) multi-engine, one (1) jet, and six (6) helicopter aircraft based there with 18,277 total operations for the 12 months ending 31 December 2013 (latest information). RWY 31 is designated Right Traffic.

Your options and conditions for this proposal are as follows:

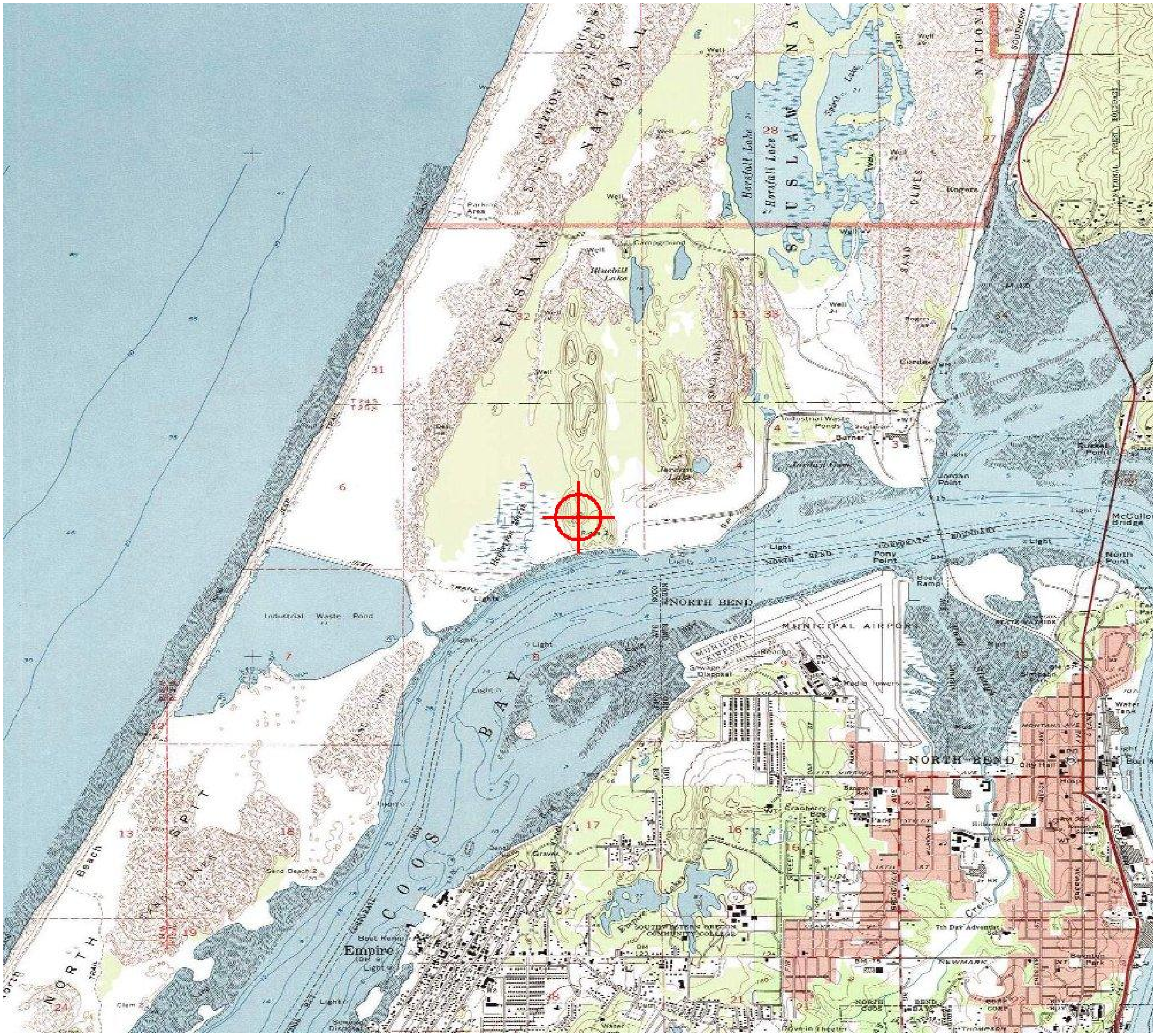
1. You must resolve the 42 foot VFR Traffic Pattern Airspace penetration by lowering the structure height, with all appurtenances, to a maximum height at 157 feet AGL (167 AMSL). The FAA can then withdraw this objection to the proposed structure as it would not exceed obstruction standards and a favorable determination could be subsequently issued.

2. You can terminate the proposal at this location.

Further FAA study for any height greater than 157 feet AGL (167 AMSL) is not an option.

Please email me within 60 days of the date of this letter at Paul.Holmquist@faa.gov with your intentions and any questions you might have regarding this aeronautical study.

Close Print



NORTH BEND
MUNICIPAL AIRPORT
COOS BAY
Empire
SOUTHWESTERN OREGON COMMUNITY COLLEGE
Industrial Waste Pond
Horsfall Lake
Jordan Cove
Pony Point
McCullough Bridge
North Point

Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2017-ANM-5389-OE

Issued Date: 05/07/2018

Drew Jackson
Jordan Cove LNG
5615 Kirby Dr
Houston, TX 77005

**** NOTICE OF PRESUMED HAZARD ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	Amine Regenerator
Location:	North Bend, OR
Latitude:	43-26-01.57N NAD 83
Longitude:	124-16-03.43W
Heights:	42 feet site elevation (SE)
	126 feet above ground level (AGL)
	168 feet above mean sea level (AMSL)

Initial findings of this study indicate that the structure as described exceeds obstruction standards and/or would have an adverse physical or electromagnetic interference effect upon navigable airspace or air navigation facilities. Pending resolution of the issues described below, the structure is presumed to be a hazard to air navigation.

If the structure were reduced in height so as not to exceed 125 feet above ground level (167 feet above mean sea level), it would not create a substantial adverse effect and a favorable determination could subsequently be issued.

See Attachment for Additional information.

NOTE: PENDING RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE, THE STRUCTURE IS PRESUMED TO BE A HAZARD TO AIR NAVIGATION. THIS LETTER DOES NOT AUTHORIZE CONSTRUCTION OF THE STRUCTURE EVEN AT A REDUCED HEIGHT. ANY RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE MUST BE COMMUNICATED TO THE FAA SO THAT A FAVORABLE DETERMINATION CAN SUBSEQUENTLY BE ISSUED.

IF MORE THAN 60 DAYS FROM THE DATE OF THIS LETTER HAS ELAPSED WITHOUT ATTEMPTED RESOLUTION, IT WILL BE NECESSARY FOR YOU TO REACTIVATE THE STUDY BY FILING A NEW FAA FORM 7460-1, NOTICE OF PROPOSED CONSTRUCTION OR ALTERATION.

If we can be of further assistance, please contact our office at (206) 231-2990, or paul.holmquist@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2017-ANM-5389-OE.

Signature Control No: 350680447-364504785 (NPH)
Paul Holmquist
Specialist

Attachment(s)
Additional Information

ASN 2017-ANM-5389-OE

Abbreviations

AGL - above ground level	AMSL - above mean sea level	RWY - runway
VFR - visual flight rules	IFR - instrument flight rules	NM - nautical mile
ASN- Aeronautical Study Number	CAT - category aircraft	
MDA - minimum descent altitude	DA - decision altitude	

Part 77 - Title 14 Code of Federal Regulations (CFR) Part 77, Safe, Efficient Use and Preservation of the Navigable Airspace

Our aeronautical study has disclosed that the proposed 126-foot AGL (168-foot AMSL) amine regenerator structure associated with the proposed Jordan Cove Liquid Natural Gas Terminal penetrates 14 CFR Part 77 protected airspace surfaces at Southwest Oregon Regional Airport (OTH) in North Bend, OR. The OTH airport elevation is 17 feet AMSL.

The proposed structure would exceed the following Part 77 surface:

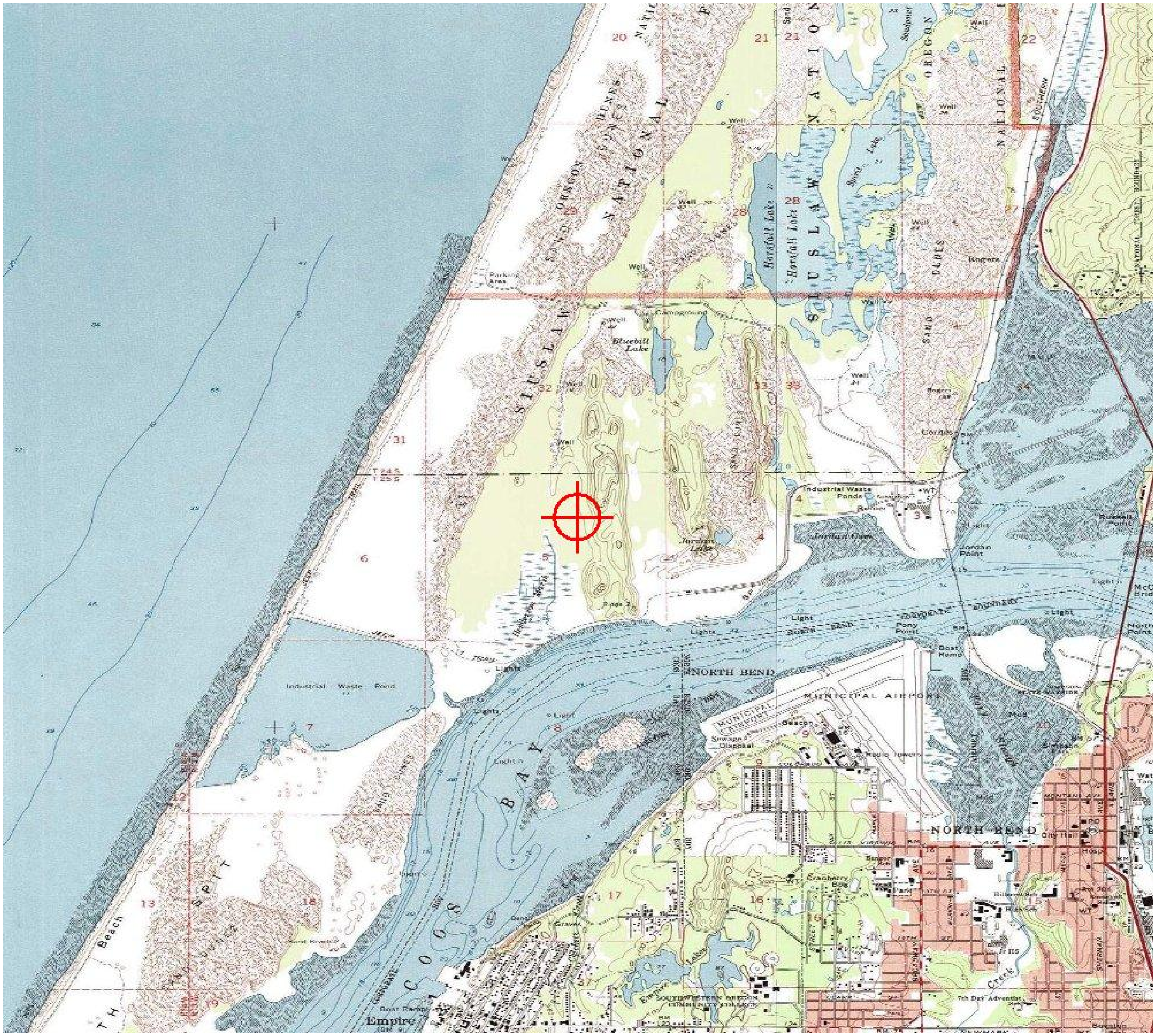
Section 77.19(a): Horizontal Surface-a height exceeding a horizontal plane 150 feet above the established airport elevation. The proposed structure would exceed the OTH Horizontal Surface by one (1) foot.

If you agree to limit the proposed structure height to 125 feet AGL (167 feet AMSL), the FAA can withdraw its objection as it would not exceed obstruction standards and a favorable determination could be subsequently issued.

You also have the option to either terminate the proposal or request further FAA study of the structure at the originally requested height. Further study will include a public notice circularization and 37-day comment period where the outcome cannot be predicted.

Please email me within 60 days of the date of this letter at Paul.Holmquist@faa.gov with your intentions and any questions you might have regarding this aeronautical study.

Close Print


NORTH BEND
Industrial Waste Pond
Industrial Waste Ponds
Campground
Park Area
Empire
Beach

Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2017-ANM-5388-OE

Issued Date: 05/07/2018

Drew Jackson
Jordan Cove LNG
5615 Kirby Dr
Houston, TX 77005

**** NOTICE OF PRESUMED HAZARD ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	Oxidizer
Location:	North Bend, OR
Latitude:	43-25-59.24N NAD 83
Longitude:	124-16-00.87W
Heights:	42 feet site elevation (SE)
	131 feet above ground level (AGL)
	173 feet above mean sea level (AMSL)

Initial findings of this study indicate that the structure as described exceeds obstruction standards and/or would have an adverse physical or electromagnetic interference effect upon navigable airspace or air navigation facilities. Pending resolution of the issues described below, the structure is presumed to be a hazard to air navigation.

If the structure were reduced in height so as not to exceed 125 feet above ground level (167 feet above mean sea level), it would not create a substantial adverse effect and a favorable determination could subsequently be issued.

See Attachment for Additional information.

NOTE: PENDING RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE, THE STRUCTURE IS PRESUMED TO BE A HAZARD TO AIR NAVIGATION. THIS LETTER DOES NOT AUTHORIZE CONSTRUCTION OF THE STRUCTURE EVEN AT A REDUCED HEIGHT. ANY RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE MUST BE COMMUNICATED TO THE FAA SO THAT A FAVORABLE DETERMINATION CAN SUBSEQUENTLY BE ISSUED.

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If we can be of further assistance, please contact our office at (206) 231-2990, or paul.holmquist@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2017-ANM-5388-OE.

Signature Control No: 350680446-364505031 (NPH)
Paul Holmquist
Specialist

Attachment(s)
Additional Information

ASN 2017-ANM-5388-OE

Abbreviations

AGL - above ground level	AMSL - above mean sea level	RWY - runway
VFR - visual flight rules	IFR - instrument flight rules	NM - nautical mile
ASN- Aeronautical Study Number	CAT - category aircraft	
MDA - minimum descent altitude	DA - decision altitude	

Part 77 - Title 14 Code of Federal Regulations (CFR) Part 77, Safe, Efficient Use and Preservation of the Navigable Airspace

Our aeronautical study has disclosed that the proposed 131-foot AGL (173-foot AMSL) oxidizer structure associated with the proposed Jordan Cove Liquid Natural Gas Terminal penetrates 14 CFR Part 77 protected airspace surfaces at Southwest Oregon Regional Airport (OTH) in North Bend, OR. The OTH airport elevation is 17 feet AMSL.

The proposed structure would exceed the following Part 77 surface:

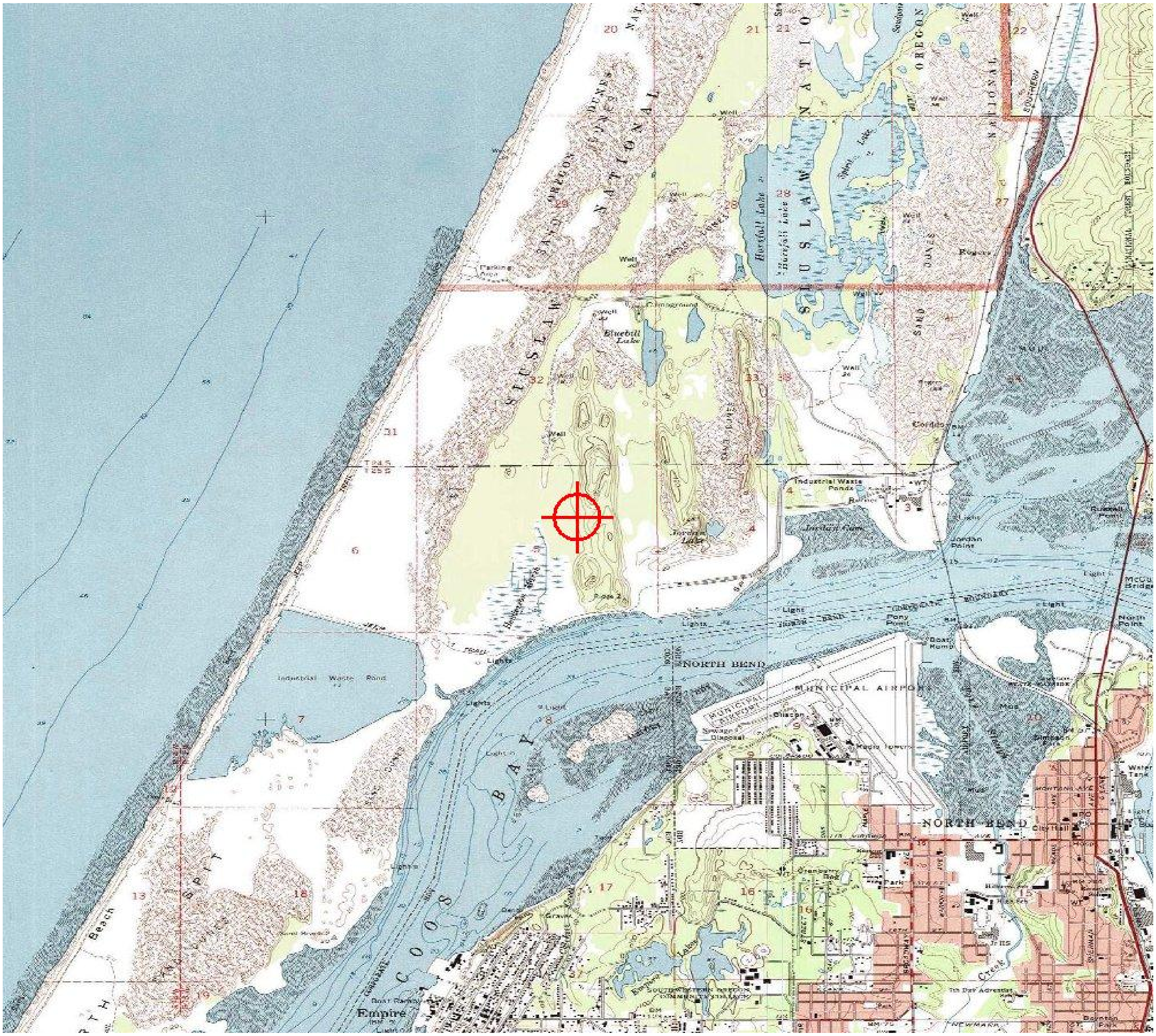
Section 77.19(a): Horizontal Surface-a height exceeding a horizontal plane 150 feet above the established airport elevation. The proposed structure would exceed the OTH Horizontal Surface by six (6) feet.

If you agree to limit the proposed structure height to 125 feet AGL (167 feet AMSL), the FAA can withdraw its objection as it would not exceed obstruction standards and a favorable determination could be subsequently issued.

You also have the option to either terminate the proposal or request further FAA study of the structure at the originally requested height. Further study will include a public notice circularization and 37-day comment period where the outcome cannot be predicted.

Please email me within 60 days of the date of this letter at Paul.Holmquist@faa.gov with your intentions and any questions you might have regarding this aeronautical study.

Close Print


NORTH BEND
MUNICIPAL AIRPORT
Industrial Waste Pond
Industrial Waste Ponds
Bluebill Lake
Jordan Lake
Horsfall Lake
SIUSLAW NATIONAL
B A Y
C O O S
Empire
City Hall

Mail Processing Center
Federal Aviation Administration
Southwest Regional Office
Obstruction Evaluation Group
10101 Hillwood Parkway
Fort Worth, TX 76177

Aeronautical Study No.
2017-ANM-5387-OE

Issued Date: 05/07/2018

Drew Jackson
Jordan Cove LNG
5615 Kirby Dr
Houston, TX 77005

**** NOTICE OF PRESUMED HAZARD ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	LNG Tank North
Location:	North Bend, OR
Latitude:	43-25-53.61N NAD 83
Longitude:	124-16-01.16W
Heights:	23 feet site elevation (SE)
	219 feet above ground level (AGL)
	242 feet above mean sea level (AMSL)

Initial findings of this study indicate that the structure as described exceeds obstruction standards and/or would have an adverse physical or electromagnetic interference effect upon navigable airspace or air navigation facilities. Pending resolution of the issues described below, the structure is presumed to be a hazard to air navigation.

If the structure were reduced in height so as not to exceed 144 feet above ground level (167 feet above mean sea level), it would not create a substantial adverse effect and a favorable determination could subsequently be issued.

Any height exceeding 203 feet above ground level (226 feet above mean sea level), will result in a substantial adverse effect and would warrant a Determination of Hazard to Air Navigation.

See Attachment for Additional information.

NOTE: PENDING RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE, THE STRUCTURE IS PRESUMED TO BE A HAZARD TO AIR NAVIGATION. THIS LETTER DOES NOT AUTHORIZE CONSTRUCTION OF THE STRUCTURE EVEN AT A REDUCED HEIGHT. ANY RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE MUST BE COMMUNICATED TO THE FAA SO THAT A FAVORABLE DETERMINATION CAN SUBSEQUENTLY BE ISSUED.

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If we can be of further assistance, please contact our office at (206) 231-2990, or paul.holmquist@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2017-ANM-5387-OE.

Signature Control No: 350680445-364508370 (NPH)

Paul Holmquist
Specialist

Attachment(s)
Additional Information

ASN 2017-ANM-5387-OE

Abbreviations

AGL - above ground level	AMSL - above mean sea level	RWY - runway
VFR - visual flight rules	IFR - instrument flight rules	NM - nautical mile
ASN- Aeronautical Study Number	CAT - category aircraft	
MDA - minimum descent altitude	DA - decision altitude	

Part 77 - Title 14 Code of Federal Regulations (CFR) Part 77, Safe, Efficient Use and Preservation of the Navigable Airspace

Our aeronautical study has disclosed that the proposed 219-foot AGL (242-foot AMSL) north liquid natural gas tank structure associated with the proposed Jordan Cove Liquid Natural Gas Terminal penetrates 14 CFR Part 77 protected airspace surfaces at Southwest Oregon Regional Airport (OTH) in North Bend, OR. The OTH airport elevation is 17 feet AMSL.

The proposed structure would exceed the following Part 77 surfaces:

a. Section 77.17(a)(2): A height that is 200 feet above ground level or above the established airport elevation, whichever is higher, within three nautical miles of the established reference point of an airport, excluding heliports, with its longest runway more than 3,200 feet in actual length, and that height increases in the proportion of 100 feet for each additional nautical mile of distance from the airport up to a maximum of 500 feet. This proposed structure would exceed the OTH Part 77.17(a)(2) surface by 19 feet.

b. Section 77.19(a): Horizontal Surface-a height exceeding a horizontal plane 150 feet above the established airport elevation. The proposed structure would exceed the OTH Horizontal Surface by 75 feet.

Additionally, this proposed structure would exceed the OTH VFR traffic pattern airspace in the Part 77 Conical Surface as defined in FAA JO 7400.2L, 6-3-8, Evaluating Effect on VFR Operations. The VFR Conical Surface is defined in Part 77 Section 77.19(b) as a surface extending outward and upward from the periphery of the VFR Part 77 Horizontal Surface at a slope of 20:1 for a horizontal distance of 4,000 feet .

This proposed structure would exceed the OTH VFR Traffic Pattern Conical Surface by 16 feet. The not-to-exceed height of 203 feet AGL (226 AMSL) will avoid penetrating the Conical Surface.

The OTH Airport Master Record, http://www.gcr1.com/5010web/airport.cfm?Site=OTH, states there are 36 single engine, eight (8) multi-engine, one (1) jet, and six (6) helicopter aircraft based there with 18,277 total operations for the 12 months ending 31 December 2013 (latest information). RWY 31 is designated Right Traffic.

Your options and conditions for this proposal are as follows:

1. You must resolve the 16 foot VFR Traffic Pattern Airspace penetration by lowering the structure height, with all appurtenances, to a maximum height at 203 feet AGL (226 AMSL).

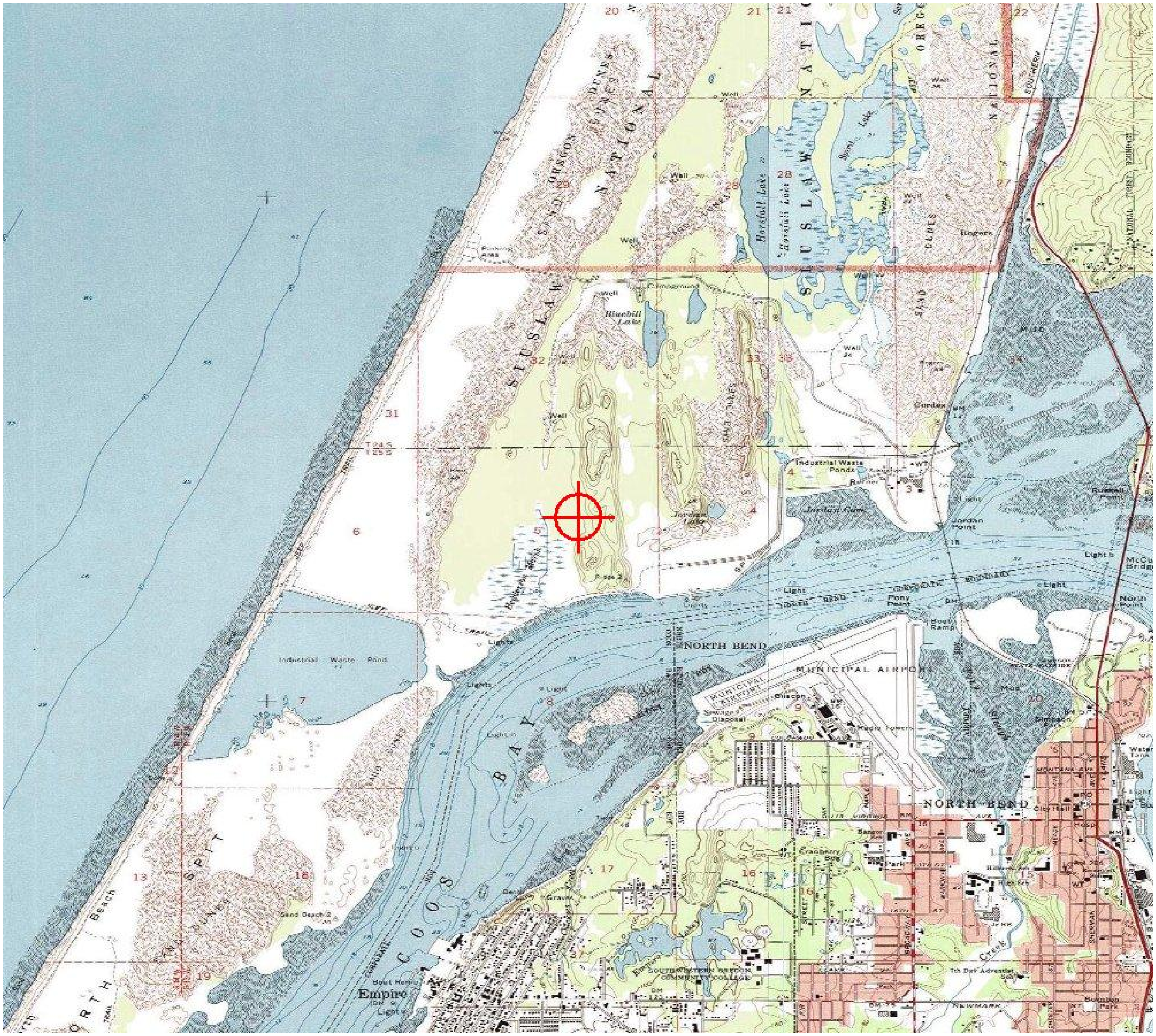
2. You can agree to limit the structure height to 144 feet AGL (167 feet AMSL). The FAA can then withdraw this objection to the proposed structure as it would not exceed obstruction standards and a favorable determination could be subsequently issued.

3. You can terminate the proposal at this location.

4. You can request further study for any height between 144 AGL and 203 AGL. Further study will include a public notice circularization and 37-day comment period where the outcome cannot be predicted. Further FAA study for any height greater than 203 AGL/ 226 AMSL is not an option.

Please email me within 60 days of the date of this letter at Paul.Holmquist@faa.gov with your intentions and any questions you might have regarding this aeronautical study.

Close Print


Bluebill Lake
Horsfall Lake
Industrial Waste Ponds
Jordan Cove
Jordan Point
Pony Point
Industrial Waste Pond
NORTH BEND
MUNICIPAL AIRPORT
NORTH SPIT
COOS BAY
Empire
SOUTHWESTERN OREGON COMMUNITY COLLEGE

Mail Processing Center Federal Aviation Administration Southwest Regional Office Obstruction Evaluation Group 10101 Hillwood Parkway Fort Worth, TX 76177	Aeronautical Study No. 2017-ANM-5386-OE

Issued Date: 05/07/2018

Drew Jackson
Jordan Cove LNG
5615 Kirby Dr
Houston, TX 77005

**** NOTICE OF PRESUMED HAZARD ****

The Federal Aviation Administration has conducted an aeronautical study under the provisions of 49 U.S.C., Section 44718 and if applicable Title 14 of the Code of Federal Regulations, part 77, concerning:

Structure:	LNG Tank South
Location:	North Bend, OR
Latitude:	43-25-48.88N NAD 83
Longitude:	124-16-00.87W
Heights:	23 feet site elevation (SE)
	219 feet above ground level (AGL)
	242 feet above mean sea level (AMSL)

Initial findings of this study indicate that the structure as described exceeds obstruction standards and/or would have an adverse physical or electromagnetic interference effect upon navigable airspace or air navigation facilities. Pending resolution of the issues described below, the structure is presumed to be a hazard to air navigation.

If the structure were reduced in height so as not to exceed 144 feet above ground level (167 feet above mean sea level), it would not create a substantial adverse effect and a favorable determination could subsequently be issued.

Any height exceeding 181 feet above ground level (204 feet above mean sea level), will result in a substantial adverse effect and would warrant a Determination of Hazard to Air Navigation.

See Attachment for Additional information.

NOTE: PENDING RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE, THE STRUCTURE IS PRESUMED TO BE A HAZARD TO AIR NAVIGATION. THIS LETTER DOES NOT AUTHORIZE CONSTRUCTION OF THE STRUCTURE EVEN AT A REDUCED HEIGHT. ANY RESOLUTION OF THE ISSUE(S) DESCRIBED ABOVE MUST BE COMMUNICATED TO THE FAA SO THAT A FAVORABLE DETERMINATION CAN SUBSEQUENTLY BE ISSUED.

IF MORE THAN 60 DAYS FROM THE DATE OF THIS LETTER HAS ELAPSED WITHOUT ATTEMPTED RESOLUTION, IT WILL BE NECESSARY FOR YOU TO REACTIVATE THE STUDY BY FILING A NEW FAA FORM 7460-1, NOTICE OF PROPOSED CONSTRUCTION OR ALTERATION.

If we can be of further assistance, please contact our office at (206) 231-2990, or paul.holmquist@faa.gov. On any future correspondence concerning this matter, please refer to Aeronautical Study Number 2017-ANM-5386-OE.

Signature Control No: 350680444-364508838 (NPH)
Paul Holmquist
Specialist

Attachment(s)
Additional Information

Additional information for ASN 2017-ANM-5386-OE

ASN 2017-ANM-5386-OE

Abbreviations

AGL - above ground level
AMSL - above mean sea level
RWY - runway
VFR - visual flight rules
IFR - instrument flight rules
NM - nautical mile
ASN- Aeronautical Study Number
CAT - category aircraft
MDA - minimum descent altitude
DA - decision altitude
Part 77 - Title 14 Code of Federal Regulations (CFR) Part 77, Safe, Efficient Use and Preservation of the Navigable Airspace

Our aeronautical study has disclosed that the proposed 219-foot AGL (242-foot AMSL) south liquid natural gas tank structure associated with the proposed Jordan Cove Liquid Natural Gas Terminal penetrates 14 CFR Part 77 protected airspace surfaces at Southwest Oregon Regional Airport (OTH) in North Bend, OR. The OTH airport elevation is 17 feet AMSL.

The proposed structure would exceed the following Part 77 surfaces:

a. Section 77.17(a)(2): A height that is 200 feet above ground level or above the established airport elevation, whichever is higher, within three nautical miles of the established reference point of an airport, excluding heliports, with its longest runway more than 3,200 feet in actual length, and that height increases in the proportion of 100 feet for each additional nautical mile of distance from the airport up to a maximum of 500 feet. This proposed structure would exceed this surface by 19 feet.

b. Section 77.19(a): Horizontal Surface-a height exceeding a horizontal plane 150 feet above the established airport elevation. The proposed structure would exceed the OTH Horizontal Surface by 75 feet.

Additionally, this proposed structure would exceed the OTH VFR traffic pattern airspace in the Part 77 Conical Surface as defined in FAA JO 7400.2L, 6-3-8, Evaluating Effect on VFR Operations. The VFR Conical Surface is defined in Part 77 Section 77.19(b) as a surface extending outward and upward from the periphery of the VFR Part 77 Horizontal Surface at a slope of 20:1 for a horizontal distance of 4,000 feet .

This proposed structure would exceed the OTH VFR Traffic Pattern Altitude (TPA) Conical Surface by 37 feet and the OTH VFR TPA Conical Surface plan on file by 38 feet. . The not-to-exceed height of 181 AGL / 204 AMSL will avoid penetrating the Conical Surface (plan on file).

The OTH Airport Master Record, http://www.gcr1.com/5010web/airport.cfm?Site=OTH, states there are 36 single engine, eight (8) multi-engine, one (1) jet, and six (6) helicopter aircraft based there with 18,277 total operations for the 12 months ending 31 December 2013 (latest information). RWY 31 is designated Right Traffic.

Your options and conditions for this proposal are as follows:

1. You must resolve the 38 foot VFR Traffic Pattern Airspace penetration by lowering the structure height, with all appurtenances, to a maximum height at 181 AGL / 204 AMSL.

2. You can agree to limit the structure height to 144 feet AGL (167 feet AMSL). The FAA can then withdraw this objection to the proposed structure as it would not exceed obstruction standards and a favorable determination could be subsequently issued.

3. You can terminate the proposal at this location.

4. You can request further study for any height between 144 AGL and 181 AGL. Further study will include a public notice circularization and 37-day comment period where the outcome cannot be predicted. Further FAA study for any height greater than 181 AGL/ 204 AMSL is not an option.

Please email me within 60 days of the date of this letter at Paul.Holmquist@faa.gov with your intentions and any questions you might have regarding this aeronautical study.

Close Print

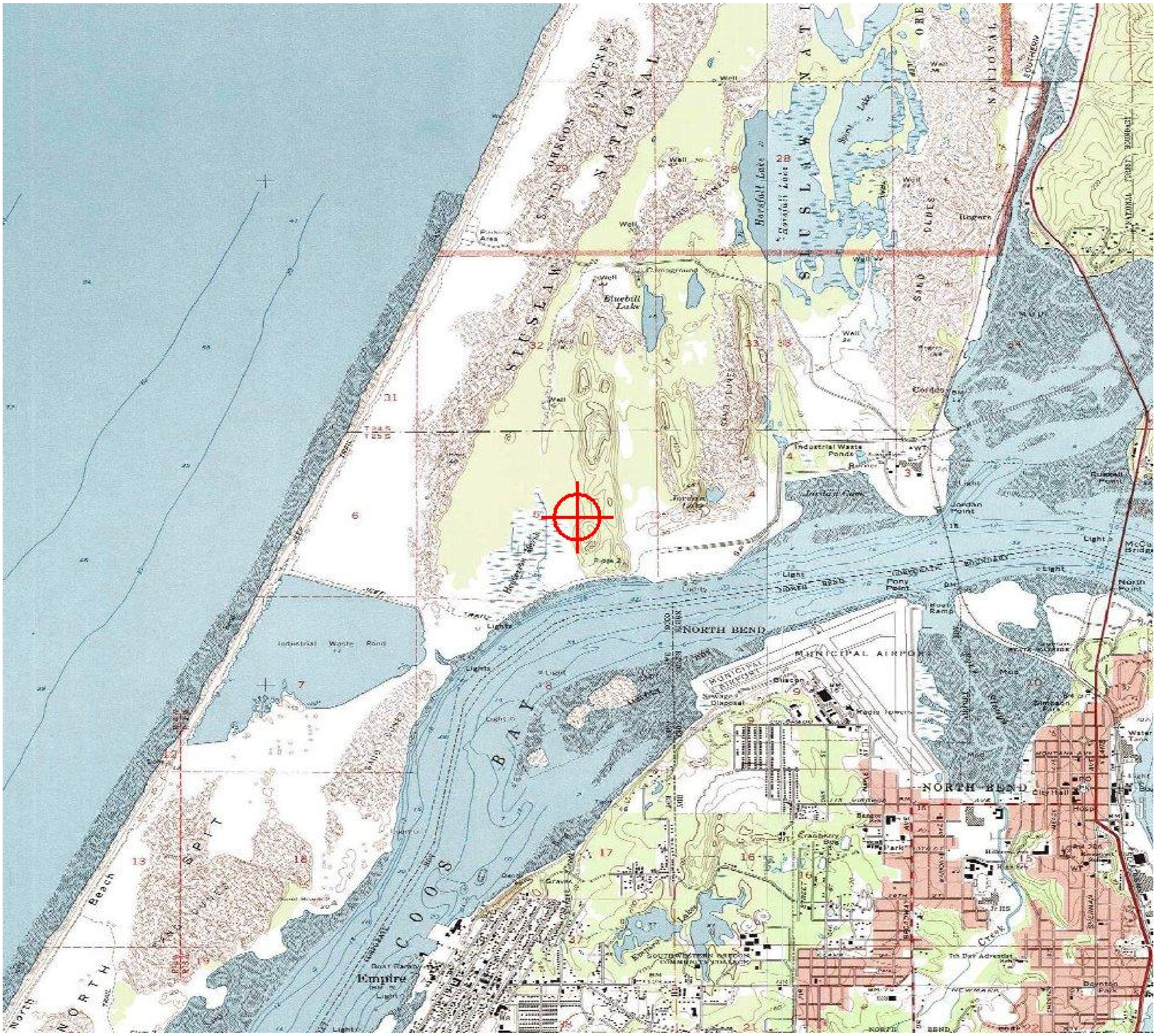

Bluebill Lake
Horsfall Lake
Industrial Waste Ponds
Jordan Cove
Jordan Point
NORTH BEND
MUNICIPAL AIRPORT
Industrial Waste Pond
COOS BAY
Empire
NORTH SPIT
North Beach
Pony Point
North Point
Russell Point
McCullough Bridge
City Hall
Downtown Park

Exhibit 33

https://theworldlink.com/news/local/deq-hits-clausen-oysters-with-fine/article_9fb57e0c-b070-11df-8cc0-001cc4c03286.html

DEQ hits Clausen Oysters with $25,000 fine

By Gail Elber, Staff Writer Aug 25, 2010

The Oregon Department of Environmental Quality has levied $24,992 in penalties on Clausen Oysters in North Bend for wastewater violations.

According to DEQ, the business operated from 2005 to 2009 without a wastewater discharge permit, incurring penalties of $16,349.

It then violated its newly obtained permit this year by failing to monitor wastewater and report monitoring results to DEQ, incurring penalties of $5,643.

It also discharged water to the bay without screening it, incurring a $3,000 penalty.

'Out of the blue'

Lilli Clausen, who with her husband Max has owned the company on Haynes Inlet since 1994, said that the letter from DEQ came "out of the blue."

She said that for 2003 and 2005, she paid for the permit and has the canceled checks.

For other years, she said, she never got a bill.

Her microbiological testing has been done, but the reports weren't filed due to a miscommunication, she said.

And the required screening system has long been a bone of contention between her and the DEQ.

"We're going to appeal," she said.

Spotty permits

Clausen Oysters, owned by Max and Lilli Clausen, has operated a processing facility at 66234 North Bay Road since 1994. Originally, it had a permit to discharge process wastewater - generated from washing oysters and equipment - to Haynes Inlet.

Wastewater from the company's sinks and toilets isn't at issue. It's treated in a septic tank and dispersed in a drainfield across the road from the bay.

In November 2005, the environmental agency canceled the facility's process wastewater permit because the Clausens had not renewed it.

For four years, the Clausens operated the facility without a permit, finally obtaining one in January 2010.

Reports required

But after obtaining the new permit, the Clausens didn't follow its requirements, the environmental agency said.

They didn't have equipment in place to screen solids out of their wastewater, as their permit required.

They also didn't submit monthly discharge monitoring reports with production information, microbiological test results, and amounts of waste solids produced.

Clausen said that she paid for permits in 2003 and 2005, and never saw a bill after 2005.

"I'm quite concerned about our credit, so if I had seen a bill, I would have paid it."

She said she paid for 2009 when she applied for a permit in November 2009, which she received in January 2010.

"If I had known then that I owed anything, I could have paid it then and there."

Screens a problem

Clausen has struggled with the agency's requirement to screen her process wastewater.

Regulations require a fine screen that clogs constantly, Clausen said, which caused problems in her operation.

"It is most impractical and very unnecessary," she said.

Clausen maintains that no oyster meat enters the wash water - just mud it washes off the oysters.

"The mud comes out of the bay; it goes back in the bay."

Recently they got a screen that works, she said.

But Steve Nichols of the Department of Environmental Quality's Coos Bay office, who inspects seafood processing facilities, said he hasn't seen it in action yet.

As for the missing discharge water quality reports, Clausen isn't yet sure what happened.

She said that she pays to have the North Bend wastewater treatment plant do the testing.

She thought it would send in the reports, but apparently they weren't being sent to the right place, she said.

The Clausens have until Sept. 10 to file an appeal.

Reporter Gail Elber can be reached at 541-269-1222, ext. 234; or at gelber@theworldlink.com.

Exhibit 34

Federal Aviation Administration

Memorandum

Date: JAN 21 2015

To: Regional Airports Division Managers
610 Branch Managers
620 Branch Managers
Airports District Office Managers

From: Director, Office of Airport Planning and Programming (APP-1)

Director, Office of Airport Safety and Standards (AAS-1)

Subject: Technical Guidance and Assessment Tool for Evaluation of Thermal Exhaust Plume Impact on Airport Operations

The Federal Aviation Administration (FAA) has received several inquiries and requests from state and local government and airport operators for guidance on the appropriate separation distance between power plants and airports where exhaust plumes from power plant smoke stacks and cooling towers may cause disruption to aircraft near Federally-obligated airports. The only related FAA regulations address the physical restrictions of the exhaust stack height. There are no FAA regulations protecting for plumes and other emissions from exhaust stacks.

In response, the FAA's Airport Obstruction Standards Committee (AOSC) was tasked to study the impact exhaust plumes may have on flight safety. The AOSC study evaluated the following:

1. How much turbulence is created by the exhaust plumes?
2. Is this turbulence great enough to cause loss of pilot control?
   If so, what size aircraft are impacted?
3. Is there a lack of oxygen (within a plume) causing loss of engine or danger to pilot/passengers?
4. Are there harmful health effects to the pilot or passengers from flying through the plume?

After thorough analysis, the FAA has determined the overall risk associated with thermal exhaust plumes in causing a disruption of flight is low. However, the FAA has determined that thermal exhaust plumes in the vicinity of airports may pose a unique hazard to aircraft in critical phases of flight (particularly takeoff, landing and within the pattern) and therefore are incompatible with airport operations.

Flight within the airport traffic pattern, approach and departure corridors, and existing or planned flight procedures may be adversely affected by thermal exhaust plumes[1]. The FAA-sponsored research indicates that the plume size and severity of impact on flight can vary greatly depending on several factors at a site such as:

- Stack size, number, and height; type of exhaust or effluent (e.g., coolant tower cloud, power plant smoke, etc.);
- Proximity of stacks to the airport flight paths;
- Temperature and vertical speed of the effluent;
- Size and speed of aircraft encountering exhaust plumes; and
- Local winds, ambient temperatures, stratification of the atmosphere at the plume site.

Airport sponsors and land use planning and permitting agencies around airports are encouraged to evaluate and take into account potential flight impacts from existing and planned development that produce plumes (such as power plants or other land uses that employ smoke stacks, cooling towers or facilities that create thermal exhaust plumes).

To aid these reviews the FAA contracted MITRE Corporation to develop a model to predict plume size and severity of flight impact from a site of thermal exhaust plume(s). MITRE developed the "Exhaust-Plume-Analyzer" and it is available for no cost. Access can be found for licensing and downloading from MITRE at: http://www.mitre.org/research/technology-transfer/technology-licensing/exhaust-plume-analyzer

The MITRE Exhaust-Plume-Analyzer can be an effective tool to assess the impact exhaust plumes may impose on flight operations at an existing or proposed site in the vicinity of an airport.

The FAA Advisory Circular (AC) 5190-4, A Model Zoning Ordinance to Limit the Height of Objects Around Airports (Airport Compatible Land Use Planning), is currently being updated to include comprehensive guidance to airport sponsors and local community planners on airport compatible land use issues, including evaluation of thermal exhaust plumes. The updated AC is expected to be issued in FY 2015.

[1] On July 24, 2014, the FAA issued a change to the Aeronautical Information Manual (AIM) to update terminology and provide more detail regarding the associated hazards of exhaust plumes. See the updated AIM flight instruction to pilots at Section 5-5-15, Avoid Flight in the Vicinity of Exhaust Plumes (Smoke Stacks, Cooling Towers) at http://www.faa.gov/air_traffic/publications/atpubs/aim/aim0705.html.

In the interim, please provide this technical memorandum to airport sponsors to advise them of the availability of the Exhaust-Plume-Analyzer. Sponsors, state and local planning organizations, and permitting jurisdictions now have the opportunity to ensure that their planning and land use development decisions adequately evaluate the potential effects of thermal exhaust plumes on airport operations.

Should you have any questions concerning this memorandum please contact Rick Etter, Airport Planning and Environmental Division (APP-400) at 202-267-8773 or by email at rick.etter@faa.gov.

Exhibit 35

WILLAMETTE WEEK

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April 22nd, 2015 12:01 am NIGEL JAQUISS | News Stories

Hot Air

Pilots say the Port of Portland's plans to sell land for a power plant next to the Troutdale Airport include a fatal flaw.

FLYING SCARED: Mike Rhodes spent four years building his RV-9A plane from a kit. He says a proposed natural gas-fired power plant near the Troutdale Airport presents a "clear and present danger" to aviation. - IMAGE: Will Corwin

Mike Rhodes fell in love with flying nearly 50 years ago at the Troutdale Airport while on a school field trip, and from his first flight, he knew he wanted to be a pilot.

Today, Rhodes, 61, a nuclear engineer who lives in Gresham, keeps a two-seater plane he built himself at the Troutdale Airport, 10 miles east of Portland along I-84. He's logged more than 2,000 hours flying—always conscientious about safety for himself and his passengers.

But Rhodes says he and hundreds of other pilots who regularly use Troutdale, the state's third-busiest airport, now fear for their safety.

“What they want to do,” Rhodes says, “will make flying in an out of Troutdale dramatically more dangerous.”

The “they” posing the threat, Rhodes says, is the airport’s owner, the Port of Portland.

The port wants to sell 38 acres directly north of the Troutdale Airport to the developer of a natural gas-fired power plant. The proposed plant, called the Troutdale Energy Center, would create a powerful heat updraft that experts say could endanger small planes flying in and out of the airport.

That development is currently the subject of a permitting dispute pitting the state’s Energy Facility Siting Council, which issues permits for new electrical generating plants, against a coalition of environmentalists and aviation groups, including the Oregon State Aviation Board and groups representing airplane owners and pilots.

“I understand the port wants to maximize revenue from the real estate it owns,” says Rhodes, “but developing this power plant is detrimental to another part of the port—and to pilots.”

Port spokeswoman Kama Simonds says the developers of the Troutdale Energy Center conducted extensive safety modeling that assured the port of the project’s safety.

“The port believes that the Troutdale Energy Center and the Troutdale Airport can successfully coexist,” Simonds says.

There’s some irony in the port finding itself at loggerheads with pilots and the aviation board. Airports are the cash cow for a port with grim financial challenges elsewhere.

Labor disputes have cost the port its marine container business. That has left the port even more focused on Portland International Airport, whose landing fees and parking revenues are the agency’s lifeblood.

The port is also in the real estate and economic development business. It bought the contaminated site of a shuttered Troutdale aluminum plant in 2007. Selling part of it to the Troutdale Energy Center (for an undisclosed price) would allow the development of the reclaimed industrial land.

The Troutdale Airport, with its 5,400-foot runway, typically handles small planes, although private jets also land and take off there. Flight instructors have moved operations to Troutdale from Hillsboro, the state’s busiest airport. The two airports will generate about $3.5 million in revenue for the port this year, most of that from Hillsboro.

Although the smaller airports generate only a tiny fraction of PDX’s revenue, they play a vital role in the port’s system. The port depends on the Hillsboro and Troutdale airports to handle small aircraft that would otherwise need to use PDX. The smaller airports handle 50 percent more takeoffs and landings than PDX while providing training grounds for domestic and international pilots.

Initially, pilots worried that a power plant at Troutdale would hamper visibility. Gas-fired generating plants work by boiling water to produce steam that drives turbines. When the water is cooled, the steam roiling out of the plant's cooling towers could fog pilots' flight paths and create a hazard.

But the bigger concern now is heat.

Earlier this year, the Federal Aviation Administration directed Troutdale users to an independent consulting firm to analyze the potential impact of the invisible plume of hot air that the combustion of gas by the plant would produce.

"You're putting a known but invisible hazard right into the path that pilots using Troutdale must fly," says Mary Rosenblum, a Canby resident and president of the Oregon Pilots Association.

Rosenblum says modeling shows the plume could suddenly lift one wing and flip a plane upside down.

"This would happen when the plane is 1,000 feet or less off the ground," Rosenblum says. "At that altitude, you cannot recover."

The FAA consultant's initial analysis in March found that the invisible plumes could cause as many as a dozen planes to lose control and crash annually—with fatal consequences. A second run of the same model earlier this month found it could happen even more often.

Risk modeling done for the Troutdale Energy Center in 2013 found no such danger.

Rhodes scoffs at that earlier analysis. The nuclear engineer—who spends his days calculating the proper dosages of radiation for cancer patients—has reviewed the modeling and says the proposed power plant represents "a clear and present danger" to pilots.

"Engineers and mathematicians work hard to 'average out' calculated risk for their clients," Rhodes said in written testimony. "I'm an engineer. I know how the system works. Don't kid yourself, cherry-picking data to support a client's position happens all the time."

The FAA regulates only physical structures, such as towers or smokestacks that exceed 500 feet, not plumes.

But in January, the federal regulator issued guidance on hot air plumes.

"The FAA has determined that thermal exhaust plumes in the vicinity of airports may pose a unique hazard to aircraft in critical phases of flight (particularly takeoff, landing and within the pattern)," says an FAA memo to airport managers dated Jan. 21, 2015, "and therefore are incompatible with airport operations."

That warning would seem to give pause to the Port of Portland, which owns the land where the generating plant would be built, and to the state energy siting council, which in 2013 gave tentative approval to the plant's location next to the Troutdale Airport.

Todd Cornett, an assistant director for the Oregon Department of Energy responsible for staffing the siting council, says his agency's staff recommended proceeding with the project after concluding it met all the criteria for locating a power plant.

The group financing the Troutdale Energy Center, Energy Investors Funds, builds plants all over the country—not without incident. In 2010, a plant in Middletown, Conn., similar to the one proposed for Troutdale, blew up during early testing, killing six people and resulting in a $16.6 million fine by the Occupational Safety and Health Administration—the third-largest in OSHA history. A spokesman for TEC didn't return *WW*'s calls.

The pilots' safety concerns about the Troutdale plant come on top of environmental worries about the pollution the plant would emit.

The conservation group Friends of the Gorge opposes the plant. And the U.S. Forest Service, which enforces the Columbia River Gorge National Scenic Area Act, says locating a power plant at the western gateway to the gorge is a bad idea.

Agency officials say pollutants emitted from the plant would block views in the gorge and endanger sensitive plant species.

The new safety study and the environmental concerns are part of an ongoing contested-case hearing over the permitting of the power plant. Opponents to the site forced the hearing, in which both sides will make their best case for or against the safety and environmental effects of the plant.

Rhodes says he'll be "stunned" if the state siting council proceeds with approval of the plant after the new risk study. Even if someone raises additional information affirming the plant's safety, he adds, the burden of proof still rests on the applicant.

"State agencies are supposed to work on behalf of the people of Oregon, not an applicant," Rhodes says. "In this case, they are working in the licensees' interest. That's a direct conflict of interest."

U.S. Department
of Transportation
**Federal Aviation
Administration**

Position Paper

Safety Concerns of Exhaust Plumes

Prepared by:
Federal Aviation Administration
Airport Obstructions Standards Committee Working Group

July 8, 2014

Background:

In 2008, a safety concern was raised to Federal Aviation Administration (FAA) that in some instances exhaust plumes were causing disruption to flights. In addition, California Energy Commission and other organizations were requesting guidance from the FAA on what is the appropriate proximity power plants can be constructed near an airport. The only FAA regulations are on the physical restrictions of the exhaust stack height. There are no FAA regulations protecting for plumes and other emissions from exhaust stacks.

In September 2008, the FAA's Airport Obstruction Standards Committee (AOSC) was tasked to study the impact exhaust plumes may have on flight safety. In 2009, a task was added to an FAA support contract that evaluated the following:

- How much turbulence is created by the Exhaust Plumes?
- Is this turbulence great enough to cause loss of pilot control?
    - If so, what size aircraft are impacted?
- Is there a lack of oxygen causing loss of engine or danger to pilot/passengers?
- Are there harmful health effects to the pilot or passengers in flying through the plume?

In fall 2010, the initial Exhaust Plume Report was completed. After careful review, the AOSC determined that the information in the initial Plume Report needed to be further verified and validated.

In spring 2011, FAA's Federally Funded Research & Development Center operated by the MITRE Corp was tasked to verify and validate the initial study with an agreed upon completion in fall 2012.

MITRE completed their initial task in September 2012 and delivered a study and validated Exhaust Plume model. The study indicates exhaust plumes can create hazards for aircraft in a limited area above the stack in terms of turbulence caused by upward motion of the plume and reduced oxygen content inside the plume. The reduced oxygen is not a danger to pilots, but could cause failure of helicopter engines if hovering over the plume. It also indicated that weather conditions are an important factor in the size of the risk area. The conditions which create the largest risk area are calm winds, low temperatures, and neutral or stable stratification of the atmosphere. The reverse is also true, windy conditions (greater than eight (8) knots) and warmer temperatures, the risk area is minimized.

An industry meeting was hosted by the FAA in January 2013 in which MITRE briefed on the initial study and explained their Exhaust Plume Model. Industry recommended that the Plume Model be updated to include light sport aircraft and when an aircraft crosses over the plume while already in a turn.

The industry group also expressed a desire for the FAA to take affirmative action from the results of the plume model to declare plumes as hazards, as they do with structures under Part 77. The industry group believes preemptive planning is very important for preventing construction of plume emitting facilities in the vicinity of airports. They reiterated a desire for the FAA to declare them hazards as an aid to empower the State's position in that regard.

Final Steps:

1. The FAA Office of Airports will update Advisory Circular (AC)150/5190-4, Airport Land Use Compatibility Planning, to address the compatibility of exhaust plumes near airports; scheduled to be completed by Fall of 2014.
2. The FAA Office of Aviation Safety will further update the Aeronautical Information Manual (AIM) to provide pilots information regarding the potential hazards over exhaust plumes; scheduled to be completed in Fall of 2014.
3. The FAA tasked the MITRE Corporation to update the Exhaust Plume Model to include the industry recommendations, as well as make it a fully executable that can run on a personal computer. The Model will be available the Fall of 2014. How to access the model will be outlined in the AC 150/5190-4.

Conclusion:

After a thorough analysis, the FAA has determined the overall risk associated with thermal exhaust plumes in causing a disruption of flight is very unlikely. However, the FAA determined that thermal exhaust plumes in the vicinity of airports may pose a unique hazard to aircraft in critical phases of flight and therefore are incompatible. We recommend that airport owners, in cooperation with local communities, follow the guidance outlined in Advisory Circular (AC)150/5190-4, Airport Land Use Compatibility Planning.

The information and recommendation provided in this Position Paper supersedes any previous studies or reports on thermal exhaust plumes completed by the FAA.

Prepared by:
Federal Aviation Administration
Airport Obstructions Standards Committee Working Group
John Speckin, Regions and Center Operations
Patrick Zelechoski, Flight Standards
John Bordy, Flight Standards
Robert Bonanni, Airports
John Page, Air Traffic Organization
Ron Singletary, Air Traffic Organization

Exhibit 37

4. Protect your aircraft while on the ground, if possible, from sleet and freezing rain by taking advantage of aircraft hangars.

5. Take full advantage of the opportunities available at airports for deicing. Do not refuse deicing services simply because of cost.

6. Always consider canceling or delaying a flight if weather conditions do not support a safe operation.

c. If you haven't already developed a set of Standard Operating Procedures for cold weather operations, they should include:

1. Procedures based on information that is applicable to the aircraft operated, such as AFM limitations and procedures;

2. Concise and easy to understand guidance that outlines best operational practices;

3. A systematic procedure for recognizing, evaluating and addressing the associated icing risk, and offer clear guidance to mitigate this risk;

4. An aid (such as a checklist or reference cards) that is readily available during normal day−to−day aircraft operations.

d. There are several sources for guidance relating to airframe icing, including:

1. http://aircrafticing.grc.nasa.gov/index.html

2. http://www.ibac.org/is−bao/isbao.htm

3. http://www.natasafety1st.org/bus_deice.htm

4. Advisory Circular (AC) 91−74, Pilot Guide, Flight in Icing Conditions.

5. AC 135−17, Pilot Guide Small Aircraft Ground Deicing.

6. AC 135−9, FAR Part 135 Icing Limitations.

7. AC 120−60, Ground Deicing and Anti−icing Program.

8. AC 135−16, Ground Deicing and Anti−icing Training and Checking.

The FAA Approved Deicing Program Updates is published annually as a Flight Standards Information Bulletin for Air Transportation and contains detailed information on deicing and anti−icing procedures and holdover times. It may be accessed at the following web site by selecting the current year's information bulletins:
http://www.faa.gov/library/manuals/examiners_inspectors/8400/fsat

7−5−15. Avoid Flight in the Vicinity of Thermal Plumes (Smoke Stacks and Cooling Towers)

a. Flight Hazards Exist Around Thermal Plumes. Thermal plumes are defined as visible or invisible emissions from power plants, industrial production facilities, or other industrial systems that release large amounts of vertically directed unstable gases. High temperature exhaust plumes may cause significant air disturbances such as turbulence and vertical shear. Other identified potential hazards include, but are not necessarily limited to, reduced visibility, oxygen depletion, engine particulate contamination, exposure to gaseous oxides, and/or icing. Results of encountering a plume may include airframe damage, aircraft upset, and/or engine damage/failure. These hazards are most critical during low altitude flight, especially during takeoff and landing.

b. When able, a pilot should fly upwind of possible thermal plumes. When a plume is visible via smoke or a condensation cloud, remain clear and realize a plume may have both visible and invisible characteristics. Exhaust stacks without visible plumes may still be in full operation, and airspace in the vicinity should be treated with caution. As with mountain wave turbulence or clear air turbulence, an invisible plume may be encountered unexpectedly. Cooling towers, power plant stacks, exhaust fans, and other similar structures are depicted in FIG 7−5−2. Whether plumes are visible or invisible, the total extent of their unstable air is difficult to ascertain. FAA studies are underway to further characterize the effects of thermal plumes as exhaust effluents. Until the results of these studies are known and possible changes to rules and policy are identified and/or published, pilots are encouraged to exercise caution when flying in the vicinity of thermal plumes. Pilots are encouraged to reference the Airport/Facility Directory where amplifying notes may caution pilots and identify the location of structure(s) emitting thermal plumes.

FIG 7-5-2
Plumes

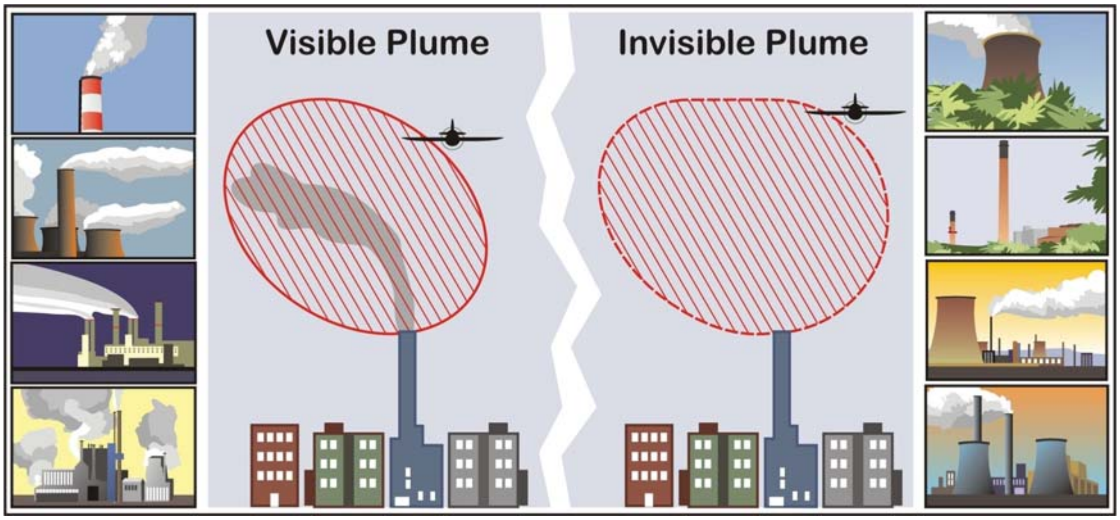

Exhibit 38

15th Annual Coos Basin SALMON DERBY

COOS BAY, OREGON

September 13th & 14th 2014

Presented by: ODFW, Coos County STEP Commission, Eel Tenmile STEP, South Coast Anglers STEP & Douglas Timber Operators

Over $1,000 in Cash & Prizes!

Including $100 for Kids Biggest Fish

AWARDS GIVEN THROUGH 10TH PLACE

DERBY TICKETS FOR 2 DAY EVENT – $20 PER PERSON

KIDS 13 AND UNDER FISH FREE!!*

**WHEN ACCOMPANIED BY PAYING ADULT FISHERMAN*

Advance tickets at: The Bite's on Bait and Tackle, Coos Bay Marine, Y-Marina and at the kickoff BBQ.

Day-of tickets at: California Street, Eastside, Dora's Place & Myrtle Trees Boat Ramps

Why we do what we do

Teaching the next generation

Fishing heats up on the river

Kickoff BBQ & Silent Auction Friday, September 12th 5-8 pm

Derby Tickets at Door!

NORTH BEND COMMUNITY CENTER • 2222 BROADWAY, NORTH BEND

FREE TO CONTESTANTS & TICKET HOLDERS • $5 DINNER TICKETS FOR NON-DERBY FAMILY, FRIENDS & AUCTION ATTENDEES (DINNER SERVED UNTIL 7 PM ONLY) • $5 OYSTER BAR

FANTASTIC AUCTION ITEMS!

ROD & REEL COMBOS INCLUDING ONE WITH SET-UP BY RICK HOWARD, CUSTOM ROD WITH COUNTING REEL, CARVED BEAR WITH SALMON, STAINLESS BBQ, ARTWORK, GOLF PACKAGES, AREA RUG, RECLINER, LOTS OF FISHING GEAR, RAMP PASSES, JEWELRY, DOWNRIGGERS, AND MUCH MORE.

MANY THANKS TO OUR GENEROUS DONORS!

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THANK YOU TO THE 2014 ANNUAL COOS BASIN AMATEUR SALMON DERBY SPONSORS. WE COULDN'T DO IT WITHOUT YOU!

TITLE SPONSORS Douglas Timber Operators • Southport Forest Products • Coquille Indian Tribe • Oregon Fish & Wildlife

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Friends of the Derby • Gold Coast Truck Repair

In addition, the Derby Committee wishes to thank the many dedicated volunteers who make our programs possible and all of the businesses and individuals who have given their support to Salmon Enhancement & Education programs for over 30 years. If any of the 15th Annual sponsors have been inadvertently omitted, please accept our apology.

Exhibit 39

South Coast Basin

Rivers and Streams

Flow Restoration Priorities for Recovery of Anadromous Salmonids in Coastal Basins

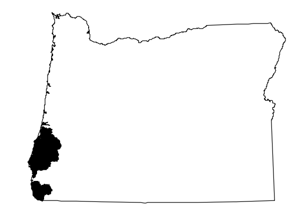
The Oregon Plan

Streamflow Restoration Priorities
Measure IV.A.8

Instream Water Right Program
Habitat Conservation Division

Field and Technical
Services Division

Location Map



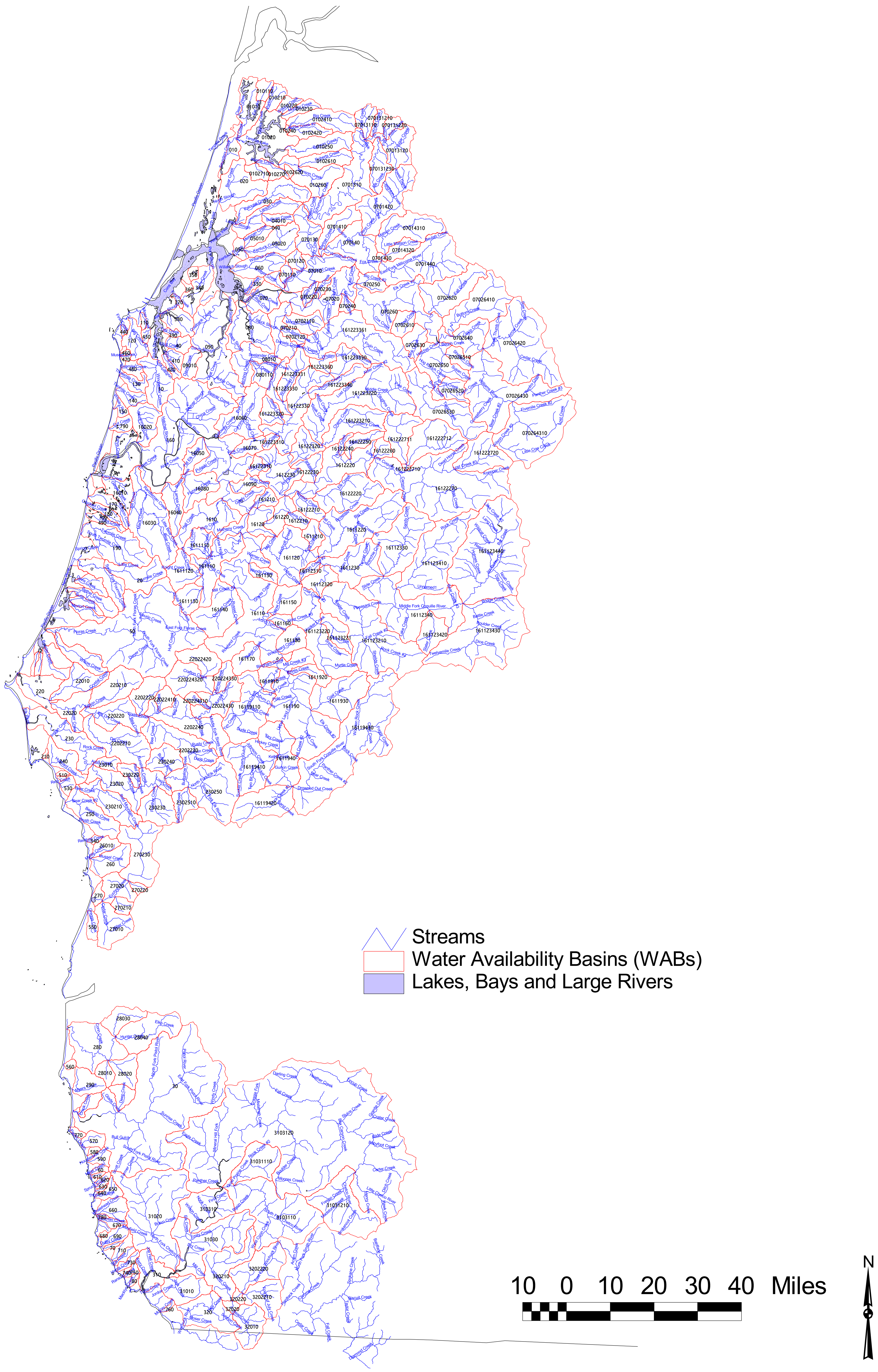


Exhibit 40

Final Environmental Impact Statement

JORDAN COVE ENERGY AND PACIFIC CONNECTOR GAS PIPELINE PROJECT

Jordan Cove Energy Project, L.P.	Docket Nos. CP13-483-000
Pacific Connector Gas Pipeline, L.P.	CP13-492-000

FERC/EIS – 0256F

Federal Energy Regulatory Commission

Office of Energy Projects

Washington, DC 20426

Cooperating Agencies

US Department of Agriculture Forest Service, Pacific Northwest Region
Department of the Army, Corps of Engineers, Portland District
US Department of Energy
US Environmental Protection Agency, Region 10
US Department of Homeland Security Coast Guard, Portland
US Department of the Interior Bureau of Land Management, Oregon State Office
US Department of the Interior Bureau of Reclamation, Klamath Basin Area Office
US Department of the Interior, Fish and Wildlife Service, Oregon State Office
US Department of Transportation, Pipeline and Hazardous Materials Safety Administration

September 2015

(33 CFR 151). Spills of fuel or other oils are more likely to be released into surface waters during fueling or bunkering at the dock when the hazardous materials are being transferred onto the vessel. To reduce the risk of spills during fuel transfer, procedures should be followed by the chief engineer familiar with the system to be involved in operations (78 FR 60099). With the implementation each vessel's shipboard oil pollution emergency plan, impacts resulting from the spill of fuel, or oil, or other hazardous liquids would be minimized.

Water Releases from LNG Vessels at the Terminal Berth

LNG vessels at the Jordan Cove terminal berth would release ballast water and engine cooling water into the marine slip. No wastewater would be discharged from the LNG vessels into the slip. The LNG vessels may arrange with licensed private entities for refueling, provisioning, and collection of sanitary and other waste waters contained within the vessel. The licensed private entities would transport the waste to a permitted treatment facility. Discharges from vessels are subject to regulation by EPA. EPA currently regulates discharges incidental to the normal operation of vessels operating in a capacity as a means of transportation with the Vessel General Permit. This general permit became effective December 2013 and includes general effluent limits applicable to all discharges; general effluent limits applicable to 26 specific discharge streams; narrative water-quality based effluent limits; inspection, monitoring, recordkeeping, and reporting requirements; and additional requirements applicable to certain vessel types. Vessels of 300 gross tons or more or that have the ability to hold or discharge more than 8 cubic meters of ballast must submit a notice of intent in order to receive permit coverage. Jordan Cove would provide permitting requirements to the LNG vessels calling on the Project.

<u>Ballast Water</u>

The Coast Guard mandates a ballast water exchange (BWE) process for vessels arriving at U.S. ports. The BWE process includes complete exchange of ballast water in the open sea at least 200 miles from U.S. waters. Therefore, the ballast water discharged by LNG vessels at the Jordan Cove terminal would have originated in the open sea rather than a foreign port.

LNG vessels at the terminal slip would discharge ballast concurrently with the LNG cargo loading. The amount of ballast water discharged must, at a minimum, be adequate to maintain the LNG ship in a positive stability condition and with an adequate operating draft while the LNG cargo is loaded. Jordan Cove expects its terminal to be visited by 90 LNG vessels per year. Each LNG vessel would discharge approximately 9.2 million gallons of ballast water during the loading cycle to compensate for 50 percent of the mass of LNG cargo loaded.[52]

The LNG loading rate is designed to be 10,000 m^3/hr (with a peak capacity of 12,000 m^3/hr), or 4,600 metric tons per hour (t/hr) (5,520 t/hr peak), consequently the ballast water discharge rate would be approximately 20,250 gpm. Typical LNG vessels have three ballast water pumps, each capable of 3,000 m^3/hr (13,210 gpm) rated capacity. The typical LNG vessel has an upper and a lower ballast water discharge on each side of the hull, referred to as sea chests. The lower unit is just above the keel, approximately 10 meters (33 feet) below the water line. The typical ballast

[52] One cubic meter of LNG is 0.46 metric tons (t), which for the maximum size of LNG vessel authorized to call on the LNG terminal (148,000 m^3) would be 68,080 t of LNG per ship. Assuming 1 t of seawater is 1.027 m^3, the amount of seawater ballast discharged (50 percent of the weight of the LNG loaded) would be approximately 34,959 m^3 (approximately 9.2 million gallons).

water discharge port or sea chest is approximately 3.5 to 4.2 square meters covered by a screen with 4.5 mm bars, spaced every 20 to 25 mm.

A potentially notable difference that may be observed in water quality could be salinity. Coos Bay is an estuary where freshwater runoff from upland rives meets seawater. According to Roye (1979), the zone of change in salinity in Coos Bay occurs at about NCM 8. The findings of the sampling conducted by OIMB (Shanks et al. 2010, 2011) in the bay near the LNG terminal indicated a wide range in salinity between seasons and tidal cycles. Salinity ranged from approximately 16 practical salinity units (psu) at low tide in winter to approximately 33 psu during high tide between May and September. On average, seawater in the world's oceans has a salinity of about 35 psu. Shanks et al. (2010, 2011) estimated the volume of water passing through Coos Bay in the vicinity of the Jordan Cove terminal during lower tidal levels to be 106 million m^3. Therefore, any increase in salinity from the 9.2 million gallons (34,825 m^3) of ballast water discharge would be approximately 0.3 percent of the water passing by the terminal. Consequently, virtually no change in salinity would occur in Coos Bay.

Another physio-chemical water quality parameter that may be influenced by the introduction of ballast water is the dissolved oxygen level. Dissolved oxygen levels are a critical component for the respiration of aquatic organisms. Among many other factors, dissolved oxygen levels in water can be influenced by water temperature, water depth, phytoplankton, wind, and current. Typical water column profiles indicate a decrease in dissolved oxygen with an increase in depth. Some factors that often influence this stratification include sunlight attenuation for photosynthetic organisms that can produce oxygen, wind, wave, and current that results in mixing. ODEQ records indicate that dissolved oxygen is rarely below the 6 mg/l standard below NCM 13 in Coos Bay (Roye 1979).

Water that is collected within the ballast tanks of a ship would lack many of these important influences and could suppress dissolved oxygen levels. However, ballast water that is discharged is not expected to be anoxic (i.e., lacking all oxygen), just lower than what levels would likely be at the surface. In addition, ballast water would be discharged near the bottom of the slip where dissolved oxygen levels may already be lower. Therefore, no significant impacts are likely to occur as a result of discharging ocean water with potentially suppressed dissolved oxygen levels.

Water temperatures and pH in Coos Bay are not likely to be significantly altered as a result of the release of ballast water by LNG vessels in the Jordan Cove marine slip. The temperature of the water in Coos Bay undergoes both seasonal and diurnal fluctuations. In December and March, the ocean and fresh water entering the estuary had similar temperatures, around 50°F. In summer, low stream flows results in a rise of temperatures in the bay, to above 60°F in September at NCM 8 (Roye 1979). Since ballast water is stored in the ship's hull below the waterline, water temperatures are not expected to deviate much from ambient temperatures of the surrounding bay water. The pH of the ballast water (reflective of open ocean conditions) may be slightly higher as compared to that of freshwater estuaries. However, this slight variation is not expected to have any impacts on existing marine organisms.

LNG Vessel Engine Cooling Water

The LNG vessels would also re-circulate water for engine cooling while loading LNG at the berth. No chemicals would be added to the cooling water. The amount of cooling water to be re-circulated is a function of the propulsion system of the LNG vessel. For purposes of this analysis, typical cooling water flow rates were used. Cooling water flows while at the berth are approximately 1,300 m^3/hr (343,421 gallons per hour or 5,723 gpm). For a 148,000 m^3 vessel, this would total approximately 6.1 million gallons while at berth (for 17.5 hours). The intake port for this engine cooling water is approximately the same size and at the same location as the ballast water intake port, 3.5 to 4.2 square meters covered by a screen with 4.5 mm bars, spaced every 25 mm and approximately 32 feet below the water line, or 5.6 feet from the keel of the LNG vessel. The velocity across this port is approximately 0.28 ft/sec with a temperature differential of 3°C.

The effects of engine cooling water discharged by an LNG vessel at the terminal berth on the temperature of the water in the marine slip were evaluated (CHE 2011b). The engines would be running to provide power for standard hotelling activities as well as running the ballast water pumps. The activities that would require LNG vessel power and the assumptions used to develop the engine cooling water flow requirements are as follows:

- hotelling operations require the generation of 1.9 MW of power during the entire time that the LNG vessel remains in the slip. The vessel is anticipated to be within the slip for a total of 17.5 hours; and
- a typical auxiliary power unit for an LNG vessel is the Wartsila 34DF. This is a dual-fuel (liquid and natural gas) unit that is a complete primary driver/generator package capable of being sized upwards to 6.9 MW output. Fuel to power conversion is 7,700 kilojoules per kilowatt-hour (kJ/kWh) (7,305 British thermal units per kWh [Btu/kWh]). This system has an overall fuel to power efficiency of 46.7 percent, thereby resulting in the rejection of 3,893 Btu of heat into the cooling water for each kWh of power generated.

All calculations that follow are based upon the transfer of 148,000 m^3 of LNG from the LNG storage tanks to the LNG vessel. The 148,000 m^3 vessel is set as the basis because it represents the largest vessel authorized by the Coast Guard to call on the LNG terminal.

The total gross waste heat discharged into the slip from the cooling water stream would be due primarily to the hotelling operations (including the power required to run the ballast water discharge pumps) because the shore-side LNG pumps would be used to transfer the LNG from the LNG storage tanks to the LNG vessel. The hotelling operations were assumed to be as follows:

- hotelling operations – 17.5 total hours x 1,900 kW x 3,983 Btu/kWh = 132.5 MMBtu; and
- the total amount of heat discharged into the slip during each vessel call is approximately 132.5 MMBtu.

Two models (the 3-D UM3 model and the DKHW model) were used to study possible slip temperature changes resulting from the discharge of engine cooling water by an LNG vessel at the Jordan Cove berth. The models simulate hydrodynamic mixing processes of submerged discharges and predict temperature fields and dispersion of non-conserved substances in ambient waterbodies. Cooling water numerical modeling requires input of steady-state flow velocity in the modeling domain. The results of tidal flowing modeling using the SELFE model showed that ambient current velocities inside the slip vary, depending on tidal stage. Peak current speeds in the berth only exceed approximately 0.32 fps less than 2 percent of the time. Therefore, for cooling water modeling, two steady state ambient flow velocities were assumed and used further in the analysis: high velocity = 0.32 fps and typical velocity = 0.16 fps.

The modeling assumptions are conservative in that a steam-powered ship was used. Steam-powered ships tend to be older than the newer more modern dual-fuel diesel electric ships that require lower quantities of cooling water.

Results of the modeling showed that for typical ambient flow conditions at a distance of 50 feet from the discharge point (LNG vessel sea chest), temperatures would not exceed 0.3ºC (0.54ºF) above the ambient temperature (CHE 2011b). This temperature difference would decrease with distance from the point of discharge. Considering the volume of water in the Jordan Cove marine slip (an estimated 4.8 cy), and tidal mixing in Coos Bay, the release of heated water from LNG vessel engine cooling operations would not substantially increase water temperatures.

Also ameliorating the impact of the release of warm engine cooling water from an LNG vessel at the Jordan Cove berth would be the decrease in temperature of the surrounding slip water due to the cooling effect that would occur from the addition of LNG cargo to the vessel. The cold LNG cargo could moderate effects on slip water temperature. Because of the extreme differential of the temperature of the cargo in the LNG vessel (-260°F) and that of the surrounding bay water (nominally 50°F) there is a constant uptake of heat by the LNG vessel. This heat uptake is manifested by the amount of LNG cargo that changes state from liquid to vapor on a daily basis. The typical LNG vessel sees 0.25 percent of its liquid cargo converted to the gaseous state each 24 hours because of this warming. In this process, 219 Btu of heat is absorbed for each pound of LNG converted to vapor. This results in a total of 53 MMBtu absorbed by a typical 148,000 m^3 LNG vessel during the 17.5 hours it is within the slip. It is reasonable to assume that 50 percent or more of the heat uptake by the vessel is extracted from the water.[53]

In addition, ballast water discharged from the LNG vessel would also comprise some portion of the water withdrawn for cooling and affected by its discharge. As the greatest predicted temperature increase from the release of engine cooling water is only about 0.5°F and that increase would be reduced further in proximity to the LNG vessel, we conclude that the thermal effect of LNG vessel operations at the berth would have very minimal impact on background water temperatures.

4.4.2.2 Pacific Connector Pipeline

The Pacific Connector pipeline would cross six subbasins including the Coos, Coquille, South Umpqua, Upper Rogue, Upper Klamath, and Lost River. Within the six subbasins, 19

[53] This assumption is further reinforced by the fact that the heat transfer coefficient between water and steel is significantly higher than the heat transfer coefficient between air and steel. Therefore, it is estimated that 26.5 MMBtu would be removed from the water in the slip by the LNG vessel during its stay. Thus, a portion of the 132.5 MMBtu of thermal energy discharged into the slip from the cooling water is offset by the uptake of 26 MMBtu by the LNG vessel itself, resulting in a net heat input to the slip of 106.5 MMBtu per 148,000 m^3 LNG vessel call.

Jordan Cove LNG terminal on individuals conducting those activities. Use of the crabbing and clamming areas in Coos Bay should not be any more affected by the passage of LNG vessels than they are currently affected by the passage of other deep-draft ships. However, if crabbing and clamming activities were to occur within the established security zones, those activities would be required to cease and temporarily move out of the way. Crab pots outside of the navigation channel should not be affected by LNG vessel traffic in the waterway. Passive equipment, such as crab pots, would be permitted to remain within the security zone while an LNG vessel is present, though the attending crabbing vessels would be required to vacate (Berg 2008).

However, there could be indirect impacts on clams and crabs from shoreline erosion or bottom sediment disturbed by LNG vessel traffic in the waterway. Those impacts are addressed in sections 4.4.2.1 and 4.6.2.1 of this EIS. We concluded that wakes from LNG vessels in the navigation channel would not cause major shoreline erosion much beyond natural waves, and propeller wash from LNG vessels would not greatly disturb the channel bottom.

There would also be impacts from the dredging in the bay to create the access channel for the Jordan Cove terminal. Those impacts have been addressed in sections 4.4.2.1 and 4.6.2.2 in this EIS. We concluded that dredging of the access channel would only have temporary impacts on bay water quality, and increased sedimentation from the dredging would be limited in extent. For example, if a hydraulic dredge was used, turbidity would be estimated to increase about 14 mg/l at 200 feet from the cutterhead under high water conditions. The limited time and extent of dredging siltation should not result in long-term or population wide impacts on clams and crabs near the Jordan Cove terminal. In fact, as mitigation for wetland impacts, Jordan Cove would be creating new eelgrass beds in Coos Bay that could serve as nursery habitat for crabs, would also be creating new wetlands at Kentuck Slough, and would be acquiring 3 acres of unvegetated sand as part of its habitat mitigation program. Therefore, we conclude that the Project would not have significant adverse impacts on recreational clamming and crabbing activities in Coos Bay.

<u>Boating and Fishing</u>

The waterway for LNG vessel traffic to and from the terminal, Jordan Cove's access channel to its marine slip, and the proposed eelgrass mitigation area would be within Coos Bay. Coos Bay is utilized for recreational boating, angling, clamming and crabbing, as well as commercial fishing, oyster farming, and commercial shipping. The Coos Bay estuary is discussed in more detail in section 4.4.1. Aquatic resources are addressed in more detail within section 4.6, and commercial shipping and fishing are discussed in section 4.9. Recreational resources located along the waterway for LNG vessel marine traffic were discussed in section 4.7.1.3 in the FERC's May 2009 FEIS for Docket Nos. CP07-441-000 and CP07-444-000. Recreational clamming and crabbing activities are discussed above, while recreational boating and fishing in Coos Bay is discussed below.

According to a 2008 study by the Oregon State Marine Board (OSMB), recreational boaters in Coos Bay took a total of 31,560 boat trips the previous year. Nearly 90 percent of the boat use-days involved fishing (including angling, crabbing, and clamming), 9 percent was for pleasure cruising, and the remainder was for sailing and water skiing. Sixty-eight percent of the boating activities in Coos Bay originated from the Charleston Marina and the Empire ramp, 19 percent at the California Avenue boat ramps, and 4 percent at the North Spit ramps. Most of the recreational boating activities in Coos Bay occur during the summer.

The most popular fish species caught by recreational anglers out of Coos Bay include coho and Chinook salmon. Other recreational catch species include various species of perch, rockfish, flatfish, sturgeon, Pacific herring, and California halibut.

Much of the recreational angling for salmon in Coos Bay occurs in late summer and fall. It usually begins in late summer at jetty areas and moves up the bay as fish move upstream. Bank angler access on the North Spit is limited. Boat angling occurs throughout the bay, but angling is limited in some areas at times by exposure to winds. For example, the Roseburg Forest Products dock area gets less boat angling use due to exposure to wind and tidal action. Much of the boat angling for Chinook and coho salmon in the fall is concentrated around the railroad bridge and downstream. Marshfield Channel can be an area of concentrated angling for fall salmon.

Perch fishing begins in Coos Bay in late February to early March, depending on freshwater runoff into the bay, and can continue through July. Rocks around bridge abutments are targeted by anglers on the outgoing tide.

Recreational fishing for sturgeon in Coos Bay generally occurs between the railroad bridge and McCullough Bridge (U.S. Highway 101), just east of the Jordan Cove terminal, and also above the McCullough Bridge. White sturgeon can be taken year-round, but the best angling is during December through March, and when there is a heavy freshwater plume in the bay.

Recreational boating in the bay would be redirected away from the access channel and terminal slip during the construction period that includes dredging within Coos Bay. Notices would be provided to boaters by the Coast Guard and the OSMB to avoid this area during the dredging activities. Signs would be posted at the shoreline as well as at the boat ramps and marinas, and on buoys in the bay, in advance of this final task to notify boaters of the planned construction activity and the duration of the activity. If the signage and notices are not sufficient to prevent recreational boating from avoiding the construction areas, some form of physical barrier, like a continuous string of highly visible soft material floats, may be extended across the mouth of the slip or around the construction area. Construction safety inspectors would also be responsible to warn any recreational boaters who progress into the construction area. Boaters could avoid the construction area by moving to the south and east side of the bay.

During construction of the terminal, material deliveries would be made by marine transit in the existing Coos Bay navigation channel. This would include visits by about 82 break bulk cargo ships and 18 barges over a two-year period in total. As discussed below, we do not believe that the equipment delivery vessels coming to the terminal would have adverse impacts on recreational bay users much beyond current commercial cargo ship and barge traffic. Currently, the Port is visited by about 60 deep-draft cargo ships and 50 barges per year.

During operation of the LNG terminal, recreational boaters would have to avoid LNG vessels in transit within the waterway. Jordan Cove believes that up to 90 LNG vessels per year would visit its terminal. Recreational boaters using the bay at the same time as an LNG vessel is in transit within the waterway may encounter delays due the moving security zone requirements around an LNG vessel, as specified in Jordan Cove's WSA and the Coast Guard's WSR and LOR. Jordan Cove estimated that it may take an LNG vessel up to 90 minutes to transit the waterway from the buoy to the terminal at speeds between 4 and 10 knots. The maximum waiting period for an LNG vessel to pass a given point would be 30 minutes. The sum of the periods in which LNG vessels would have a potential impact on recreational and other boating activity is about 1.3 percent of all daylight hours (ECONorthwest 2012a). Pilots guiding commercial ships in the Coos Bay navigation channel currently encounter approximately six recreational boats during the transit into and out of the Port. These numbers are typically lower in winter and on weekdays than during the summer and on weekends. The Coast Guard and OSMB would continue to remind boaters of their obligation not to impede deep draft ships, regardless of the cargo.

Other Public and Special Use Areas

The LNG terminal would be approximately 0.9 mile from the Southwest Oregon Regional Airport. Potential impacts of the LNG terminal on the airport are addressed in sections 4.9 and 4.10.

4.8.1.2 Pacific Connector Pipeline

Parks and Recreational Areas or Facilities on Non-Federal Lands

Overall, the pipeline route does not cross any non-federal park lands or developed recreational facilities, and construction and operation of the pipeline should not adversely impact park users. However, construction-related activities would temporarily increase traffic on local roads used to access the parks, and park users may be able to hear construction noise while workers and equipment move through the area to install the pipeline. In addition, the pipeline route does cross a water trail, the Haynes Inlet Water Trail, as discussed below. Construction-related impacts would be temporary and short term, and should not significantly affect recreational use of parks or other recreational areas.

State Lands

Oregon Coast Trail

The Oregon Coast Trail was previously discussed above in section 4.8.1.1. The pipeline route would be within one-quarter mile of the trail where it follows Horsfall Beach road and joins the Trans-Pacific Parkway north of MP 1.5R.

Recreational users of the Oregon Coast Trail would be exposed to pipeline construction traffic along the Trans-Pacific Parkway, which is the only access road to the North Spit and the Jordan Cove Meter Station. Pacific Connector developed *Transit Management Plans* (TMP) to reduce impacts on other road travelers (see section 4.10.2). Project construction activities could be visible and audible to hikers on the Oregon Coast Trail where it joins with the Trans-Pacific Parkway, but these impacts would be temporary and short term. Furthermore, this area is adjacent to a large-scale industrial plant (i.e., Roseburg Forest Products), a railroad, and a road. There are other current noise sources such as OHVs in the ODNRA that are much louder than pipeline construction noise. Therefore, pipeline construction should not significantly affect the trail use or experience.

Haynes Inlet

Coos Bay is used for recreational boating, canoeing, kayaking, angling, clamming, and crabbing, as discussed above in section 4.8.1.1. The Pacific Connector pipeline route would cross the Haynes Inlet portion of Coos Bay between about MPs 1.7R and 4.1R. Coos Bay is a Water of the State, with the bottom managed by ODSL. The pipeline crossing of Haynes Inlet is discussed in detail in section 4.4.2.

Exhibit 41

Top 10 Beach Strolls

Sunset, October 2007

Top 10 Beach Strolls

From uninhabited and windswept to sunny and bustling, a walk for every mood

1 PACIFIC RIM NATIONAL PARK RESERVE, B.C.

LONG BEACH This 10-plus-mile stretch of pristine, surf-swept sand near the towns of Tofino and Ucluelet on Vancouver Island is a beach trekker's paradise. Flanked by rolling Pacific waves and lush temperate rain forests, Long Beach feels like the misty edge of a new world; winter visits offer storm-watching opportunities as ferocious waves pound the shoreline. $6.55 U.S., $3.27 ages 6-16; off Provincial Hwy. 4 in Pacific Rim National Park Reserve; www.pc.gc.ca/pacificrim or 250/726-7721. -KIM GRAY

2 LANAI CITY, HI

SHIPWRECK BEACH A rusting World War II-era Liberty Ship, washed up on a reef, gives the name to this 9-mile stretch of sand and lava along Lanai's northeastern shore. On calm days, the water is crystal clear; other times, you'll be buffeted by strong trade winds, but they're a boon for beachcombers. It's not unusual to come across sea-sculpted driftwood, fishing nets, lobster cages, and the odd glass float. From Lanai City, go north on Lanai Ave. and bear right on Keomuku Rd. until the paved road ends, then follow the dirt road to the left for 2 ½ miles; 800/947-4774. -DAVID LANSING

3 MALIBU, CA

ZUMA COUNTY BEACH Whether you head southeast toward the promontory of Point Dume or northwest toward the oceanfront homes of the rich and richer at Broad Beach, you'll be treated to a sunsplashed cavalcade of surfers, dolphins, and volleyball players. Summertime or not, the living here is easy, and thanks to the well-packed sand along the shoreline, the walking is too. $6 per vehicle; off Pacific Coast Hwy., just west of Kanan Dume Rd.; www.labeaches.info or 310/305-3545. -MATTHEW JAFFE

4 PRAIRIE CREEK REDWOODS STATE PARK, CA

GOLD BLUFFS BEACH Five miles north of Orick, California's northern coast really struts its stuff. For 10 beautiful miles, Gold Bluffs Beach abuts Prairie Creek Redwoods State Park. Redwoods and Sitka spruces tower on bluffs, and agile Roosevelt elk graze behind dunes in meadows carpeted in wild strawberries. You can walk the desolate beach to Fern Canyon, where steep walls covered in ferns press in on a cobbled stream. $6 per vehicle; from US. 101 north of Orick, turn left on Davison Rd., then drive 2 miles to beach parking; parks.ca.gov or 707/465-7354. -KEN MCALPINE

5 NORTH BEND, OR

NORTH SPIT About 1 mile north of the mouth of Coos Bay, the rusting stern of the New Carissa, the most notorious of recent Oregon coast shipwrecks, looms above the surfline. It's an awesome sight best seen on a 4.2-mile round-trip walk over the dunes and down the beach on the North Spit. From U.S. 101 north of North Bend, turn west on Trans Pacific Lane, and follow it AVi miles to the trailhead; blm.gov/or/districts/coosbay or 541/756-0100. -BONNIE HENDERSON

6 PACIFIC GROVE, CA

ASILOMAR STATE BEACH The Monterey Peninsula's beauty is breathtaking and enormous. But the Coast Trail will rein in your focus, guaranteeing a walk full of discovery, especially at low tide. ...

Publication information: Article title: Top 10 Beach Strolls. Contributors: Not available. Magazine title: Sunset. Volume: 219. Issue: 4 Publication date: October 2007. Page number: 34+. © Sunset Publishing Corp. Provided by ProQuest LLC. All Rights Reserved.

50 Best Places to Live: The Next Great Adventure Towns

Published: September 2008

Where to Live + Play Now!

The fifty next great adventure towns.

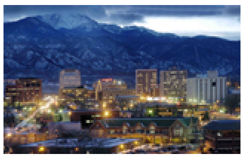
Text by Sarah Tuff and Greg Melville

A change of address can bring instant gratification. You could wake up tomorrow in Missoula and kayak off your own deck at dawn, sneak in singletrack at lunch in Chattanooga—or choose your own adventure in any one of the country's best base camps. But a move is a long-term investment. So this year we selected 50 innovative towns that aren't just prime relocation spots right now, but smart choices for the future. Not only do they have the action. They've got a plan. Now we're giving you a plan too. Inside, you'll find hometown picks that range from adventure 24/7 hubs loaded with outdoor options to urban players that offer a variety of jobs and cultural activities without sacrificing green space. You'll also hear from recent transplants who made the move and have a better quality of life to show for it. So go on—get packing. (Read the full coverage of these towns in the September 2008 issue, on newsstands August 12th.)

Plus: Take a digital tour of these towns with Nat Geo Map's Topo.com. See the maps >>

Here are the 50 next great adventure towns, presented by region and in no particular order (our top 12 picks are shown in bold). Plus: You can now post your comments on our picks in the area provided below.

WALLPAPER



My Shot Adventure Towns
Decorate your desktop with My Shot images of our top 50 places to live and play now.

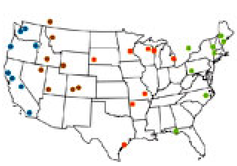
PHOTO GALLERY

Top 12 Towns Weekend Scouting Reports
Here's where to stay, play, and taste the local flavors in our top 12 cities.

BRATTLEBORO, VT

The Adventure Town Experiment
Brave is the couple willing to trade the "hippest neighborhood in America" for a shot at the Live + Play dream.

U.S. MAP INTERACTIVE



Next Weekend: Instant Adventures
Use this U.S. map to find 32 out-the-backdoor escapes.

WEST

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1. **Seattle, Washington**
2. Coos Bay, Oregon
3. Lihue, Kauai, Hawaii
4. Girdwood, Alaska
5. **Hood River, Oregon**
6. **San Francisco, California**
7. Joshua Tree, California
8. Leavenworth, Washington
9. Arcata, California
10. Klamath Falls, Oregon
11. Bellingham, Washington
12. Malibu, California

Next: Rockies Towns >>

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National Geographic Adventure is pleased to provide this opportunity for you to share your comments about this article. Thanks for taking the time to offer your thoughts.

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Exhibit 42

https://kcby.com/news/local/after-a-year-of-planning-coos-bay-has-new-marine-patrol-boat-dock

After a year of planning, Coos Bay has new marine patrol boat dock

by KCBY
Wednesday, March 16th 2016

The recently completed Coos County Marine Patrol dock near Roseburg's (formerly Roseburg Forest Products) Jordan Cove property. (March 8, 2016)

COOS BAY, Ore. -- After a year of planning the Coos County Sheriff's Office now has a marine patrol boat dock in Coos Bay.

Roseburg Forest Products helped with building and financing the new dock on the North Spit.

Sheriff's deputies now have better access to the lower bay, where water rescues happen every summer.

"For the Sheriff's marine division to have a presence out there, they would have to go all the way out to Coquille, get their boat, bring it all the way back out here to the North

Spit, launch it and by the time they get ready to get on the water, it's usually too late," says Richard Dybevik with Roseburg Forest Products. "Now they'll have the ability to have a vessel on location in the lower bay. So it's more of a rescue rather than a collection."

Sheriff Craig Zanni says they also plan to use the dock for new kinds of training.

"We're going to be upgrading the training for all our deputies in boat handling. If LNG comes, there's going to be requirements for us to be able to respond in the bay and it requires better than just being a boat operator, but operating amongst other boats and doing some routine inspections and those types of things."

Dybevik says the lower bay is always crowded with boats during the summer.

He says he's as counted as many as 100 boats in that area at one time.

Exhibit 43

ATTORNEYS SERVING PRIVATELY HELD BUSINESSES AND THEIR OWNERS

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June 24, 2015

VIA U.S. MAIL & EMAIL
SDP.Comments@state.or.us

Andrea Goodwin
Oregon Department of Energy
625 Marion St. NE
Salem, OR 97301

Re: South Dunes Power Plant

Dear Ms. Goodwin:

This correspondence is being submitted on behalf of Oregon Dunes Sand Park, LLC ("Oregon Dunes") in response to the invitation for comments on the South Dunes Power Plant (the "Project") in advance of the Public Hearing to be held June 25, 2015. Oregon Dunes owns land containing The Box Car Hill Campground (the "Campground") adjacent to the proposed site for the Project. Such land might be considered "Noise Sensitive Property" under OAR 340-035-0015(38). Jordan Cove Energy Project, L.P. ("Jordan Cove") has submitted an Application for Site Certification ("ASC") in connection with its application to site, construct and operate the Project. As part of the ASC, Jordan Cove must make certain that the Campground ceases to be classified as a noise sensitive property. In order to accomplish this goal, Jordan Cove leased the Campground from Oregon Dunes.

In the ASC, Jordan Cove stated in Exhibit X, Page 2, that it leased the Campground pursuant to a 99-year lease agreement with Oregon Dunes. While this statement is accurate for the most part, it does not tell the complete story. The lease, which commenced January 1, 2015 and was set to expire on December 31, 2015, contains two options held by Jordan Cove. The first such option entitled Jordan Cove to send written notice to Oregon Dunes by March 1, 2015 extending the term of the lease to December 31, 2016. Jordan Cove exercised that option. The second option entitles Jordan Cove to send written notice to Oregon Dunes by March 1, 2016 extending the term of the lease to December 31, 2113. Jordan Cove has not yet exercised this option, however it still has the right to do so.

Thus, while Jordan Cove has the right to lease the Campground for 99 years, it is not currently obligated to do so. Currently, it is only obligated to lease the Campground until

December 31, 2016. Upon exercise of the remaining option under the lease, Jordan Cove will be obligated to lease the Campground until December 31, 2113 and will have the ability to control the uses on the site. However, if Jordan Cove does not exercise the remaining option on or prior to March 1, 2016 and the lease terminates, Oregon Dunes will again be permitted to use the Campground in a manner so that the Campground could be considered a noise sensitive property.

To ensure that no noise sensitive use can be operated on the Campground for the duration of the useful life of the Project, Jordan Cove will need to control the site for the duration of the Project. Accordingly, in the event the Project goes forward, it should only be permitted to do so subject to the condition that Jordan Cove be required to lease the Box Car Hill Campground until at least December 31, 2113. <u>This condition has not yet been satisfied.</u>

Thank you for your attention to this matter. If you have any questions or comments, or if you need anything further from us at this time, feel free to contact me.

Very truly yours,

MOTSCHENBACHER & BLATTNER LLP

Jeremy G. Tolchin

JGT/mm
cc: Todd Goergen
H:\TONY\OREDUN.2101\LLC.001\CORRESPONDENCE\A. GOODWIN 06.24.2015.DOCX5

Exhibit 44

http://today.oregonstate.edu/archives/2015/feb/study-outlines-threat-ocean-acidification-coastal-communities-us

Study outlines threat of ocean acidification to coastal communities in U.S.

Feb 23, 2015

CORVALLIS, Ore. - Coastal communities in 15 states that depend on the $1 billion shelled mollusk industry (primarily oysters and clams) are at long-term economic risk from the increasing threat of ocean acidification, a new report concludes.

This first nationwide vulnerability analysis, which was funded through the National Science Foundation's National Socio-Environmental Synthesis Center, was published today in the journal Nature Climate Change.

The Pacific Northwest has been the most frequently cited region with vulnerable shellfish populations, the authors say, but the report notes that newly identified areas of risk from acidification range from Maine to the Chesapeake Bay, to the bayous of Louisiana.

"Ocean acidification has already cost the oyster industry in the Pacific Northwest nearly $110 million and jeopardized about 3,200 jobs," said Julie Ekstrom, who was lead author on the study while with the Natural Resources Defense Council. She is now at the University of California at Davis.

George Waldbusser, an Oregon State University marine ecologist and biogeochemist, said the spreading impact of ocean acidification is due primarily to increases in greenhouse gases.

"This clearly illustrates the vulnerability of communities dependent on shellfish to ocean acidification," said Waldbusser, a researcher in OSU's College of Earth, Ocean, and Atmospheric Sciences and co-author on the paper. "We are still finding ways to increase the adaptive capacity of these communities and industries to cope, and refining our understanding of various species' specific responses to acidification.

"Ultimately, however, without curbing carbon emissions, we will eventually run out of tools to address the short-term and we will be stuck with a much larger long-term problem," Waldbusser added.

The analysis identified several "hot zones" facing a number of risk factors. These include:

- The Pacific Northwest: Oregon and Washington coasts and estuaries have a "potent combination" of risk factors, including cold waters, upwelling currents that bring corrosive waters closer to the surface, corrosive rivers, and nutrient pollution from land runoff;
- New England: The product ports of Maine and southern New Hampshire feature poorly buffered rivers running into cold New England waters, which are especially enriched with acidifying carbon dioxide;
- Mid-Atlantic: East coast estuaries including Narragansett Bay, Chesapeake Bay, and Long Island Sound have an abundance of nitrogen pollution, which exacerbates ocean acidification in waters that are shellfish-rich;
- Gulf of Mexico: Terrebonne and Plaquemines Parishes of Louisiana, and other communities in the region, have shellfish economies based almost solely on oysters, giving this region fewer options for alternative - and possibly more resilient - mollusk fisheries.

The project team has also developed an interactive map to explore the vulnerability factors regionally.

One concern, the authors say, is that many of the most economically dependent regions - including Massachusetts, New Jersey, Virginia and Louisiana - are least prepared to respond, with minimal research and monitoring assets for ocean acidification.

The Pacific Northwest, on the other hand, has a robust research effort led by Oregon State University researchers, who already have helped oyster hatcheries reboundfrom near-disastrous larval die-offs over the past decade. The university recently announced plans to launch a Marine Studies Initiative that would help address complex, multidisciplinary problems such as ocean acidification.

"The power of this project is the collaboration of natural and social scientists focused on a problem that has and will continue to impact industries dependent on the sea," Waldbusser said.

Waldbusser recently led a study that documented how larval oysters are sensitive to a change in the "saturation state" of ocean water - which ultimately is triggered by an increase in carbon dioxide. The inability of ecosystems to provide enough alkalinity to buffer the increase in CO_2 is what kills young oysters in the environment.

SOURCE:
George Waldbusser, 541-737-8964;
waldbuss@coas.oregonstate.edu

Exhibit 45

Vulnerability and adaptation of US shellfisheries to ocean acidification

Article *in* Nature Climate Change · February 2015

DOI: 10.1038/nclimate2508

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Ocean Conservancy

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James Cook University

nature climate change

PERSPECTIVE

PUBLISHED ONLINE: XX FEBRUARY 2015 | DOI: 10.1038/NCLIMATE2508

Vulnerability and adaptation of US shellfisheries to ocean acidification

Julia A. Ekstrom*†[1], Lisa Suatoni[2], Sarah R. Cooley[3], Linwood H. Pendleton[4,5], George G. Waldbusser[6], Josh E. Cinner[7], Jessica Ritter[8], Chris Langdon[9], Ruben van Hooidonk[10], Dwight Gledhill[11], Katharine Wellman[12], Michael W. Beck[13], Luke M. Brander[14], Dan Rittschof[15], Carolyn Doherty†[15], Peter Edwards[16] and Rosimeiry Portela[17]

Ocean acidification is a global, long-term problem whose ultimate solution requires carbon dioxide reduction at a scope and scale that will take decades to accomplish successfully. Until that is achieved, feasible and locally relevant adaptation and mitigation measures are needed. To help to prioritize societal responses to ocean acidification, we present a spatially explicit, multidisciplinary vulnerability analysis of coastal human communities in the United States. We focus our analysis on shelled mollusc harvests, which are likely to be harmed by ocean acidification. Our results highlight US regions most vulnerable to ocean acidification (and why), important knowledge and information gaps, and opportunities to adapt through local actions. The research illustrates the benefits of integrating natural and social sciences to identify actions and other opportunities while policy, stakeholders and scientists are still in relatively early stages of developing research plans and responses to ocean acidification.

The ocean has absorbed about 25% of anthropogenic atmospheric CO_2 emissions, progressively increasing dissolved CO_2, and lowering seawater pH and carbonate ion levels[1]. On top of this progressive global change in oceanic carbon conditions, local factors such as eutrophication[2,3], upwelling of CO_2-enriched waters[4] and river discharge[5] temporarily increase anthropogenic ocean acidification (OA)[6] in coastal waters[7–9]. Ocean acidification could primarily affect human communities by changing marine resource availability[1]. Studies have shown that, in general, shelled molluscs are particularly sensitive to these changes in marine chemistry[10–12]. Shelled molluscs comprise some of the most lucrative and sustainable fisheries in the United States[13]. Ocean acidification has already cost the oyster industry in the US Pacific Northwest nearly $110 million, and directly or indirectly jeopardized about 3,200 jobs[13]. The emergence of real, economically measurable human impacts from OA has sparked a search for regional responses that can be implemented immediately, while we work towards the ultimate global solution: a reduction of atmospheric CO_2 emissions. Yet there is little understanding about which locations and people will be impacted by OA, to what degree, and why, and what can be done to reduce the risks.

Here, we present the first local-level vulnerability assessment for ocean acidification for an entire nation, adapting a well-established framework and focusing on shelled mollusc harvests in the United States; for other evaluations of OA social vulnerability, see refs 14–16. We explored three key dimensions—exposure, sensitivity and adaptive capacity (Fig. 1, Supplementary Fig. S1)—to assess the spatial distribution of vulnerable people and places to OA. The underlying assumption guiding this assessment is that addressing existing vulnerability can reduce future vulnerability to OA, sometimes called 'human-security vulnerability'[15].

Exposure of marine ecosystems addresses acidification driven by global atmospheric CO_2 and amplified by local factors in coastal waters. We divided the coastal waters around the United States into existing National Estuary Research Reserve System bioregions[17] (Supplementary Fig. S7), and for each bioregion, examined: (1) projected changes to ocean chemistry based on a reduction in aragonite saturation state (Ω_{Ar}) (Supplementary Fig. S2), and (2) the prevalence of key local amplifiers of OA, including upwelling, eutrophication and input of river water with low-aragonite saturation state [**AU: OK?**], for each bioregion (Supplementary Figs S4–S6). Aragonite saturation state (Ω_{Ar}) is a measure of the thermodynamic stability of this mineral form of calcium carbonate that is used by bivalve larvae and other molluscs, which is also commonly used to track OA[1]. Declining Ω_{Ar} makes it more difficult and energetically costly for larval bivalves to build shells even before Ω_{Ar} becomes corrosive [**AU: is it Ω_{Ar} that becomes corrosive, or should this be OA?**], and Ω_{Ar} seems to be the important variable for the most sensitive early stage of bivalve larvae[18]. We evaluated relative exposure to anthropogenic OA as the time [**AU: i.e. 'time until', or 'the**

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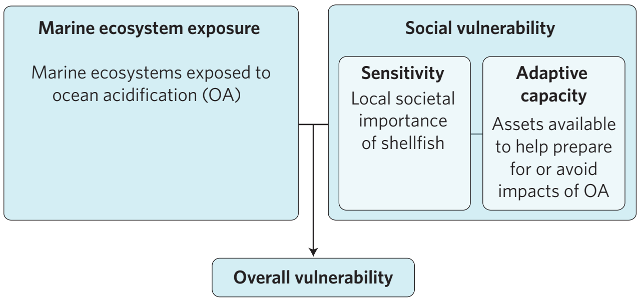

Figure 1 | Conceptual framework structuring the analysis of vulnerability to ocean acidification. Vulnerability analyses can focus on three key dimensions (exposure, sensitivity and adaptive capacity): (1) the extent and degree to which assets are exposed to the hazard of concern; (2) the sensitivity of people to the exposure; and (3) the adaptive capacity of people to prepare for and mitigate the exposure's impacts. These three dimensions together provide a relative view of a place's overall vulnerability. Adapted conceptual model components from refs 16,52–55.

extent of time for which'?] mean annual surface seawater exceeds an empirically informed absolute Ω_{Ar} threshold for several species of bivalve larvae. This indicator for disruption to the biological processes of calcification and development in larval molluscs was favoured over alternatives (for example time until the historic range of Ω_{Ar} is exceeded) because the biological mechanism was clear[19] and empirical evidence exists[20]. For comparison purposes, the Supplementary Information includes the time until the historic range of Ω_{Ar} is exceeded (Supplementary Fig. S3), but below we document the outcomes based on the Ω_{Ar} threshold projections and local amplifiers of OA.

Sensitivity of social systems was evaluated at the scale of 'clusters of coastal counties' around the United States, using three indicators of community dependence on shellfish, adapted from the National Marine Fisheries Service's fishing community vulnerability and resilience index[21]: (1) the 10-year median landed value of shellfish (including both wild and aquaculture harvests); (2) the 10-year median proportional contribution of shellfish to total value of commercial landings; and (3) the 5-year median number of licences (representing jobs) supported by shelled mollusc fishing (Supplementary Information). Sensitivity indicators were re-scaled and combined into a single index (Supplementary Information and Supplementary Fig. S8).

Adaptive capacity of social systems to cope with and adapt to OA is represented by three classes of indicators: status of state government climate and OA policies, local employment alternatives and availability of science. We examined a total of six indicators representing adaptive capacity that are derived largely from the broader economic and policy landscape, yet are directly relevant for dealing with the threat of OA (Supplementary Fig. S9). This is a deliberate departure from studies conducted at broader and finer geographic scales that use general demographic indicators (see Supplementary Information). We assessed 'potential government support for adaptation' through measures of: (1) the status of state legislative action on OA and (2) the status of state climate adaptation planning. These indicators reflect social organization and assets at the state jurisdictional level that could be used by communities to adapt to, cope with, or avoid the impacts of lost shellfish harvests. We examined aspects of employment alternatives through: (3) the diversity of shelled mollusc harvests, suggesting potential alternative shellfish that could be harvested and (4) the diversity of non-shellfish-related employment industries. These reflect the likelihood of job alternatives for shellfish harvesters and those in the aquaculture industry. Finally, we captured 'access to and availability of science' through (5) a score for marine laboratories developed to take into account the high local influence that such laboratories can have as well as the potential contribution beyond their immediate vicinity. For each county cluster, a metric based on the number of university marine laboratories (on-campus and satellite laboratories) in that county cluster was averaged with a metric based on the total number of university marine laboratories in that state (see Supplementary Information for more information) and (6) Sea Grant state budgets normalized by shoreline length. These indicators represent the availability of local scientific capacity, the potential for troubleshooting assistance, and the possibility of access to a range of tools and data products, such as available early warning information. We attributed each county cluster (as used in Sensitivity) to each variable score of the six indicators. We then combined into a single index by averaging re-scaled (0–1) overall component scores for sensitivity and adaptive capacity (Supplementary Information Fig. S9). Coincidence of high marine ecosystem exposure to OA with high sensitivity and low adaptive capacity of social systems reveals the areas at highest overall vulnerability to OA.

Places vulnerable to ocean acidification

Our results show that 16 out of 23 bioregions around the United States are exposed to rapid OA (reaching Ω_{Ar} 1.5 by 2050) or at least one amplifier (Fig. 2; Supplementary Table S1); 10 regions are exposed to two or more threats of acidification (note that Alaska and Hawaii are missing local amplifier data; Fig. 2). The marine ecosystems and shelled molluscs around the Pacific Northwest and Southern Alaska are expected to be exposed soonest to rising global OA, followed by the north-central West Coast and the Gulf of Maine in the northeast United States. Communities highly reliant on shelled molluscs in these bioregions are at risk from OA either now or in the coming decades. In addition, pockets of marine ecosystems along the East and Gulf Coasts will experience acidification earlier than global projections indicate, owing to the presence of local amplifiers such as coastal eutrophication, upwelling and discharge of low-Ω_{Ar} river water (see Supplementary Figs S4–S6, Supplementary Table S1).The inclusion of local amplifiers reveals more coastline segments around the United States that are exposed to acidification risk than when basing exposure solely on global models.

Combining sensitivity and adaptive capacity reveals that the most socially vulnerable communities are spread along the US East Coast and Gulf of Mexico (Fig. 2), yet the sources of high social vulnerability are very different between these two regions (see Supplementary Information for breakdown separated by sensitivity and adaptive capacity, Figs S8 and S9). Specifically, the East Coast is dominated by high levels of sensitivity, or economic dependence, from strong use of shellfish resources. For example, southern Massachusetts measures as having the highest sensitivity. This county cluster ranks in the top four for all three sensitivity indicators (Supplementary Fig. S8), meaning that this area has the highest mollusc harvest revenues of any coastal area in the United States, second highest number of licences and fourth highest proportion of seafood revenues coming from molluscs. In contrast, the Gulf of Mexico region is socially vulnerable from low adaptive capacity, owing to social factors such as low political engagement in OA and climate change, low diversity of shellfish fishery harvest and relatively low science accessibility (Supplementary Fig. S9).

Importantly, our visually combined overall vulnerability analysis reveals that a number of socially vulnerable communities lie adjacent to water bodies that are exposed to a high rate of OA or at least one local amplifier, indicating that these places could be at high overall vulnerability to OA (Fig. 2). The areas that are exposed to OA (including local amplifiers) and high and medium–high social vulnerability coincide include southern Massachusetts, Rhode Island, Connecticut, New Jersey and portions around the

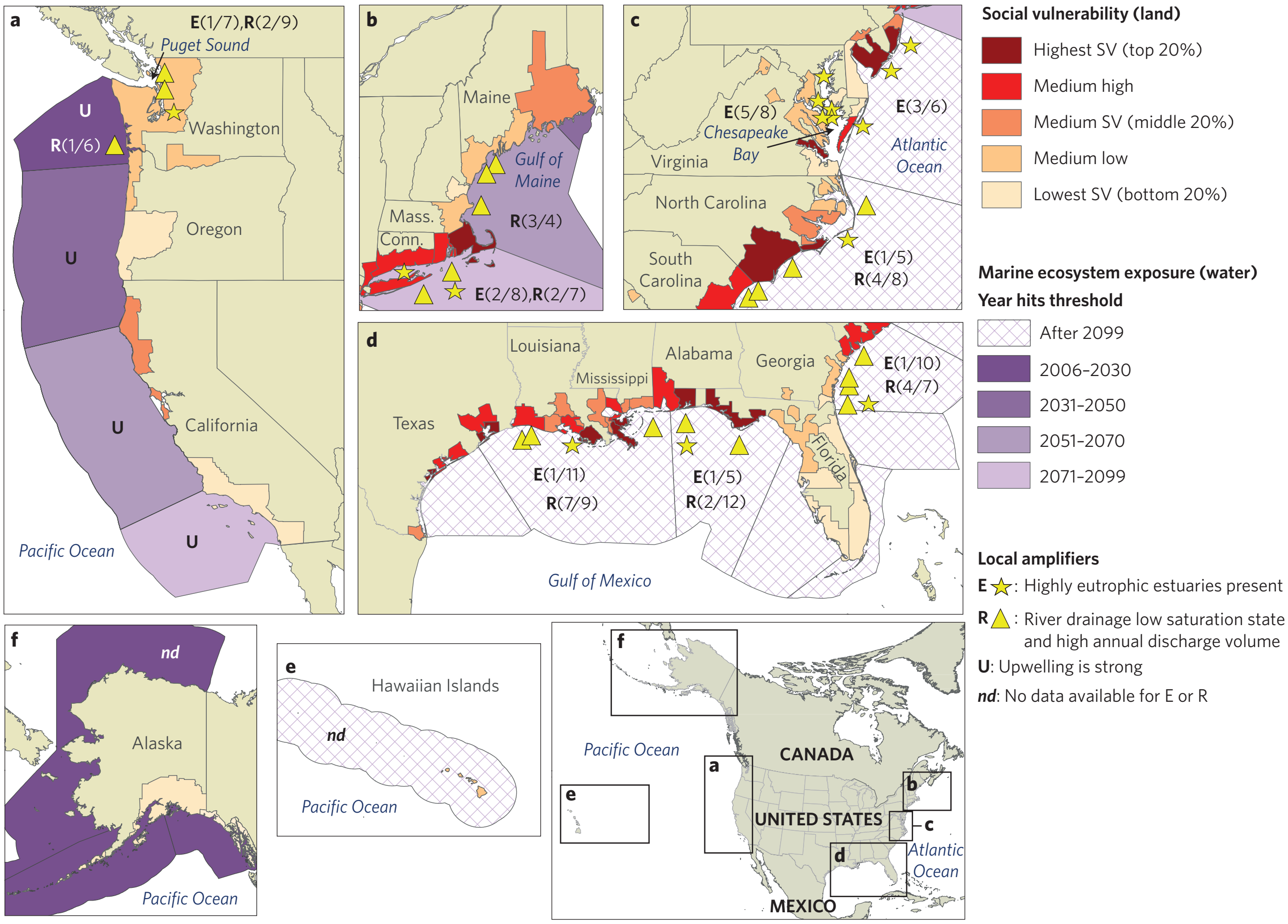

Figure 2 | Overall vulnerability of places to ocean acidification. Scores of relative social vulnerability are shown on land (by coastal county cluster) and the type and degree of severity of OA and local amplifiers to which coastal marine bioregions are exposed, mapped by ocean bioregion: (a) contiguous US West Coast; (b) Northeast; (c) Chesapeake Bay; (d) Gulf of Mexico, and Florida and Georgia's coast; (e) Hawaii Islands; and (f) Alaska. Social vulnerability (red tones) is represented with darker colours where it is relatively high. Exposure (purple tones) is indicated by the year at which sublethal thresholds for bivalve larvae are predicted to be reached, based on climate model projections using the RCP8.5 CO_2 emission scenario[27]. Exposure to this global OA pressure is higher in regions reaching this threshold sooner. Additionally, the presence and degree of exposure to local amplifiers of OA are indicated for each bioregion: E(*x*/*y*) marks bioregions [**AU: OK?**] in which highly eutrophic estuaries are documented, *x* is the number of estuaries scored as high, and *y* is the total number evaluated in each bioregion (source: ref. 56), locations of highly eutrophic estuaries are marked with a star; R(*x*/*y*) marks bioregions in which **sampled river water draining into bioregion scored** [**AU: this description is not clear grammatically: should it be 'bioregions in which... water was scored', or is something missing here? Also, does 'scoring in the top quintile' here mean top quintile of discharge volume only? Please clarify phrasing**] based on very low saturation state and high annual discharge volume (top quintile, calculated by authors from US Geological Survey[57]), *x* is the number of rivers scoring in the top quintile of those evaluated, and *y* is the total number evaluated in this study. Approximate locations of river outflows of those rivers scoring in the top quintile are marked with a delta [**AU: a yellow triangle?**]; and U marks bioregions where upwelling is very strong in at least part of the bioregion (source: ref. 58).

Chesapeake Bay, the Carolinas, and areas across the Gulf of Mexico (Fig. 2b–d). Interestingly, global ocean models that project the advance of OA, primarily as a result of atmospheric CO_2, do not reveal these areas as exposed to global OA until after 2099, based on our study's Ω_{Ar} threshold (Table 1). The marine ecosystem exposure in the areas located along the Atlantic coast and the Gulf of Mexico is from low-Ω_{Ar} conditions caused primarily by the addition of river water and eutrophication, local factors that have only more recently been considered major amplifiers of nearshore acidification[6,7]. These coastal processes are likely to tip coastal oceans past organism thresholds as atmospheric CO_2 uptake continues in the future (see ref. 22). Although the Pacific Northwest, northern California and Maine exhibit only medium and medium–low social vulnerability (Fig. 2a,b), these areas are particularly economically sensitive and lie adjacent to marine ecosystems highly exposed to global OA[23,24] (sensitivity, Supplementary Fig. S8). This profile of relatively high dependency and high exposure in these three regions has already activated significant research and local action/engagement among local scientists, government and shellfish growers (see for example refs 25,26). This engagement has driven up adaptive capacity (based on our study's indicators) in these areas, which reduces their social vulnerability relative to other regions across the United States. In comparison, the lower level of OA-related action in other regions such as the Gulf of Mexico (Fig. 2d), Massachusetts (Fig. 2b) and Mid-Atlantic (Figs 2c,d) with high overall vulnerability profiles might be partly because their marine ecosystem exposure is dominated by the presence of local OA amplifiers rather than global OA (Supplementary Fig. S2, Supplementary Table S1). At the same time, some of these areas (for example Maryland) do have strong advocates for addressing water quality which could provide an opportunity to address locally driven acidification as awareness of the issue grows.

[AU: Please indicate where Table 2 should be cited in the text.]

Table 1 | Indicators of drivers and amplifiers of ocean acidification, and the criterion for each used in this study.

Factors causing and amplifying OA (reducing Ω_{Ar})	Indicator	Scoring scale	Criterion for ranking the risk factor as 'high'
Rising atmospheric CO_2 reduces Ω_{Ar} causing chronic stress to shelled mollusc larvae	Projected year that surface water will reach $1.5\Omega_{Ar}$ (ref. 27)	Continuous scale from current year to 2099	$1.5\Omega_{Ar}$ threshold reached by 2050
Eutrophication increases pCO_2 locally via respiration, leading to reduced Ω_{Ar}	Degree of eutrophication[56]	Eutrophication scored on a five-point scale: low to high	Presence of a high-scoring eutrophic estuary in bioregion
River water can reduce Ω_{Ar} locally in coastal waters	Combined metric of river's aragonite saturation state and annual discharge volume	Rivers scored on a five-point scale: low to high	Presence of high scoring river (for low aragonite saturation and high discharge volume) in bioregion
Significant seasonal upwelling delivers water rich in CO_2 to shallow waters, leading to reduced Ω_{Ar}	Degree of upwelling[58]	Coastal zones scored on a five-point scale: low to high	Presence of high upwelling zone in bioregion

Table 2 | Indicators representing 'sensitivity' (people's dependency) on organisms expected to be affected by ocean acidification (in this study, shelled molluscs).

Indicator or measure	Source	Raw format	Processing for subindex
Landed value (median of 10 years)	Regional fisheries databases (ACCSP, GulfBase, PacFIN), and States of Alaska and Hawaii	US dollars, annual	Calculated median for years 2003–2012 Winsorized the top 10%
Percentage of shellfish by value **[AU: i.e. as percentage of all fish caught?]** (median of 10 years)		For each year: shelled molluscs value/total commercial landed value	Divided landed value of shellfish by landed value of all fish Winsorized the top 10%
Number of licences as proxy for jobs (median over 5 years)		Number of commercial licences, annual	Winsorized the top 10%

All indicators are in units of county clusters.

Robustness of analysis

To examine the robustness of these spatial patterns of vulnerability, we varied the index aggregation methodology and the selection of indicators. To test the difference in index aggregation methods for social vulnerability, we compared the output of adding and multiplying sensitivity and adaptive capacity indices and found little difference; the same set of county clusters made up the top 10 most socially vulnerable places using either aggregation method.

To explore the effect of indicator selection on adaptive capacity (and thus social vulnerability), we compared a set of commonly used generic indicators for adaptive capacity relating to income, poverty, education and age with the set of threat-specific indicators developed for this study (see Table 3 and Supplementary Figs S10 and S11). Using the generic capacity measures to calculate social vulnerability, we found that six of the same county clusters measured within the top 10 highest socially vulnerability places in the United States as those found using the threat-specific indicators (see Supplementary Information for analysis and maps). This is considerable overlap given that the two sets of variables indicate entirely different notions of adaptive capacity. Because the sensitivity indicators were developed and vetted by fisheries social science researchers[21] and alternative potentially appropriate data were not available nationwide, we did not have a useful comparison for this element from which to draw.

To explore the criterion for Ω_{Ar}, we examined one alternative for disruption of biological processes with respect to rising atmospheric CO_2: the time until average surface waters move outside the present range of Ω_{Ar} (that is, exceeding a historic envelope)[27]. The map generated by this 'historic envelope' approach shows that southern areas experience potential OA exposure earlier, which is nearly an inverse pattern to our chosen criterion of a chemical threshold when calcification and development of larval molluscs may decrease (Supplementary Fig. S3). This difference in patterns is because natural variability is much smaller in southern regions, although evidence of greater sensitivity in populations of bivalves that live in tropical and subtropical waters is lacking. This discrepancy underscores the need for targeted research integrating a physiological, ecological and evolutionary perspective on the potential and limitations of strong local biological adaptation to different carbonate regimes for commercially valuable shelled mollusc populations.

Overall, we found that variable selection has stronger effects than aggregation methods, which provides high confidence in our aggregation methods for social vulnerability. The differences found in variable selection identify research needs relating to what factors underlie vulnerability on the ground that are relevant to OA; this conversation has only just begun.

Opportunities to reduce vulnerability to ocean acidification

Social–environmental syntheses, including vulnerability analyses, can help to identify opportunities for actionable solutions to address the potential impacts of ocean acidification. Our analysis reveals where and why the overall vulnerability from OA varies among the many coastal areas of the United States, and thus identifies opportunities to reduce harm.

One way to tackle OA is by reducing marine ecosystem exposure to it. Several portions of the east coast are highly exposed to OA from high levels of eutrophication (Fig. 2b–d). In addition to releasing extra dissolved CO_2 and enhancing acidification, eutrophication can also decrease seawater's ability to buffer further acidification[3]. People in these regions are uniquely positioned to reduce exposure to OA through regional actions by curtailing eutrophication (as compared, for example, with regions exposed to upwelling). Although a significant challenge, reducing nutrient loading to the coastal zone in these areas could provide multiple benefits, making it a no-regrets option. Reducing eutrophication can decrease hypoxia and harmful algal blooms, in addition to reducing risk from fossil-fuel-derived OA at the local and regional level. Policy

Table 3 | Threat-specific indicators used to assess capacity of fishing communities to deal with impacts of ocean acidification.

Group	Indicator	Source	Raw format	Processing for subindex
Access to scientific knowledge	Budget of Sea Grant programmes	National Sea Grant	State-level total funds of budget (state and federal contributions combined, 2013)	• Re-scaled (0–1) • Attributed normalized scores to each county cluster
	Number of university marine laboratories	Direct count from registries and Internet	Latitude/longitude location of laboratories	• Combined score of laboratories per state/ shoreline length and labs per county cluster
Employment alternatives	Shelled mollusc diversity	Regional fisheries databases (ACCSP, GulfBase, PacFIN), and States of Alaska and Hawaii	Ratio of landing revenues for each taxon by county cluster	• Calculated Shannon Weiner Diversity Index
	Economic diversity	ACS Census	Proportion of county population employed in each industry	• Calculated Shannon Weiner Diversity Index for county clusters
Political action	Legislative action for OA	Keyword searches on legislature websites and follow-up calls	Established five-point scale for state's legislative progress on OA	• Re-scaled 0–1 • Attributed score to county clusters
	Climate adaptation planning	Georgetown Law School Climate programme website	Status of climate adaptation plan for state	• Re-scaled 0–1 • Attributed score to country clusters

See Supplementary Information for discussion and presentation of alternative indicators and measures.

instruments to reduce eutrophication exist in the United States[28] and can be leveraged to facilitate efforts to reduce OA[8].

Another important way to combat the effects of OA will be by reducing social vulnerability. In regions where high sensitivity (one component of social vulnerability) arises from the structure of the fishing industry, an entirely different approach to adaptation may be more appropriate than those geared to reduce marine ecosystem exposure. For example, where fishery harvest portfolios are dominated by a single species, such as in the Gulf of Mexico where mollusc production is limited to the eastern oyster (*Crassostrea virginica*), diversification of the species harvested might be a beneficial strategy.

A further way to reduce social vulnerability may be by increasing adaptive capacity of people and regions. Access and availability to science already has helped shellfish aquaculturists in the Pacific Northwest to identify and avoid some of the consequences of OA[20]. Working with local scientists, hatcheries have implemented several strategies to adapt and mitigate OA effects on bivalve seed production. Through local industry–research partnerships in the Pacific Northwest, implementation of real-time monitoring of saturation state, chemical buffering of water, changes in timing of seasonal seed production and use of selectively bred lines of oyster broodstock, this collaboration has prevented collapse of the regional oyster industry.

In every case, when developing a broader array of adaptation strategies, it is critical to work directly with the coastal communities in each region so they can develop context-appropriate and feasible adaptation options. Targeted projects to develop local adaptation plans may even require developing further regionally relevant indicators of adaptive capacity and community resilience that this nationwide study does not capture. In fact, zooming in to assess particular regions at a higher resolution would enable regional stakeholders to provide input into a possible different set of variables that defines vulnerability in their particular region based on values and social or economic context.

Barriers to and path forward for addressing OA

This study offers the first nationwide vulnerability assessment of the spatial distribution of local vulnerability from OA focusing on a valuable marine resource. But it is just a first step to understanding where and how humans and marine resources are at highest risk to OA and its local amplifiers. Another key finding of this assessment is that significant gaps in the scientific understanding of coastal ocean carbonate dynamics, organismal response and people's dependence on impacted organisms limit our ability to develop a full suite of options to prepare for, mitigate and adapt to the threats posed by OA, and these can be considered in a structured way using the framework (Fig. 3). The types of gaps identified—as commonly classified in information science and other disciplines[29,30]—range from data inaccessibility to knowledge deficiencies.

Marine ecosystem exposure. Key gaps remain in understanding how global and local processes interact to drive nearshore OA, and how this will affect marine organisms and ecological systems. Recent studies suggest that the biogeochemical interaction between global OA and local amplifiers is additive[3,22,31]; however, most ocean models used to project future OA cannot adequately resolve these processes, which are also increasingly affected by human activity[7,32]. Even though direct measurements incorporate an ever-growing global network of monitoring instruments, they are often located offshore and remain too sparse in space and time to resolve the dynamics of seawater chemistry near shore, where most shellfish live. Historically, OA monitoring has focused on offshore regions, where long-term, high-accuracy and precise measurements enabled detection and attribution of the rising atmospheric CO_2 acidification signal. But many commercially and nutritionally important organisms live in the coastal zone where they experience the combined effects of multiple processes that alter the carbonate chemistry[7]. This results in greatly variable 'carbonate weather' for a given location[33]. Characterizing this variation, including modelling how rising atmospheric CO_2 will increase the frequency, duration and severity of extreme events **[AU:OK?]**, would provide a fuller picture of how OA is unfolding within the dynamic coastal waters.

To improve our understanding of which marine ecosystems and organisms are most susceptible to ocean acidification, additional information on the Ω_{Ar} thresholds below which reproduction and survival are disrupted is needed. In the US context, the

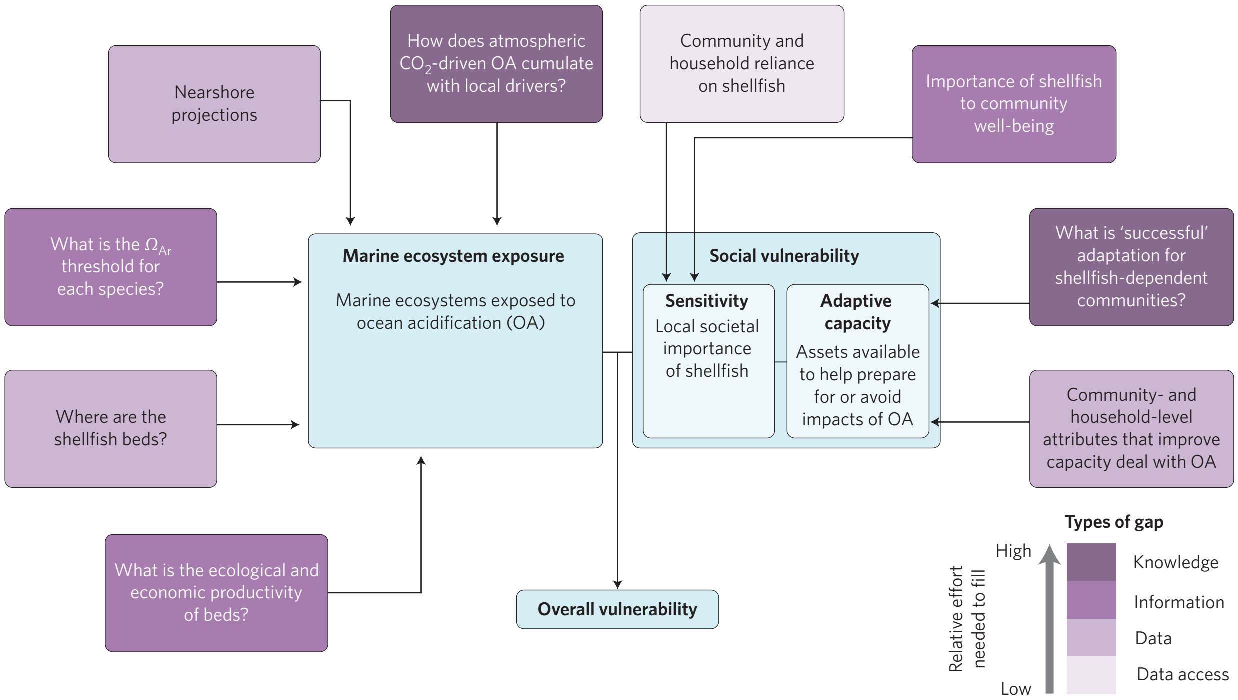

Figure 3 | Sample of gaps in knowledge related to OA vulnerability, information and data organized around components of the framework. Different types of gaps are classified by the level of effort that is required to fill them (gaining knowledge is the most challenging, whereas data access tends to be the most straightforward).

concentration of value in a limited number of shellfish species means that the identification of biologically susceptible and resistant species and populations is both prudent and feasible. Based on total landed value from 2003 to 2012, approximately 95% of shelled-mollusc revenues in the United States come from only 10 species (and 80% from five). These species include sea scallop (52.9%), eastern oyster (11.3%), Pacific geoduck (5.8%), Pacific oyster (5.2%) and six species of clam (that range from 5% to 2.6% of total value)[34]. There is some evidence of local biological adaptation of other marine taxa to varying carbonate chemistry regimes[35–37]. This potential genetic variation, if present, could be documented to aid in the development of resistant strains of cultured or other organisms.

Social vulnerability. Our study also revealed large gaps in information about mollusc-dependent communities to inform measures of social vulnerability. We do not have high-resolution nationwide data on the full cultural and societal significance of shelled molluscs. Even data on the contributions of shellfish to human nutrition, shoreline protection, and water filtration were inadequate nationwide. Incorporation of these other ecosystem services provided by molluscs could alter the social vulnerability landscape. For the commercial fisheries data that we did obtain, confidentiality constraints forced us to aggregate our analysis into county clusters, preventing county-specific or port-level analyses of social vulnerability that might have revealed more spatial heterogeneity. We also lack social science data that describe use at species-, human community-, port- or household levels. We lack data on the value chain that links threatened organisms to harvesters, processors and end-users. Finally, empirically tested adaptive capacity measures could contribute to a more rigorous evaluation of social vulnerability. This includes data on scientific spending and infrastructure directly relevant to end-users, as well as social and demographic data that are reflective of end-users (for this study, fishing and aquaculture communities) and not the general population (for example generic indicators quantifying education and income).

Beyond helping in prioritizing and developing adaptation strategies, social science is also useful to inform and guide planning for social adaptation and mitigation. As with climate change adaptation, preparing for and adapting to the impacts of OA is a social process[1,38,39]. Implementation does not occur automatically once strategies are developed, but instead must often overcome a suite of institutional (including legal), political, psychological and other types of barriers[40]. As learned from climate change initiatives, the 'softer side' of adaptation (such as coordination among stakeholders, industry and scientists) is the first step towards preparing for a threat like OA[41]. Despite its fundamental importance, this type of effort is often overlooked and remains underfunded. Social science can also help practitioners even in early stages of adaptation figure out how to engage public and policy-makers effectively in OA issues[42–44]. Farther along in adaptation processes, social science can inform the development of strategies by accounting for social values[45,46] and existing property rights in use and norms[47,48] and even helping to work out what type of information is salient for and trusted by decision-makers[49,50]. Although important for reducing its risks, social science relevant for understanding OA has been minimal thus far. A budget assessment conducted by the Interagency Working Group on Ocean Acidification reported that federal research in fiscal year 2011 allocated $270,000 of Federal funds for social science research related to OA, which represents 0.9% of the entire OA spending for that year's budget[51].

Conclusions

As with other global environmental changes, acidification of the oceans is a complex and seemingly overwhelming problem. Here we have focused only on OA (and nearshore amplifiers) as the threat to coastal species. Although other stressors also threaten coastal ecosystems, our single-threat assessment allows us to tease out where OA in isolation could hit people and organisms the hardest, which can inform research agendas and decision-making geared specifically to address OA. A vulnerability framework helps to structure our thinking about the ways in which ocean acidification will affect ecosystems and people. The framework also helps to identify and organize the opportunities and challenges in dealing with these problems. But this study is the beginning; adaptation to OA and other global environmental change is an iterative process that requires both top-down and bottom-up processes. Our analysis of OA as it relates to [**AU: OK?**] US shelled mollusc fisheries makes clear just how much the pieces of the OA puzzle vary around the country. Marine ecosystem exposure, economic dependence and social capacity to adapt create a mosaic of vulnerability nationwide. An even more diverse set of strategies may be needed to help shellfish-dependent coastal communities adapt to OA. Rather than create and apply a nationwide solution, decision-makers and other stakeholders will have to work with fishing and aquaculture communities to develop tailored locally and socially relevant strategies. Meaningful adaptation to OA will require planning and action at all levels, including regional and local levels, which can be supported with resources, monitoring, coordination and guidance at the national level.

Over the past decade, scientists' understanding of ocean acidification has matured, awareness has risen and political action has grown. The next step is to develop targeted efforts tailored to reducing social and ecological vulnerabilities and addressing local needs. Tools like this framework can offer a holistic view of the problem and shed light on where in the social–ecological system to begin searching for locally appropriate solutions.

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Author contributions

All authors provided input into data analysis and research design, and participated in at least one SESYNC workshop; J.A.E. led the drafting of the text with main contributions from L.S., S.R.C., L.H.P., G.G.W. and J.E.C.; R.v.H. contributed projections of ocean acidification; J.A.E., L.S., S.R.C., J.R. and C.D. collected the data; J.A.E. carried out data analysis and mapping.

Additional information

Supplementary information is available in the online version of the paper. Reprints and permissions information is available online at www.nature.com/reprints. Correspondence should be addressed to J.A.E.

Competing financial interests

The authors declare no competing financial interests. [**AUTHORS: OK?]**

EXHIBIT 46

https://newfoodeconomy.org/ocean-acidification-oysters-dungeness-crabs/

The ocean is changing faster than it has in the last 66 million years. Now, Oregon oysters are being farmed in Hawaii. That fix won't work forever.

November 28th, 2017
by H. Claire Brown

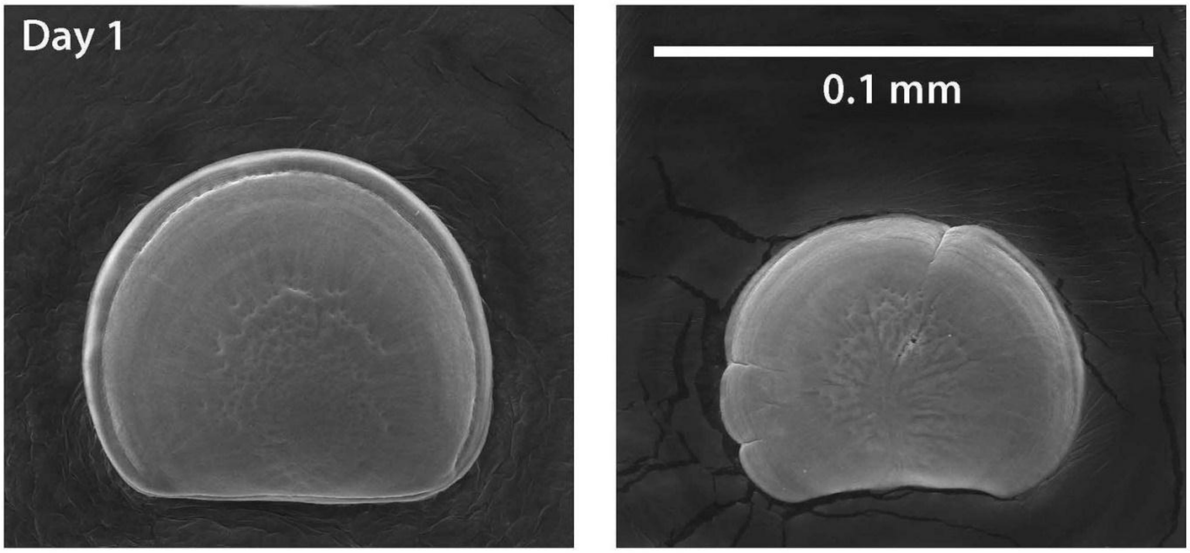
A little more than ten years ago, a mysterious epidemic wiped out baby oyster populations. It started in 2006, when Whiskey Creek shellfish hatchery in Oregon lost 80 percent of its cultured larvae. Around the same time, 200 miles north in Washington, Taylor Shellfish saw similarly high mortality rates. And oysters in the wild weren't faring much better: Oystermen who usually sourced larvae from Washington's Willapa Bay, one of the largest natural oyster-producing estuaries in the country, weren't finding enough stock to seed their beds.

It wasn't long before the epidemic migrated to the East Coast. In the Gulf of Maine, hatchery owner Bill Mook began to notice larval die-offs and slowed growth rates following big storms that pumped fresh water into his hatchery starting in 2009. Sometimes, the surviving organisms were severely deformed. No one knew exactly what had gone wrong.

> After two years of massive losses, scientists discovered what was really wrong.

Suspecting bacterial infection or a problem with the feed, Whiskey Creek and Taylor Shellfish invested in machines that kill *vibrio tubiashii,* a bacteria that is a common culprit in oyster larvae die-offs. Survival rates didn't improve.

But after two years of massive losses and no answers, scientists testing the waters discovered what was really wrong: the ocean water flowing into the hatcheries had changed, and the oysters weren't able to build their shells. Without shells, they couldn't survive.



Flickr / Oregon State University

Oyster larvae in normal conditions (left) versus oyster larvae in acidified conditions (right)

Larval oysters experience a crucial phase in their life cycle where they morph from a form not unlike free-floating dust particles into lentil-sized bivalves with the beginnings of a shell. In order to start building that shell, the larvae need to use carbonate ions from their surroundings. But seemingly all of a sudden, the ocean waters flowing into the hatcheries on the Pacific Coast had a lower concentration of carbonate ions than usual, meaning the larvae missed the dust-to-lentil growth phase that turns them into tiny oysters. As a result, most of them died.

But why had the carbonate ions dipped in the first place? Researchers discovered that the underlying cause was more than a couple years of bad luck or a minor disturbance in tidal patterns. In the mid-aughts, a global shift, which had been quietly altering the ocean's chemistry for hundreds of years, had finally washed up on the shores of the Pacific Coast. And oyster larvae, some of the most vulnerable, valuable, and closely-monitored creatures in the sea, were the first recognized victims of a process that had already started to affect aquatic life across the globe: ocean acidification, a climate change-related process that is gradually lowering pH levels in the water that covers 97 percent of the earth.

The Whiskey Creek hatchery story made the front page of the *Seattle Times* in 2009. Several years later, in 2013, the Royal Swedish Academy of Sciences published a report analyzing the media's treatment of the Whiskey Creek oyster die-offs. In that paper, the authors took a look at the relationship between the hatcheries, the media, and scientific research. What they found was that, at the time of the die-offs, a "landmark" paper had already been published by researchers at Seattle's Pacific Marine Environmental Library showing that ocean acidification was impacting the Pacific Northwest. Which means scientists *knew* the problem was a real threat, but the public hadn't yet caught on. It wasn't the authoritative research paper that got people to pay attention. It was the loss of the seed stock for an entire sector of the economy.

> It took a human story to get the public and local representatives to pay attention to the problems at hand.

The researchers found that it took a human story—a $136 million industry in the United States, employing thousands of people, turned on its head—to get the public and local representatives to pay attention to the problems at hand. Years of scientific papers couldn't accomplish what the Whiskey Creek story demonstrated in short order: When people's lives are affected, legislators hear about it. Washington's then-governor Christine Gregoire soon formed a Blue Ribbon Panel on Ocean Acidification. The panel made policy recommendations, ultimately positioning Washington State as a national leader in ocean acidification research and planning.

Flickr / Louisiana Sea Grant College Program Louisiana State University

Oyster hatcheries raise larvae into seed oysters, pictured above, then sell them to farmers. Once an oyster as reached this size, it can survive in acidified conditions

But despite one state government's proactive stance on changing seas, ocean acidification-related problems have continued to creep toward other parts of the seafood industry. And now, researchers find themselves racing to grasp the implications of a tangled underwater web that includes global warming, ocean acidification, natural seawater patterns, long-term weather events like El Niño and La Niña, and changing fishery management practices.

Ocean water has a birth place. It begins as melting ice somewhere in the North Atlantic, where the newly-formed cold water sinks to the bottom and floats slowly past the equator. It then falls into a rhythm, flowing along the depths and rising to the surface in a global "conveyor belt" that has carried water on the same path for millennia. It takes ten thousand years for a droplet to make its way to the end of the belt, where it emerges, marked with chemical signposts dating further back than written language, off the coast of Washington and Oregon.

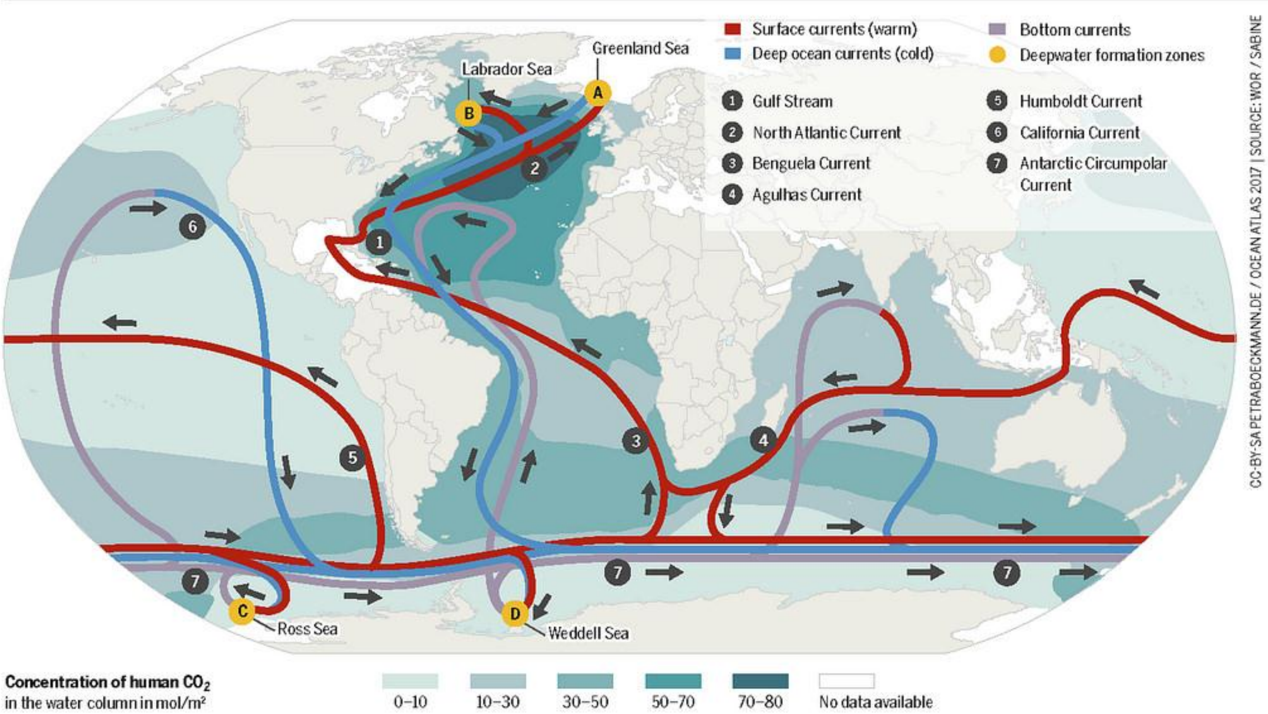
As we know, the ocean itself is also changing. It absorbs about a quarter of the carbon dioxide that humans release into the atmosphere and most of the heat from human activities. Scientists have been studying the *warming* ocean for a while—that's how we learned about sea-level rise and coral bleaching—but until the mid-1990s, no one really understood that the chemical content of the ocean was being altered, too.

> The change in ocean water pH levels likely has a million different effects on marine life.

The term "ocean acidification" refers to a change in oceanic pH. Whereas the pH of the ocean used to be 8.2, it's now hovering around 8.1. And even though that doesn't *sound* like a big difference, pH is measured on a logarithmic scale—which means, for those of us who haven't thought about logs since the SATs, that the ocean is actually about 30 percent more acidic than it used to be. It's expected to hit pH 7.8 by the end of the century.

Here's another way to look at it: The ocean is currently acidifying faster than it has in the last 66 million years.

The Global Conveyor Belt—How the Ocean Stores CO_2



CO_2 entrapment is made possible by large oceanic currents. Working like conveyor belts, they carry warm surface water, which absorbs CO_2, from the tropics in the Atlantic towards the colder poles.
On the way, the water slowly cools and becomes saltier. When it arrives in the Greenland Sea (A), the Labrador Sea (B), and at the Antarctic coast in the Ross Sea (C) and the Weddell Sea (D), the heavy surface water sinks into the depths, taking the CO_2 with it. The CO_2-rich water then flows back towards the tropics. As it travels, the cold water slowly mixes with the warmer layers above and rises—very slowly—back to the surface.

Flickr / Heinrich-Böll-Stiftung Follow

Water moves between the surface and the ocean floor as it advances along the conveyor belt

It helps to think about pH in human terms. A healthy human body typically has a pH of around 7.4, and it fluctuates very little. A change of 0.3 or 0.4—the same amount the ocean is expected to change by the end of the century—can induce a coma. If body pH rises or falls by 0.5 or more, the results are deadly. So while we don't know exactly what's happening to the organisms that live in the ocean, we know that their environment is changing more rapidly than ever, at rates that would cause serious problems for the human body.

(It's important to note that the ocean isn't actually going to turn to acid by 2100. Shallin Busch, a scientist at NOAA, explains it this way: "The North Pole is a fundamentally cold place, but we say that it's warming. Not that it's going to get warm, but that it's warm*ing.* So you can say the same thing about ocean waters: they're acidifying or becoming more acidic, but they are not acidic themselves.")

But why did ocean acidification appear in the Pacific Northwest before it showed up in Maine?

> The change in ocean water pH levels likely has a million different effects on marine life.

As I described, water moves between the surface and the ocean floor as it advances along the conveyor belt. In the Pacific Northwest, for instance, the water that welled up during the summer the oyster larvae were dying off had last seen the surface about half a century before, north of Hawaii, where it absorbed some of the atmospheric carbon being released at that time. So it's not as though the waters off Seattle are just carrying carbon emissions from the Amazon headquarters they flowed past two days ago—rather, they're carrying the carbon from all the times they welled up to the surface since the Industrial Revolution. "We know that even if all carbon dioxide emissions ceased today, the waters off the Pacific Northwest would continue to acidify for at least another 50 years, so the train is already coming," says Busch.

The water in the Pacific near Washington is at the end of the conveyor belt, and because it's so old it contains a lot of carbon dioxide from the natural decomposition of the organisms that have been dying in it for thousands of years. So when the *added* carbon dioxide from human emissions is mixed with this already-carbon-rich environment during upwelling events, the combination is enough to kill oyster larvae.

Flickr / Louisiana Sea Grant College Program Louisiana State University

The decrease in concentration of carbonate ions—the change that prevented oysters from building their shells—is the most concrete and observable effect of ocean acidification so far

Here's another way to think about it: If the waters in a hatchery are normally somewhere around pH 8.1, they may dip down to pH 7.8 during annual upwelling events when old, carbon-rich water naturally rises to the surface, as happens every summer. But when that old acidic water is mixed with *new* acidic water (the latter being the surface waters impacted by human-released carbon dioxide 50 years ago), the combination can nudge the pH down to, say, 7.7. And it's that small added difference that kills oyster larvae. The human-generated carbon nudges the water across the threshold.

The change in ocean water pH levels likely has a million different effects on marine life, most of which we still know nothing about. The decrease in concentration of carbonate ions—the change that prevented oysters from building their shells—is the most concrete and observable effect of ocean acidification so far. But scientists and fishermen are now trying to tease out all the other, subtler changes. For instance, how a negative impact on one species could affect an entire food chain, or whether or not a change in pH can alter a fish's ability to make decisions. The predictions are all over the place—remember that *Washington Post* story about "super crabs" invading the Chesapeake Bay? (Probably not gonna happen.) But research has advanced rapidly in the last few years. Here's what we know now.

Oysters on the West Coast

> "I was afraid if I didn't do something, then our business would just slowly die."

Once the West Coast hatcheries—which shepherd the larvae through the first stage of life before selling them to farmers as hardy juveniles—diagnosed the problem, they moved quickly to organize a response. The Pacific Coast Shellfish Growers Association recommended that NOAA establish water monitoring systems that give industry players real-time information about the quality of the water flowing into their farms. Hatcheries then used that information to manipulate the water flowing onto their properties—block it when it's too rich in carbon, open the floodgates when the upwelling is over. Many hatcheries have also installed pricey buffering systems that automatically add sodium carbonate to the seawater to balance its chemistry.

But manipulating the incoming water can only work for so long. To escape the West Coast upwelling events, some hatcheries are moving operations as far south as Hawaii.

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The oyster industry was the first to be affected by ocean acidification, and it has adapted quickly

Taylor Shellfish—one of the first farms to be impacted by the die-offs—expanded its existing Hawaii hatchery, growing seed oysters and Manila clams. The shellfish are hatched in tropical waters, then shipped northward to mature in places like the Puget Sound.

In 2012, Willapa Bay's Dave Nisbet followed suit. Unlike Taylor Shellfish, which had always relied on its own hatchery for seed oysters, Nisbet's company had depended on harvesting wild oyster seed. He took NOAA's warnings about ocean acidification to heart and decided to build his hatchery in Hawaii, even though it would have been much less expensive to build one in Washington. "I just got nervous," Nisbet told the *Seattle Times* in 2012. "I was afraid if I didn't do something, then our business would just slowly die."

> Even though shellfish represent some the most vulnerable populations, they're also the easiest to fix.

Once shellfish pass through the crucial early development stages where they grow their shells, they're more impervious to changes in ocean water. Adolescent oysters, for instance, can thrive in conditions that kill larval clams. West Coast oystermen haven't yet seen acidification-triggered damage to older shellfish.

The oyster industry was the first to be affected by ocean acidification, and it has adapted quickly. In many ways, even though shellfish represent some the most vulnerable populations, they're also the easiest to fix: The infrastructure to hatch farmed shellfish was in place long before ocean acidification became a concern, and individuals can survive the trip from Hawaii to Seattle. But other species—like Dungeness crabs, which aren't farmed, and Alaskan salmon, which migrate—don't have such a simple life cycle.

California's Dungeness crabs

If larval oysters die-offs were the earliest indicator of the coastal arrival of ocean acidification, then Dungeness crabs are the species researchers and fishermen worry may struggle next. They represent the most valuable fishery on the West Coast, generating $167 million in ex-vessel value in California in 2011. Like oysters, Dungeness crabs are a key driver of the fishing industry, so lucrative that many fishermen rely on them to guarantee an annual income.

Flickr / California Department of Fish and Wildlife

Like oysters, Dungeness crabs rely on carbonate to build their shells. But carbonate isn't the primary molecule they use

Paul McElhany, a researcher at NOAA, has been testing potential impacts of lowered pH levels on Dungeness crabs. In 2016, his Seattle-based team collected egg-laying female crabs and hatched their young in treated water with varying levels of carbon dioxide.

The researchers' results would concern any fisherman. At an acidified pH level of 7.5, which has *already* been observed during upwelling events in the Puget Sound, only about a third of the Dungeness crabs survived into the juvenile stage as compared to those that survived in waters with a normal pH. (Remember, the open ocean is at about pH 8.1 now. It's expected to hit pH 7.8 by the end of the century.)

McElhany says scientists aren't quite sure *why* the acidified conditions led to such a big drop in crab survival rates. Like oysters, Dungeness crabs rely on carbonate to build their shells. But carbonate isn't the *primary* molecule they use. Which means the lower survival rate was probably caused by something other than what killed the larval oysters, something scientists have not yet identified.

> Ocean acidification *could* be impacting Dungeness crab life cycles already.

And this experiment only manipulated pH levels in a controlled environment. The results, though stark, don't even come close to mimicking conditions in the wild. "Out in the field you've got multiple things going on at the same time because you've got ocean acidification, you also have temperature, climate change, and changes in fishery practice," McElhany explains. If two-thirds of Dungeness crabs are dying inside a tank that doesn't contain predators, fluctuating temperatures, or hard-to-find food, the results in the open ocean could be much worse.

Out in the field, fisherman John Mellor has been keeping an eye on the impossibly complex oceanic patterns that swirl through the crabs' habitat. And while he doesn't think he's witnessed ocean acidification impacting crab populations first hand, he's seen warming waters directly affect the crab catch.

To be clear, ocean acidification *could* be impacting Dungeness crab life cycles already. But because they aren't farmed and because their West Coast habitat has been so abnormal for the last few years—we'll get to that in a second—it's impossible to separate ocean acidification from everything else that's happening along their migration routes.

Flickr / Oregon Department of Fish & Wildlife

Unlike shellfish, which can start their lives in Hawaiian hatcheries to avoid being damaged by a bit of bad water, Dungeness crabs only grow in the wild

But there *have* been recent events that have impacted the Dungeness crab fishery, and they show how a small environmental change (in this case, so small the crabs didn't even notice) can affect the industry as a whole. It's these types of indirect impacts—problems that involve organisms far down the food chain, not the crabs themselves—that researchers like McElhany can't yet predict in a lab. But that doesn't mean they're insignificant.

Between 2014 and 2016, a mass of warm water known as "The Blob" was hanging out along the West Coast. It hasn't been proven that the blob was a direct result of climate change, though Mellor says many people assume it was. Regardless, scientists expect blob-like conditions to become more common as ocean waters continue to warm.

The blob disrupted local environments, causing die-offs of sea lions and fur seals. It also made a certain type of algae really, really happy. That algae, *Pseudo-nitzschia australis,* produces a toxin called domoic acid. (It has "acid" in its name, but that's where its relationship to ocean acidification ends.) Humans can't eat too much domoic acid without getting sick.

The Dungeness crabs aren't bothered by domoic acid. They can eat a lot of the affected algae and it won't impact their survival rates. But when they eat the algae, the domoic acid stays in their bodies. And it can cause real problems for humans eating cooked crabs—think short-term memory loss, comas, and seizures.

Crabs are a reminder that our knowledge of this phenomenon is far from complete.

Regulators in California don't let fishermen catch Dungeness crabs if the crabs have eaten too much algae—no one wants to pass domoic acid poisoning off on some unsuspecting diner. But those restrictions are hard on fishermen. A few years back, Mellor's season was delayed by five months as he waited for the crab tests to come back clean.

"You can't really go drive for Uber," he says, adding that he had to be ready to start fishing at any moment.

To recap: The crabs hadn't gone anywhere. They were healthy and thriving, and they hadn't moved from their normal stomping grounds. But warmer-than-usual waters meant higher-than-normal levels of algae, and that algae made the crabs poisonous to humans. This is the kind of butterfly effect that will likely impact Dungeness populations long before pH levels drop down to 7.5, and it's this type of phenomenon scientists are hoping to predict by running computer simulations of entire food webs in acidified conditions.

Jessica Fu

This year, crab fishing season in Oregon has already been delayed because of domoic acid

Shallin Busch, the scientist at NOAA who studies ocean acidification and fisheries, has been working to predict the effects of ocean-wide change on specific populations. "Basically we created a model of the West Coast food web in the computer and we put in this scenario of ocean acidification from the chemistry change," she explains. "We looked to see what might happen to fish populations that we harvest under acidification. The take-home answer is that the Dungeness crab harvest was most impacted by our scenarios," she says. "What this model work was showing was that there's also likely to be some indirect effect, kind of a food web effect of acidification as well."

It'll take years for the gap between lab-generated conclusions and the natural world to narrow.

Unlike shellfish, which can start their lives in Hawaiian hatcheries to avoid being damaged by a bit of bad water, Dungeness crabs only grow in the wild. "The crabs walk in and out of the canyons, and then they'll walk up onto the shelf, and they feed on the clam beds and the worm beds and whatever they can eat, and then they typically will mate in February, March, April—and then after they're done mating, they eat a little more and then molt," Mellor says. All the while, they're migrating throughout different parts of the ocean floor.

This year, Mellor's fishing season started on time. Crab fishermen in Oregon weren't so lucky—their season has already been delayed because of domoic acid.

If oysters show the most direct and observable link between ocean acidification and survival rates, the crabs are a reminder that our knowledge of this phenomenon is far from complete. It'll take years for the gap between lab-generated conclusions and the natural world to narrow. In the meantime, crab populations will continue to live in a changing habitat.

Elsewhere

Though we have the most data about oysters and Dungeness crabs, researchers are also focusing on the potential impacts of ocean acidification on other commercially-valuable species. McElhany says there's some preliminary evidence that shows elevated acidity may impact the part of a salmon's brain that helps it avoid predators—another incidence of a subtle change that could have catastrophic consequences. Earlier this month, biologists began sounding the alarm bells about Alaska's red king crabs, warning that they could be extinct in the next century. King crabs struggle to build their shells in acidified conditions, and researchers hypothesize that they simply can't generate enough energy to maintain a survivable internal pH as external pH levels continue to fall.

Unsplash / Charlotte Coneybeer

There's a little hope, though: In the king crab trials, a few of the juveniles made it out alive in lab conditions that simulated Alaskan waters a hundred years from now. Those crabs may be able to pass their traits onto their young, creating a new generation of crustaceans that can survive in changing waters.

What can we do about the impact of ocean acidification right now? "We don't have that answer for you," Busch says. "We're hoping in the future that we will. There's this massive global effort to better understand species sensitivity, better understand ecosystem changes, do better monitoring. That's one thing."

ENVIRONMENT, **FARM**, **HEALTH**, **POLICYDUNGENESS CRABSOCEAN ACIDIFICATIONOYSTERSSHELLFISHWASHINGTON STATE**

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PRIMARY RESEARCH ARTICLE

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Elevated CO_2 impairs olfactory-mediated neural and behavioral responses and gene expression in ocean-phase coho salmon (*Oncorhynchus kisutch*)

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Abstract

Elevated concentrations of CO_2 in seawater can disrupt numerous sensory systems in marine fish. This is of particular concern for Pacific salmon because they rely on olfaction during all aspects of their life including during their homing migrations from the ocean back to their natal streams. We investigated the effects of elevated seawater CO_2 on coho salmon (*Oncorhynchus kisutch*) olfactory-mediated behavior, neural signaling, and gene expression within the peripheral and central olfactory system. Ocean-phase coho salmon were exposed to three levels of CO_2, ranging from those currently found in ambient marine water to projected future levels. Juvenile coho salmon exposed to elevated CO_2 levels for 2 weeks no longer avoided a skin extract odor that elicited avoidance responses in coho salmon maintained in ambient CO_2 seawater. Exposure to these elevated CO_2 levels did not alter odor signaling in the olfactory epithelium, but did induce significant changes in signaling within the olfactory bulb. RNA-Seq analysis of olfactory tissues revealed extensive disruption in expression of genes involved in neuronal signaling within the olfactory bulb of salmon exposed to elevated CO_2, with lesser impacts on gene expression in the olfactory rosettes. The disruption in olfactory bulb gene pathways included genes associated with GABA signaling and maintenance of ion balance within bulbar neurons. Our results indicate that ocean-phase coho salmon exposed to elevated CO_2 can experience significant behavioral impairments likely driven by alteration in higher-order neural signal processing within the olfactory bulb. Our study demonstrates that anadromous fish such as salmon may share a sensitivity to rising CO_2 levels with obligate marine species suggesting a more wide-scale ecological impact of ocean acidification.

KEYWORDS
GABA, ocean acidification, olfactory bulb, olfactory rosette, salmon

1 | INTRODUCTION

The substantial rise in atmospheric CO_2 observed over the past 100 years has led to increased concentrations of dissolved CO_2 in marine waters, resulting in lowered pH, a process known as ocean acidification (OA). The degree of pH change and the rate at which these changes are occurring may ultimately exceed many marine organism's ability to adapt to this changing environment (Hoegh-Guldberg & Bruno, 2010). Marine biota have evolved to live in ocean waters with a consistent range in chemical composition, and therefore, even small changes in mineral content, pH, and/or temperature outside of the normal range can have large impacts on marine organisms at different life stages (Fabry, Seibel, Feely, & Orr, 2008; Kroeker et al., 2013; Marshall et al., 2017). Hard corals, hard-shelled mollusks, and plankton are among the more well-known examples of marine organisms that are sensitive to shifts in water chemistry induced by elevated CO_2 (Busch, Maher, Thibodeau, & McElhany, 2014; Hofmann et al., 2010; Orr et al., 2005).

While the effects of elevated CO_2 on calcifying organisms such as corals and mollusks have received considerable attention, the possible effects of elevated CO_2 on the neurophysiology and behavior of marine fish are an increasing concern (Ashur, Johnston, & Dixson, 2017). Elevated CO_2 has been linked to abnormal neuronal and behavioral responses in several species of marine fish including effects on auditory function (Simpson et al., 2011), vision (Chung, Marshall, Watson, Munday, & Nilsson, 2014; Ferrari et al., 2012), lateralization (Domenici, Allan, McCormick, & Munday, 2011), and elevated anxiety (Hamilton, Holcombe, & Tresguerres, 2014). In particular, a number of studies have implicated changes in CO_2 and pH levels on altered olfactory-mediated behaviors in marine fish from both tropical and temperate environments (Chivers et al., 2014; Cripps, Munday, & McCormick, 2011; Devine, Munday, & Jones, 2012; Dixson, Munday, & Jones, 2010; Ferrari et al., 2012; Hamilton et al., 2014; Leduc, Munday, Brown, & Ferrari, 2013; Miller, Watson, Donelson, McCormick, & Munday, 2012; Porteus et al., 2018).

The olfactory system is critical for many aspects of a fish's life including locating appropriate habitat, finding prey, avoiding predators, social and reproductive interactions with conspecifics, orientation, and navigation (Dittman & Quinn, 1996; Gerlach, Atema, Kingsford, Black, & Miller-Sims, 2007; Hara, 1992; McIntyre, Baldwin, Beauchamp, & Scholz, 2012; Quinn, 2011; Yambe et al., 2006). Fish rely on their olfactory system for survival, and any olfactory impairment may have profound effects on wild fish populations (Baldwin, Sandahl, Labenia, & Scholz, 2003; Sandahl, Baldwin, Jenkins, & Scholz, 2007). The olfactory system in most fish consists of a peripheral sensory epithelium (olfactory rosette) that connects directly to the olfactory bulb. Odorants in the environment bind to receptors on olfactory sensory neurons in the sensory epithelia, eliciting axon potentials that send a signal to the olfactory bulb. At the olfactory bulb, the signal is modulated and relayed to secondary neurons and higher brain centers, ultimately leading to behavioral responses (Hamdani & Doving, 2007). Neural signaling within this complex process, from odorant detection to behavioral outcome, is highly dependent upon tightly controlled ion gradients across neuronal membranes (Schild & Restrepo, 1998) and is highly sensitive to changes in water chemistry (Tierney et al., 2010).

Elevated CO_2-mediated interference of olfactory function could have profound effects on marine fish survival. For example, tropical reef fish exposed to CO_2 concentrations predicted to occur within the next 50–100 years demonstrated altered responses to odors that allowed fish to discriminate healthy reef habitat and that facilitated homing and dispersal (Devine et al., 2012; Munday et al., 2009). Furthermore, elevated CO_2 levels altered normal avoidance responses of fish to predator odors and chemical alarm cues (Dixson et al., 2010; Welch, Watson, Welsh, McCormick, & Munday, 2014) and interfered with prey detection abilities in reef predators (Cripps et al., 2011) and sharks, a group of fish known for their reliance on their highly sensitive olfactory system (Dixson, Jennings, Atema, & Munday, 2014). Finally, OA-related conditions interfered with the process of olfactory learning by reef fish (Ferrari et al., 2012). Several studies have extended these findings to directly demonstrate that CO_2-mediated interference of olfactory function may have direct effects on survival (Dixson et al., 2010; Ferrari et al., 2015). However, if a fish is exposed to elevated CO_2 and survives to successfully reproduce, recent research on multigenerational effects of parental exposure to elevated CO_2 has shown that offspring can exhibit enhanced resistance to the effects of elevated CO_2 (Allan, Miller, McCormick, Domenici, & Munday, 2014; Murray, Malvezzi, Gobler, & Baumann, 2014; Schunter et al., 2017; Welch & Munday, 2017; Welch et al., 2014).

Pacific salmon are a critical component of Pacific Northwest coastal ecosystems (Quinn, 2011). Anadromous (rear in saltwater but spawn in freshwater) salmon populations may be particularly impacted by ecosystem changes (Crozier et al., 2008) because they rely on both the freshwater and marine environment for different life cycle stages (Quinn, 2011). In this respect, salmon, and other anadromous fishes, may be particularly interesting species to study in the context of the sensitivity or resistance to the effects of elevated CO_2 because elevated CO_2 is likely to have different physiological effects in freshwater and saltwater. Some obligate marine fish species (e.g., benthic dwellers) have displayed a potential resistance to the effects of elevated CO_2 on neuronal function and behavior due to the seawater chemistry of their preferred habitat (Hamilton et al., 2017; Jutfelt & Hedgärde, 2015; Schmidt et al., 2017). While some initial studies have examined the effects of elevated CO_2 on salmon in freshwater (Ou et al., 2015), there are no studies to date that have investigated the neural and behavioral responses of ocean-phase, juvenile salmon to elevated CO_2 in the marine environment. In this study, we examined the potential effects of elevated CO_2 on olfactory-mediated behaviors and the potential mechanisms underlying these behavioral changes in coho salmon (*Oncorhynchus kisutch*) adapted to saltwater. Proper olfactory function is critical for all aspects of a salmon's life cycle, especially during their extraordinary homing migrations, wherein they use olfactory cues to identify their natal stream (Dittman & Quinn, 1996). Therefore, even minor impairment of olfactory function due to OA may ultimately have profound effects on salmon survival and population sustainability in the Pacific Ocean. We hypothesized that elevated CO_2, at levels predicted to occur over the next 50–100 years, would significantly alter behaviors, neuronal signaling, and gene expression in the olfactory system of coho salmon.

2 | MATERIALS AND METHODS

2.1 | Animals and housing

Coho salmon for these experiments were the offspring of anadromous adults spawned at the Washington Department of Fish and Wildlife's Issaquah Creek Hatchery, Issaquah, WA, USA. Experimental fish were transferred as embryos from the Issaquah Hatchery in January 2016 and 2017, reared in freshwater at the Northwest Fisheries Science Center until undergoing the parr–smolt transformation (1.5 year of age; 15.0 g ± 5.7 g), and then transferred to saltwater at the Northwest Fisheries Science Center's Mukilteo Marine Research Station (Mukilteo, WA, USA) on May 5, 2016, and May 24, 2017. After transfer to saltwater, fish were maintained under a natural photoperiod and fed BioVita Fry Feed (Bio-Oregon, Longview, WA). Water quality, fish health, and water delivery systems were monitored daily in fresh and salt water. All animal care and procedures were in accordance with University of Washington's Institutional Animal Care and Use Committee rules and approval, protocol # 4097-1.

2.2 | Seawater chemistry/exposures

Maintenance of seawater CO_2 concentrations followed previously described methodologies (Busch et al., 2014). Exposures consisted of three different CO_2 concentrations, including a control (ambient) nominal concentration of 700 µatm, which approximates the present-day average value of CO_2 in Puget Sound Marine Waters (Reum et al., 2015), a medium CO_2 level (nominal concentration of 1,600 µatm) predicted to periodically occur over the next 50 years, and a high CO_2 level (nominal concentration of 2,700 µatm) predicted to periodically occur over the next 100 years (Busch et al., 2014). Duplicate exposure tanks (2 foot diameter × 2 foot high, 178-L cylindrical tanks) for each treatment were maintained as a flow-through system, supplied by a unique head tank for each exposure tank (Supporting Information Figure S1). Water turnover rate was approximately once every hour. Source water for the head tanks was pumped from a depth of 60 feet from Puget Sound, degassed, and filtered prior to CO_2 manipulation. A Honeywell universal data analyzer controller and Durafet pH probe monitored and maintained the pH via CO_2 injection within each head tank. Target pH levels (as measured on a total pH scale) were 7.8 for control, 7.5 for medium, and 7.2 for high CO_2 exposure levels. To ensure proper water chemistry was maintained throughout exposures, water samples were collected from each exposure tank three times during each experiment (day 0, day 7, and day 14) for measurement of total alkalinity (TA) and dissolved inorganic carbon (DIC). Water samples were analyzed at the NOAA Pacific Marine Environmental Laboratory using standard test procedures for all analyses (Dickson, Sabine, & Christian, 2007). Water temperature, pH, and salinity were checked daily throughout the experiment. Water temperature in the exposure tanks remained at 12°C for the duration of the exposures. The ambient water temperature of the source water from Puget Sound averaged 11–12°C at the time of the exposures.

The start of the exposures was staggered over a month for logistical reasons to allow for behavioral and neurophysiological testing following each of the 14-day exposures. To begin the experiment, fish were transferred from their rearing tanks to their exposure tanks (n = 4 fish/tank) and acclimated for 24 hr in 700 µatm CO_2 control water. After acclimation, fish were exposed to experimental CO_2 levels for 14 days and tested for behavioral responses (n = 48 fish/treatment). A subset of these fish (n = 24) was used for electro-olfactogram (EOG)/electroencephalogram (EEG) neurophysiological and RNA-Seq (n = 8 fish per treatment) analysis.

2.3 | Odorant preparation

To investigate the effects of elevated CO_2 on olfactory-mediated salmon behavior, we used salmon skin extract, a prototypical predation odor that elicits a reliable and measurable avoidance response (Brown & Smith, 1997; Sandahl et al., 2007; Williams et al., 2016). Salmon skin extract was prepared as described previously with minor modifications (Williams et al., 2016). Briefly, skin tissue collected from coho salmon was homogenized in artificial seawater (Instant Ocean, Blacksburg, VA), filtered, and centrifuged to remove particulates. Protein content of the skin extract was determined using the Bradford assay (Bio-Rad, Hercules, CA), and stock concentrations were normalized to 2.4 mg/ml protein concentration in artificial seawater and stored at −80°C until needed. Working stocks of L-alanine and L-serine (Sigma-Aldrich, St. Louis, MO) for use in the EOG and EEG analysis were prepared on the day of use in artificial seawater. Working concentrations of the odorants were as follows: 10 µg/L skin extract (behavioral analysis), 2.4 mg/L skin extract (EOG and EEG analysis), and 10^{-2} M L-alanine and L-serine (EOG and EEG analysis). A higher concentration of the skin extract was used for electrophysiological analysis than for behavioral analysis due to the fact that measurable neuronal signal intensity is reduced in ocean-phase salmon due to the effect of high saltwater conductivities on electrophysiological recording (Sommers, Mudrock, Labenia, & Baldwin, 2016).

2.4 | Behavioral analysis

Following the 14-day exposure, behavioral analysis was conducted as previously described (Williams & Gallagher, 2013) using two-choice mazes surrounded by a black curtain and illuminated from below with infrared light to minimize stress. Each maze (100 × 40 × 25 cm) consisted of two arms (50 cm long and 20 cm wide) that terminated at a holding chamber (40 × 40 cm). A perforated gate separated the arms from the holding chamber. A dye test confirmed that no mixing between the arms occurred. The maze received water (flow rate of 3 L/min) from the same head tanks used to generate the exposure water, thus ensuring that salmon were tested in the same water chemistry they experienced during exposures. Individual coho salmon from each CO_2 treatment (n = 48) were allowed to acclimate for 10 min in the holding chamber, and then behaviors were recorded for 10 min prior to odorant addition. After the 10-min pre-odor period, skin extract (10 μg/L) was delivered into one arm (randomized each trial) using a peristaltic pump and behaviors were recorded for an additional 10 min. An overhead infrared light-sensitive video camera (EverFocus® EQ900, Duarte, CA) provided video recordings of the behavioral responses. Proportion of time spent on odor side of the maze was analyzed using EthoVision XT 10 behavioral software (Noldus, Leesburg, VA). Following each behavioral trial, each maze was flushed with exposure water (without odorants) for 20 min.

Differences in response to CO_2 exposure were evaluated with a beta regression model that included CO_2 exposure and pre-odor period movement as covariates using the “betareg” R package (Zeileis, Cribari-Neto, Gruen, & Kosmidis, 2016). We selected a final model based on Akaike information criterion (AIC) comparison of models with CO_2 exposure and pre-odor fraction alone and as interactions. Bootstrap 95% prediction intervals on the beta regression-modeled treatment means were calculated based on 5,000 resamples using the “boot” R package (Canty & Ripley, 2017).

2.5 | Neurophysiological analysis

EOG and EEG recordings were performed the day after behavioral testing using methods previously described with minor modifications (Baldwin & Scholz, 2005). Fish were anesthetized with 50 mg/L tricaine methanesulfonate (MS-222; Western Chemicals Inc., WA) and injected intramuscularly with gallamine triethiodide (0.3 mg/kg body weight; Sigma-Aldrich, MO). A small tube inserted in the fish's mouth delivered artificial seawater (10°C) containing MS-222 (50 mg/L) to their gills. A gravity-fed glass capillary tube perfused the rosette with artificial seawater at a rate of 2 ml/min. Fish were acclimated for 5 min before the start of electrophysiological recordings. The recording microelectrode was placed at the midline of the rosette at the base of the posterior lamella for EOGs, and against the surface of the right mediodorsal cluster of the olfactory bulb for EEGs (Figure 1). Because there is spatial variation in responsiveness to different odorants in the olfactory bulb, before the start of the experimental recording, the location of the maximal EEG responses to the odorants was determined for each individual by positioning the microelectrode at different points across the olfactory bulb. The two regions that gave the most consistent signal were used as the recording sites for the entire experiment. A reference electrode was placed on the midline of the posterior-dorsal surface of the head, and a ground electrode was placed in the caudal muscle during recordings. Odorant-induced neural signals were acquired and filtered with an AC/DC amplifier (A-M Systems Inc.® Model 3000, Sequim, WA). Seawater/odors were delivered to the rosette using gravity-assisted flow, regulated by electronic valves and into a single manifold output through a thermoelectric chiller (temp 10°C). Fish received three pulses of each odorant (skin extract, L-serine, and L-alanine) with 2-min intervals between pulses. Based on an averaged and integrated recorded response curve, the amplitude of each EOG response was measured in microvolts (μV) as the maximum evoked peak minus the prestimulus basal activity level. Based on an averaged and integrated recorded response curve, the maximum odorant-evoked response for the EEG was the peak signal amplitude minus the prestimulus basal activity level. Signal duration for the EEG responses was calculated from the moment an odorant-induced signal was detected until the moment the signal returned to basal (pre-odor) levels. Triplicate responses to each odorant were averaged to produce a single response value for each odorant. EEGs were not performed on the medium CO_2 exposure group due to the logistics of the procedure, that is, length of time needed for each fish on the rig and number of fish that could be

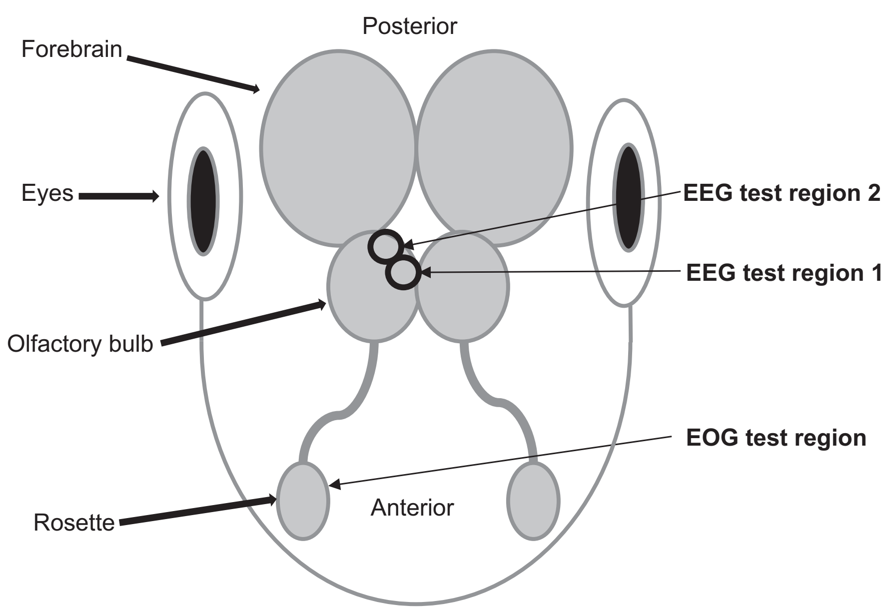

FIGURE 1 Diagram of salmon olfactory system and test sites used for EOG and EEG analysis of odorant-induced signals following exposures to varying levels of CO_2

recorded each day. Example EOG and EEG traces are located in Supporting Information Figure S2.

For the EOG analysis, a one-way ANOVA was used to test for significant differences between control and exposure groups, followed by a Dunn's multiple comparison test. For the EEG analysis, a *t* test was used to test for differences between control and high exposure groups. All analyses were done using GraphPad Prism 5 software. Differences were considered significant at $p < 0.05$.

2.6 | RNA-Seq analysis

Olfactory rosette and bulb tissues were collected from $n = 5$ individuals from the control, medium, and high CO_2 exposure groups following EOG analysis. Tissues were immediately stored in RNA*later*® before being frozen at −80°C (Thermo Fisher Scientific, Waltham, MA).

2.6.1 | RNA QC

RNA purity was assessed measuring $OD_{260/280}$ and $OD_{260/230}$ ratios with a NanoDrop ND-1000 Spectrophotometer (Thermo Fisher Scientific, Waltham, MA). RNA integrity was determined using the Agilent RNA 6000 Nano Kit with an Agilent 2100 Bioanalyzer (Agilent Technologies, Santa Clara, CA). All RNA samples were of appropriate size, quantity, and quality ($OD_{260/280}$ and $OD_{260/230}$ ratios of 1.8–2.1) and were used for RNA-Seq analysis ($n = 5$ for each exposure group/tissue).

2.6.2 | Sample processing and sequencing

cDNA libraries were prepared from 1 μg of total RNA using the TruSeq Stranded mRNA kit (Illumina, San Diego, CA) and the Sciclone NGSx Workstation (Perkin Elmer, Waltham, MA). Prior to cDNA library construction, ribosomal RNA was removed by means of poly-A enrichment. Each library was uniquely barcoded and subsequently amplified using a total of 13 cycles of PCR. Library concentrations were quantified using Qubit fluorometric quantitation (Life Technologies, Carlsbad, CA). Average fragment size and overall quality were evaluated with the DNA 1000 assay on an Agilent 2100 Bioanalyzer. Each library was sequenced with paired-end 100 bp reads to a minimum depth of 30 million reads on an Illumina HiSeq 4000. The average number of reads was 44.99 ± 6.47 million (mean ± *SE*) from olfactory rosette samples and 46.11 ± 4.41 million from olfactory bulb samples (Supporting Information Table S1).

We aligned the reads for each sample to the Atlantic salmon (*Salmo salar*) transcriptome (NCBI ICSASG_v2 build, downloaded 9/29/2017) using the Salmon aligner, accounting for GC, and sequencing bias (Patro, Duggal, & Kingsford, 2015; Patro, Duggal, Love, Irizarry, & Kingsford, 2017). Although there is a completed genome and transcriptome for coho salmon available (https://www.ncbi.nlm.nih.gov/genome/13127?genome_assembly_xml:id=309046), the functional Gene Ontology (GO) annotation for this species is not well developed relative to that for Atlantic salmon. Therefore, we chose to align the RNA-Seq data against the Atlantic salmon transcriptome, because the alignment results were similar between the two species (*S. salar*—60% of reads mapped; *O. kisutch*—73% of reads mapped). The aligned counts were imported into R (r-project.org) using the Bioconductor tximport package and then summarized at the gene level (Soneson, Love, & Robinson, 2015). We excluded any gene that was not expressed in at least four samples (i.e., any gene that had fewer than ten counts in less than four samples), to remove any data that were likely to be primarily noise. We then fit a generalized linear model with a negative binomial link function using the Bioconductor edgeR package and made comparisons between groups using likelihood ratio tests. We selected differentially expressed genes based on a false discovery rate (FDR) of 0.1 (i.e., we expect that at most 10% of the selected genes are false positives). To identify biological function that may have been perturbed due to changes in CO_2 exposure, we computed Fisher's exact tests based on GO terms, selecting those terms with a *p*-value <0.05.

3 | RESULTS

3.1 | Exposure water chemistry

Measured pH values for each exposure were consistent across the experiments and varied little within each exposure over the course of each experiment (standard deviation ≤0.03; Table 1). pH values from the Durafet sensors were consistent with discrete spectrophotometric measurements of pH from each exposure tank. Alkalinity in all exposure conditions, within and across experiments, was similar. Mean temperature in the exposure tanks ranged from 11.9–12.8°C, with small variation in each treatment over each experiment (standard deviation ≤0.2°C).

3.2 | Effects of elevated CO_2 on salmon behaviors

Using AIC analysis, the beta regression model containing only the interaction term between the CO_2 treatment and the pre-odor behavior covariate was selected ($p < 0.001$; pseudo-$R^2 = 0.24$) (Figure 2, Supporting Information Figure S3). This model indicated that fish exposed to control CO_2 levels avoided the side of the maze scented with skin extract (Figure 2, 26.7% ± 3.6% of time in odor (mean ± *SE*)), while fish that experienced the medium (Figure 2, 35.0% ± 4.5% of time in odor) and high (Figure 2, 52.3% ± 5.5% of time in odor) CO_2 treatments did not show a significant attraction or avoidance to the alarm odor. Individual fish from the medium and high CO_2 treatments tended to move around the maze less during the 20-min trials compared to controls. Conversely, fish in the control CO_2 treatment did not show a reduced tendency to explore the maze during the trial.

3.3 | Effects of elevated CO_2 on olfactory neurophysiological function

Neuronal responses in the olfactory epithelium to skin extract, L-alanine, and L-serine, as measured by EOG, were not affected by prior

TABLE 1 Water chemistry parameters

Exposure	Dates	Head tank	Salinity (psu)	Temperature (°C)	System pH: Durafet setting	System pH: Spec	(µatm)pCO_2*	Ω_a*	TA (µmol/kg)	DIC (µmol/kg)
1	8/18–9/23/16	A	29.9 ± 0.2	12.9 ± 0.4	7.2	7.2 ± 0.01	2,848.6 ± 143.9	0.31 ± 0.02	2,055.8 ± 11.4	2,127.4 ± 6.9
		B	29.9 ± 0.2	12.7 ± 0.2	7.8	7.8 ± 0.03	807.2 ± 16.2	0.98 ± 0.00	2,058.3 ± 12.4	2,001.4 ± 15.7
		A + B	29.9 ± 0.2	12.9 ± 0.3	7.5	7.4 ± 0.01	1,739.8 ± 28.3	0.49 ± 0.01	2,057.4 ± 12.1	2,083.1 ± 16.2
		C	29.9 ± 0.2	12.8 ± 0.3	7.2	7.3 ± 0.09	2,728.4 ± 15.6	0.32 ± 0.00	2,058.0 ± 11.9	2,137.9 ± 20.1
		D	29.9 ± 0.2	12.8 ± 0.2	7.8	7.8 ± 0.03	748.0 ± 72.0	1.05 ± 0.07	2,057.7 ± 11.9	1,994.5 ± 23.6
		C + D	29.9 ± 0.2	12.9 ± 0.2	7.5	7.4 ± 0.02	1,679.9 ± 83.1	0.51 ± 0.02	2,057.1 ± 11.8	2,078.7 ± 26.4
2	7/12–8/29/17	A	29.4 ± 0.3	11.9 ± 0.4	7.8	7.8 ± 0.03	630.1 ± 38.2	1.10 ± 0.03	2,017.5 ± 34.2	1,932.3 ± 37.3
		B	29.4 ± 0.2	12.0 ± 0.4	7.2	7.2 ± 0.08	2,698.4 ± 47.2	0.30 ± 0.01	2,016.7 ± 36.9	2,089.6 ± 29.8
		A + B	29.4 ± 0.2	12.0 ± 0.4	7.5	7.5 ± 0.05	1,424.3 ± 27.4	0.54 ± 0.00	2,019.0 ± 34.5	2,014.5 ± 34.3
		C	29.4 ± 0.2	11.7 ± 0.3	7.8	7.8 ± 0.03	636.9 ± 70.3	1.10 ± 0.08	2,005.2 ± 48.8	1,931.3 ± 40.3
		D	29.4 ± 0.2	11.8 ± 0.2	7.2	7.2 ± 0.00	2,587.7 ± 75.5	0.31 ± 0.00	2,015.4 ± 32.5	2,087.1 ± 29.0
		C + D	29.4 ± 0.2	11.9 ± 0.2	7.5	7.4 ± 0.01	1,565.9 ± 65.9	0.50 ± 0.00	2,018.4 ± 35.2	2,032.0 ± 39.3

Notes. DIC: dissolved inorganic carbon; Spec.: spectrophotometer; TA: total alkalinity.
*Ω_a and pCO_2 values were calculated via the "seacarb" package in R studio using data from DIC analysis and pH measured via spectrophotometry.

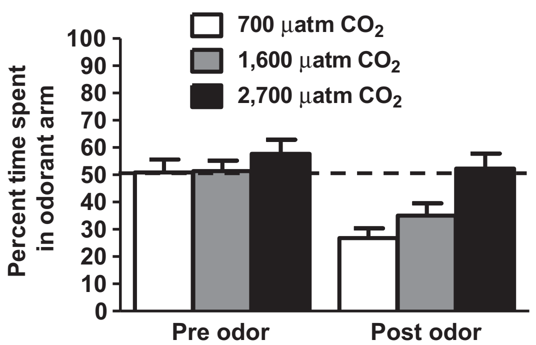

FIGURE 2 Behavioral responses to skin extract (alarm odor) odorant following CO_2 exposures. 700 µatm is the control CO_2 exposure level, 1,600 µatm is the medium CO_2 exposure level, and 2,700 µatm is the high CO_2 exposure level. Percent time juvenile coho salmon spent in the side of a two-choice maze receiving skin extract odorant before (pre-odor) and after (post-odor) introduction of the odorant. Dashed line indicates 50% level. All data represent mean ± *SEM* of n = 48 individuals

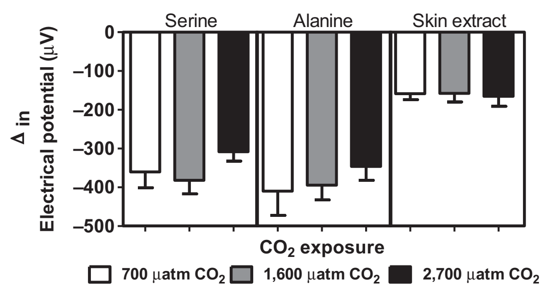

FIGURE 3 Electro-olfactogram (EOG) recorded responses of odorant-induced signaling within the olfactory rosettes of coho salmon exposed to three levels of CO_2. 700 µatm is the control CO_2 exposure level, 1,600 µatm is the medium CO_2 exposure level, and 2,700 µatm is the high CO_2 exposure level. Bars indicate the magnitude of the odorant-induced response relative to background water recorded from the olfactory epithelium. All data represent a mean ± *SEM* of n = 12 individuals

exposure to elevated CO_2 (Figure 3). However, EEG recordings revealed significant differences in peak odor-induced signaling in the right mediodorsal cluster (Figure 1, test region 1) of the olfactory bulbs of control and high CO_2 exposure coho salmon (p = 0.0068 and F = 4.754, Figure 4). High CO_2 exposure increased the mean peak signal amplitude of responses in this bulb region to skin extract (49.6% ± 39.1% increase (mean ± *SD*) and L-alanine (59.1% ± 78.7% increase) relative to responses in control fish (Figure 4a). Furthermore, the duration of EEG responses to skin extract and L-alanine tended to be longer in coho salmon exposed to high CO_2 levels compared to control fish (20.1 ± 4.0 s vs. 16.2 ± 6.5 s and 18.5 ± 4.4 s vs. 14.1 ± 5.0 s, respectively), but this difference was not significant (Figure 4b). Peak odor signal (skin extract: 0.024 ± 0.014 vs. 0.028 ± 0.015; L-alanine: 0.017 ± 0.008 vs. 0.021 ± 0.013) and duration (skin extract: 15.7 ± 4.8 s vs. 19.59 ± 5.9 s; L-alanine: 14.1 ± 4.4 s vs. 16.9 ± 9.5 s) in the right mediodorsal cluster test region 2 did not significantly differ between high CO_2 and control fish for either test odor (Figure 5) suggesting that CO_2 effects are specific to discrete bulbar regions and neurons.

3.4 | Effects of elevated CO_2 on gene expression in the salmon olfactory system

There were significant changes in gene expression in the olfactory system of coho salmon exposed to elevated CO_2. In particular, we observed considerable change in gene expression within the olfactory bulbs following exposure to the high CO_2 level (over 800 differentially expressed genes) relative to controls (Figure 6, Supporting

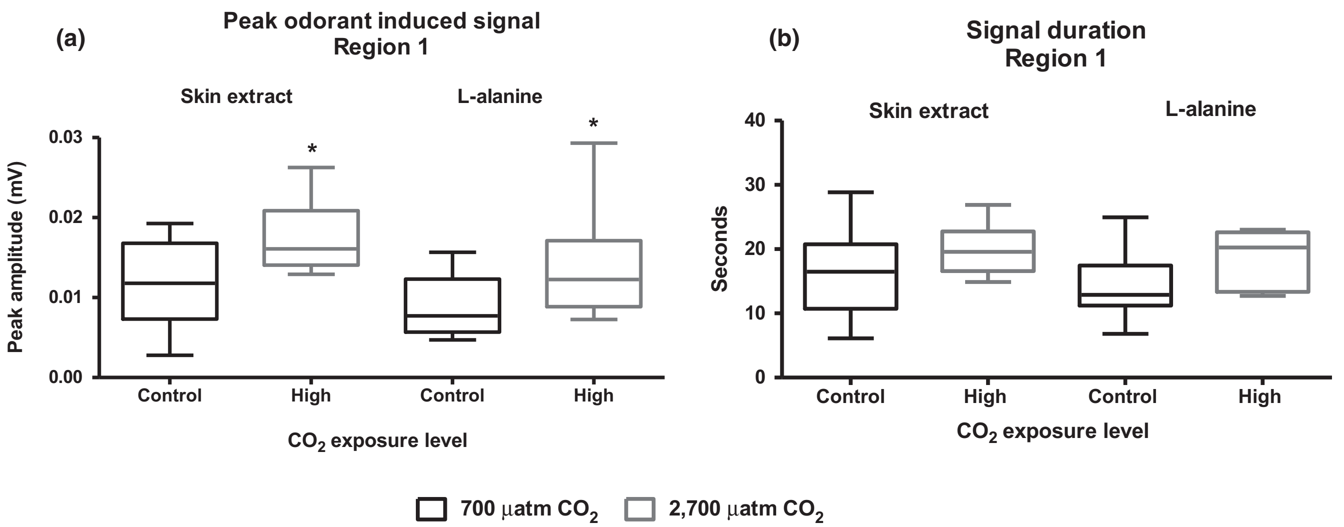

FIGURE 4 Electroencephalogram (EEG) recording data of odorant-induced signaling in test region one of the olfactory bulb from salmon exposed to two levels of CO_2. Data represented as a box and whisker plot showing median peak amplitude with whiskers representing the 5th and 95th percentile. 700 µatm is the control CO_2 exposure level, and 2,700 µatm is the high CO_2 exposure level. (a) Peak odorant-induced signaling by L-alanine and skin extract (alarm odor). (b) Duration of odorant-induced signaling by L-alanine and skin extract (alarm odor). Asterisks indicate significant differences between control and high exposure groups ($p \leq 0.05$)

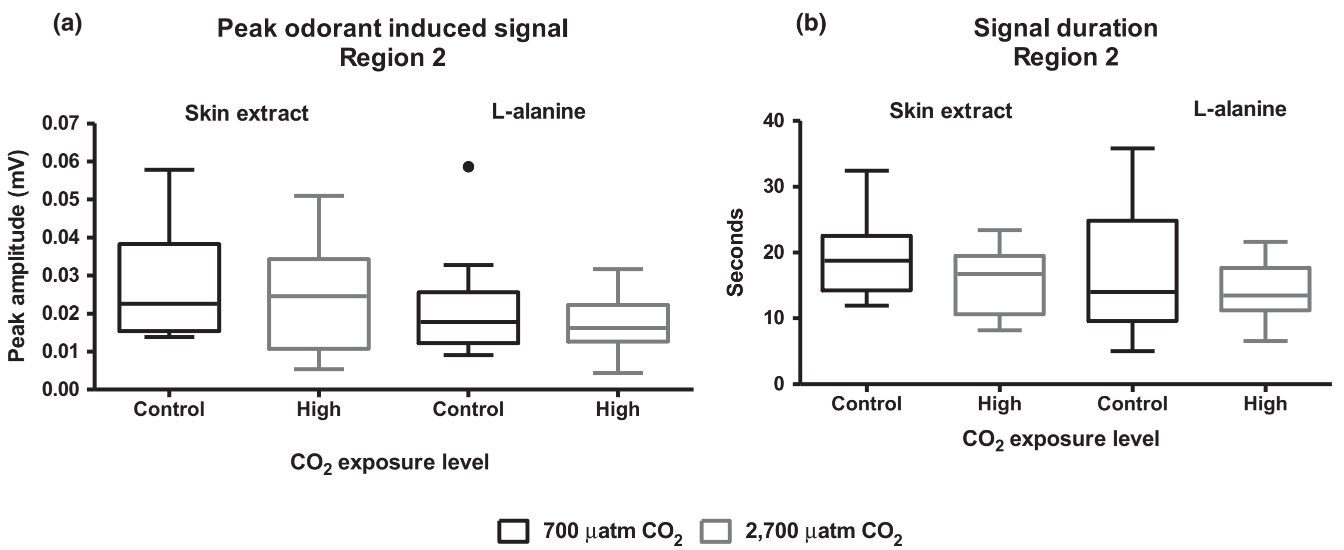

FIGURE 5 Electroencephalogram (EEG) recording data of odorant-induced signaling in test region two of the olfactory bulb from salmon exposed to two levels of CO_2. Data represented as a box and whisker plot showing median peak amplitude with whiskers representing the 5th and 95th percentile. 700 µatm is the control CO_2 exposure level, and 2,700 µatm is the high CO_2 exposure level. (a) Peak odorant-induced signaling by L-alanine and skin extract (alarm odor). (b) Duration of odorant-induced signaling by L-alanine and skin extract (alarm odor). The black dot indicates an outlier data point

Information Figure S4). A large number of these genes were involved in neural signaling/signal transduction, ion transport, and energy homeostasis (Supporting Information Figure S5). There were also significant differences in gene expression in the olfactory bulbs of medium CO_2 exposure fish relative to controls (61 differentially expressed genes) although these genes were predominantly associated with cytoskeletal function and not relevant to neural signaling. In contrast, there were relatively fewer changes in gene expression in the olfactory rosettes between control and medium (50 differentially expressed genes) or high exposure groups (20 differentially expressed genes) (Figure 6). None of the genes were significantly associated with olfactory neural signaling pathways.

We did not observe significant changes in gene expression of the GABA type A receptor, which has been hypothesized to play a role in CO_2-linked disruption of neuronal and behavioral signaling in marine fish (Schunter et al., 2017). Interestingly, however, the

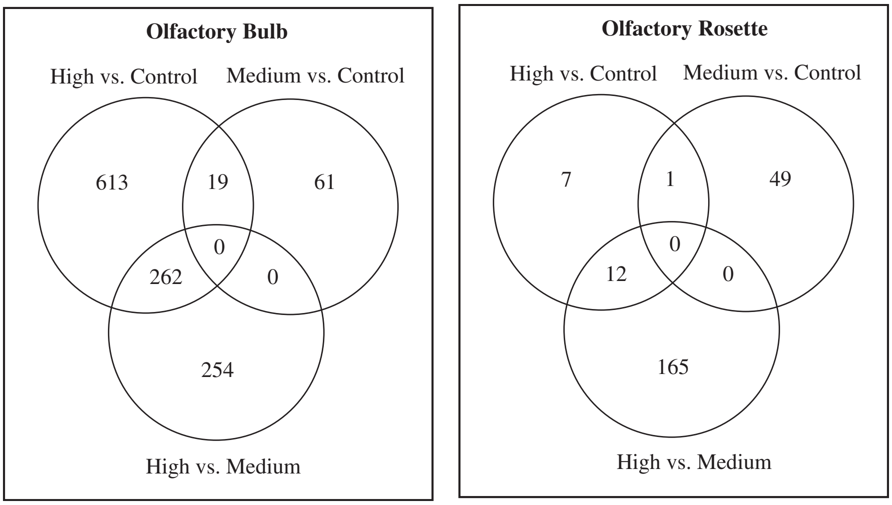

FIGURE 6 Venn diagram of RNA-Seq analysis of olfactory bulb and olfactory rosette gene expression in coho salmon exposed to three levels of CO_2. Venn diagrams show the number of significantly changed genes between each exposure group comparison. Numbers of genes listed in overlapping portion of the circles indicate number of significantly changed genes shared between each exposure comparison. Control = 700 µatm CO_2 exposure, Medium = 1,600 µatm CO_2 exposure, High = 2,700 µatm CO_2 exposure

expression of the GABA type B receptor subunit 2 (*gaba*$_{b2}$) was significantly elevated in the olfactory bulb following the high CO_2 exposure (Table 2, FDR <0.1). We also observed CO_2-induced changes in many other genes associated with GABA signaling, including increases in *hcn2*, *snap25*, and *kcc1*, which are associated with GABA-linked ion transport and synaptic activity, and significant decreases in expression of *slc6a13* and *aldh9a1*, two genes involved in GABA uptake and synthesis, respectively (Table 2). In addition to GABA signaling genes, other genes linked to neurotransmitter function (including glutamate and serotonin signaling), ion transport (*slc26a6*), G protein receptor function, neural differentiation, and melatonin production (*asmt* and *aanat*) displayed altered gene expression after elevated CO_2 exposure (Table 2). Genes important in neural energy production were also significantly altered following elevated CO_2 exposures, including a downregulation of the gene *slc22a16* (l-carnitine transport), and an upregulation of *slc2a6*, involved in glucose transport.

Interestingly, we also observed changes in gene expression of many genes associated with the photoreception system in the olfactory bulb of high exposure fish (Supporting Information Figure S5). Some of these genes included rhodopsin, parapinopsin, and various voltage-dependent ion channel genes. The reason for the inclusion of photoreception-related genes within the expression profile of the olfactory bulbs remains unclear; however, it is likely that genes involved in the olfactory and photoreception systems may share similar signal transduction function in both tissues. This hypothesis is supported by at least two other studies that reported the expression of olfactory genes in the visual system (Jovancevic et al., 2017; Pronin et al., 2014).

4 | DISCUSSION

Collectively, our results indicate that elevated CO_2 concentrations altered neural signaling pathways within the olfactory bulb and impaired olfactory-mediated behavioral responses of ocean-phase coho salmon. Given the primary need for a functional olfactory system for salmon living in the ocean to find prey, avoid predators, and ultimately find their natal stream during homing migrations, these results suggest that future predicted CO_2 concentrations in the ocean may have a profound effect on Pacific salmon and their ecosystems. Our behavioral results indicated that ocean-phase coho salmon were sensitive to acute exposures to elevated CO_2 concentrations that have been predicted to occur within the next 50–100 years. The strong avoidance behavior elicited by skin extract in the control group was decreased or eliminated in coho salmon exposed to either the medium (1,600 µatm) or high (2,700 µatm) CO_2 treatments. These results indicate that anadromous salmon may be just as sensitive to the effects of elevated CO_2 as obligate marine species that have shown behavioral impairments at similar [CO_2] levels (Chung et al., 2014; Devine et al., 2012; Hamilton et al., 2017, 2014; Munday et al., 2009; Porteus et al., 2018). While future oceanic CO_2 concentrations may not reach such high steady-state levels, exposures to transient CO_2 concentrations at these levels may already occur in some regions and will likely be more common. Juvenile coho salmon spend up to a year rearing in freshwater (Quinn, 2011) before migrating downstream to the ocean, undergoing the physiological transformation of smoltification that prepares them for life in seawater, including changes in osmoregulation and ion balance regulation (Maryoung et al., 2015; McCormick, 2012; Quinn, 2011). Our results suggest that despite having an adaptable olfactory system that functions in both marine and freshwater environments with very different pHs and water chemistries, the relative sensitivity of these anadromous fish to elevated CO_2 in the ocean is similar to other marine fish.

Tightly controlled ion balances play a key role in proper olfactory neuronal signaling, and it has been hypothesized that elevated CO_2-induced changes in transmembrane ionic gradients impair neuronal signaling and, ultimately, olfactory-mediated behaviors (Heuer, Welch, Rummer, Munday, & Grosell, 2016; Tresguerres & Hamilton, 2017). This is consistent with our analysis of neuronal signaling in the olfactory epithelium and the olfactory bulb. Elevated CO_2 did not alter neuronal responses to odorants in the olfactory epithelium suggesting that odorant-induced signaling within olfactory sensory neurons was not impacted following a shift in CO_2 concentration

TABLE 2 Significantly changed genes of relevance to neural function and signaling within the olfactory bulbs from coho exposed to high CO_2 vs. control CO_2

ENTREZID	Accession number	Gene name	Putative name	log_2 fold change	FDR
106562041	LOC106562041	Guanine nucleotide-binding protein subunit alpha-14-like	*gna14*	3.307	2.81197E−10
106574723	LOC106574723	Gamma-aminobutyric acid type B receptor subunit 2-like	*gabbr2*	2.645	9.1231E−06
106575665	LOC106575665	Cyclic nucleotide-gated channel cone photoreceptor subunit alpha-like	*cnga3*	2.660	0.000141938
106611384	LOC106611384	Synaptosomal-associated protein 25-B-like	*snap25*	1.883	0.000460991
106588157	LOC106588157	Potassium/sodium hyperpolarization-activated cyclic nucleotide-gated channel 2-like	*hcn*	3.968	0.00053587
106603743	LOC106603743	Glutamate receptor ionotropic, kainate 4-like	*grik4*	1.012	0.001089553
106569207	LOC106569207	Solute carrier family 12 member 7-like	*kcc1*	1.368	0.001601933
106602119	LOC106602119	Neuronal acetylcholine receptor subunit alpha-3-like	*chrna3*	2.201	0.001653337
106592065	LOC106592065	Neuronal acetylcholine receptor subunit alpha-3	*chrna3*	2.227	0.001665897
106573978	LOC106573978	Excitatory amino acid transporter 5-like	*slc1a7*	1.792	0.001803254
106577203	LOC106577203	Potassium voltage-gated channel subfamily H member 1-like	*kcnh7*	2.466	0.001981873
106584365	LOC106584365	Diencephalon/mesencephalon homeobox protein 1-like	*dmbx1*	4.100	0.002118515
106583073	LOC106583073	Guanine nucleotide-binding protein G(t) subunit alpha-2-like	*gnai2b*	2.588	0.002170767
106573780	LOC106573780	Solute carrier organic anion transporter family member 3A1-like	*slc21a11*	0.860	0.003012925
106572933	LOC106572933	Voltage-dependent L-type calcium channel subunit alpha-1D-like	*cacna1d*	2.282	0.003645407
106567981	LOC106567981	Neuropeptide Y receptor type 1-like	*npy1r*	−0.649	0.004204007
106605869	LOC106605869	Gamma-aminobutyric acid type B receptor subunit 2-like	*gabbr2*	1.773	0.004302948
106613596	LOC106613596	Excitatory amino acid transporter 5-like	*slc1a7*	3.902	0.004457749
106571997	LOC106571997	Guanine nucleotide-binding protein G(I)/G(S)/G(T) subunit beta-1	*gbb1*	0.574	0.004760336
106578273	LOC106578273	Vesicular glutamate transporter 1-like	*vglut1*	1.625	0.005044121
106607367	LOC106607367	Serotonin *N*-acetyltransferase-like	*aanat*	4.020	0.005443605
106600164	LOC106600164	Aldehyde dehydrogenase family 9 member A1-like	*aldh9a1*	−5.891	0.005486887
106573635	LOC106573635	Large neutral amino acids transporter small subunit 1-like	*slc7a5*	1.072	0.008210081
106572937	LOC106572937	Voltage-dependent L-type calcium channel subunit alpha-1F-like	*cacna1f*	1.879	0.008455018
106612651	LOC106612651	Sodium-dependent serotonin transporter-like	*slc6a4*	1.050	0.009377377
106587671	LOC106587671	Guanine nucleotide-binding protein subunit beta-5-like	*gnb5*	2.359	0.009479934
106561149	LOC106561149	Solute carrier organic anion transporter family member 3A1-like	*slc21a11*	1.019	0.011541751
106613200	LOC106613200	Short transient receptor potential channel 2-like	*trpc2*	−1.432	0.011879951
106572934	LOC106572934	Voltage-dependent L-type calcium channel subunit alpha-1D-like	*cacna1d*	1.807	0.01216225
106562494	LOC106562494	Guanine nucleotide-binding protein subunit beta-5-like	*gnb5*	1.104	0.012539596
106568477	cplx4	Complexin 4	*cplx4*	4.491	0.012892164
106611148	LOC106611148	Neurexin-1a	*nrxn1*	−0.464	0.015068892
106592915	LOC106592915	Regulator of G protein signaling 9-like	*rgs9*	3.017	0.015068892
106585038	LOC106585038	Phosphatidylinositol 4-phosphate 5-kinase type-1 beta-like	*pip5k1b*	−0.538	0.015068892
106560428	LOC106560428	Excitatory amino acid transporter 5-like	*slc1a7*	3.492	0.01547044
106612376	LOC106612376	Protein phosphatase 1A-like	*pp1*	2.488	0.017048588
106581568	LOC106581568	Guanylyl cyclase-activating protein 1-like	*guca1a*	3.316	0.018566427
106587958	LOC106587958	Sodium/potassium/calcium exchanger 1-like	*slc24a1*	2.005	0.019726988
106605751	LOC106605751	Neuronal pentraxin-1-like	*nptx1*	2.216	0.021659612
106561698	LOC106561698	Solute carrier organic anion transporter family member 1C1-like	*slco1c1*	3.137	0.022324012
106580796	slc6a4	Solute carrier family 6 member 4	*slc6a4*	2.050	0.022324012
106572384	LOC106572384	Sodium-coupled neutral amino acid transporter 3-like	*slc38a3*	2.164	0.023464354
106574495	LOC106574495	Guanine nucleotide-binding protein subunit alpha-11-like	*gna11*	−0.285	0.025017626
106579173	LOC106579173	Synaptotagmin-2-like	*syt2*	4.003	0.02540081

(Continues)

TABLE 2 (Continued)

ENTREZID	Accession number	Gene name	Putative name	$\log_2$ fold change	FDR
106605091	LOC106605091	Guanine nucleotide-binding protein G(I)/G(S)/G(T) subunit beta-3-like	*gnb3*	2.403	0.026220179
106583542	LOC106583542	Sodium- and chloride-dependent GABA transporter 2-like	*slc6a13*	0.972	0.028452986
106603834	LOC106603834	Solute carrier family 22 member 5-like	*slc22a5*	−1.252	0.029247296
106587942	LOC106587942	Sodium/potassium/calcium exchanger 1-like	*slc24a1*	2.012	0.030142477
106561912	LOC106561912	Cyclic nucleotide-gated cation channel beta-1-like	*cngb1*	3.621	0.032324991
106607984	LOC106607984	Solute carrier family 22 member 16-like	*slc22a16*	1.073	0.03395494
106561031	gpr37	G protein-coupled receptor 37	*gpr37*	1.019	0.035891712
106564793	LOC106564793	Sodium/calcium exchanger 1-like	*slc8a1*	1.535	0.037274497
106597363	LOC106597363	Guanylyl cyclase-activating protein 2-like	*gcap2*	3.478	0.037274497
106566781	LOC106566781	Solute carrier family 26 member 6-like	*slc26a6*	1.458	0.042405183
106594011	LOC106594011	Sodium/potassium/calcium exchanger 1-like	*slc24a1*	2.008	0.045357056
106577267	LOC106577267	Neuronal pentraxin-1-like	*np1*	1.727	0.047487725
106581084	LOC106581084	G protein-activated inward rectifier potassium channel 3-like	*girk3*	3.466	0.048892792
106561886	kcnk5	Potassium two-pore domain channel subfamily K member 5	*kcnk5*	1.098	0.051870554
106591467	LOC106591467	Neuronal pentraxin receptor-like	*nptxr*	−0.435	0.054754969
106570824	LOC106570824	Neuroligin-3-like	*nlgn3*	−0.609	0.068821378
106561537	slc27a4	Solute carrier family 27 member 4	*slc27a4*	−0.341	0.06932593
106610602	slc4a1ap	Solute carrier family 4 member 1 adaptor protein	*slc4a1ap*	−0.254	0.070027446
106572936	LOC106572936	Voltage-dependent L-type calcium channel subunit alpha-1S-like	*cacna1s*	1.622	0.073257288
106600499	LOC106600499	Excitatory amino acid transporter 5-like	*slc1a7*	3.387	0.075511344
106564801	LOC106564801	Potassium voltage-gated channel subfamily H member 1-like	*kcnh1*	1.124	0.076952544
106586510	asmt	Acetylserotonin O-methyltransferase	*asmt*	4.053	0.078732281
106573300	LOC106573300	Guanylyl cyclase inhibitory protein-like	—	4.062	0.079046904
106588065	LOC106588065	Synaptic vesicle glycoprotein 2B-like	*sv2b*	3.356	0.079105596
106585781	slc2a6	Solute carrier family 2 member 6	*slc2a6*	−1.210	0.08829066
106584763	LOC106584763	Potassium voltage-gated channel subfamily C member 1-like	*kcnc1*	−0.601	0.097240875

Notes. Selected based on a FDR <0.1.
FDR: false discovery rate.

that was sufficient to cause behavioral impairments. These results differ from those recently reported for European sea bass (Porteus et al., 2018). The robustness of the EOG responses to altered CO_2 levels may reflect the ability of olfactory sensory neurons to modulate ionic balances while in direct contact with the ambient water because they must be able to detect odorants in the presence of shifting ion concentrations and water chemistries. In contrast, neurons in the olfactory bulb have evolved to function in the tightly controlled fluid chemistry of the central nervous system and may be more sensitive to potential changes in extracellular fluid chemistry (Abbott, Patabendige, Dolman, Yusof, & Begley, 2010; Somjen, 2002). Our EEG recordings support this hypothesis, as elevated CO_2 exposures increased the amplitude, and tended to increase the duration of odorant-induced responses within specific regions of the olfactory bulb. This CO_2-induced increase in excitatory signaling is consistent with the hypothesis that disruption of neuronal signaling in marine fish is associated with disruption of inhibitory GABA signaling (Nilsson et al., 2012; Tresguerres & Hamilton, 2017). Specific odorant-generated signals in the olfactory bulb guide odorant perception and downstream behaviors. Alteration of this odorant specific signal, via dysregulation of the GABA signaling pathway, could lead fish to perceive odorants in an inappropriate way and thus lead to altered behavioral responses.

It has been hypothesized that the main mechanism of behavioral disruption by elevated CO_2 exposure is via alteration of GABA signaling in the central nervous system, driven by a reversal of the Cl^-/HCO_3^+ membrane gradient and a linked disruption of the normal inhibitory action of the $GABA_A$ receptor (Nilsson et al., 2012). The reversal of the Cl^-/HCO_3^+ neuronal membrane gradient results in a reversal of the intended GABA signaling. Therefore, GABA receptor activation results in hyperpolarization of the neuron rather than depolarization. This could potentially lead to inappropriate or overactivation of neurons. CO_2-induced increases in the amplitude of neuronal responses in the mediodorsal olfactory bulb in response to odorants are consistent with this hypothesis. Inhibitory GABAergic neurons in the olfactory bulb play a critical role in synchronization and regulation of neuronal signals required for appropriate odor discrimination (Lizbinski & Dacks, 2017; Tabor, Yaksi, & Friedrich, 2008). The lack of observed effects of CO_2 in the olfactory epithelium and some discrete regions of the olfactory bulb may be due to differential spatial distribution of GABAergic neurons and GABA receptors within these tissues and the role of GABAergic neurons in regulating signaling of specific odorants and mixtures (Cocco et al., 2017; Lizbinski & Dacks, 2017; McGann, 2013; Tabor et al., 2008). For example, while G protein-coupled $GABA_B$ receptors are present in the axonal presynaptic region of the olfactory sensory neurons within the olfactory bulbs, $GABA_A$ receptors are broadly present on mitral/tufted cell secondary neurons within the olfactory bulb (McGann, 2013; Tan, Savigner, Ma, & Luo, 2010).

Consistent with the hypothesis that CO_2 effects on olfactory behaviors involve GABA signaling, our RNA-Seq analysis found that several genes involved in GABA signaling were altered at a CO_2 concentration shown to cause neurobehavioral disruption. These results are largely similar to studies that examined elevated CO_2 effects on mRNA expression of $GABA_A$ receptor genes in other fish species (Lai, Fagernes, Jutfelt, & Nilsson, 2016; Schunter et al., 2017). Interestingly, while we found no change in expression of the $GABA_A$ receptor mRNA in the olfactory bulb under high CO_2 conditions, we did observe a significant increase in $gaba_{B2}$ receptor mRNA expression. The metabotropic $GABA_B$ receptor is involved in a distinct inhibitory pathway compared to ionotropic $GABA_A$ receptor and works to modulate neural activity via presynaptic and postsynaptic signaling pathways. However, $GABA_A$ and $GABA_B$ receptors play complementary and distinct roles in modulating olfactory signaling. The $GABA_B$ receptor is a G protein-coupled receptor that, upon activation, inhibits calcium channel function (which can in turn reduce neural excitability and neurotransmitter release) and activates potassium channels to hyperpolarize neurons (Bettler, Kaupmann, Mosbacher, & Gassmann, 2004). Neuronal hyperpolarization via $GABA_A$ receptor modulation of Cl^- influx is quicker than the $GABA_B$ pathway as it does not rely on slower secondary messengers.

To our knowledge, we are the first to report changes in $GABA_B$ gene expression under elevated CO_2, which presents an interesting new component to the list of signaling molecules involved in behavioral alterations under elevated CO_2. Increased expression of the $GABA_B$ receptor could indicate a response by salmon olfactory bulb neurons to compensate for the loss of normal function of the $GABA_A$ receptor pathway. Increased expression of $GABA_A$ receptor mRNA, as a potential compensation for loss of function under elevated CO_2 conditions, is also found in three-spined sticklebacks (Lai et al., 2016). This theory is supported by the fact that several other genes associated with GABA signaling were also significantly altered in coho salmon in the present study. The significant increase in *hcn2*, which plays critical roles in membrane excitability, integration of synaptic inputs, and the generation of membrane potential oscillations within the olfactory bulb, suggests alterations in signal modulation under elevated CO_2 conditions (He, Chen, Li, & Hu, 2014). Two other genes associated with synaptic transmission and modulation of neuronal GABA signaling through Cl^- transport, *snap25* and *kcc1*, also showed significant increases in expression further suggesting altered neuronal signaling within the olfactory bulbs (Abe, Minowa, & Kudo, 2018; Delgado-Martínez, Nehring, & Sørensen, 2007; Delpire, 2000; Wang et al., 2005). The increases in *slc6a13* and *slc38a3*, which can serve roles in taurine/GABA uptake and glutamate uptake needed for GABA synthesis, respectively, potentially indicate increased production or uptake of GABA as a compensatory response by the bulb neurons (Chan et al., 2016; Scimemi, 2014). There was also a significant decrease in *aldh9a1*, which is involved in the production of GABA, and was reported to be overexpressed in fish tolerant of elevated CO_2 exposures (Schunter et al., 2016). Furthermore, the significant changes in expression of the multitude of other genes involved in signal transduction, ion transport (such as *slc26a6* which serves a vital role in transporting HCO_3^+/Cl^-), and machinery related to neurotransmitters such as glutamate, serotonin, and acetylcholine also indicate a potential compensatory response to restore normal neural signaling within the olfactory bulbs.

We found increased expression of major genes involved in melatonin and the circadian rhythm, *asmt* and *aanat*, genes that play key roles in the production of melatonin and its precursor *N*-acetylserotonin. Melatonin production has been linked to modulation of ion regulation in rainbow trout in response to changes in salinity (López-Patiño, Rodríguez-Illamola, Gesto, Soengas, & Míguez, 2011). Schunter et al. (2016) found similar results in damselfish wherein offspring from parents sensitive to elevated CO_2 also had elevated levels of *asmt* mRNA expression, as opposed to offspring from CO_2-tolerant parents. GABA signaling has also been linked to circadian rhythm regulation, and the alteration of expression of genes central to $GABA_B$ function could be driving these changes in genes linked to the circadian rhythm as well (DeWoskin et al., 2015). In total, the RNA-Seq data indicate that olfactory bulb neural signaling pathways experienced major changes on a wide scale in response to the elevated CO_2 exposure, potentially as a mechanism to restore normal function, albeit unsuccessful during the exposure window given our behavioral and neurophysiology results.

The results of our study highlight the fact that salmon, once acclimated to saltwater, are susceptible to neurophysiological changes that can influence behavioral function under shifts in pH similar to those expected with OA. These results are worrisome as the native range of coho salmon in the North East Pacific Ocean is characterized by strong upwelling currents and is predicted to be impacted by elevated CO_2 and low pH projected for the foreseeable future. Indeed, many areas in the Salish Sea (encompassing the Strait of Georgia, Strait of Juan de Fuca, and Puget Sound in Washington State, USA, and British Columbia, CDN) already experience CO_2 and pH levels, at certain times of the year, that are similar to those affecting fish in our study (Feely et al., 2010). Olfaction plays a central role in the salmon life history, and the impairment of normal olfactory-driven behaviors in juvenile salmon can jeopardize their survival. Furthermore, the GABA signaling system hypothesized to be impaired under elevated CO_2 conditions is critical in many other areas of the central nervous system, including vision, mechanoreception, and control of anxiety. However, the effects of elevated CO_2

on these critical neuronal systems, remain to be investigated and are largely unknown in salmon (Ou et al., 2015).

While future real-world exposures to CO_2 concentrations at 2,700 μatm are likely to only occur in a transient scenario similar to our exposure paradigm, longer term exposures would be informative to investigate a potential for salmon to acclimate to the changed chemistry and regain normal neural function. Furthermore, while our study did not investigate recovery of normal behavioral function following cessation of the exposures, there is evidence that such recovery does happen in fish (Chivers et al., 2014; Jarrold, Humphrey, McCormick, & Munday, 2017). The environment that salmon reside in (i.e., open ocean vs. nearshore environment, time of year they reside in each environment, and the water depth they reside at) is important to consider going forward as the degree of neural impairment driven by elevated CO_2 could vary (Jarrold et al., 2017; Pacella, Brown, Waldbusser, Labiosa, & Hales, 2018).

In conclusion, juvenile ocean-phase coho salmon are sensitive to neurobehavioral disruption induced by exposure to elevated CO_2 associated with climate change predictions in the Puget Sound region. Salmon are a keystone species in many aquatic ecosystems in the North Eastern Pacific Ocean and already face substantial pressure from other anthropogenic and nonanthropogenic factors. The potential effects of elevated CO_2 on their mortality will only add to this pressure for long-term survivorship of Pacific salmon.

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CONFLICT OF INTEREST

The authors declare no competing interests.

AUTHOR CONTRIBUTIONS

C.W., A.D., E.G., P.M., T.B., and S.B. all participated in the design of the experiment. C.W. and M.M. conducted the study. T.B. and J.M. conducted the bioinformatics. C.W. wrote the paper with editorial input from A.D., E.G., P.M., S.B., T.B., J.M., and M.M.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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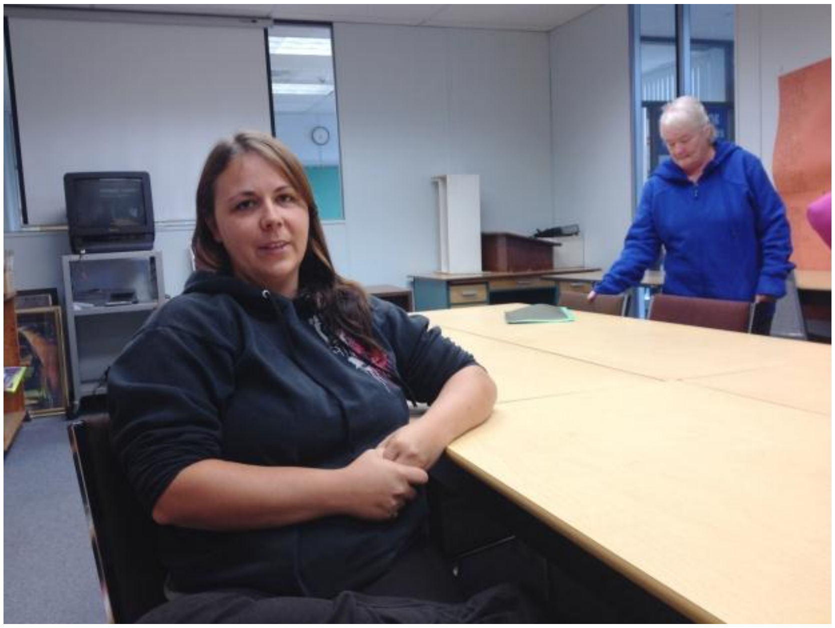
Exhibit 49

http://www.vancouversun.com/business/energy/Northwest+boom+already+bust+some/10326811/story.html?__lsa=0882-6c5e

Northwest B.C.'s LNG boom is already a bust for some (with video)

Heated economy drives up prices and drives out tenants

By Gordon Hoekstra, Vancouver Sun November 5, 2014



Oct. 1 - Kitimat - April Roy is one of the residents in Kitimat that have been evicted from apartments slated for renovation in anticipation of a economic boom from proposed LNG projects. Roy and her three children had been living in the Kuldo Apartments, but has had to move. As a result, her rent has increased significantly.
Photograph by: Gordon Hoekstra , Vancouver Sun

KITIMAT — In an ironic twist, April Roy moved to Kitimat five years ago from Fort McMurray to escape the high rents.

She found a three-bedroom apartment for $522, but then as a construction boom fuelled by the prospects of liquefied natural gas projects heated the local economy, the Kuldo Apartments were bought by Calgary-based Kiticorp and renovated.

She was evicted last year and had to find other accommodation.

Roy did, but at $1,200 for a cramped two-bedroom. She was only able to make the rent because she has a partner now, she said.

"That's the only reason we managed it, or we would have been out on the streets," she said.

The story is not a new one.

The recipe is simple: large industrial projects bring in thousands of workers and, combined with speculation, housing prices and rents are driven up.

It's been played out in places such as Fort McMurray in northern Alberta and in Fort St. John in northeastern B.C.

The first recent wave of workers to northwest B.C. came with Rio Tinto's $4.8-billion modernization of its aluminum smelter scheduled to be finished next year, and the $736-million Northwest Transmission Line, completed three months ago.

The next wave is meant to tap into Asia's thirst for energy.

Petronas, Shell and Chevron, whose proposed LNG projects total more than $30 billion, would require as many as 16,000 workers.

While camps have been built to accommodate workers, some of them have spilled out into the communities, particularly when they have been given hefty living-out allowances.

In Kitimat, housing prices and rents have as much as tripled. Prices and rents are also up significantly in Terrace, the region's service hub, and are rising in Prince Rupert as well.

In Kitimat, rental vacancy rates were 35-40 per cent three years ago, but they are now approaching zero.

While the rejuvenated housing market has meant new investments to improve the rental housing stock in northwest B.C., it has displaced hundreds of people on low and fixed incomes, say housing advocates.

Kitimat housing resource worker Paul LaGace says more low-income housing is needed from the province.

But that's not the answer, says the B.C. Liberal government.

Let the market react to the influx of people and increasing wages, and where necessary assist people with rent subsidies where they are already living, says Natural Gas Development Ministry Rich Coleman, who has responsibility for housing.

LaGace says the so-called "renovictions" number in the hundreds.

Some renovations are legitimate, but sometimes landlords are simply using it as a ruse to get people out, slapping up a coat of paint and new carpets to charge higher rents, he said.

The problem is that with little government low income housing in Kitimat, and rising rents in Terrace and Prince Rupert, there are few options for people, said LaGace.

They have placed some people in Terrace, but sometimes they have little choice but to tell people to move to another town, perhaps trying to see if they have family elsewhere, he said.

"It's a bad situation," said LaGace.

In Prince Rupert, where a pair of LNG projects are proposed, the same problems are starting to emerge.

Ulf Kristiansen, with the Prince Rupert Unemployed Centre Society, said he believes a big increase in evictions is tied to an early influx of construction workers for LNG projects.

The annual allowable rent increase is about two per cent for existing tenants, but if you get a new tenant you can charge more. “Landlords are looking for any excuse to evict people so they can charge one-and-a-half times to double the rent,” he said.

At a mobile home park in Port Edward, just 10 minutes from Prince Rupert and adjacent to the proposed $11-billion Pacific Northwest LNG project led by Petronas, tenants were served eviction notices in August.

The tenants and are trying to fight the evictions.

Park resident Ken Jennings said he believes the new owners are simply trying to capitalize on the coming LNG boom at the expense of longtime park residents.

Jennings, 76, said he has no idea where he and his wife, Mary, 78, who are paying just over $200 for pad rent, will go.

“What a way to treat seniors,” he said.

Stonecliff Properties president Victoria Beattie said she bought the park as an investment.

She said she planned to fix the sewer and water system in the park, fill in empty spots with new trailers but keep some spots low rent, and potentially expand the park.

But Beattie says she has been stymied by the tenants, and has decided simply to close the park, as it will cost less than keeping it open.

In Kitimat, Kiticorp makes no apologies for its investment in the Kuldo apartments.

Nearly half of the 80 units were shuttered because it was cheaper for the previous landlord to turn off the heat and other services, given the low rents, says Kiticorp president Eli Abergel.

He also make no secret of their effort to benefit from the construction boom.

“It’s obviously inevitable that some of our tenants were displaced. But we still have some tenants paying very, very low rent that we still keep in our units. So, it’s all about balance for us,” he says.

Abergel also said that ultimately it’s the community and provincial government’s responsibility to deal with any need for low-income housing.

Chevron, which has not made a final investment decision on its Kitimat LNG project, said that displacing people on low and fixed incomes is a concern.

Rod Maier, a Chevron spokesman for the Kitimat LNG project, said the company does not want to create negative impacts in communities where it develops projects, which is why it tries to hire local as much as possible and will set up a 3,000-person worker camp if the project goes ahead.

Chevron has just completed a 600-person camp in Kitimat.

But Maier noted that sometimes the influx of workers and knowledge of living expense allowances will drive rents up on their own, noting that happened in Saint John's, Nfld., with the development of the Hibernia offshore oil project.

Stacey Tyers, a Terrace city councillor and poverty law advocate for the Terrace and District Community Services Society, says the biggest problem is the living-out allowance provided to workers.

At $130 a day, three workers can share a house and still pocket money, but it completely prices out the average home renter, she said.

And in a service centre such as Terrace, there are many retail workers who simply can't afford the doubling in rents for a two-bedroom place that now range from $1,200 to $1,500.

Between December and February last year, elementary schools in Terrace lost 60 children because their families couldn't afford to live in the community, she said.

The City of Terrace has taken steps to allow secondary suits in all areas, and is also in the midst of passing bylaws to allow carriage houses, reduce lot sizes and house sizes.

But low-income housing is the first solution, said Tyers.

"We keep explaining to the provincial government that housing is actually a barrier to our economic growth because we can't have businesses open here if their employees have nowhere to live," said Tyers.

Coleman, who has the housing portfolio, said the province is working with northwest communities to address the issues of increasing rents.

But Coleman noted that it is a natural phenomena: any time there is economic growth, there is going to be a change in the housing market.

He noted there had been a real problem with a depressed housing market in northwest B.C. for a long time, which has meant that very little new housing has hit the market.

"We wouldn't build social housing to fill the gap — we would actually let the market do that," he said.

Coleman is a proponent of increasing densities, adding carriage houses and increasing basement suites.

Add to that subsidized rents for those that need it where they are living and you create a quicker, more flexible solution, he said.

ghoekstra@vancouversun.com

Exhibit 50

http://www.cbc.ca/news/canada/british-columbia/b-c-lng-work-camps-concern-for-northern-towns-say-mayors-1.2938393

B.C. LNG work camps concern for northern towns, say mayors

Two northern B.C. mayors share their city's struggle with the impending influx of temporary workers

By Radio West, CBC News Posted: Feb 02, 2015

With promises of an LNG boom and Site C on the horizon, some B.C. communities are grappling with how to cope with the prospect of hundreds of workers arriving on their doorstep.

Two northern B.C. cities have already begun to deal with the issue. In Kitimat, two work camps are being built within city limits. Fort St. John will soon decide if it will allow the same thing.

"There's no doubt the people in that neighbourhood and the affected neighbourhood were not thrilled about it," said Kitimat mayor Phil Germuth.

Germuth said he voted against one of the work camp proposals because he didn't feel like there had been enough consultation with the residents of the neighbourhood where it is being built.

"I'm not saying you can't put a camp in a residential neighbourhood," said Germuth. "But if you're going to do it you really owe it to the people who are going to be affected by it, in my opinion, that they need to be consulted greatly with their concerns."

The proposal, a camp that will house 2,000 workers from any company willing to rent it, did get accepted by council. To ensure a legacy from the project, the city decided to charge a one-time tax of $500 per bed, which will go towards future affordable housing projects.

The idea of legacy is important to city of Fort St. John as well.

"Our top priority, as any community in the north," said Fort St. John Mayor Lori Ackerman, "is the development of vital permanent sustainable communities that provide the citizens with a high quality of life."

Ackerman said the buildings could house seniors or serve as affordable housing when they're eventually vacated.

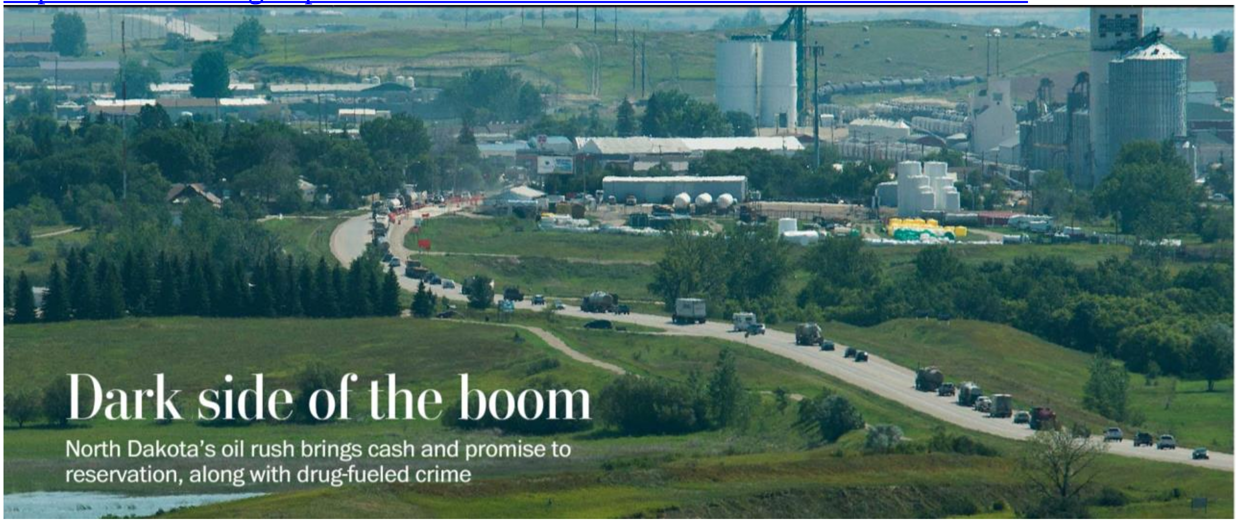
She said the city is concerned about the impact on services such as health care, police and social welfare. Residents were also worried about traffic.

As a result of those concerns, the city has commissioned research on the potential impact of the camps. The results should be in to council in about two or three months.

"We're going to have to talk about community engagement at that point," said Ackerman.

The Washington Post

http://www.washingtonpost.com/sf/national/2014/09/28/dark-side-of-the-boom/



Above: Tractor-trailers tied to oil production back up traffic and are seen everywhere in and around New Town.

By Sari Horwitz ; Photos by Linda Davidson ; Published on Sept 28, 2014

FORT BERTHOLD INDIAN RESERVATION, N.D. — Tribal police Sgt. Dawn White is racing down a dusty two-lane road — siren blaring, police radio crackling — as she attempts to get to the latest 911 call on a reservation that is a blur of oil rigs and bright-orange gas flares.

“Move! C’mon, get out of the fricking way!” White yells as she hits 102 mph and weaves in and out of a line of slow-moving tractor-trailers that stretches for miles.

In just five years, the Bakken formation in North Dakota has gone from producing about 200,000 barrels to 1.1 million barrels of oil a day, making North Dakota the No. 2 oil-producing state, behind Texas, and luring thousands of workers from around the country.

But there is a dark side to the multibillion-dollar boom in the oil fields, which stretch across western North Dakota into Montana and part of Canada. The arrival of highly paid oil workers living in sprawling “man camps” with limited spending opportunities has led to a crime wave -- including murders, aggravated assaults, rapes, human trafficking and robberies -- fueled by a huge market for illegal drugs, primarily heroin and methamphetamine.

Especially hard-hit are the Indian lands at the heart of the Bakken. Created in 1870 on rolling grasslands along the Missouri River, Fort Berthold (pronounced Birth-Old), was named after a U.S. Army fort and is home to the Mandan, Hidatsa and Arikara Nation -- known as the MHA Nation, or the Three Affiliated Tribes.

“It’s like a tidal wave, it’s unbelievable,” said Diane Johnson, chief judge at the MHA Nation. She said crime has tripled in the past two years and that 90 percent is drug-related. “The drug problem that the oil boom has brought is destroying our reservation.”

Once farmers and traders, the Mandan was the tribe that gave Lewis and Clark safe harbor on their expedition to the Northwest but was decimated in the mid-1830s by smallpox. Over many years, the 12 million acres awarded to the three tribes by treaty in 1851 has been reduced to 1 million by the United States.

The U.S. government in 1947 built the Garrison Dam and created Lake Sakakawea, a 479-square-mile body of water that flooded the land of the Three Affiliated Tribes, wiped out much of their farming and ranching economy, and forced most of them to relocate to higher ground on the prairie.

“When the white man said, ‘This will be your reservation,’ little did they know those Badlands would now have oil and gas,” MHA Nation Chairman Tex “Red Tipped Arrow” Hall said in an energy company video last year. “Those Badlands were coined because they’re nothing but gully, gumbo and clay. Grass won’t grow, and horses can’t eat and cattle or buffalo can’t hardly eat . . . but there’s huge oil and gas reserves under those Badlands now.”

The oil boom could potentially bring hundreds of millions of dollars to the tribes, creating the opportunity to build new roads, schools, and badly needed housing and health facilities. But the money is coming with a steep social cost, according to White, her fellow tribal officers and federal officials who are struggling to keep up with the onslaught of drugs and crime.

“We are dealing with stuff we’ve never seen before,” White said after leaving the scene of the latest disturbance fueled by drugs and alcohol. “No one was prepared for this.”

The 20-member tribal police force is short-staffed and losing officers to higher-paying jobs on the oil fields. Sometimes, there are only two tribal officers on duty to cover the whole reservation, including part of the North Dakota Badlands. There is only one substance-abuse treatment center, with room for only nine patients at a time, to help the soaring number of heroin and meth addicts.

Over the summer, the White House Office of National Drug Control Policy singled out drug trafficking in the Bakken oil patch as a “burgeoning threat.” Violent crime in North Dakota’s Williston Basin region, which includes the reservation, increased 121 percent from 2005 to 2011. The Bakken is also experiencing a large influx of motorcycle gangs, trying to claim “ownership” of the territory and facilitating prostitution and the drug trade, according to a federal report.

“Up until a few years ago, Fort Berthold was a typical reservation struggling with the typical economic problems that you find in Indian Country,” said Timothy Q. Purdon, the U.S. attorney for North Dakota, whose office prosecutes violent crime on the reservation.

“But now, boom — barrels of oil mean barrels of money,” Purdon said. “More money and more people equals more crime. And whether the outsiders came here to work on a rig and decided it would be easier to sell drugs or they came here to sell drugs, it doesn’t make any difference. They’re selling drugs. An unprecedented amount.”

Operation Winter’s End

Hall, the longtime chairman of the Three Affiliated Tribes, called it the “worst tragedy” on the Fort Berthold reservation in his memory.

On a November afternoon two years ago, an intruder burst into a home in New Town, the largest town on the reservation, and shot and killed a grandmother and three of her grandchildren with a hunting rifle. A fourth grandchild, a 12-year-old boy, survived by hiding under his slain brother’s body and pretending he was dead.

The young man responsible for the killings slit his own throat hours later in a nearby town. He was high on meth, according to federal officials.

On the same day, in an unrelated incident, Sgt. White stopped a motorist who was wanted on an outstanding warrant. As she grabbed the handle of his car door, the driver, who had drugs in the vehicle, took off, dragging her on the ground for half a block and sending her to the hospital with a concussion.

It seemed as though big-city drug violence had arrived like a sudden storm.

“We wanted to find out, immediate top priority, what happened here,” Purdon said. “Who was this shooter? Where did he get the meth? Who was he involved with? And what can we do about it?”

Purdon and the FBI teamed up with White and other tribal officers, focusing on a large-scale drug-trafficking ring led by two brothers from Wasco, Calif. — Oscar and Happy Lopez. In the summer of 2013, in an investigation dubbed Operation Winter’s End, Purdon indicted 22 people, including the Lopez brothers as well as members of the tribes, for dealing heroin and meth on or around Fort Berthold. The drugs came from Mexico through Southern California, officials said.

One suspect, Michael Smith, was wanted on a warrant for drug trafficking in Colorado. He holed himself up in a reservation house with a gun for more than 12 hours before the police knocked down the walls with a front-end loader.

"The 'wow effect' was pretty strong," said Assistant U.S. Attorney Rick Volk, who oversaw the case. "That's not something that happens every day in a small town like New Town."

Since then, Purdon has indicted more than 40 other people who have all pleaded guilty to felony drug charges in the ongoing Winter's End case, with a large amount of the meth and heroin also coming from gangs in Chicago or dealers in Minneapolis.

Investigating crime on Fort Berthold is more difficult than most places because the reservation sits in six different counties each with its own sheriff — some of whom do not have a good relationship with the tribe, according to tribal members. If the victim and suspect are both Native American, the tribal police or the FBI handles the arrest. But if the suspect is not Native American, in most cases the tribal police can detain the suspect but then have to call the sheriff in the county where the crime occurred. Sometimes they have to wait several hours before a deputy arrives to make the arrest. In a murder case, the state or the FBI might be involved, depending on the race of the victim and the suspect.

"There are volumes of treatises on Indian law that are written about this stuff," Purdon said. "It's very complicated. And we're asking guys with guns and badges in uniforms at 3:30 in the morning with people yelling at each other to make these decisions — to understand the law and be able to apply it."

In the quadruple murder, for example, all four victims were white. But police didn't immediately know if the perpetrator was white or Native American, so there was initial confusion among law enforcement officials about who was in charge of the investigation.

"Can you imagine the idea that we didn't know the race of the shooter, so we didn't know at first who had jurisdiction over the homicide?" Purdon asked. "That's not something your typical county sheriff has to deal with."

The killer was later identified as a 21-year-old Native American.

'I helped bring that heroin here'

In the front seat of her cruiser, White, an Army veteran who grew up in Fort Berthold, carries an eagle feather and a photograph of the rodeo-champion grandfather who raised her.

Volk calls her "the eyes and ears of the reservation," a cop who is able to find anyone. Her fervor to save her people from the ravages of heroin and meth gives White the fortitude to arrest even tribal members she knows well.

"I put the uniform on," White said, "I have no family. I have no friends."

Before she sets out on patrol, she lights the end of braided sweet grass, a tradition of the Plains Indians to drive away bad spirits. White, a mother of three, places it on her dashboard for protection.

White also carries a set of pink handcuffs, a personal signature that she says represents “girl power.” One night last year, White slapped the cuffs on one of her relatives, Rachelle Baker, a 29-year-old former Fort Berthold teacher who became addicted to heroin shortly after it arrived on the Bakken.

“I was in the back of her cruiser, cussing her out, telling her to get away from me, ‘you don’t know what you’re doing,’ ” Baker said in a recent interview. “I was bawling my eyes out. I was sweating, my hair was sticking to my face. She took my hair and pushed it back and she said, ‘Rachelle, I don’t want to see you like this anymore. I don’t want to see you live like this. You need to get better for your kids, Rachelle.’ And she closed the door.”

Three years ago, Baker’s boyfriend at the time got heroin from an oil rig worker who had brought it with him from Boston. “That was the first time in my life I ever saw it,” Baker said.

Soon, she was hooked on heroin, buying from a dealer who came from Minneapolis and shooting up, along with her friends, on a reservation where she said “there’s no other recreation.”

“There’s not a movie theater here,” Baker said. “There’s not a swimming pool. There’s nothing. There’s nothing to do here.”

She became pregnant and was using when she had her baby boy.

“I just couldn’t stop,” Baker said. She shot up so many times that she couldn’t find an easy vein and inserted needles into her neck, legs, ankles and toes. One time, she shot up in her forehead.

By last fall, Baker was also using meth. In January of this year, social workers took away both of her children, now ages 3 and 1.

“That was the lowest point in my life,” Baker said. She said she tried to kill herself by swallowing 200 Tylenol pills. Baker was transferred from the hospital to a mental-health facility and then jail, where lying in the bunk she said she felt a sense of peace for the first time in years.

“Because it felt like the nightmare I had been living was finally over,” she said.

When she was released, Baker enrolled in a treatment program; she’s now been drug-free for nearly eight months. She’s in counseling and finished parenting classes. She is tested for drugs every week and is one step away from regaining custody of her children. She’s helping to start two Narcotics Anonymous groups at Fort Berthold, where there was none.

But in a few months, Baker goes to federal court, where she said she faces 56 months in prison. She pleaded guilty to distribution of heroin after being caught in Purdon’s drug sweep.

"It is so sad because I am finally getting my life back together," Baker said. "But I helped bring that heroin here. I sold it to people here on the reservation. I gave it to family members. And if I have to pay that price, then I will."

An unsafe community

Responding to another call, White pulls up to the reservation's 4 Bears Casino and Lodge to check on a small child who was left inside a car while her mother went inside to gamble.

Lined up outside the casino's hotel are four other police cars. They are not the cruisers of officers who have come to investigate the child. They belong to several new recruits who have no place to live. The housing shortage has forced officers to move with their families into casino hotel rooms until homes are built for them.

Three Affiliated Tribes Police Chief Chad Johnson said he needs at least 50 more officers.

"I get a lot of applicants from all over," Johnson said. "The first thing they ask is if we have housing available. We've been putting them up in the casino, but some of them have families and they don't want their families living in a casino."

Johnson, the judge, has the same problem recruiting prosecutors. "We can't get them to come to the MHA Nation because of the lack of housing and the community is becoming so unsafe," she said. "It is extremely dangerous to live here now."

While Fort Berthold needs more police officers, housing for recruits, more tribal prosecutors and judges, and additional drug treatment facilities, some residents say their leaders have made questionable purchases, including a yacht. Just behind the casino on the lake sits a gleaming white 96-foot yacht that the tribe purchased last year to be used for a riverboat gambling operation.

While some federal officials have questioned the tribe's financial priorities, tribe members have called for an investigation into their leader's business dealings.

Earlier this year, the seven-member tribal business council led by Hall voted to hire a former U.S. attorney to examine Hall's private oil and gas business dealings on Fort Berthold -- including his relationship with James Henrikson, a man who was arrested on felony weapons charges and was indicted two weeks ago on 11 counts, including murder-for-hire of an associate.

Hall, who served as chairman for 12 years, lost his reelection bid the same week. In a statement, he has denied "affiliation with any gangs" and said he is cooperating with federal investigators in the Henrikson case.

Another member of the tribal council, Barry Benson, was arrested this year on drug charges.

Federal officials have sent more agents and resources to the Bakken, tripling the number of prosecutions in what Purdon calls a "robust response" to the crime wave.

But, he added, “it’s not for me to talk about what the appropriate response is by the state of North Dakota, or these counties and the tribe.”

Sen. Heidi Heitkamp (D-N.D.) created a task force this month of North Dakotans to focus on the increase in drug-related crime and human trafficking in the Bakken, including Fort Berthold.

The state “could absolutely do more,” Heitkamp said in an interview, pointing to the need for more mental-health services, drug treatment facilities and drug courts.

“We are blessed with a growing economy and the country’s lowest unemployment rate, but there was a 20 percent increase in drug crimes in North Dakota last year,” Heitkamp said. “A better-coordinated response from the state would be helpful. The lack of roads, housing and law enforcement has stretched this small rural reservation to the max.”

‘The last of the last’

Earlier this year at a tribal conference in Bismark, N.D., which Purdon and Attorney General Eric H. Holder Jr. attended, White was presented with an award for her work trying to eradicate drug trafficking at Fort Berthold.

She choked back tears as she walked to the podium, where she dedicated her award to her Native American grandparents who raised her. She spoke about the time she has spent away from her three children because of her job.

“I sacrifice because this is the only place I’m going to be a cop, the Fort Berthold Indian Reservation,” White said, her voice cracking.

“This is the last of what my people have,” White said. “Our people have survived so many things in history. The methamphetamine use, the heroin use, is just another epidemic like smallpox and boarding schools. And the last of the last are going to have to survive. And I want to be in the front lines because that was my vow — to protect my people.”

Exhibit 52

INTERNATIONAL
BROTHERHOOD OF ELECTRICAL WORKERS
LOCAL UNION NO. 932

BAY AREA LABOR CENTER
3427 NEWMARK & ASH
NORTH BEND, OREGON 97459

TELEPHONE: (541) 756-3907
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November 12, 2014

Dear Brothers and Sisters,

The Federal Energy Regulatory Commission published the draft Environmental Impact Statement for the Jordan Cove Energy Project on November 3, 2014. This is an important milestone for this project and sets the final steps for approval and construction.

The most important of these final steps will be the public hearings that the FERC will hold. The first of which will be in Coos Bay on Monday December 8th at the Performing Arts Center at Southwestern Oregon Community College at 6:00 PM.

It is critical that we get as many supporters as possible to this hearing. I am requesting that every member of Local 932 make every effort to attend this hearing. To facilitate that effort, the December local union meeting will be held at 4 PM on Monday December 8th located at the Union Hall, 3427 Ash St. North Bend, and will conclude at 5 PM; at which time we will head to the public hearing.

If you plan on attending please wear your green Boost Southwest Oregon T-shirt. If you plan on attending and don't have one, call the hall ahead of time, and let us know the size you want, and we will have one at the union meeting for you.

Once again, this is the one public hearing that we need to show up in force to. The antis' will be there as this is their last chance to kill the project. We need to show the Feds that there are many more that want this project built.

Also, the building trades have an agreement on subsistence and travel for the construction of Jordan Cove.

If a worker lives in the man camp, they will received $25 a day subsistence with a five day max. They will also receive $25 a day travel for each day worked.

For a worker not staying in the man camp, they will receive $50 a day subsistence for each day worked and if they work all scheduled shifts will receive subsistence for 7 days. They will receive $25 a day travel for each day worked.

There is no free zone and this applies only to journeymen and apprentices.

See you on the 8th of December.

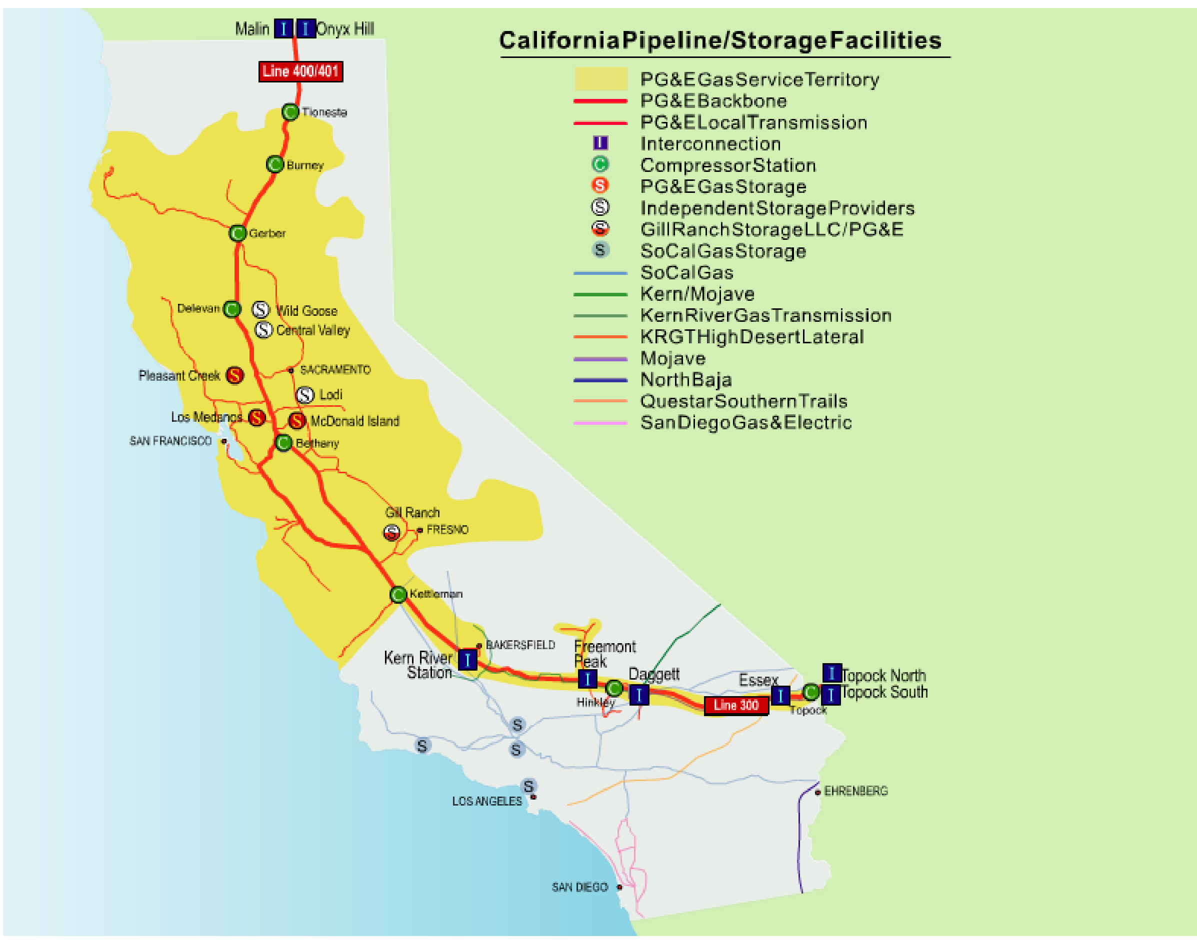
Fraternally,

Robert Westerman
Business Manager
IBEW Local 932
RW/lak

Exhibit 53

Alternative Jordan Cove Facility Siting / Pacific Connector Pipeline Route #1

A variety of Natural Gas pipeline infrastructure to West Coast Ports already exists. A detailed explanation as to why the Jordan Cove Energy Project did not look at utilizing these already existing pipelines and Ports in order to develop their LNG Export terminal should be analyzed in the EIS. A detailed explanation as to why PG & E is no longer a partner in this project should also be included.



Alternative Jordan Cove LNG Export Terminal Siting Locations (#2)

An explanation as to why other siting locations such as the Jerden Cove just north of Winchester Bay and/or the Industrial Site in Gardner, Oregon, were not analyzed as siting locations for the Jordan Cove LNG terminal, should be included in the EIS review.

Example #3
Pipeline Transportation and Terminal Location

Example #4

Pacific Trail Pipeline Project

PACIFIC TRAIL PIPELINES

MOVING NATURAL GAS FROM WESTERN CANADA TO ASIAN MARKETS

Pacific Trail Pipelines will provide a direct connection between the Spectra Energy Transmission pipeline system and the Kitimat LNG terminal for the transportation of natural gas from Western Canada to Asian markets.

Click to enlarge

Quick Facts:

- Pipeline location: Summit Lake to Kitimat, British Columbia
- Pipeline length: Approximately 463 km
- Pipeline capacity: Up to approximately 1,000 MMcf/d
- Compressor station: 1
- Diametre of pipe: 42 inches

Latest News

25/Feb/2013

Pacific Trail Pipelines Limited Partnership sign $200 million commercial agreement with 15 First Nations regarding the pipeline component of the Kitimat LNG Project
Read More »

11/Feb/2013

Apache, Chevron complete Chevron Canada's entry into Kitimat LNG
Read More »

Overview of Proposed Energy Operations of Jordan Cove Export Project

The proposed Jordan Cove Energy Project is located at Coos Bay in southern Oregon. JCEP received FERC approval in Docket No. CP07-444 to construct an LNG import facility. FERC also approved the construction of the Pacific Connector Pipeline. JCEP has received authorization from the Department of Energy in Docket No. 11-127-LNG to export LNG from the site to FTA countries. It intends to file applications in 2012 to export to non-FTA countries and to amend its FERC authorization to include authority to construct a dual-use import-export facility.

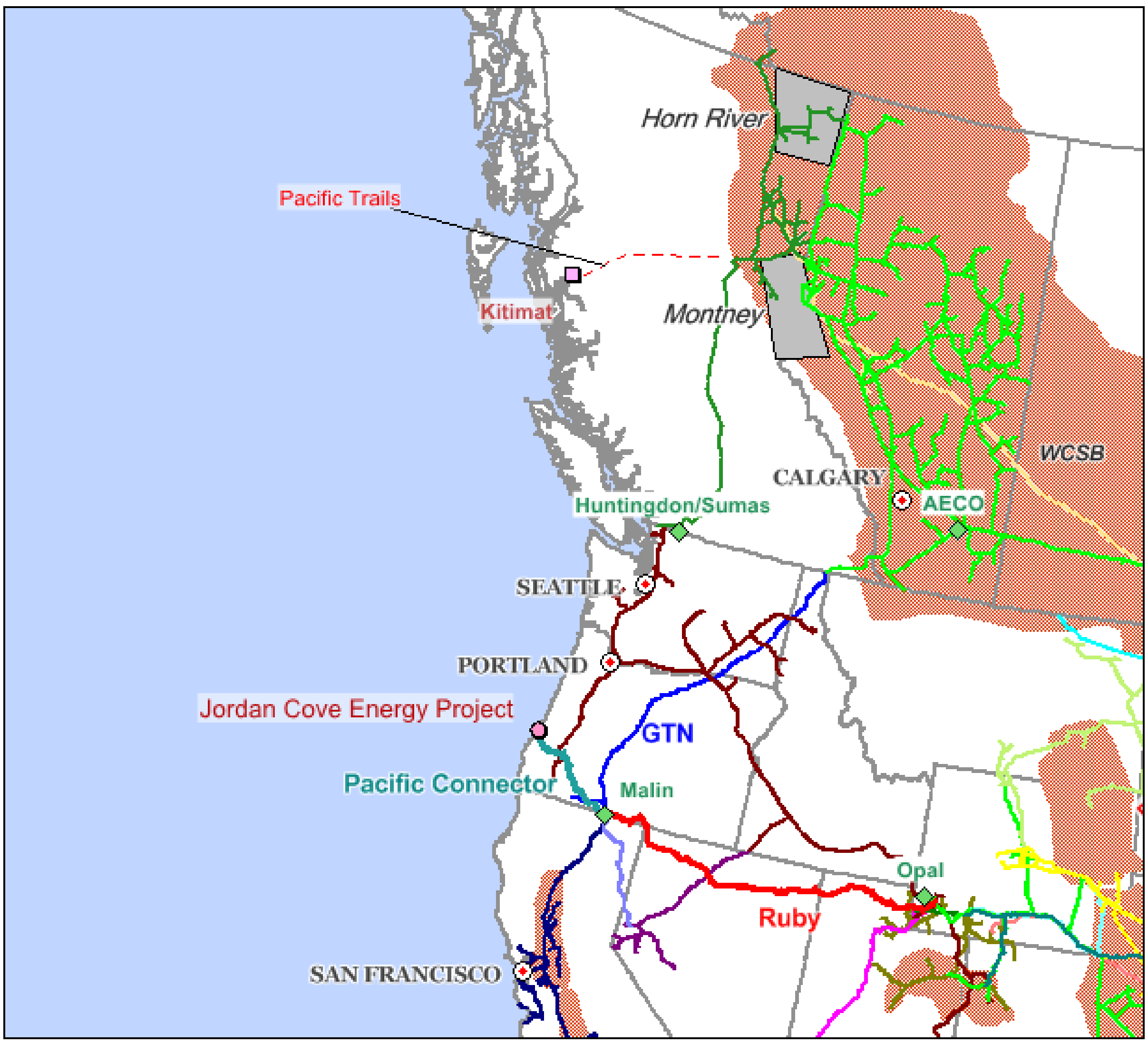


Figure 15: Jordan Cove Energy Project Location Map

Exhibit 54

http://business.financialpost.com/commodities/energy/pembina-pipelines-new-purpose-get-canadas-oil-and-gas-to-the-rest-of-the-world

Pembina Pipeline's new purpose: Get Canada's oil and gas to the rest of the world

CEO shifts to getting hydrocarbons to the U.S. and Asia, especially in light of Canada's infrastructure problems, which he thinks will only get worse

By Claudia Cattaneo
February 16, 2018
Last Updated
February 20, 2018

Political priorities come and go, especially when it comes to energy these days, and Pembina Pipeline Corp. has been adding value one piece of infrastructure at a time since the days of Louis St. Laurent.

Its most recent growth spurt, much of it through the oil and gas downturn, has boosted its enterprise value to $26.7 billion, from $14.4 billion in 2014 when current chief executive Mick Dilger took over, and from $3 billion 10 years ago.

With that kind of pedigree, you could do worse than pay attention to Dilger, who believes it would be better for governments to help improve the value of existing resources rather than chase new energy sources.

Canada, he points out, sits on some of the world's best and largest deposits of natural gas, which could be the bridge fuel to both help solve the climate change challenge by replacing coal and turn the country into a green superpower.

"How bad does it have to get in Canada before people care?" Dilger said in an interview in the company's Calgary headquarters. "Monies don't come from governments. They come from adding value, and maybe parts of Canada have had it too good and we need some pain before people start to wake up. It's also frustrating to me because I am mindful of the environment."

Pembina is little known outside Western Canada, partly because it rarely seeks publicity, partly because much of its business has been in energy-friendly Alberta.

It grew from a single oil pipeline built in 1954 by Alberta's Mannix dynasty to transport oil from the Pembina oil discovery in Drayton Valley, Alta. The company is now widely held — the Mannix family remains a shareholder — and is now Canada's third-largest pipeline company after Enbridge Inc. and TransCanada Corp.

Pembina has achieved its lofty position by building or buying infrastructure to serve its oil and gas customers in Western Canada, specifically pipelines linked to the oilsands in Alberta and shale discoveries such as the Montney and the Duvernay, storage tanks, fractionation plants that separate light hydrocarbon mixtures into individual substances, and gas-processing facilities.

The next projects in its core geography continue to reflect its time-tested mantra: do the most with the molecules you have.

The projects include a proposed $4-billion petrochemical plant in Sturgeon County in Alberta's Heartland with equal partner Petrochemical Industries Co. of Kuwait, and a $250-million liquefied petroleum gas export terminal in Prince Rupert, B.C.

"We think we have a purpose beyond what we have done, which is to play our part alongside other sector companies to **get our hydrocarbons to the rest of the world**," Dilger said.

But its next game-changing project could be in the United States. Pembina is making progress on reviving the US $10-billion Jordan Cove Energy Project, a liquefied natural gas export terminal on the Oregon coast to process Western Canadian gas, which is in great demand in Asia, but prices have languished because of a lack of export infrastructure.

"We think we have a purpose beyond what we have done, which is to play our part alongside other sector companies to get our hydrocarbons to the rest of the world"

-Mick Dilger-

Jordan Cove was part of Pembina's acquisition of Veresen Inc. last year, part of a $100-billion U.S. buying spree by Canada's top three pipeline companies over the past three years.

In addition to Pembina's purchase of Veresen, whose assets are half in the U.S., Enbridge bought Spectra Energy Corp. and TransCanada purchased Columbia Pipeline Group Inc.

The U.S. is where Pembina's larger competitors have already spread out to get around Canada's infrastructure gridlock and to take advantage of the more favourable business environment down south.

"That is $100-billion worth of money that could have been spent in Canada," said Dilger, a 54-year-old accountant by trade. "Think about that: the royalties, the jobs. The trend is, as their economy gets more pro business and pro-development, and ours goes the other way, capital will flee Canada. Those are all irrefutable conclusions to the way we are going, versus the way they are going."

The struggling but advanced Jordan Cove LNG project was denied an export permit by the U.S. Federal Energy Regulatory Commission two years ago because of a lack of customers even during a period of weak LNG prices, but Pembina has since filed a new permit application and expects a ruling this November.


An artist's rendering of the Jordan Cove project. Handout/Jordan Cove Energy

"We believe (the project) filed a winning application this time," Dilger said. "They had tremendous local support and federal support. I am not trying to predict what is going to happen in 2023 with commodity prices. But today, the price of gas in Tokyo is US $11. The price of gas in Alberta on a bad day is like $1. It costs you $5 to $6 to get it there. So there is a massive arbitrage today. I don't know what it's going to be in 2023, but there is a lot of interest right now."

Pembina is trying to secure customers and finish pipeline engineering, but if everything works out, the company will be in a position to make a final investment decision as soon as the end of 2018, Dilger said, which might mean the project could be completed in 2023.

"Pembina was smart to keep the project alive because the LNG market is coming to them now," said Dan Tsubouchi, chief market strategist at Stream Asset Financial Management, who believes global LNG demand is recovering a lot faster than previously anticipated.

Buying Veresen also gave Pembina two strategic Canadian gas export assets: a 50 per cent interest in the Alliance natural gas pipeline from Western Canada to Chicago (the rest is owned by Enbridge), and a roughly 43 per cent stake in a natural-gas-processing venture, Aux Sable.

But Dilger worries Canada's energy infrastructure problems will only get worse because of reforms announced by Ottawa last week to modernize the regulatory and environmental reviews of energy projects.

For example, allowing anyone in Canada to have an opinion on whether a major project should go ahead politicizes reviews and puts the country down a "very dangerous" path, he said.

There are three LNG projects making progress on the B.C. coast — LNG Canada led by Royal Dutch Shell PLC with partners PetroChina, Korea Gas Corp. and Mitsubishi Corp. of Japan; Woodfibre LNG, owned by the RGE Group of companies based in Singapore; and Kitimat LNG, a joint venture between Chevron Corp. and Australia's Woodside Petroleum Ltd. — but politics and high costs have been a long-running challenge.

Jordan Cove, meanwhile, would process up to 1.3 billion cubic feet a day of both Western Canadian gas or U.S. Rockies gas into LNG for export to Asia, but it's not the only energy export project that could take Canadian energy in the U.S. to reach Asian markets.

The proposed Eagle Spirit oil pipeline is also moving forward with plans to establish a tanker terminal in Alaska to export Canadian oil and get around the federal Liberal government's tanker ban.

Dilger believes Jordan Cove has a higher chance of success under Pembina than it had under Veresen because it has the money to finance it, the expertise to build both the plant and a 400-kilometre pipeline through tough terrain, and the relationships with Western Canadian producers and Asian customers to make it viable.

Some day, Pembina would like to build an LNG facility on the B.C. coast, too, Dilger said, but Jordan Cove has key advantages: it is cheaper to build a pipeline to receive Western Canadian gas from existing networks than build over the Canadian Rockies; its location near larger population centres means there is labour available to build it; and shorter travel time to Asian markets versus the U.S. Gulf Coast means lower transportation costs for its LNG.

Another priority is the expansion of the Alliance pipeline, one of Canada's large gas export highways into the Chicago hub.

Pembina will move ahead with Veresen's plans to expand the system by up to 500 million cubic feet a day, adding to the current level of 1.8 billion cubic feet a day, by using compression. A binding open season for interested shippers is under way.

"The best market in North America right now is Chicago," Dilger said, "I'd like to see Canadian gas get there and get some higher netbacks."

The Veresen acquisition diversified Pembina's assets into gas and into a new region, he said, but it also fits with the company's integrated business model, which he said is better than having disparate energy businesses geographically.

As for moving into new energy sources such as wind and solar, Dilger doesn't see the value proposition for his company, adding: "How's that working for Ontario so far?"

Financial Post

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Exhibit 55

JANUARY 2018

JORDAN COVE LNG AND PACIFIC CONNECTOR PIPELINE GREENHOUSE GAS EMISSIONS BRIEFING

FACTS AT A GLANCE

Total Annual GHG Emissions:	**36.8 million metric tons**
Emissions Equivalent:	**15.4 times the 2016 emissions of Oregon's last remaining coal-fired power plant (the Boardman plant) – or 7.9 million passenger vehicles**
Pipeline Project Name:	Pacific Connector Gas Pipeline
LNG Export Terminal Project Name:	Jordan Cove Energy Project
Ownership:	Pembina Pipeline Corporation
Operator:	TBD
Pipeline Length:	229 miles
Pipeline Diameter:	36 inches
Pipeline Capacity:	1.2 billion cubic feet per day (cf/d)
LNG Export Capacity:	7.8 million metric tons of gas per year (MMT/Y)
Project Cost:	$10 billion
Land Affected:	5,146 acres
States Directly Affected:	Oregon
Counties Affected:	Coos, Douglas, Jackson, and Klamath
Gas Source:	The Rocky Mountain states of Utah, Wyoming, and Colorado and the Montney Basin in British Columbia
Claimed Destination Markets:	Primarily Asia – Japan and China
Intended Permit and Project Schedule (Est.):	Final Environmental Impact Statement (August 2018); FERC order granting authorization and state permits (November 2018); Construction (first half of 2019); In-service date (first half of 2024)

SUMMARY

The proposed Pacific Connector Gas Pipeline and Jordan Cove Energy Project would transport and process into liquefied natural gas (LNG) around 430 billion cubic feet of fossil gas annually.[a] The greenhouse gas (GHG) emissions triggered by the project will be significant, but to date the scope of these emissions has not been well understood.

This paper provides an estimate of the full lifecycle emissions of the project, calculating a reference and high case estimate using the best available information. It finds that the project would add significantly to greenhouse gas emissions both globally and within the state of Oregon.

The emissions estimate includes an estimated range of methane leakage along the supply chain and finds that even a conservative estimate of methane leakage undermines claims that the gas supplied to global markets via the project would lead to a net reduction in GHG emissions. The paper also finds that there is no evidence to support an assumption that gas supplied by the project would replace coal in global markets.

In order to address the global climate crisis, emissions from all sources of fossil fuel must be reduced to zero by mid-century. Building and operating this project will undermine that goal. This paper provides the clear climate rationale against the project going ahead.

a We use the term fossil gas to mean natural gas produced from fossil fuel sources.

Above: LNG Tanker ©Smit Ebro , Grace Dahlia & Fairplay 21

PACIFIC CONNECTOR GAS PIPELINE MAP

PROJECT OVERVIEW

The Pacific Connector Gas Pipeline (PCGP) is a proposed 36-inch fracked gas pipeline that would run 229 miles across southern Oregon to a proposed liquefied natural gas export terminal at Jordan Cove, near Coos Bay, OR. The pipeline would start in southern Klamath County in the farming community of Malin, OR.

The proposed route of the pipeline crosses the Cascade mountains, threatening public and private lands, traditional tribal territories, and more than 2,000 acres of forest. Close to 400 rivers and streams would be crossed, including the Rogue, Klamath, Umpqua, Coos, and Coquille Rivers.

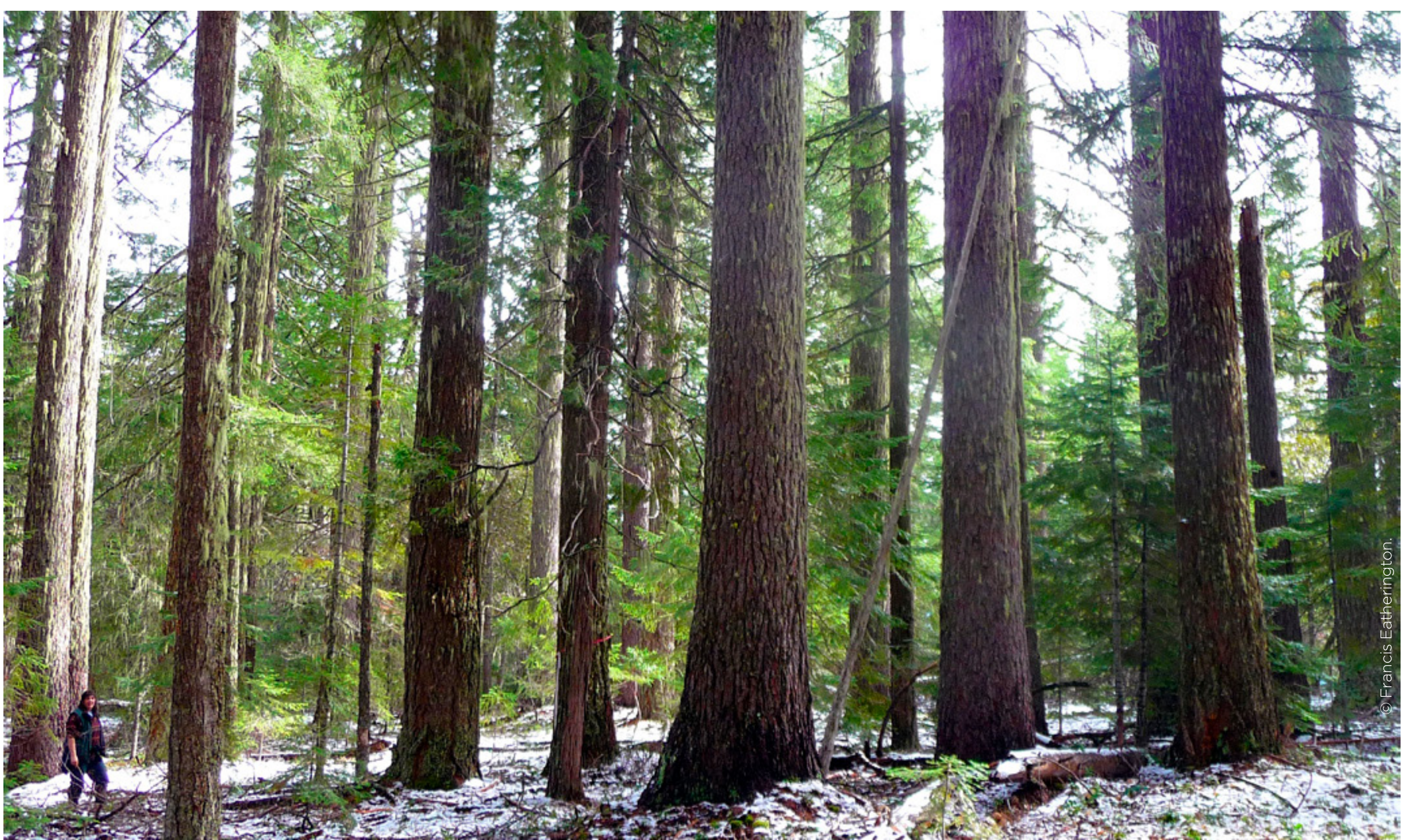
The project is facing significant opposition from indigenous communities along the pipeline route, including the Klamath Tribes, as well as the Yurok and Karuk Tribes along the Klamath River. The construction of the pipeline and the terminal would disturb sacred sites, burial grounds, and cultural resources and could also impact critical runs of salmon and steelhead. The Jordan Cove LNG export terminal would be built on traditional Coos tribal territory. There are also over 500 landowners along the pipeline route that would be impacted by the pipeline, and many will face eminent domain proceedings for the private project if it moves forward. More than 400 landowners, organizations, tribal members, and concerned citizens have filed motions to intervene with the Federal Energy Regulatory Commission (FERC) in opposition to the project, with only five interventions filed in support.[1]

The project backer is the Canadian company Pembina Pipeline Corporation, a fossil fuel giant that recently merged with Veresen, the original proponent of the pipeline proposal. The pipeline would be fed by either of two existing pipelines – the Ruby Pipeline that runs from the Rocky Mountains in Wyoming to Malin, or the Gas Transmission Northwest pipeline that runs from British Columbia. Each pipeline is capable of carrying 100 percent of Pacific Connector's capacity of 1.2 billion cubic feet per day. This creates a unique situation in which Canadian and U.S. fracked gas could compete for export, and opens the possibility that Jordan Cove could provide export service for 100 percent Canadian-sourced fracked gas.

The Pacific Connector Pipeline and the Jordan Cove Energy Project were first proposed in 2005 as a gas import project. The original project was vacated in 2012 and replaced with a LNG export proposal in 2013. In a rare federal decision, FERC denied the project application in 2016, stating that, "because the record does not support a finding that the public benefits of the Pacific Connector Pipeline outweigh the adverse effects on landowners, we deny Pacific Connector's request for certificate authority to construct and operate its project."[2] In early 2017, project backers reapplied under the Trump administration, which has stacked FERC with new appointees.

Pembina plans to complete the federal and state permit process by November 2018. It plans to begin construction in the first half of 2019 and bring the export terminal online by the first half of 2024.

Proposed path of pipeline through Umpqua National Forest, south of Tiller, MP 109.



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FOSSIL GAS AND CLIMATE CHANGE

Climate science clearly indicates the need to reduce consumption of all fossil fuels and make a just transition to a clean energy economy.[3] Building major fossil gas infrastructure today undermines action to protect our climate. Increasing access to fossil gas spurs its use, locking us into releasing more emissions when we must progressively produce and use less of all fossil fuels, including gas.

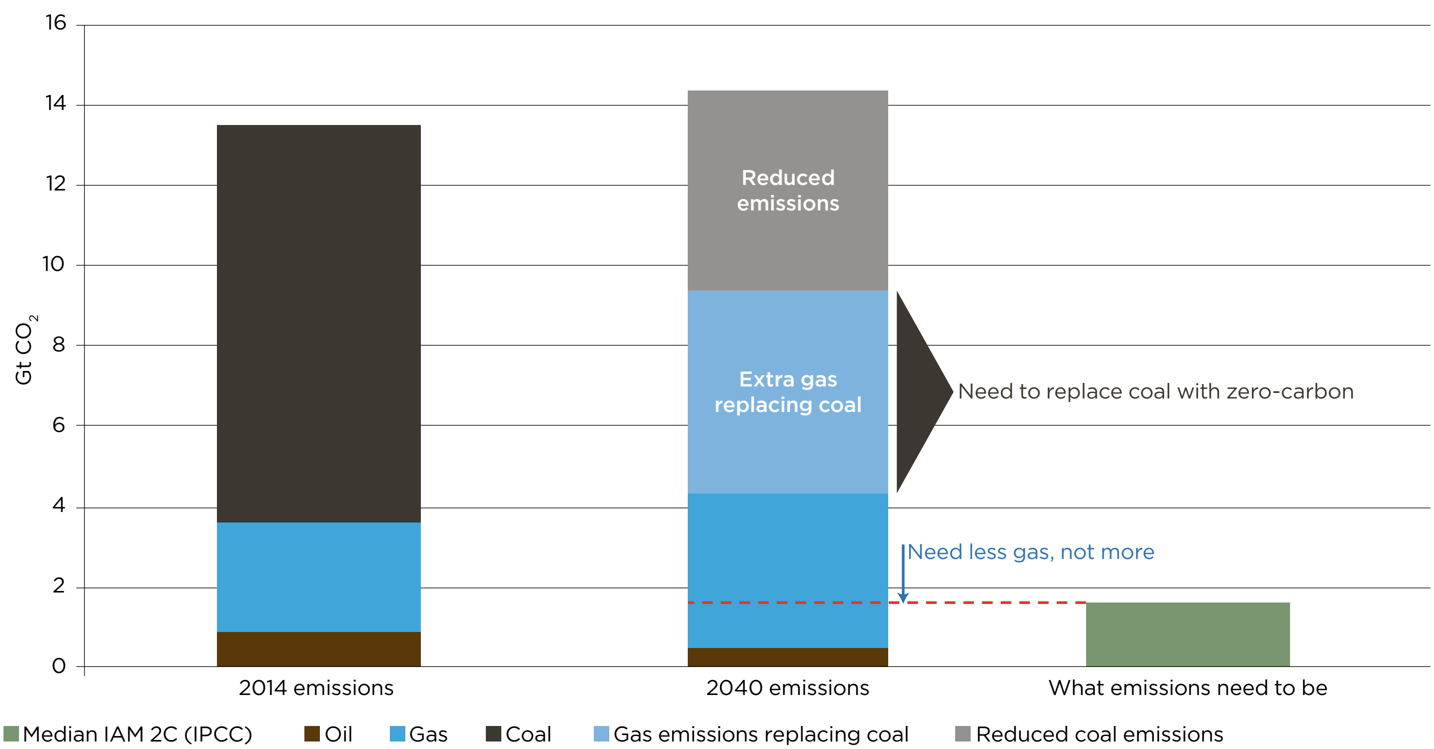
Much of the debate on fossil gas and climate has focused on measuring and reducing the leakage of methane, a potent greenhouse gas, to the atmosphere. But focusing on methane leakage alone distracts from the core issue at hand. To meet climate goals, fossil gas production and consumption must, like that of other fossil fuels, be phased out. Reducing methane leakage, even to zero, does not alter that fact.

Fossil gas proponents also argue that more gas capacity is needed to complement renewable energy sources. Several factors undermine this case, summarized as follows:[4]

1. **No Room for New Fossil Gas:** Climate goals require the power sector to be decarbonized by mid-century. This means gas use must be phased out, not increased (see Figure 1).
2. **New Gas is Holding Back Renewable Energy:** Wind and solar are now cheaper than coal and gas in many regions. This means new gas capacity often displaces new wind and solar rather than old coal.
3. **The Wrong Gas at the Wrong Time:** Claims that gas supports renewable energy development are false. The cheapest gas generation technology, Combined Cycle Gas Turbines (CCGT), is designed for base load operation, not intermittent peaking. In any case, most grids are a long way from renewable energy penetration levels that would require back up. Storage and demand response will be ready to step in by the time they are really required.
4. **New Gas Locks in Emissions for 40+ Years:** Companies building multibillion-dollar gas infrastructure today expect to operate their assets for around 40 years. Emissions goals mean this expectation cannot be met.
5. **Too Much Gas Already:** The coal, oil, and gas in the world's currently producing and under construction projects, if fully extracted and burned, would take the world far beyond safe climate limits. Opening new gas fields is inconsistent with the Paris climate goals.

The fact that methane leakage cannot be reduced to zero, and therefore emissions from fossil gas are in fact higher than is often accounted for, only makes the phasing out of fossil gas more urgent. By enabling an increase in production and consumption of fossil gas, the Jordan Cove LNG terminal and Pacific Connector Gas pipeline will contribute significant amounts of greenhouse gas emissions that will exacerbate climate change.

Figure 1: We Need Less Gas, Not More: Global Emissions from Power Generation (2014 and projected 2040 in IEA New Policies Scenario) Compared to Median IPCC 2040 Power Emissions Consistent With a Likely 2°C Scenario



Source: Oil Change International analysis, see Endnote 4.

PROJECT EMISSIONS ESTIMATED AT 36.8 MILLION METRIC TONS ANNUALLY

The lifecycle greenhouse gas emissions of the project depend on the amount of gas exported through it, and the methane and carbon emissions associated with extracting, piping, processing, transporting, and burning that volume of gas.

The Jordan Cove LNG terminal is expected to export 7.8 million tons of LNG per year.[5] This would require around 85 percent of the 1.2 billion cf/d capacity of the Pacific Connector pipeline.[6] However, the Jordan Cove Energy Project has signed agreements to use 95.8 percent of the pipeline's capacity. This allows for an additional 10 percent of pipeline capacity for seasonal fluctuations and to carry gas to run equipment at the LNG terminal. The greenhouse gas emissions estimate is therefore based on delivering 1.15 billion cf/d to Jordan Cove.

In our reference case, which utilizes a mean methane leakage rate of 1.77 percent across the gas supply chain, we estimate the total lifecycle emissions caused by the project to be over 36.8 million metric tons (MMT) of carbon dioxide equivalent (CO_2e) per year. This is equivalent to over 15.4 times the 2016 emissions from Oregon's only remaining coal plant, the Boardman coal plant, or equivalent to the annual emissions from 7.9 million passenger vehicles. The Boardman plant is scheduled to close in 2020 because of climate and air pollution concerns.[7]

Based on a peer-reviewed study of methane leakage for gas production in three Rocky Mountain states,[8] a high-end estimate brings the overall leakage rate to just over 4 percent. This would raise the annual lifecycle emissions from the project to nearly 52 million metric tons. This would be nearly 22 times the emissions from the Boardman coal plant, or equivalent to the annual emissions from 11.1 million passenger vehicles.

For Oregon's emissions inventory, emissions savings from shutting down Boardman will be cancelled out by this project.

Annual emissions within Oregon would be over 2.2 MMT, which is slightly less than the 2016 emissions from the Boardman plant. For Oregon's emissions inventory, emissions savings from shutting down Boardman will be cancelled out by this project. In fact, in-state emissions could be higher if the project leads to additional gas being transported on the GTN pipeline from Canada. This would increase emissions at GTN compressor stations located in Oregon.

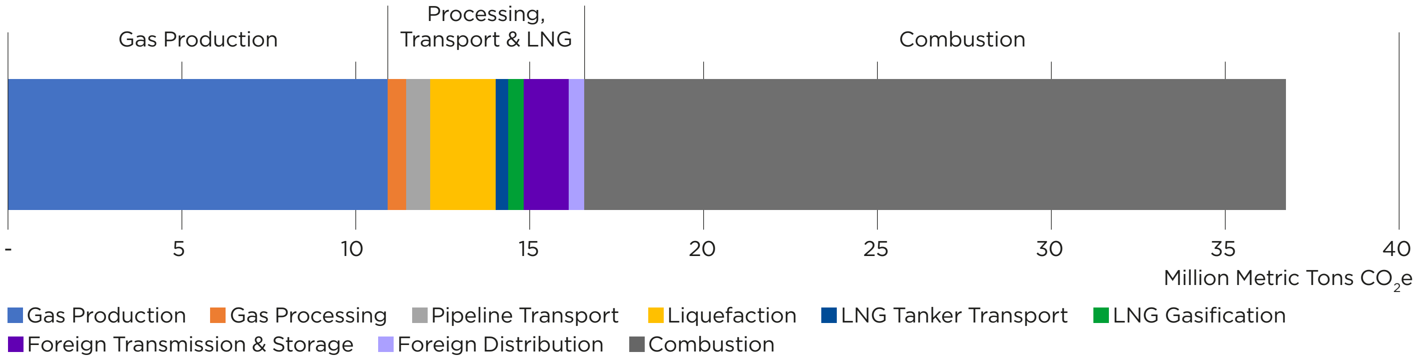
Outside of Oregon, emissions come from fracked gas production and processing, pipeline transport to the state line, tanker transport from Jordan Cove to destinations in Asia, transmission, distribution, and storage between the regasification facility

Table 1: Lifecycle GHG Emissions from Jordan Cove LNG and Pacific Connector Pipeline

Lifecycle Stage	Reference Case (MMT/Y)	High Case (MMT/Y)
Gas Production	10.9	26.0
Gas Processing	0.51	0.52
Pipeline Transport to Jordan Cove	0.78	0.78
Gas Liquefaction	1.8	1.8
Tanker Transport	0.44	0.44
LNG Gasification	0.40	0.40
Foreign Transmission & Storage	1.3	1.3
Foreign Distribution	0.43	0.43
Combustion	20.2	20.2
Total	36.8*	52.0*

*Figures may not add due to rounding.
Source: Oil Change International – See Appendix for details.

Figure 2: Full Lifecycle Emissions from Jordan Cove LNG and Pacific Connector Pipeline - Reference Case



Source: Oil Change International – See Appendix for details.

and points of final use, and finally the combustion of gas.

For methane leakage rates in the production zone, we reference a study published in *Environmental Science & Technology* in June 2017 by researchers from University of Wyoming and Colorado State University. That study quantified atmospheric methane emissions from active natural gas production sites in normal operation in four major U.S. basins/plays: Upper Green River (Wyoming), Denver-Julesburg (Colorado), Uintah (Utah), and Fayetteville (Arkansas).[9] The difference between our reference and high case estimates is primarily based on the difference between the middle and high measurements in the range of figures presented in this paper. However, we did make some downward adjustments to leakage rates in Colorado in both cases, in acknowledgment of new methane regulations in that state (see the Appendix for more details on leakage rates).[10]

For the pipeline and liquefaction emissions of the Jordan Cove and Pacific Connector project, we used emissions data from the latest project application.[11] Elsewhere in the supply chain, we used methane leakage rates based on EPA national averages where we did not have project-specific data. These figures likely underestimate leakage, leading to a conservative estimate of total emissions in our analysis.

We used a 20-year global warming potential factor of 86 to convert methane to carbon dioxide equivalent. For more details on methane assumptions and full details of sources and methods, please see the Appendix.

LNG EXPORTS WOULD HAVE NO EMISSIONS ADVANTAGE OVER COAL

As climate science indicates we must move as quickly as possible toward zero emissions, replacing coal with gas is clearly not a climate solution.[12] Nonetheless, the gas industry and its supporters continue to use this as a talking point, claiming that doing so would lead to a net reduction in emissions. However, even in the hypothetical scenario that every molecule of gas exported from Jordan Cove replaces coal in the destination market, the emissions associated with this project suggest that no net saving in greenhouse gas emissions would occur. In fact, the project could lead to higher net greenhouse gas emissions.

In 2014, the U.S. Department of Energy (DOE) released a "Life Cycle Greenhouse Gas Perspective on Exporting Liquefied Natural Gas from the United States."[13] The report, conducted by the National Energy Technology Laboratory (NETL), found that "compared to domestically produced and combusted gas, there is a significant increase in the lifecycle GHG emissions that are attributed to the LNG supply chain, specifically from liquefaction, tanker transport, and regasification processes."

Domestically, the current climate "break-even" point for lifecycle methane leakage is about 2.7 percent when switching from coal to gas for electricity over a 20-year lifecycle. That means that new gas combined cycle power plants reduce climate impacts compared to coal plants only when leakage remains under 2.7 percent.[14] Other estimates have put the domestic break-even point at 2.8 percent.[15]

When exporting LNG to Asia, the methane leakage rate must be significantly lower to have a "break-even" climate impact. The DOE/NETL report found that when comparing the climate impacts of LNG to coal-fired electricity in China, the lifecycle methane leakage rate would have to stay below 1.4 percent – when exporting LNG from New Orleans to Shanghai – to produce benefits over a 20-year timeframe.

NETL did not model lifecycle greenhouse gas emissions resulting from exporting LNG from the West Coast of the United States to Asian markets. Presumably, the climate break-even point would be slightly higher when exporting LNG from Oregon's Jordan Cove to Asia, given the closer geographic proximity. For comparison, the report found that the break-even point for LNG exports from New Orleans to Europe is 1.9 percent. Therefore, based on the DOE/NETL estimates, the climate break-even point for LNG exported from Jordan Cove to Asia is likely somewhere between 1.4 and 1.9 percent.

Our reference case estimate of methane leakage along the project's entire chain of supply is 1.77 percent. This is likely a conservative estimate as a number of factors could mean the real leakage rate is significantly higher (see Appendix). Even at this relatively low methane leakage rate, claims that greenhouse gas emissions are reduced by replacing coal in Asia with LNG exports from Jordan Cove are unsubstantiated, in part because the methane leakage associated with the project will likely be above the break event point.

FERC'S INADEQUATE CLIMATE ANALYSIS

The Federal Energy Regulatory Commission (FERC) is the primary federal agency that assesses the need for and impacts of interstate gas pipelines and LNG facilities, and it issues permits for construction and operation.[16]

FERC has yet to conduct an updated analysis of the Jordan Cove project, but we know FERC has repeatedly failed to fully assess and analyze the greenhouse gas emissions of the projects it permits. In August 2017, the Sierra Club together with landowners successfully overturned FERC's approval of the Southeast Market Pipelines Project, an interstate fossil gas pipeline project proposed through Alabama, Georgia, and Florida, based on inadequate information on greenhouse gas emissions in the project's environmental impact statement (EIS).[17] Although the project is already completed, the U.S. Court of Appeals vacated and remanded FERC's permits and ordered the agency to issue a supplemental EIS (SEIS) quantifying the project's downstream emissions.

FERC issued a draft of the SEIS in September 2017[18] and the Sierra Club filed detailed and scathing comments on the draft in November.[19] The Sierra Club comments not only call out the continuing inadequacy of FERC's climate emissions analysis, but also add clarity to the case for fully accounting for the entire emissions profile of fossil gas projects.

As in many of FERC's EIS documents, FERC preempts its discussion of greenhouse gas emissions and climate change in the draft SEIS with an assertion that the gas delivered by the project will replace dirtier fossil fuels, namely coal-fired power generation. The Sierra Club raises a number of points regarding this assumption that have salience for Jordan Cove LNG and similar proposed fossil gas infrastructure.

The Sierra Club argues that, to demonstrate that a project is instrumental to the retirement of other fossil fuel capacity, FERC must compare future scenarios with and without the project, rather than simply "juxtapos(ing) past conditions with a future in which the pipeline is built."[20]

A paper published in the international journal *Energy* in November 2017 discussed this issue in detail, specifically examining scenarios in which U.S. LNG is exported to Asia.[21] The paper found that the displacement of coal by LNG exports is far from a given, and that, as a result of U.S. exports of LNG, "emissions are not likely to decrease and may increase significantly due to greater global energy consumption, higher emissions in the US, and methane leakage."[22]

The Sierra Club comments also point out that accelerating projections of renewable energy adoption indicate that retiring coal capacity is not necessarily replaced with gas. Further, much of the coal generation capacity slated for retirement is old and inefficient. It is therefore typically operating far below capacity and likely to be retired whether a new gas pipeline is built or not. In this way, comparisons between retiring installed coal capacity and building new gas-fired capacity are misleading. For power plant emissions to be reduced by retiring coal and adding gas, new gas capacity would have to be run at similarly low utilization rates, which would likely not be economical. With no concrete analysis to back up its assumptions, FERC's attempt to discount gas pipeline emissions based on the offset of dirtier energy sources has no basis in fact.

The Jordan Cove Energy Project makes similar assertions regarding gas replacing coal, claiming that, "(n)atural gas is the cleanest-burning hydrocarbon available, and its transportation to other markets will allow consumers to move away from higher-emission fuels such as coal."[23] The company provides no evidence to support this.

Finally, as the "Climate and Fossil Gas" section explains, the premise that replacing coal with gas leads to positive climate outcomes is flawed. Emissions from fossil fuels need to be close to zero by mid-century to ensure a safe climate. Therefore, any new gas infrastructure built today will need to be replaced with zero emissions energy sources before it reaches the end of its economic life. With Jordan Cove currently scheduled to come online in 2024, investors would expect it to still be operating long after the transition to clean energy should be complete.

There is no evidence that the project would reduce emissions in line with the climate goals established by science - in fact, existing analyses point to the opposite. The 36.8 million tons of annual GHG emissions associated with the project must therefore be viewed as additional pollution that cannot be squared with any greenhouse gas reduction strategy.

There is no evidence that the project would reduce emissions in line with the climate goals established by science - in fact, existing analyses point to the opposite.

OREGON'S CLIMATE GOALS

In 2007, the Oregon legislature adopted goals to reduce climate pollution to 10 percent below 1990 levels in 2020 and at least 75 percent below 1990 levels by 2050.[24] According to these goals, Oregon's greenhouse gas emissions should be below 14.1 MMT in 2050. The state legislature is currently considering the "Clean Energy Jobs Bill," which creates a mechanism to reduce climate pollution in line with state goals.

These goals may fall below the targets set in the UNFCCC's Paris Agreement, which Governor Kate Brown committed to after President Donald Trump withdrew in 2017. The Paris Agreement commits to keeping global temperature rise "well below" 2 degrees Celsius (C) compared to pre-industrial levels and aims for a maximum temperature rise of 1.5°C. The latter goal requires global greenhouse gas emissions to fall to zero by around 2050, while the former (2°C) goal requires emissions to reach zero by about 2065.[25] According to the Oregon Global Warming Commission 2017 Report, Oregon is currently not on track to reach statutorily mandated emission reduction goals in 2020 or 2050.[26]

The total in-state annual emissions of the Jordan Cove Project, which only includes emissions from the LNG terminal, compressor stations, and leakage along the pipeline route, would be over 2.2 MMT, while the total lifecycle emissions of this project are over 36.8 MMT. The LNG terminal alone would emit over 1.8 MMT of greenhouse gas pollution a year, becoming the largest single source of climate pollution in the state of Oregon after 2020. If Oregon reaches its 2050 climate reduction goals, the in-state emissions of Jordan Cove will be equal to 16 percent of Oregon's total emissions, while the lifecycle greenhouse gas emissions will be over 261 percent.

In 2016, the Oregon legislature passed SB-1547, which requires investor-owned utilities to eliminate coal-fired power from Oregon by 2035 because of pollution and climate concerns. Only considering in-state emissions, the Jordan Cove LNG Export Terminal and the Pacific Connector Pipeline would be roughly equivalent to the Boardman coal plant, which is set to close in 2020 in order to meet emissions goals. Considering the total life cycle emissions, this project would be equivalent to over 15.4 Boardman coal plants.

If the state of Oregon's climate policies progress toward alignment with the goals of the Paris Agreement, as Governor Brown has stated she intends,[27] then the project's in-state emissions will constitute an increasingly large proportion of remaining allowable emissions, while providing no actual energy supply for the state. By mid-century, the project will have to be shut down – decades before investors expect the project's economic life to end. Finally, Oregon's commitment to climate leadership would be undermined by hosting a facility that supports unsustainable global emissions and undermines climate action in other regions.

The project's in-state emissions will constitute an increasingly large proportion of remaining allowable emissions, while providing no actual energy supply for the state.

Table 2: GHG Emissions of the Jordan Cove Energy Project as a Percentage of Oregon's GHG Emissions

		Jordan Cove Energy Project		
		LNG Terminal Emissions	Total Project In-State Emissions	Total Project Lifecycle Emissions
	MMT CO_2e per year	1.8	2.2	36.8
Oregon 2015 Emissions	63.4	2.9%	3.5%	58%
Oregon 2050 Goals (75% below 1990)	14.1	13%	16%	261%
Under 2 MOU[b] (2 MT per capita by 2050[c])	11.2	16%	20%	329%

Source: Oil Change International

b The Under 2 MOU, signed by Oregon Gov. Kate Brown in 2015, is a commitment by sub-national governments to reduce GHG emissions towards net-zero by 2050. Central to this is the public commitment by all signatories to reduce GHG emissions by 80-95% below 1990 levels, or to 2 metric tons of carbon dioxide-equivalent per capita, by 2050.
c Based on 5,588,500 Oregon estimated population in 2050. http://www.oregon.gov/das/OEA/Pages/forecastdemographic.aspx

CONCLUSIONS

This briefing provides a calculation and discussion of the greenhouse gas emissions of the Pacific Connector Gas Pipeline and Jordan Cove LNG Export Terminal proposed in the state of Oregon. It clearly shows that the project would add significantly to greenhouse gas emissions both in the state of Oregon and globally.

The analysis shows that methane leakage along the project's supply chain undermines any claim that the project would supply destination markets with cleaner fuel. In addition, the remaining global carbon budget has no room to replace coal with gas, even if methane leakage were zero. In fact, the expansion of fossil gas undermines renewable energy development.

The project would increase the flow of fossil gas to the global market and in doing so would run counter to the goals of the Paris Agreement on climate change. The project would undermine Oregon's potential to play a leadership role in addressing global climate change.

APPENDIX: METHODS AND SOURCES FOR ESTIMATING JORDAN COVE LNG GREENHOUSE GAS EMISSIONS

GENERAL OVERVIEW OF LIFECYCLE EMISSIONS

Lifecycle greenhouse gas emissions include a combination of combustion emissions from burning fossil gas, emissions from producing, processing, and transporting the gas, and methane leakage – the intentional or unintentional leakage of fossil gas into the atmosphere along the full supply chain. In the case of liquefied natural gas export, additional combustion and leakage emissions from liquefaction, tanker transport, regasification, and transport from the import terminal to the ultimate point of consumption must also be included.

Developing any estimate of potential lifecycle greenhouse gas emissions from a proposed project requires using a variety of sources and assumptions. An emissions factor of 117.1 pounds of CO_2 per thousand cubic feet for the combustion of fossil gas is well established and this comprises the largest proportion of total emissions.[28]

Estimates of emissions occurring upstream of the proposed project include the production and processing of fossil gas and are based on available peer-reviewed and government data. For the Pacific Connector pipeline and Jordan Cove terminal, emissions estimates for equipment to be installed, such as compressors and engines, or electricity to be consumed, are supplied in the project applications and environmental impact statement. Emissions occurring downstream or after the defined project's parameters must be determined using other available sources.

The production, processing, and transport of fossil gas requires energy. For example, diesel, gasoline, fossil gas, or electricity are consumed to run drilling rigs, trucks for materials transport, compressors for pipeline pressure, and many other processes that require engines, turbines, and other equipment. Much of the emissions estimates for these stages are derived from expectations of the fuel such equipment is expected to consume based on projected utilization rates and operating times.

In addition to these fuel-based emissions, the production and handling of fossil gas leads to significant quantities of the gas being emitted to the atmosphere uncombusted. Some of this is emitted as part of standard processes such as the blow down of pipelines during maintenance. These intentional emissions of fossil gas are considered 'venting.' Some gas escapes from valves and seals as a result of equipment wear and tear or malfunction and these emissions are considered 'fugitive.'

Fossil gas is primarily made up of methane (CH_4), a hydrocarbon that, pound for pound, is a more powerful heat-trapping gas than carbon dioxide (CO_2), the primary GHG that is causing global temperatures to rise and the climate to change. Because the measurement and analysis of GHGs is based on much more abundant CO_2, the impact of methane on the atmosphere is expressed as a carbon dioxide equivalent (CO_2e) according to its global warming potential (GWP).

CALIBRATING CH_4 WITH CO_2

The study of methane's impact on warming has evolved in the past decade and estimates of the GWP of methane have increased as more has been learned. Methane lasts about 12 years in the atmosphere while CO_2 lasts for centuries. To calibrate methane's impact with that of CO_2, two time horizons have been used: 20 years and 100 years.

We use the 20-year GWP timeframe and 86 GWP for methane from the Intergovernmental Panel on Climate Change's (IPCC) most current *Assessment Report 5* (AR5), because whereas CO_2 accumulates in the atmosphere over the long term, the impact of methane is felt in the short term. Its most important contribution to total warming occurs at the time of peak atmospheric CO_2 concentrations (i.e. net zero CO_2 emissions) – that is, when CO_2 has its greatest warming effect, and methane potentially adds to that maximum amount of warming. According to analyses of IPCC scenarios, net CO_2 emissions need to reach zero around 2050 to have a 50 percent chance of limiting warming to 1.5 degrees Celsius, and around 2065 to have a likely chance of staying below 2 degrees Celsius of warming.[29]

With those scenarios in mind, if the Jordan Cove plant operates from 2024 to 2064, the average molecule of methane will be emitted in 2044 – respectively six years or twenty-six years before peak CO_2 concentrations. As those molecules will have their greatest impact in the period immediately prior to or beyond the point at which CO_2 concentrations should peak, the shorter range GWP is the more relevant measure for the project's methane emissions.[30]

The 100-year GWP is most commonly used by government and industry. It calibrates the GWP of methane at 34 times that of CO_2. However, according to the IPCC: "There is no scientific argument for selecting 100 years compared with other choices. The choice of time horizon is a value judgement because it depends on the relative weight assigned to effects at different times."[31]

The U.S. Environmental Protection Agency (EPA) generally uses the 100-year metric.[32] We strongly urge the EPA and all federal government agencies assessing the impact of fossil gas systems to use the 20-year GWP to properly measure the impact of methane leaked to the atmosphere. This is particularly important at a time when the production of gas is growing so fast, driving increased gas consumption.

STAGES AND SOURCES FOR THE JORDAN COVE GHG ESTIMATE

The estimate of lifecycle emissions begins with fossil gas production and runs the entire journey of the gas through to combustion. In the case of the Jordan Cove LNG terminal, gas would be primarily produced from shale plays in either the Canadian or U.S. Rockies and be transported by pipeline to Malin on the southern Oregon border where the Pacific Connector pipeline would begin.

Project application documents were used for the emissions estimates for the Pacific Connector pipeline and the Jordan Cove LNG plant. The only change we made to these estimates was to convert CH_4 to CO_2e using the 20-year GWP discussed in the previous section.

Methane leakage estimates at the production stage were based on the latest available peer-reviewed science for gas produced in the Rocky Mountain states of Colorado, Utah, and Wyoming.[33] While gas for the project may also be sourced from Canada, data for Canadian production were not available.

The stages, rounded figures, emissions assessed, and data sources for the full lifecycle GHG emissions of the Jordan Cove Energy Project are summarized in Table A1. Calculations are based on producing 7.8 million tons of LNG per year (374.4 Bcf/y), the maximum the project can produce. Fossil gas reaching the project was set to 431.4 Bcf/y, or 95.8% of the maximum 1.2 Bcf/d capacity of the Pacific Connector pipeline, which is how much capacity the company has reserved. The initial volume of gas needed from the wellhead to supply that volume of gas to the project is 437.7 Bcf/y (after factoring in methane leakage). All GHG emissions are shown in million metric tons per year (MMT/Y).

The leakage rates from Table A3 and Table A4 were applied to the Production, Gas Processing, Foreign Transmission and Storage, and Foreign Distribution stages, and resulting emissions are shown as 'Reference Case' and 'High Case' emissions per lifecycle stage in Table A1. Data for combustion and leakage emissions for the Pacific Connector Pipeline and Jordan Cove liquefaction facility were taken from the respective FERC applications. Emissions from the Ruby Pipeline, which would feed gas to the Pacific Connector, were based on 77 percent (1.15 Bcf/d) of the total estimated emissions (0.523 MMT/Y) described in the project's FERC order.[34]

METHANE LEAKAGE RATE ESTIMATE

The gas arriving for liquefaction at Jordan Cove would be delivered by the proposed Pacific Connector Pipeline, which would connect to the Ruby and Gas Transmission Northwest Pipelines. While it is not known at this point exactly where that gas would come from, for purposes of estimating methane leakage, this analysis assumes that 100 percent of the gas will be sourced from the Rocky Mountains region – specifically from Colorado, Wyoming, and Utah, the three most productive Rocky Mountain states for natural gas.[35] This choice was made because, while gas could also come from the Montney Basin in British Columbia, there is a lack of peer-reviewed data sources about fugitive methane emissions from natural gas production in British Columbia.

Table A1: Lifecycle Stages, Emissions, and Sources for the Pacific Connector Pipeline and Jordan Cove Energy Project

Lifecycle Stage	Reference Case (MMT/Y)	High Case (MMT/Y)	Emissions Assessed	Sources
Gas Production	10.9	26.0	Methane emissions resulting from normal operations, routine maintenance, and system upset – mainly from gathering stations, pneumatic controllers, liquids unloading, and offshore platforms; and CO_2 emissions from fuel combustion.	Methane Leakage: Robertson, et al. in *Environmental Science & Technology*, June 2017. http://pubs.acs.org/doi/abs/10.1021/acs.est.7b00571 CO_2: International Institute for Sustainability Analysis and Strategy. http://iinas.org/tl_files/iinas/downloads/GEMIS/2014_Fracking_analysis_comparison.pdf
Gas Processing (dry-wet gas separation)	0.51	0.52	Methane emissions resulting from normal operations, routine maintenance, and system upsets – mainly fugitive emissions from compressors and seals.	Based on national EPA data in "Inventory of U.S. Greenhouse Gas Emissions and Sinks": https://www.epa.gov/sites/production/files/2017-02/documents/2017_complete_report.pdf
Transmission to Jordan Cove	0.78	0.78	CO_2, CH_4, and N_2O emissions from compressor station, pipeline, and meter stations associated with Pacific Connector and Ruby pipelines. Includes fugitive emissions, venting, and combustion-related emissions.	Emissions for PCGP based on project application. http://pacificconnectorgp.com/wp-content/uploads/2017/09/1.1-PCGP-Application-and-Exhibit.pdf For Ruby pipeline, estimate based on FERC certificate order. https://www.ferc.gov/CalendarFiles/20100405150436-CP09-54-000.pdf
LNG Liquefaction	1.8	1.8	CO_2, CH_4, and N_2O emissions from liquefaction operations, fugitive emissions, and on-site vessel fuel combustion.	Figures from Jordan Cove application. http://pacificconnectorgp.com/wp-content/uploads/2017/09/1.1-PCGP-Application-and-Exhibit.pdf
Tanker Transport	0.44	0.44	CO_2 emissions from fuel combustion.	Based on distance to Tokyo and Shanghai, and Jaramillo et al. http://www.ce.cmu.edu/~gdrg/readings/2005/10/12/Jaramillo_LifeCycleCarbonEmissionsFromLNG.pdf
LNG Gasification	0.40	0.40	CO_2 emissions from fuel combustion.	Based on: Jaramillo et al http://www.ce.cmu.edu/~gdrg/readings/2005/10/12/Jaramillo_LifeCycleCarbonEmissionsFromLNG.pdf
Foreign Transmission & Storage	1.3	1.3	Methane emissions resulting from normal operations, routine maintenance, and system upsets – fugitive emissions from compressor stations and venting from pneumatic controllers account for most of the emissions from this stage.	Based on EPA estimates in U.S. "Inventory of U.S. Greenhouse Gas Emissions and Sinks": https://www.epa.gov/sites/production/files/2017-02/documents/2017_complete_report.pdf
Foreign Distribution	0.43	0.43	Methane emissions resulting from normal operations, routine maintenance, and system upsets – mainly from fugitive emissions from pipelines and stations.	Based on EPA estimates in U.S. "Inventory of U.S. Greenhouse Gas Emissions and Sinks": https://www.epa.gov/sites/production/files/2017-02/documents/2017_complete_report.pdf
Combustion	20.2	20.2	CO_2 emissions from fuel combustion.	EPA Fuel Emissions Factors Assumptions https://www.epa.gov/sites/production/files/2015-08/documents/chapter_11_other_fuels_and_fuel_emission_factors.pdf
Total	36.8*	52.0*		

*Figures may not add due to rounding

Table A2: EPA Methane Leakage Rate Estimates from 2017 U.S. GHG Inventory

Lifecycle Stage	Leakage Rate
Field Production leakage	0.79%
Processing leakage	0.08%
Transmission and Storage leakage	0.25%
Distribution leakage	0.08%
Total leakage	1.20%

Source: Oil Change International

Table A3: Reference Methane Leakage Rate for Jordan Cove GHG Lifecycle Analysis

Lifecycle Stage	Leakage Rate
Field Production leakage	1.36%
Processing leakage	0.08%
Transmission and Storage leakage	0.25%
Distribution leakage	0.08%
Total leakage	1.77%

Source: Oil Change International

Table A4: High-End Methane Leakage Rate for Jordan Cove GHG Lifecycle Analysis

Lifecycle Stage	Leakage Rate
Field Production leakage	3.66%
Processing leakage	0.08%
Transmission and Storage leakage	0.25%
Distribution leakage	0.08%
Total leakage	4.08%

Source: Oil Change International

For stages of the process for which we did not have access to project-specific estimates for leakage – Processing, Foreign Transportation and Storage, and Foreign Distribution (see Table A1) – we used national level data from the U.S. EPA. Data from the EPA's latest GHG inventory would indicate that the U.S. national methane leakage rate is 1.2%.[36] That figure is a blended composite of all fossil gas production nationally, and does not account for regional variation. Table A2 shows the breakdown of EPA's methane emission estimates from all stages of the domestic fossil gas lifecycle.

For U.S. Rocky Mountain-specific methane leakage figures, this analysis looked to a recent peer-reviewed study published in *Environmental Science & Technology* in June 2017. The study was conducted by researchers from University of Wyoming and Colorado State University and quantified atmospheric methane emissions from active gas production sites in normal operation in four major U.S. basins/plays: Upper Green River (Wyoming), Denver-Julesburg (Colorado), Uintah (Utah), and Fayetteville (Arkansas) (Robertson et al. 2017).[37]

The emissions were measured within the basins on randomly chosen days in 2014 and 2015 from the University of Wyoming Mobile Laboratory utilizing the EPA's Other Test Method (OTM) 33a. The median methane leakage rates measured from the three Rocky Mountain basins during the field production stage were 0.18 percent (0.12–0.29%) in Wyoming, 2.1 percent (1.1–3.9%) in Colorado, and 2.8 percent (1.0–8.6%) in Utah.

The mean average of those field production leakage rates is 1.69 percent, with a high-end average of 4.26 percent, but it was determined for this study to make an adaptation. Since 2014, Colorado has implemented rules to reduce oil and gas methane emissions through air pollution control practices and technologies, including leak detection and repair (LDAR) requirements.[38] Therefore, the low-end of the range measured by the study in Colorado may be a fairer assessment of expected methane emissions for fossil gas production in the Denver-Julesburg basin than the median rate used for the other two states. Using the low end of the methane leakage range for Colorado, the average field production leakage rate in the Rocky Mountain states, as reported in Robertson et al., would be 1.36 percent, with a high-end average of 3.66 percent. The high end for Colorado was assumed to be the median leakage rate in the study (2.1 percent).

Based on national EPA data, but regionalized to account for field production methane emissions measured in the Rocky Mountains, the reference methane leakage rate for gas exported from Jordan Cove is 1.77 percent. The high-end methane leakage rate for gas exported from Jordan Cove is 4.08 percent.

CONSERVATIVE ASSUMPTIONS BAKED INTO LEAKAGE ESTIMATE

The leakage rate estimates presented in the preceding section are conservative in at least two ways. First, several studies have found that EPA emissions factors for leakage from existing fossil gas systems are too low. For example, a July 2015 study published in *Environmental Science & Technology* by researchers from University of Arkansas – Fayetteville, University of Houston, Purdue University, Aerodyne Research, Inc., Colorado State University, Carnegie Mellon University, and Environmental Defense Fund found that anthropogenic methane emissions from the oil and gas industry were 50 percent higher than estimates derived from the EPA inventory.[39]

More recent studies have measured leakage rates of between 4.2 and 8.4 percent in the Bakken shale region.[40] If domestic fossil gas processing and transmission emissions are higher than EPA estimates, the lifecycle leakage rate for Jordan Cove's LNG would be higher than this paper presents.

Second, this analysis used EPA's relatively low domestic leakage rate estimates for the transmission and storage and distribution stages, rather than rates in Asia, where those two stages of the fossil gas lifecycle would take place in the case of the Jordan Cove project. If the pipelines in Asian countries importing Jordan Cove's gas leak at higher rates than the EPA estimates for U.S. pipelines, the actual lifecycle leakage rate for Jordan Cove's LNG would be higher than our estimate.

Tanker emissions estimates were based on a paper from the Civil and Environmental Engineering Faculty at Carnegie Mellon University and amended based on the shipping distance between Jordan Cove and Shanghai and Tokyo. We assumed a 50/50 split of shipments between these two ports.

ENDNOTES

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The full calculations can be found in the spreadsheet available at http://bit.ly/JCLNG-GHGs.

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Exhibit 56

INTERNATIONAL GAS UNION
UNION INTERNATIONALE DU GAZ

2018 World LNG Report

27th World Gas Conference Edition

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Photo courtesy of Chevron

2. State of the LNG Industry[1]

293.1 MT
Global trade in 2017

Global Trade: For the third consecutive year, global LNG trade set a record, reaching 293.1 million tonnes (MT). This marks an increase of 35.2 MT (+12%) from 2016; the second largest ever, only behind the 40 MT increase of 2010. The increase in trade was supported by a corresponding increase in LNG supply, driven by Australian and US projects. With additional trains at Australia Pacific LNG, Gorgon LNG, and higher production from existing trains, Australia added 11.9 MT of production in 2017. United States production gains of 10.2 MT were driven entirely by Sabine Pass LNG, which added two new trains in 2017. Asia continued to be the driver of global demand, with China growing by 12.7 MT – the largest annual growth by a single country ever. This was driven by the strong environmental policy designed to promote coal-to-gas switching. The other key countries driving global LNG growth include South Korea, Pakistan, Spain, and Turkey for a combined 11.9 MT. The Pacific Basin continues to be the key driver of trade growth, with intra-Pacific trade flows reaching a record 125 MT, shaped by Australian production and Chinese demand.

88 MT
Non long-term trade, 2017

Short and Medium Term LNG Market (as defined in Chapter 8): Non long-term LNG trade reached 88.3 MT in 2017, an increase of 16 MT year-on-year (YOY) and accounted for 30% of total gross LNG trade. The substantial increase in short-term trade in 2017 can be attributed to growing LNG supply and demand elasticity.

New short-term supply largely came from ramp-ups in the Atlantic Basin, where new liquefaction capacity added during the year was contracted mostly to short-term traders and aggregators. Nearly 70% of exports from Sabine Pass LNG were traded on the non long-term market in 2017, and 100% of exports from the newly-restarted Angola LNG were sold under either spot or short-term contracts. Although China continues to receive volumes under new long-term contracts, the scale of its growth in 2017 meant that the country also had a substantial increase in short-term imports as well; the market's non long-term growth of 4.7 MT in 2017 was the largest of any importer.

$6.85/MMBtu
Average Northeast Asian spot price, 2017

Global Prices: Average Asian LNG prices (both spot and contracted) increased by $1.33 per million British thermal units (MMBtu) over 2016 owing to rising oil prices and stronger Pacific Basin demand, but most price markers experienced significant variation during the year. As new supply came online and slightly overwhelmed demand, LNG prices fell across the globe into the summer season, only to rise steadily in the second half of the year. After falling to $5.28/MMBtu in August 2017, landed Northeast Asian spot prices reached an average $9.88/MMBtu by January 2018 owing to the effects of a cold winter and strong demand from Chinese environmental regulation. The United Kingdom National Balancing Point (NBP) also experienced significant variation during the year, climbing from a low of $4.46/MMBtu in June to a high of $7.76/MMBtu in December. As prices rose globally, differentials between basins were similar to their level in 2016, with Asian spot prices spending a few notable months in the middle of the year at a discount to NBP again. However, by January 2018, Asian spot prices had climbed back to a $2.91/MMBtu premium to NBP.

[1] The scope of this report is limited only to international LNG trade, excluding small-scale projects, unless explicitly stated. Small-scale projects are defined as anything less than 0.5 MTPA for liquefaction, 1.0 MTPA for regasification, and 60,000 cm for LNG vessels. Domestic trade between terminals is also not included.

369 MTPA
Global nominal liquefaction capacity, March 2018

Liquefaction Plants: Global liquefaction capacity remains in the extended phase of build-out that began in 2016, driven largely by capacity in Australia and the United States. Between January 2017 and March 2018, 32.2 MTPA of liquefaction capacity was added. In engineering progress, the first floating liquefaction (FLNG) project came online in Malaysia, with additional FLNG projects set to come online during 2018 and beyond. Although no new liquefaction capacity had been added in Russia since Sakhalin 2 LNG T2 in 2010, the first train of Yamal LNG achieved commercial operations in March 2018 and is expected to ultimately add 17.4 MTPA of liquefaction capacity. Looking forward, Australia and the United States will continue to represent the majority of liquefaction capacity additions in the short term; including Wheatstone LNG, Prelude FLNG, and Ichthys LNG in the former; and Cove Point LNG, Freeport LNG, and Elba Island LNG in the latter. As of March 2018, 92.0 MTPA of liquefaction capacity was under construction. Only one project reached a final investment decision (FID) during 2017, Coral South FLNG (3.4 MTPA) – the first project to be sanctioned in Mozambique. While progress was made on other proposals, FID activity globally remains low in comparison to previous years.

875 MTPA
Proposed liquefaction capacity, March 2018

New Liquefaction Proposals: Although reaching FID has become a challenging prospect over the past few years, continued resource discovery and strong reserves have underpinned a growing list of proposed projects. As of March 2018, the total liquefaction capacity of proposed projects reached 875.5 MTPA, with the majority in the United States and Canada. Despite the large amount of proposed capacity in those two countries, the announcement in early 2017 by Qatar that it would lift the moratorium on production of its North Field to underpin new liquefaction trains, provides further potential supply. With many under-construction projects expected to contribute to strong global supply over the next few years, many developers have moved on to the early-2020s as the next available window in which to bring a new liquefaction project online.

851 MTPA
Global nominal regasification capacity, March 2018

Regasification Terminals: Global regasification capacity has continued to increase, rising to 851 MTPA by March 2018, out-pacing increases in liquefaction capacity. A total of 45 MTPA of regasification capacity was added during 2017, most of it during January 2017, as terminals that had been completed during 2016 began commercial operations. The key additions made during the second half of 2017 were all in Asia, including Pakistan, Thailand, and Malaysia. No new markets added large-scale regasification capacity during the year, for the first time in ten years[2]. Along with the rapid increase in liquefaction capacity expected through the end of the decade, additional regasification capacity is expected to be constructed. Additions will be in both mature markets which are experiencing increased gas demand, as well as in new markets where governments have made developing gas demand a priority. There remains an additional 87.7 MTPA of regasification capacity under construction as of March 2018. This includes capacity across several new markets, such as Bahrain, Bangladesh, Panama, the Philippines, and Russia. Of under-construction capacity, 37.7 MTPA of capacity is anticipated online during 2018, much of it in China.

84 MTPA[3]
FSRU capacity, March 2018

Floating Regasification: Three FSRU projects came online during 2017, boosting total regasification capacity of floating projects to 84 MTPA. A terminal at Pakistan's Port Qasim added 5.7 MTPA, and Turkey's first floating project, the Etki terminal, began operations in January 2017. As of March 2018, seven FSRUs were under construction. Many of these projects are in new markets, including Bahrain, Bangladesh, and Panama, showing the continued use of floating technologies to access new sources of demand. Other projects, such as those in India and Turkey, highlight the use of FSRUs in quickly addressing growing demand. As of January 2018, nine FSRUs were on the order book of shipbuilding yards. Furthermore, several FSRUs were open for charter, with some being used as conventional LNG carriers, indicating no immediate shortage of vessels for floating terminals.

478 Vessels
LNG fleet, end-2017

Shipping Fleet: The global LNG shipping fleet consisted of 478 vessels at the end of 2017, including conventional vessels and ships acting as FSRUs and floating storage units. In 2017, a total of 27 newbuilds (including three FSRUs) were delivered from shipyards. Relative to the previous year, this was a much more balanced addition relative to liquefaction capacity, but the accumulation of the tonnage buildout from the previous years kept short-term charter rates low for most of 2017. However, toward the end of the year, an increase in Asian spot purchases led short-term charter rates to rise; by December 2017, rates for dual-fuel diesel electric/tri-fuel diesel electric (DFDE/TFDE) tankers reached an average $81,700/day.

9.8% of Supply
Share of LNG in global gas supply in 2016[4]

LNG in the Global Gas Market: Natural gas accounts for just under a quarter of global energy demand, of which 9.8% is supplied as LNG. Although LNG supply previously grew faster than any other natural gas supply source – averaging 6.0% per annum from 2000 to 2016 – its market share growth has stalled since 2010 as indigenous production and pipeline supply have competed well for growing global gas markets. Despite the lack of market share growth in recent years, the large additions of LNG supply through 2020 mean LNG is poised to resume expansion.

[2] While Malta began LNG imports in 2017, its regasification terminal is small-scale at 0.4 MTPA of capacity, and thus is not included in regasification capacity totals, but is included in the trade balance.
[3] This 84 MTPA is included in the global regasification capacity total of 851 MTPA quoted above.
[4] Data for pipeline trade and indigenous gas production comes from the BP Statistical Review. Data for 2017 is not yet available.

Exhibit 57

Current Applications

Coos County

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Applications Available for Comment:

Applicant (Click name for details & Full Application)	Application Number	Status	Waterbody	Location	Activity Type (Click for descriptions)	Comments
Coquille Watershed Association	APP0061819	Technical Review	Coquille R	28S13W18	R/F (Culv,RemFill,Tidegate)	View | Add
Coquille Watershed Association	APP0061820	Technical Review	Baker Cr	31S12W03	R/F (FishHabit,RemFill)	View | Add
Robinson Concrete Pumping	APP0061288	Technical Review	Tenmile Lk	23S12W20CD	R/F (Dock,OverWater,Piling)	View | Add

Applications Not Yet Available for Comment:

Applicant (Click name for details & Full Application)	Application Number	Status	Waterbody	Location	Activity Type (Click for descriptions)
AT&T Corp.	APP0061818	Application Review	Pacific O	27S14W08	R/F (Cbl,Removal)
Southport Forest Products LLC	APP0061629	Application Review	Coos Bay	25S13W07DD	R/F (Piling,RemFill)
Sugarman Stan	APP0060181	App. - Awaiting App/Notif Revision	Fishtrap Cr	28S13W33	R/F (ErosionCon,Fill,Road)
Tenmile Lakes Basin Partnership	APP0061806	App. - Awaiting App/Notif Revision	Shutter Cr	23S12W29BC	GP ()

Applications No Longer Available for Comment:

Applicant (Click name for details & Full Application)	Application Number	Status	Waterbody	Location	Activity Type (Click for descriptions)	Comm
Coos Bay City of	APP0061778	Technical Review	Coal Bank Sl	25S13W34DD	R/F (ErosionCon,Pipeline,RemFill,Util)	Viev
Jordan Cove Energy Project LP	APP0060697	App. - Extension	Wetland/Coos R/Rogue R/Klamath R	25S13W04	R/F (Pipeline,RemFill)	Viev
Lyon Construction LLC	APP0061291	App. - Extension	Tenmile Lk	23S12W21CB	R/F (Dock,OverWater,Piling,RemFill)	Viev

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Applicant (Click name for details & Full Application)	Application Number	Status	Waterbody	Location	Activity Type (Click for descriptions)

Recent NSP (Voluntary Restoration) Notifications:

Applicant (Click name for details & Full Application)	Application Number	Status	Waterbody	Location	Activity Type (Click for descriptions)

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Current Applications

Coos County

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Applications Available for Comment:

Applicant (Click name for details & Full Application)	Application Number	Status	Waterbody	Location	Activity Type (Click for descriptions)	Comments
Jordan Cove Energy Project LP	APP0060697	Technical Review	Wetland/Coos R/Rogue R/Klamath R	25S13W04	R/F (Pipeline,RemFill)	View | Add

Applications Not Yet Available for Comment:

Applicant (Click name for details & Full Application)	Application Number	Status	Waterbody	Location	Activity Type (Click for descriptions)
Ballard Shellfish Co.	APP0061387	App. - Awaiting App/Notif Revision	Coos Bay	25S13W08	R/F (Fill,FloatStruc,Other ,OverWater)
Robinson Concrete Pumping	APP0061288	App. - Awaiting App/Notif Revision	Tenmile Lk	23S12W20CD	R/F (Dock,OverWater,Piling)
Southport Forest Products LLC	APP0061629	App. - Awaiting App/Notif Revision	Coos Bay	25S13W07	R/F (Piling,RemFill)
Sugarman Stan	APP0060181	App. - Awaiting App/Notif Revision	Fishtrap Cr	28S13W33	R/F (ErosionCon,Fill,Road)

Applications No Longer Available for Comment:

Applicant (Click name for details & Full Application)	Application Number	Status	Waterbody	Location	Activity Type (Click for descriptions)	Comments
Bandon Port of	APP0061566	Technical Review	Coquille R	28S14W30	R/F (Fill,OverWater)	View
Georgia Pacific West LLC	APP0061457	App. - Extension	Isthmus Sl	25S13W35	R/F (Piling,RemFill)	View
Lyon Construction LLC	APP0061291	Technical Review	Tenmile Lk	23S12W21CB	R/F (Dock,OverWater,Piling)	View
North Bend City of	APP0061371	Technical Review	Wetland/Coos Bay	25S13W15AA	R/F (BoatRamp,Dock,Piling,PublicUse,RemFill)	View

Recent GA Notifications:

Applicant (Click name for details & Full Application)	Application Number	Status	Waterbody	Location	Activity Type (Click for descriptions)
Lyon Construction LLC	APP0061725	Application Review	Tenmile Lk	23S12W09BA	GA (OverWater)
Lyon Construction LLC	APP0061746	Application Review	Tenmile Lk	23S12W10BB	GA (OverWater)

Recent NSP (Voluntary Restoration) Notifications:

Applicant (Click name for details & Full Application)	Application Number	Status	Waterbody	Location	Activity Type (Click for descriptions)

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Exhibit 58

CP13-483

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue, Suite 900
Seattle, WA 98101-3140

OFFICE OF
ECOSYSTEMS,
TRIBAL AND PUBLIC
AFFAIRS

ORIGINAL

August 18, 2015

The Honorable Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E., Room 1A
Washington, DC 20426

Dear Ms Bose:

The U.S. Environmental Protection Agency (EPA) is providing comments about the Jordan Cove Liquefaction and Pacific Connector Pipeline Project (EPA Project Number 12-0042-FRC), which specifically pertain to the management of dredged material excavated during maintenance of the proposed facility (FERC Docket: CP13-483-000).

The purpose of this letter is to provide detail and clarity on expectations for analysis and management of Coos Bay Dredged Material Disposal Sites. These comments support and expand EPA's previous comments as they have pertained to EPA's responsibilities under Section 102 and Section 103 of the Marine Protection, Research, and Sanctuaries Act (MPRSA). The EPA provided comments to the Federal Energy Regulatory Commission (FERC) and the U.S. Army Corps of Engineers (USACE) on this topic on October 29, 2012 (National Environmental Protection Act scoping letter), January 12, 2015 (USACE Public Notice), and February 11, 2015 (Draft Environmental Impact Statement).

Jordan Cove's Dredged Material Management Plan (May 2013) provides a cursory analysis of volume, grain size, and disposal options for the maintenance dredged material. Although the Dredged Material Management Plan discusses these three variables, there will continue to be uncertainty about whether material would be suited for Coos Bay Ocean Dredged Material Disposal Site F (Site F), Coos Bay Ocean Dredged Material Disposal Site H (Site H), or both. Also, there will be uncertainty about the volume of dredged material that would need to be disposed during each maintenance event, and when the first maintenance dredging event would occur. Given these uncertainties, EPA has not been provided sufficient information to state that Site H and/or Site F is a suitable disposal site for the duration of the FERC license. The analysis and assumptions provided in the Dredged Material Management Plan are potentially sufficient for the first maintenance dredging event as long as the assumptions, i.e., grain size and volumes, do not change.

When considering the disposal options for dredged material beyond the first maintenance event, the project proponent should understand that Site F and Site H do not have unlimited capacity. Capacity of these two sites depends upon several factors, all of which change through time (most notably, the volume of material dumped at the sites and winter storm events which move the material offsite). Thus, it is imperative that the project proponent conduct a thorough analysis of the ability of these two disposal sites to accept the volumes of maintenance dredged material, the consequences of disposal on the physical conditions of the site(s), and the consequences for those entities that currently use the sites for disposal of dredged material. The primary user of Site F and Site H is the USACE for their maintenance of the Federal Navigation channels in Coos Bay. The Oregon International Port of Coos Bay also has requested and received a permit from USACE, with EPA concurrence, to dispose of dredged material at both Site F and H, as appropriate.

Prior to formally initiating a request for a MPRSA Section 103 permit from the USACE, the project proponent must complete site capacity assessments for both Site F and Site H. The project proponent must include the EPA and the USACE Ocean Dumping Coordinators in the development of the assessments. A site capacity assessment includes, at a minimum: 1) a timeframe upon which to conduct an analysis. This would range between 10-20 years; 2) an analysis of how the proposed disposal changes the bathymetry and sediment dynamics at the ODMDSs; 3) an analysis as to how the proposed disposal affects the longevity of the ODMDS; and 4) an analysis of the how the proposed disposal alters the availability of the ODMDSs for the current users.

This analysis would determine whether Site F and/or Site H is appropriate for disposal of Jordan Cove's maintenance dredged material. Should the analysis conclude that Site F and/or Site H could not accommodate the maintenance dredged material, the project proponent would need to coordinate with EPA to designate a new ODMDS. The EPA's designation process for an ocean disposal site (40 CFR Part 228) is an approximately 5 year process. Thus, the project proponent would need to begin discussions with EPA and the USACE at least 7 years prior to the anticipated second maintenance dredging event.

Please feel free to contact me at (206) 553-1601 or by email at reichgott.christine@epa.gov, or you may contact Bridgette Lohrman of my staff at (503) 326-4006 or by email lohrman.bridgette@epa.gov if you have any questions about the content of this letter.

Sincerely,

Christine B. Reichgott

Christine B. Reichgott, Manager
Environmental Review and Sediment Management Unit

cc: Paul Friedman, FERC
Wendy Briner, USACE
Kate Groth, USACE
Tyler Krug, USACE

Exhibit 59

Continental Shelf Research 95 (2015) 1–14

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Research paper

The impact of channel deepening and dredging on estuarine sediment concentration

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A R T I C L E I N F O

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A B S T R A C T

Many estuaries worldwide are becoming more urbanised with heavier traffic in the waterways, requiring continuous channel deepening and larger ports, and increasing suspended sediment concentration (SSC). An example of a heavily impacted estuary where SSC levels are rising is the Ems Estuary, located between the Netherlands and Germany. In order to provide larger and larger ships access to three ports and a shipyard, the tidal channels in the Ems Estuary have been substantially deepened by dredging over the past decades. This has led to tidal amplification and hyper concentrated sediment conditions in the upstream tidal river. In the middle and outer reaches of the Ems Estuary, the tidal amplification is limited, and mechanisms responsible for increasing SSC are poorly understood. Most likely, channel and port deepening lead to larger SSC levels because of resulting enhanced siltation rates and therefore an increase in maintenance dredging. Additionally, channel deepening may increase up-estuary suspended sediment transport due to enhanced salinity-induced estuarine circulation.

The effect of channel deepening and port construction on SSC levels is investigated using a numerical model of suspended sediment transport forced by tides, waves and salinity. The model satisfactorily reproduces observed water levels, velocity, sediment concentration and port deposition in the estuary, and therefore is subsequently applied to test the impact of channel deepening, historical dredging strategy and port construction on SSCs in the Estuary. These model scenarios suggest that: (1) channel deepening appears to be a main factor for enhancing the transport of sediments up-estuary, due to increased salinity-driven estuarine circulation; (2) sediment extraction strategies from the ports have a large impact on estuarine SSC; and (3) maintenance dredging and disposal influences the spatial distribution of SSC but has a limited effect on average SSC levels.

1. Introduction

Many estuaries worldwide have been modified in the past decades to centuries, in order to reclaim land and to allow ever larger ship access to inland waterways. These interventions include channel deepening and straightening as well as reclamation of the intertidal area, frequently leading to a combination of tidal amplification, increasing estuarine circulation, and increasing flood-dominance of tidal asymmetry (Winterwerp and Wang, 2013; Winterwerp et al., 2013). All of these mechanisms lead to increased residual transport. Tidal amplification strengthens the ebb and the flood tide transports, and consequently also the difference between ebb and flood (in case of an asymmetric tide). For example, a flood-dominant estuary will then become more flood-dominant. An increase in the flood dominance of the tides strengthens the flood flow velocities and weakens ebb flow velocity. Sediment transport increases non-linearly with the flow, leading to larger flood tide transport. Estuarine circulation leads to up-estuary transport; any increase herein therefore enlarges the up-estuary sediment transport. Which of these mechanisms is more important is site-specific, depending on the tidal regime, fresh water supply and sediment type. As a result of larger up-estuary sediment transport, in most (if not all) estuarine systems, the suspended sediment concentration has strongly increased. Some examples are the Ems River (Winterwerp et al., 2013; de Jonge et al., 2014), the Elbe (Kerner, 2007; Winterwerp et al., 2013), the Weser (Schrottke et al., 2006), and the Loire (Walther et al., 2012; Winterwerp et al., 2013).

The response of estuarine suspended sediment concentrations caused by anthropogenic influences is still poorly known. Decadal time-series documenting long-term changes in suspended sediment concentrations are rare (Fabricius et al., 2013). Additionally, many of these anthropogenic measures took place gradually and

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concurrently, and the response of estuarine suspended sediment dynamics to these changes may be slow (Winterwerp et al., 2013) and difficult to separate. Lastly, estuarine suspended sediment dynamics are complex, with up-estuary transport usually dominated by a combination of different physical mechanisms. Up-estuary decreasing salinity gradients generate an up-estuary directed near-bed flow velocity and down-estuary directed surface flow (estuarine circulation: Hansen and Rattray, 1965) which, combined with typical higher near-bed sediment concentrations, generates up-estuary sediment transport. This type of vertical circulation is relevant for fine sediment transport when this mechanism maintains (partial) stratification; in well-mixed estuaries horizontal circulation tends to develop at the expense of vertical circulations (Dyer, 1994). Estuarine circulation may be strengthened by tidal straining (differential advection of salinity by a vertical velocity shear; Simpson et al., 1990), demonstrated by Burchard and Baumert (1998) to enhance up-estuary transport, as well as by tidal asymmetry in internal mixing (Jay and Musiak, 1994). An asymmetry in the tidal velocity field may also lead to up-estuary sediment transport when the duration of High Water (HW) slack exceeds the period of Low Water (LW) slack or when the duration of the flood is shorter than that of the ebb (Friedrichs and Aubrey, 1988). Spatial variations further contribute, with settling lag generating landward sediment transport in response to landward decreasing flow velocities (Postma, 1961) or water depth (van Straaten and Kuenen, 1957). A time-variation in sediment properties (mainly due to flocculation and consolidation) further adds to the complexity (Scully and Friedrichs, 2007; Winterwerp, 2011). The relative contribution of these mechanisms differs per estuary, but may also change in time as a response to human interventions (Winterwerp, 2011).

In addition to influencing hydrodynamics and thereby long-term sediment transport processes, deepening (and port construction) in turbid estuaries will also increase siltation rates and, as a result, maintenance dredging needs and disposal. On the short term, maintenance dredging leads to increasing concentration levels in the direct vicinity of the dredging vessel (e.g. Collins, 1995; Pennekamp et al., 1996; Mikkelsen and Pejrup, 2000; Smith and Friedrichs, 2011). In the long-term, the effects of dredging on SSC is dominated by more complex mechanisms related to the water–bed interaction such as buffering of fines in the sandy seabed (van Kessel et al., 2011a), which is more difficult to quantify (van Kessel and van Maren, 2013). Most studies related to the effect of dredging originate from coral reef and seagrass environments, where their impact is most detrimental; see reviews by Erftemeijer and Lewis, 2006 (seagrass) and Erftemeijer et al., 2012 (corals). However, the question remains, to what extent dredging influences a long-term increase in suspended sediment concentrations (apart from its short-term impact), for the Ems Estuary and other systems. Finally, deepening allows larger ship access and often also to more intense ship traffic. Therefore resuspension by ships is likely to enhance suspended sediment concentrations further (van Houtan and Pauly, 2007; Aarninkhof, 2008).

Given the scarcity of available data over sufficiently long timescales, the wide range of human impacts, and the non-linear behaviour associated with sediment transport processes, a quantitative assessment of changes in suspended sediment concentration in an estuary caused by human activities is challenging. In this paper we use a numerical model to systematically investigate the individual contributions of deepening and dredging on suspended sediment dynamics in a heavily influenced estuary (the Ems Estuary) for which a reasonably large amount of data (recent and historical) exists. Existing process studies focussed on the tidal river draining into the larger estuary (the lower Ems River), in which changes in tidal dynamics are dominant and the suspended sediment concentrations increased several orders of magnitude in the past 3 decades. The conclusions of these studies are based on (semi-) analytical idealised models, revealing the role of sediment-induced density currents (Talke et al., 2009) settling lag (Chernetsky et al., 2010), deepening and hydraulic roughness (Winterwerp et al., 2013) and the potential role of the length (Schuttelaars et al., 2013) and depth (de Jonge et al., 2014) of the tidal river. Observations by de Jonge (1983) in the Ems Estuary suggest an increase in SSC as a result of dredging activities, but available data is limited, and collected in a period when construction work simultaneously took place. Despite large amounts of dredging, knowledge on the effect of deepening in the outer estuary as well as the effect of dredging and subsequent release on long-term SSC remains limited. A model approach to simulate long-term sediment dynamics, recently developed by van Kessel et al. (2011a), provides a tool to obtain better insight in the relative importance of dredging and subsequent disposal (van Kessel and van Maren, 2013), in the short term as well as the long-term.

This paper aims to better understanding the relative role of deepening and dredging on the sediment dynamics in the Ems Estuary in quantitative terms. We will first introduce the Ems Estuary, and describe the historical changes in suspended sediment concentration during dredging and deepening of the estuary. In the following section, the model is introduced and calibrated (Section 3) with which the effect of dredging and deepening is further quantified and analysed (Section 4).

2. The EMS estuary

The Ems estuary, situated on the Dutch–German border (Fig. 1), is an estuary which has undergone large anthropogenic changes in the past decades to centuries. Land reclamations carried out in the past 500 years have greatly reduced the intertidal area. Since 1650, the size of the Ems Estuary (the subtidal, intertidal and intratidal area) up to Eemshaven (between km 35 and 70; see Fig. 1 for location) decreased by 40% from 435 to 258 km^2 (Herrling and Niemeyer, 2007). The combined intertidal and supratidal area decreased by 45% from 285 to 156 km^2. Infilling is mostly of marine origin (the Wadden Sea and/or North Sea); the sediment load carried by the Ems River or smaller local rivers is very small. Human interferences in the estuary have accelerated in the past 50 years, with the construction/extension of three ports (Eemshaven, Delfzijl and Emden) and a large shipyard (Papenburg). The present-day approximate maintenance depths of the approach channels to the ports are 12 m (Eemshaven), 10 m (Delfzijl) and 11 m (Emden), requiring regular maintenance dredging. The tidal channels in the Ems Estuary were historically organised as distinct ebb- and flood-channels (van Veen, 1950). Some of these channels have degenerated as a result of channel deepening, effectively transforming parts of the estuary (especially its middle reaches; see Fig. 1 for location) into a single-channel system. Channel deepening affects tidal propagation, typically increasing the tidal range; which in turn leads to higher turbidity levels (Uncles et al., 2002). Deepening, but especially port construction, leads to more maintenance dredging and subsequent sediment dispersal; de Jonge (1983, 2000) suggests that this has significantly influenced the average turbidity levels. In this section, we will illustrate changes in bathymetry, sediment concentrations, and dredging in more detail.

The impact of human activities is most pronounced in the lower Ems River, a tidal river draining into the Ems estuary (see Fig. 1). The water depth increased from 4 m below MHW (circa 1960) up to 7.5 m below MHW (present day), leading to a strong tidal amplification and increasing suspended sediment concentrations. While suspended sediment concentrations were typically 10s to 100s of mg/l in the 1950's (Postma, 1961) and 1970s

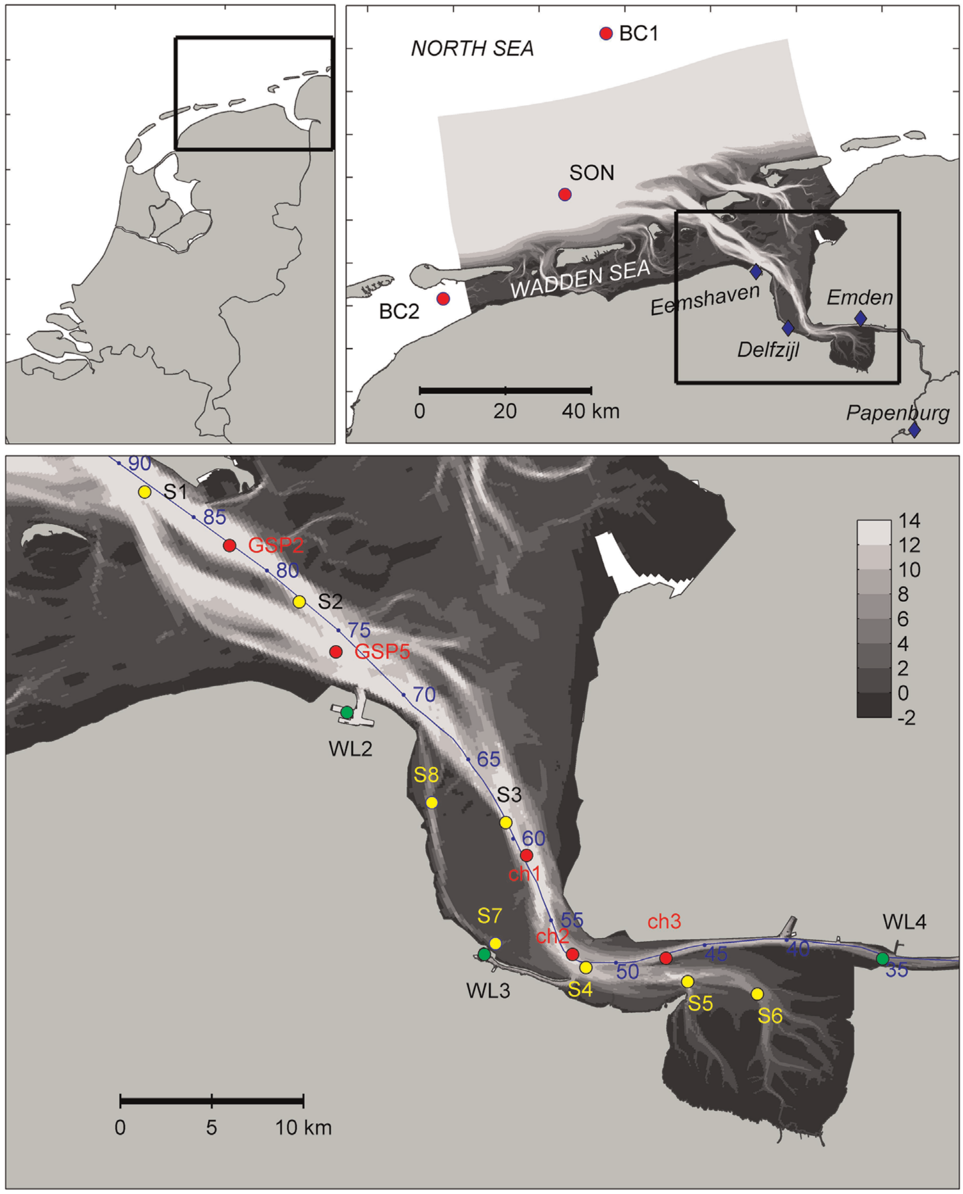

Fig. 1. Top right: map of the Ems estuary and model domain with the ports of Emden, Delfzijl, and Eemshavenand observation stations for waves (SON) and salinity (BC1 and BC2). Lower panel: more detailed map with observation stations Yellow dots stations indicate suspended sediment concentration observation points, green dots are water level observation points, and red dots represent flow velocity observations and model output. The blue markers and numbers are Ems kilometres, a standard reference in the estuary. Only the bed level between −2 and 14 m is shown to highlight the difference in tidal flats and channels, but the channels and offshore sea may be up to 30 m deep. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

(de Jonge et al., 2014), the present-day lower Ems River is characterized by thick fluid mud deposits with concentrations in the order of 10s to 100s of g/l (Talke et al., 2009; Wang, 2010; Papenmeier et al., 2013). Large quantities of fine sediment are transported from the Ems estuary into the lower Ems River by a combination of density-driven flow (Talke et al., 2009, Donker and de Swart, 2013), lag effects (Chernetsky et al., 2010) and various types of tidal asymmetry (Winterwerp, 2011), possibly strengthened by tidal resonance after construction of an up-estuary weir (Schuttelaars et al., 2013). However, it remains unclear to what extent changes in the lower Ems River affect the Ems estuary. The high turbidity zone of the lower Ems River may be partly flushed into the Ems estuary during large winter discharge events (Postma, 1981, de Jonge et al., 2014). On the other hand over 1 million tons of fine sediment are extracted annually from the lower Ems River (Krebs and Weilbeer, 2008) potentially reducing the suspended sediment concentration in the Ems estuary.

Four standardized measurement locations exist in the Ems estuary, which are regularly sampled as part of the standard Dutch Monitoring Programme (hereafter called MWTL, see locations in Fig. 1). Measurements started in the early 1970s, but before 1990 the sampling strategies and methods regularly changed. Since 1990, the suspended matter is clearly increasing (Fig. 2) – statistical analyses reveal that this increase is statistically significant at the 95% confidence level (Vroom et al., 2012).

The most dramatic changes that took place in the estuary itself (excluding the lower Ems River) were deepening of the tidal channels and changes in dredging volumes and strategy. North of km 610 (Fig. 3), the morphological change is mainly reflected in laterally migrating channels. However, in the narrow section (between km 595 and 605), the main navigation channel became consistently deeper, whereas a degenerated tidal channel west of the main channel continually filled up with sediment (both with several metres).

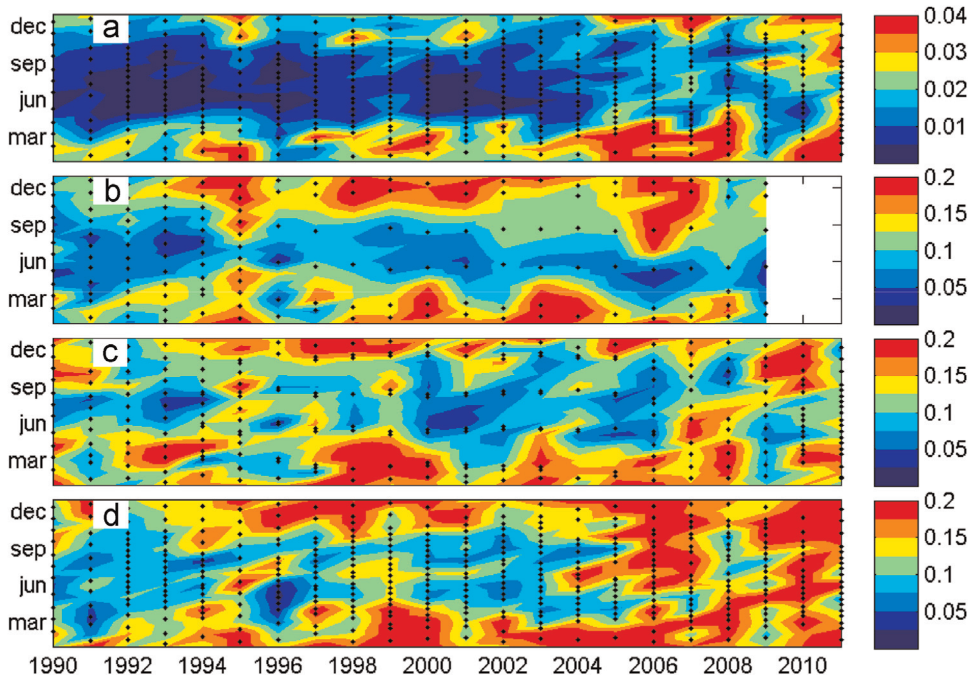

Fig. 2. Timestack plot of suspended sediment concentration in kg/m^3 in S1 (a; most seaward station), S8 (b), S7 (c), and S6 (d; most landward station); see Fig. 1 for locations. Observations at S8 were discontinued in 2010.

Since the 1960s the dredging activities in the Ems estuary have increased significantly (Fig. 4). The dredging volume is the amount of sediment that is removed from the seabed. This sediment can be extracted (when sediment is brought on land) or dispersed (when the sediment is disposed on dumping grounds elsewhere in the estuary). Sediment can be extracted for navigational purposes or for sand mining; the latter by definition meaning extraction. There have also been several changes in dredging strategies over the past decades. Most of the dredged sediment is muddy (Mulder, 2013).

An important observation is that the total dredging volume was at its peak in the 1970s and 1980s ($\sim$18 million m^3), but has decreased since then to $\sim$10 million m^3. Surprisingly, the amount of dispersed sediment has remained fairly constant (at $\sim$8 million m^3). The main change is related to sediment extraction. Between 1960 and 1994, 5.1 million m^3/year on average was extracted from the port of Emden (1.5 million m^3/year) and fairway (3.6 million m^3/year). Since 1994, sediment is no longer dredged from the port of Emden, but instead regularly re-aerated, thereby preventing consolidation. The resulting poorly consolidated bed remains navigable, and consequently the port no longer requires maintenance dredging (Wurpts and Torn, 2005). Sediment is still extracted from the lower Ems River. Since the early 1980s, the yearly dredged volume in the lower Ems River is disposed on land and has been steadily increasing from around 200,000 m^3/yr (Krebs and Weilbeer, 2008) to 1.5–2 million m^3/yr since 1993 (Weilbeer and Uliczka, 2012). Initially, the dredged sediment was sandy but is now predominantly muddy (Krebs and Weilbeer, 2008).

Sediment originating from the Emden fairway and the ports of Delfzijl and Eemshaven are dispersed in the Ems Estuary. Six million m^3/yr is dredged from the Emden fairway (Ems-km 40–53), and disposed seaward of Ems-km 64 (see Fig. 1 for the Ems km, but Section 4 for the location of the disposal grounds). An additional 2.8 million m^3/yr is dredged from the ports of Delfzijl and Eemshaven (Mulder, 2013), half of which is locally re-suspended through water injection dredging (Port of Delfzijl). About 1 million m^3/yr is dredged from the Eemshaven and disposed locally, whereas 0.3 million m^3/yr is dredged from the port of Delfzijl and disposed in the Dollard basin.

The rapid rise in required dredging volumes in the lower Ems River (around 1993) coincided with deepening of the lower Ems River from 5.7 to 7.3 m (1991–1994). However, in the same period the port of Emden ended its annual extraction of $\sim$5 million m^3/yr, increasing the amount of sediment available for transport into the lower Ems River. The increase in dredging requirements may therefore be the result of deepening, but also of the changing dredging strategies.

The main human interventions can be summarised as follows. Over centuries, the size of the intertidal areas has been gradually reduced, resulting in increasingly less natural sediment sinks. In the past decades, several ports have been constructed and extended, requiring deepening of the approach channels and dredging and disposal of sediment. In the port of Emden, sediment was not disposed of, but $\sim$5 million m^3 of sediment was annually extracted. This extraction strategy ended in 1994, simultaneously with a substantial deepening of the lower Ems River. The effect of tidal channel deepening in the Ems Estuary and sediment extraction from the port of Emden will be investigated in more detail in the next section.

3. Numerical model setup and calibration

3.1. Hydrodynamics

In order to quantify the individual impacts of dredging and deepening on the suspended sediment dynamics, a 3D numerical model was setup using the Delft3D software. The 8 vertical σ-layers increase logarithmically in thickness from the bed to the surface (2, 3, 5, 8, 13, 19, 25 and 25% respectively). The model bathymetry is based on surveys by the Dutch Ministry of Public Works in 2005 (Fig. 1). The model is forced at the seaward boundaries by water levels, salinity and temperature. The water level time series were derived from a larger operational model available online (http://opendap-matroos.deltares.nl/thredds/catalog/maps/normal/hmcn_kustfijn/catalog.html), in which tidal and storm-induced water level variations are modelled. The salinity is

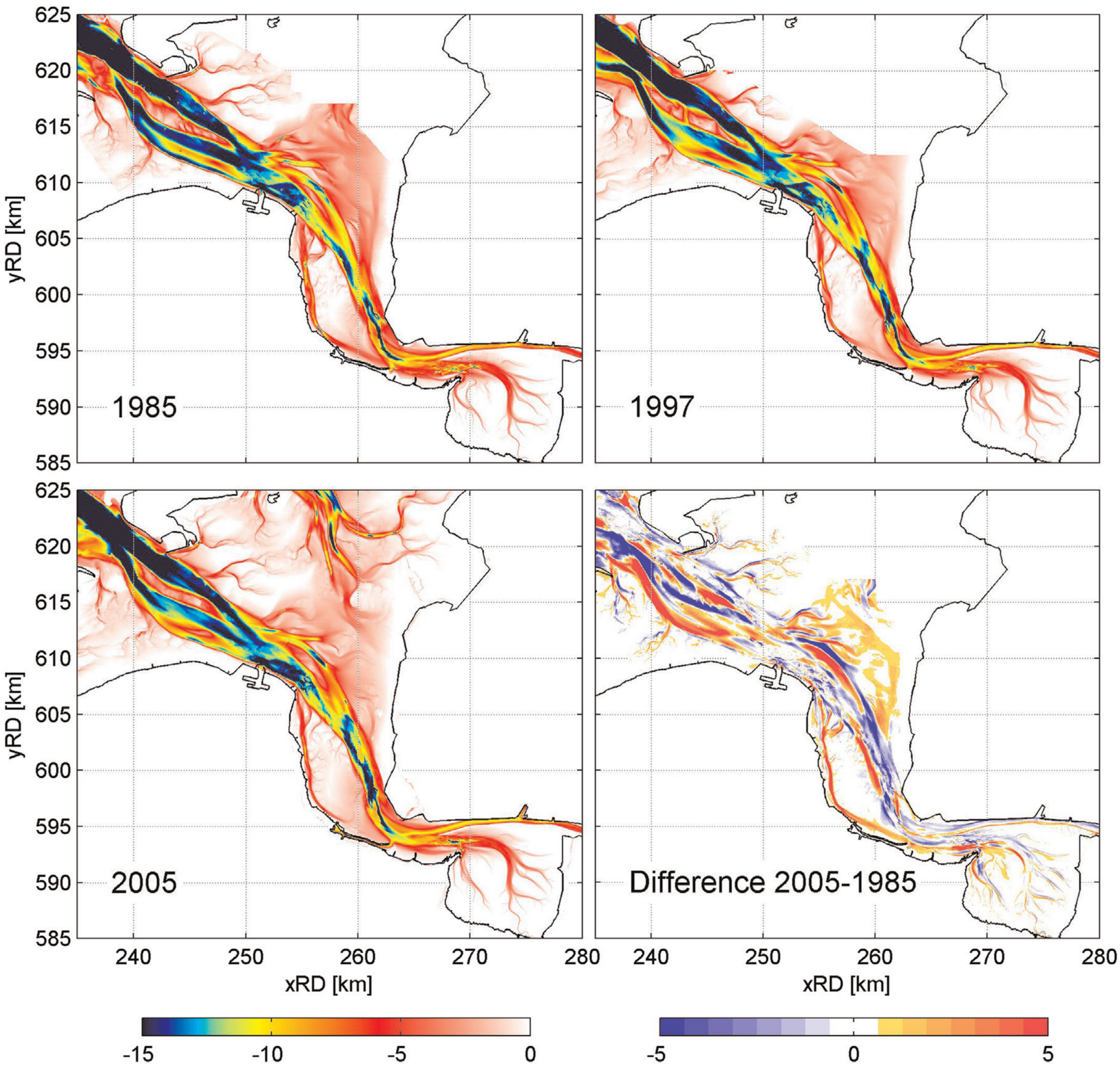

Fig. 3. Bathymetry in the Ems estuary in 1985, 1997, and 2005 (in metres relative to Dutch ordnance datum, based on soundings by the Dutch ministry of public works), and the difference between 1985 and 2005 (in metres).

derived from a nearby observation station measured every 4 weeks (live.waterbase.nl). Six rivers drain into the model of which the discharge of the largest (the Ems River) varies between 30 and 300 m^3/s (Fig. 5). The other rivers are typically an order of magnitude smaller, but also prescribed in the model. The effect of waves is computed with a SWAN wave model (Booij et al., 1999) run in online mode to include wave–current interaction. The wave model is forced by wave parameters (significant wave height, direction and the representative wave period) observed at an offshore wave buoy (Fig. 5) assuming a JONSWAP-spectrum (Hasselmann et al., 1973), and a spatially varying wind field (HIRLAM).

The computed water levels are compared with one-year observations in the frequency domain (using harmonic analysis; Pawlowicz et al., 2002) at 4 selected water level stations covering the estuary (Table 1). Typically, the error in computed water level amplitudes A_h and phases ϕ_h of the individual constituents is less than 5%, with even higher accuracy in the outer reaches of the estuary. From the most seaward station (S1) to the most up-estuary station shown here (WL3) the tides (observed as well as computed) are amplified by ~50%. Flow velocity has been observed for a period of 5 months at two stations (GSP2 and GSP 5) located in the estuary mouth. The amplitudes and phases of the modelled flow velocity (Table 2) are within 20% of observations at the most seaward station (GSP2) and in slightly better agreement deeper into the estuary (GSP5).

The type of asymmetry is determined by the flow velocity phase inclination θ_u of M_4 with M_2, given by $\theta_u = 2\phi_{u,M2} - \phi_{u,M4}$. The modelled and observed θ_u is 279 and 298° respectively using results from Table 2 at station GSP 5 (GSP 2 is not used to compute θ_u because of the small flow velocity amplitude $A_{u,M4}$). Tides with θ_u between 225° and 315° have equal ebb and flood flow velocities, but a longer duration of high water (HW) slack than low water (LW) slack. Such a slack tide asymmetry generates landward sediment transport by the settling lag (Postma, 1961); especially fine sediment is sensitive to local asymmetries in the duration of slack tide (Friedrichs, 2011). For short tidal basins, a phaselag θ_u of 270° corresponds to a phaselag in water levels θ_h of 180° (Friedrichs and Aubrey, 1988). The phaselag θ_h (with $\theta_h = 2\phi_{h,M2} - \phi_{h,M4}$) is typically between 160 and 180° in the four selected water level stations (Table 1, for both observations and model results), therefore in line with the velocity asymmetry. Both the water levels and the velocity data therefore show that the duration of HW slack exceeds the duration of LW slack (promoting tide-driven up-estuary sediment transport) which is reproduced by the model.

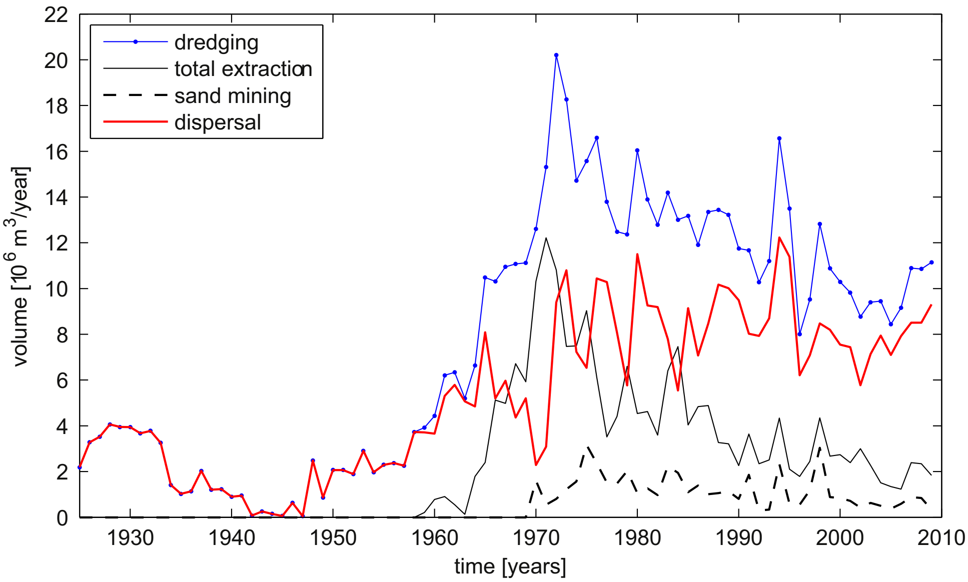

Fig. 4. Dredging volumes for the Ems estuary since 1925. Dredging volumes before 1960 are from de Jonge (1983) and exclude sand mining. Dredging volumes after 1960 is from Mulder (2013) for the Ems estuary (including sand mining) and from Krebs (2006) in the lower Ems River (until 2006; after 2006 a constant value of 1.5 million m^3 is assumed). Total extraction includes sand mining and dredge spill. Before 1994, this sediment was mainly from the port of Emden and approach channel (Mulder, 2013), averaging 5 million m^3/yr. After 1994, mostly sediment dredged in the lower Ems River is brought on land (~ 1.5 million m^3; Weilbeer and Uliczka, 2012). Sediment dispersal is the difference between dredging and total extraction.

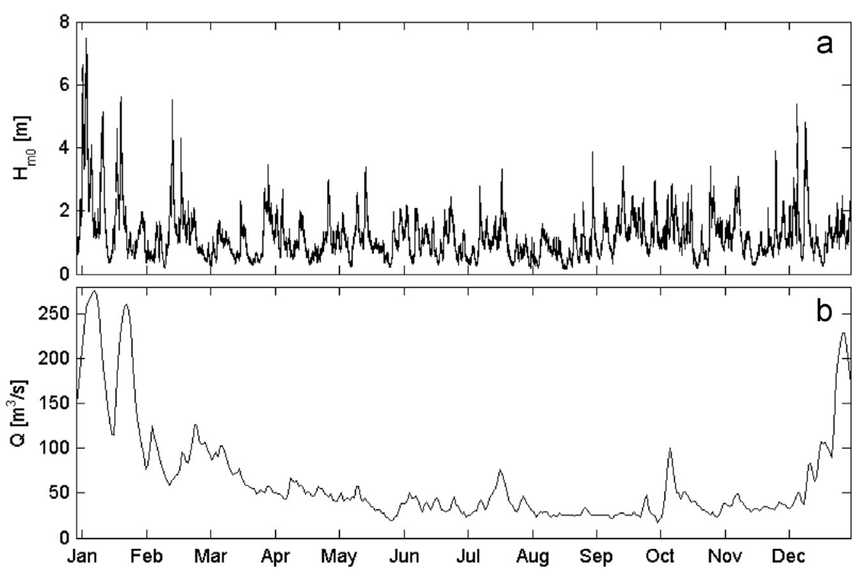

Fig. 5. Wave height (a) observed in an offshore wave station (SON, see Fig. 1 for location), and daily discharge (b) of the main river draining into the Ems Estuary (the Ems river at Herbrum), in 2012.

Table 1
Observed/modelled water level amplitudes (A_h) and phases (ϕ_h) of the 4 largest tidal constituents at stations S1 and WL1 – WL3. See Fig. 1 for the location of stations.

Constituent	Parameter	Station			
		S1	WL2	WL3	WL4
M_2	A_h [cm]	104/102	124/122	141/138	156/147
	ϕ_h [°]	248/247	281/275	300/295	313/313
S_2	A_h [cm]	31/30	35/35	40/39	42/44
	ϕ_h [°]	327/325	5/359	234/272	43/45
N_2	A_h [cm]	13/13	17/16	20/18	23/20
	ϕ_h [°]	236/235	275/269	298/294	312/314
M_4	A_h [cm]	9/9	10/10	18/17	18/13
	ϕ_h [°]	336/334	39/34	70/74	114/96

Table 2
Observed/modeled major flow velocity amplitudes (A_u) and phases (ϕ_u) of the 4 largest tidal constituents at stations GSP2 and GSP5. See Fig. 1 for the location of stations. Observed flow velocity amplitudes of 5 cm/s or less are shaded grey.

Constituent	Parameter	Station	
		GSP2	GSP5
M_2	A_u [cm/s]	80/96	87/99
	ϕ_u [°]	13/23	32/32
S_2	A_u [cm/s]	22/26	22/26
	ϕ_u [°]	85/96	103/103
N_2	A_u [cm/s]	17/17	17/18
	ϕ_u [°]	351/6	10/14
M_4	A_u [cm/s]	2/6	11/13
	ϕ_u [°]	325/327	126/145

3.2. Sediment transport

Next, a sediment transport model has been setup incorporating the effect of the buffering of fine sediments in the seabed (applying the algorithms developed by van Kessel et al., 2011a) and accounting for deposition in, and dredging and dispersal of sediments from the three estuarine ports. These algorithms are coupled offline with the hydrodynamics, and have been applied previously in the North Sea (van Kessel et al., 2011a), the Western Scheldt (van Kessel et al., 2011b), and Singapore (van Maren et al., 2014). This model distinguishes two bed layers: an upper layer (S_1) which rapidly accumulates and erodes, and a deeper layer (S_2) in which sediment accumulates gradually and from which it is only eroded during energetic conditions (spring tides or storms). This S_2 layer represents a sandy layer in which fine sediment accumulates during calm conditions. When the bed shear stress exceeds a critical value the sandy layer becomes mobile, and fine sediment that infiltrated earlier into this layer is slowly released. However, the transport of the sand layer itself is not modelled, but prescribed as a layer of a constant, and user-defined, thickness. Most sediment is stored (buffered) in this S_2 layer; S_1 represents the typically thin fluff layer consisting of mud, which rapidly erodes.

The erosion rate E_1 of S_1 depends linearly on the amount of available sediment below a user-defined threshold M_0/M_1:

$$E_1 = mM_1\left(\frac{\tau}{\tau_{cr,1}} - 1\right), \quad m < \frac{M_0}{M_1}$$

$$E_1 = M_0\left(\frac{\tau}{\tau_{cr,1}} - 1\right), \quad m > \frac{M_0}{M_1}$$

Here m is the mass of sediment in layer S_1 (in kg/m^2). This has the important consequence that also in dynamic environments the equilibrium sediment mass on the bed is non-zero, contrary to standard Krone-Partheniades (KP) models. Typically, this results in smoother and more realistic model behaviour in mixed sand–mud environments ($m < M_0/M_1$). For completely muddy areas ($m > M_0/M_1$), the buffer model switches to standard KP formulations for erosion of bed layer S_1. Hence, M_0 is the standard zero-order erosion parameter (kg/m^2/s) whereas M_1 (1/s) is the erosion parameter for limited sediment availability.

The erosion E_2 of S_2 scales with the excess shear stress to the power 1.5, in line with empirical sand transport pick up functions, assuming that fines trapped within the sandy bed are released when sand is mobilised:

$$E_2 = p_2M_2\left(\frac{\tau}{\tau_{cr,2}} - 1\right)^{1.5}$$

Here, p_2 is the fines fraction in S_2 (computed by the model) and M_2 is the resuspension parameter for S_2 (kg/m^2/s).

The deposition flux D is the settling velocity w_s times the near-bed sediment concentration C:

$$D = w_sC$$

The deposition flux D is divided between layers S_1 and S_2 with a burial parameter α:

$$D_1 = (1 - \alpha)w_sC$$

$$D_2 = \alpha w_sC$$

The value for α is based on calibration (van Kessel and van Maren, 2013), and is typically 0.05–0.2. A low value for α implies a slow exchange with buffer layer S_2. In combination with settings for M_2 and $\tau_{cr,2}$ it also determines the residence time of fines in the buffer layer.

We use two sediment fractions, IM1 with a large settling velocity (1.2 mm/s) and IM2 with a small (0.25 mm/s) settling velocity. The settling velocity of IM1, representing fairly large and rapidly settling flocs, is based on observed settling velocities of flocs in the Ems estuary typically between 1 and 2 mm/s (van Leussen and Cornelisse, 1996). The IM2 settling velocity corresponds to the minimum settling velocity observed by van Leussen and Cornelisse (1996). The spatial distribution of IM1 and IM2 is determined by the model: all sediment in the model domain entered through the open boundaries, where IM1 and IM2 were prescribed at equal sediment concentrations.

Spatially uniform values for the critical shear stress for erosion τ_{cr} are prescribed for the S_1 layer and the S_2 layer. Sediment which does not or only marginally consolidates has a critical shear stress for erosion τ_{cr} of several 0.01 to ~0.1 Pa (e.g. Widdows et al., 2007). Therefore the critical shear stress for the fluff layer is very low ($\tau_{cr,1} = 0.05$ Pa), implying that sediment in the top layer is easily resuspended. Sediment in S_2 is assumed to erode during more energetic conditions only, when a substantial amount of sand is brought in suspension and the mud trapped in the sand layer is released. This occurs at larger shear stresses than the initiation of motion of sand particles; earlier studies (van Kessel et al., 2011a) suggested a value around 1 Pa. In this study, $\tau_{cr,2}$ is set to 0.9 Pa. The thickness of the sand bed (layer S_2) is set to 10 cm, representing the zone where active mixing by biological activity and (bedform-related) sediment transport takes place. The erosion parameters M_0, M_1, and M_2 (see Table 3) are obtained through calibration (van Kessel and van Maren, 2013). Flocculation and consolidation are not modelled. The use of 2 bed layers represents model behaviour similar to consolidation: during low energy conditions sediment is progressively buried in layer 2 (and is therefore no longer regularly resuspended). Also the effect of biology (influencing the erodibility of the intertidal mud deposits) is not accounted for in the model.

The boundary conditions at the North Sea and Wadden Sea are set at 10 mg/l and 100 mg/l for IM1 and IM2 respectively, based on long-term observation stations (similar to the observations in Fig. 2). A sediment concentration of 10 mg/l is also prescribed to all fresh water sources. An equilibrium bed condition (the amount of sediment in S_1, S_2, and in suspension) is obtained by: running the model with a thin S_2 bed layer (for faster adaptation time) for a number of years; then increasing the thickness of the S_2 layer to 10 cm (a typical active layer depth); and finally running the model repetitively with cyclic hydrodynamic forcing until dynamic equilibrium is achieved (where the suspended sediment concentration and sediment availability vary with tidal and seasonal timescales, but not over the years). Depending on the settings of the model, a dynamic equilibrium for both the distribution of mud on the bed and suspended in the water column is achieved within several years (Five years using the settings in Table 3). The bed level in the sediment transport model is kept constant, so it is not a morphological model: erosion and deposition influences the available mass of sediment below a bed level which is constant in time.

Nine areas are defined from which sediment is dredged once

Table 3
Sediment transport model settings.

Parameter	Description	IM1	IM2
$w_{s,0}$ [mm/s]	Settling velocity	1.2	0.25
M_0 [kg/m^2/s]	Erosion parameter	2.5×10^{-3}	2.5×10^{-3}
M_1 [/s]	Erosion parameter	1.2×10^{-4}	1.2×10^{-4}
M_2 [kg/m^2/s]	Erosion parameter	1.2×10^{-3}	1.2×10^{-3}
$\tau_{cr,1}$ [Pa]	Critical bed shear stress	0.05	0.05
$\tau_{cr,2}$ [Pa]	Critical bed shear stress	0.9	0.9
α [−]	Burial rate	0.1	0.1
Thickness S_2 [m]	Thickness of sand bed	0.1	

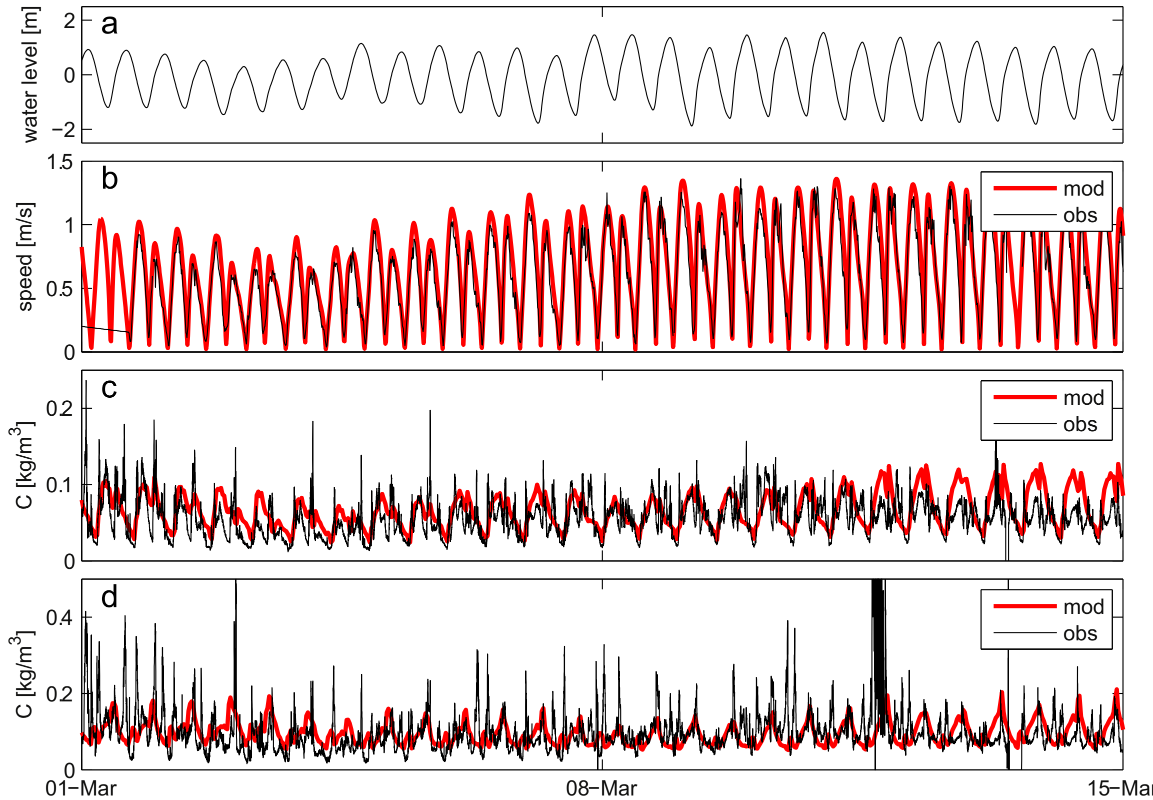

Fig. 6. Computed water level (a); observed (black) and computed (red) depth-averaged flow velocity (b); near-surface sediment concentration 4 m below the water surface, (c); and near-bed sediment concentration (d) at location GSP5, from 1 to 15 March 2012. See Fig. 1for the location. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

every week (from layer S_1 and layer S_2), and disposed in the dumping locations designated to the dredging sites. Dredging is instantaneous, but disposal is distributed over 3 days to avoid unrealistic peaks in the suspended sediment concentrations. Given the large dredging volumes in the area, discretization of dredging and dumping in different areas provides a more realistic description of sediment transport in the estuary. Additionally, the computed deposition rates in the ports can be compared with observed dredging volumes, providing validation of the sediment transport model. An added value of such a dredging module is that it allows for a quantitative insight in the long-term effects on dredge spoil dispersal.

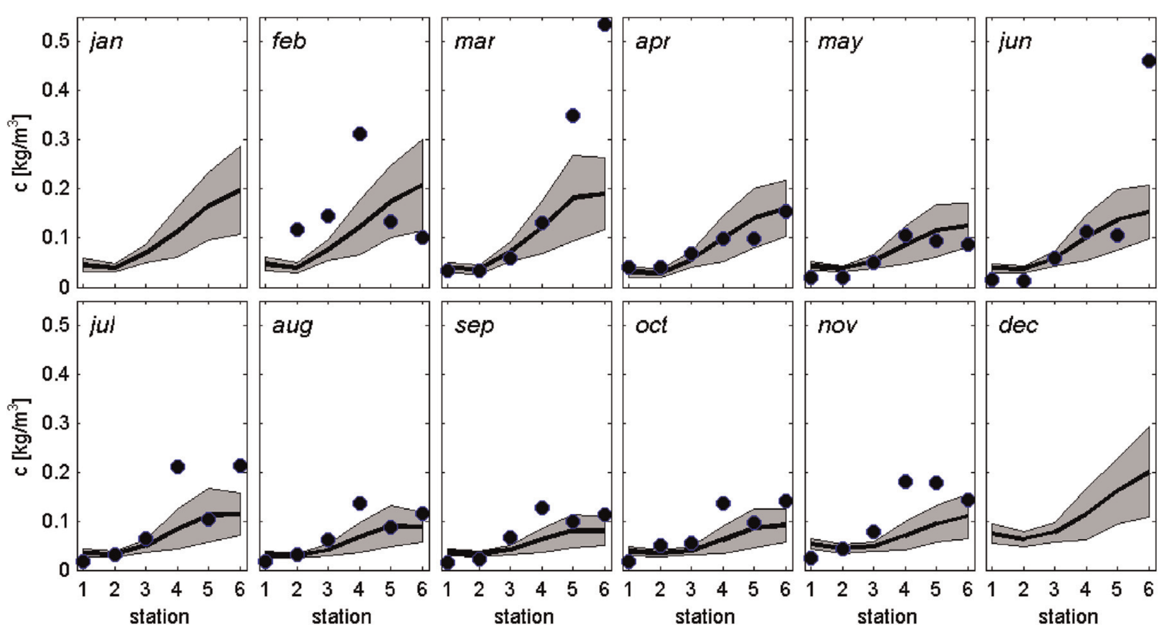

Fig. 7. Monthly averaged computed surface sediment concentration (black line, with grey shading indicating the standard deviation) and observed surface sediment concentration (black dots, February through November) in 2012 at stations S1–S6 (in kg/m^3). See Fig. 1 for the location of stations.

A time-series comparison of the computed and observed suspended sediment concentration at station GSP5 (Fig. 6) reveals that the intra tidal and spring neap variation in SSC are well reproduced. The computed near-bed sediment concentration is typically two times larger than the near-surface sediment concentration, which is in line with field observations, suggesting that the vertical sediment concentration gradients are reproduced. The along-estuary gradient in SSC is evaluated by comparing the model against snapshot surface samples collected every 2–4 weeks at 6 stations (S1–S6, see Fig. 1 for location). The model reproduces the observed up-estuary increase in the surface sediment concentration, and the seasonal variation of the sediment concentration with larger sediment concentrations during the winter months (Fig. 7). The largest deviations between observations and model results occur in February and November. An explanation for this could be that sediment flushed from the lower Ems River is underestimated by the model: the largest deviations occur at stations halfway the estuary. This flushing is underestimated because the sediment transport processes in the Ems River are very complex – see the end of this section. Nevertheless, even though two-weekly snapshot measurements only provide an indicative value for comparison with a sediment transport model, the reasonable correspondence suggests the model reproduces the actual estuarine suspended sediment concentration gradient.

The model also reproduces the pronounced up-estuary increase in mud content in the bed (Fig. 8). The highest mud content is observed and computed in the Dollard bay and the approaches to the port of Delfzijl. In line with observations, the computed mud content increases in the landward direction of the Wadden Sea (the coastal lagoon adjacent to the Ems Estuary) as well. The computed siltation in the three ports in the estuary is typically around 0.5–0.8 million tons/yr. The computed deposition in the ports of Eemshaven and Delfzijl are within 10% of the long-term observed deposition rates (Table 4). However, deposition in the port of Emden and its approach channel is strongly underestimated. This is probably related to the hyper turbid conditions in the lower Ems River, which drains into the Ems estuary close to the port of Emden.

The sedimentary conditions in this reach of the river require a different modelling approach with more complex formulations to account for flocculation, sediment-induced density effects, and consolidation. These processes demand for more detailed and short time scale simulations which conflict with the multi-year objectives of this study. Therefore a more accurate description of the sediment dynamics in the lower Ems River is beyond the scope of this paper.

Table 4
Estimated and computed deposition rates.

Port/area	Estimated deposition (million tons/yr)	Computed deposition (million tons/yr)
Eemshaven	0.5	0.44
Delfzijl	0.8	0.76
Emden port and fairway	1.6	0.55

4. Effect of sediment extraction sediment disposal and deepening

The developed model is subsequently used to experiment with historic scenarios. This reference model reflects the present-day conditions (i.e. the 2005 bathymetry and no extraction of sediment). It was hypothesised earlier in this paper that discontinuing sediment extraction (dredging the ports and bringing sediment on land) has led to a pronounced increase in SSC. Therefore the reference model with dredging is re-run with extraction (instead of dredging and dumping) of all sediment depositing in the port of Emden and its approach channel. With respect to this scenario with extraction, the reference model (with dredging from Emden) leads to an increase of 0–50 mg/l in SSC in the outer reaches, but up to 100 mg/l within the estuary (Fig. 9a). The typical concentrations in these up-estuary sections are 100–300 mg/l (Fig. 7), implying the impact of dredging strategy is substantial. However, it was also concluded that the model strongly underestimates deposition rates in the port of Emden and its approach channel (Table 4). Therefore, although historically as much as 2.5 million tons were extracted on an annual basis, only 0.5 million tons/yr is extracted in the model. To better approximate the effect of extracting such a large sediment mass, the model is also run with extraction from all ports (totalling a mass of 1.75 million tons, see Table 4). This leads to a two-fold larger suspended sediment concentration change (Fig. 9b).

The most realistic way to evaluate the effect of the presence of ports (excluding their approach channels) is by comparing the model including ports and subsequent dredging and disposal activities (the reference model), with a scenario without ports (and therefore also without deposition in ports nor related dredging and disposal activities). Including ports raises the suspended sediment concentration in the vicinity of disposal sites, but decreases the sediment concentration further away from the disposal sites (Fig. 9c). This follows from the large sediment accumulation rates in the ports, extracting sediment from the estuary and hence lowering the ambient suspended sediment concentration.

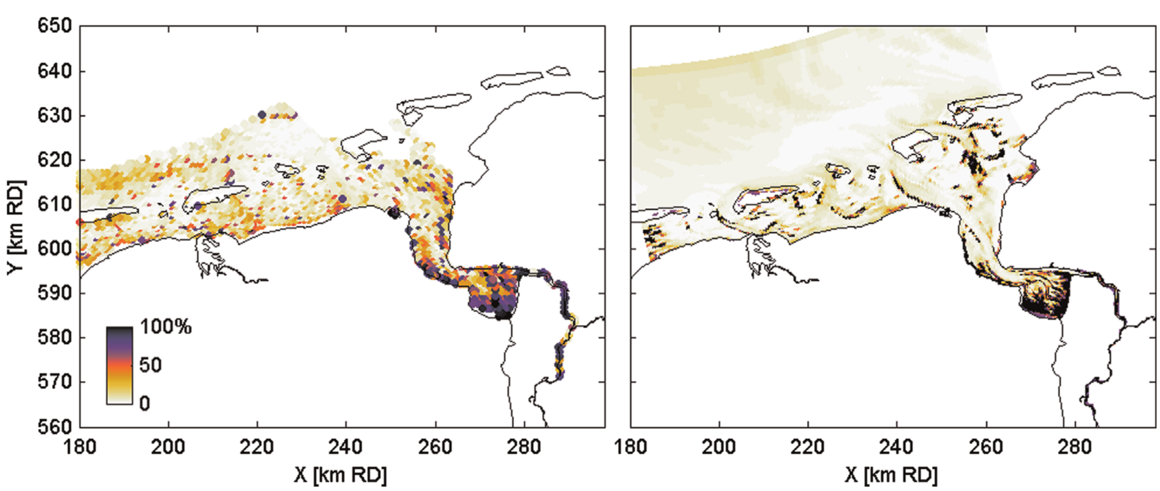

Fig. 8. Observed (left, based on surveys from 1989) and computed (right, S1 and S2) mud content in the bed (in %).

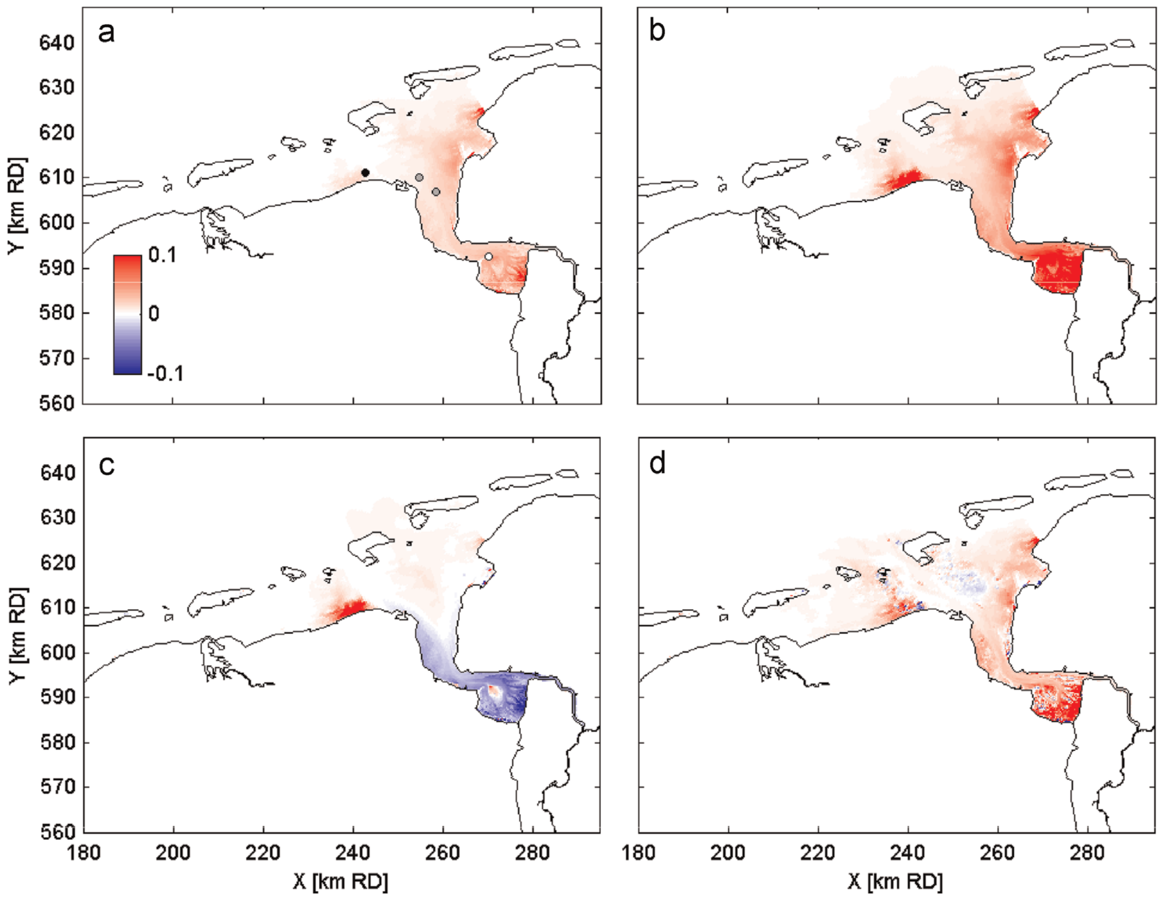

Fig. 9. Computed increase of yearly averaged surface suspended sediment concentration (in kg/m^3) for 4 scenarios. The increase is defined as the difference of the annual means, computed for Scenario (a): dredging and dumping of all ports, compared with extracting from Emden; Scenario (b): dredging and dumping from all ports, compared with extraction from all ports; Scenario (c) construction of ports and resulting dredging and disposal of sediment, compared with no ports nor dredging activities; Scenarios (d) extraction from Emden with the 1985 bathymetry compared to dumping from Emden and 2005 bathymetry. The disposal grounds are visualised in panel (a) with circles, with a colour depending on the origin of the disposed sediment (black for Eemshaven, grey for Emden, and white for Delfzijl).

In order to allow ships to enter the ports, tidal channels are frequently deepened. The tidal channels in the Ems estuary have been deepened with several metres (Fig. 3). As a consequence, a model with the 1985 bathymetry was setup. The closest approximation of the change from the 1980s to the 2000s is by comparing the reference model with a scenario including the 1985 bathymetry model and extraction from the port of Emden (Fig. 9d). Compared to extraction only (Fig. 9a), the increase in suspended sediment concentration is larger. Therefore the impact of deepening alone is evaluated in more detail.

The model is run with the 1985 and 2005 bathymetry (with all other settings equal). The year 2005 is simulated with a baroclinic model (including density-induced effects due salinity) and a barotropic model (without density effects) in order to separate the change in SSC due to estuarine circulation. Deepening of the estuarine channels alone leads to an increase of more than 50 mg/l

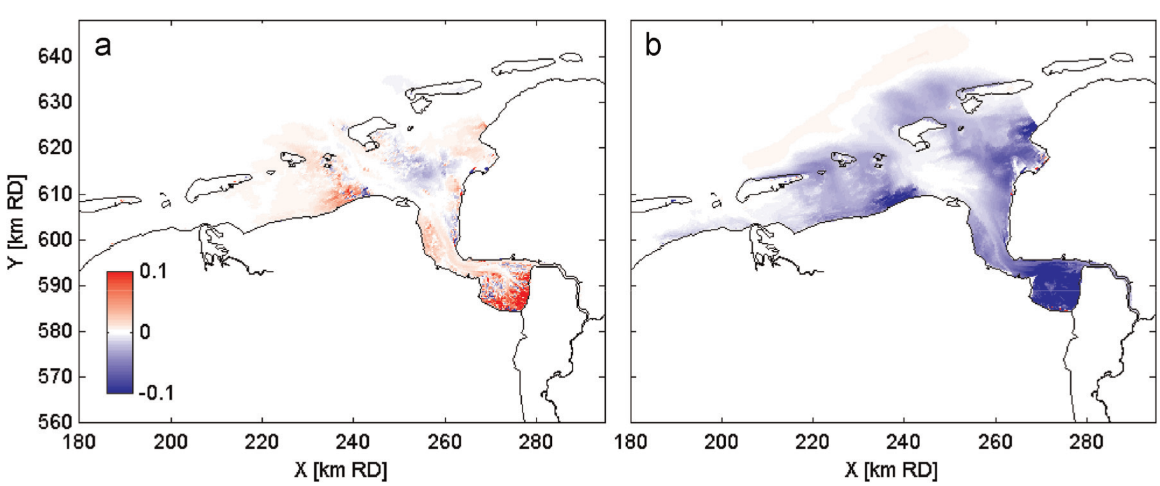

Fig. 10. Computed increase in surface sediment concentration (in kg/m^3) due to deepening from 1985 to 2005 (a) and a reduction in surface sediment concentration by running the model without density effects (b).

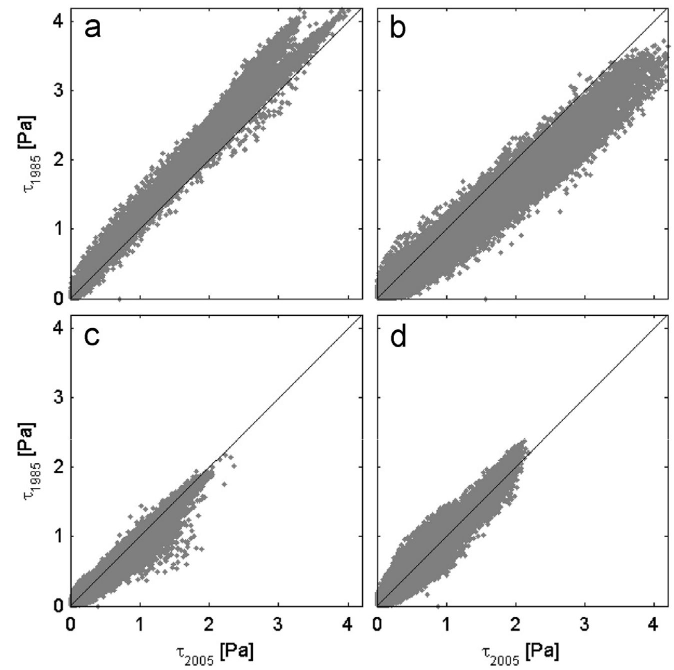

Fig. 11. Bed shear stress computed every 10 minutes at GSP2 (a), ch1 (b), ch2 (c), and ch3 (d) for 2005 (*x*-axis) and 1985 (*y*-axis): plotted values cover the full year. See Fig. 1 for the location of stations.

in the up-estuary parts (Fig. 10a). The tide-induced bed shear stresses differ slightly between 1985 and 2005 (Fig. 11) because of small phase shifts in the propagation of the tides, but there is no overall trend. At station GSP2, the bed shear stress was slightly larger in 1985 whereas the bed shear stress at ch1 was slightly larger in 2005. Such relatively small changes do not have an effect on turbidity as large as in Fig. 10a.

A more realistic mechanism for this change therefore is estuarine circulation. Estuarine circulation is a residual flow component (superimposed on the oscillating tidal currents) which develops in the presence of a horizontal salinity gradient, and increases in strength with larger water depth. The surface flow velocity is directed towards the area of higher salinity, the near-bed velocity is directed towards the freshwater source. Since the near-bed sediment concentration is higher than the near-surface sediment concentration (see also Fig. 6), estuarine circulation generates up-estuary sediment transport. For the 2005 bathymetry, estuarine circulation is a key mechanism for up-estuary transport, which is demonstrated with a model excluding density effects. The suspended sediment concentration in this barotropic model is much lower than the reference model (Fig. 10b), demonstrating the importance of estuarine circulation.

The effect of salinity is therefore further explored with residual flow velocity profiles at 4 stations throughout the main channel of the Ems estuary (Fig. 12, see Fig. 1 for the location). Without density effects, the residual flow velocity is low and displays a logarithmic vertical profile. In contrast, for both 1985 and 2005 (with density effects) the residual near-bed flow velocity is typically directed up-estuary. However, the magnitude of the near-bed flow velocity is typically two times larger in 2005, compared to 1985. It is therefore concluded that the deepening of the tidal channels in the estuary in the period 1985 to 2005 has strengthened density-induced estuarine circulation patterns, which subsequently substantially raised the suspended sediment concentration.

5. Discussion

5.1. Long-term effects of dredging on SSC

With a few exceptions such as de Jonge (1983), the long-term impact of dredging on suspended sediment concentrations has received fairly limited attention in scientific literature. The long-term morphological effects of dredging are fairly well known due to the relatively large amount of (historic) topographic data in heavily modified estuaries (e.g. Jeuken and Wang, 2010; Monge-Ganuzas et al., 2013). Most commonly, studies related to dredging-induced turbidity focus on the sediment dynamics in the direct vicinity of the dredger (Pennekamp et al., 1996; Mikkelsen and Pejrup, 2000; Spearman et al., 2011; Smith and Friedrichs, 2011), on the fate or deposition of dredged sediment (e.g. Bai et al., 2003; Van den Eynde, 2004; Cronin et al., 2011; Hayter et al., 2012; Alba et al., 2014), or on the impact on sensitive ecosystems (Erftemeijer

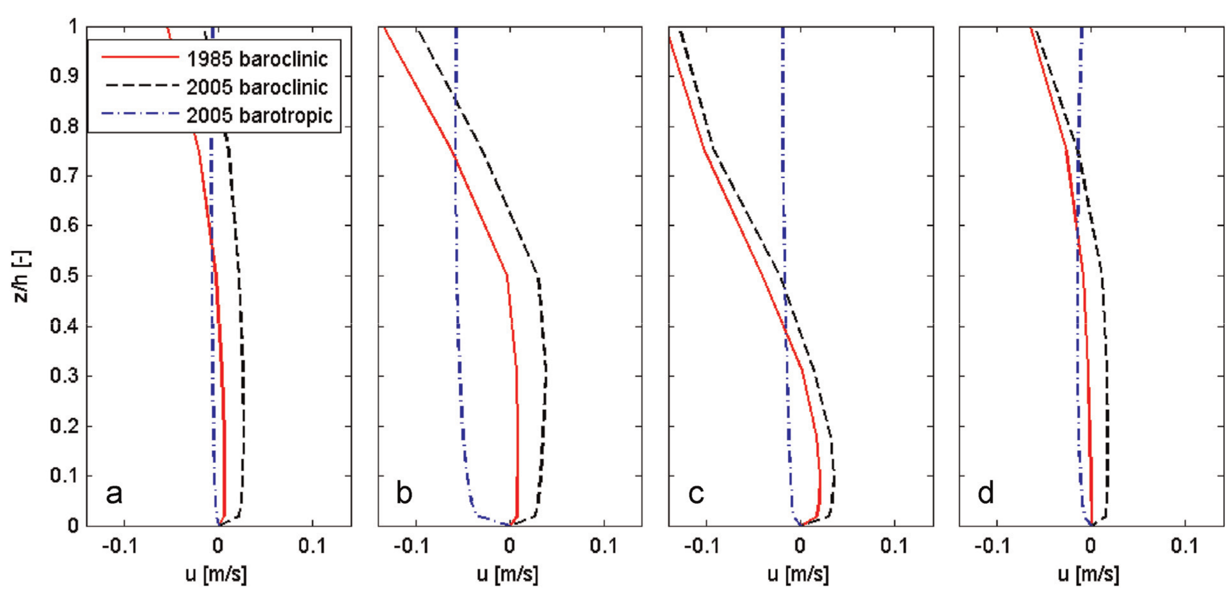

Fig. 12. Residual flow velocity profiles, with positive values directed up-estuary, computed at GSP2 (a), ch1 (b), ch2 (c), and ch3 (d) for 1985 and 2005 (baroclinic mode) and 2005 (barotropic mode, i.e. no density effects). The averaging period is January through March, the period during which the fresh water discharge is largest. See Fig. 1 for the location of stations.

and Lewis, 2006; Erftemeijer et al., 2012). When carefully executed, the impact of dredged sediment disposal on turbidity may be limited to the short-term and near-field (Fredette and French, 2004). Often the dispersion of individual plumes is considered, whereas it is the long term cumulative effect of a large number of individual plumes that determines the impact. Over longer timescales resuspension of dredged material from the seabed may become the dominant factor contributing to turbidity (van Kessel and van Maren, 2013). Fettweis et al. (2011) observed a long-term increase in the suspended sediment concentration and formation of fluid mud. Fluid mud formation is not included in our model, even though fluid mud forms in the entrance of the Emden navigation channel. Regular resuspension of this fluid mud layer contributes to elevated sediment concentration levels. As indicated earlier, the underestimated sediment concentrations in February and November are possibly related to the complex suspended sediment dynamics in the navigation channel, which are not captured by the model. If any long-term increase in SSC is related to fluid mud formation, this will not be properly accounted for in the model applied here.

In our simulations, the effect of dredging and disposal is large when comparing the present-day situation (a scenario in which dredged sediment is disposed) to a scenario in which sediment is not disposed but sediment is still allowed to settle in ports (equivalent to extraction, see Fig. 9b). However, a more appropriate scenario to estimate the effect of dredging and disposal is to compare the present-day situation to a scenario without ports (and hence no dredging and disposal). This reveals a much more limited effect of dredging and disposal: the sediment concentration increases near the disposal sites but slightly decreases elsewhere (Fig. 10c). Our results are difficult to compare with de Jonge (1983), who concluded that the suspended sediment concentrations in the Ems Estuary in a specific year depended on the distance dredged during that year. This relationship was strongly influenced by capital dredging for construction of the Eemshaven, and it remains unclear how much of the dredged sediment in the analyses is extracted or disposed. Moreover, although the distance dredged and sediment concentration is correlated in de Jonge's data, both also increase in time: hence the increase may also be the result of channel deepening.

5.2. Effects of deepening on SSC

It is well known that salinity-induced density currents lead to up-estuary transport of sediment (e.g. Meade, 1969; Uncles et al., 1985). In our model, this effect of salinity-induced residual currents is demonstrated by the pronounced difference between the computed sediment concentration in barotropic (excluding salinity-induced residual currents) and baroclinic (including salinity-induced residual currents) simulations (Fig. 11b). The magnitude of the residual flow velocity u in the tidal channel scales with the cubed water depth h as in Hansen and Rattray (1965):

$$u_z \equiv h^3\left(1 - 9\left(\frac{z}{h}\right)^2 + 8\left(\frac{z}{h}\right)^3\right)$$

As a result of this strong depth-dependence, deepening of tidal channels leads to strengthening of the residual current. For a 10 m deep channel, deepening by 2–4 m leads to a 1.7–2.7-fold increase in salinity-induced residual flow (assuming the horizontal salinity gradient is unaffected by deepening). In very few (if any) estuaries worldwide, observational evidence exists for the impact of deepening on estuarine circulation. The reason for this is that the residual flow velocity is very sensitive to the observational technique and exact location. Channel deepening is often accomplished over many years or even decades. Identical data collection programs before and after channel deepening are therefore few or non-existent. A reliable alternative to assess the impact of deepening on residual currents is a scenario analysis using a well-calibrated process-based numerical model.

Our model strongly suggests that baroclinic processes influence the estuarine suspended sediment dynamics, and that the magnitude of estuarine circulation increased as a result of deepening. As a result, the modelled response to channel deepening is an up-estuary increase in SSC. It should be realised that the computed effect of different scenarios (dumping/extraction, 1985/2005, barotropic/baroclinic) is influenced by the parameter settings and process formulations of the numerical sediment transport model. Therefore, while the trends remain valid, the absolute values or details in the spatial patterns of changes in suspended sediment concentration computed with process-based numerical models as used here should be interpreted carefully.

5.3. Other impacts

The change in dredging strategy and deepening is likely not the only contributor to increased suspended sediment concentration. In the Ems Estuary, and the lower Ems River, the loss of tidal flats may influence long-term changes in the suspended sediment dynamics. Deepening of the lower Ems River (the main river draining into the Ems Estuary) has strongly amplified the tides and increased the suspended sediment concentrations within the tidal river (e.g. de Jonge et al., 2014). One million tons of sediment is annually extracted from the lower Ems River (Krebs and Weilbeer, 2008), and on the long term the tidal river may therefore reduce the sediment concentration in the estuary. However, regular flushing of the tidal river during high discharge events (Spingat and Oumeraci, 2000) transports sediments from the river into the estuary, and the long-term effect of the tidal river on the estuary remains poorly known. Additionally, many of the intertidal areas that existed in the Ems estuary have been reclaimed in the past centuries. These intertidal areas provided a natural sink for sediment to accumulate.

Since 1650, the size of the Ems Estuary has decreased by 40% (177 km,see Section 2) due to infilling with fine sediments. Most of this accumulation took place in the Dollard, which used to be much larger: the present-day intertidal area used to be tidal channels. In some areas, deposition must therefore have been many metres. These sediment deposits are well consolidated, and therefore have a dry density of $\sim$1500 kg/m^3. Assuming an average thickness in deposition of 3 m yields an average annual accumulation rate of 2.3 million tons (partly consisting of sand), between 1650 and present. This number is a very crude estimate for the yearly siltation rates, and more research is needed to further quantify it. Nevertheless, the long-term loss of sediments by deposition is probably comparable to the extraction rates from the port of Emden ($\sim$2.5 million tons/yr). With a constant supply of sediments, removal of this natural sink inevitably leads to a rise in suspended sediment concentrations. It therefore seems likely that apart from deepening and port construction, the suspended sediment concentration has already been slowly increasing for centuries. Compared to the large dredging volumes, and especially the impact of extraction, the impact of changing ship traffic (hypothesized in Section 1) is probably a minor effect

This leads to the following hypothesis for the increasing suspended sediment concentrations in the Ems Estuary:

1. The potential sediment supply to the Ems estuary by the North Sea and Wadden Sea has always been large.
2. The large-scale reclamation of intertidal areas increased the suspended sediment concentrations in the past centuries.

3. Large-scale port construction but especially deepening of the tidal channels in the 1960s increased the up-estuary sediment transport; however.
4. The increase in suspended sediment concentration remained limited because of large-scale sediment extraction (on average ~2.5 million tons/yr) in and near the port of Emden until the early 1990s.
5. After 1990, sediment was no longer extracted, and as a result the suspended sediment concentrations increased substantially.

5.4. Relevance for other estuaries

Many estuaries worldwide are heavily modified. Channels are deepened to accommodate larger ships, and intertidal areas are reclaimed to for need of land. These changes have led to tidal amplification and to increasing suspended sediment concentrations (Winterwerp and Wang, 2013; Winterwerp et al., 2013). The role of dredging on the suspended sediment concentration and the impact of deepening on turbidity through enhanced estuarine circulation (both addressed in this paper), have so far received little scientific attention. This is probably because (1) many of these human interventions occur concurrently, and therefore it is difficult to distinguish individual contributions, and (2) long-term data documenting changes in suspended sediment concentration are rare (Fabricius et al., 2013). Although the impact of dredging is often monitored and modelled on short timescales (especially during capital dredging works), long-term effects have so far only been established to a limited degree (van Kessel and van Maren, 2013).

Some aspects of the results presented here on the Ems Estuary are very site-specific, such as the sediment extraction. However, most other aspects are probably typical for estuaries in populated areas: (1) intertidal areas are reclaimed, leading to a loss of sediment sinks, (2) channels are deepened, resulting in more up-estuary transport of sediment. We therefore believe that the results presented here apply to a wide range of turbid estuaries in which tidal channels have been deepened for port construction, and tidal flats reclaimed for land use.

6. Conclusions

A calibrated suspended sediment transport model has been setup to simulate suspended sediment dynamics in the Ems Estuary. This model suggests that the observed increase in the suspended sediment concentration can be mainly related to the increase in up-estuary transport of sediment due to estuarine circulation caused by deepening of tidal channels. It is also possible that the large-scale reclamation of intertidal areas increased the suspended sediment concentrations in the past centuries. Discontinuing the large-scale sediment extraction from the port of Emden produced an additional pronounced increase in SSC because the imported sediment was not further removed from the system. The effect of the ports themselves, including dredging and dumping, is lower than deepening and consequent extraction. Compared to an estuary without ports, the sediment concentration in the present-day estuary is higher near disposal sites, but lower elsewhere in the estuary (because the ports act as sinks). The Ems estuary provides an example of a heavily impacted estuary for which a relatively large amount of data is available, but may be representative for many estuaries worldwide.

Acknowledgements

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Exhibit 60

Marine Pollution Bulletin

Volume 32, Issues 8–9, August–September 1996, Pages 615-622

Report

The effects of marine gravel extraction on the macrobenthos: Results 2 years post-dredging

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Available online 25 February 1999.

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Abstract

An offshore experimental dredging study was initiated off North Norfolk (UK) in 1992 to investigate the impacts of marine gravel extraction on the macrofauna. A dredged ‘treatment’ and a non-dredged ‘reference’ site were selected to evaluate the initial impacts and subsequent processes of recolonization. A survey of the benthos was conducted prior to the removal of 50 000 t of marine aggregate from the treatment site. Thereafter annual monitoring surveys were conducted commencing immediately after the dredging episode. Results indicated that whilst the dominant species recolonized quickly following dredging many rarer species did not. Evidence from sidescan sonar records and underwater cameras indicated a considerable amount of sediment transport during the first two winters following dredging and the once well-defined dredge tracks have now become infilled with sand and gravel. The substantially reduced biomass at the treatment site some 24 months after dredging is thought to be due to a local increase in sediment disturbance caused by tide and wave action over the winter period. Finally, the biological findings of this study are discussed in relation to their wider environmental significance.

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Estuarine, Coastal and Shelf Science

Volume 39, Issue 1, July 1994, Pages 75-91

Regular Article

Seagrasses, Dredging and Light in Laguna Madre, Texas, U.S.A.

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Available online 25 May 2002.

https://doi.org/10.1006/ecss.1994.1050

Abstract

Light reduction resulting from maintenance dredging was the suspected cause of large-scale loss of seagrass cover in deep parts of Laguna Madre between surveys conducted in 1965 and 1974. Additional changes to 1988, together with an analysis of dredging frequency and intensity for different parts of the laguna, were consistent with this interpretation. Intensive monitoring of the underwater light regime and compilation of detailed environmental data for 3 months before and 15 months after a dredging project in 1988 revealed reduced light attributable to dredging in four of eight subdivisions of the study area, including the most extensive seagrass meadow in the study area. Dredging effects were strongest close to disposal areas used during this project but still were detectable on transects >1·2 km from the nearest dredge disposal area. In the subdivision of the study area where most of the dredge disposal occurred, light attenuation was increased throughout the 15 months of observation after dredging. In the seagrass meadow and the transition zone at the outer edge of the meadow, effects were evident up to 10 months after dredging. Resuspension and dispersion events caused by wind-generated waves are responsible for the propagation of dredge-related turbidity over space and time in this system.

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Keywords

light attenuation; dredging; seagrasses; coastal lagoon; Texas coast

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Exhibit 62

Marine Pollution Bulletin

Volume 58, Issue 6, June 2009, Pages 832-840

Dredging related metal bioaccumulation in oysters

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Available online 3 March 2009.

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https://doi.org/10.1016/j.marpolbul.2009.01.020

Abstract

Bivalves are regularly used as biomonitors of contaminants in coastal and estuarine waters. We used oysters to assess short term changes in metal availability caused by the resuspension of contaminated sediments. Sydney Rock Oysters, *Saccostrea glomerata*, were deployed at multiple sites in Port Kembla Harbour and two reference estuaries for 11 weeks before dredging and for two equivalent periods during dredging. *Saccostrea* experienced large increases in accumulation of zinc, copper and tin during dredging in the Port relative to oysters deployed in reference estuaries. Lead and tin were found to be permanently elevated within Port Kembla. We present a clear and un-confounded demonstration of the potential for dredging activities to cause large scale increases in water column contamination. Our results also demonstrate the usefulness of external reference locations in overcoming temporal confounding in bioaccumulation studies.

Keywords

Saccostrea; Sediments; Bioavailability; Resuspension; BACI

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Exhibit 63

http://theworldlink.com/news/local/shell-shock/article_389a9be8-77dc-11df-9127-001cc4c03286.html

Shell shock

June 14, 2010
By Nate Traylor, Staff Writer - The World

Images of the oil slick devastating the Gulf of Mexico's seafood industry bring back nightmarish memories for Max and Lilli Clausen.

In 1999, Clausen Oysters in North Bend was the victim of a fuel spill that ruined millions of dollars of product.

That spill, caused by a grounded freighter, was an ink blot compared with the massive eruption of crude spewing off the coast of Louisiana. The local disaster wreaked similar havoc, though on a much smaller scale.

The Clausens, both well past retirement age, sympathize with their Gulf Coast colleagues, some of whom they know from lobbying functions and industry events.

Authorities are failing to take quick, effective action to mop up BP's mess, just as they underperformed here 11 years ago, Lilli Clausen said.

"What upsets me is the politics," she said. "They're doing too much talking and not taking enough action."

In February 1999, a freighter carrying 400,000 gallons of diesel fuel and bunker oil ran aground a mile north of the North Spit. Its name, New Carissa, soon would become famous.

Tug boats were unavailable to tow the ship out to sea. Meanwhile, inclement weather continued to drive the vessel toward shore.

Eventually the hull cracked. Oil leaked. The ship was declared a total loss. Officials blew it up.

"After that ship broke apart, that oil just came in," Lilli Clausen recalls.

Oil from the New Carissa killed more than 200 birds and did immeasurable damage to local sea organisms.

The Coast Guard set out booms to prevent oil from reaching the South Slough National Estuarine Reserve. But little was done to protect private oyster beds. Fuel touched all 600 acres of the Clausens' farm, wiping out about $2 million to $3 million in product.

"We lost 70 to 75 percent of our oysters," Max Clausen said.

"We asked for booms," Lilli Clausen said. "They promised us."

The booms didn't come. Oil spread into the bay. Tar balls and sheen on the water prompted state health officials to shut down all commercial oyster operations. The Clausens laid off half of their crew.

Likewise, Louisiana health officials have closed some oyster production and canceled shrimp season on the central coast. Even those that are still operating are battling the misconception that their product is unsafe for consumption.

"They're losing their markets," Lilli Clausen said. "We did, too."

Lilli Clausen recalled an embarrassing article published in a trade magazine, reporting Coos Bay was serving oily oysters.

"People quit buying," she said.

The Clausens fought a nearly 5-year legal battle with their insurer. The company was reluctant to pay, arguing rain, not oil, had killed their crop.

After an appeal, the Clausens won a $1.2 million settlement, but recovering from the disaster took nearly a decade. They would have retired years ago had it not occurred.

Similarly, some Louisiana oyster farmers can expect a long, uphill battle before they see financial reparations, Lilli Clausen said.

GRI-00/0189

A MODEL FOR SIZING HIGH CONSEQUENCE AREAS ASSOCIATED WITH NATURAL GAS PIPELINES

TOPICAL REPORT

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C-FER Report 99068

Prepared for:

GAS RESEARCH INSTITUTE
Contract No. 8174

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October 2000

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13. ABSTRACT (*Maximum 200 words*) This report developed a simple and defendable approach to sizing the ground area potentially affected by a worst-case ignited rupture of a high-pressure natural gas pipeline. Based on this model, a simple equation has been developed that relates the diameter and operating pressure of a pipeline to the size of the area likely to experience high consequences in the event of an ignited rupture failure. Pipeline incident reports, located in the public domain, were reviewed and provide the basis for evaluating the validity of the proposed affected area equation. The correlation suggests that the simple equation provides a credible estimate of affected area.			
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RESEARCH SUMMARY

Title	A Model for Sizing High Consequence Areas Associated with Natural Gas Pipelines
Contractor(s)	C-FER Technologies
GRI-Contract Number	8174
Principal Investigator(s)	Mark J. Stephens
Report Type	Topical Report
Objective State	To develop a simple and defendable approach to sizing the ground area potentially affected by the failure of a high-pressure natural gas pipeline.
Technical Perspective	The rupture of a high-pressure natural gas pipeline can lead to outcomes that can pose a significant threat to people and property in the immediate vicinity of the failure location. The dominant hazard is thermal radiation from a sustained fire and an estimate of the ground area affected by a credible worst-case event can be obtained from a model that characterizes the heat intensity associated with rupture failure of the pipe where the escaping gas is assumed to feed a fire that ignites very soon after line failure.
Technical Approach	An equation has been developed that relates the diameter and operating pressure of a pipeline to the size of the affected area in the event of a credible worst-case failure event. The model upon which the hazard area equation is based consists of three parts: 1) a fire model that relates the rate of gas release to the heat intensity of the fire; 2) an effective release rate model that provides a representative steady-state approximation to the actual transient release rate; and 3) a heat intensity threshold that establishes the sustained heat intensity level above which the effects on people and property are consistent with the adopted definition of a High Consequence Area (HCA).
Results	For methane with an HCA threshold heat intensity of 5,000 Btu/hr ft^2, the hazard area equation is given by: $r = 0.685\sqrt{p\,d^2}$ where r is the hazard area radius (ft), d is the line diameter (in), and p is the maximum operating pressure (psi).
Project Implications	Natural gas transmission line operators will provide periodic assurances that their pipelines are safe. The Federal code 49CFR192 mandates increased wall thickness thereby reducing the corrosion and mechanical damage risks as the population density increases. The definition of High Consequence Areas is expected to require additional protection for people with limited mobility such as day care centers, old age homes, and prisons. This report suggests the definition for the HCA area of increased protection be set by two parameters, the pipe diameter and it's operating pressure.

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1. INTRODUCTION

1.1 Scope and Objective

This report summarizes the findings of a study conducted by C-FER Technologies (C-FER), under contract to the Gas Research Institute (GRI), to develop a simple and defendable approach to sizing the ground area potentially affected by the failure of a high-pressure natural gas pipeline. This work was carried out at the request of the Integrity Management and Systems Operations Technical Advisory Group (IM&SO TAG), a committee of GRI.

1.2 Technical Background

The failure of a high-pressure natural gas pipeline can lead to various outcomes, some of which can pose a significant threat to people and property in the immediate vicinity of the failure location. For a given pipeline, the type of hazard that develops, and the damage or injury potential associated with the hazard, will depend on the mode of line failure (*i.e.*, leak vs. rupture), the nature of gas discharge (*i.e.*, vertical vs. inclined jet, obstructed vs. unobstructed jet) and the time to ignition (*i.e.*, immediate vs. delayed). The various possible outcomes are summarized in Figure 1.1.

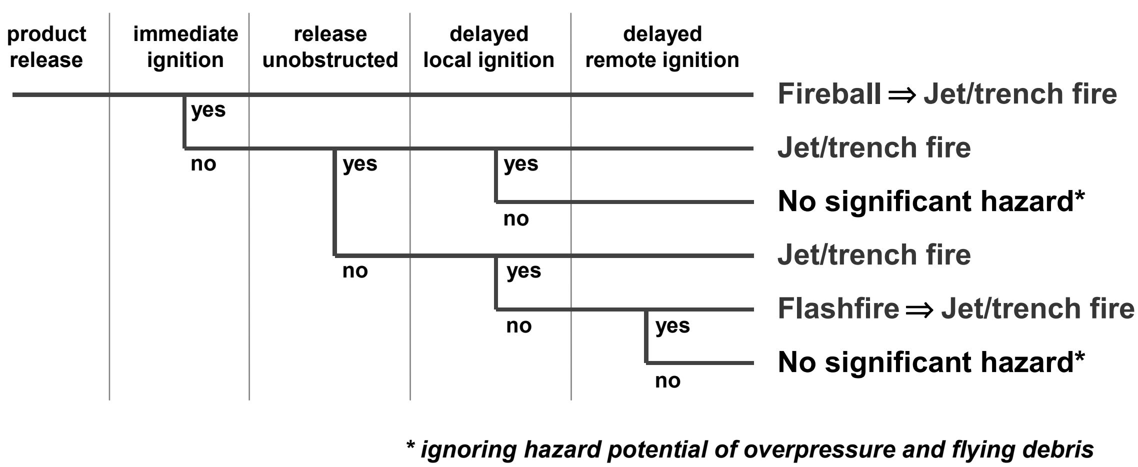

Figure 1.1 Event tree for high pressure gas pipeline failure (adapted from Bilo and Kinsman 1997).

For gas pipelines, the possibility of a significant flash fire resulting from delayed remote ignition is extremely low due to the buoyant nature of the vapor, which generally precludes the formation of a persistent flammable vapor cloud at ground level. The dominant hazard is, therefore, thermal radiation from a sustained jet or trench fire, which may be preceded by a short-lived fireball.

In the event of line rupture, a mushroom-shaped gas cloud will form and then grow in size and rise due to discharge momentum and buoyancy. This cloud will, however, disperse rapidly and a quasi-steady gas jet or plume will establish itself. If ignition occurs before the initial cloud disperses, the flammable vapor will burn as a rising and expanding fireball before it decays into a sustained jet or trench fire. If ignition is slightly delayed, only a jet or trench fire will develop. Note that the added effect on people and property of an initial transient fireball can be accounted for by overestimating the intensity of the sustained jet or trench fire that remains following the dissipation of the fireball.

A trench fire is essentially a jet fire in which the discharging gas jet impinges upon an opposing jet and/or the side of the crater formed in the ground. Impingement dissipates some of the momentum in the escaping gas and redirects the jet upward, thereby producing a fire with a horizontal profile that is generally wider, shorter and more vertical in orientation, than would be the case for a randomly directed and unobstructed jet. The total ground area affected can, therefore, be greater for a trench fire than an unobstructed jet fire because more of the heat-radiating flame surface will typically be concentrated near the ground surface.

An estimate of the ground area affected by a credible worst-case failure event can, therefore, be obtained from a model that characterizes the heat intensity associated with rupture failure of the pipe, where the escaping gas is assumed to feed a sustained trench fire that ignites very soon after line failure.

Because the size of the fire will depend on the rate at which fuel is fed to the fire, it follows that the fire intensity and the corresponding size of the affected area will depend on the effective rate of gas release. The release rate can be shown to depend on the pressure differential and the hole size. For guillotine-type failures, where the effective hole size is equal to the line diameter, the governing parameters are, therefore, the line diameter and the pressure at the time of failure. Given the wide range of actual pipeline sizes and operating pressures, a meaningful fire hazard model should explicitly acknowledge the impact of these parameters on the area affected.

1.3 Report Organization

The hazard model developed to relate the area potentially affected by a failure to the diameter and pressure of the pipeline is described in Section 2.0. Validation of the proposed hazard area model, based on historical data from high-pressure gas pipeline failure incidents in the United States and Canada, is presented in Section 3.0.

2. HAZARD MODEL

2.1 Overview

An equation has been developed that relates the diameter and operating pressure of a pipeline to the size of the area likely to experience high consequences in the event of a credible worst-case failure event. The hazardous event considered is a guillotine-type line rupture resulting in double-ended gas release feeding a trench fire that is assumed to ignite soon after failure.

The hazard model upon which the hazard area equation is based consists of three parts: 1) a fire model that relates the rate of gas release to the heat intensity of the fire as a function of distance from the fire source; 2) an effective release rate model that provides a representative steady-state approximation to the actual transient release rate; and 3) a heat intensity threshold that establishes the sustained heat intensity level above which the effects on people and property are consistent with the definition of a high consequence area. Note that in the context of this study, an HCA is defined as the area within which the extent of property damage and the chance of serious or fatal injury would be expected to be significant in the event of a rupture failure.

The basis for each model, and any underlying assumptions, are described in Sections 2.2 through 2.4. The hazard area equation obtained by combining the model components is described in Section 2.5.

2.2 Fire Model

A jet flame can be idealized as a series of point source heat emitters spread along the length of the flame (see Figure 2.1). Each point source can be is assumed to radiate an equal fraction of the total heat with the heat flux I_i at a given location resulting from point source *i* being given by (Technica 1988):

$$I_i = \frac{\eta X_g Q_{eff} H_c}{4 n_p \pi x_i^2} \qquad [2.1]$$

where H_c = heat of combustion (constant for given product) ≅ 50,000 kJ/kg for methane;
η = combustion efficiency factor = 0.35;
X_g = emissivity factor = 0.2;
n_p = number of point sources;
Q_{eff} = effective gas release rate; and
x_i = radial distance from heat source *i* to the location of interest.

The total heat flux reaching a given point is obtained by summing the radiation received from each point source emitter.

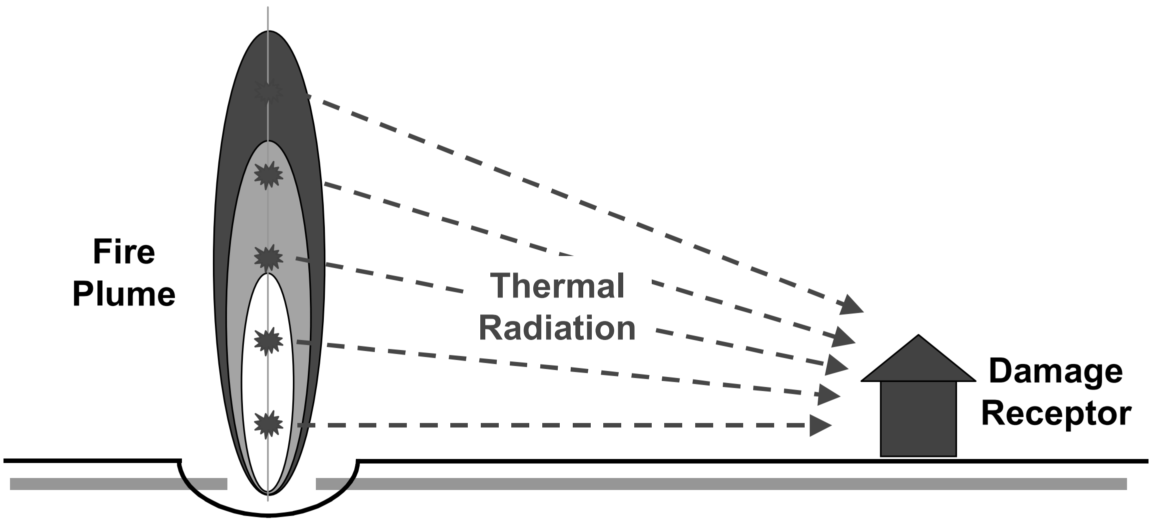

Figure 2.1 Conceptual fire hazard model.

A simplifying assumption, that generally yields a conservative estimate of the total heat flux received by ground level damage receptors, involves collapsing the set of heat emitters into a single point source emitter located at ground level (see Figure 2.2).

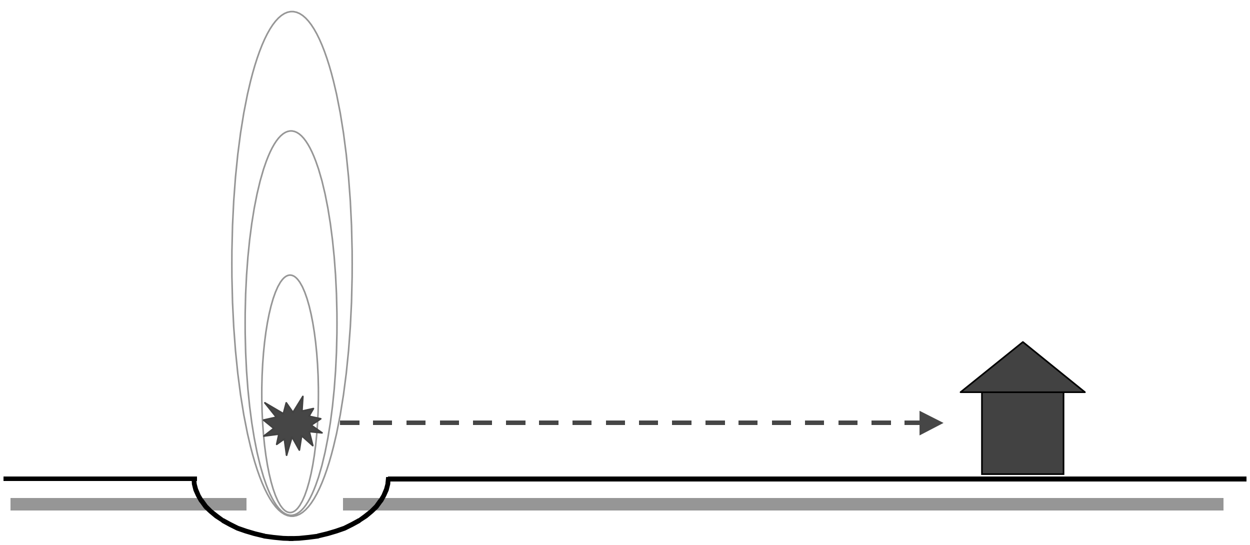

Figure 2.2 Simplified fire hazard model.

The resulting equation for the total heat flux I at a horizontal distance of r from the fire center is given by:

$$I = \frac{\eta \, X_g \, Q_{eff} \, H_c}{4\pi \, r^2} \qquad [2.2]$$

This simplification is, in some respects, more consistent with the geometry of a trench fire which, due to the jet momentum dissipation (see Section 1.2), concentrates more of the heat-radiating flame surface near ground level. Note, however, that while a ground-level point source model represents a conservative approximation to a vertically-oriented jet flame or trench fire, this conservatism is partially offset by the fact that the model does not explicitly account for the possibility of laterally-oriented jets and/or the effects of wind on the actual position of the fire center relative to the center of the pipeline.

Note, also, that for a single point source emitter located at ground level directly above the pipeline, the locus of points receiving a heat flux of I defines a circular area of radius r centered on the pipeline. Thermal radiation hazard zones of increasing impact severity are, therefore, described by concentric circles centered on the pipeline having radii that correspond to progressively higher heat fluxes.

The adopted heat flux versus distance relationship given by Equation [2.2] represents an extension of the widely recognized flare radiation model given in API RP 521 (API 1990). It can be shown to be less conservative than the API flare model (*i.e.*, it gives lower heat intensity estimates at a given distance) but this should not be considered surprising since the API model is widely recognized to be conservative (Lees 1996).

The adopted model is also preferred over some of the more generic, multi-purpose models available for industrial fire hazard analysis because it acknowledges factors, ignored by other models, that play a significant role in mitigating the intensity of real-world jet fire events. In particular, it accounts for the incomplete combustion of the escaping gas stream (through the combustion efficiency factor η), and it acknowledges (through the emissivity factor X_g) that a significant portion of the radiant heat energy will be absorbed by the atmosphere before it can reach targets at any significant distance from the flame surface.

2.3 Effective Release Rate Model

The rate of gas release from a full-bore line rupture varies with time. Within seconds of failure, the rate of release will have dropped to a fraction of the peak initial value and over time the release rate will decay even further. This tendency for rapid release rate decay is illustrated in Figure 2.3, which shows how the rate would be expected to vary with time for two representative line diameter and operating pressure combinations. The relative release rate estimates shown in the figure were calculated using a non-dimensional rate decay model presented in a study by the Netherlands Organization of Applied Scientific Research, Division of Technology for Society (TNO 1982) which is based on realistic gas flow and decompression characteristics and which acknowledges both the compressibility of the gas and the effects of pipe wall friction.

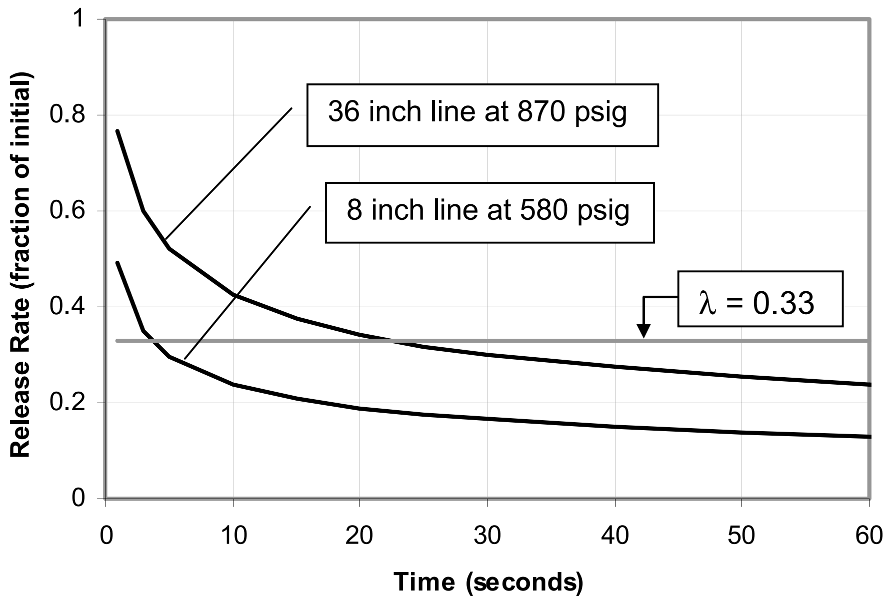

Figure 2.3 Release rate decay.

The peak initial release rate from the single end of a full-bore line rupture can be estimated using the widely recognized gas discharge equation given by the Crane Co. (1981) for sonic or choked flow through an orifice:

$$Q_{in} = C_d \frac{\pi d^2}{4} p \frac{\varphi}{a_0} \qquad [2.3a]$$

where φ = flow factor = $\gamma \left(\frac{2}{\gamma + 1} \right)^{\frac{\gamma+1}{2(\gamma-1)}}$; [2.3b]

a_0 = sonic velocity of gas = $\sqrt{\frac{\gamma R T}{m}}$; [2.3c]

C_d = discharge coefficient ≅ 0.62;
γ = specific heat ratio of gas ≅ 1.306 for methane;
R = gas constant = 8,310 J/(kg mol)/K;
T = gas temperature ≅ 288 K or 15 C;
m = gas molecular weight ≅ 16 kg/mol for methane;
d = effective hole diameter ≅ line diameter; and
p = pressure differential ≅ line pressure.

Given that the release rate is highly variable, it follows that the size and intensity of the associated fire will also vary with time and the peak intensity of the fire will depend on exactly when ignition occurs. The hazard model developed herein accounts for the above by approximating the transient jet or trench fire as a steady state fire that is fed by an *effective* release rate. The effective release rate is a fractional multiple of the peak initial release rate that can be used to obtain estimates of sustained heat flux that are comparable to those obtained from a more realistic transient fire model that assumes a slight delay in ignition time.

For a guillotine-type failure of a pipeline resulting in double-ended release, the effective release rate that is assumed to feed a steady-state fire is given by:

$$Q_{eff} = 2\lambda Q_{in} = 2\lambda C_d \frac{\pi d^2}{4} p \frac{\varphi}{a_0} \qquad [2.4]$$

where λ is the release rate decay factor and the factor of 2 acknowledges that gas will be escaping from both failed ends of the pipeline.

In general, the most appropriate value for the release rate decay factor will depend on the size of pipeline being considered, the pressure in the line at the time of failure, the assumed time to ignition, and the time period required to do damage to property or cause harm to people. Given that even immediate ignition will require several seconds for the establishment of the assumed radiation conditions and given further that a fatal dose of thermal radiation can be received from a pipeline fire in well under 1 minute (see Section 2.4), it follows from Figure 2.3 that a rate decay factor in the range of 0.2 to 0.5 will likely yield a representative steady state approximation to the release rate for typical pipelines.

In a study of the risks from hazardous pipelines in the United Kingdom conducted by A. D. Little Ltd. (Hill and Catmur 1995), the authors report using a release rate decay factor of 0.25. A slightly more conservative value for λ of 0.33 has been adopted herein to ensure that the sustained fire intensity associated with nearly immediate ignition of fires associated with large diameter pipelines will not be underestimated (see Figure 2.3). Given that anecdotal information on natural gas pipeline failures suggests that the time to ignition may typically be in the range of 1 to 2 minutes (as in the Edison, New Jersey incident of 1994), the adopted release rate decay factor will likely yield an effective release rate estimate that overestimates the actual rate for the full duration of a typical gas pipeline rupture fire.

2.4 Heat Intensity Threshold

For people, the degree of harm caused by thermal radiation is usually estimated using a model that relates the chance of burn injury or fatality to the thermal load received where the thermal load L_p is given by an equation of the form (Lees 1996):

$$L_p = t\, I^n \qquad [2.5]$$

where t is the exposure duration, I is the heat flux and n is an index.

Various recognized thermal load vs. effect models based on Equation [2.5] are summarized in Table 2.1 together with calculated estimates of the exposure times required to reach various conditions of injury and mortality for persons exposed to specified heat intensity levels. If it is assumed that within a 30 second time period an exposed person would remain in their original position for between 1 and 5 seconds (to evaluate the situation) and then run at 5 mph (2.5 m/s) in the direction of shelter, it is estimated that within this period of time they would travel a distance of about 200 ft (60 m). On the further assumption that, under typical conditions, a person can reasonably be expected to find a sheltered location within 200 ft of their initial position, a 30 second exposure time is considered credible and is, therefore, adopted as the reference exposure time for people outdoors at the time of failure.

Radiation Intensity or Heat Flux ($Btu/hr\ ft^2$)	Radiation Intensity or Heat Flux (kW/m^2)	Time to Burn Threshold (Eisenberg et al. 1975) $t*I^{1.15} = 195$	Time to Blister Threshold - lower[1] (Hymes 1983)[2] $t*I^{1.33} = 210$	Time to Blister Threshold - upper[1] (Hymes 1983)[2] $t*I^{1.33} = 700$	Time to 1% Mortality (Hymes 1983)[2] $t*I^{1.33} = 1060$	Time to 50% Mortality (Hymes 1983)[2] $t*I^{1.33} = 2300$	Time to 100% Mortality[3] (Bilo & Kinsman 1997) $t*I^{1.33} = 3500$
1600	5.05	30.3	24.4	81.3	123.1	267.1	406.4
2000	6.31	23.5	18.1	60.4	91.5	198.5	302.1
3000	9.46	14.7	10.6	35.2	53.4	115.8	176.2
4000	12.62	10.6	7.2	24.0	36.4	79.0	120.2
5000	15.77	8.2	5.4	17.9	27.0	58.7	89.3
8000	25.24	4.8	2.9	9.6	14.5	31.4	47.8
10000	31.55	3.7	2.1	7.1	10.8	23.3	35.5
12000	37.85	3.0	1.7	5.6	8.4	18.3	27.9

Note:
1) Hymes gives a thermal load range (210 to 700) rather than a single value for blister formation
2) the thermal load values given by Hymes are based on a revised interpretation of the results obtained by Eisenberg et al.
3) Bilo and Kinsman assume that 100% mortality corresponds to a lower bound estimate of the thermal load associated with the spontaneous ignition of clothing

Table 2.1 Effects of thermal radiation on people.

The exposure time estimates closest to this reference time are highlighted in Table 2.1 for each different thermal load effect. Note that the onset of burn injury within the reference exposure time is associated with a heat flux in the range of 1,600 to 2,000 Btu/hr ft^2 (5 to 6.3 kW/m^2), depending on the burn injury criterion. The chance of fatal injury within the reference exposure time becomes significant at a heat flux of about 5,000 Btu/hr ft^2 (15.8 kW/m^2), if the significance threshold is taken to be a 1% chance of mortality (*i.e.,* 1 in 100 people directly exposed to this thermal load would not be expected to survive).

For property, as represented by a wooden structure, the time to both piloted ignition (*i.e.,* with a flame source present) and spontaneous ignition (*i.e.,* without a flame source present) can also be estimated as a function of the thermal load received. For buildings, the thermal load L_b is given by an equation of the form (Lees 1996):

$$L_b = (I - I_x)t^n \quad [2.6]$$

where I_x is the heat flux threshold below which ignition will not occur.

Models based on Equation [2.6], developed from widely cited tests as re-interpreted by the UK Health and Safety Executive (Bilo and Kinsman 1997), are summarized in Table 2.2 together with calculated estimates of the exposure times required for both piloted and spontaneous ignition at selected heat intensity levels.

Radiation Intensity or Heat Flux (Btu/hr ft^2)	Radiation Intensity or Heat Flux (kW/m^2)	Time to Piloted Ignition[1] (Bilo & Kinsman 1997) $(I-14.7)*t^{0.667}=118.6$	Time to Spontaneous Ign.[1] (Bilo & Kinsman 1997) $(I-25.6)*t^{0.8}=167.6$
4000	12.62	no ignition	no ignition
5000	15.77	1162.3	no ignition
8000	25.24	37.8	no ignition
10000	31.55	18.7	65.0
12000	37.85	11.6	26.3
Note: 1) based on experiments on American whitewood			

Table 2.2 Effects of thermal radiation on wooden structures.

From Table 2.2 it can be seen that 5,000 Btu/hr ft^2 (15.8 kW/m^2), corresponds to piloted ignition after about 20 minutes (1,200 seconds) of sustained exposure. The table further shows that spontaneous ignition is not possible at this heat intensity level. It is therefore assumed that this heat intensity represents a reasonable estimate of the heat flux below which wooden structures would not be destroyed, and below which wooden structures should afford indefinite protection to occupants.

Note that the model employed for estimating the effects of thermal radiation on property explicitly considers the duration of exposure required to cause ignition. Some earlier wood ignition models, which appear to be the basis for the often cited 4,000 Btu/hr ft^2 (12.6 kW/m^2) threshold for piloted wood ignition, are in fact associated with an almost indefinite time to ignition and are, therefore, considered to be overly conservative given the transient (decaying) nature of real pipeline rupture fires.

In light of the above, if a high consequence area is defined as the area within which both the extent of property damage and the chance of serious or fatal injury would be expected to be significant, it follows that this area can reasonably be defined by a heat intensity contour corresponding to a threshold value below which:

- property, as represented by a typical wooden structure, would not be expected to ignite and burn;
- people located indoors at the time of failure would likely be afforded indefinite protection; and
- people located outdoors at the time of failure would be exposed to a finite but low chance of fatality.

The information presented on thermal load effects suggests that below 5,000 Btu/hr ft^2, a wooden structure would not be expected to burn and it, thereby, affords indefinite protection to sheltered persons. Also, this heat intensity level corresponds to approximately a 1 percent chance of fatality for persons exposed for a credible period of time before reaching shelter. A heat flux of 5,000 Btu/hr ft^2 has, therefore, been adopted as the threshold heat intensity for the purpose of sizing a high consequence area.

2.5 Hazard Area Equation

Substituting the expression developed for the effective release rate (Equation [2.4]) into the heat intensity versus distance formula (Equation [2.2]), replacing all constants and rearranging gives the following expression for the radial distance to locations where the heat flux is equal to the threshold value:

$$r = \sqrt{\frac{2348\, p\, d^2}{I_{th}}} \quad \text{(ft)} \tag{2.7}$$

where I_{th} = threshold heat intensity (Btu/hr/ft^2);
p = line pressure (psi); and
d = line diameter (in).

For a threshold heat intensity of 5,000 Btu/hr ft^2, the above expression reduces to:

$$r = 0.685\sqrt{p\, d^2} \tag{2.8}$$

Equation [2.8] can, therefore, be used to estimate the radius of a circular area surrounding the assumed point of line failure within which the impact on people and property would be expected to be consistent with the adopted definition of a high consequence area.

Hazard area radii, as calculated using Equation [2.8] are plotted in Figure 2.4 as a function of line diameter and operating pressure. The figure shows that, for pipelines operating at pressure levels in the range of 600 to 1,200 psi, the calculated hazard area radius ranges from under 100 ft for small diameter lines to over 1,100 ft for large diameter lines.

Note that the concept of relating the potential hazard area to the line diameter and operating pressure is not new. An approach similar to that described herein has been an integral part of the high pressure gas transmission pipeline code in the United Kingdom since 1977 (Knowles *et al*. 1978 and IGE 1993). The standard as developed in the United Kingdom incorporates the concept of a Building Proximity Distance (BPD), multiples of which serve to define development exclusion zones and establish the pipeline corridor width for the purpose of determining Location Class. The BPD is calculated directly from the line diameter and the maximum operating pressure.

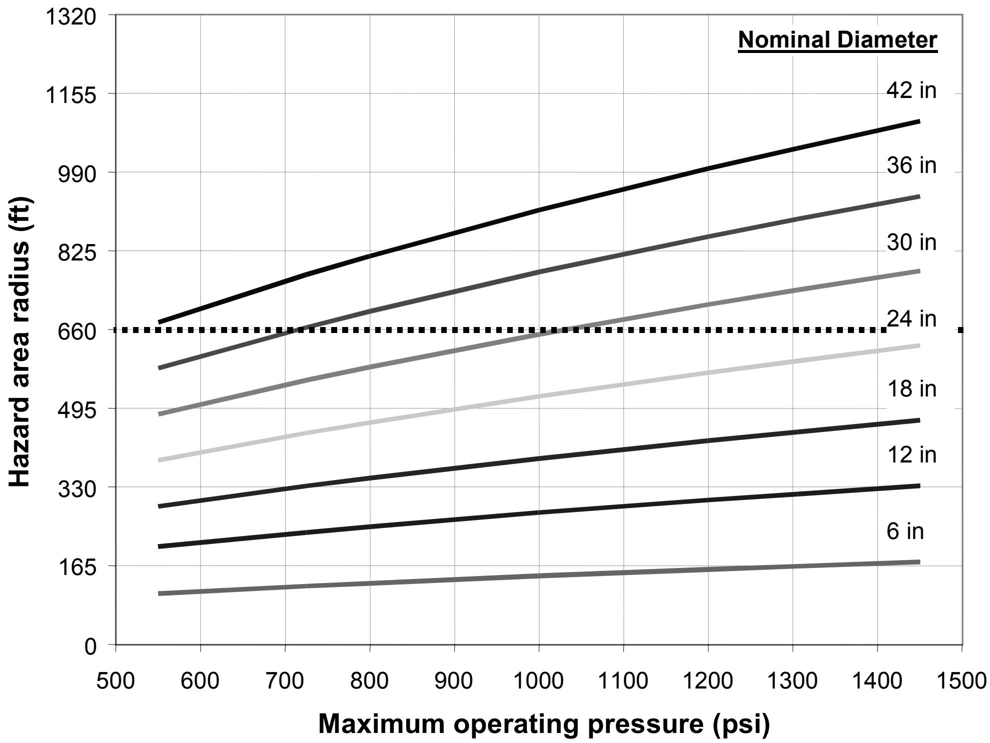

Figure 2.4 Proposed hazard area radius as a function of line diameter and pressure.

3. MODEL VALIDATION

Pipeline incident reports, located in the public domain, were reviewed to provide a basis for evaluating the validity the proposed hazard area model given by Equation [2.8]. The data sources reviewed included reports on pipeline incidents in the United States prepared by the National Transportation Safety Board (NTSB) going back to 1970, and similar reports on incidents in Canada prepared by the Transportation Safety Board (TSB) going back to 1994. Note that the information extracted from these reports required some interpretation due to differences in the way the information was reported. The processed data together with hazard area estimates obtained using Equation [2.8] are summarized in Figure 3.1. A summary of the information that forms the basis for Figure 3.1 is given in Table 3.1.

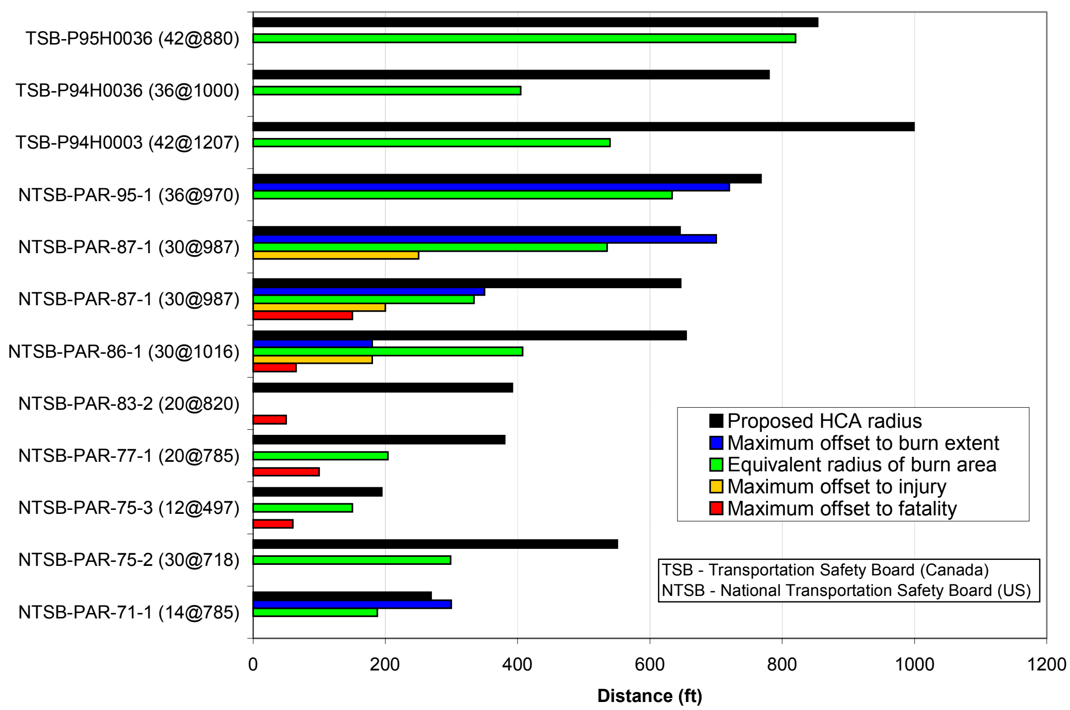

Figure 3.1 Comparison between actual incident outcomes and the proposed hazard area model.

In interpreting the incident outcomes summarized in Figure 3.1 note the following:

- the *equivalent radius of burn area* is the radius of a circle having an area equal to the reported area of burnt ground;
- the *maximum offset to burn extent* is the maximum reported of inferred lateral extent of burnt ground measured perpendicular to a line tracing the alignment of the pipeline prior to failure; and
- the *maximum offset to injury/fatality* is the maximum reported or inferred distance to an injury/fatality again measured perpendicular to a line tracing the alignment of the pipeline prior to failure.

Figure 3.1 shows that in every case the hazard area calculated using the proposed equation is greater than the actual reported area of burnt ground. In addition, with the sole exception of one of the incidents reported in NTSB-PAR-87-1, the radius obtained from the hazard area equation conservatively approximates the maximum lateral extent of the burn zone. Finally, in all cases the calculated hazard zone radius significantly exceeds the maximum reported offset distance to injury or fatality.

Note, however, that whereas the interpretation of reported burn areas and burn distances is obvious, caution should be exercised in interpreting maximum offset distances to injury and fatality. Given that most of the incidents occurred in sparsely populated areas, the reported injury and fatality offsets are more indicative of where people happened to be at the time of failure rather than being representative of the maximum possible distances to injury or fatality for the incident in question.

Acknowledging the uncertainty associated with interpreting reported offsets to injury and fatality, the balance of information still overwhelmingly indicates that the proposed hazard area radius equation provides a reasonable, if somewhat conservative, estimate of the zone of high consequence.

It is thought that one of the main reasons for the apparent conservatism in the proposed hazard area model is that it is based on an effective sustained release rate that is consistent with the assumption of almost immediate ignition. The actual time to ignition for many of the reported incidents is probably longer (see incident notes in Table 3.1) making the effective release rate approximation conservative.

Date	Report	Location	Incident	Damage	Maximum Burn Distance	Diameter (in)	Pressure (psi)
1969	NTSB-PAR-71-1	near Houston, Texas	Rupture at 3:40 p.m. on September 9th, explosive ignition 8 to 10 minutes after failure.	Burned area 370 ft long by 300 ft wide (all to one side). Houses destroyed by blast to 250 ft, heat damage to 300 ft, 106 homes damaged, 9 injuries, and 0 fatalities.	300 ft	14	789
1974	NTSB-PAR-75-2	near Bealeton, Virginia		Burned area 700 ft by 400 ft.		30	718
1974	NTSB-PAR-75-3	near Farmington, New Mexico	Rupture at 3:45 a.m. on March 15th, ignition soon after failure.	Earth charred within a 300 ft diameter circle, 3 fatal injuries (within 60 ft offset)		12.75	497
1976	NTSB-PAR-77-1	Cartwright, Louisiana	Rupture at 1:05 p.m. on August 9th, ignited within seconds	Burn area 3 acres (implies a 200 ft radius circle), 6 fatalities (within about 100 ft offset) and 1 injury.		20	770
1982	NTSB-PAR-83-2	Hudson, Iowa		5 fatalities (within 150 ft, less than 50 ft offset).		20	820
1984	NTSB-PAR-86-1	near Jackson, Louisiana	Rupture at 1:00 p.m. on November 25th, ignition soon after failure.	Burned area 1450 ft long by 360 ft wide (furthest fire extent 950 ft), 5 fatalities (within 65 ft, 0 ft offset), and 23 injuries (within 800 ft,180 ft offset).	Offset 180 ft. Distance 950 ft.	30	1016
1985	NTSB-PAR-87-1	near Beaumont, Kentucky	Rupture at 9:10 p.m. on April 27th, ignition soon after failure.	Burned area 500 ft wide by 700 ft long. 2 houses, 3 house trailers and numerous other structures and equipment destroyed. 5 fatalities due to smoke inhalation in house 318 ft from rupture (150 ft offset), 3 people burned running from house 320 ft from rupture (200 ft offset) one hospitalized with 2nd degree burns.	Offset 350 ft. Distance 500 ft.	30	990
1986	NTSB-PAR-87-1	near Lancaster Kentucky	Rupture at 2:05 a.m. on February 21st, ignition soon after failure.	Burned area 900 ft by 1000 ft. 2 houses, 1 house trailer and numerous other structures and equipment destroyed. 3 people burned running from house 280 ft from rupture (requiring hospitalization), 5 others received minor burn injuries running from dwellings between 200 and 525 ft from rupture (250 ft offset).	Offset 700 ft. Distance 800 ft.	30	987
1994	NTSB-PAR-95-1	Edison, New Jersey	Rupture at night on March 23rd, ignition within 1 to 2 minutes after failure.	Burned area 1400 ft long by 900 ft wide. Fire damage to dwelling units up to 900 ft from rupture, dwelling units at 500 ft and beyond caught fire between 7 to 10 minutes after failure, no fatalities but 58 injuries.	Offset 720 ft. Distance 960 ft.	36	970
1994	TSB Report No. P94H0003	Maple Creek, Saskatchewan	Rupture at 7:40 p.m. on February 14th, ignition soon after failure.	Fire burn area 21.0 acres (8.5 hectares).		42	1207
1994	TSB Report No. P94H0036	Latchford, Ontario	Rupture at 7:13 a.m. on July 23rd, ignition soon after failure.	Fire burn area 11.8 acres (4.77 hectares), heat-affected area 18.6 acres (7.52 hectares).		36	1000
1995	TSB Report No. P95H0036	Rapid City, Manitoba	Rupture of 42 inch line at 5:42 a.m. on July 29th, ignition soon after failure leading to rupture and fire on adjacent 36 inch line at 6:34 a.m.	Fire burn area 48.5 acres (19.6 hectares), heat-affected area 198 acres (80 hectares).		42	880

Table 3.1 Summary of relevant North American pipeline failure incident reports.

4. REFERENCES

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Exhibit 65

ELLEN F. ROSENBLUM
Attorney General

FREDERICK M. BOSS
Deputy Attorney General

DEPARTMENT OF JUSTICE
GENERAL COUNSEL DIVISION

December 1, 2017

Ms. Kimberly D. Bose, Secretary
888 First Street, N.E., Room 1A
Washington, DC 20426

Re: *Jordan Cove LP Pacific Connector Gas Pipeline LP*
Docket Nos. PF17-4-000, CP17-494-000, and CP17-495-000

Dear Ms. Bose:

Please find the attached comments, submitted by the Oregon Department of Energy on behalf of the Oregon Department of Geology and Mineral Industries, in the above-referenced matters.

Sincerely,

/s/ Jesse D. Ratcliffe

Jesse D. Ratcliffe
Assistant Attorney General
Natural Resources Section

JDR:pjn/8643729

Oregon
Kate Brown, Governor

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November 6, 2017

Sean Mole
Jordan Cove Analyst
Oregon Department of Energy
550 Capitol St NE, 1st floor
Salem, OR 97301

Re: DOGAMI Comments Related to Geologic Hazards and the Proposed Jordan Cove LNG Terminal and Pacific Gas Connection Pipeline

Dear Mr. Mole:

The Oregon Department of Geology and Mineral Industries (DOGAMI) reviewed the materials relating to geologic hazards in:

- Resource Report 6 – Geological Resources Jordan Cove Energy Project, dated April 2017
- Resource Report 6 – Pacific Connector Gas Pipeline Project, dated May 2017
- Draft Resource Report 13 – Engineering and Design Material, Chapter 13.3 Natural Hazards and Conditions, Jordan Cove Energy Project, dated May 2017, which includes:
  - Appendix I.13 Natural Hazard Design Investigations and Forces, and
  - Appendix J.13 Site Investigation and Conditions, and Foundation Design

DOGAMI finds the information in the Resource Reports submitted by the Applicant to be incomplete, has comments about possible deficiencies in the scientific and engineering analyses related to geologic hazards; and at this point is not satisfied that geologic hazards will be adequately addressed to ensure public safety. Please see attached: 1) General Review comments, and 2) comments on the Resource Reports.

While DOGAMI has regulatory and statutory authority on mining operations and building in the tsunami regulatory zone, this letter is not intended to address those specific requirements. The Applicant must meet Oregon building code requirements and Oregon laws, including Section 1803.2.1 Tsunami Inundation Zone of the Oregon Structural Specialty Code (Oregon Revised Statutes [ORS] 455.446 and 455.447).

Thank you for the opportunity to assist with this project. If you have any questions, please contact me at 971-673-1555 (brad.avy@oregon.gov) or Yumei Wang at 971-673-1551 (yumei.wang@oregon.gov).

Sincerely,

Brad J. Avy
Director and State Geologist

cc: Jon Allan, Tsunami Lead
Bill Burns, Natural Hazards Section Supervisor
Laura Gabel, Geologist
Ian Madin, Deputy Director and Chief Scientist
Jed Roberts, Geological Survey and Services Program Manager
Yumei Wang, Engineer

General Review Comments

This proposed project is in a high seismic hazard area due to the Cascadia Subduction Zone, which can produce a magnitude 9 earthquake, and the proposed Liquefied Natural Gas (LNG) Terminal facility is located in the Cascadia tsunami inundation zone. Some specific concerns related to the performance of the proposed facilities and public safety include:

1. The long duration of shaking expected with a magnitude 9 earthquake and how it might impact the proposed facilities and safety of people;
2. Ground failure of the softer and looser soils in the nearby area and how it may impact the proposed facilities and safety of people;
3. How the proposed facilities may negatively impact the tsunami hazards in the surrounding areas and safety of people;
4. Tsunami scour in the nearby area and how the Maximum Considered Tsunami (MCT), that is, the design tsunami, may impact the local landforms, including the dunes, and proposed facilities and safety of people;
5. Dynamic erosion of the North Spit dunes in response to the design tsunami and how it may impact tsunami runup at the proposed facilities and safety of people;
6. Tsunami debris impacting the nearby area and how it may impact the local landforms, including the dunes, proposed facilities and safety of people;
7. Dependencies on existing infrastructure that may fail, such as roads and levees; and
8. Lack of discussion of instrument monitoring safety programs related to potential ground failures, including ground settlement of soft soils and movement of landslides.

DOGAMI encourages designing and building for disaster resilience and future climate using science, data and community wisdom to protect against and adapt to risks. This will allow people, communities and systems to be better prepared to withstand catastrophic events and future climate—both natural and human-caused—and be able to bounce back more quickly and emerge stronger from shocks and stresses.

Applicant should follow existing regulations (e.g., State of Oregon's Oregon Revised Statutes, Oregon Administrative Rules, Oregon building codes, federal laws, and local regulations):

- Use best practices supporting public safety;
- Use a long-term view to protect citizens, property, environment, and standard of living;
- Integrate resilience, where possible, by avoiding high risk areas or embracing higher performance standards than may be required by building codes and regulations. This will lessen damage and speed recovery after disasters, and improve continuity of operations.

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5. Dynamic erosion of the North Spit dunes in response to the design tsunami and how it may impact tsunami runup at the proposed facilities and safety of people;
6. Tsunami debris impacting the nearby area and how it may impact the local landforms, including the dunes, proposed facilities and safety of people;
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- Integrate resilience, where possible, by avoiding high risk areas or embracing higher performance standards than may be required by building codes and regulations. This will lessen damage and speed recovery after disasters, and improve continuity of operations.

DOGAMI Comments on Resource Reports

DOGAMI's comments pertain to the specific resource reports as presented by the Applicant. It is possible that some of the comments on Resource Report 6 are addressed in Resource Report 13; however, the Applicant has not explained nor organized the information in a manner that can be readily reviewed.

Resource Report 6 – Jordan Cove Energy Project

9. The Resource Report 6 Jordan Cove Energy Project is incomplete. For example, none of the Appendices for have been provided in Resource Report 6, including:
   - Appendix A.6 – Geotechnical Data Report, Jordan Cove LNG Project
   - Appendix B.6 – Seismic Ground Motion Hazard Study, Jordan Cove LNG Project
   - Appendix C.6 – Geotechnical Report, Jordan Cove LNG Project
   - Appendix D.6 – Estuary Flood Risk and Hazard Study, Jordan Cove LNG Project
   - Appendix E.6 – Tsunami Hydrodynamic Modelling, Jordan Cove LNG Project
   - Appendix F.6 – Tsunami Maximum Run-up Modelling, Jordan Cove LNG Project
   - Appendix G.6 – Tsunami Wave Amplitude Analysis, Jordan Cove LNG Project
   - Appendix H.6 – Design Wind Speed Assessment, Jordan Cove LNG Project

10. Section 6.4.1.1 Earthquakes of the Resource Report 6 – Jordan Cove Energy Project provides seismic ground motions that are both incomplete and unclear. For example, the Applicant states that there is a "comparison in Table 6.4.1 includes values for soft rock site conditions as well as the anticipated site soil conditions after construction." Please provide this information in a clear manner that includes informative labels for the reviewer.

11. Section 6.4.1.1 Earthquakes of the Resource Report 6 – Jordan Cove Energy Project provides seismic ground motions that have not used new building code reference documents, namely American Society of Civil Engineers (ASCE) 7-16. Please discuss why ASCE 7-16 has not been used, or provide and discuss design values using ASCE 7-16.

12. Section 6.4.1.3 Soil Liquefaction of the Resource Report 6 – Jordan Cove Energy Project refers to Appendix C.6, however, this appendix was not provided. As requested earlier, please provide information that is referenced.

13. Section 6.4.1.3 Soil Liquefaction of the Resource Report 6 – Jordan Cove Energy Project does not include information on the method used for the liquefaction triggering analyses. DOGAMI recommends that the Applicant conduct analyses consistent with the National

Academies Liquefaction Study Report (2016), available at https://www.nap.edu/catalog/23474/state-of-the-art-and-practice-in-the-assessment-of-earthquake-induced-soil-liquefaction-and-its-consequences.

For all of the liquefaction analyses, the assumptions, methods used, and uncertainties associated with them should be explicitly stated and presented for each step of the analysis. This includes the uncertainties associated with field investigations, lab testing, triggering analyses, settlement analyses, lateral spreading analyses, and proposed mitigation. This should also be a part of any future analyses including soil-structure interaction and other modeling of the structural responses to the hazards and for proposed mitigation. Results should be summarized so that it is clear which resulting values are being used for design purposes.

14. Section 6.4.1.4 Tsunamis of the Resource Report 6 – Jordan Cove Energy Project states: "The modeled rupture scenario XL1 has an estimated period longer than the 10,000-year event discussed in Volume 2, Section 13.I.2.4 of FERC's Guidance Manual for Environmental Report Preparation (February 2017)." DOGAMI's XL1 is a deterministic scenario. The DOGAMI XL1 scenario is not associated with a period longer than the 10,000-year event.

    Since 2016, there has been a national standard for tsunami resilient design in the American Society of Civil Engineers (ASCE) 7-16 Chapter 6 Tsunami Loads and Effects. This is the consensus-based engineering standard that is a referenced requirement in the latest (2018) International Building Code (IBC). The IBC is a model code that is widely adopted throughout the country including by the State of Oregon. ASCE 7-16 was extensively vetted by the American Society of Civil Engineers using an accredited and audited consensus process.

    DOGAMI recommends the Applicant comply with ASCE 7-16. DOGAMI recommends that the Applicant meet or exceed the inundation limit and other design parameters in the ASCE 7 Tsunami Design Geodatabase and select design procedures and parameters, such as design inundation depths and flow velocities, which would result in a proposed facility that will protect human safety. Any modeling procedure for determining site-specific tsunami design inundation and velocities should follow Section 6.7 of ASCE 7-16 and demonstrate that the tsunami input meets the Probabilistic Tsunami Hazard Analysis Offshore Tsunami Amplitude of the ASCE Tsunami Design Geodatabase. Maps and criteria in the ASCE 7-16 design standard are based on engineering risk analysis and reliability targets. The ASCE 7-16 Maximum Considered Tsunami (MCT) has a 2% probability of being exceeded in a 50-year period, or a 2,475 year average return period. The ASCE 7-16 MCT is a design basis event, characterized by the inundation depths and flow velocities at the stages of inflow and outflow most critical to the structure(s).

The Applicant should clearly present each step of the multiple tsunami analyses in a manner suitable for peer review by qualified professionals. All analyses, methods, assumptions and final values used for the structural design procedures for tsunami effects should be clearly documented so that results are reproducible. This includes, but is not limited to, identifying debris impact loads, foundation design factors, uplift forces, scour forces, and loads for all Tsunami Risk Category III and IV Nonbuilding Structures and designated nonstructural components.

15. Section 6.4.1.4 Tsunamis of the Resource Report 6 – Jordan Cove Energy Project refers to the existing Trans Pacific Parkway/US- 101 Intersection as being in the tsunami inundation zone. The Applicant states "To maintain grades, improvements to the intersection will not remove the intersection from the tsunami inundation zone." There appears to be only one access road for the proposed Jordan Cove LNG facility. This access road is in the tsunami inundation zone. In order for the access road to be reliably useable for safety purposes after a future tsunami disaster, it would need to incorporate both earthquake and tsunami resistant designs. These designs would need to factor in potential cyclic strain, liquefaction and lateral spreading from ground shaking. In addition, the designs would need to account for tsunami forces, including flooding, velocities, scour, buoyancy and debris impact. Has this roadway and access to the proposed facilities been evaluated for possible damage due to tsunami forces, such as tsunami scour and tsunami debris impact? Please provide analyses, results and, if needed, proposed mitigation that addresses both post-earthquake and post-tsunami safety for proposed berms, roadways and elevated ground. Related documents should be complete, clearly organized and presented to allow for peer review by qualified specialists.

<u>Resource Report 6 – Pacific Connector Gas Pipeline Project</u>

16. The Resource Report 6 – Pacific Connector Gas Pipeline Project is incomplete. For example, some of the Appendices for have not been provided, including:
    - APPENDIX C – Site-Specific Landslide Evaluation
    - APPENDIX H – Geotechnical Boring Logs
    - APPENDIX I – Laboratory Testing
    - APPENDIX J – Seismic Reflection Survey – Stukel Mt. Fault

17. The Applicant states (on page 7): "With the exception of those in the Klamath Falls area, these mapped surface faults are not considered active and are not believed to be capable of renewed movement or earthquake generation (USGS, 2002 interactive fault website)". DOGAMI considers Quaternary active faults as capable of generating potentially damaging earthquakes. DOGAMI has mapped late Quaternary faults in Coos Bay, which could impact the proposed project. Please refer to this publication: www.oregongeology.org/pubs/gms/GMS-094.pdf. DOGAMI recommends that a thorough literature review be conducted for known Quaternary active faults, as well as a site specific investigation that covers the proposed project area to evaluate if unknown Quaternary faults exist that may negatively impact the proposed facilities. Analysis of recently acquired lidar data throughout Oregon has identified numerous previously unidentified late Quaternary or Holocene fault scarps including in the Klamath Falls area. The entire pipeline right-of-way (ROW) should be evaluated thoroughly with lidar coverage of a broad area around the ROW to identify potentially hazardous faults.

18. The Applicant states (on page 8): "The PCGP Project is located in relatively sheltered areas of Coos Bay, where the effects of a tsunami on the pipeline are expected to be relatively minor". DOGAMI requests the tsunami analyses that supports this statement. What tsunami modeling was conducted for the proposed pipeline alignment? What are the tsunami flow depths used to estimate scour potential? Were tsunami scouring forces evaluated for both the incoming (inflow) and outgoing (outflow) tsunami waves?

19. The Applicant states (on page 9): "The recurrence interval between Cascadia events has been irregular and ranges from about 100 to 1,000 years (Atwater and Hemphill-Haley, 1997). Typical recurrence intervals are thought to be on the order of 400 to 600 years (Clague et al., 2000)." DOGAMI requests that the Applicant consider the most recent scientifically peer reviewed data on recurrence intervals for the Cascadia Subduction Zone (e.g., Goldfinger, et al, 2016). DOGAMI recommends that the Applicant consider the continually evolving scientific information on the Cascadia Subduction Zone and related seismic hazards.

20. The Applicant states (on page 10): " PGAs for the PCGP Project are listed in Table 2, based on USGS (2008) data compilation." DOGAMI requests that the Applicant consider the most recent USGS data, including the 2014 USGS seismic hazard maps.

21. The Applicant states (on page 10) "Higher PGAs are possible where soft soil overlies bedrock, such as in the vicinity of North Slough and Haynes Inlet MP 1.47H to 5.3H. We estimate Site Class D conditions are appropriate for the MP 1.47H to 5.3H areas." It is

common in estuaries to have soils that are softer than Site Class D conditions due to the presence of estuarine muds and river sediments, and these soils may amplify earthquake shaking. Rather than the Applicant estimating the Site Class type as D, DOGAMI recommends that both a literature review and site specific analyses are conducted to determine actual Site Class types and use those to determine PGAs and other relevant seismic ground motions and response. Downhole shear wave velocity measurements of Coos Bay estuarine sediments are available in the DOGAMI O-13-06 database.

22. The Applicant states (on page 11): " ...there is a low risk of pipeline damage from ground shaking in the absence of other deformation adversely affecting the pipeline. Based on these studies, the potential damage to buried pipelines from ground shaking intensity at the site is considered to be low." DOGAMI requests the Applicant to provide information on the vulnerability of buried pipelines in sloped areas without ground deformation during seismic shaking, such as along portions of the proposed corridor that crosses the Coast, Klamath and Cascade Ranges.

23. The Applicant states (on page 11): "ancient, inactive faults have no potential for rupture." DOGAMI finds this statement to be misleading. Weak planes or zones, such as ancient faults and bedding planes, can be displaced from earthquake shaking. DOGAMI recommends that the Applicant evaluate weak planes and zones for potential displacement that could impact the proposed pipeline.

24. The Applicant reviews faults that cross the proposed pipeline on pages 11 - 13 and includes "TABLE 3. MAPPED QUATERNARY AND HOLOCENE FAULTS CROSSING THE PCGP PROJECT". DOGAMI recommends that Applicant evaluate all faults that can impact the pipeline, including nearby active faults in Coos Bay. As stated in an earlier comment, DOGAMI has mapped late Quaternary faults in Coos Bay, which could impact the proposed project. Please refer to this publication: www.oregongeology.org/pubs/gms/GMS-094.pdf. DOGAMI recommends that a thorough literature review be conducted for known Quaternary active faults, as well as a site specific investigation that covers the proposed project area to evaluate if unknown Quaternary faults exist that may negatively impact the proposed facilities.

25. The Applicant states (on page 13): "As mentioned in the previous section, published maps are adequate for identifying the presence or absence of active faults, but are generally not detailed enough for pipeline design." DOGAMI disagrees with this statement—many areas have not been carefully mapped by geologists and it is highly likely that many active faults have not yet been identified. Furthermore, newer technologies that allow for identification

of active faults are now readily available whereas in the past they were not. As stated in an earlier comment, DOGAMI recommends that a thorough literature review be conducted for known Quaternary active faults, as well as a site specific investigation that covers the proposed project area to evaluate if unknown Quaternary faults exist that may negatively impact the proposed facilities.

26. The Applicant discusses a three phase liquefaction analysis approach and states (on page 15): "This second phase liquefaction analysis was completed using simplified methods (Seed et al., 2003; Idriss and Boulanger, 2008; and Boulanger and Idriss 2014)". DOGAMI recommends that the Applicant conduct analyses consistent with the National Academies Liquefaction Study Report (2016), available at https://www.nap.edu/catalog/23474/state-of-the-art-and-practice-in-the-assessment-of-earthquake-induced-soil-liquefaction-and-its-consequences. For the Applicant's second phase, conducting analyses using additional methods to estimate liquefaction triggering would be considered as standard-of-practice. As DOGAMI stated in earlier comments, for all of the liquefaction analyses, the assumptions, methods used, and uncertainties associated with them need to be explicitly stated and presented for each step in the analysis. This includes the uncertainties associated with field investigations, lab testing, triggering analyses, settlement analyses, lateral spreading analyses, and proposed mitigation. This should also be a part of any future analyses including soil-structure interaction and other modeling of the structural responses to the hazards and for proposed mitigation. Results should be summarized so that it is clear which results are being used for design purposes.

27. The Applicant states (on page 15): "If liquefaction will be triggered at previously identified susceptible pipeline segments under the maximum considered earthquake (MCE) per ASCE 7-10 code". As DOGAMI stated in an earlier comment, the Applicant has developed seismic ground motions that have not used newer building code reference documents, namely ASCE 7-16, which was published in 2016 as opposed to 2010. Ground motion values using ASCE 7-16 should be presented and used in the liquefaction analyses.

28. The Applicant states (on page 16): "the liquefaction and lateral spreading potential at Indian Creek (MP 128.58 – 128.62) remains unknown and access to the site remains restricted". DOGAMI requests that the Applicant keep DOGAMI informed on the status of this situation and data gap, and explain their next steps. For example, will the Applicant select another proposed route?

29. The Applicant states (on page 16): "The third phase analysis for the rerouted pipeline segment extending from MP 1.5H to 5.5H is in process and the results will be available for

the final submittal of this report." DOGAMI requests that the Applicant keep DOGAMI informed on the status of these analyses.

30. The Applicant states (on page 17): "Higher PGAs are possible where soft soil overlies bedrock, such as in the vicinity of North Slough at MP 1.47 to 3.2H and Haynes Inlet MP 4.7H to 5.5. We estimate Site Class D conditions are appropriate for the North Slough and Haynes Inlet areas." As DOGAMI stated earlier, it is common in estuaries to have soils that are softer than Site Class D conditions due to the presence of estuarine muds and river sediments, and these soils may amplify earthquake shaking. Rather than the Applicant estimating the Site Class type as D, DOGAMI recommends that site specific analyses are conducted to determine actual Site Class types and use those to determine PGAs and other relevant seismic ground motions and response.

31. The Applicant states (on page 20): "At the Coos River site, stresses exceed 100 percent SMYS but are estimated to be below the combined stress limit as shown in Figure 4.3.1 above. However, the analyses were based on elastic modulus and when the yield stress is exceeded, as in the case of the Coos River site, a fully plastic analysis is required to accurately assess the pipe stresses and strains. A fully plastic analysis requires modeling the stress-strain behavior of the pipeline under cyclic conditions in such a way as to capture strain-hardening effects, which requires a full-scale cyclic pipe load test to develop accurate model parameters. It also requires that the operational hoop, thermal, and internal pressures are accounted for during cyclic conditions. This type of analysis is beyond the scope and expertise of GeoEngineers." DOGAMI recommends that appropriate pipeline analyses are conducted by qualified specialists for the Coos Bay site, and potential impacts associated with liquefaction, lateral spreading, cyclic strain, and buoyancy forces be addressed to ensure public safety.

32. The Applicant states (on page 20): "with the potential for very large, long recurrence interval, Cascadia events". DOGAMI finds this statement as misleading. Seismologists and earthquake geoscientists, as professionals, would not generally consider earthquake recurrence intervals on the order of a few hundred years to be "very large, long". DOGAMI requests the Applicant to clarify, substantiate or change their statement.

33. The Applicant states (on page 20): "a fully plastic analysis of pipe strain will be completed to verify that the liquefaction and lateral spreading induced plastic deformation of the pipe at the Coos River crossing is tolerable." As stated earlier, DOGAMI recommends that appropriate pipeline analyses are conducted by qualified specialists for the Coos Bay site,

and potential impacts associated with liquefaction, lateral spreading, cyclic strain, and buoyancy forces are addressed to ensure public safety.

34. The Applicant states in their Conclusion sector (on page 21): "One Holocene (active) fault crossing and three Quaternary fault crossings were identified along the proposed pipeline alignment as listed in Table 3." As DOGAMI stated earlier, DOGAMI recommends that a thorough literature review be conducted for known Quaternary active faults, as well as a site specific investigation that covers the proposed project area to evaluate if unknown Quaternary faults exist that may negatively impact the proposed facilities. The faults should not be limited to locations of the proposed pipeline crossings.

35. The Applicant states (on page 25): "some of the later reroute alignments are currently outside the area of LiDAR and aerial photograph coverage". DOGAMI recommends the Applicant obtain high resolution lidar for all areas that may impact the proposed facilities along the proposed route. Lidar coverage should be collected with enough buffer distance to characterize potential seismic and landslide hazards. For example, for landslide hazards, the lidar should include from the valley bottom to the top of the ridge. Also, there is publicly available statewide aerial photography. Please evaluate the potential large landslides keeping in mind that landslides may extend from the tops of ridges and may move downslope to block rivers. In addition, lidar should be used to evaluate seismic sources.

36. The Applicant states (on page 27): "The DOGAMI study provides a broad-scale assessment and mapping of slopes potentially susceptible to RMLs along the portion of the pipeline within Coos, Douglas and Jackson counties (MPs 1.5H - 166). The potential for RMLs to occur east of MP 166 generally is considered to be relatively low based on geologic conditions, relatively little rainfall and statistically fewer past historical RML occurrences. However, the slopes east of MP 166 were reviewed for this hazards report to identify high-risk sites based on general guidelines provided in Forest Practices (FP) Technical Note 2 of the Oregon Department of Forestry (ODF, 2000). The ODF guidelines recommend screening for high-risk sites by identifying slopes that exceed 65 percent gradient on existing topographic maps, then performing surface reconnaissance to identify high risk site features." Both the DOGAMI RML and ODF RML methods are outdated. DOGAMI recommends that the Applicant use current state of practice methods that include lidar as a base map.

37. The Applicant states (on page 27): "Based on available topographic mapping, no slopes along the pipeline alignment east of MP 166 exceed 65 percent or appear to be at high

potential for RML occurrence." DOGAMI does not agree with the conclusion based on the fact that state-of-practice methods were not used to develop this conclusion. DOGAMI recommends that the Applicant use current state of practice methods that include lidar as a base map.

38. The Applicant states (on page 46): "As currently planned the portions of the pipeline that are crossing waterbodies that have the potential to be impacted by tsunami scour, will be installed using trenchless methods at depths well below the potential scour depths. Therefore, tsunami scour is not considered a hazard to the pipeline project." The Applicant further states "The modeling analysis showed that some temporary scour may occur in Coos Bay along the pipeline during inundation of the tsunami (approximately 1 to 2 hours)." The Applicant indicates that scour from tidal currents and river flows are approximately 3 feet at the pipeline crossing, and "it is recommended to use a 3-foot depth of scour resulting from tsunami impact". DOGAMI requests the Applicant provide information on maximum potential scour depth from a Cascadia tsunami. Also, DOGAMI requests information on the minimum factor of safety the Applicant applied to address the maximum potential scour depth from Cascadia tsunamis along the proposed alignment in greater Coos Bay area.

<u>Draft Resource Report 13 Engineering and Design Material, Chapter 13.3 Natural Hazards and Conditions, Jordan Cove Energy Project, dated May 2017, which includes:</u>

- <u>Appendix I.13 Natural Hazard Design Investigations and Forces, and</u>
- <u>Appendix J.13 Site Investigation and Conditions, and Foundation Design</u>

Based on the review of tsunami-related documents in Resource Report 13, DOGAMI requests additional supporting information that discusses and clarifies the following:

39. The Applicant, in general, found that their MIKE21 modeling matched the DOGAMI L1 first wave arrival (which reflects the largest wave), although wave amplitudes and phase differences were observed for later wave arrivals. No explanation is provided to account for the latter differences. DOGAMI requests further discussion of differences in the modeling results after the initial wave arrival to account for phase and amplitude differences observed in the modeling results.

40. DOGAMI requests that the Applicant provide peer reviewed documentation that describes the MIKE21 FM model and its ability to model tsunami inundation. Many issues are unclear, for example, does MIKE21 adequately account for the (vertical) wave runup on the wall and/or composite structure?

41. DOGAMI requests that the Applicant provide further explanation of the approach used to define the digital elevation model (DEM) that is recommended. In particular, how does the developed grid differ from the tsunami grids generated by NOAA's National Center for Environmental Information (NCEI). These data may be obtained here: https://www.ngdc.noaa.gov/mgg/inundation/tsunami/.

42. DOGAMI requests that the Applicant explain to what extent has the model been tuned to match the DOGAMI L1 scenario and inundation results.

43. DOGAMI requests that the Applicant provide a better depiction of the three cases used to define the design crests. It is unclear whether the design reflects a berm, wall, or a composite structure around the perimeter of the entire complex, or portions of the complex. Please provide figures that characterize the proposed design.

44. DOGAMI requests that the Applicant explain why mean high water (MHW) was used as opposed to MHHW (as used by DOGAMI).

45. Values of future sea level rise (SLR) presented by the Applicant are based on existing (historical) trends derived for the Charleston tide gauge. Based on its current rate, estimates were made out into the future (i.e. 30 years). This is an overly simplistic approach that assumes the past is the key to the future and hence discounts possible acceleration of SLR in the future. A more effective approach would be to base future estimates on the National Research Council (2012) SLR study that was completed for the US West Coast. National Research Council estimates account for expected local tectonic changes as well eustatic and steric responses and are a more reasonable (and current) estimates for the future. Please address SLR using current scientific data and methods.

46. Provide analysis of the potential role of sediment erosion of the North Spit dunes caused by the design tsunami. Research on the US East Coast suggests that sediment erosion during a tsunami may be significant and could impact inundation extents and runup (Tehranirad et al., 2015, 2016; Tehranirad, 2016). This notion is also supported by field studies following the March 11, 2011 Tohoku, Japan tsunami (Goto et al., 2012; Tanaka et al., 2012).

47. Provide analyses of the potential role of tsunami wave reflection/focusing/defocusing as the tsunami impacts the proposed LNG facilities and its possible public safety implications for the surrounding Coos Bay environment. Tsunami waves that impact against proposed protective structures (e.g., berm, wall or composite structure) and the subsequent transfer of that energy to other areas within the bay is a public safety concern. DOGAMI requests

additional modeling for the purposes of addressing public safety. All documents should be complete, clearly organized and presented to allow for peer review by qualified specialists.

48. DOGAMI requests that the Applicant provide analysis of maritime vessels and their potential to become ballistics within the bay. Maritime evacuation planning in response to the tsunami should be conducted and provided.

49. DOGAMI requests that the Applicant provide analysis on the potential for off-site debris impacting the facilities and the potential ramifications with respect to public safety.

50. DOGAMI requests that the Applicant provide information on each of the DEMs used for the tsunami model. For example, were three different DEMs used that reflect the three different case studies: berm, wall and composite structure? Please provide the DEMs.

51. Elevated structures, including elevated berms, used for assembly areas in the tsunami inundation zone are subject to ASCE 7-16 chapter 6 requirements. To ensure public safety, DOGAMI strongly recommends that the Applicant design all elevated structures to be used as assembly areas in the ASCE tsunami design zone in accordance with ASCE 7-16 chapter 6. Design documents should be complete, clearly organized and presented to allow for peer review by qualified specialists.

Document Content(s)

Exhibit 66

PUBLIC COMMENT

Provided by Barbara Gimlin, P.O. Box 1527, North Bend, OR 97459

Intertidal Flats Mitigation Proposed for Kentuck Slough
Jordan Cove Energy Project Joint Permit Applications
U.S. Army Corps of Engineers/Oregon Department of State Lands
January 11, 2015

INTRODUCTION

This public comment document presents concerns and credibility issues regarding the Compensatory Wetland Mitigation (CWM) plans submitted or referred to in current U.S. Army Corps of Engineers (Corps) and Oregon Department of State Lands (DSL) Joint Permit Applications (JPAs) for the Jordan Cove Energy Project (JCEP) in North Bend, Oregon. Of the CWM versions presented for the overall JCEP project, this document focuses on only one portion of each— the estuarine mitigation proposed for the Intertidal Flats Mitigation Site at Kentuck Slough.

The estuarine mitigation proposed for Kentuck by the JCEP has not undergone the serious environmental and hydrologic evaluation needed to ensure the mitigation will not result in contamination of the Coos Bay estuary, flooding of adjacent and upstream property owners, and a potential mosquito infestation that would affect area residents. Much more input is needed from hydrologists, engineers, natural resources scientists, and planners to fully understand and design a plan for the site that will address current and future site-specific conditions on the ground, including upstream of the site. The inconsistencies in the plans brought forward, together with the lack of appropriate studies and documentation, is alarming. As it stands, there is a significant potential for substantial adverse effects from the mitigation proposed at Kentuck.

Coos Bay is my playground and I enjoy boating, fishing, clamming, and crabbing in the bay. Kentuck is part of the neighborhood I live in. If toxins are released into the bay from the existing plans for the project, be it from the extensive soil contamination at the main facility site or former golf course toxins released by opening up Kentuck, it will likely have a devastating effect to marine life and the humans who consume shellfish if the issues presented are not fully addressed. In addition, my neighbors who live up Kentuck Way Lane already have increased annual flooding problems, and that will likely increase even more by the current plans for Kentuck.

There are various CWM plans floating around in the regulatory system for the mitigation proposed for the overall project, and all include various versions of the mitigation proposed for Kentuck. The lack of consistency is an indicator that the project warrants close and interactive scrutiny by the local, state and federal agencies that are authorized to review and approve the project.

BACKGROUND

The comments included in this document are based on my personal observations living one mile from Kentuck since 2008, along with firsthand knowledge of the JCEP while working on the project as environmental consultant while employed by SHN Consulting Engineers & Geologists, Inc. (SHN) in Coos Bay from March 2013 to April 2014.

The existing bridge over the Kentuck Slough channel is located on East Bay Road and includes four large tidegates that regulate the flow between the channel and the Coos Bay estuary. The structure was rebuilt in 2007 and Coos County received $2,321,000 through Oregon Transportation Investment Act funds in 2003 to construct the project. Now the JCEP wants to remove the bridge and tidegates and open up the estuary along East Bay Road by building a bridge and allowing tide waters into both the former Kentuck golf course and the historical inlet that at one time extended approximately five miles inland prior to being filled over 60 years ago.

Figure 1. Existing tidegates (4) at the East Bay Road bridge over the Kentuck Slough channel. The tidegates and bridge were rebuilt in 2007 at the cost of over $2 million. (1-8-15).

The most recent JCEP JPA on record for the DSL was submitted in March 2014. The most recent version of the JPA submitted to the Corps was in October 2014. There are four CWM plans included and referred to in project documentation. They were all prepared by David Evans and Associates, Inc. (DEA) and look very similar. Of note, two different (but similar) CWM plans are included in the full JPA document submitted to the Corps for the current JCEP permit application, and both are dated October 2014. It is unclear which CWM plan is the final product, even from the narrative, but it appears the CWM plan attached first in the document is the one that is moving forward. In addition, two other

CWM plans were submitted to the DSL and are associated with their project documentation (December 2011, March 2014).

My concerns about the lack of proper study and analysis for the Kentuck mitigation portion of the project repeatedly fell on deaf ears while I worked on the project under SHN. I sat in on weekly conference calls with DEA, the consulting company hired by the project to (among many things) write the CWP plan. It was like they didn't want to hear anything that would interfere with what they had in place. This was despite the fact that the plan(s) in place did not take into account the issues brought forth in this public comment. I went as far as to send site photos during flooding stages and documentation of ongoing fill being conducted upstream that could affect the site hydrology. To my knowledge, it was ignored. The issues certainly were not included or addressed in the resultant CWM plans proposed by DEA, or in any other part of the JPAs prepared by DEA that were submitted to the Corps and DSL.

The CWM plans used in the current JPA for the Corps frequently refer to the DSL Removal-Fill (RF) Permit No. 37712-RF (issued by the DSL in December 2011 and expiring December 21, 2016) as providing approval for the mitigation proposed for estuarine resources at Kentuck for the current JCEP project. DSL Permit 37712-RF is based on a JPA submitted to the DSL in 2011 by the International Port of Coos Bay (Port) for the Port's previously proposed Oregon Gateway Marine Terminal project.

The current JCEP DSL permit recorded online at the DSL's website (as of January 8, 2015), Permit 54908-RF, is dated March 20, 2014, and includes a CWM plan dated March 2014. The March 2014 CWM plan has significant changes from the CWM plan approved by the DSL in December 2011, and is different from the two October 2014 CWM plans included in the Corps JPA. There is no documentation provided in any of the JCEP documents to demonstrate the previous CWM plan approved for the Port DSL permit issued in 2011 has been subsequently approved (as revised) for the current DSL permit for the JCEP. The 2011 approval was based on a different applicant and a different overall project. If the Corps and/or DSL have approved the subsequent changes, that process of approval should be documented as part of the administrative record included in the most current JPAs.

There is a lack of consistency in the information presented for review in the JPAs and associated CWM plans. It can be difficult at times to tell what is actually planned for the site. Even the most current CWM plan presented has not been updated and lists the construction of the project and associated mitigation as anticipated to begin in the 3rd and 4th quarters of 2014.

Despite the above inconsistencies, the comments and questions presented in this document are valid for all CWM plans associated with the JCEP.

EXISTING EAST BAY ROAD BRIDGE AND ASSOCIATED TIDEGATES

The narratives for the various CWM plans for Kentuck do not clearly present information on the existing tidegate structure installed under the current East Bay Road bridge that connects Kentuck Slough to Coos Bay. It is a substantial structure with four large tidegates and was rebuilt in 2007.

Prior to the recent replacement, the previous bridge did not meet current design standards and needed to be replaced.   Attached to the downstream side of the existing bridge was a set of three 7.5-ft wide by 10-ft high top-hinged tide gates. One of the tide gates was wedged in the gate slot and completely inoperable. The other two gates functioned, but leaked significantly during flood tides. Additionally, the gates were frequently overtopped during high tides.

The leaky gates allowed for saltwater intrusion into the slough and also resulted in an increase in the amount of saltwater that intruded into adjacent land via groundwater flow. This negatively affected the quality of the soil during the summer months when there is little freshwater inflow to the slough to help dilute the salt concentrations from the bay water. The local landowners indicated at the time that the volume of saltwater influx to the slough was tolerable, but any increase would not be acceptable.

WEST Consultants, Inc., was hired to conduct an HEC-RAS unsteady flow hydraulic model of the tidegate designs for the new bridge to accommodate and improve upon conditions that encourage the estuarine habitat, while at the same time would not increase the volume of saltwater influx to the slough over the existing conditions. Kentuck Slough is considered an important salmonid habitat. Therefore, the hydraulic parameters for the replacement tidegates installed in 2007 were developed in close consultation with the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), and the Oregon Department of Fish and Wildlife.

After over $2 million being spent to create an efficient bridge with tidegates at Kentuck in 2007, the JCEP now wants to undo it. For the complicated mitigation proposed at Kentuck for the JCEP, more complex hydraulic analysis to identify the impacts is needed to support the determination of appropriate mitigation. Removal of the existing bridge and tidegates needs full evaluation of existing hydrology, hydraulics, sediment transport, fluvial geomorphology and water quality, and the supporting documentation needs to be presented for evaluation.

INTERTIDAL FLATS MITIGATION PROPOSED — KENTUCK SITE

The Kentuck Slough site is referred to as “primarily unvegtated mudflat and tide channels, and some salt marsh.” The following appears to be the scope of work for the JCEP CWM plan related to the site, from the JPA submitted to the Corps:

> *Jordan Cove Energy Project Compensatory Wetland Mitigation Plan – Part B*
>
> **1.2.2 Intertidal Flats Mitigation Site (Kentuck Slough Site)**
>
> **Mitigation Goal 2:** Reestablish tidal flow to approximately 45.01 acres of historical intertidal habitats adjacent to Kentuck Slough. (Actual area as currently designed will be 46.59 acres, which results in additional contingency credits. Mitigation Goal 2 and associated Objectives are based on the minimum acreage needed to meet standard DSL mitigation ratios). To achieve this goal, the following objectives will be carried out:
>
> • **Objective 2.1:** Construct a new bridge in East Bay Drive to allow tidal exchange between Kentuck Inlet and the “back nine” of Kentuck Golf Course.
> • **Objective 2.2:** Construct a new cross dike between the front and back nine of Kentuck Golf Course, with a standard tidegate to drain the front nine to the back nine, and construct a fish friendly tidegate array through the Kentuck Slough dike, allowing the majority of flow from Kentuck Slough to enter the back nine.
> • **Objective 2.3:** Remove the culvert and tidegate located adjacent to the east side of East Bay Road near the southeast corner of the golf course site.

• **Objective 2.4:** Restore tidal connection to the irrigation pond creek system through installation of a fish passable culvert that meets ODFW fish passage criteria.
• **Objective 2.5:** Construct and/or enhance approximately 6,000 linear feet of tide channels.
• **Objective 2.6**: Establish an approximately 1.73 acre wetland bench along Kentuck Slough by relocating the existing levee southward.
• **Objective 2.7:** Establish an emergent to scrub-shrub, brackish to freshwater transitional plant community along the Kentuck Slough bench described in Objective 2.6.
• **Objective 2.8:** Establish a minimum of 0.18 acres of salt marsh habitat within the internal portion of the Kentuck Slough site, with the remainder of the internal portion (43.10 acres) being mudflat and/or tide channel. A greater amount of salt marsh, with subsequent reduction in mudflat is acceptable.

Below is the general study area used by DEA for Kentuck.

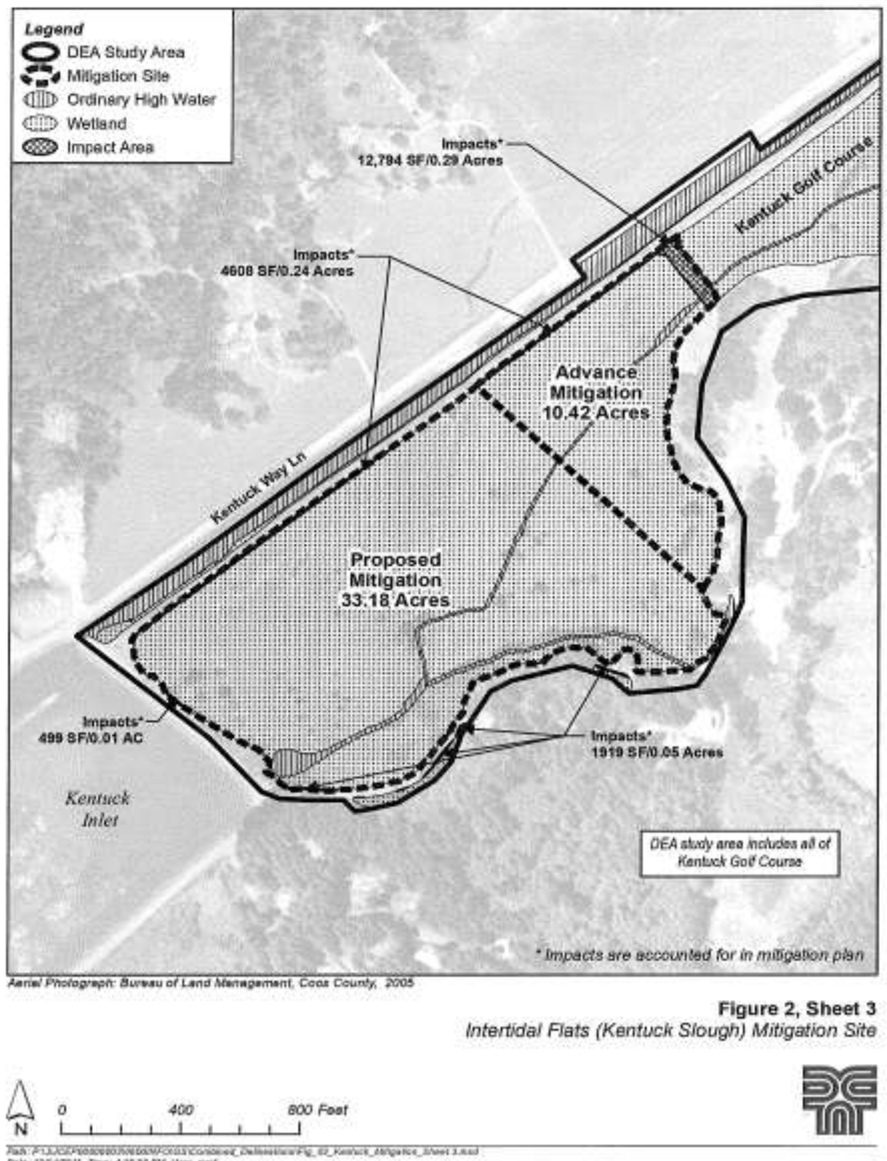


Figure 2. Study area used by DEA to development mitigation at the Kentuck Slough site.

Changes to the JCEP CWM Plan in the October 2014 Corps Permit Application

One of the CWM plans for Kentuck submitted in the October 2014 JPA to the Corps states mitigation for the site has been refined based on agency comments since the issuance of DSL Permit 37712-RF in 2011. What agency comments were considered and why aren't they referenced and documented? For the current CWM plan, the following are fairly significant changes to the mitigation proposed from what was previously approved in DSL Permit 37712-RF in 2011:

- The October 2014 CWM plan includes the establishment of 12.49 additional acres of tidally influenced habitats at the site and adjacent areas that were not included in 2011.
- Mitigation improvements such as levee relocation, cross-dike placement, roadway upgrades, etc., wil now result in 3.11 acres of permanent incidental wetland impacts, of which 0.59 acres was previously included.
- An additional 0.59 acres of incidental emergent wetlands impacts wil result from improvements needed at the site, in addition to the 10.47 acres of mudflat impacts presented in 2011.
- Current designs include raising elevations within the site to better support establishment of salt marsh, provided there is suitable material to import to raise grades. (*This seems a bit vague.*)
- The current design proposes rebuilding the existing Kentuck Slough levee roughly adjacent to the south side of the existing levee and restoring the area under the old levee back to wetland, creating a wetland bench along the slough channel.

Inconsistencies in Elevation Data

The October 2014 CWM plan states the following:

- *The primary salt marsh surface at the reference site (immediately downstream of East Bay Road) occurs between approximately elevations 5.5 and 8.5 feet NAVD88 (North American Vertical Datum of 1988). However, typical elevations within the former golf course range between 2.0 and 4.0 feet NAVD88. These lower elevations in the former golf course preclude vegetation establishment, and therefore mudflat would be the predominant habitat type without intervention. … Current design includes raising elevations within the site to better support establishment of salt marsh; however this is reliant on having suitable material to import to raise grades.*

However, in a November 4, 2010, letter to Chuck Wheeler at the National Marine Fisheries Service, DEA states the following:

- *The proposed mitigation would reestablish tidal flow to approximately 33 acres of historic intertidal mudflat/low marsh habitat adjacent to Kentuck Slough. Survey information confirms that elevations within the golf course are appropriate for establishing mudflat habitat. The primary salt marsh surface at the reference site (immediately downstream of East Bay Drive) occurs between elevations 7.0 and 9.0 feet mean low low water (MLLW). However, typical elevations within the golf course range between 4.0 and 6.0 feet MLLW. These lower elevations in the golf course preclude vegetation establishment and therefore mudflat will be the predominant habitat type (DEA 2010).*

Why would the elevation at MLLW immediately downstream of East Bay Road (7.0-9.0 feet) be higher than the NAVD88 elevation data at the same site presented by DEA in 2014 (5.5-8.5 feet)? In turn, the MLLW listed for the golf course in 2010 (4.0-6.0 feet) is higher than the NAVD88 elevation data in 2014 (2.0-4.0 feet). No supporting documents from site visits, field studies, and surveys conducted are provided for any of the assertions. And it sure seems like much more elevation data is needed overall.

PRIMARY CONCERNS ABOUT THE PROPOSED MITIGATION AT KENTUCK

Potential Site Contaminants

The former golf course at Kentuck operated over four decades before closing in 2009. The CWM plans do not demonstrate that any studies on contaminants have been conducted at the site, particularly for contaminants that may be harmful to marine life. While fertilizers, pesticides and herbicides have improved in recent years, who knows what was previously used at the site and the residual contamination risk the previous use as a golf course may pose.

Attachment A for the October 2014 Corps JPA lists the following regarding potential hazardous materials that may be encountered by the overall project:

> 13. **Hazardous, Toxic, and Waste Material Handling:** Petroleum products, chemicals, fresh cement, sandblasted material and chipped paint, wood treated with leachable preservatives or other deleterious waste materials shall not be allowed to enter waters of this state. Machinery refueling is to occur at least 150 feet from waters of this state and confined in a designated area to prevent spillage into waters of this state. Barges shall have containment system to effectively prevent petroleum products or other deleterious material from entering waters of this state. Project-related spills into waters of this state or onto land with a potential to enter waters of this state shall be reported to the Oregon Emergency Response System (OERS) at 1-800-452-0311.

This short section does not begin to address the issue of potential contaminants at the Kentuck mitigation site, which is part of the overall JCEP. In addition to concerns over the prior use as a golf course, other concerns were brought up during a Coos County Commissioners meeting on September 22, 2009. The commissioners approved a zone change for the Kentuck Golf Course to exclusive farm use to allow the Port to use the land. Commissioner Bob Main voted no, in light of concerns he said he had about pollutants washing into Coos Bay. Commissioners Nikki Whitty and Kevin Stufflebean voted yes.

A story carried in *The* World newspaper on September 23, 2009, said developers had devised a plan that would flood the back nine holes of the course to satisfy government wetland replacement requirements for the JCEP, and that they would remove part of the dike west of the course and build a bridge for East Bay Road. It also included the following:

> *Main said he was concerned that a former methamphetamine lab in a house in the area had contaminated the course and would leach into the bay if the mitigation plans proceeded. Oregon's Department of Health Services has a house on Golf Course Lane listed as unfit for use.*

Main's fellow commissioners and the Port's lawyer tried to reassure Main, noting that state and federal agencies would check into those issues through a biological assessment and U.S. Army Corps of Engineers review. Main remained opposed.

"I'm not comfortable that they will check that potential problem," he said.

Mark Whitlow, a Portland attorney representing the Port, said it was premature to discuss the runoff issue, because the primary purpose of the meeting was the zone change.

"Until the Port's project goes forward, there is no project proposal for the site," he said.

There is no mention in any of the CMP plans that the potential contamination from the former meth house has been investigated. This is not for lack of knowledge. I brought up the article during the summer of 2013 twice during weekly conference calls with DEA and also provided DEA staff with a copy of the article. And it's clear the JCEP's attorney, Mark Whitlow, was aware of the potential issue. At a minimum, it should be brought up and addressed in all project documents related to the proposed mitigation.

Site Hydrology

There is a serious lack of documentation of existing hydrological studies that have been conducted for the proposed Kentuck mitigation, including upstream of the site. The area floods frequently and even when the golf course was open, the locals referred to it as the "yacht club" during the rainy season. Farms and homes to the north of the Kentuck Slough channel, along with to the west (upstream) for approximately three miles, are frequently flooded during heavy rains.

Figure 3. Former Kentuck Golf Course taken from East Bay Road (looking west) following heavy rain. The channel is on the other side of the levy shown on the left. (12-24-14)

The October 2014 CMP plan states that groundwater at the site was typically observed in soil pits from 10 inches depth to within an inch or two of the surface. It further states that saturation typically occurred 2 inches above this depth and that these conditions are "typical of wintertime conditions." The plan, however, does not present any data, dates, or locations to substantiate this claim. From driving past the site on an almost daily basis for the past 6-1/2 years, I can tell you the ground saturation is frequent and much deeper during rainy periods. Heavy rains can occur in the fall, winter, and spring, and further monitoring and analysis is needed to accurately depict the current hydrology.

Figure 4. Kentuck Slough channel west of East Bay Road bridge and tidegates (north of the former Kentuck golf course) following heavy rain. (12-24-14)

Section 4.3.2.1 of the October 2014 CWM plan for existing hydrology states the following:

> *Shallow ponding was observed in many locations throughout the former golf course, but was most pronounced in the western half. Ground topography throughout the former golf course varies slightly, with roughly 2 to 3 feet of difference in relief from location to location. Drift lines were observed along the edges of the higher areas, which suggest that ponding was substantially greater before the site visit occurred. This ponding is likely the result of direct precipitation, which had not occurred for more than a week before the site visit.*

My first question would be, "What site visit?" And just one site visit was conducted to determine the existing hydrology? It's far from adequate. Where's the documentation? When was it conducted? One site visit vaguely referred to in the plan is listed as having occurred in January 2009. Is that the one they're referring to? The short Existing Hydrology section refers to shallow inundation occurring during "high tide," but what high tide? Tides vary many feet with the lunar cycle. Where is the data, are there photos, and how can they possibly claim the four paragraphs in Existing Hydrology represent the existing hydrology? The science is missing.

There is limited space for water to go at Kentuck and opening up the estuary will likely increase the flooding potential far upstream and to the north if this factor is not carefully studied and analyzed in the development of a project design. In addition, the annual rise of the world's oceans, thought to be approximately 1 cm a year, also needs to be calculated in.

Figure 5. Farm north of Kentuck Way Lane at Mile Post 1 following heavy rain. (12-24-14)

The above photo of a farm north of Kentuck Way Lane shows typical flooding during heavy rains. The site is west (upstream) of the new tidegate and dike proposed in the mitigation, despite the substantial reinforcement at the existing bridge and tidegates one mile downstream. The flooding extends to the south and west of Kentuck Way Lane, as shown in the next photo.

Figure 6. Farm south of Kentuck Way Lane at Milepost 1.5. Photo taken from Kentuck Lane at Milepost 1 and is looking west beyond the proposed tidegate and berm for the JCEP Kentuck mitigation. (12-24-14)

The October 2014 CWM plan refers to potential site constraints identified in the CWM plan authorized under DSL Permit 37712-RF, including the following:

> *Opening the site to tidal influence creates the risk of increased flooding potential and saltwater intrusion to adjacent and upstream landowners. New cross dike construction and repair and/or enhancement of the existing dike are therefore required to ameliorate this risk.*

That all sounds well and good, but where are the studies and data to address how the new tidegate and dike will address the increased tidal flow and the substantial flooding that occurs well upstream of the site they propose to block off?

Flood impacts (stage, velocity, duration) need to be addressed regarding current alterations that have been taking place upstream. In particular, Main Rock Products, Inc. (Main Rock) between Mile Post (MP) 3 and 4 has been progressively filling a 47.41 acre parcel located at 95688 Kentuck Way Lane (Parcel No. 1100, Coos County Tax ID: 25400, Map No. 25S12W04). The area is listed by the USFWS Wetlands Mapper as being Palustrine, emergent and temporarily flooded (PEMA) wetlands. As the fill amount has increased, portions of the wetlands have been excavated out to define the next boundary for the fill extension.

Figure 7. Coos County tax map showing the location of the Main Rock Products, Inc. parcel being filled.

Currently the western 1/3 of the parcel is being filled. However, further east along Kentuck Way Lane, the remaining 2/3 of the tax lot has also been progressively filled since 2003.

On January 8, 2014, I submitted an alleged violation report regarding the fill to Anita Andazola, Corps Compliance & Enforcement specialist, at the Corps North Bend Field Office. The alleged violation was provided to DEA at the time and followed up with discussion during a conference call with DEA on January 13, 2014, while I still worked for SHN. During the conference call, after expressing my extensive concerns about the Kentuck mitigation proposed, Sean Sullivan, DEA JCEP project lead, said unless there was a malfunction of the tidegate proposed for mitigation, problems were not anticipated. I reiterated that I felt it was quite likely the extensive amount of fill that has been occurring upstream of the mitigation site will affect the overall hydrology of the area and we left it at that.

On July 9, 2014, I followed up with Anita Andazola at the Corps on the alleged violation report submitted in January. Her response was that the information had previously been provided by the Corps to the EPA and she recommended I contact Yvonne Vallette of the EPA's Portland office. I spoke with Yvonne the same day and found out that another alleged violation report had been turned in by one of the adjacent property owners in October of 2013. Yvonne had visited the Corps' office in North Bend and met with Anita about various projects. She said she had expected to do a site visit and conduct further review of the Kentuck situation at that time, but they were not able to get to it. The Oregon Department of Environmental Quality National Pollution Discharge Elimination Systems (NPDES) permit was reissued for Main Rock on November 18, 2013 (Facility No. 52575), without modifications. Main Rock continues to operate under a permit under the Oregon Department of Geology and Mineral Industries (DOGAMI), which allegedly has approved the fill. A copy of the correspondence with the Corps and EPA is attached.

Figure 8. Ongoing fill activities along Kentuck Way Lane. View is at MP 3.2 looking east. (1-11-15)

A site visit on January 11, 2015, confirmed that extensive fill of the western portion of the Main Rock parcel has been continuing and now extends much further towards Kentuck Creek to the south since January 2014, filling a very wet area. The fill that is being placed appears to be spoils extracted from marketable rock/gravel and appears to be have a high silt/clay component. There are no sediment and erosion control measures in place for the extensive fill piles placed at the site. Instead, there are visible bulldozer tracks where the fill is systematically being pushed into the wetlands. Over the years, there has likely been a significant rise in elevation at the site(s) for the fill that has placed. It has created a platform-like over-sized berm for the surrounding wetlands and creek.

Figure 9. Ongoing fill activities along Kentuck Way Lane. View is at MP 3.2 looking west. (1-11-15)

Historical photos help to show the amount of fill that has been progressively been placed by Main Rock in recent years south of MP 3 and 4 of Kentuck Way Lane. For the parcel being filled, Kentuck Creek weaves back and forth along the long lot, occurring south of the site for the western 1/3 and eastern 1/3 but crossing over to the northern side adjacent to the road (Kentuck Way Lane) for the middle portion.

In Google Earth imagery from August 27, 2007, you can see where fill has been placed to the east at approximately MP 3.4.   The images from November 16, 2011, show that Main Rock also began to fill the wetlands to the west from approximately MP 3.1-3.3, with the fill measuring approximately 445' long by 60' wide. By July 22, 2012, it was approximately 665' long and 120' wide. Although the length didn't change much by the next Google Earth photo taken on May 3, 2013 (approximately 690' long), the width of the fill from Kentuck Way Lane toward Kentuck Creek increased to approximately 190 feet.   Since the last imagery, the length and particularly the width has increased much more. Not easily seen from Kentuck Way Lane is the extensive excavating and bulldozing of fill that is occurring at the current site along the southern boundary of the fill.

Figure 10. Fill placed south of Kentuck Way Lane between MP 3 and 4 (top right) as of August 27, 2007.

Figure 11. Fill placed south of Kentuck Way Lane between MP 3.1 and 3.3 as of July 22, 2012.

Figure 12. Fill placed between MP 3 and 4 as of May 3, 2013.

When the Kentuck mitigation site is newly re-opened to Coos Bay to increase the size of the estuary, complex and dynamic flow patterns are likely to occur. It is essential that the plan design takes into account the increased flows, tidal channels, and how flooding of adjacent properties to the north and west will be prevented. A hydrodynamic model that clearly researches and addresses the capacity and flow dynamics likely to occur needs to be developed and submitted for approval prior to issuance of Corps and DSL permits associated with the project. This should include monitoring that extends upstream of the proposed mitigation site and be based, at a minimum, on tides, storm surge, stream velocity, flow capacity, projected long-term sea level rise and, most importantly, current conditions. In addition, the current monitoring proposed in the CWM plans is far from adequate (once a year) and needs to be revised to ensure all seasons and scenarios are monitored and addressed.

Nautical charts displayed at the Coos Bay Boat Building Center show that from 1865 to 1937 Kentuck Slough extended approximately 5 miles inland from its current site and was an inlet. By 1947 approximately ½ of the inlet was filled in to the east, and by 1953 the inlet was primarily filled in west of East Bay Road. Today, the Kentuck Slough channel that remains is regulated by four large tidegates under East Bay Road, with a levy separating the channel east of the bridge/tidegates from the former Kentuck Golf Course site (closed in September 2009). The proposed JCEP Kentuck mitigation site extends from river mile 0.0 to 0.9 of the Kentuck Slough channel. In addition, there is a 5' diameter culvert and tidegate near the southeast corner of the former golf course along East Bay Road (approximately 1/10 mile from the four existing tidegates and associated bridge) that will be revised.

Figure 13. Nautical chart from 1937 shows Kentuck Inlet extending approximately 5 miles inland.

Figure 14. Nautical chart from 1947 shows Kentuck Inlet as filled to the west, reducing its size approximately in half.

Figure 15. By 1953, the nautical chart shows Kentuck Inlet filled to its approximate location today, with a channel now in its place.

The CWM plan (page 10) states the Kentuck mitigation site is a “100-acre historic flood terrace” that historically “would have been classified as an estuarine wetland.” **Historically it was an inlet.**

AND WHAT ABOUT THE MOSQUITOES?

In the summer of 2012, an expansion project undertaken by the USFWS was completed for the Bandon Marsh south of Coos Bay. The purpose of the project was to allow tidal flats to resume their natural state after being diked and used for grazing land by farmers for decades. The expansion resulted in a huge mosquito infestation the following summer that was referred to as a biological disaster. It wreaked havoc on all surrounding property owners and made ventures outside a chore to escape the mosquitoes. The increase of mosquitoes was determined to be caused by removing tidegates, digging ditches, and increasing hydrology for the expansion. The original price tag for the 1000-acre restoration project was $4 million dollars. It inflated to $10 million plus and could have grown upwards of $100 million dollars if it were not for the temporary suspension of the marsh expansion in September 2013, until the situation could be contained.

While the Kentuck Slough mitigation proposed is smaller in size, it is very similar in terms of expansion of tidal flats. The potential for a similar mosquito infestation at Kentuck needs to be thoroughly evaluated and brought forward in discussions.

CONCLUSION

The estuarine mitigation proposed for Kentuck by the JCEP has a significant potential to result in contamination of the Coos Bay estuary, flooding of adjacent and upstream property owners, and a potential mosquito infestation that would affect area residents. During my time working on the JCEP under SHN, I encountered serious transparency and integrity issues with the management of both SHN and DEA. From inaccurate site plans submitted with permits to failing to address issues as they arose, the standard operating procedures of “let’s wait and see if it comes out in public comment” is not the proper response to issues. Hence my public comment.

Before the project starts moving dirt around (or mud and sand), it needs to conduct a full analysis on every aspect of the mitigation proposed at Kentuck and demonstrate it understands the implications to the environment it will be affecting. The issues ranges far beyond the CWM comments presented in this document for the Kentuck. There is a pattern being set for the JCEP, and another major issue is the ongoing neglect by the project to properly address soil contamination issues at the facility site on the North Spit of Coos Bay. As with the soil contamination issues, additional studies are needed to ensure the designs and plans in place prior to ground disturbing activities fully address the potential adverse effects of the project.

It is my assertion that inadequate environmental and hydrologic studies have been conducted to warrant the Kentuck Slough mitigation to proceed as planned. It is imperative the Corps and DSL make sure the proper process is followed to ensure the natural and human environment will be protected to the maximum extent possible. That is not being done by the current CWM proposed and the residents who call Coos Bay and North Bend home deserve better. Both agencies need to ask tough questions, to coordinate with other respective agencies to ensure they are approving the same actions, and to expect complete investigation and analysis before approving any action.

cc: Shawn Zinszer, Portland District Regulatory Branch Chief, USACE Portland District Regulatory Branch
Teena Monical, Eugene Section Chief, USACE Eugene Field Office
Tyler Krug, Project Manager, USACE North Bend Field Office
Mary Abrams, Director, Oregon Department of State Lands (DSL)
Bob Lobdell, Resource Coordinator, Oregon DSL
Ken Phippen, Branch Chief, Oregon Coast Habitat Branch, National Marine Fisheries Service (NMFS)
Chuck Wheeler, Fisheries Biologist, NMFS Oregon Coast Habitat Branch
Dennis McLerran, Administrator, U.S. Environmental Protection Agency (EPA), Region 10
Anne Dalrymple, Enforcement Coordinator, EPA Office of Compliance and Enforcement, Region 10
Laura Todd, Field Supervisor, Newport Field Office, U.S. Fish and Wildlife Service
Patty Burke, District Manager, BLM Coos Bay District Office
Dick Pedersen, Director, Oregon Department of Environmental Quality (DEQ)
Sara Christensen, 401 Water Quality Certification Coordinator, Oregon DEQ
Steve Nichols, Permitting/Compliance Specialist, DEQ Coos Bay Office
Mike Gray, ODFW District Fish Biologist, Charleston Field Office
Stuart Love, ODFW District Wildlife Biologist, Charleston Field Office
Christopher Claire, ODFW Habitat Protection Biologist
Patti Evernden, Coos County Planning Department
Juna Hickner, Coastal State-Federal Relations Coordinator, Oregon Department of Land Conservation and Development
Crystal Shoji, Mayor, City of Coos Bay
Thomas Leahy, Councilor, Coos Bay City Council
Rick Wetherell, Mayor, City of North Bend
David Koch, Chief Executive Officer, International Port of Coos Bay
John Souder, Executive Director, Coos Watershed Association
Warren Brainard, Chief, Confederated Tribes of Coos Lower Umpqua and Siuslaw Indians (CTCLUSI)
Howard Crombie, Director, Department of Natural Resources, CTCLUSI
Bob Garcia, Chairman, CTCLUSI
Don Ivy, Chief, Coquille Indian Tribe
Brenda Meade, Chairperson, Coquille Indian Tribe

ATTACHMENT
July 2014 Correspondence with the Corps and EPA

From: "Vallette, Yvonne" <Vallette.Yvonne@epa.gov>
To: "Andazola, Anita M NWP" <Anita.M.Andazola@usace.army.mil>, bgimlin@charter.net
Date: 07/09/2014 08:05:51 EDT
Subject: RE: [EXTERNAL] Checking in and update on alleged violation submitted for Kentuck on 1-8-14 (UNCLASSIFIED)

Anita: I chatted w/ Barb this afternoon to assure her that we have taken a look at this situation. I think next steps is to talk w/ DOGAMI and get a better sense of what their permit allows (or not). Looking at the aerial photos, there definitely seems to be some fill creep happening. That overburden pile is just getting wider and wider (and probably taller), so a line needs to be drawn somewhere to stop it from spreading. Let's talk tomorrow if you have time.

Yvonne Vallette, PWS
Aquatic Ecologist
U.S. Environmental Protection Agency
Region 10, Oregon Ops Office
805 SW Broadway, Ste. 500
Portland, OR 97205
Phone: (503) 326-2716
Cell: (503) 545-4962

-----Original Message-----

Sent: Wednesday, July 09, 2014 4:18 PM
From: Andazola, Anita M NWP To: bgimlin@charter.net
Cc: Vallette, Yvonne
Subject: RE: [EXTERNAL] Checking in and update on alleged violation submitted for Kentuck on 1-8-14 (UNCLASSIFIED)
Classification: UNCLASSIFIED
Caveats: NONE

Barb - This information has been previously provided by the Corps to EPA. You may be interested in contacting EPA directly. Yvonne Vallette is likely your best option at 503-326-2716.

Sincerely,
Anita Andazola, Biologist
Corps of Engineers Regulatory
Eugene Section
Compliance & Enforcement
2201 Broadway, Ste. C
North Bend, Oregon 97459
541-756-5316 office
541-751-1624 Fax
http://www.nwp.usace.army.mil/Missions/Regulatory.aspx

-----Original Message-----

Sent: Wednesday, July 09, 2014 3:51 PM
From: bgimlin@charter.net
To: Andazola, Anita M NWP
Subject: [EXTERNAL] Checking in and update on alleged violation submitted for Kentuck on 1-8-14

Hi Anita,

I wanted to touch base with you about the report of an alleged violation I submitted to you on January 8 for the fill of wetlands at 95688 Kentuck Way Lane in North Bend (attached). The fill continues and last week they were going gangbusters with trucks back and forth to the site, repeatedly dumping fill. I went for a bicycle ride past the site and was very disheartened to see what was occurring. They have completely filled in the two large rectangular ponded areas along the road (shown in the previous photos) and they continue to fill the site to the south with all the ponded areas from those photos also filled in now.

The continued and large expanse of fill in USFWS-designated wetlands is bound to increase the flooding downstream of their neighbors. Should I contact the USFWS and/or the EPA about this? I would like to know something is being done and that corrective actions will be required.

I'd be happy to take some additional photos if that would help. I am cc'ing my friend Carri Baker who lives approximately 1 mile west of the site and who will undoubtedly continue to be affected more and more by the fill that is occurring. As previously mentioned, I would like to keep this report confidential.

Thank you for your assistance in this matter and I'll look forward to hearing from you. Something needs to be done, and sooner rather than later.

Barb

Barbara J. Gimlin
P.O. Box 1527
North Bend, OR 97459

Exhibit 67

DICKSTEINSHAPIRO LLP

1825 Eye Street NW | Washington, DC 20006-5403
TEL (202) 420-2200 | FAX (202) 420-2201 | dicksteinshapiro.com

February 6, 2014

Via Electronic Filing

Ms. Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E., Room 1A
Washington, DC 20426

Re: Supplemental Information
Supplement to Technical Memorandum – Tsunami Hydrodynamic Modeling
Jordan Cove Energy Project, L.P., Docket No. CP13-483-000

Dear Ms. Bose:

Jordan Cove Energy Project, L.P. (JCEP) hereby submits for filing in the above referenced docket supplemental information described below that is related to JCEP's application, filed May 21, 2013, for authorization to site, construct and operate a natural gas liquefaction and liquefied natural gas export facility on the North Spit of Coos Bay in unincorporated Coos County, Oregon. Specifically, Coast & Harbor Engineering, Inc. (CHE) has prepared a Supplement to CHE's Technical Memorandum on Tsunami Hydrodynamic Modeling dated September 26, 2013 (CHE 2013b) and filed in this docket on October 1, 2013 as Attachment 6.16-1 to the Second Supplemental Response to Environmental Information Request. The Supplement to Technical Memorandum addresses the differences between the most recent report (CHE 2013b) and the previously submitted report (Zhang 2012).

All information included in this filing is Public. This filing is being made electronically. All persons on the Official Service List will be served by email with a copy of this filing. Three courtesy paper copies and three CDs of this filing are being provided for the Office of Energy Projects (OEP), to the attention of Paul Friedman, Steven Busch and James Glaze, respectively, and one courtesy paper copy and one CD are being provided to each of John Scott at Tetra Tech, the third party environmental contractor for JCEP's project, and Bob Bachman, also a FERC contractor. Finally, all other persons listed below will be served by email with a copy of this filing.

If you have any questions about this filing, please contact me at webbb@dicksteinshapiro.com or 202-420-4782 or my colleague Joan Darby at darbyj@dicksteinshapiro.com or 202-420-2745.

Respectfully submitted,

/s/ *Beth L. Webb*

Attorney for
Jordan Cove Energy Project, L.P.

cc: Service List
Paul Friedman, OEP, FERC
Steven Busch, OEP, FERC
James Glaze, OEP FERC
John Scott, Tetra Tech
Joe Iozzi, Tetra Tech
Bob Bachman
Paul Uncapher, North State Resources
Lorraine Salas, BLM
Leslie Frewing, BLM
Wes Yamamoto, FS
Kristen Hiatt, BOR
Heidi Firstencel, COE
Russ Berg, USCG
Marc Talbert, DOE
Teresa Kubo, EPA
Doug Young, FWS
Thomas Finch, DOT

Enclosure

COAST & HARBOR
ENGINEERING

Supplement to Technical Memorandum
Jordan Cove LNG Facility Tsunami Hydrodynamic Modeling

This document supplements the Technical Memorandum on Tsunami Hydrodynamic Modeling prepared by Coast & Harbor Engineering, Inc. (CHE) dated September 26, 2013, CHE (2013b). The supplement addresses the differences between the most recent report (CHE 2013b) and previously submitted report (Zhang 2012).

The most recent tsunami hydrodynamic modeling study conducted by CHE (2013b) was initiated to update the previous work performed by Zhang (2012) to implement the most recent guidelines and requirements of the Federal Energy Regulatory Commission (FERC). The following updates were implemented in the 2013 study:

- Model bathymetry and topography at the project site were updated from the previous study of Zhang (2012) to reflect the most recent design elevations in the tsunami hydrodynamic modeling. The previous study of Zhang (2012) did not include some recent modifications of design bathymetry and topography elevations of the project.
- Tsunami hydrodynamic modeling was conducted using the Mean High Water (MHW) tidal elevation, in coordination with the Oregon Department of Geology and Mineral Industries (DOGAMI) and FERC. The previous study of Zhang (2012) had used Mean Higher High Water (MHHW).
- To account for uncertainties in prediction of tsunami wave runup on the protection berm around the LNG facility, a safety factor of 1.3 was applied to the results of tsunami hydrodynamic modeling, as required by FERC and in anticipation of an update to the American Society of Civil Engineers Minimum Design Loads for Buildings and Other Structures (ASCE/SEI 7-10) to be released in 2016. The detailed methodology for implementation of this safety factor is explained in CHE (2013a). The previous study of Zhang (2012) had not used this safety factor.
- The most recent tsunami hydrodynamic modeling study by CHE (2013b) uses the L1 rupture scenario ("Large" splay fault Cascadia source), which represents 3 of 19 full-margin Cascadia events over the last 10,000 years, following Priest *et al.* (2009, 2010) and Witter *et al.* (2011). DOGAMI estimated that this scenario is probably the closest scenario to the FERC required 2,475-year return period design earthquake event. The previous study of Zhang (2012) had used XL and XXL rupture scenarios in addition to the L1 event. Upon further discussion and coordination with DOGAMI and FERC, it was agreed that the L1 rupture scenario is the appropriate design scenario to meet FERC requirements.

It was expected that implementation of the above items in the tsunami hydrodynamic modeling study of CHE (2013b) will lead to results different from that of Zhang (2012) in terms of water surface elevation and depth-averaged velocity. In order to ensure consistency between recent (CHE 2013b) and previous (Zhang 2012) tsunami modeling studies, first, a repeat of modeling effort conducted by Zhang (2012) using exactly the same modeling grid, input files, and source code was conducted and results of Zhang (2012) were reproduced. Second, a comparison between modeling results of CHE (2013b) and Zhang (2012) for the modified landscape was conducted (for the L1 rupture scenario).

Figures 1 through 3 demonstrate and compare the extent of maximum inundation from the two studies of CHE (2013b) (shown in red), and Zhang (2012) (shown in yellow) for the L1 event for the modified landscape. Figure 1 compares the modeling results on the large scale, for the entire Coos Bay. The figure shows a reasonable overall agreement in terms of extent of tsunami inundation (and hence, water surface elevation) between results obtained in CHE (2013b) and Zhang (2012).

Figure 2 shows a zoomed-in view of the modeling at the project site. The shown differences between modeling results are expected and mainly due to implementation of the most recent design elevations in constructing the model bathymetry and topography by CHE (2013).

Figure 3 presents a zoomed-in view of the modeling results in Coos Bay further inland from the project site. The figure shows a larger extent of inundation, mostly at embayment areas, predicted by Zhang (2012) tsunami modeling compared to that of CHE (2013b). The difference in the inundation extents can be explained as follows:

- The landscape in the area between yellow and red lines is relatively flat, with typical elevations of 6 to 8 ft above NAVD88, and mainly at the end of embayment areas. This means that even small changes in water surface elevation correspond to rather large changes in extent of inundation (runup) on these flat landscapes.

- A safety factor of 1.3 is not applicable in the areas with elevations less than MHW (6.46 NAVD88). Therefore this factor cannot be used to increase the water surface elevation in this modeling domain.

- Therefore, it is expected that inundation extent due to tsunami that was modeled at MHHW elevation exceed inundation extent due to tsunami that was modeled at MHW elevation in these areas.

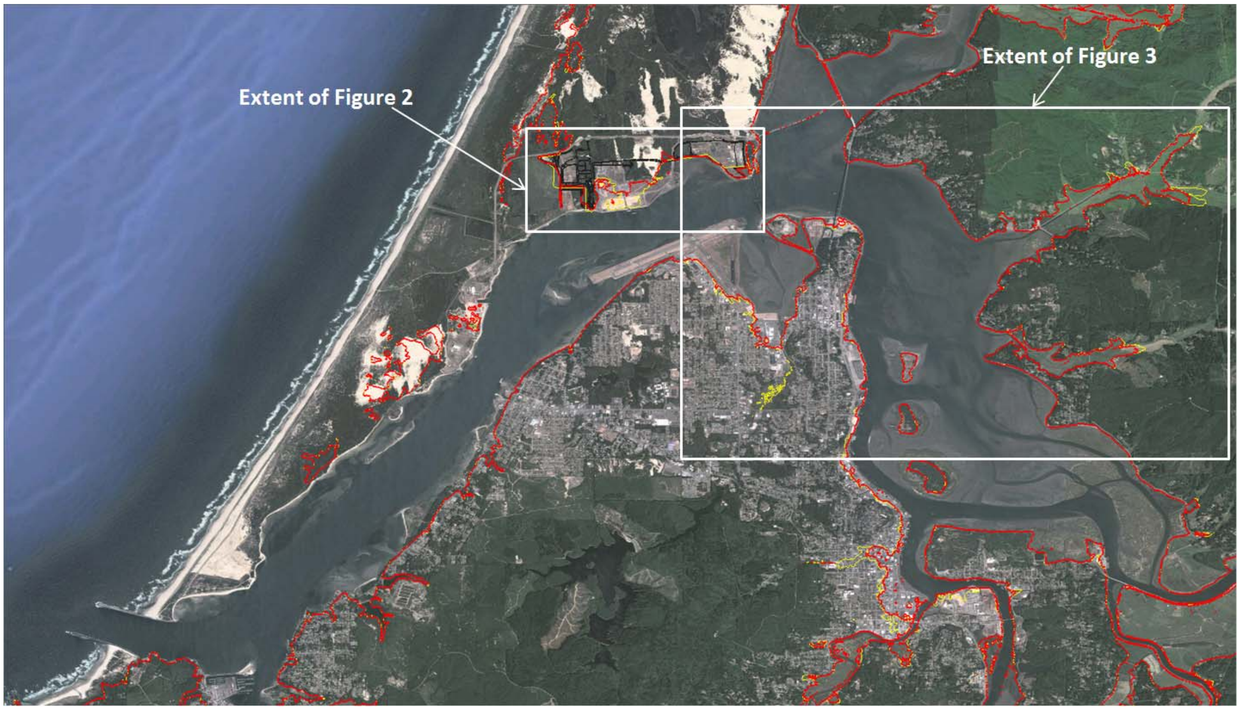


Figure 1. Extent of tsunami wave inundation for L1 Scenario for Coos Bay for modified landscape obtained from Zhang (2012) study, shown in yellow and CHE (2013b) study, shown in red

Figure 2. Extent of tsunami wave inundation for L1 Scenario at project site for modified landscape obtained from Zhang (2012) study, shown in yellow and CHE (2013b) study, shown in red

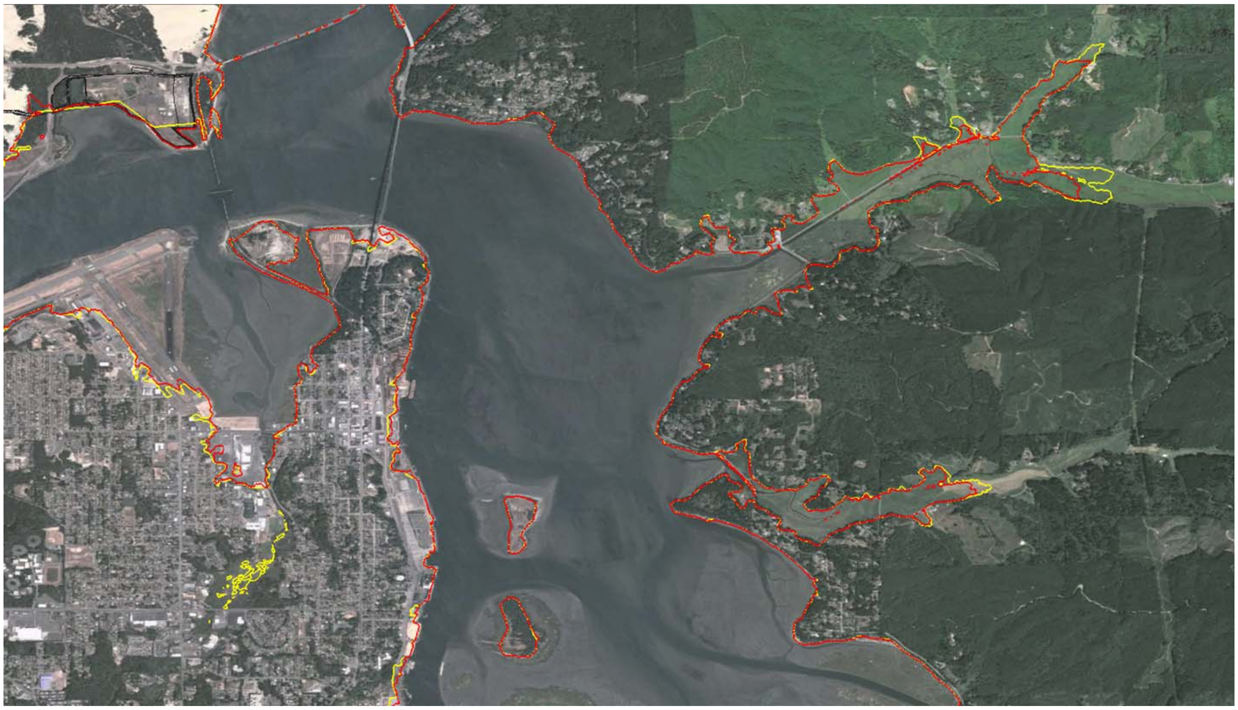


Figure 3. Extent of tsunami wave inundation for L1 Scenario further east of project site for modified landscape obtained from Zhang (2012) study, shown in yellow and CHE (2013b) study, shown in red

1. References

CHE. 2013a. Jordan Cove Energy Project, Tsunami Hydrodynamic Modeling Input and Methodology. Coast & Harbor Engineering. Edmonds, WA.

CHE. 2013b. Technical Memorandum: Jordan Cove LNG Facility Tsunami Hydrodynamic Modeling. Prepared for Jordan Cove Energy Project. Coast & Harbor Engineering. Edmonds, WA.

Priest, G.R., Goldfinger, C., Wang, K., Witter, R., Zhang, Y., Baptista, A.M. 2009. Tsunami hazard assessment of the Northern Oregon coast: a multi-deterministic approach tested at Cannon Beach, Clatsop County, Oregon: Oregon Department of Geology and Mineral Industries Special Paper 41.

Priest, G.R., Goldfinger, C., Wang, K., Witter, R., Zhang, Y., Baptista, A.M. 2010. Confidence levels for tsunami-inundation limits in northern Oregon inferred from a 10,000-year history of great earthquakes at the Cascadia subduction zone: Natural Hazards, doi10.1007/s11069-009-9453-5.

Witter, R. C., Y. Zhang, K. Wang, G. R. Priest, C. Goldfinger, L. L. Stimely, J. T. English, and P. A. Ferro. Special Paper 43, Simulating tsunami inundation at Bandon, Coos County, Oregon, using hypothetical Cascadia and Alaska earthquake scenarios.

Zhang, Y.J. 2012. Final Report, Site-Specific Tsunami Modeling at the Jordan Cove LNG Facility Coos County, Using New Cascadia Sources. Center for Coastal Margin Observation & Prediction (CMOP), Oregon Health & Science University.

Exhibit 68

Oregon
John A. Kitzhaber, MD, Governor

DEQ of Environmental Quality
Western Region Eugene Office
165 East 7th Avenue, Suite 100
Eugene, OR 97401
(541) 686-7838
FAX (541) 686-7551
TTY 711

June 25, 2014

Mr. Robert L. Braddock
Vice President-Project Manager
Jordan Cove Energy Project L.P.
125 Central Ave., Suite 380
Coos Bay, OR 97420

Re: Warning Letter with Opportunity to Correct
Jordan Cove-Ingram Yard Contaminated Soils
WLOC-WRE-2014-0033
North Bend, Coos County Proj 6765

Dear Mr. Braddock:

In late April 2014, the Oregon Department of Environmental Quality (DEQ) was informed that contaminated soils had been encountered, excavated and incorporated into onsite berms at the Jordan Cove Ingram Yard site. This activity was part of the site preparation associated with geotechnical tests to be conducted as part of the Jordan Cove Energy Project. On May 8, 2014, I conducted an inspection at the Jordan Cove Ingram Yard site in North Bend, OR.

Based upon the inspection of your facility, and our review of the May 7, 2014 letter report prepared by your consulting engineering firm, SHN documenting the aforementioned site preparation work, DEQ has concluded that Jordan Cove Energy Project L.P. (Jordan Cove) is responsible for the following violations of Oregon environmental law:

VIOLATION #1

OAR 340-093-0040(1) - Prohibited Disposal states the following:

(1) No person shall dispose of or authorize the disposal of solid waste except at a solid waste disposal site permitted by DEQ to receive that waste, or at a class of disposal site specifically exempted by OAR 340-093-0050(3) from the requirement to obtain a solid waste permit.

As described in the SHN letter report, contaminated soils were encountered, excavated, and graded with much of the materials used to construct onsite berms. Investigations conducted at the site in the mid-2000's had identified the presence of these contaminated soils, which are native soils mixed with residual sludge waste. Weyerhaeuser had disposed of sludge waste in the Ingram Yard area when their mill was in operation. Based on results of the earlier site investigations, the contaminated soils contain low levels of potentially bioaccumulating chemicals that must not be placed in the waters of the state.

While it was recognized that contamination level in the soil material are low such that the soils can be left onsite, DEQ stated in a September 15, 2006 No Further Action (NFA) letter that "any residually contaminated soil or sediment excavated during future site activities or development must be properly managed and disposed in accordance with DEQ regulations and policies."

Therefore, the disposal of solid waste (i.e., contaminated soils) that occurred during the site preparation work required a solid waste permit. As the site preparation activities were a short-term operation, DEQ can issue a specific solid waste permit called a "letter authorization."

Disposing of or authorizing the disposal of a solid waste at a location not permitted by DEQ to receive that solid waste is a Class I violation of OAR 340-012-0065(1)(c).

Corrective Action(s) Requested

In order to correct the violation cited above, minimize the impacts of the violation on the environment and employee safety, and to avoid further enforcement action by the DEQ, we request that Jordan Cove take the following action by the date indicated:

Corrective Action – Violation #1:

a) Submit a completed application for a new solid waste disposal site permit. Specifically, the type of permit requested should be a Solid Waste Letter Authorization (SWLA) as this type of permit is applicable for short-term projects. Please submit your application to DEQ **by no later than July 31, 2014**.

Should this violation remain uncorrected or should Jordan Cove repeat this violation, this matter may be referred to the DEQ's Office of Compliance and Enforcement for formal enforcement action, including assessment of civil penalties and/or a DEQ order. Civil penalties can be assessed for each day of violation.

If it is anticipated that future activities at this site will result in the additional excavation and disposal of contaminated soils/materials at the Jordan Cove Energy Project site, these contaminated soils/materials must be managed and/or disposed of in accordance with DEQ rules. If the contaminated soils/materials will be disposed of onsite, Jordan Cove will need to apply for a new solid waste disposal site permit.

If you believe any of the facts in this Warning Letter are in error, you may provide information to me at the office at the address shown at the top of this letter. The DEQ will consider new information you submit and take appropriate action.

The DEQ endeavors to assist you in your compliance efforts. Should you have any questions about the content of this letter or desire additional technical assistance, please feel free to contact me by e-mail at wong.gene@deq.state.or.us or by phone at 541-687-7438.

Sincerely,

Gene Wong, P.E., Environmental Engineer
Solid Waste Permitting and Compliance
Western Region – Eugene Office

Cc: File

Ec: Fran Holman; DEQ – Salem
Mary Camarata, DEQ - Eugene
Office of Compliance and Enforcement - DEQ Headquarters
J. Mark Denning, SHN Consulting Engineers, 275 Market Avenue, Coos Bay, OR 97420-2228
Kelly McNutt, Kiewit Infrastructure West Co., 2215 E. 1st St., Vancouver, WA 98661

X:\Solid Waste\SWLA\SWLA2014\JordanCove\WLOC(6-14)

Oregon
John A. Kitzhaber, MD, Governor

Department of Environmental Quality
Western Region Salem Office
750 Front Street NE, Suite 120
Salem, OR 97301-1039
(503) 378-8240
FAX (503) 373-7944
TTY 711

July 31, 2014

Mr. Robert L. Braddock
Vice-President-Project Manager
Jordan Cove Energy Project L.P.
125 Central Ave., Suite 380
Coos Bay, OR 97420

RE: JCEP LNG Terminal Project L.P. – Ingram Yard
SW Permit No. 1545, SW Project No. 6809
Solid Waste Letter Authorization Permit
Coos County

Dear Mr. Braddock:

The enclosed Solid Waste Letter of Authorization (SWLA) Permit No. 1545 is issued in response to your application received July 21, 2014. This SWLA has been issued to allow the excavation and temporary storage of low-level impacted ash/soil in berms as part of the Test Pile and Ground Improvement Program performed at the Ingram Yard area of the JCEP LNG Terminal Project, as described in your SWLA application. This SWLA also sets forth specific requirements for the maintenance of the berms.

You are urged to carefully read the permit and comply with its conditions.

SWLA Permit No. 1545 is valid until January 31, 2015. For more information on DEQ's Solid Waste Program including rules, statutes and technical assistance visit
http://www.deq.state.or.us/lq/sw/index.htm.

Sincerely,

Brian Fuller, Manager
Western Region Hazardous and Solid Waste
Permitting and Compliance

Encl: SWLA Permit

Cc: File

ec: Gene Wong, DEQ Eugene
Fran Holman, DEQ-Salem
Office of Compliance and Enforcement – DEQ Headquarters
J. Mark Denning, mdenning@shn-engr.com

X:\Solid Waste\SWLA\SWLA2014\1545JordanCove\PermitCvrLtrJul2014

State of Oregon
Department of Environmental Quality

SOLID WASTE DISPOSAL SITE PERMIT: LETTER AUTHORIZATION

Oregon Department of Environmental Quality
165 East 7th Avenue, Suite 100
Eugene, Oregon 97401

Telephone: (541) 686-7838

Issued in accordance with the provisions of ORS Chapter 459 and subject to the land use compatibility statement referenced below.

ISSUED TO:

Jordan Cove Energy Project, L.P.
125 Central Avenue, Suite 380
Coos Bay, OR 97420

(541) 266-7510

FACILITY NAME AND LOCATION:

JCEP LNG Terminal Project, L.P.
Jordan Cove Road
Coos County

PROPERTY OWNER:

Jordan Cove Energy Project, L.P.
125 Central Avenue, Suite 380
Coos Bay, OR 97420

Attn: Robert Braddock

OPERATOR:

Jordan Cove Energy Project, L.P.
125 Central Avenue, Suite 380
Coos Bay, OR 97420

(541) 266-7510

ISSUED IN RESPONSE TO:

- an application for Solid Waste Letter of Authorization (SWLA) received July 21, 2014; and
- a Land Use Compatibility Statement signed by the Coos County Planning Dept. Director, July 11, 2014.

Pursuant to OAR 340-093-0050(5) the determination to issue this permit is based on findings and technical information included in the permit record.

ISSUED BY THE OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY

July 31, 2014

Brian Fuller, Manager
Hazardous and Solid Waste Program
Western Region

Date

PERMITTED ACTIVITIES

In accordance to SWLA No. 1545, which **will expire on January 31, 2015**, the permittee is hereby authorized in conformance with the requirements, limitations and conditions set forth in this document including all attachments.

PERMITTED ACTIVITIES

Description

In response to a Warning Letter issued by DEQ on June 25, 2014 (WLOC-WRE-2014-0033), Jordan Cove Energy Project, L.P. (Jordan Cove) applied for a Solid Waste Letter Authorization Permit (SWLA) to address the short term project that has already been conducted at their site. This project, which was associated with the Test Pile and Ground Improvement Program being performed at the site, involved the grading and temporary stockpiling of low-level impacted ash/soil at the Ingram Yard area of the Jordan Cove Liquefied Natural Gas (LNG) project. The disposal of solid waste (i.e., low-level impacted ash/soil) onsite requires a solid waste permit.

The purpose of the Test Pile and Ground Improvement Program was to investigate various methods for pile driving and ground improvement techniques to determine design parameters and efficient construction techniques for the Jordan Cove Energy Project. In order to perform these geotechnical tests, it was necessary to excavate and temporarily store both clean and low-level impacted ash/soil. Approximately 1,700 cubic yards of soil (both clean and low-level impacted soil) was excavated during the grading activities in the Ingram Yard.

Work on the project began in February 2014 and grading activities in this area for the geotechnical tests were substantially completed in April 2014. Grading operations at the testing site removed the top 12- to 60-inches of sand and top soil. All exposed soil at the finished grade of the test site was clean sand. The low-level impacted ash/soil that had been removed was integrated into larger stockpiles that were subsequently placed into the perimeter berms around the test area. Gravel was used to cover the flat test area surfaces, while the surface of the berms were seeded and mulched.

Activities of the project must be conducted in compliance with following requirement: the structural integrity of the perimeter berms must be maintained to reduce the potential for any materials from the low-level impacted ash/soil to leach out of the berms.

A permanent disposal plan for the ash/soil material temporarily stored as part of the Test Project, as well as ash/soil material not disturbed by the Test Project in the Ingram Yard area, is being developed by Jordan Cove. This plan will need to be submitted to and approved by DEQ prior to any future grading activities where the ash/soil material will be disturbed. This plan should be submitted as part of an application for a new Solid Waste Disposal Permit for this material. It is anticipated that the ash/soil material will be utilized as fill material during planned construction of the LNG terminal and permanently buried.

Disclaimers

The issuance of this permit does not convey property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights.

DEQ, its officers, agents, or employees do not sustain any liability on account of the issuance of this permit or on account of the construction, maintenance, or operation of facilities pursuant to this permit.

Authority

Conditions of this permit are binding upon the permittee. The permittee is liable for all acts and omissions of the permittee's contractors and agents [ORS 459.376].

The permittee shall allow representatives of DEQ access to the project areas at all reasonable times for the purpose of making inspections, surveys, collecting samples, obtaining data and carrying out other necessary functions related to this permit.

Issuance of this permit does not relieve the permittee from the responsibility to comply with all other applicable federal, state or local laws or regulations. This includes the following solid waste requirements, as well as all updates or additions to these requirements:

1. Solid Waste Letter Authorization Permit Application received July 21, 2014,
2. Oregon Revised Statutes, Chapters 459 and 459A,
3. Oregon Administrative Rules, Chapter 340, and
4. Any other documents submitted by the permittee and approved by DEQ.

Solid Waste Letter of Authorization No.1545 expires on January 31, 2015.

Exhibit 69

https://theworldlink.com/news/science/where-have-the-wild-birds-gone-study-counts-billion-fewer/article_a626eed1-2063-52e5-9e5e-a6c7a903f593.html

Where have the wild birds gone? Study counts 3 billion fewer than 1970, stunning scientists

By Seth Borenstein and Christina Larson AP Science Writers
Sep 19, 2019

FILE - This April 14, 2019 file photo shows a western meadowlark in the Rocky Mountain Arsenal National Wildlife Refuge in Commerce City, Colo. According to a study released on Thursday, Sept. 19, 2019, North America's skies are lonelier and quieter as nearly 3 billion fewer wild birds soar in the air than in 1970. Some of the most common and recognizable birds are taking the biggest hits, even though they are not near disappearing yet. The population of eastern meadowlarks has shriveled by more than three-quarters with the western meadowlark nearly as hard hit. (AP Photo/David Zalubowski, File)
David Zalubowski

North America's skies are lonelier and quieter as nearly 3 billion fewer wild birds soar in the air than in 1970, a comprehensive study shows.

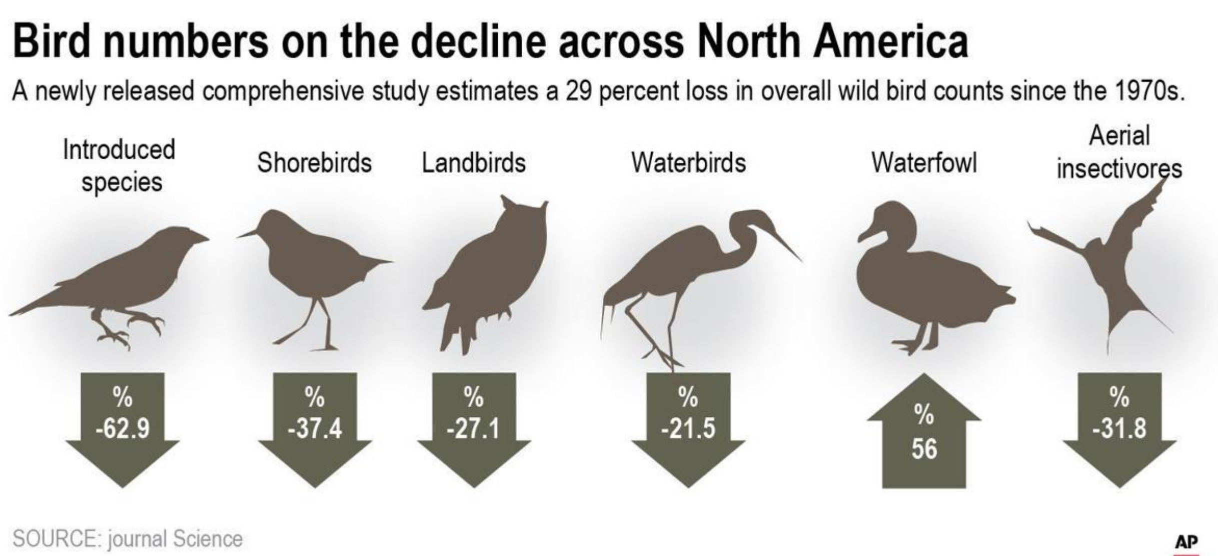
The new study focuses on the drop in sheer numbers of birds, not extinctions. The bird population in the United States and Canada was probably around 10.1 billion nearly half a century ago and has fallen 29% to about 7.2 billion birds, according to a study in Thursday's journal Science .

"People need to pay attention to the birds around them because they are slowly disappearing," said study lead author Kenneth Rosenberg, a Cornell University conservation scientist. "One of the scary things about the results is that it is happening right under our eyes. We might not even notice it until it's too late."

Rosenberg and colleagues projected population data using weather radar, 13 different bird surveys going back to 1970 and computer modeling to come up with trends for 529 species of North American birds. That's not all species, but more than three-quarters of them and most of the missed species are quite rare, Rosenberg said.

Using weather radar data, which captures flocks of migrating birds, is a new method, he said.

"This is a landmark paper. It's put numbers to everyone's fears about what's going on," said Joel Cracraft, curator-in-charge for ornithology of the American Museum of Natural History, who wasn't part of the study.



A new study finds there are nearly 3 billion fewer wild birds flying in North American skies than in 1970.; f.duckett

"It's even more stark than what many of us might have guessed," Cracraft said.

Every year University of Connecticut's Margaret Rubega, the state ornithologist, gets calls from people noticing fewer birds. And this study, which she wasn't part of, highlights an important problem, she said.

"If you came out of your house one morning and noticed that a third of all the houses in your neighborhood were empty, you'd rightly conclude that something threatening was going on," Rubega said in an email. "3 billion of our neighbors, the ones who eat the bugs that destroy our food plants and carry diseases like equine encephalitis, are gone. I think we all ought to think that's threatening."

Some of the most common and recognizable birds are taking the biggest hits, even though they are not near disappearing yet, Rosenberg said.

The common house sparrow was at the top of the list for losses, as were many other sparrows. The population of eastern meadowlarks has shriveled by more than three-quarters with the western meadowlark nearly as hard hit. Bobwhite quail numbers are down 80%, Rosenberg said.

Grassland birds in general are less than half what they used to be, he said.

Not all bird populations are shrinking. For example, bluebirds are increasing, mostly because people have worked hard to get their numbers up.

Rosenberg, a birdwatcher since he was 3, has seen this firsthand over more than 60 years. When he was younger there would be "invasions" of evening grosbeaks that his father would take him to see in Upstate New York with 200 to 300 birds around one feeder. Now, he said, people get excited when they see 10 grosbeaks.

The research only covered wild birds, not domesticated ones such as chickens.

Rosenberg's study didn't go into what's making wild birds dwindle away, but he pointed to past studies that blame habitat loss, cats and windows.

"Every field you lose, you lose the birds from that field," he said. "We know that so many things are killing birds in large numbers, like cats and windows."

Experts say habitat loss was the No. 1 reason for bird loss. A 2015 study said cats kill 2.6 billion birds each year in the United States and Canada, while window collisions kill another 624 million and cars another 214 million.

That's why people can do their part by keeping cats indoors, treating their home windows to reduce the likelihood that birds will crash into them, stopping pesticide and insecticide use at home and buying coffee grown on farms with forest-like habitat, said Sara Hallager, bird curator at the Smithsonian Institution.

"We can reverse that trend," Hallager said. "We can turn the tide."

—

Follow Seth Borenstein on Twitter at @borenbears and Christina Larson at @larsonchristina .

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The Associated Press Health and Science Department receives support from the Howard Hughes Medical Institute's Department of Science Education. The AP is solely responsible for all content.

Exhibit 70

Smithsonian.com

SmartNews Keeping you current

Even Without Ears, Oysters Can Hear Our Noise Pollution

Study shows that certain frequencies of noise cause oysters to clam up

(Wikimedia Commons)

By Jason Daley
smithsonian.com
October 27, 2017

Of course, oysters don’t have ears. They've never heard the cowbell in Blue Oyster Cult’s “Don’t Fear the Reaper” or heard a recitation of the oyster classic, *The Walrus and the Carpenter.* But as Teresa L. Carey at PBS Newshour reports, a new study suggests that oysters may still suffer one of the downsides of having ears: noise pollution.

As Carey reports, researchers have long known that noise pollution can impact a range of sea creatures—and might even be responsible for some mass strandings of whales. Researcher Jean-Charles Massabuau of the University of Bordeaux and his team wanted to see if the sound created by boats, ships and other human activities on the water also impacted invertebrates.

Massabuau brought 32 Pacific oysters into his laboratory and used a loudspeaker to play various frequencies to the bivalves. Happy oysters tend to keep their shells cracked open; when they are stressed or face a threat, they slam their shells shut. So the team played a range of frequencies, measuring the how quickly the oysters closed their shells.

It turned out, the oysters reacted most strongly to noises between 10 and 1000 hertz, showing the most sensitivity to sounds between 10 and 200 hertz. As Douglas Quenqua at *The New York Times* reports, those lower frequencies are often produced by cargo ships, seismic research, wind turbines and pile driving. Higher frequencies created by jet skis and small boats, however, did not seem to bother the animals. They published their results in the journal *PLOS ONE*.

“They are aware of the cargo ships,” Massabuau tells Carey. “What is for sure is that they can hear. The animals can hear these frequencies.”

Of course oysters don’t hear like humans. Instead, they have hair cells on the outside of their shells that sense vibration. The researchers believe the oysters use these hairs to detect things like breaking waves and ocean currents caused by rising tides giving them cues for when to feed.

“To hear the current arriving could prepare them for eating and digesting, possibly as when we hear and smell that somebody is preparing dinner,” Massabuau tells Quenqua. Noise pollution, however, could muddle the oysters' ability to read the tides, affecting their long term health.

University of Hull marine biologist Mike Elliott, however, says it’s not clear if the noise pollution is having an impact. He has conducted similar studies on mussels and hermit crabs, who have similar reactions to certain frequencies. “It is quite a big leap from detecting a response [to sound] to if the animal is being harmed by it,” Elliott tells Carey. “The big challenge is converting this into a response that denotes harm to the organism.”

Massabuau agrees with this conclusion and plans to continue the study, focusing on whether the long-term exposure negatively impacts the oysters.

It's not just shellfish feeling the vibes. A 2015 study on general noise pollution in the oceans suggests it could be having significant impacts on a variety of species. In particular there’s growing evidence that air guns, which are used for seismic surveys, can cause hearing damage in whales and fish and stress from chronic noise pollution can negatively impact reproduction in many other species.

Perhaps, to help the creatures of the sea we first need to learn a lesson from the oysters, and just pipe down.

About Jason Daley

Jason Daley is a Madison, Wisconsin-based writer specializing in natural history, science, travel, and the environment. His work has appeared in *Discover*, *Popular Science*, *Outside*, *Men’s Journal*, and other magazines.

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Exhibit 71

ScienceDaily
https://www.sciencedaily.com/releases/2019/03/190313143307.htm

Review of noise impacts on marine mammals yields new policy recommendations

Date: March 13, 2019

Source: University of California - Santa Cruz

Summary: Marine mammals are particularly sensitive to noise pollution because they rely on sound for so many essential functions, including communication, navigation, finding food, and avoiding predators. An expert panel has now published a comprehensive assessment of the available science on how noise exposure affects hearing in marine mammals, providing scientific recommendations for noise exposure criteria that could have far-reaching regulatory implications.

FULL STORY

A trained spotted seal (Phoca largha) cooperates in an underwater hearing test at Long Marine Laboratory, UC Santa Cruz. (NMFS permit 18902)
Credit: B. Wakefield

Marine mammals are particularly sensitive to noise pollution because they rely on sound for so many essential functions, including communication, navigation, finding food, and avoiding predators. An expert panel has now published a comprehensive assessment of the available science on how noise exposure affects hearing in marine mammals, providing scientific recommendations for noise exposure criteria that could have far-reaching regulatory implications.

Published March 12 in *Aquatic Mammals*, the paper is a major revision of the first such assessment, published in 2007 in the same journal. Both efforts were led by Brandon Southall, a research associate at the Institute of Marine Sciences at UC Santa Cruz and senior scientist at Southall Environmental Associates.

"One of the things we did in 2007 was to identify major gaps in our knowledge, and we now have considerably more data. We thought there was enough new science to reconvene the panel and revisit these issues," said Southall, who served as director of NOAA's Ocean Acoustics Program from 2004 to 2009.

Concern about the potential for ocean noise to cause hearing damage or behavioral changes in marine mammals began to mount in the 1990s, focusing initially on activities related to the oil and gas industry. In the early 2000s, the association of sonar with mass strandings of deep-diving whales became another focus of concern. Shipping and construction activities are other important sources of ocean noise pollution.

Loud noises can cause temporary or permanent hearing loss, can mask other sounds, and can disturb animals in various ways. The new paper focuses on direct effects of noise pollution on hearing in marine mammals. Separate papers addressing behavioral effects and the acoustics of different sound sources will be published later this year.

"Noise-induced hearing loss occurs in animals the same way it does in humans. You can have a short-term change in response to exposure to loud noise, and you can also have long-term changes, usually as a result of repeated insults," said coauthor Colleen Reichmuth, a research scientist who leads the Pinniped Cognition and Sensory Systems Laboratory at UC Santa Cruz.

Because animals vary in their sensitivities to different types and frequencies of sound, the panel categorized marine mammal species into groups based on what was known about their hearing. The new paper includes all living species of marine mammals.

"The diversity of species is such that a one-size-fits-all approach isn't going to work," said coauthor Darlene Ketten, a neuro-anatomist with joint appointments at Woods Hole Oceanographic Institute and Boston University's Hearing Research Center. "We need to understand how to avoid harm, and the aim is to provide guidelines to say, if this or that species is in your area, here's what you need to avoid."

Over the past decade, the number of scientific studies on hearing in marine mammals has grown rapidly, enabling the panel to refine and improve its groupings and assessments. Accompanying the paper is a set of appendices compiling all the relevant information for 129 species of marine mammals.

"We did a comprehensive review, species by species, for all living marine mammals," said Reichmuth, who led the work on the appendices. "We pulled together the available knowledge covering all aspects of hearing, sound sensitivity, anatomy, and sound production. That's the scientific basis for the species groupings used in the noise exposure criteria."

"The appendices are a really important resource that does not exist anywhere else," Southall said. "The 2007 paper was the most impactful single paper I've ever published -- it's been cited in the literature more times than all my other papers combined -- and I expect this new paper will have a similar impact."

The 2007 paper covered only those species under the jurisdiction of the National Marine Fisheries Service (NOAA Fisheries). NOAA Fisheries issued U.S. regulatory guidance in 2016 and 2018 based on the 2007 paper and a 2016 Navy technical report by James Finneran, a researcher at the U.S. Navy Marine Mammal Program in San Diego and a coauthor of both papers.

In addition to covering all marine mammals for the first time, the new paper also addresses the effects of both airborne and underwater noise on amphibious species in coastal environments, such as sea lions. According to Southall, publishing the new noise exposure criteria along with a comprehensive synthesis of current knowledge in a peer-reviewed journal is a major step forward.

"There are regulatory agencies around the world that are thirsting for this kind of guidance," Southall said. "There are still holes where we need more data, but we've made some big strides."

Research on seals, sea lions, and sea otters at the UCSC Pinniped Lab now run by Reichmuth has provided much of the new data on hearing in amphibious marine mammals. Working with trained animals at UCSC's Long Marine Laboratory, Reichmuth's team is able to conduct controlled experiments and perform hearing tests similar to those used to study human hearing.

Finneran's program in San Diego and coauthor Paul Nachtigall's program at the University of Hawaii have provided much of the data for dolphins and other cetaceans.

But some marine mammals, such as baleen whales and other large whales, simply can't be held in a controlled environment where researchers could conduct hearing tests. That's where Ketten's research comes in. Ketten uses biomedical imaging techniques, including CT and MRI, to study the auditory systems of a wide range of species.

"Modeling an animal's hearing based on the anatomy of its auditory system is a very well-established technique that can be applied to baleen whales," Ketten explained. "We also do this modeling for the species that we can test in captivity, and that enables us to hone the models and make sure they're accurate. There has been a lot of resistance to modeling, but it's the only way to study hearing in some of the species with the greatest potential for harm from human sounds."

Southall said he regularly hears from people around the world looking for guidance on regulating noise production by activities ranging from wind farm construction to seismic surveys. "This paper has significant international implications for regulation of noise in the ocean," he said.

Story Source:

Materials provided by **University of California - Santa Cruz**. Original written by Tim Stephens. *Note: Content may be edited for style and length.*

Journal Reference:

1. Brandon L. Southall, James J. Finneran, Colleen Reichmuth, Paul E. Nachtigall, Darlene R. Ketten, Ann E. Bowles, William T. Ellison, Douglas P. Nowacek, Peter L. Tyack. **Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects**. *Aquatic Mammals*, 2019; 45 (2): 125 DOI: 10.1578/AM.45.2.2019.125

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- MLA
- APA
- Chicago

University of California - Santa Cruz. "Review of noise impacts on marine mammals yields new policy recommendations." ScienceDaily. ScienceDaily, 13 March 2019. <www.sciencedaily.com/releases/2019/03/190313143307.htm>.

Exhibit 72

USDA
United States Department of Agriculture

OREGON DUNES NATIONAL RECREATION AREA MAP & GUIDE

Forest Service U.S. Department of Agriculture

Siuslaw National Forest

Welcome to the Oregon Dunes National Recreation Area!

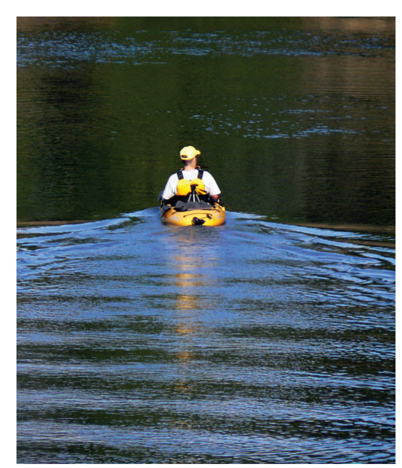
Explore the largest expanse of coastal sand dunes in North America.

In 1972 Congress recognized the unique value of the Oregon Dunes by designating the National Recreation Area to be managed by the U.S. Forest Service for "public outdoor recreation use and enjoyment by present and future generations, and the conservation of scenic, scientific, historic values…"

Formed by the ancient forces of wind, water and time, these dunes are like no others in North America, and extend for 40 miles along the Oregon coast between Florence and Coos Bay. Wind sculpted dunes tower almost 500 feet above the ocean shore and blend with rivers, lakes and temperate rainforests to create a remarkably diverse ecosystem.

Enjoy hiking through forests and dunes, riding an off-highway vehicle through a landscape of sand, or watching a sunset from a scenic beach. How about picnicking, camping, boating or fishing on one of the 30 lakes or rivers? Perhaps you're a birder, beachcomber, berry or mushroom gatherer, or looking for accessibility? There are many opportunities to enjoy this special area.

Please remember to share the responsibility of stewardship for this rare, ecologically complex, and beautiful national treasure. Tread Lightly!



Oregon Dunes Visitor Center

Visitor information and bookstore

855 Hwy 101
Reedsport, OR 97467
Phone: 541-271-6000

Visit our website: http://www.fs.usda.gov/siuslaw

@siuslawnf @SiuslawNF

Camping

Most developed campgrounds on the forest can be reserved in advance. Reserve online at www.recreation.gov or call toll free 1-877-444-6777 (International: 518-885-3639, TDD: 877-333-6777).

Sand camps are sites are located directly on the sand, dispersed along the Oregon Dunes National Recreation Area. Camping access is by Off Highway Vehicle (OHV) on soft sand only and is allowed by reservation only through www.recreation.gov.

Passes

At some popular sites, a day-use fee may be required but many sites do not require fees. Recreation fees help maintain facilities and provide services. Day-use fees are $5 per vehicle per day. You can purchase your pass online at discovernw.org or on site (cash or check only).

Other passes are also accepted. Popular passes include the $30 Northwest Forest Pass (good for 1 year for national forest sites in OR and WA), or the $80 America the Beautiful Annual Pass (good for 1 year for more than 2,000 Federal recreation sites.), and the $35 Oregon Pacific Coast Passport (good for 1 year at coastal Oregon State Parks and Federal sites).

Other passes available include the Senior Pass (62+ older), Access Pass (permanent disability), Military Pass (current U.S. military members and dependents), and the 4th Grade Pass (free for 4th grade students). Learn more at https://store.usgs.gov/pass.

How did all this sand get here?

Like you, these sands traveled long and far.

How far and how long did you travel to get here? For the grains of the Oregon Dunes, it has taken about 55 million years, starting with the building of the Coast and Cascade Mountain Ranges.

Following the mountains' formation, glaciers, rivers, wind, and rainfall began to grind these peaks down to tiny grains of sand and carry them to the ocean. There, currents push the sand onshore, where winds sculpt each grain into dunes.

Wind Carves the Dunes

The Foredune is a low hill parallel to the ocean. It exists because European beachgrass slows the wind, causing sand to drop out and pile up.

Behind the foredune, the wind scours out the **Deflation Plain** all the way down to the water table and provides an area for plants to thrive.

Summer winds carve wave patterns in the sand called **Transverse Dunes**. As the seasonal winds change direction, so do the patterns in the sand.

At times the forest marches forward, other times the dunes smother the forest. Sometimes dunes leave pockets of forest, called **Tree Islands**, surrounded by sand.

Oblique Dunes are the largest and most spectacular dunes, sometimes growing as tall as 180 feet and pushing inland 3 to 16 feet per year.

Dune Invaders!

European beachgrass was planted along the West Coast in the early 1900s to stabilize sandy coastlines and protect roads, water supplies, jetties, and homes. The grass thrived in its new environment.

Beachgrass gains the upper hand

The grass slowed the sand's movement, and it piled up in a huge long foredune along the beach. Behind this dune, plants found a better place to grow. In just 50 years, huge mats of vegetation formed where there was once open sand. Now, plants and animals that need open sandy areas struggle to survive, and the open sand disappears from view.

Land managers battle back

European beachgrass is tough. It spreads quickly and thrives when buried under sand. Managers are exploring ways to control the grass, including hand-pulling, bulldozing, and spraying herbicides.

Who will win the battle? Only time will tell.

Sharing the Beach with the Western Snowy Plover

Where is your home? For a local bird, the coastal sand is home, nursery and grocery store. The Western Snowy Plover needs dry, open sand along the beach to survive. As the European beachgrass invades the open sand, it reduces nesting areas and provides homes for predators. This bird is now threatened with extinction.

If you think no one is home, look again!

Imagine blending into your home so well no could see you! The plover's feathers and nests blend into the sand. This disguise protects the birds from predators; but people, who cannot see the birds, sometimes walk through the birds' sandy nests thinking no one is home.

You can help the Snowy Plover!

From March 15-September 15 please observe all posted regulations

No dogs, vehicles, bicycles, kites, or drones are allowed on plover beaches. Walk on wet, hard-packed sand only.

Learn more at http://go.usa.gov/x9AfP.

PLOVER LOVE
#ShareTheBeach

Where the Coast Mountain Range meets the Dunes and Ocean

The mild wet climate creates a lush rainforest, lakes and rivers…and home for many birds.

Often seen at…

South Jetty

Osprey, Marsh Wren, Coopers Hawk, Tundra Swan

Siltcoos

Great Blue Heron

Oregon Day Use

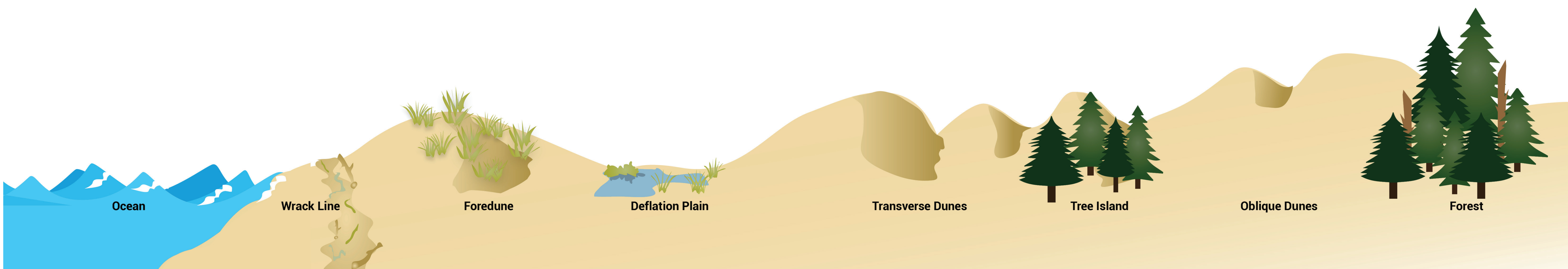
Stellars Jay, Wren-tit, Bald Eagle

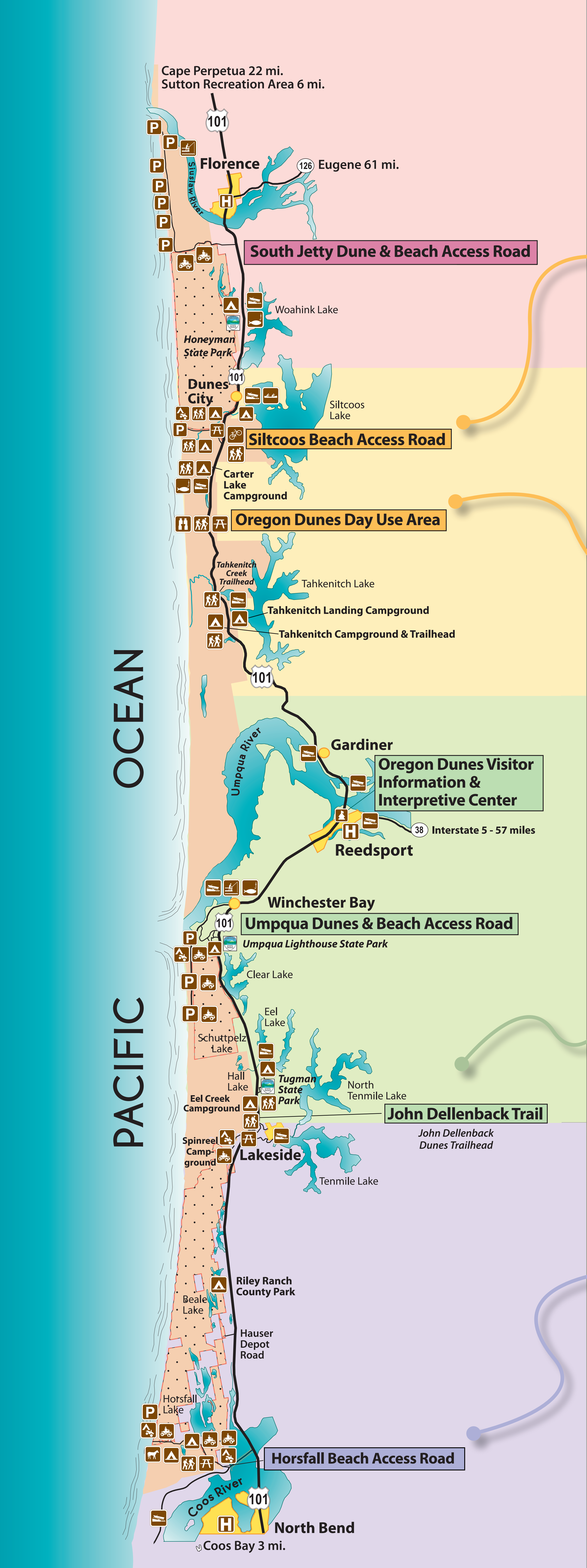
Eel Creek Campground

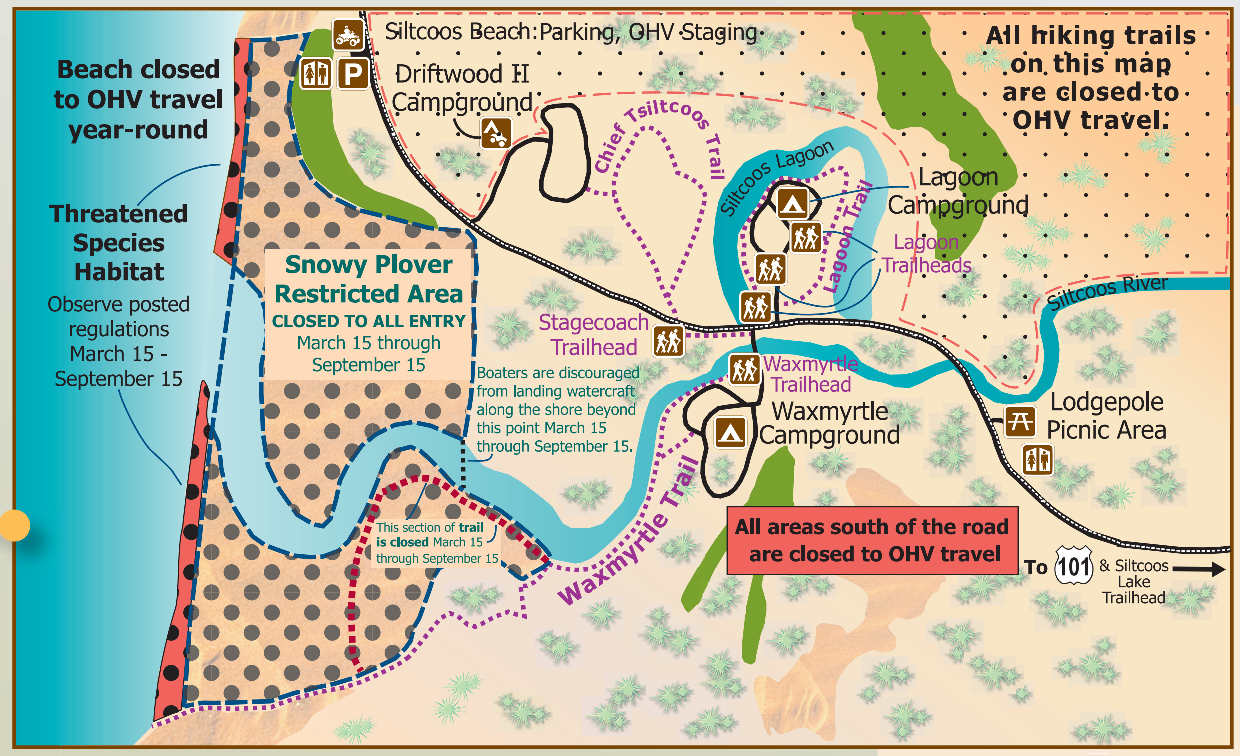
Northern Flicker, Chestnut Backed Chickadee

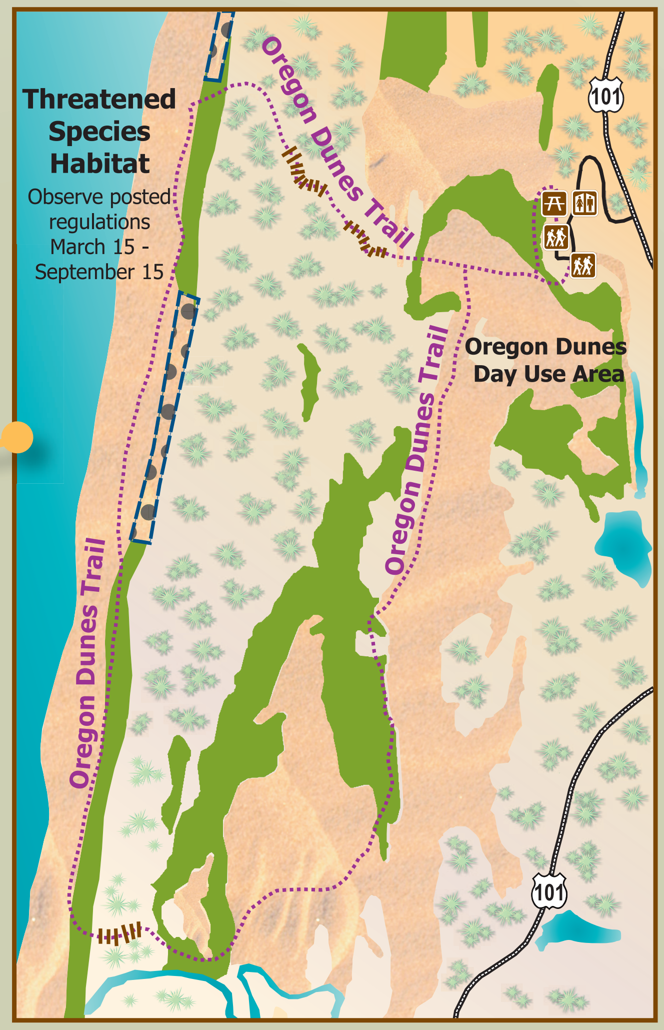
Bluebill Trail

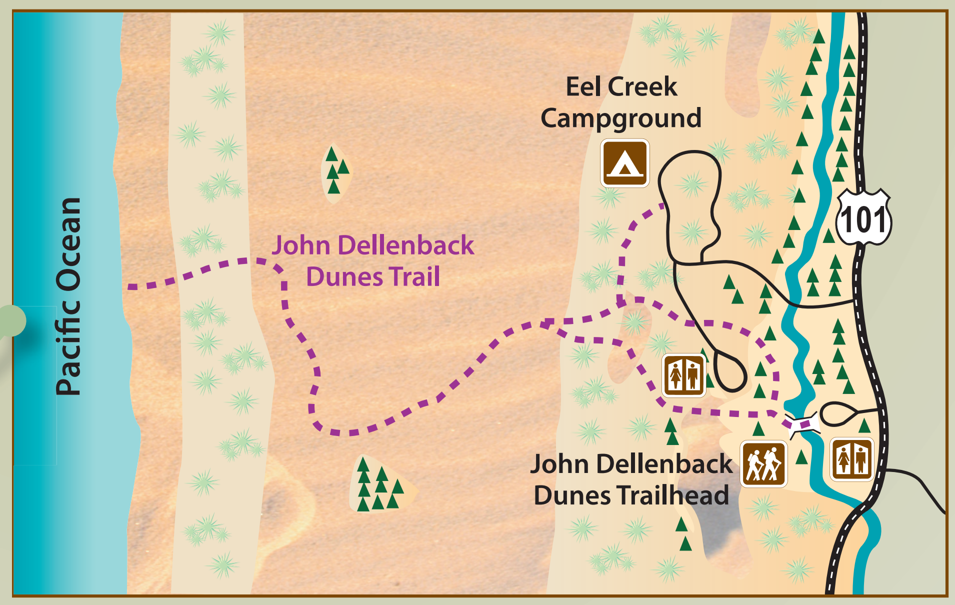
Mallards, Northern Harrier, White-tailed Kite

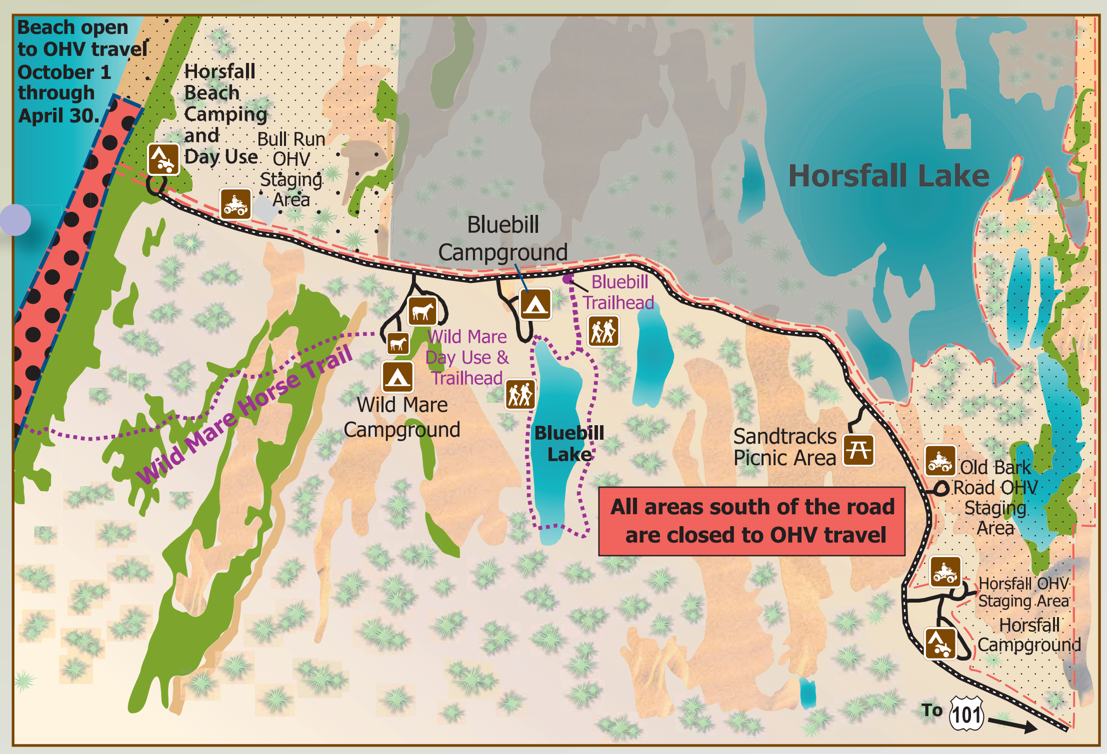












Legend

- Parking Area
- US Forest Service Office
- Visitor Center
- Viewpoint
- Picnic Area
- Restrooms
- Hospital
- City
- Boat Ramp
- Canoeing
- Fishing
- Pier Fishing
- Mountain Biking
- Horse Trail
- Hiking/ Trailhead
- Seasonal Trail
- Trail
- Boardwalk
- Trees/ Shrubs
- Campground
- OHV Campground
- OHV Staging Area
- OHV Closure Area
- OHV Management Area
- USFS Boundary
- Non-USFS Land
- Snowy Plover Restricted Area
- Open Sand
- Vegetation
- Water/ Wet Sand

TSUNAMI EVACUATION ROUTE

In an EMERGENCY, dial 911

During Earthquakes...

If outdoors, STAY OUTDOORS. Avoid buildings, lights and power lines.

After an Earthquake a TSUNAMI is possible

Before and during a Tsunami...

Immediately MOVE INLAND to HIGHER GROUND and stay there. STAY AWAY FROM THE BEACH!

Never go down to the beach to watch a tsunami come in. If you can see the wave you are too close. If the water moves AWAY from the shoreline, move inland to higher ground immediately!

Further information regarding tsunami safety, evacuation, safe relocation and the tsunami ready program is available at www.tsunami.gov. For emergency planning information and how to put together an emergency kit and other preparedness initiatives to be ready for disasters, visit www.ready.gov.

Tour Guides
Under Forest Service Permit

Guided Vehicle Tours
- Sandland Adventures
- Sand Dunes Frontier
- Spinreel Rentals

Exhibit 73

The World – Coos Bay
https://theworldlink.com/news/local/utvs-to-takeover-box-car-hill-this-weekend/article_c3258d6e-e77f-5073-b28c-8d2a657c7186.html

UTVs to 'takeover' Box Car Hill this weekend

NICHOLAS A. JOHNSON - The World
Jun 27, 2019

Riders navigate at the dunes Wednesday at Box Car Hill during the UTV Takeover in North Bend.
Ed Glazar The World

A message scrawled on a sand covered tire Wednesday during the UTV takeover at Boxcar Hill Campground in North Bend. Ed Glazar The World

NORTH BEND — Once again the UTV Takeover has, as its name suggests, taken over Box Car Hill with thousands coming from all over to watch and participate in a weekend full of ATV and UTV events.

While most leave the events to the professionals and just come for a viewing, nearly anyone can participate in the various events from June 26-30 out on Box Car Hill, located on the Transpacific Highway north of the McCullough Bridge. Events run all day and entry to the takeover costs $25 for general admission.

UTV Takeover
A rider speeds up a hill Wednesday out of Box Car Hill campground during the UTV Takeover in North Bend.

A Utility Task Vehicle, also known as a side-by-side, is similar to an all-terrain vehicle but typically larger and uses a steering wheel and pedals rather than handlebars and can carry passengers.

Events include more extreme activities like barrel racing, drag strip racing, and a wheeliefest. However, there are plenty of events throughout the weekend for those who might prefer to just eat food, listen to music and watch the more adventurous types tear around the dunes.

The Sand Outlaw is a helmets-required event where two drivers face off and simultaneously barrel down two equal tracks, the distance of two football fields. The course contains several elevation changes, jumps, crossovers and hurdles. The competition is single elimination, with winners moving on to another round and losers staying back to watch. Like most larger events, the prize for the Sand Outlaws event is $100 and four raffle tickets, with second being $50 and two raffle tickets.

UTV Takeover
An vehicle sits Wednesday among vendor tents during the UTV takeover at Boxcar Hill Campground in North Bend.

Some of the less competitive events only net winners $40 and four raffle tickets or $20 and two raffle tickets. Events like the Blind Bandit adhere to this prize structure. The Blind Bandit event sees blindfolded drivers attempt to navigate through a tight obstacle course, while receiving only verbal instructions from the passenger.

Throughout the takeover, participants and spectators have the opportunity win and purchase raffle tickets. Those entered in the raffle have a chance to win up to $20,000 in prizes from various sponsors and vendors.

Nicholas A. Johnson can be reached at 541-266-6049, or by email at nicholas.johnson@theworldlink.com.

Exhibit 74

From: Dan Shoemaker (FAA)
Sent: Wednesday, January 20, 2016 10:08 AM
To: Jody McCaffree; Robert VanHaastert (FAA)
Cc: Mitch T Swecker (OR Dept Aviation); Jeff CAINES (OR Dept Aviation); Heather Peck (OR Dept Aviation)
Subject: RE: RE - Jordan Cove LNG Export Project airport concerns

Good morning, Ms. McCaffree.

I appreciate your taking the time to express your concerns regarding the potential for plume and flare effects on aircraft operations at Southwest Oregon Regional Airport. However, the FAA obstruction evaluation process is limited to only the physical effect the structure would have on Part 77 airspace surfaces; instrument procedures and routes; air traffic control minimum flight and vectoring altitudes; runway design surfaces; radar, communications, and radio navigational and landing aid signals; and visual landing aids and control tower visibility arcs. While the FAA can make advisory statements about other potential issues, such as exhaust plumes and flares, visual and thermal glare, and thermal and mechanical turbulence, it cannot determine a structure to be a hazard to air navigation based solely upon these factors. These are ultimately land-use issues that must be decided by local governments, based upon the FAA's guidance. The memoranda you cited are just that: advisory in nature, and intended to give land-use decision makers information with which they can rule on proposed structures and facilities.

As a result, the FAA Obstruction Evaluation Group cannot reconsider the previously issued determinations of no hazard to air navigation.

Dan Shoemaker
Airspace Specialist
Seattle Obstruction Evaluation Group
[redacted]

From: Jody McCaffree
Sent: Tuesday, January 19, 2016 4:15 PM
To: 'Dan Shoemaker (FAA)'; 'Robert VanHaastert (FAA)'
Cc: Mitch T Swecker (OR Dept Aviation); Jeff CAINES (OR Dept Aviation); Heather Peck (OR Dept Aviation)
Subject: RE - Jordan Cove LNG Export Project airport concerns

Dear Mr. Shoemaker and Mr. VanHaastert:

On January 7, 2016, the Jordan Cove Energy Project (JCEP) filed FAA form 7460-2 for extensions of the following determinations by the FAA. (See listing below)

I would like to request that the FAA reconsider some of their determinations of "NO HAZARD TO AIR NAVIGATION" in some of these filings.

On January 21, 2015, and September 24, 2015, the FAA released memorandums concerning: "*Technical Guidance and Assessment Tool for Evaluation of Thermal Exhaust Plume Impact on Airport Operations.*" In these memorandums the FAA determined that *thermal exhaust plumes in the vicinity of airports may pose a unique* *hazard to aircraft in critical phases of flight (particularly takeoff, landing and within the pattern) and therefore are incompatible with airport operations*.

The proposed Jordan Cove LNG Export project would be releasing considerable amounts of heat into the atmosphere from their two (2) proposed gas flares, their six (6) proposed South Dunes Power Plant (SDPP) venting stacks and their six (6) proposed LNG liquefaction trains. No one to my knowledge has addressed this issue or the cumulative impacts from Jordan Cove releasing all this high volume of heat into the atmosphere in the vicinity of the Southwest Oregon Regional Airport flight paths. Jordan Cove's July 2013 Thermal Plume Study considered only 5 SDPP venting stacks and did not consider Jordan Cove's proposed gas flares, liquefaction trains or the operation of the facility at full build out.

No single proposed component of the Jordan Cove LNG Export project would be able to exist without the other components, so it is essential that the cumulative impacts of Jordan Cove's proposed structures be considered with respect to potential impacts to the Southwest Oregon Regional Airport.

Jordan Cove is proposing to raise their current static property levels to 46 and 60 feet in height in the vicinity of their proposed LNG terminal facility. The cumulative impact of all their proposed structures could and most likely would cause electrical and/or multipath interference for aircraft which may lead to navigational errors in critical phases of air flight. One accident is all it would take to cause cascading failures at the proposed LNG facility and the potential for a catastrophic accident affecting the entire Coos Bay area.

Going forward, please consider carefully your decisions with respect to the following FAA filings by the proposed Jordan Cove LNG facility. I would like to be notified of any additional decisions made by the FAA on these filings and/or chances for citizen comment.

Citizens have rebuttal comments due on January 26, 2016, under Coos County Land Use file No. HBCU-15-05 for the proposed Jordan Cove LNG facility. Any help I can obtain with determining Jordan Cove's entire *thermal plume hazard* would be appreciated.

The following Jordan Cove proposed structures are currently up for FAA form 7460-2 review and extensions:

Flare at JCEP South Dunes Power Plant Exp 1-24-2016
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=201501157

Flare at JCEP Storage / Liquefaction Exp 1-24-2016
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194344098

Amine Contractor 2-E
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194344077

Amine Contractor 1-W
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194344066

TURG/HRSG Stack 6
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194342174

TURG/HRSG Stack 5
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194340340

TURB/HRSG Stack 4
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194340310

TURB/HRSG Stack 3
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194340287

TURB/HRSG Stack 2
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194340280

TURB/HRSG Stack 1
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194340290

Transmission Line: 13R-Dead-end
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194338098

Transmission Line: 13L-Dead-end
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194338096

Transmission Line: 12-Suspension
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194338092

Transmission Line: 11R-Dead-end
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194338087

Transmission Line: 11L-Dead-end
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194338083

Transmission Line: 10-R-Dead-end
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194338048

Transmission Line: 10-L-Dead-end
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194338047

Transmission Line: 9-R-Dead-end
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194338044

Transmission Line: 9-L-Dead-end
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194338003

Transmission Line: 8 - Suspension
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194338001

Transmission Line: 7 - Suspension
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194338000

Transmission Line: 6 - Suspension
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194337998

Transmission Line: 5 - Suspension
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194337989

Transmission Line: 4 - Suspension
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194337978

Transmission Line: 3 - Suspension
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194337969

Transmission Line: 2-R – Dead-end
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194337956

Transmission Line: 2-L – Dead-end
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194337948

Building: Compressor Shelter Roof 1-N
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194344104

Building: Compressor Shelter Roof - 2
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194344125

Building: Compressor Shelter Roof - 3
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194344128

Building: Compressor Shelter Roof - 4-S
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194344131

The following Jordan Cove structures are not currently up for FAA form 7460-2 review and extension but are essential components of the LNG facility:

LNG Storage Tanks – Two (2) - FAA Notice of Presumed Hazard 7-24-2014
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194337946

LNG Storage Tank – North - FAA Notice of Presumed Hazard 7-24-2014
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=195630983

Amine Tower 2-E - FAA Notice of Presumed Hazard 7-24-2014
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194338105

Amine Tower 1-W – FAA Notice of Presumed Hazard 7-24-2014
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=194338102

LNG Carrier Vessel - Docked – Completed 6-25-2015 with expiration 12-25-2016
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=195631327

LNG Carrier Vessel – Transiting through Bay – Not completed - Work in Process
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=253732721
and
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=249632862

Monopole - Not completed - Work in Process
https://oeaaa.faa.gov/oeaaa/external/searchAction.jsp?action=displayOECase&oeCaseID=273550454

Sincerely,

Jody McCaffree
PO Box 1113
North Bend, OR 97459
[redacted]

Exhibit 75

LEGEND

- Manhole
- Pump Station
- Settling Pond
- Landfill

Leachate Lines

- Existing Leachate Line
- New Leachate Line
- Disconnect Leachate Line

City Water Lines

- Existing City Water Line
- New Water Line
- Disconnect City Water Line

BASIN DETAIL PLAN FROM FILE BY GSI WATER SOLUTIONS, INC., DATED FEBRUARY 28, 2012

North

0 180 360 FT

GRI JORDAN COVE ENERGY PROJECT
FORMER WEYERHAEUSER MILL SITE AND INGRAM YARD
WORK PLAN FOR JOINT PROGRAM REGULATORY CLOSURE

BASIN DETAIL PLAN

JULY 2013 | JOB NO. 4277-S | FIG. 3

RESIDUAL MILL CONTAMINATION FROM FILE BY DEQ (2012)

North

0 400 800 FT

GRI

JORDAN COVE ENERGY PROJECT
FORMER WEYERHAEUSER MILL SITE AND INGRAM YARD
WORK PLAN FOR JOINT PROGRAM REGULATORY CLOSURE

RESIDUAL MILL CONTAMINATION

JULY 2013 | JOB NO. 4277-S | FIG. 4

Exhibit 76

BIODIVERSITY LOSS

Decline of the North American avifauna

Kenneth V. Rosenberg[1,2]*, Adriaan M. Dokter[1], Peter J. Blancher[3], John R. Sauer[4], Adam C. Smith[5], Paul A. Smith[3], Jessica C. Stanton[6], Arvind Panjabi[7], Laura Helft[1], Michael Parr[2], Peter P. Marra[8]†

Species extinctions have defined the global biodiversity crisis, but extinction begins with loss in abundance of individuals that can result in compositional and functional changes of ecosystems. Using multiple and independent monitoring networks, we report population losses across much of the North American avifauna over 48 years, including once-common species and from most biomes. Integration of range-wide population trajectories and size estimates indicates a net loss approaching 3 billion birds, or 29% of 1970 abundance. A continent-wide weather radar network also reveals a similarly steep decline in biomass passage of migrating birds over a recent 10-year period. This loss of bird abundance signals an urgent need to address threats to avert future avifaunal collapse and associated loss of ecosystem integrity, function, and services.

Slowing the loss of biodiversity is one of the defining environmental challenges of the 21st century (*1*–*5*). Habitat loss, climate change, unregulated harvest, and other forms of human-caused mortality (*6*, *7*) have contributed to a thousandfold increase in global extinctions in the Anthropocene compared to the presumed prehuman background rate, with profound effects on ecosystem functioning and services (*8*). The overwhelming focus on species extinctions, however, has underestimated the extent and consequences of biotic change, by ignoring the loss of abundance within still-common species and in aggregate across large species assemblages (*2*, *9*). Declines in abundance can degrade ecosystem integrity, reducing vital ecological, evolutionary, economic, and social services that organisms provide to their environment (*8*, *10*–*15*). Given the current pace of global environmental change, quantifying change in species abundances is essential to assess ecosystem impacts. Evaluating the magnitude of declines requires effective long-term monitoring of population sizes and trends, data that are rarely available for most taxa.

Birds are excellent indicators of environmental health and ecosystem integrity (*16*, *17*), and our ability to monitor many species over vast spatial scales far exceeds that of any other animal group. We evaluated population change for 529 species of birds in the continental United States and Canada (76% of breeding species), drawing from multiple standardized bird-monitoring datasets, some of which provide close to 50 years of population data. We integrated range-wide estimates of population size and 48-year population trajectories, along with their associated uncertainty, to quantify net change in numbers of birds across the avifauna over recent decades (*18*). We also used a network of 143 weather radars (NEXRAD) across the contiguous United States to estimate long-term changes in nocturnal migratory passage of avian biomass through the airspace in spring from 2007 to 2017. The continuous operation and broad coverage of NEXRAD provide an automated and standardized monitoring tool with unrivaled temporal and spatial extent (*19*). Radar measures cumulative passage across all nocturnally migrating species, many of which breed in areas north of the contiguous United States that are poorly monitored by avian surveys. Radar thus expands the area and the proportion of the migratory avifauna that is sampled relative to ground surveys.

Results from long-term surveys, accounting for both increasing and declining species, reveal a net loss in total abundance of 2.9 billion [95% credible interval (CI) = 2.7–3.1 billion] birds across almost all biomes, a reduction of 29% (95% CIs = 27–30%) since 1970 (Fig. 1 and Table 1). Analysis of NEXRAD data indicates a similarly steep decline in nocturnal passage of migratory biomass, a reduction of 13.6 ± 9.1% since 2007 (Fig. 2A). Reduction in biomass passage occurred across the eastern United States (Fig. 2, C and D), where migration is dominated by large numbers of temperate- and boreal-breeding songbirds; we observed no consistent trend in the Central or Pacific flyway regions (Fig. 2, B to D, and table S5). Two completely different and independent monitoring techniques thus signal major population loss across the continental avifauna.

Species exhibiting declines (57%, 303 out of 529 species) on the basis of long-term survey data span diverse ecological and taxonomic groups. Across breeding biomes, grassland birds showed the largest magnitude of total population loss since 1970—more than 700 million breeding individuals across 31 species—and the largest proportional loss (53%); 74% of grassland species are declining. (Fig. 1 and Table 1). All forest biomes experienced large avian loss, with a cumulative reduction of more than 1 billion birds. Wetland birds represent the only biome to show an overall net gain in numbers (13%), led by a 56% increase in waterfowl populations (Fig. 3 and Table 1). Unexpectedly, we also found a large net loss (63%) across 10 introduced species (Fig. 3, D and E, and Table 1).

A total of 419 native migratory species experienced a net loss of 2.5 billion individuals, whereas 100 native resident species showed a small net increase (26 million). Species overwintering in temperate regions experienced the largest net reduction in abundance (1.4 billion), but proportional loss was greatest among species overwintering in coastal regions (42%), southwestern aridlands (42%), and South America (40%) (Table 1 and fig. S1). Shorebirds, most of which migrate long distances to winter along coasts throughout the hemisphere, are experiencing consistent, steep population loss (37%).

More than 90% of the total cumulative loss can be attributed to 12 bird families (Fig. 3A), including sparrows, warblers, blackbirds, and finches. Of 67 bird families surveyed, 38 showed a net loss in total abundance, whereas 29 showed gains (Fig. 3B), indicating recent changes in avifaunal composition (table S2). Although not optimized for species-level analysis, our model indicates that 19 widespread and abundant landbirds (including two introduced species) each experienced population reductions of >50 million birds (data S1). Abundant species also contribute strongly to the migratory passage detected by radar (*19*), and radar-derived trends provide a fully independent estimate of widespread declines of migratory birds.

Our study documents a long-developing but overlooked biodiversity crisis in North America—the cumulative loss of nearly 3 billion birds across the avifauna. Population loss is not restricted to rare and threatened species, but includes many widespread and common species that may be disproportionately influential components of food webs and ecosystem function. Furthermore, losses among habitat generalists and even introduced species indicate that declining species are not replaced by species that fare well in human-altered landscapes. Increases among waterfowl and a few other groups (e.g., raptors recovering after the banning of DDT) are insufficient to offset large losses among abundant species (Fig. 3). Notably, our population loss estimates are conservative because we estimated loss only in breeding populations. The total loss and

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*Corresponding author. Email: kvr2@cornell.edu
†Present address: Department of Biology and McCourt School of Public Policy, Georgetown University, 37th and O Streets NW, Washington, DC 20057, USA.

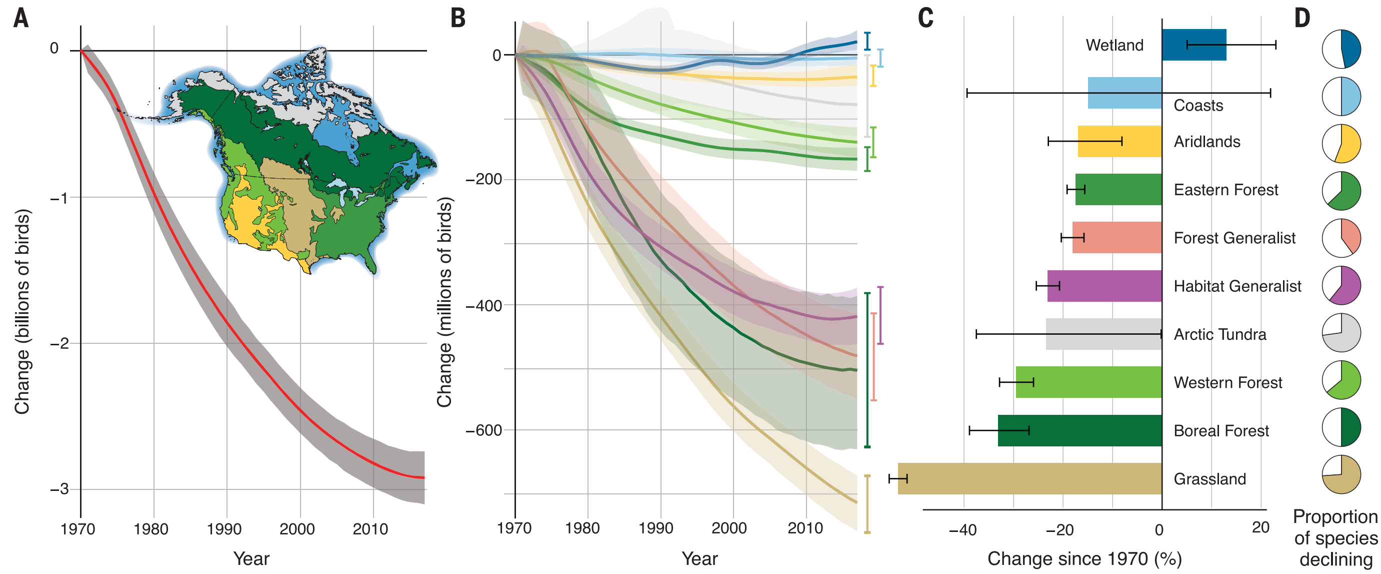

Fig. 1. Net population change in North American birds. (**A**) By integrating population size estimates and trajectories for 529 species (*18*), we show a net loss of 2.9 billion breeding birds across the continental avifauna since 1970. Gray shading represents the 95% credible interval (CI) around total estimated loss. Map shows color-coded breeding biomes based on Bird Conservation Regions and land cover classification (*18*). (**B**) Net loss of abundance occurred across all major breeding biomes except wetlands (see Table 1). (**C**) Proportional net population change relative to 1970, ±95% CI. (**D**) Proportion of species declining in each biome.

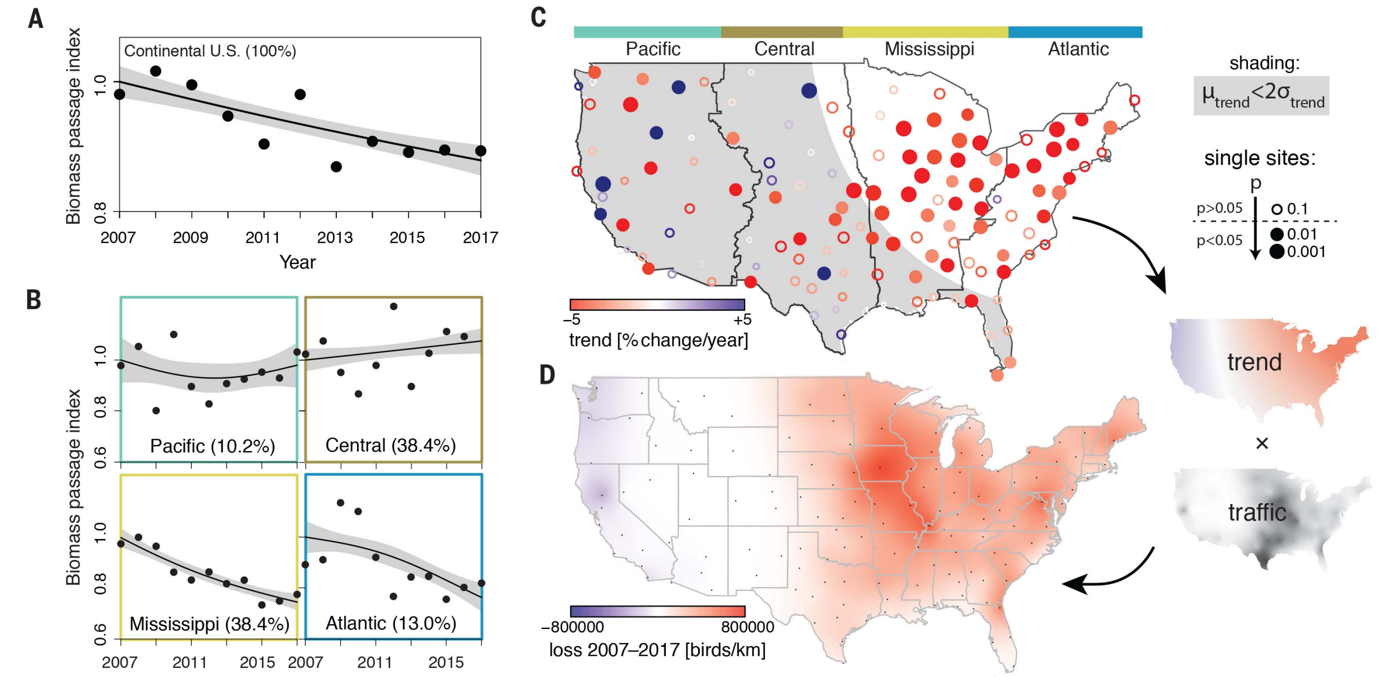

Fig. 2. NEXRAD radar monitoring of nocturnal bird migration across the contiguous United States. (**A**) Annual change in biomass passage for the full continental United States (black) and (**B**) the Pacific (green), Central (brown), Mississippi (yellow), and Atlantic (blue) flyways [borders indicated in (C)], with percentage of total biomass passage (migration traffic) for each flyway indicated; declines are significant only for the full United States and the Mississippi and Atlantic flyways (tables S3 to S5). (**C**) Single-site trends in seasonal biomass passage at 143 NEXRAD stations in spring (1 March to 1 July), estimated for the period 2007–2017. Darker red colors indicate higher declines and loss of biomass passage, whereas blue colors indicate biomass increase. Circle size indicates trend significance, with closed circles being significant at a 95% confidence level. Only areas outside gray shading have a spatially consistent trend signal separated from background variability. (**D**) Ten-year cumulative loss in biomass passage, estimated as the product of a spatially explicit (generalized additive model) trend, times the surface of average cumulative spring biomass passage.

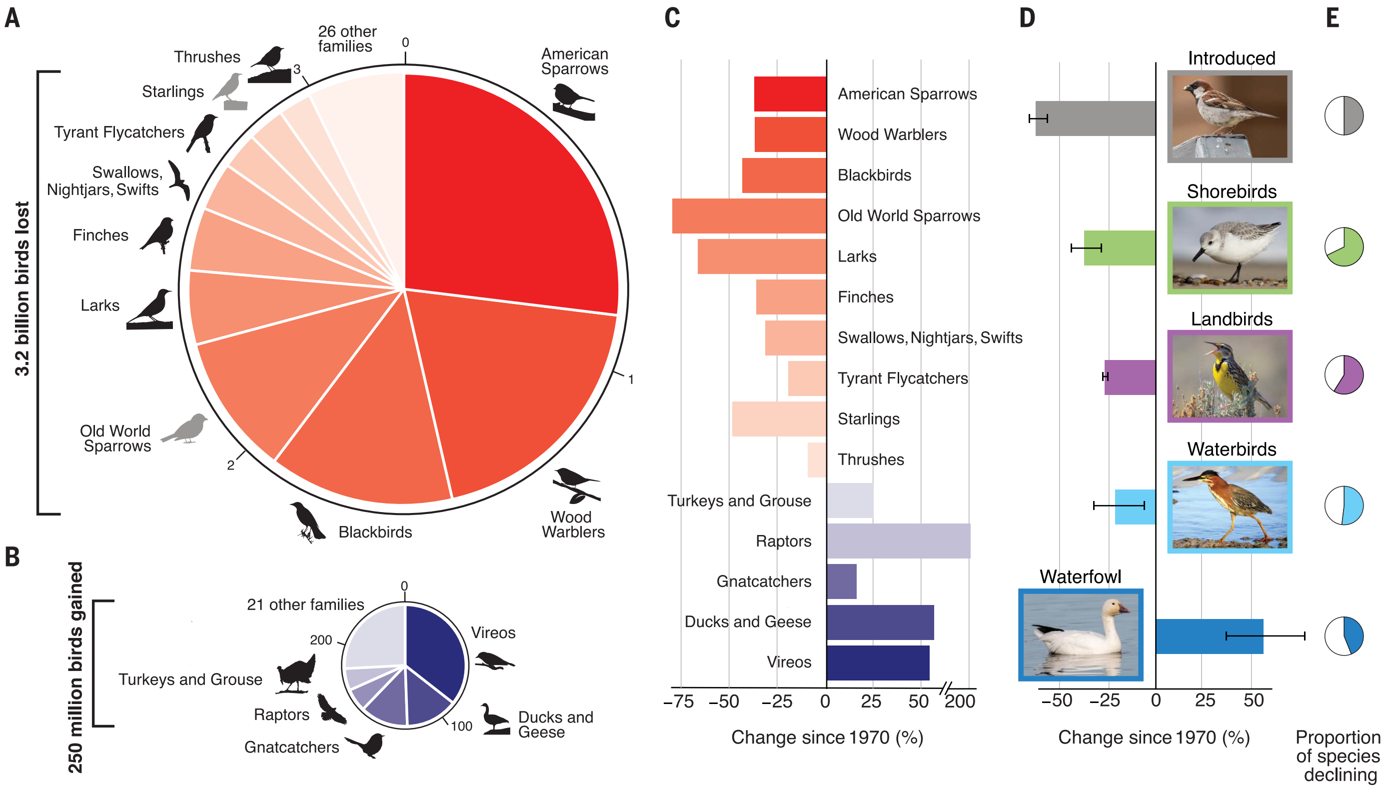

Fig. 3. Gains and losses across the North American avifauna over the past half-century. (**A**) Bird families were categorized as having a net loss (red) or gain (blue). Total loss of 3.2 billion birds occurred across 38 families; each family with losses greater than 50 million individuals is shown as a proportion of total loss, including two introduced families (gray). Swallows, nightjars, and swifts together show loss within the aerial insectivore guild. (**B**) Twenty-nine families show a total gain of 250 million individual birds; the five families with gains greater than 15 million individuals are shown as a proportion of total gain. Four families of raptors are shown as a single group. Note that combining total gain and total loss yields a net loss of 2.9 billion birds across the entire avifauna. (**C**) For each individually represented family in (B) and (C), proportional population change within that family is shown. See table S2 for statistics on each individual family. (**D**) Percentage population change among introduced and each of four management groups (18). A representative species from each group is shown (top to bottom, house sparrow, *Passer domesticus*; sanderling, *Calidris alba*; western meadowlark, *Sturnella neglecta*; green heron, *Butorides virescens*; and snow goose, *Anser caerulescens*). (**E**) Proportion of species with declining trends.

impact on communities and ecosystems could be even higher outside the breeding season if we consider the amplifying effect of "missing" reproductive output from these lost breeders.

Extinction of the passenger pigeon (*Ectopistes migratorius*), once likely the most numerous bird on the planet, provides a poignant reminder that even abundant species can go extinct rapidly. Systematic monitoring and attention paid to population declines could have alerted society to its pending extinction (*20*). Today, monitoring data suggest that avian declines will likely continue without targeted conservation action, triggering additional endangered species listings at tremendous financial and social cost. Moreover, because birds provide numerous benefits to ecosystems (e.g., seed dispersal, pollination, pest control) and economies [47 million people spend U.S.$9.3 billion per year through bird-related activities in the United States (*21*)], their population reductions and possible extinctions will have severe direct and indirect consequences (*10*, *22*). Population declines can be reversed, as evidenced by the exceptional recovery of waterfowl populations under adaptive harvest management (*23*) and the associated allocation of billions of dollars devoted to wetland protection and restoration, providing a model for proactive conservation in other widespread native habitats such as grasslands.

Steep declines in North American bird populations parallel patterns of avian declines emerging globally (*14*, *15*, *22*, *24*). In particular, depletion of native grassland bird populations in North America, driven by habitat loss and more toxic pesticide use in both breeding and wintering areas (*25*), mirrors loss of farmland birds throughout Europe and elsewhere (*15*). Even declines among introduced species match similar declines within these same species' native ranges (*26*). Agricultural intensification and urbanization have been similarly linked to declines in insect diversity and biomass (*27*), with cascading impacts on birds and other consumers (*24*, *28*, *29*). Given that birds are one of the best monitored animal groups, birds may also foreshadow a much larger problem, indicating similar or greater losses in other taxonomic groups (*28*, *30*).

Pervasiveness of avian loss across biomes and bird families suggests multiple and interacting threats. Isolating spatiotemporal limiting factors for individual species and populations will require additional study, however, because migratory species with complex life histories are in contact with many threats throughout their annual cycles. A focus on breeding season biology hampers our ability to understand how seasonal interactions drive population change (*31*), although recent continent-wide analyses affirm the importance of events during the nonbreeding season (*19*, *32*). Targeted research to identify limiting factors must be coupled with effective policies and societal change that emphasize reducing threats to breeding and nonbreeding habitats and minimizing avoidable anthropogenic mortality year-round. Endangered species legislation and international treaties, such as the 1916 Migratory Bird Treaty between Canada and the United States, have prevented extinctions

Table 1. Net change in abundance across the North American avifauna, 1970–2017. Species are grouped into native and introduced species, management groups (landbirds, shorebirds, waterbirds, waterfowl), major breeding biomes, and nonbreeding biomes [see data S1 in (*18*) for assignments and definitions of groups and biomes]. Net change in abundance is expressed in millions of breeding individuals, with upper and lower bounds of each 95% credible interval (CI) shown. Percentage of species in each group with negative trend trajectories is also noted. Values in bold indicate declines and loss; those in italics indicate gains.

Species group	No. of species	Net abundance change (millions) and 95% CIs			Percent change and 95% CIs			Proportion species in decline
		Change	LC95	UC95	Change	LC95	UC95	
Species summary								
All N. Am. species	529	**–2,911.9**	–3,097.5	–2,732.9	**–28.8%**	–30.2%	–27.3%	57.3%
All native species	519	**–2,521.0**	–2,698.5	–2,347.6	**–26.5%**	–28.0%	–24.9%	57.4%
Introduced species	10	**–391.6**	–442.3	–336.6	**–62.9%**	–66.5%	–56.4%	50.0%
Native migratory species	419	**–2,547.7**	–2,723.7	–2,374.5	**–28.3%**	–29.8%	–26.7%	58.2%
Native resident species	100	*26.3*	7.3	46.9	*5.3%*	1.4%	9.6%	54.0%
Landbirds	357	**–2,516.5**	–2,692.2	–2,346.0	**–27.1%**	–28.6%	–25.5%	58.8%
Shorebirds	44	**–17.1**	–21.8	–12.6	**–37.4%**	–45.0%	–28.8%	68.2%
Waterbirds	77	**–22.5**	–37.8	–6.3	**–21.5%**	–33.1%	–6.2%	51.9%
Waterfowl	41	*34.8*	24.5	48.3	*56.0%*	37.9%	79.4%	43.9%
Aerial insectivores	26	**–156.8**	–183.8	–127.0	**–31.8%**	–36.4%	–26.1%	73.1%
Breeding biome								
Grassland	31	**–717.5**	–763.9	–673.3	**–53.3%**	–55.1%	–51.5%	74.2%
Boreal forest	34	**–500.7**	–627.1	–381.0	**–33.1%**	–38.9%	–26.9%	50.0%
Forest generalist	40	**–482.2**	–552.5	–413.4	**–18.1%**	–20.4%	–15.8%	40.0%
Habitat generalist	38	**–417.3**	–462.1	–371.3	**–23.1%**	–25.4%	–20.7%	60.5%
Eastern forest	63	**–166.7**	–185.8	–147.7	**–17.4%**	–19.2%	–15.6%	63.5%
Western forest	67	**–139.7**	–163.8	–116.1	**–29.5%**	–32.8%	–26.0%	64.2%
Arctic tundra	51	**–79.9**	–131.2	–0.7	**–23.4%**	–37.5%	–0.2%	56.5%
Aridlands	62	**–35.6**	–49.7	–17.0	**–17.0%**	–23.0%	–8.1%	56.5%
Coasts	38	–6.1	–18.9	8.5	–15.0%	–39.4%	21.9%	50.0%
Wetlands	95	*20.6*	8.3	35.3	*13.0%*	5.1%	23.0%	47.4%
Nonbreeding biome								
Temperate N. America	192	**–1,413.0**	–1,521.5	–1,292.3	**–27.4%**	–29.3%	–25.3%	55.2%
South America	41	**–537.4**	–651.1	–432.6	**–40.1%**	–45.2%	–34.6%	75.6%
Southwestern aridlands	50	**–238.1**	–261.2	–215.6	**–41.9%**	–44.5%	–39.2%	74.0%
Mexico–Central America	76	**–155.3**	–187.8	–122.0	**–15.5%**	–18.3%	–12.6%	52.6%
Widespread neotropical	22	**–126.0**	–171.2	–86.1	**–26.8%**	–33.4%	–19.3%	45.5%
Widespread	60	–31.6	–63.1	1.6	–3.7%	–7.4%	0.2%	43.3%
Marine	26	**–16.3**	–29.7	–1.2	**–30.8%**	–49.1%	–2.5%	61.5%
Coastal	44	**–11.0**	–14.9	–6.7	**–42.0%**	–51.8%	–26.7%	68.2%
Caribbean	8	–6.0	1.4	–15.7	12.1%	–2.8%	31.7%	25.0%

and promoted recovery of once-depleted bird species. History shows that conservation action and legislation work. Our results signal an urgent need to address the ongoing threats of habitat loss, agricultural intensification, coastal disturbance, and direct anthropogenic mortality, all exacerbated by climate change, to avert continued biodiversity loss and potential collapse of the continental avifauna.

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SUPPLEMENTARY MATERIALS

science.sciencemag.org/content/366/6461/120/suppl/DC1
Materials and Methods
Figs. S1 to S7
Tables S1 to S5
Databases S1 and S2
References (*36–101*)

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Science

Decline of the North American avifauna

Kenneth V. Rosenberg, Adriaan M. Dokter, Peter J. Blancher, John R. Sauer, Adam C. Smith, Paul A. Smith, Jessica C. Stanton, Arvind Panjabi, Laura Helft, Michael Parr and Peter P. Marra

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Staggering decline of bird populations

Because birds are conspicuous and easy to identify and count, reliable records of their occurrence have been gathered over many decades in many parts of the world. Drawing on such data for North America, Rosenberg *et al.* report wide-spread population declines of birds over the past half-century, resulting in the cumulative loss of billions of breeding individuals across a wide range of species and habitats. They show that declines are not restricted to rare and threatened species––those once considered common and wide-spread are also diminished. These results have major implications for ecosystem integrity, the conservation of wildlife more broadly, and policies associated with the protection of birds and native ecosystems on which they depend.

Science, this issue p. 120

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Exhibit 77

https://www.lnglawblog.com/2019/10/phmsa-proposes-lng-transportation-by-rail-rule/

PHMSA Proposes LNG Transportation by Rail Rule

Posted on Oct 23, 2019

The U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration ("PHMSA"), in coordination with the Federal Railroad Administration ("FRA"), has published a notice of proposed rulemaking ("NPRM") to authorize the transportation of LNG by rail in DOT-113 specification tank cars. According to the press release, currently, LNG may only be transported via rail in a portable tank with an approval from FRA. However, the DOT-113 specification tank car is specifically designed for the transportation of refrigerated liquefied gases, and current Hazardous Materials Regulations authorize the DOT-113 specification tank car for transportation of other flammable cryogenic liquids. Therefore, this design specification may be similarly suitable for the transport of LNG. "The NPRM is a result of President Trump's April 2019 Executive Order recognizing the leading role the U.S. plays in producing and supplying LNG and the need to continue to transport this energy resource in a safe and efficient way."

Exhibit 78

HEGGIES

REPORT 40-1530-R1

Revision 1

PNG LNG Project
LNG Facilities
Environmental Noise Impact Assessment

PREPARED FOR

Coffey Natural Systems
126 Trenerry Crescent, Abbotsford, VIC 3067

15 JANUARY 2009

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PNG LNG Project

LNG Facilities

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7 NOISE MODELLING METHOD

7.1 Introduction

Noise modelling of construction activities and operations of the LNG facility was completed using the CONCAWE (Conservation of Clean Air and Water Europe) noise prediction method incorporated in the 'SoundPLAN' noise modelling program.

The CONCAWE method is a research paper especially designed and originally developed for the requirements of large facilities, specifically petrochemical complexes, in Europe. It was published in 1981 under the title, *The propagation of noise from petroleum and petrochemical complexes to neighbouring communities.* This method was selected due to the capability of modelling meteorological effects on noise propagation over large distances.

The SoundPLAN noise modelling program uses the following information to predict noise levels at nearby receivers:

- Three-dimensional digital terrain map of site and surrounding area.
- Frequency-based sound power level noise data for plant and equipment operating at the site.
- Intervening ground cover.
- Shielding by barriers, intervening buildings or topography.
- Atmospheric conditions.

7.2 Construction Noise

Construction activities at the LNG Facilities will consist of two primary components: the LNG Jetty/MOF and LNG Plant and, associated utilities, offsites and accommodation facilities.

Construction will include the following stages:

- Site preparation and civil works (marine facilities).
- Construction of the earth causeway and Materials Offloading Facility.
- Site preparation and civil works (LNG Plant).
- Construction of the LNG processing facilities.
- Construction of LNG Plant and LNG Offsites.
- Construction of the earth causeway and LNG Jetty.
- Commissioning.

It is anticipated that this construction of the LNG Facilities will take approximately four years.

7.2.1 Site Preparation and Civil Works

Site preparation includes significant noise-producing activities such as:

- Vegetation clearance and timber removal using equipment such as chainsaws and bulldozers.
- Topsoil removal using equipment such as bulldozers and scrapers.
- Earthworks using equipment such as front-end loaders, backhoes, graders, rollers, dump trucks and water carts.

- Construction of the earth causeway and Materials Offloading Facility using equipment such as excavators, bulldozers, dump trucks, graders, rollers, and concrete trucks. Sheet piling is required for the final section of the causeway and the dock area.

Civil works will typically include significant noise producing activities such as;

- Installation and operation of concrete and asphalt batch plants.
- Upgrade of the existing local road running from Port Moresby to the LNG Facilities, using equipment such as front-end loaders, backhoes, graders, rollers, dump trucks and water carts. This work will be of short duration and generally occur only during the daytime. It is difficult to comprehensively predict noise from such activities; however, due to the short duration of works and the limited amount of equipment required for this portion of the project, it is unlikely that unacceptable impacts would occur.
- Installation of foundation structures and paved areas within the LNG Facilities using pile drivers, heavy rollers, dump trucks, concrete trucks, generators and steel reinforcement fabrication hand tools such as grinders and welders.
- Installation of on-site roads using equipment such as rollers, dump trucks and asphalt laying equipment.

During the course of construction many of these activities will occur simultaneously and at varying levels of intensity. It is difficult therefore, to accurately predict construction noise emissions throughout the entire construction period. In order to facilitate the noise assessment a number of typical 'worst case' scenarios have been developed.

The predicted noise level in the model is based on an assumption that all equipment is operating simultaneously and at full load. Construction activities using a fleet of mobile equipment tend to have an intermittent nature and reduced equipment duty cycles which lead to typical overall site noise emissions being approximately 3 to 8 dBA below that predicted. A conservative 'de-rating' factor of 3 dBA has been applied to model-predicted noise levels shown in **Table 17**.

A site preparation scenario assumes the activities of topsoil removal and earthworks with the equipment shown in **Table 11** operating simultaneously.

Table 11 Site Preparation Scenario – Equipment List

Equipment	Sound Power Level dBA re: 10^{-12} W	Number of items	Approximate location
Chainsaws	114	1	LNG Facilities area
Bulldozer small	114	1	LNG Facilities area
Bulldozer large	116	1	LNG Facilities area
Scraper	113	1	LNG Facilities area
Grader	110	1	LNG Facilities area
Front-end loader / Backhoe	108	2	LNG Facilities area
Roller	106	1	LNG Facilities area
Dump truck	115	3	LNG Facilities area
Water cart	100	1	LNG Facilities area
General 4WD vehicles	80	3	LNG Facilities area
Dump trucks	115	2	Materials Offloading Facility
Excavator large	110	2	Materials Offloading Facility
Bulldozer small	114	1	Materials Offloading Facility
roller	112	1	Materials Offloading Facility
Sheet pile driver	122	1	Materials Offloading Facility
General 4WD vehicles	80	2	Materials Offloading Facility

The civil works scenario assumes that the equipment shown in **Table 12** will be operating simultaneously.

Table 12 Civil Works Scenario – Equipment List

Equipment	Sound Power Level dBA re: 10^{-12} W	Number of items	Approximate location
Pile driver	122	1	LNG storage tank area
Roller	106	2	LNG Facilities area
Concrete batch plant	111	1	LNG Facilities area
Asphalt batch plant	111	1	LNG Facilities area
Concrete mixer truck	110	3	LNG Facilities area
Concrete pump and vibrator	112	2	LNG Facilities area
Grinders	111	3	LNG Facilities area
Generator and welder	105	3	LNG Facilities area
General 4WD vehicles	80	5	LNG Facilities area

7.2.2 Construction of the LNG Processing Facilities, Plant Utilities and Offsites

Construction of the LNG processing facilities and utilities will include noise-producing activities such as:

- Receipt and transportation of large plant items from Materials Offloading Facility to the LNG Facilities site using equipment such as tugs and barges, offloading crawler cranes and heavy transport equipment.

- Onsite steel fabrication and pipe erection using equipment such as tower cranes, grinders, welders, generators, air compressors and tools.
- Erection and assembly of plant items using equipment such as tower cranes, forklifts, gensets, air compressors and tools.
- Construction of the permanent accommodation village.
- Construction of the trestle construction LNG Jetty which would typically require equipment such as pile driving and crawler cranes. Initial piling, using a modified crane, will occur from the earthen causeway then move to a jack-up barge.

The LNG Facilities construction scenario assumes activities including the Material Offloading Facility equipment receipt, on-site steel fabrication, plant assembly and erection, together with village construction, occurs with the equipment shown in **Table 13** operating simultaneously.

Table 13 Construction of the LNG Facilities and LNG Jetty Scenario – Equipment List

Equipment	Sound Power Level dBA re: 10^{-12} W	Number of items	Approximate location
Crawler crane	111	1	MOF
Heavy transport	105	1	MOF
Tower crane	110	1	LNG Facilities area
Welder and generator	105	3	LNG Facilities area
Grinder	110	3	LNG Facilities area
Air compressor	106	3	LNG Facilities area
Forklift	95	2	LNG Facilities area
Hammering	107	10	Accommodation village
Flat bed truck	114	2	LNG Facilities area
General 4WD vehicles	80	5	LNG Facilities area
Piling from barge	118	1	LNG Jetty
Crawler crane from barge	113	1	LNG Jetty

7.3 Operational Noise

LNG Facilities operations comprise a large number of processes, activities and equipment which produce noise. Significant noise sources are located within the LNG processing and utilities areas, the LNG Jetty and harbour area and the flare area.

The operational duty cycles of each item of equipment are wide-ranging and difficult to approximate at this early stage. Accordingly, a 'typical' worst-case approach has been adopted. Scenarios of significant noise-producing operations at each of the relevant areas have been modelled.

7.3.1 LNG Processing and Utilities

Noise modelling of the LNG processing operations was undertaken by engineering and construction services company KBR, in Houston, Texas. KBR have extensive experience in the design of LNG facilities and have taken noise measurements of similar existing facilities.

Their noise model incorporates a general two-train layout with sound power level information obtained from a combination of measured levels from similar facilities, manufacturer supplied data and contract specification OH&S performance requirements.

The following input assumptions have been provided by KBR;

- Class D Acoustic insulation for compressor suction and discharge piping consists of a porous layer 50 mm thick with 0.8 mm thick aluminized steel jacketing (7 kg/m^2) and a second porous layer 50 mm thick with 1.3 mm aluminized steel jacketing (11.3 kg/m^2).
- No in-line silencers for compressor suction or discharge lines.
- 85 dBA @ 1m for all enclosures.
- 85 dBA @ 1m for all ducting and intake silencers.
- 85 dBA @ 3m from top of gas turbine exhaust stack.
- 90 dBA sound power limit per fan for air coolers.
- 80 dBA @ 1m for all other rotating equipment and control valves.
- Typical LNG Plant buildings included for shielding.

The breakdown of total sound power level data assumed in the noise model is included in **Table 14**.

Table 14 LNG Processing and Utilities

Plant items	Sound Power Level dBA ref. 10^{-12} W
LNG Train	124
Generator	116

Figure 8 Example of LNG processing facility

7.3.2 Shipping

It is estimated that LNG tankers will make 95 port calls per annum, while the condensate carriers will make 17 port calls per annum. After arrival at the Gulf of Papua, tankers will lay at anchor approximately 2 km offshore. When entering the LNG Port they will be under the control of the harbour pilot and assisted by tugs as they traverse the channel to the LNG Jetty.

LNG loading will take approximately 8 to 10 hours, during which only minimal noise-emitting equipment will be operating, such as pumps and tanker auxiliary power generators.

For the purposes of predicting noise emissions from shipping operations, a maximum activity case was assumed. The scenario includes a single LNG tanker under way shortly after departing the LNG jetty assisted by up to four tugs. A further vessel docked at the condensate berth was also included.

The breakdown of total Sound Power Level data assumed in the noise model is included in **Table 15**.

Table 15 Shipping Significant Noise Sources

Equipment	Number	Sound Power Level dBA ref. 10^{-12} W
LNG tanker (under way)	1	111
Tugs (under load)	4	111
Condensate tanker (auxiliary power only)	1	101
Condensate pumping	1	105

Figure 9 Typical LNG Tanker and Tugs

7.3.3 Flare

During normal LNG Plant operations it is necessary to occasionally and intermittently burn unwanted gas from a flare tower.

The gas flare tower will be located approximately 500 metres north of the LNG Plant and will be up to 100 metres high.

ExxonMobil has an equipment performance specification that requires vendor-supplied elevated gas flare equipment to have a maximum sound power level presented in **Table 16**.

Table 16 Elevated Flare Maximum Sound Power Level – dB ref. 10^{-12} W

Equipment	Octave Band Center Frequencies, Hz								
	63	125	250	500	1000	2000	4000	8000	Total
Elevated Flares	119	118	115	110	109	109	111	112	124 dB

Figure 10 A Typical Gas Flare

8 MODEL PREDICTIONS AND ASSESSMENT

8.1 Construction Noise Assessment

Construction noise levels have been predicted for the three scenarios detailed in **Section 7.2**. Each scenario represents a 'typical' maximum activity with all equipment operating. The predicted L_{Aeq} noise level has been predicted for non-adverse and adverse meteorological enhancement conditions.

Table 17 Predicted Construction Noise Levels in dBA ref. 20 µPa

Location of most affected receptor	Noise limit		Site preparation		Civil works		Construction of LNG facilities & utilities & LNG Jetty	
	Day	**Night**	**Non adverse**	**Adverse**	**Non adverse**	**Adverse**	**Non adverse**	**Adverse**
Papa	50	40	27	33	26	32	21	27
Metago Bible College	50	40	26	33	24	30	21	27
Boera	50	40	19	25	12	18	16	21
Lea Lea	50	40	18	24	11	16	13	18

The predicted construction noise levels will comply with the project's noise criteria under all conditions during the day and night periods. Furthermore, construction noise is likely to be inaudible against the existing ambient background noise level, particularly during the night period.

Noise contours for neutral propagation conditions are shown for the site preparation scenario in **Figure 11**, for the civil works scenario in **Figure 12** and for the construction of LNG Facilities in **Figure 13**.

8.2 Blasting

It is not anticipated that blasting will be required as part of the construction of the onshore LNG Facilities.

Explosive charges may be required to break up larger coral reef structures in the LNG Jetty and navigational channel. Sufficient details of the locations and size of blasts required are not available to predict airblast and vibration levels, however, as blasts will be underwater it is anticipated that the requirements will be satisfied and accordingly blasting will be unlikely to cause significant impacts to receptor locations.

Notwithstanding the above, a blasting management plan for both the terrestrial and marine environments will be established with consideration of the ANZECC guideline and AS 2187.2-1993 as detailed in **Section 6.5** and in consultation with local communities.

Figure 11 Predicted Site Preparation Scenario Noise Contours

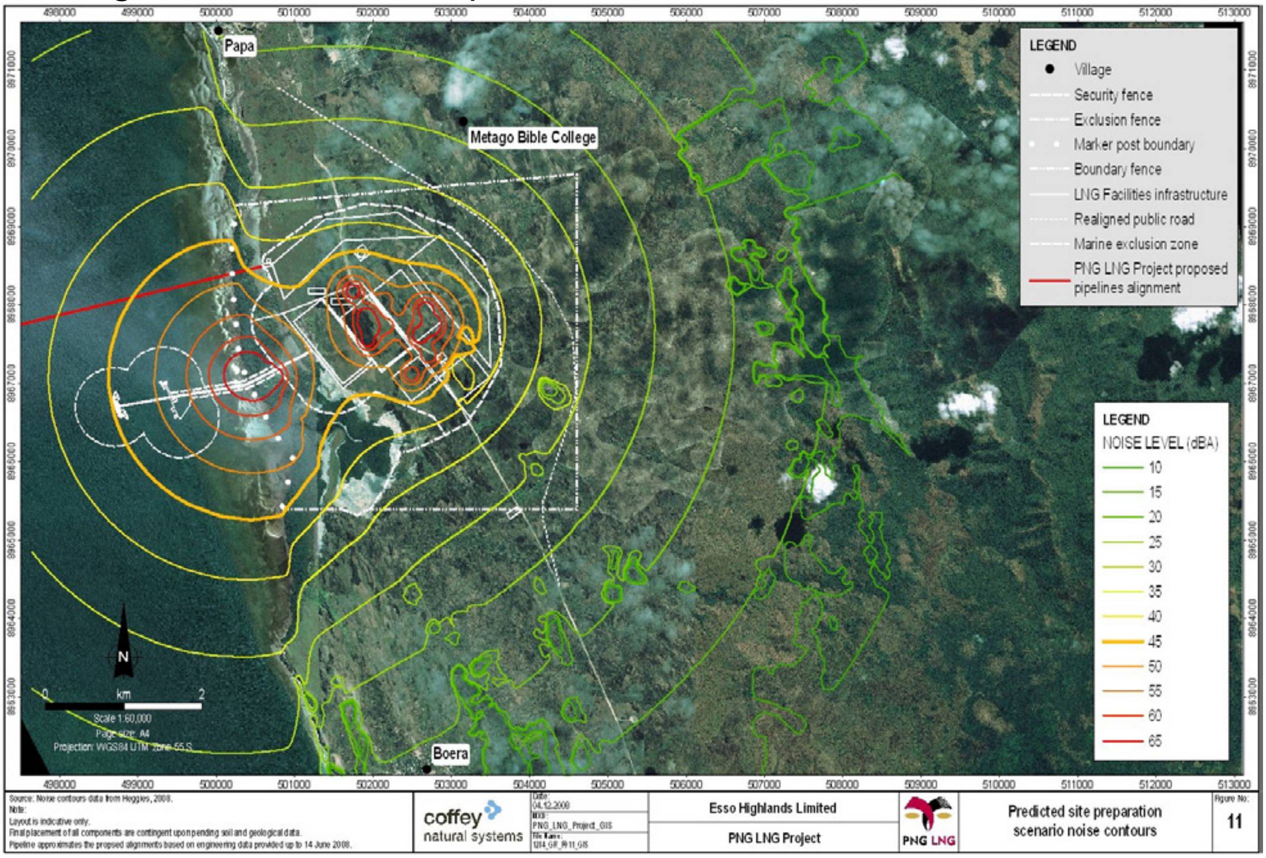


Figure 12 Predicted Civil Works Scenario Noise Contours

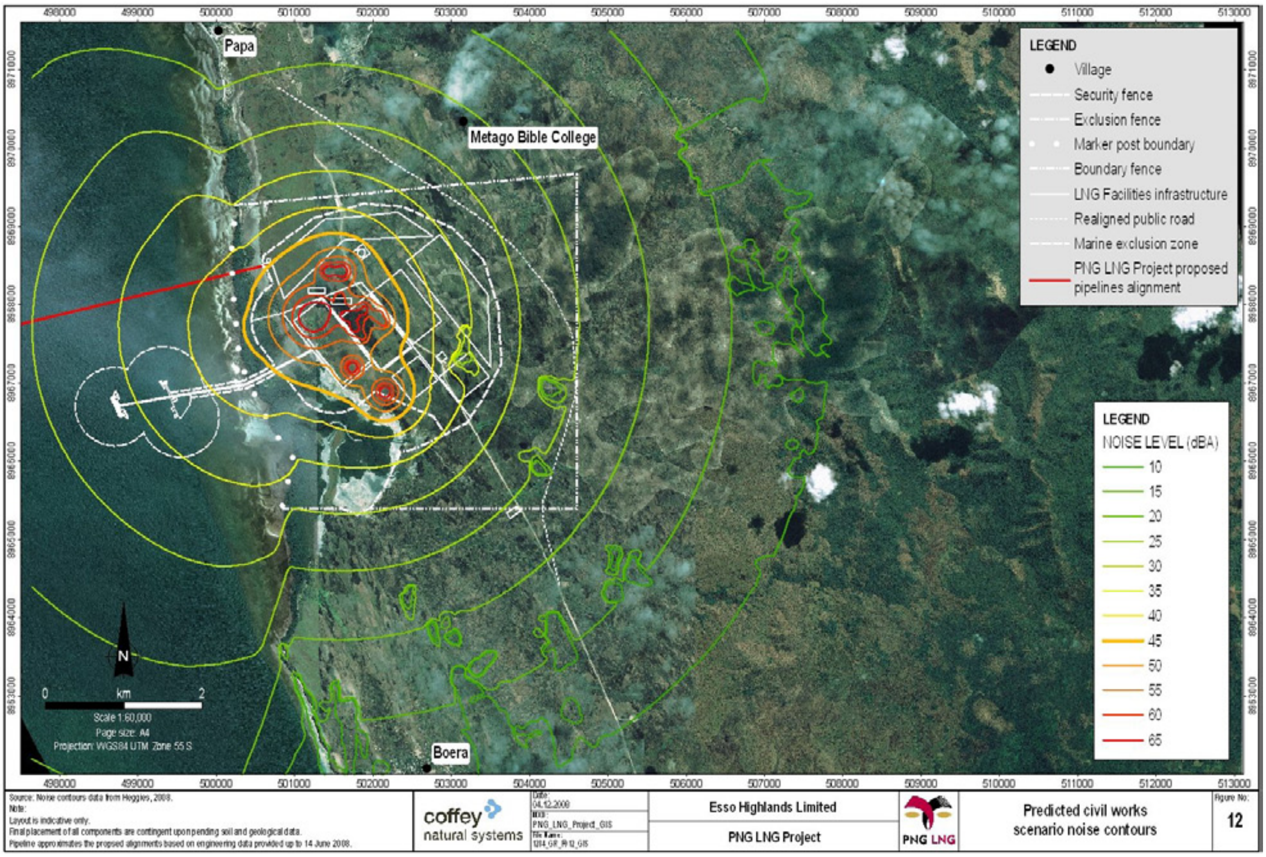
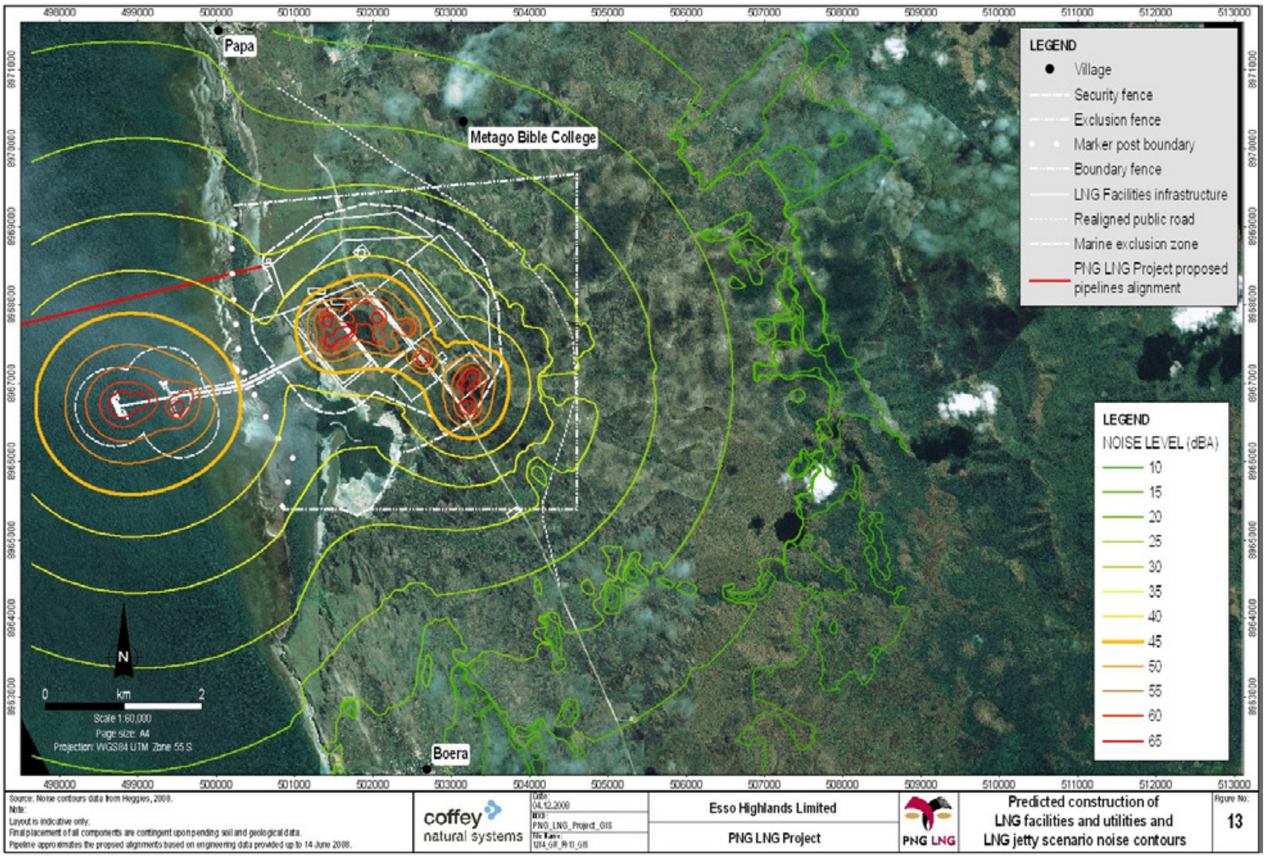


Figure 13 Predicted Construction of LNG Facilities Scenario Noise Contours



8.3 Operational Noise Assessment

Construction noise levels have been predicted for the three scenarios detailed in **Section 7.3**. Each scenario represents a 'typical' maximum activity with all equipment operating. The predicted LAeq noise level has been predicted for non-adverse and adverse meteorological enhancement conditions.

Table 18 Operational Noise Levels in dBA ref. 20 µPa

Location of Most Affected Receptor	Noise limit		LNG Processing and Utilities		Shipping		Flare		Cumulative	
	Day	Night	Neutral	Adverse	Neutral	Adverse	Neutral	Adverse	Neutral	Adverse
Papa	50	40	29	33	28	34	35	35	37	39
Metago Bible College	50	40	29	33	18	23	33	34	35	37
Boera	50	40	25	30	21	25	10	13	27	31
Lea Lea	50	40	~25	~30	22	26	11	13	27	32

8.3.1 LNG Processing and Utilities

Predicted noise levels shown in **Table 18** indicate that they will be compliant during all periods of the day under all meteorological conditions. Noise contours for neutral propagation conditions are shown in **Figure 15**.

A typical received frequency spectrum is shown in **Figure 14** and illustrates that the noise at receptor locations is unlikely to have dominant low frequencies and when plotted on a Balanced Noise Criterion Curve (NCB Curve) appears to achieve a good spectral balance. Whilst a number of individual noise sources within the LNG Plant are tonal in character the large number of total noise sources will result in overall received noise being more broadband in nature.

It is anticipated that noise character that would be considered more prominent or annoying such as tonality or low frequency content are unlikely to be dominant and accordingly the predicted receptor's noise levels presented in **Table 18** have not been adjusted.

Figure 14 Typical received frequency spectrum

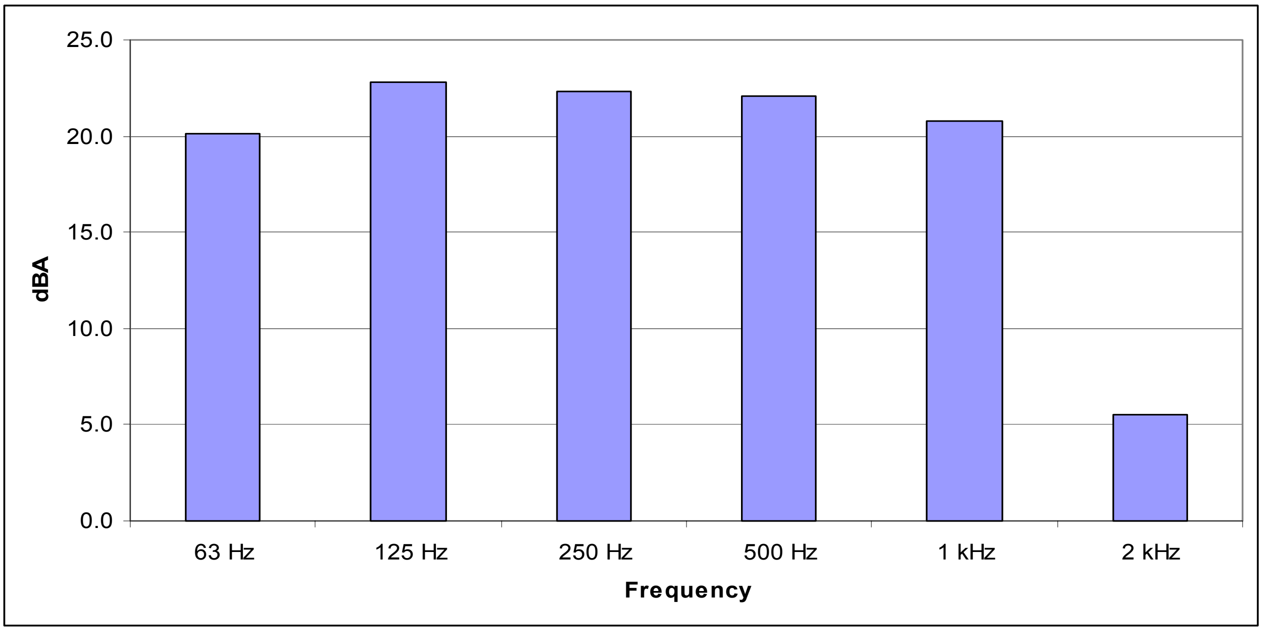
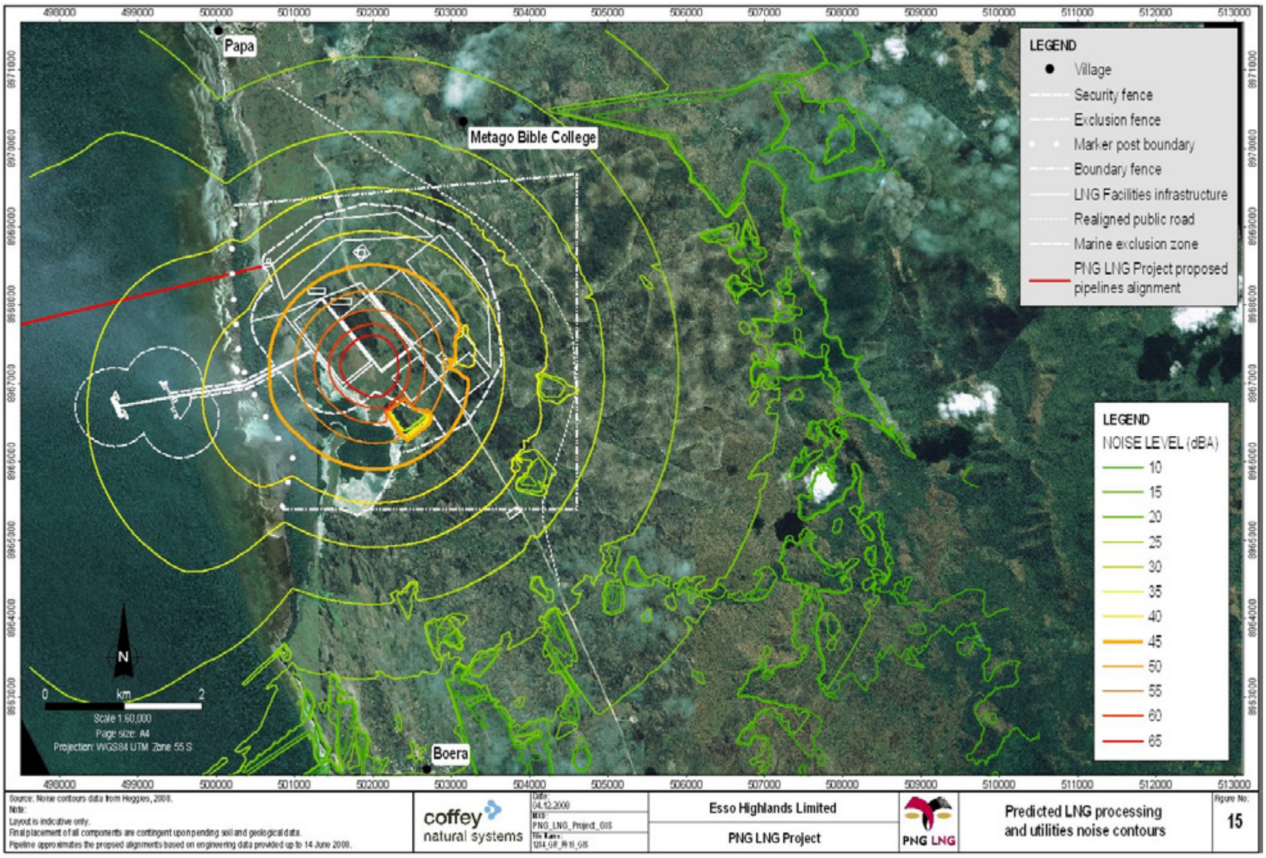


Figure 15 Predicted LNG Processing and Utilities Noise Contours

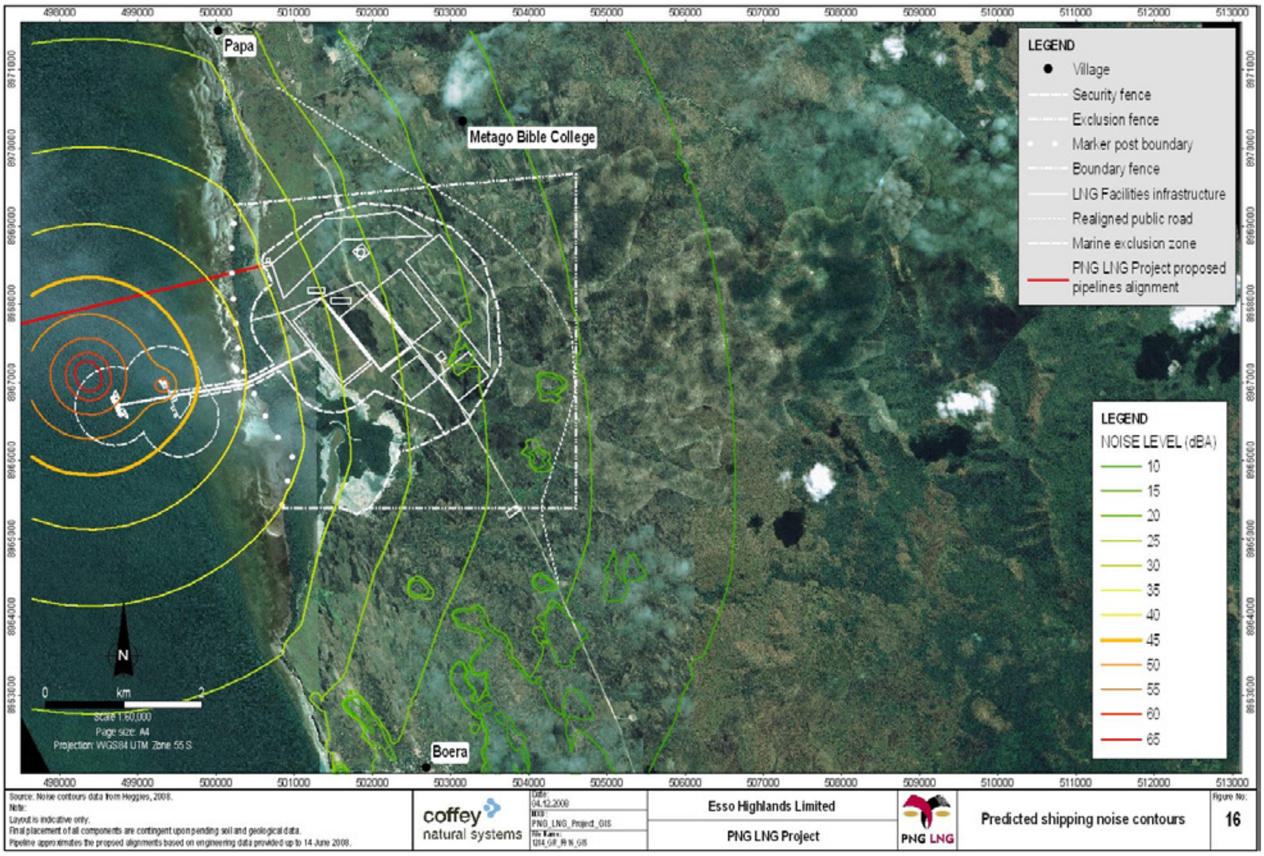


8.3.2 Shipping

Predicted noise levels shown in **Table 18** indicate that they will be compliant during all periods of the day under all meteorological conditions. Noise contours for neutral propagation conditions are shown in **Figure 16**.

It should be noted that the most significant noise sources for the scenario evaluated are from the LNG tanker and tugs. These sources will be moving along the channel and may on occasions traverse closer to sensitive receptors than modelled and hence result in higher noise levels than predicted. However, the closer locations are unlikely to produce noise levels in excess of the project noise limits. Furthermore, the elevated noise levels from these sources are only going to be short in duration and infrequent.

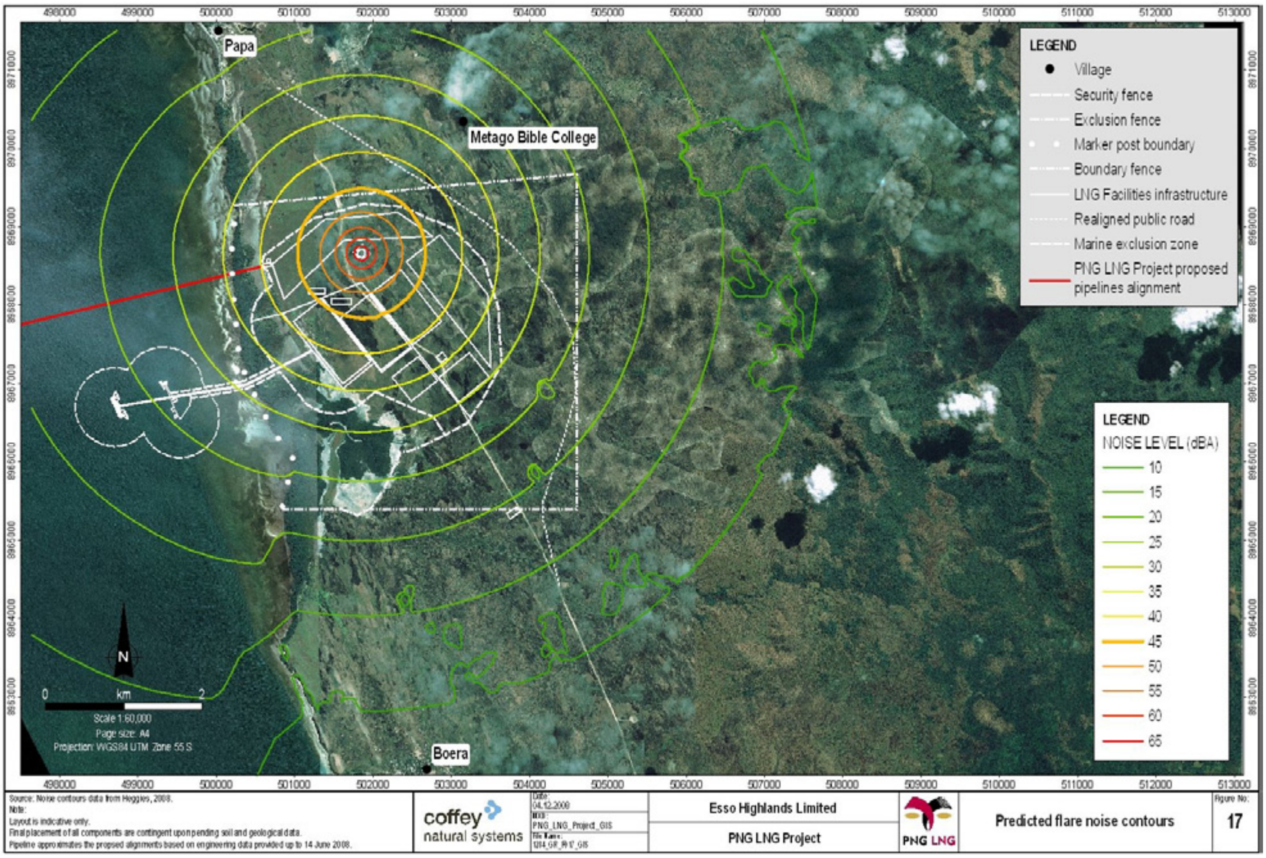
Figure 16 Predicted Shipping Noise Contours



8.3.3 Flare

Predicted noise levels shown in **Table 18** indicate that these will be compliant during all periods of the day under all meteorological conditions. Noise contours for neutral propagation conditions are shown in **Figure 17**.

Figure 17 Predicted Shipping Noise Contours



8.3.4 Traffic Noise

The Port Moresby to Lea Lea road will be the sole road to the LNG Facilities site and will carry increased traffic during both construction and operation of the project.

The route is sufficiently far from the villages of Boera (~2.5 km) and Porebada (~2.7 km) to mitigate road noise. The Napa Napa Road section of the route passes through residential communities closer to Port Moresby, where communities are located on the road.

A traffic count survey was conducted in May–June 2008 at a total of five sites across the project area. For the purposes of estimating the number of heavy vehicles, it was assumed that half the total registered as ute/trucks would be classified as heavy vehicles and all buses and Public Motor Vehicles (PMV) were heavy vehicles.

It has been assumed that the peak hour during the day period would carry 6% of daily traffic, whereas during the night period the peak hour would carry 0.08% of daily traffic.

Table 19 summarises the potentially affected communities along the transport route.

Table 19 Description of Potentially Affected communities on the Lea Lea to Port Moresby Road

Community / Receptor	Description	Approximate setback distance to closest affected dwellings	Approximate number of affected dwellings	Approximate existing daily traffic movements / % heavy vehicles
Konebada Petroleum Park	Lea Lea Road – Porebada Road intersection	200m	6	930 / 67%
Koukou-Ranu Hedadi	Napa Napa Rd approximately 700 m northwest of the Baruni intersection	50m	5	930 / 67%
Baruni	Napa Napa Rd approximately 700 m south of the Baruni intersection	15-20m	30	3300 / 75%
Kanudi	Possible residences associated with oil facility on Napa Napa Road	60	2	> 3300 / 55%
Idubada / Port Moresby Technical College	Napa Napa Road dwellings and classrooms nearest to road	50m	5	> 3300 / 55%
Idubada	Possible residences associated with oil facility on Napa Napa Road	20-30	3	> 3300 / 55%
Hagara Primary School	Napa Napa Road classrooms nearest to road	25m	4	>> 3300 / 75%
Poreporena Villages	Includes villages of Gabi, Hanuabada and Hohodae, dwellings nearest to road	40m	30	>> 3300 / 55%

Construction

During construction, considerable traffic will be generated by the project. This will be for the purposes of moving staff, equipment and supplies. Approximately 7500 staff will be employed by the project during construction and a temporary construction camp providing accommodation, services and messing facilities for them will be built, thereby reducing potential traffic movement.

The construction of the Materials Offloading Facility will provide a means of receiving large-scale deliveries of materials and equipment by sea. Materials and equipment sourced domestically or, prior to the completion of the Material Offloading Facility, will be delivered by road. This will typically include:

- Contractor's earthmoving equipment fleet.
- Materials and prefabricated modules required for the construction camp.
- Delivery of fuel and supplies.

The estimated peak traffic volume during construction is 500 vehicles per day, of which a high proportion (70%, 350 vehicles) are heavy vehicles.

Operations

Traffic generated during operations will be more limited. Operational staff will be housed in the permanent camp, with all LNG product exported via the LNG jetty. Traffic generated during operations will include movement of staff during roster changeover, delivery of general supplies of food and other consumables, and waste removal.

The estimated peak traffic volume during operations is 50 vehicles per day, of which a high proportion (50%) are heavy vehicles.

Predictions

Predicted peak hourly noise levels from traffic at the most affected receptor in each community studied were calculated based on the assumptions for vehicle mix and the approximate setback distance. It was assumed that traffic travelled at approximately 45 km/h and that no shielding or reflections would affect noise propagation. The results are presented in **Table 20**.

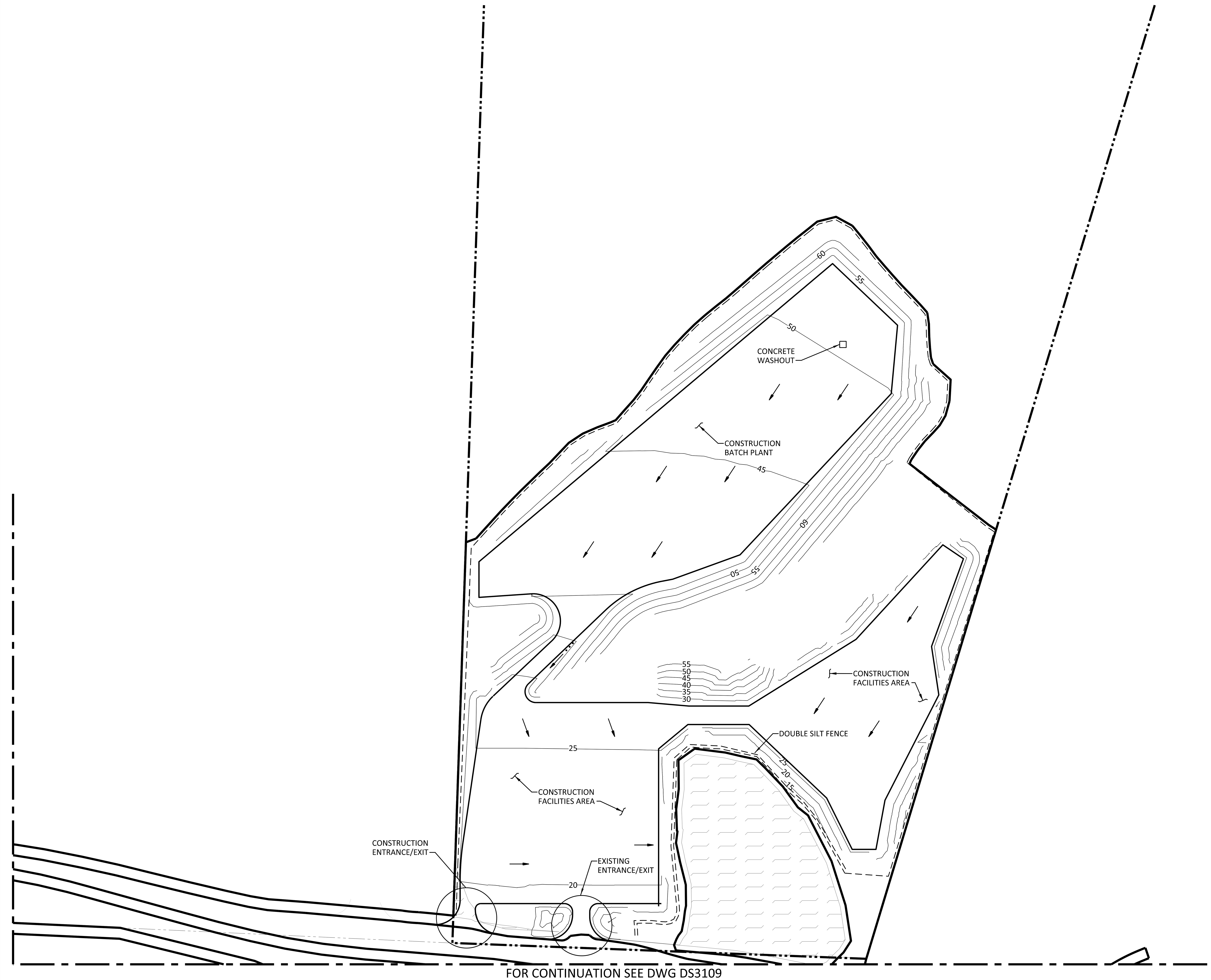
Table 20 Estimated Peak Hourly Road Traffic Noise Levels

Community / Receptor	Estimated road traffic noise level dBA					
	Existing		During Construction		During Operation	
	Day	Night	Day	Night	Day	Night
Konebada Petroleum Park	46	37	48	39	46	37
Koukou-Ranu Hedadi	53	44	55	46	53	44
Baruni	64	55	65	56	63	54
Kanudi	~ 57	~ 48	~ 58	~ 49	~ 57	~ 48
Idubada / Port Moresby Technical College	~ 58	~ 49	~ 59	~ 50	~ 58	~ 49
Idubada	~ 61	~ 52	~ 63	~ 54	~ 61	~ 52
Hagara Primary School	> 61	> 53	> 62	> 53	> 61	> 53
Poreporena Villages	> 59	> 50	> 60	> 51	> 59	> 50

Based upon the above estimations it is evident that some dwellings located on the Napa Napa Road in the village of Baruni are already exposed to potentially high traffic noise levels as a result of their proximity and the considerable traffic through the village. As a consequence of project construction noise levels are estimated to increase by up to a further 1 dBA.

Given the minimal setback distance in Baruni it may be necessary to relocate some dwellings to enable access for wide loads which would effectively increase set-back distances and reduce traffic noise levels. Furthermore, alternative route alignments to reduce noise and traffic impacts in Baruni could be effective.

Exhibit 79



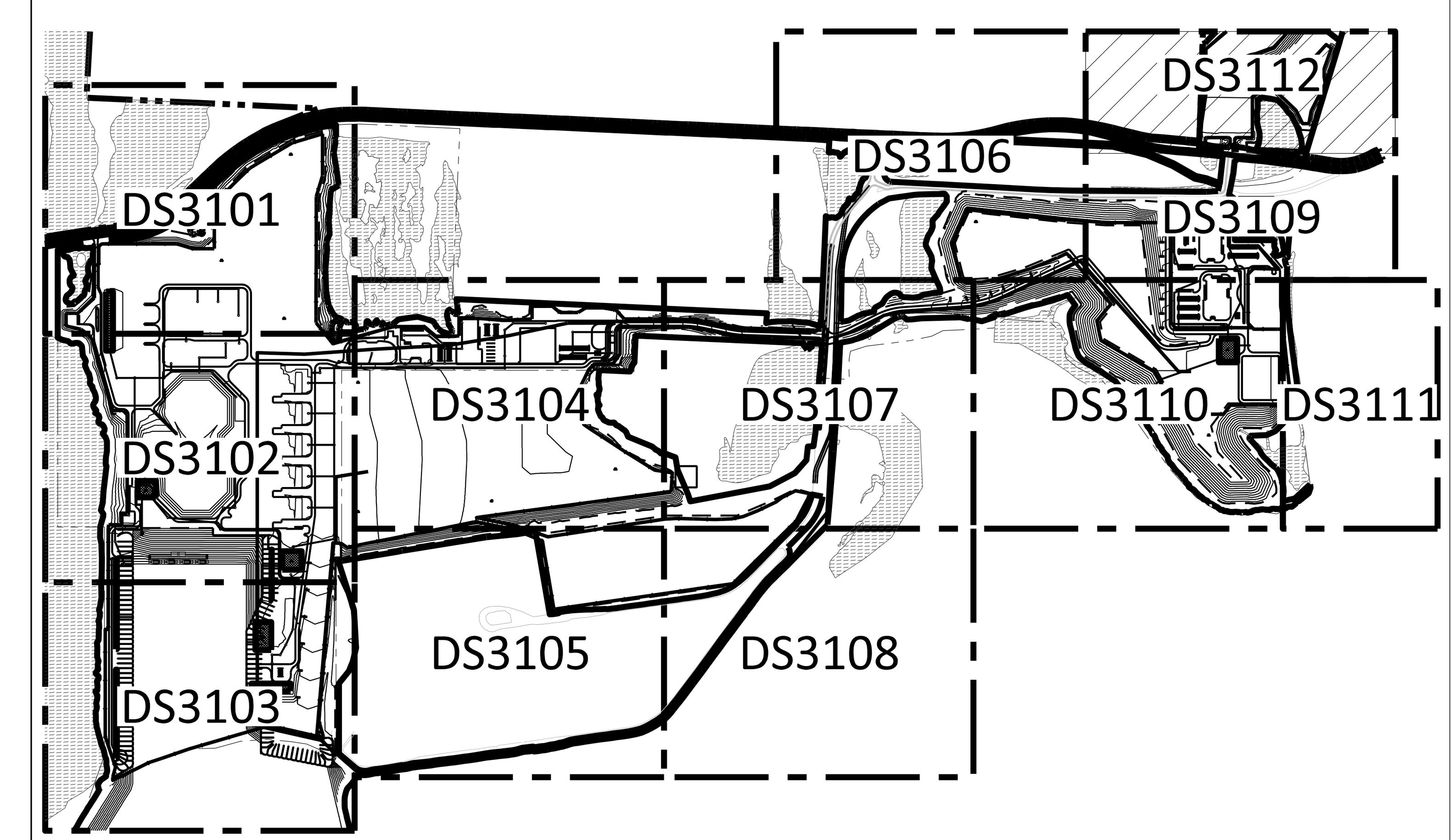
FOR CONTINUATION SEE DWG DS3109

100' 50' 0 100' 200'
1"=100'

OFFSITE CONSTRUCTION AREAS

DS3113 APCO LAYDOWN SITE
DS3114 PORT LAYDOWN SITE
DS3115 MILL CASINO OFFSITE PARK & RIDE
DS3116 MYRTLEWOOD OFFSITE PARK & RIDE
DS3117 METEOROLOGICAL TOWER SITE

KEY PLAN



NOTES

1. SEE DRAWING 0000-DS3100 FOR GENERAL NOTES, LEGEND AND ABBREVIATIONS.

KBJ
JORDAN COVE LNG

Jordan Cove LNG

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NO	DATE	JCLNG REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP	NO	DATE	KBJ REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP

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SIGNED
DATE REG NO.

DESIGNER | DRAWN
CHECKED | DATE

JORDAN COVE LNG PROJECT
EROSION AND SEDIMENT CONTROL PLAN
AREA 12

PROJECT: 189980-0000-DS3112 (DRAWING NUMBER) REV
JCLNG NUMBER: J1-000-CIV-GRD-KBJ-01304-12 REV

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