July 24, 2014

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

Re: Rebuttal comments on Coos County Pacific Connector Gas Pipeline application for (2) year CUP extension on former County File No. HBCU-10-01 (REM-11-01), Coos County Final Orders 10-08-045PL and 12-03-018PL. Extension Application and Appeal under County File No. ACU-14-08 & AP-14-02.

Dear Hearing Officer Stamp:

Please accept the following rebuttal comments into the record of the Coos County Pacific Connector Gas Pipeline (PCGP) land use extension application ACU-14-08 & AP-14-02.

At the Hearing held on July 11, 2014, in testimony submitted both orally and in writing, there was a discussion concerning what changes had occurred to the Coos County Zoning and Land Development Ordinance since the PCGP CUP was issued in March of 2012. The McCaffree July 11, 2014, written testimony on pages 21 - 24 lists some of the changes that have occurred since the Pacific Connector’s original pipeline CUP. Exhibit 14 in the McCaffree July 11, 2014, submittal has the Planning Director’s March 22, 2012 Notice of Decision on File No. ABI-12-01. Also please find attached the Planning Director’s decisions on Coos County File No. ACU-12-12/ABI-12-02 (Exhibit A) and Coos County File No. ACU-12-16/ACU-12-17/ACU-12-18 (Exhibit B) referenced in the July 11th testimony.

The pipeline has changed from its original intended purpose plus the physical structure, location, route and land use in the areas of the original PCGP CUP has also changed. One example of the physical change in the current PCGP that is different from the original Coos County PCGP CUP application was described in the written testimony I submitted at the July 11, 2014, hearing. See McCaffree July 11, 2014, Exh 18 for an example of a section of the original pipeline route filed with the 2010 PCGP CUP application and then compare that to McCaffree July 11, 2014, Exh 17 for this same section of pipe found in the PCGP Federal Energy Regulatory Commission (FERC) application filed in June of 2013. Other examples of changes are detailed in Exhibits C, D and E. These show more examples of pipeline segment changes from the original Pacific Connector CUP route to the current proposed pipeline route that has been filed with the FERC. In addition, there have been several additional applications for alternative PCGP CUP routes that differ from the original PCGP CUP that have also been filed in Coos County under Coos County File No. HBCU-13-04 and HBCU-13-06. This all clearly shows that there has been a change sufficient to McCaffree rebuttal on ACU-14-08
July 24, 2014
Page | 1
cause a new conditional use permit to be sought for the pipeline as required by CCZLDO 5.0.700.

According to the original Coos County PCGP CUP application, the PCGP was to be buried at least 3 foot under the ground but that differs from the pipeline that was filed with FERC in June of 2013. The current proposed pipeline segment that has been filed with the FERC on the North Spit in the same general area as the 2010 PCGP route found in Exhibits C and D will not be buried but exposed and in the open running alongside a proposed road and bridge some 40 feet above the current grade. (See Exhibit E—McCaffree July 11, 2014, Exh 16) The current proposed pipeline would connect the proposed Jordan Cove South Dunes Power Plant with the Jordan Cove Storage and Liquefaction facility. This proposed change by the Jordan Cove / Pacific Connector project to raise the entire 500 acre property on the North Spit some 40 to 45 feet above current grade (See Exhibit F) now places the project in direct conflict with the Southwest Oregon Regional Airport in North Bend. (See Exhibit G) This hazard and elevation change was not there previously. This also creates a conflict with the Comprehensive Plan and CCZLDO 1.1.200 with regard to “Promoting and protecting the public health, safety, convenience and general welfare” and “Facilitating fire and police protection.”

As discussed at the July 11th hearing, pipelines are considered hazardous facilities and the Williams Co. who will build and operate the Pacific Connector Gas Pipeline has a terrible safety record. (See Exhibit H) This is why there is such a concern with the new Earthquake and Tsunami studies and mapping that were completed AFTER the original PCGP CUP was issued. (See McCaffree July 11, 2014, tsunami map and Exh 10) The thinner pipe the company had planned to use in rural areas such as Coos County is no longer acceptable considering this new information concerning earthquake and tsunami risk. Even if thicker pipe was used, it is doubtful that the pipeline would be able to withstand the amount of movement that is currently predicated to occur when the Cascadia subduction earthquake occurs. An abstract of the earthquake study referenced at the July 11, 2014, hearing that was published on August 1, 2012, is attached as Exhibit I. The Oregon Resilience Report dealing with how to handle the new earthquake and tsunami information was published in Feb of 2013. See Exhibit J for select pages and maps found in that report indicating how devastating the Cascadia subduction earthquake and tsunami would be to the South Coast of Oregon when it occurs. The Oregonian article discussed at the July 11th hearing that was published on June 26, 2014, is attached as Exhibit K. The article states among many other things the following:

..."It should be an assumption that this will happen during the lifetime of the facility," said Chris Goldfinger, a seismologist at Oregon State University and leading authority on subduction zone earthquakes. "You can engineer anything to survive anything if you put enough money into it, but I’ve seen a lot of very well-engineered stuff destroyed as if it were Legos."

"From my perspective, and the probabilities, I would certainly have reservations about building one of these terminals down there," he said...

McCaffree rebuttal on ACU-14-08
July 24, 2014
Page | 2
"I would say every one of us would be reluctant to suggest a liquefied natural gas terminal on the coast here," said Anne Trehu, an OSU geologist who studies the Cascadia Subduction Zone. 

Run-up and subsidence estimates were considerably less for the smaller, more likely, earthquake scenarios that Zhang modeled. In either case, the study concluded that the height of the proposed design "exceeds the design level tsunami event."

Yet Zhang also says "all the results need to be taken with a grain of salt." Before the Japanese quake in 2011, he said, geophysicists had concluded that 15-meter-high waves were not possible at Fukushima.

Yet that's exactly what happened, resulting in cascading series of failures that ultimately resulted in the meltdown of three nuclear reactors. (Emphasis added)

Oregonian Article, published June 126, 2014, Exhibilt K

FEMA floodplain mapping changes along the PCGP route also have changed since the original CUP. These are referenced in the McCaffree July 11, 2014, testimony on page 23 and in Exb 13 submitted July 11, 2014.

Lilli Clausen in oral argument at the July 11th hearing brought up the fact that the Pacific Connector Gas Pipeline project had recently been out re-drilling test wells in the Estuary and that workers associated with the project told Lilli that they are looking to do an HDD pipeline route across the Haynes Inlet. This information was provided to FERC in June of 2013 in with the Pacific Connector FERC application (See Exhibit L) but it has never been submitted to Coos County. The Pacific Connector Gas Pipeline needs to decide where their proposed pipeline would actually go. This is the problem with doing the Conditional Land Use Permit application BEFORE THE FERC ORDER. How can we citizens analyze a pipeline route that changes with every turn? Landowners have a right to have a fair process, not the piece mill process that has been occurring to date. Once the FERC decides on the final route and issues their Final Order, then the Pacific Connector should work towards obtaining their Coos County CUP permit based on the actual final route and location of the pipeline.

The changes that have occurred to date with the proposed pipeline use, route and land use are sufficient to require a new conditional use permit to be sought for the use. I recommend the CUP for the entire pipeline route needs to be redone completely AFTER FERC HAS ISSUED THEIR FINAL ORDER and established the final pipeline route.

Sincerely,

Jody McCaffree

McCaffree rebuttal on ACU-14-08
July 24, 2014
Page | 3
McCaffree
Index for Exhibits
July 24, 2014

Re: Pacific Connector Gas Pipeline Extension Application and Appeal
Under County File No. ACU-14-08 & AP-14-02.

Exhibit A: Planning Director Notice of Administrative Conditional Use and Boundary Interpretation with maps issued on Sept 17, 2012 for Coos County File No. ACU-12-12/ABI-12-02 - Coos County Boundary Interpretation for the Coos Bay Estuary Management Plan for Jordan Cove Energy Project, L.P./Fort Chicago Holdings II U.S. LLC. [Final Decision was actually a Boundary revision.]

Exhibit B: Planning Director Notice of Decision issued on Oct 4, 2012 for Coos County File No. ACU-12-16/ACU-12-17/ACU-12-18 - Coos County Permit for fill in Beach and Dune Areas for Steve Donovan, SHN Consulting Engineers/Weyerhaeuser NR Company.

Exhibit C: Pacific Connector Pipeline Environment alignment map for a section of the proposed pipeline on the North Spit that was submitted in with the original CUP application in 2010.

Exhibit D: Figure 2.1-6 found in the May 2009 Final Environmental Impact Statement of the Federal Energy Regulatory Commission that shows the Pacific Connector Gas Pipeline route on the North Spit. Document was filed in with the original Coos County Pacific Connector CUP application proceeding.

Exhibit E: Current pipeline route and documents showing details about an access road and utility corridor filed with the Federal Energy Regulatory Commission (FERC) by Jordan Cove in May 2013.

Exhibit F: World article entitled “Jordan Cove plans safety measures” April 7, 2013, concerning plans to raise the property level on the North Spit 40 to 45 feet above what it is currently. Also included is a document from Jordan Cove’s Resource Report 1 filed with the FERC in May 2013 showing placement sites for removal and fill on the North Spit.

Exhibit G: March 2013 Southwest Oregon Regional Airport overlay by SHN Consulting Engineers and Geologist, Inc. filed in with the South Dunes Power Plant Coos County CUP application.

Exhibit H: Williams pipeline company safety record overview.

**Exhibit J:** Select pages and maps from *The Oregon Resilience Plan – Reducing Risk and Improving Recovery for the next Cascadia Earthquake and Tsunami* – Report to the 77th Legislative Assembly from the Oregon Seismic Safety Policy Advisory Commission (OSPAC) Salem, Oregon, February 2013:

**Exhibit K:** The Oregonian “*Jordan Cove LNG terminal at Coos Bay designed for Cascadia quake, tsunami though hazards remain*” By Ted Sickinger - June 26, 2014
http://www.oregonlive.com/business/index.ssf/2014/06/coos_bay_lng_terminal_designed.html#incart_river

**Exhibit L:** Pacific Connector June 2013 Alternatives Appendix No. 10H – *Direct Pipe Feasibility Evaluation Haynes Inlet (May 1, 2013)* filed with the FERC in June of 2013.
Exhibit A
PLANNING DIRECTORS NOTICE OF WITHDRAWAL AND REISSUANCE OF ADMINISTRATIVE CONDITIONAL USE AND ADMINISTRATIVE BOUNDARY INTERPRETATION

This notice is to serve as public notice and decision notice and if you have received this notice by mail it is because you are a participant, adjacent property owner, special district, agency with interest, or person with interest in regard to the following land use application. Please read all information carefully as this decision may affect you. (Please see the attached vicinity map for the location of the subject property).

NOTICE IS HEREBY GIVEN that the Planning Director is officially withdrawing the original decision for file # ACU-12-12/ABI-12-02 that was issued on July 25, 2012 and reissuing a new decision on this matter on September 17, 2012.

The withdrawal and reissuance of this decision came about after an appeal was filed by Courtney Johnson, Crag Law Center representing Oregon Shores Conservation Coalition and Oregon Coast Alliance. After reviewing the appeal, Staff coordinated a meeting with the applicant’s attorney and the appellants’ attorney to see if a resolution could be reached. A settlement agreement was reached to withdraw the original application and to reissue this revised decision. The appellants have agreed to withdraw the appeal upon the reissuance of a decision.

The Planning Director has made a revised Administrative Boundary Interpretation for the Coos Bay Estuary Management Plan. The interpretation is for the western boundary of 6-Water Dependent Development Shorelands (6-WD); the eastern boundary of 5-Water Dependent Shorelands (5-WD); and a portion of the eastern boundary of 5A-Natural Shorelands (5A-NS).

The Planning Director has also approved a request for an Administrative Conditional Use for fill within the 6-WD zoning district subject to conditions as stated in the staff report. The property is identified as Township 25 Range 13 Section 04/05 TL 101/100 & 200. The applicant is Jordon Cove Energy Project, L.P. and the owner is Fort Chicago Holdings II U.S. LLC. The subject property is located north of the City of North Bend off of Jordan Cove Road and the Trans-Pacific Parkway.

The applicable criteria is found in Coos County Zoning and Land Development Ordinance (LDO) Sections 4.1.400 Interpretation of Zoning District Boundaries; 4.5.276(B)(5) 5-WD - Uses, Activities and Special Conditions; and Appendix 3, Volume II- CBEMP POLICIES- Policies 17, 18, 23, 14, 27, 30, 49, 50, and 51.

*PLEASE NOTE – Decisions are subject to requirements and conditions stated in the staff report.

The application and all documents and evidence contained in the record, including the staff report and the applicable criteria, are available for inspection, at no cost, in the Planning Department located at 225 North Adams Street, Coquille, Oregon. Copies may be purchased at a cost of 50 cents per page.
Pursuant to Article 5.8 of the LDO, this decision may be appealed to the Coos County Hearings Body within 15 days of the date notice of this decision is mailed, by filing a Notice of Appeal (NOA) with the Planning Department on the NOA form provided by the Department, along with the required filing fee. This means **appeals must be received in the Planning Department by 5:00 p.m. on October 2, 2012;** otherwise, the appeal is not timely and will not be considered. Appeals should be submitted in the form of one (1) original and fourteen (14) copies. If copies are not provided, the Planning Department will make the copies at a cost of 50 cents per page billed to the submitter. The decision on this application will not be final until the period for filing an appeal has expired. Pursuant to Oregon Revised Statutes (ORS) 197.830, the decision cannot be appealed directly to the Land Use Board of Appeals.

Further explanation concerning any information contained in this notice can be obtained by contacting the Planning Department at (541) 396-7770 or by visiting the Planning Department between the hours of 8:00 AM – 5:00 PM (closed noon – 1:00 PM), Monday through Friday.

COOS COUNTY PLANNING DEPARTMENT  
Staff Contact: Jill Rolfe, Interim Planning Director or Debby Darling, Planning Tech

**POSTED & MAILED ON:** September 17, 2012  
**POST THROUGH:** October 2, 2012
File: ACU-12-12 / ABI-12-02

Applicant/Owner: Jordan Core Energy Project, L.P.
Fort Chicago Holding II U.S. LLC

Location: Township 25S Range 13W
Section 04/05 TL 101/100, 200

Proposal: ABI for CEEMP / To allow fill
Exhibit B
REVISED* (10/4/12)

NOTICE OF PLANNING DIRECTOR'S DECISION/PUBLIC NOTICE

This notice is to serve as public notice and decision notice and if you have received this notice by mail it is because you are a participant, adjacent property owner, special district, agency with interest, or person with interest in regard to the following land use application. Please read all information carefully as this decision may affect you. (See the vicinity map on the reverse side for the location of the subject property).

NOTICE IS HEREBY GIVEN on October 4, 2012, the Coos County Interim Planning Director has approved, with conditions, file numbers ACU-12-16/ACU-12-17/ACU-12-18. The conditions are explained in the staff report which is on line at http://www.co.coos.or.us/Departments/Planning.aspx under pending applications.

The application request are for conditional uses for fill in the Beach and Dune Areas with Limited Development Suitability located in the Industrial (IND) zone; and conditional use for fill and vegetative shoreline stabilization in the Coos Bay Estuary Management Plan (CBEMP) zoning designation 7-Development Shorelands (7-D). The property is identified as Township 25 Range 13 Section 03/04 Tax Lots 200/100. The applicant is Steve Donovan, SHN Consulting Engineers & Geologist and the property owner is Weyerhaeuser NF Company. The subject properties are zoned Industrial (IND) and CBEMP 7-Development (7-D).

### APPLICABLE CRITERIA

**Coos County Zoning and Land Development Ordinance (LDO) and Coos County Comprehensive Plan (CCCP)**

| Conditional use for fill in the Beach and Dune Areas with Limited Development Suitability located in the IND zone | Commercial-Industrial Zoning Districts |
| LDO Section 4.2.600, Table 4.2e | Phenomenon 4 Beaches & Dunes, 4a. limited development suitability |
| LDO Article 4.7, Table 4.7a | 5.10 Dunes, Ocean and Coastal Lake Shorelands, Strategy 2 |
| Appendix 1, Volume I, POLICIES | Riparian Protection Standards for CBEMP |
| LDO Section 4.5.180 | Conditional use for fill and vegetative shoreline stabilization in the Coos Bay Estuary Management Plan (CBEMP) zoning designation 7-D |
| LDO Section 4.5.286(B)(5) | 7-D - Uses, Activities and Special Conditions |
| LDO Section 4.5.286(B)(5) | 7-D - Uses, Activities and Special Conditions #5 |
| Appendix 3, Volume II- CBEMP POLICIES | Policies 9, 14, 17, 18, 23, 27, 30, 49, 50, and 51 |
The application and all documents and evidence contained in the record, including the staff report and the applicable criteria, are available for inspection, at no cost, in the Planning Department located at 225 North Adams Street, Coquille, Oregon. Copies may be purchased at a cost of 50 cents per page.

**APPEAL INFORMATION**

Pursuant to Article 5.8 of the LDO, this decision may be appealed to the Coos County Hearings Body within 15 days of the date notice of this decision is mailed, by filing a Notice of Appeal (NOA) with the Planning Department on the NOA form provided by the Department, along with the required filing fee. This means appeals must be received in the Planning Department by 5:00 p.m. on October 19, 2012; otherwise, the appeal is not timely and will not be considered. Appeals should be submitted in the form of one (1) original and fourteen (14) copies. If copies are not provided, the Planning Department will make the copies at a cost of 50 cents per page billed to the submitter. The decision on this application will not be final until the period for filing an appeal has expired. Pursuant to Oregon Revised Statutes (ORS) 197.830, the decision cannot be appealed directly to the Land Use Board of Appeals.

Further explanation concerning any information contained in this notice can be obtained by contacting the Planning Department at (541) 396-3121 or 756-2020, extension 210, or by visiting the Planning Department between the hours of 8:00 AM – 5:00 PM (closed noon – 1:00 PM), Monday through Friday.

COOS COUNTY PLANNING DEPARTMENT

Jill Rolfe, Interim Planning Director

Coos County Staff Members
Jill Rolfe, Interim Planning Director
Debby Darling, Planning Tech
Amy Dibble, Planning Aide

**POSTED & MAILED ON:** October 4, 2012 **POST THROUGH:** October 19, 2012
COOS COUNTY PLANNING DEPARTMENT
Mailing Address: 250 N. Baxter, Coos County Courthouse, Coquille, Oregon 97423
Physical Address: 225 N. Adams, Coquille Oregon
Phone: (541) 396-7770
Fax: (541) 396-1022/TDD (800) 735-2900

File: ACU-12-16/ACU-12-17/ACU-12-18
Applicant/Owner: SHN Consulting Engineers/Geologists, Weyerhaeuser NR Company
Location: Township 25S Range 13W Section 3/4 TL 200/100
Proposal: To Allow Fill in IND Zone,
To Allow Fill in CBEMP 7-D Zone,
Vegetative Shoreline Stabilization in CBEMP 7-D
Exhibit C
PACIFIC CONNECTOR GAS PIPELINE

Narrative in Support of Consolidated Land Use Applications

Submitted
April 14, 2010
Exhibit D
Final Environmental Impact Statement

JORDAN COVE ENERGY AND PACIFIC CONNECTOR GAS PIPELINE PROJECT

Jordan Cove Energy Project, L.P. Docket Nos. CP07-444-000
Pacific Connector Gas Pipeline, L.P. CP07-441-000

FERC/EIS – 0223F

Federal Energy Regulatory Commission

Office of Energy Projects
Washington, DC 20426

Cooperating Agencies

USDA Forest Service, Pacific Northwest Region
Department of the Army, Corps of Engineers, Portland District
US Environmental Protection Agency, Region 10
US Department of Homeland Security, Coast Guard, Portland
US Department of Transportation, Pipeline and Hazardous Materials Safety Administration
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
Douglas County, Oregon

May 2009
Exhibit E
Exhibit F
Jordon Cove plans safety measures

THE WORLD

NORTH BEND — Standing on the future site of the Jordan Cove Energy Project, its director of public affairs explained where various parts of the plant would lie. He described the extensive safety measures the company is taking.

The director, Michael Hinrichs, provided a tour Tuesday morning to Ray Bucheger, a lobbyist, Rep. Caddy McKeown, Rosie Shatkin, advisor for Sen. Arnie Roblan and Chuck Deister, advisor for Jordan Cove Energy Project. He described the extensive safety measures the company is taking.

Hinrichs said the project was taking precautions to ensure the public’s best interests were met. He said he was aware of the environmental groups’ concerns about safety and impact.

“When our permits get approved, we can say with confidence that all precautions have been taken,” Hinrichs said.

From right to left: Michael Hinrichs, Chuck Deister, Ray Bucheger and Rep. Caddy McKeown tour the Jordan Cove Energy Project site on the North Spit Tuesday morning. Hinrichs, director of public affairs for the project, hopes construction will begin in 2014. The first step is to raise the whole 500-acre property 40 to 45 feet above its current level. He expects it will take up to a year to complete that portion. At the height of construction there will be 2,100 jobs.

Michael Hinrichs, director of public affairs for the Jordan Energy Cove Project, shows Rosie Shatkin, legislative policy advisor to Sen. Arnie Roblan, the layout of the project site on the North Spit Tuesday. Tankers will ship liquefied natural gas from the site to other countries.

Workers with Geotechnical Resources, Inc. in Portland drill 80 feet down on the North Spit to get samples of the dirt at the Jordan Cove Energy Project site on Tuesday. Michael Hinrichs, director of public affairs for the project, said the site has a lot of sand, which is good for construction.
<table>
<thead>
<tr>
<th>Facility</th>
<th>Construction Phase</th>
<th>Volume (mcy)</th>
<th>Placement Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slip</td>
<td>Land Based Excavation</td>
<td>2.3</td>
<td>LNG Terminal Site and South Dunes Power Plant Site</td>
</tr>
<tr>
<td>Fresh Water Phase</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slip</td>
<td>Dredging in Pocket Behind Berm (Base Option)</td>
<td>Up to 1.5</td>
<td>LNG Terminal Site and South Dunes Power Plant Site</td>
</tr>
<tr>
<td>Salt Water Phase</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slip</td>
<td>Dredging from Bay (Option 1)</td>
<td>Remaining of 1.5</td>
<td>LNG Terminal Site and South Dunes Power Plant Site</td>
</tr>
<tr>
<td>Slip</td>
<td>Dredging to Remove Berm</td>
<td>0.5</td>
<td>LNG Terminal Site</td>
</tr>
<tr>
<td>Access Channel</td>
<td>Dredging from Bay</td>
<td>1.3</td>
<td>South Dunes Power Plant Site</td>
</tr>
</tbody>
</table>
Exhibit G
Exhibit H
Williams Safety Record
The Compliance and Safety Records of Williams (WMB),
Williams Partners L.P. (WPZ), Williams Midstream

- 2002 – Williams is reported to be in financial distress and on verge of bankruptcy

- 2002 – Williams has class action lawsuit filed against it alleging that it failed to disclose failing financial conditions (33)

- 2003 (May 1) - Williams' Northwest Pipeline ruptures dramatically. The company's natural-gas artery burst with a roar on May 1 near Lake Tapps, sparking evacuations at a school, a supermarket and about 40 homes. Inspectors later identified the cause as "stress corrosion cracking." After repairs were made to the line near Lake Tapps in May, inspectors ordered the company to reduce the line's gas pressure 20 percent to 632 pounds per square inch. (53)

- 2003 – Williams pays $20 million (along with Encana Company) to settle claims of reporting false data to manipulate the U.S. natural gas market (25)

- 2003 (Dec 13) – For the second time in six months, Williams' Northwest Pipeline (which runs from Sumas to Mexico) ruptured, releasing gas for three hours before it could be stopped. The Office of Pipeline Safety ordered Northwest Pipeline, a division of the Oklahoma-based Williams Cos. Inc. natural-gas drilling and transportation company, to idle the 26-inch line. The company must demonstrate the 47-year-old line is safe or replace certain segments before it begins operating the line again. (53)

- 2004 – FINED $30,000 for a fire at a well in Parachute, Colorado (47)

- 2006 (November 11) - A report indicated that a 300- to 400-foot section of the Williams Northwest natural gas pipeline had dropped into the Toutle River near Castle Rock when the river bank gave way. The exposed pipe did not rupture but Cowlitz County emergency crews established a 300-foot perimeter around the exposed pipe due to the potential of the pipeline rupturing which would have caused a significant explosion and fire. The pipeline is part of a 4,000-mile-long pipeline that carries fuel to Washington, Oregon, Idaho, Wyoming, Utah and Colorado. (54)

- 2007 – Williams agrees to pay $290 million to settle class action lawsuit filed in 2002

- 2007 (August 10) - It was reported that 27 horses were found dead near a gas leak of the Northwest Pipeline, which is one of the Williams Companies pipelines. Company personnel discovered the dead horses on the ranch while conducting routine maintenance checks on the 24-inch pipeline that runs underground. The dead horses were found 300 to 400 yards from where the leak was suspected. (55)

- 2008 (Sept 14) – A 36-inch Williams' natural gas pipeline exploded in Appomattox County Virginia [Transco] the blast ripped a 32-foot section of pipe from the ground and caused a 1,100 feet burn zone. Property damage reported to exceed $3 million. (35) The fireball demolished two houses and blistered the siding on homes 400 yards away. Flames shot in the air in excess of 300 feet and five people were injured in the blast. The aftermath of the explosion left a 15-foot crater in the ground. Twenty-three families were evacuated. (56) The Appomattox rupture was caused by corrosion of the 53-year-old pipeline, which had been inspected three months earlier by a "smart pig," a computerized scanning device that travels through a pipeline searching for dings, dents or corrosion, but had not yet been repaired. Transco's owner, the Williams Cos., paid the U.S. Transportation Department a $952,000 fine,
replaced 2,500 feet of the pipeline, "smart pigged" all of its pipelines in Virginia and performed pressurized water tests to validate the repairs. (63)

• 2009 – FINED $952,000 for failure to monitor corrosion adequately with the Virginia pipeline explosion in 2008 (36) (43) The Pipeline Safety Trust from 1986 through 2008 showed 11 non-public injuries and $43 million in damages along the entire length of that William’s Transco line. Most of the failures were caused by material defects, corrosion or outside forces. (57)

• 2010 – Transco Pipeline leak in Texas. Leak was not reported for 4 days. The ¼ inch diameter leak caused a reported $57,000 in property damage. Aerial patrol did not see the leak. Found by an operator who saw some bubbles. (22)

• 2010 / 2011 – FINED $275 Thousand over failing to implement and/or maintain storm water measures to prevent potential pollutants during planned construction in Parachute, Colorado. State inspectors notified Williams (Bargath) in Nov. 2010 of violations and told them to take immediate action. According to report, Williams did not fix violation for 7 months. (8) (28)

• 2011 – FINED $23,000 by PHMSA for failure to conduct own annual inspections of Natural Gas compressors stations in Texas and Louisiana (18)

• 2011 (Dec 3) – [Transco] Natural Gas Pipeline rupture & explosion in Marengo County, Alabama. 8 acres burn. Coating failure blamed as cause. Reports state that the corrosion was not recognized by Williams even though they claimed to have systems in place. (2) (36)

• 2011 (Dec 6) - The Federal Pipeline and Hazardous Material Safety Administration (PHMSA) issued a Corrective Action Order to Williams Partners in connection with a massive natural gas explosion that occurred in Marengo County, Alabama, on Dec. 3, 2011, on the company’s Transco pipeline. (57)

• 2012 (March 5) - Williams Partners subsidiary, the Transcontinental Gas Pipeline Co. LLC, was fined $50,000 by PHMSA for failure to follow its own, internal policies related to controlling external corrosion in natural gas pipelines running through the New York City borough of Staten Island. (57)

• 2012 (March 29) – Gas leak caused explosion at Natural Gas Compressor Station in Pennsylvania. Williams restarts the station within 24 hours and started pumping fracked gas despite request from PA Dept. of Environmental Protection not to do so. DEP states they make it very clear on the above matter but because it was not an official order no fines were issued. 1 ton of Methane released. (2) (16) The federal Pipeline and Hazardous Material Safety Administration (PHMSA) issued a Corrective Action Order to Williams Partners on Dec. 6, 2011, in connection with a massive natural gas explosion that occurred in Marengo County, Alabama, on Dec. 3, 2011, on the company’s Transco pipeline. The facility that exploded in Pennsylvania fed pressurized natural gas into the Transco pipeline. (57)

• 2012 (April 9) - The Williams Transco natural gas pipeline, an 11,000 mile pipeline that runs from the Gulf Coast to markets on the eastern seaboard, sprung a leak in Bergen County, New Jersey, according to a recent media report (dated April 4, 2012). The leak in a 36-inch-diameter section of the pipeline represents the second incident calling in to question the pipeline’s integrity in less than a month. The Williams Co., which is already operating under a federal Corrective Action Order in connection with a massive natural gas pipeline explosion in Alabama last year, has a lengthy record of pipeline safety violations, according to documents obtained by NaturalGasWatch.org (58)
• 2012 – Transco/Williams FINED $50,000 by PHMSA for failure to follow own internal policies with controlling corrosion in Natural Gas pipeline in NY (18)

• 2012 – Transco natural gas leak in New Jersey (18) (44)

• 2012 (Dec. 20) – The beginning of the Natural Gas Liquid (NGL) pipeline leak in Parachute, Colorado (population 1,000). Parachute Creek runs through the small town, which is nestled next to the Colorado River.

• 2013 (Jan) – Williams discovers leak of NGLs in Parachute plant while working on construction to expand the plant. Reports say the leak was found by ACCIDENT. Leak stopped, but Benzene, a cancer causing agent, has contaminated soil. Williams says leak not affecting creek. (8) (34)

• 2013 (March 8) – Williams begins cleanup (2 months later) of Benzene leak (NGL) in Parachute, CO. Authorities and landowners notified that the soil has been contaminated. No mention that groundwater is poisoned. Reports say that Williams didn’t report the spill/leak earlier because they thought less than 25 gallons had leaked.

• 2013 (March 15) – Groundwater in Parachute is contaminated with Benzene from NGL leak. Spill finally announced to public. Benzene is cancer-causing agent that breaks down bone marrow. (8) (20) (34) (41)

• 2013 (March) – Reports say Williams/Transco rejects U.S. Army Corp of Engineers safety recommendations in connection with the proposed Rockaway Lateral natural gas pipeline, claiming the requirements would “needlessly delay” the project and force cost overruns. (7)

• 2013 (March 23) – Williams Natural gas pipeline in West Virginia ruptures (30) According to media reports, the accident occurred just days after the company rejected safety recommendations from the U.S. Army Corps of Engineers in connection with controversial new natural gas pipeline of similar diameter proposed for New York City. Natural gas gathering pipelines move methane from the wells in the gas fields to processing facilities, where it is then moved downstream via natural gas transmission lines. Natural gas gathering lines operate essentially unregulated by federal agencies. (59)

• 2013 (April) – Parachute, CO residents question credibility of Williams who is in charge of testing their water and want the government to take over. Contamination continues to spread into their creek. (8) (42)

• 2013 (April) – Williams say faulty pressure gauge cause of leak in Parachute. Diesel found at gates of Parachute water supply. Benzene detected in creek. State Health Dept takes over oversight of leak. (8) (9)

• 2013 (May) – Benzene levels rise in Parachute, CO creek. State agency tells Williams violated it the law. (8)

• 2013 (May) – Williams announces it will not expand the Parachute, Co plant expansion NOT because of the NGL leak but due to low gas prices. (8)

• 2013 (May 14) - An explosion touched off a fire at a natural gas compressor facility owned by the Williams Co in New Milford, Pennsylvania, sending flames shooting high into the night sky. No one was injured in the explosion and subsequent fire. Williams has a lengthy history of pipeline safety violations
according to documents obtained by Natural Gas Watch and this incident represents the second explosion at a Williams-owned facility in Pennsylvania’s Susquehanna County in 14 months. (60)

• 2013 (May 21) – Williams holds Analyst Day in New York City. CEO Alan Armstrong states they have been working on the Bluegrass pipeline project for about 9 – 10 months. Williams states Bluegrass Pipeline is BIG and it’s RISKY in terms of permitting.

• 2013 (May 30) According to the Natural Gas Watch, Williams (Transco), the natural gas company proposing to build a massive, new natural gas pipeline through wetlands and recreation areas in coastal New York City, asked federal regulators for an exemption to existing wildlife protection laws to “harass” a range of marine life during the pipeline’s construction. (61)

• 2013 (June 13) – Williams’ Natural Gas Liquid (NGL) cracker plant that process NGLs in Louisiana Explodes and Burns. That chemical plant was in middle of $350 million expansion. 700 contract workers were present; 2 people killed (ages 29 & 47); 70 injuries; 62,000 pounds of toxic chemical released (1) (4) (5) (6) (39)

• 2013 (June 14) – Investigations into Williams Louisiana explosion reveals three years of noncompliance with Federal Clean Air Act, Williams had NOT conducted an OSHA inspection in 10 years.

• 2013 (July 10) – Williams (Bargath) FINED $7,854 by OSHA for failing to protect workers they sent excavate toxic soil near the Williams’ Parachute, Co plant that leaked Benzene. Report states that Williams did not have a decontamination procedure or ensure its employees received safety training related to the spill. Williams states it has not agreed to or accepted OSHA’s allegations. (49)

• 2013 (July 13) – Benzene levels increase at a point in the Parachute, CO Williams NGL leak. 130 tons per day of contaminated soil has been stockpiled. (3)

• 2013 (July 20) – Report shows that Williams expects to remove and treat as many as 26 million gallons of groundwater over a half-year to a year at the site of its natural gas liquids leak alongside Parachute Creek. About 155,000 gallons of tainted groundwater removed in March has been disposed of in an injection well in Grand County, Utah. (52)

• 2014 (March 31) - A blast at the Williams Northwest Pipeline plant in the town of Plymouth, along the Columbia River, also punctured a liquefied natural gas storage tank. Flames shot up into the air at least a hundred feet high. There were worries of a much larger explosion due to the close proximity of the LNG storage tanks. Deputies went door to door throughout the town of Plymouth evacuating about 200 residents in a 2-mile radius (62)

Sources
9. leak photos: http://www.colorado.gov/cs/Satellite?blobcol=urldata&blobheadername1=Content-Disposition&blobheadername2=Content-Type&blobheadervalue1=inline%3B+filename%3D%22Natural+Gas+Liquids+Release+Photographs.pdf%22&blobheadervalue2=application%2Fpdf&blobkey=id&blobtable=MungoBlobs&blobwhere=125185588603&ssbinary=true
17. http://www.naturalgaswatch.org/?p=2056
22. http://wccongress.org/wcc/2013/05/30/parachute-creek-spill-overview/
33. http://wpenergy.com
http://www.b2i.us/Profiles/Investor/Investor.asp?zID=630&from=du&lID=62994&myID=13611&l=1&Validate=3&l=
46. http://www.b2i.us/profiles/investor/NewsPrint.asp?b=630&lID=60830&m=rl&pop=1&cat=1799&G=343
53. Pipeline vs Rail & Truck
56. “Some Appomattox residents return home after explosion” September 14, 2008: www.newsadvance.com
58. This Week In Natural Gas Leaks and Explosions – April 9, 2012: http://www.naturalgaswatch.org/?p=1332
60. This Week In Natural Gas Leaks and Explosions – May 27, 2013: http://www.naturalgaswatch.org/?p=2046

While accidents associated with the transportation of hazardous materials via rail and road are more frequent than pipeline incidents, rail and truck spills are limited to the amount of product that can be held in transit. According to a review of data from the Pipelines and Hazardous Materials Administration (PHMSA) completed by the Association of American Railroads, total railroad crude oil spills between 2002-2012 equaled less than one percent of the total pipelines spills (railroads spilled 2,268 barrels total vs. pipelines spilled 474,441 barrels total). Additionally, during the same time period, average pipeline spills were four times larger than the average rail spill (average 65 barrels by rail vs. average 266 barrels by pipeline).
Exhibit I
Turbidite Event History—Methods and Implications for Holocene Paleoseismicity of the Cascadia Subduction Zone


Abstract

Turbidite systems along the continental margin of Cascadia Basin from Vancouver Island, Canada, to Cape Mendocino, California, United States, have been investigated with swath bathymetry; newly collected and archive piston, gravity, kasten, and box cores; and accelerator mass spectrometry radiocarbon dates. The purpose of this study is to test the applicability of the Holocene turbidite record as a paleoseismic record for the Cascadia subduction zone. The Cascadia Basin is an ideal place to develop a turbidite paleoseismologic method and to record paleoearthquakes because (1) a single subduction-zone fault underlies the Cascadia submarine-canyon systems; (2) multiple tributary canyons and a variety of turbidite systems and sedimentary sources exist to use in tests of synchronous turbidite triggering; (3) the Cascadia trench is completely sediment filled, allowing channel systems to trend seaward across the abyssal plain, rather than merging in the trench; (4) the continental shelf is wide, favoring disconnection of Holocene river systems from their largely Pleistocene canyons; and (5) excellent stratigraphic datums, including the Mazama ash and distinguishable sedimentological and faunal changes near the Pleistocene-Holocene boundary, are present for correlating events and anchoring the temporal framework.

Multiple tributaries to Cascadia Channel with 50- to 150-km spacing, and a wide variety of other turbidite systems with different sedimentary sources contain 13 post-Mazama-ash and 19 Holocene turbidites. Likely correlative sequences are found in Cascadia Channel, Juan de Fuca Channel off Washington, and Hydrate Ridge slope basin and Astoria Fan off northern and central Oregon. A probable correlative sequence of turbidites is also found in cores on Rogue Apron off southern Oregon. The Hydrate Ridge and Rogue Apron cores also include 12–22 interspersed thinner turbidite beds respectively.

We use 14C dates, relative-dating tests at channel confluences, and stratigraphic correlation of turbidites to determine whether turbidites deposited in separate channel systems are correlative—triggered by a common event. In most cases, these tests can separate earthquake-triggered turbidity currents from other possible sources. The 10,000-year turbidite record along the Cascadia margin passes several tests for synchronous triggering and correlates well with the shorter onshore paleoseismic record. The synchronicity of a 10,000-year turbidite-event record for 500 km along the northern half of the Cascadia subduction zone is best explained by paleoseismic triggering by great earthquakes. Similarly, we find a likely synchronous record in southern Cascadia, including correlated additional events along the southern margin. We examine the applicability of other regional triggers, such as storm waves, storm surges, hyperpycnal flows, and teletsunami, specifically for the Cascadia margin.

The average age of the oldest turbidite emplacement event in the 10-0-ka series is 9,800±210 cal yr B.P. and the youngest is 270±120 cal yr B.P., indistinguishable from the A.D. 1700 (250 cal yr B.P.) Cascadia earthquake. The northern events define a great earthquake recurrence of ~500–530 years. The recurrence times and averages are supported by the thickness of hemipelagic sediment deposited between turbidite beds. The southern Oregon and northern California margins represent at least three segments that include all of the northern ruptures, as well as ~22 thinner turbidities of restricted latitude range that are correlated between multiple sites. At least two northern California sites, Trinidad and Eel Canyon/pools, record additional turbidities, which may be a mix of earthquake and sedimentologically or storm-triggered events, particularly during the early Holocene when a close connection existed between these canyons and associated river systems.

The combined stratigraphic correlations, hemipelagic analysis, and 14C framework suggest that the Cascadia margin has three rupture modes: (1) 19–20 full-length or nearly
full length ruptures; (2) three or four ruptures comprising the southern 50–70 percent of the margin; and (3) 18–20 smaller southern-margin ruptures during the past 10 k.y., with the possibility of additional southern-margin events that are presently uncorrelated. The shorter rupture extents and thinner turbidites of the southern margin correspond well with spatial extents interpreted from the limited onshore paleoseismic record, supporting margin segmentation of southern Cascadia. The sequence of 41 events defines an average recurrence period for the southern Cascadia margin of ~240 years during the past 10 k.y.

Time-independent probabilities for segmented ruptures range from 7–12 percent in 50 years for full or nearly full margin ruptures to ~21 percent in 50 years for a southern-margin rupture. Time-dependent probabilities are similar for northern margin events at ~7–12 percent and 37–42 percent in 50 years for the southern margin. Failure analysis suggests that by the year 2060, Cascadia will have exceeded ~27 percent of Holocene recurrence intervals for the northern margin and 85 percent of recurrence intervals for the southern margin.

The long earthquake record established in Cascadia allows tests of recurrence models rarely possible elsewhere. Turbidite mass per event along the Cascadia margin reveals a consistent record for many of the Cascadia turbidites. We infer that larger turbidites likely represent larger earthquakes. Mass per event and magnitude estimates also correlate modestly with following time intervals for each event, suggesting that Cascadia full or nearly full margin ruptures weakly support a time-predictable model of recurrence. The long paleoseismic record also suggests a pattern of clustered earthquakes that includes four or five cycles of two to five earthquakes during the past 10 k.y., separated by unusually long intervals.

We suggest that the pattern of long time intervals and longer ruptures for the northern and central margins may be a function of high sediment supply on the incoming plate, smoothing asperities, and potential barriers. The smaller southern Cascadia segments correspond to thinner incoming sediment sections and potentially greater interaction between lower-plate and upper-plate heterogeneities.

The Cascadia Basin turbidite record establishes new paleoseismic techniques utilizing marine turbidite-event stratigraphy during sea-level highstands. These techniques can be applied in other specific settings worldwide, where an extensive fault traverses a continental margin that has several active turbidite systems.

**Figure 1.** Turbidite-channel and canyon-system types along the Cascadia margin. Dashed portion of Astoria Channel currently has no surface expression, but it is mapped in the subsurface (Wolf and others, 1999).

### Introduction

Cascadia Basin includes the deep ocean floor over the Juan de Fuca and Gorda Plates and extends from Vancouver Island, Canada, to the Mendocino Escarpment off northern California, United States (figs. 1, 2). Cascadia Basin contains a variety of Quaternary turbidite systems that exhibit different patterns of channel development and an extensive Holocene
Exhibit J
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)

Salem, Oregon
February 2013
1. Cascadia: Oregon’s Greatest Natural Threat

Introduction

When, not if, the next great Cascadia subduction zone earthquake strikes the Pacific Northwest, Oregon will face the greatest challenge in its history. Oregon’s buildings, transportation network, utilities, and population are simply not prepared for such an event. Were it to occur today, thousands of Oregonians would die, and economic losses would be at least $32 billion. In their current state, our buildings and lifelines (transportation, energy, telecommunications, and water/wastewater systems) would be damaged so severely that it would take three months to a year to restore full service in the western valleys, more than a year in the hardest-hit coastal areas, and many years in the coastal communities inundated by the tsunami. Experience from past disasters has shown that businesses will move or fail if services cannot be restored in one month; so Oregon faces a very real threat of permanent population loss and long-term economic decline.

We cannot avoid the future earthquake, but we can choose either a future in which the earthquake results in grim damage and losses and a society diminished for a generation, or a future in which the earthquake is a manageable disaster without lasting impact. We need to start preparing now by assessing the vulnerability of our buildings, lifelines, and social systems, and then developing and implementing a sustained program of replacement, retrofit, and redesign to make Oregon resilient to the next great earthquake. We know how to engineer buildings, roads, and power lines to withstand this earthquake; the hard part will be to find the will, commitment, and persistence needed to transform our state.

The Oregon legislature recognized the scale of this problem when it passed House Resolution 3 in 2011 (see Appendix I for details of House Resolution 3), noting the likely impact of a Cascadia earthquake and the need for a plan to move the state towards resilience to that event. The Oregon Seismic Safety Policy Advisory Commission (OSSPAC) was charged with developing a resilience plan, which is described in this report. The report summarizes the science of Cascadia subduction zone earthquakes and estimates their impacts; it then provides detailed analysis of the current vulnerability of our buildings and business community, and our transportation, energy, communication, and water/wastewater systems. The report defines the performance targets that each sector must meet to achieve adequate resilience, and provides detailed recommendations for the actions required to meet those targets over the next 50 years.

How OSSPAC Developed This Plan

House Resolution 3 passed by the 2011 legislature directed OSSPAC to “lead and coordinate preparation of an Oregon Resilience Plan that reviews policy options, summarizes relevant reports and studies by state agencies and makes recommendations on policy direction to protect lives and keep commerce
Geologists have assembled a ten thousand year record of past Cascadia earthquakes (see Figure 1.3) by studying sediments in coastal marshes and on the ocean floor. This record shows that past earthquakes have occurred at highly variable intervals and can range widely in size and in which parts of the Pacific Northwest they affect. About half of the past earthquakes have been very large (estimated magnitude 8.3 to 8.6) and centered on the southern Oregon coast, while the other half have been great (estimated magnitude 8.7 to 9.3) and extending from northern California to British Columbia. The most recent event occurred on January 26, 1700 AD, and was a great earthquake with a magnitude of 9.0. The time interval between previous earthquakes has varied from a few decades to many centuries, but most of the past intervals have been shorter than the 313 years since the last event. It is simply not scientifically feasible to predict, or even estimate, when the next Cascadia earthquake will occur, but the calculated odds that a Cascadia earthquake will occur in the next 50 years range from 7-15 percent for a great earthquake affecting the entire Pacific Northwest to about 37 percent for a very large earthquake affecting southern Oregon and northern California. The likelihood of a M 9 Cascadia earthquake during our lifetimes and the consequences of such an earthquake are both so great that it is prudent to consider this type of earthquake when designing new structures or retrofit of existing structures, evaluating the seismic safety of existing structures, or planning emergency response and preparedness.
Figure 1.4: Simulated shaking for the magnitude 9.0 Cascadia scenario.
Figure 1.6: Ground failure and movement for the magnitude 9.0 Cascadia earthquake scenario. Colored areas could experience more than one foot of ground movement due to earthquake-induced landslides in steep areas and liquefaction failure in lowlands. Both forms of ground failure can cause severe damage.

The amount of tsunami inundation that would be experienced along the coast due to the scenario magnitude 9.0 earthquake is quite variable and depends on local topography. Large parts of many low-lying communities, such as Warrenton, Seaside, Rockaway Beach, and Neskowin (see Figure 1.7), will be inundated.
Figure 1.8: Estimated permanent land subsidence from the scenario magnitude 9.0 earthquake for the Oregon Coast. Subsidence would occur during the earthquake.
Oregon's Infrastructure and Risk

The estimated impacts of a Cascadia subduction earthquake in Oregon are catastrophic. This is partly due to the sheer size and power of a magnitude 9.0 earthquake, but it is also the result of the inherent vulnerability of our buildings and lifelines. In 1974, Oregon adopted a statewide building code that mandated some seismic resistance for new construction. Prior to that date, the majority of buildings in Oregon had been designed without regard to earthquake forces. In 1993, Oregon's building codes were changed to require designs that would accommodate shaking from a Cascadia subduction zone earthquake, almost doubling the earthquake forces used in earlier codes. This means that the majority of buildings in Oregon have not been designed to resist the shaking from a magnitude 9.0 Cascadia earthquake. This widespread vulnerability of Oregon's buildings is grimly illustrated in the Statewide Seismic Needs Assessment completed by the Oregon Department of Geology and Mineral Industries (DOGAMI) in 2007. This study surveyed public schools and public safety buildings (police and fire stations, hospitals, and emergency operation centers) in Oregon and assessed their potential for collapse in a major earthquake. Almost half of the 2,193 public school buildings examined had a high or very high potential for collapse, as did almost a quarter of the public safety buildings. Of the 2,567 highway bridges in the Oregon Department of Transportation (ODOT) system, 982 were built without seismic considerations, and of the rest, only 409 were designed specifically with consideration of Cascadia subduction zone earthquakes. The list goes on: old, brittle iron water pipes in the Portland water system, century-old bridges over the Willamette River, and highways and power transmission lines that traverse landslide-prone terrain. The core of our vulnerability to a Cascadia earthquake is not the earthquake alone, but the inadequacy of our built environment.

The experience of the Tohoku earthquake shows that few structures are likely to survive in the tsunami inundation zone. In Oregon, the USGS estimates that almost 1,900 businesses employing nearly 15,000 people are located in the scenario inundation zone. The inundation zone also contains almost 10,500 housing units with a total population of just over 22,000. This exposure to the extreme hazard posed by the tsunami is unavoidable.

Another major factor that amplifies the effects of a Cascadia earthquake is the interdependency of our lifeline systems, coupled with the wide geographic spread of a Cascadia disaster. Unlike a severe storm, a Cascadia subduction earthquake would simultaneously damage power, natural gas, and petroleum lines, roads and bridges, water and sewer systems, critical buildings, and communications over large parts of three states (i.e., California, Oregon and Washington). Restoration of communication service would require that electric power be restored, which would require that roads and bridges be repaired, which in turn would require that the petroleum delivery and distribution system be repaired. These interdependencies between lifeline systems would be made even more difficult by the broad geographic extent of the damage. The nearest undamaged urban areas from which assistance could be organized would be Spokane, Washington, Boise, Idaho, and Redding, California. Virtually all of the resources required for the recovery of lifeline systems would have to come from outside the affected states.
Estimated Impacts

The scenario Cascadia earthquake would be an unprecedented catastrophe for Oregon and for the United States. It would impact every aspect of life for all Oregonians and for the residents of northern California, Washington, and British Columbia. The effects of a Cascadia subduction earthquake will be greatest on the coast, which is right next to the subduction zone fault, and will diminish as one goes inland. This, in combination with Oregon’s mountainous geography, divides the state into four impact zones: within the tsunami zone, damage will be nearly complete. In the coastal zone, shaking will be severe, liquefaction and landsliding will be widespread and severe, and damage will be severe. In the valley zone, shaking will be strong, liquefaction and landsliding will be common but less severe, and moderate damage will be widespread. In the eastern zone, shaking will be mild, landslides and liquefaction sporadic, and damage generally light.

The impacts of a great subduction earthquake on Oregon are impossible to predict accurately, but several studies have estimated damage and casualties, and those estimates give a sense for how far-reaching a disaster the next great earthquake will be. Estimated consequences include:

- Earthquake deaths ranging from 650 to 5,000, with another 600 to 5,000 deaths due to the tsunami.
- 24,000 buildings completely destroyed, and another 85,000 with extensive damage requiring months to years of repair.
- Approximately $32 billion in economic losses.
- 27,600 displaced households.
- Almost 10 million tons of debris (1 million dump truck loads).

These high levels of damage and loss reflect both the great size of the earthquake and the fact that many buildings, roads, bridges, and utility networks were designed before Oregon’s building codes and practices recognized any significant earthquake threats, and most were designed before codes began to take great subduction earthquakes into account. Lifeline systems, such as highways and pipelines, are particularly vulnerable to ground failure, which will be widespread in the next great earthquake. As a result, the vulnerability analyses done for this plan are grim. For example, if the earthquake were to happen tomorrow, the estimated time to restore function would be:

- One to three years to restore drinking water and sewer service in the coastal zone.
- One month to one year to restore water and sewer in the valley zone.
- Six to twelve months to restore partial function of the top-priority highways in the valley zone.
- Two to four months to restore police and fire stations in the valley zone.
- Eighteen months to restore healthcare facilities in the valley zone, three years or more in the coastal zone.
• One to three months to restore electricity service in the valley zone.

• Three to six months to restore electricity service in the coastal zone.

These estimates of the time it will take to restore the functions necessary to maintain our population and economy are sobering, particularly when coupled with the likelihood that businesses will start to leave the state if services are not restored within one month. If we pursue a policy of “business as usual,” our future after the next Cascadia earthquake will include decades-worth of declining economy and population. We can only avoid this future and achieve resilience by starting now on a sustained program to reduce our vulnerability and decrease our recovery time before the next earthquake inevitably occurs.

Recommendations

The Cascadia Scenario workgroup prepared a description of the likely effects of a magnitude 9 subduction earthquake for the other workgroups to use in their evaluations. The scenario used the best currently available data, and well-established methods, but still provides an estimate that has a lot of uncertainty and little detail. For an improved understanding of the threat posed by Cascadia earthquakes, we recommend that the state:

► Support Oregon universities and state agencies to carry out research into the effects of future Cascadia subduction earthquakes and tsunamis on Oregon’s landscape, population, buildings and lifelines;

► Support Oregon universities and state agencies in preparing more detailed and accurate estimates of damage and loss in Oregon from future Cascadia subduction earthquakes and tsunamis; and

► Provide ready access to the best available Cascadia earthquake information for emergency responders and planners, architects and engineers, and the general public.

► In order to ensure that design of future structures, retrofit of existing structures, seismic vulnerability evaluations and preparedness planning will provide adequate resilience, we also recommend that all of these efforts use, as a minimum, the ground motion parameters provided by the most current version of the International Building Code, which reflect the most current USGS seismic hazard maps.
Water for Fire Suppression

In the current state of readiness, existing water systems would experience extensive leaks and breaks in water supply pipelines. These leaks, coupled with loss of water supply facilities, such as treatment plants and pump stations, would drain the water systems. This loss of volume and pressure would critically limit the availability of water supply for conventional urban firefighting: fire hydrants would be rendered useless, and many fire sprinkler systems would be inoperable (even those sprinkler systems that remain intact).

Urban and suburban firefighting strategies would resemble those commonly used in rural areas: water for fire suppression would only be available from lakes, rivers, streams, swimming pools, and any surviving local water storage reservoirs. Fire engines would draft from these sites and rely on tankers to move water to fires. The combination of transportation infrastructure damage, compromised emergency communications systems, and high emergency incident volumes, would limit the ability of fire departments to respond to individual incidents. Fire departments would have to identify, assess, and prioritize responses and would focus on life safety and containment rather than trying to extinguish every fire. Photos of previous earthquake-relate fire events are shown in Figures 8.8–8.10.

Figure 8.8: Fire in the Marina District required a fireboat to pump water for suppression, Loma Prieta earthquake, San Francisco, 1989. Over 100 pipeline failures occurred within the immediate area. (Source: Photo Source Unknown)
Potable Water Supplies

In the current state of readiness, water utilities would be unable to provide water from the existing distribution system. Communities would rely on emergency supplies for the first one to two weeks, depending on location and on the condition of transportation infrastructure. Some areas would have no water supplies during that time. Water for healthcare facilities such as hospitals would be severely restricted. Emergency water supplies would meet only subsistence needs (for example, direct consumption and very limited bathing). For the first one to two months, water would be delivered via tankers to smaller tanks and bladders distributed throughout the community. People would wait in line to fill their containers and then carry the water home. Some water would come from portable water
Exhibit K
Jordan Cove LNG terminal at Coos Bay designed for Cascadia quake, tsunami though hazards remain

Loading Photo Gallery

Ted Sickinger | tsickinger@oregonian.com By Ted Sickinger | tsickinger@oregonian.com
Email the author | Follow on Twitter
on June 26, 2014 at 11:38 AM, updated June 27, 2014 at 3:37 PM

The worst-case scenario would be truly cataclysmic. A full rupture of the Cascadia Subduction Zone, unleashing a mega-thrust earthquake and tsunami comparable to the magnitude 9.1 temblor that devastated the coast of Japan in 2011.

The region's top seismic experts say such a quake could violently shake the entire Pacific Northwest for more than five minutes, liquefying soil, tossing massive structures off their foundations and sinking entire sections of Oregon's coastal landmass by several meters.

The damage would be most severe in areas closest to the rupture, such as Coos Bay, where the dangerous portion of the fault line passes eight miles off the coast. A subsequent tsunami could magnify the damage, transforming the entire estuary into a giant mixing bowl of devastation.

That's exactly why many Coos Bay residents oppose the Jordan Cove Energy Project, a natural gas export terminal proposed on a sand spit north of town.

They envision multiple pipe breaks leaking a witches brew of methane, ethylene and propane; a gas-fed inferno on the roof of one of the two storage tanks; or a tanker full of LNG ripped from its shipping berth and grounded, its contents leaking into the channel and forming an enormous, highly flammable vapor cloud.

From a regulatory perspective, such a nightmare scenario is not on the radar. The Federal Energy Regulatory Commission, the U.S. Coast Guard and the Pipeline and Hazardous Materials Safety Administration don't require Jordan Cove to model anything like it in the company's hazard analysis submitted to FERC.

They do require Jordan Cove to model an isolated set of single-spill scenarios, each completely contained within the facility's impoundment systems. According to the company and its engineering consultants, the resulting fire and vapor dispersion zones would be confined within Jordan Cove's property line and pose no threat to the public.

A cascading set of failures of the kind seen at Japan's Fukushima nuclear plant, where three reactors were pushed into a meltdown after a similar mega-thrust quake and tsunami, is not part of the public safety analysis.

"We don't close the waterways for maybes," said Coast Guard Lieutenant Russ Berg, discussing the possibility of a runaway tanker during a tsunami. "That's like closing airports that are close to volcanoes."
Not exactly. Experts maintain that a mega-thrust earthquake off the Oregon coast is not simply a possibility, it's inevitable. **In fact, it's overdue.** Historically such quakes have recurred every 240 years, with the last one 314 years ago.

"It should be an assumption that this will happen during the lifetime of the facility," said Chris Goldfinger, a seismologist at Oregon State University and leading authority on subduction zone earthquakes. "You can engineer anything to survive anything if you put enough money into it, but I've seen a lot of very well-engineered stuff destroyed as if it were Legos."

"From my perspective, and the probabilities, I would certainly have reservations about building one of these terminals down there," he said.

Project backers say their design is hardened against a magnitude 9 quake. They've planned myriad mitigation measures and multiple lines of defense.

"We've tried to take everything into account and build everything up beyond what the state considers the worst case scenario," said Jordan Cove's project manager, Bob Braddock.

He notes there are more than 30 LNG facilities on the coast of Japan. "They've been through an event close to what were talking about here, and none of them experienced a problem," he said.

The Japanese are the gold standard in earthquake preparedness. Yet when their engineers mapped the geometry of ocean trenches off Japan's east coast, they determined that a series of tsunami 15 meters high was not possible. Likewise, the failure of backup power systems and other containment measures was not considered plausible.

But in 2011, that's exactly what happened, to disastrous effect.

"I would say every one of us would be reluctant to suggest a liquefied natural gas terminal on the coast here," said Anne Trehu, an OSU geologist who studies the Cascadia Subduction Zone.

The Federal Energy Regulatory Commission has yet to issue its Draft Environmental Impact Statement for the facility, which will include its assessment of the facility's risks and mitigation plans. FERC's report is due this summer. And the project still faces a complicated permitting process before construction can begin.

The Oregonian put together the following overview based on interviews with Jordan Cove officials, industry experts, regulators and scientists, and a review of the company's hazard assessments filed with FERC.

**Isn't an earthquake a low-risk scenario?**
No. Scientists say there is a 40 percent chance of a mega-thrust quake centered off Coos Bay in the next 50 years.

The Cascade Subduction Zone, which runs parallel to the coast within eight miles of Coos Bay, is the mirror image of the fault line off Japan. It’s where the Juan De Fuca tectonic plate plunges beneath the North American continental plate. Right now, there is immense strain on the fault line, potential slippage that’s been accumulating since the last mega-thrust quake on January 26, 1700.

The timing of such quakes’ recurrence is imprecise, and varies along the length of the fault. Geologists say they’re more frequent along the southern section near Coos Bay, with an average recurrence at about 240 years.

When the fault finally ruptures, it could generate a maximum earthquake between magnitude 8.3 and 9.2, according to Jordan Cove’s analysis.

What are the general risks in a mega-thrust earthquake?

The physical risks to structures come from violent ground motion, soil liquefaction, lateral spreading and subsidence, meaning the entire coastal shelf sinks relative to sea level. Water-saturated sand and silt are particularly prone to liquefaction, experts say. Finally, there’s the tsunami generated by the quake.

Models provide scientists and engineers with a best guess of what might happen in a quake of a given size, but it's really just a best guess. Ground acceleration in earthquakes of a given magnitude vary widely, while tsunami size is dependent on the amount of slippage at the fault line and the shape of wave.

So what’s the ground like at the project site?

It's sand, silt and organic mill waste. The LNG terminal is proposed on a former mill site on the North Spit of Coos Bay, an overgrown sand spit that juts into the Pacific Ocean just north of town. The site is at the south end of the Oregon Dunes National Recreation Area, and sits atop a mantle of fine-grained sand and silt about 120 feet deep, underlain by weathered sandstone.

No faults are reported at the site and there has been only moderate seismic activity in Coos Bay during the last 170 years.

What exactly do they plan to build and why here?

Plans for the North Spit include: a liquefaction plant to purify and super-chill the natural gas into a liquid; storage tanks that would hold up to 80 million gallons of liquefied gas; smaller tanks for refrigerant chemicals; a shipping berth to load the LNG onto tankers; and a 420 megawatt power plant to supply electricity for the whole operation.
Why here? Coos Bay is an industrial port. Its leaders welcome the economic development opportunity, while other communities along the west coast have rejected LNG terminals.

**How is the LNG facility being designed to reduce earthquake damage?**

The first priority is to increase the density of existing soil at the site to prevent settling and collapse of the structures built on top during an earthquake. Jordan Cove's consultants concluded that the majority of sand at the site was dense enough to resist liquefaction during a magnitude 9 earthquake, but soil borings revealed a number of vulnerable layers. One potential solution is to drill a vibrating probe into those strata to rearrange the soil and eliminate voids. If that doesn’t do the job, engineers could inject cement into the strata to stabilize them.

Jordan Cove’s shipping berth will be excavated out of the North Spit. The spoils will be used to build two 80-acre mesas to elevate the storage tanks, liquefaction equipment and power plant above the predicted tsunami inundation zone. Again, the plan is to compact that soil to ensure it doesn’t settle differentially during an earthquake. The soil will not be reinforced or anchored, but the platforms will be surrounded by storm surge barriers reinforced with rip rap.

**What happens if one of the LNG storage tanks is ruptured?**

FERC doesn't consider that "a credible event," so Jordan Cove isn't required to analyze it. Jordan Cove says its required demonstrate that the tanks won't fail due to ground shaking that would be experienced in a magnitude 9 earthquake. The "full containment" tanks comprise a massive steel pot with a suspended aluminum ceiling to hold the LNG, three feet of insulation and a three-foot-thick concrete sarcophagus that’s big enough to impound the inner tank's contents if they leak. The resulting structure is so rigid that it's not considered plausible to break it open. The plan is to build the tanks on seismic isolation bearings, essentially putting them on a bed of springs, which would minimize shaking and sloshing in the tanks.

Braddock says the earthen dike surrounding the two tanks is tall enough to contain all 80 million gallons of LNG, but Jordan Cove isn’t required to model what would happen in that scenario.

**So what kind of leak are they required to model?**

The worst-case scenario is the biggest possible leak in a given area of the plant if a pipe was cut and associated pumps operated full blast for 10 minutes. The applicant is also required to model "jetting" leaks in refrigerant pipes operating under high pressure.

For Jordan Cove, the biggest possible leak is assumed to be equal to a 10-minute flow of the facility's maximum rate for pumping LNG into a tanker, or about 630,490 gallons. That's within the capacity of the facility's impoundment basins.

The model assumes single leaks, not multiple simultaneous pipe breaks. It also assumes that each spill is fully contained in an underlying trench and successfully directed to one of two impoundment basins.
So what is the risk when there's a leak?

On land, the immediate risk is one of asphyxiation to terminal operators as the LNG warms up and forms a dense methane fog close to the ground. As the gas continues to warm and dissipate, it forms a vapor cloud that can drift with the prevailing wind. If the methane reaches a concentration between five and fifteen percent, it is combustible if it reaches an ignition source.

On water, the big risk is a pool fire. Water forms a heat source to warm the LNG and form a substantial vapor cloud. If there is a sudden ignition of that cloud, the result can be a pool fire that is impossible to extinguish and will continue burning until the fuel supply is exhausted.

Spill risks are amplified at an LNG export facility by chemicals used to refrigerate and liquefy the natural gas -- ethylene, propane and methylbutane. They are heavier chemicals that can form denser vapor clouds and dissipate more slowly. Such clouds are subject not only to a flash fire when ignited, but potentially a powerful explosion that could damage other tanks and equipment at the facility.

FERC does not require applicants to models spills on water. But for each spill within the facility, Jordan Cove is required to demonstrate that a resulting fire, flammable vapor cloud or vapor cloud explosion will not extend beyond its property line or compromise the integrity of the storage tanks.

The consultant that performed the hazard analysis for Jordan Cove, Gex Con U.S., essentially found that the facility posed no hazard. The modeled vapor clouds from the modeled chemical spills remained, for the most part, within the facility's property line, aided by vapor barriers around the tanks and liquefaction equipment (which the model assumes would survive an earthquake). Likewise, the thermal radiation and explosion hazards from the design spills remained within the facility's property line. Jordan Cove plans to negotiate control for one area beyond its property line affected in some scenarios.

What risks does a tsunami pose to the LNG terminal?

Inundation of the LNG terminal or the power plant, or damage to a tanker full of LNG berthed at the facility.

Jordan Cove hired Joseph Zhang, a former professor in Oregon who now works at the Virginia Institute of Marine Science, to conduct tsunami modeling.

Zhang calculated that the first wave would sweep over the North Spit approximately 20 minutes after the earthquake, with a second, larger wave propagating up the shipping channel 10 minutes later. Depending on their timing, the waves could offset or reinforce each other, potentially amplifying the effects.

The study indicated that the biggest water run-up -- as high as 50 feet -- would occur on the ocean-facing side of the LNG tanks. Combined with the maximum expected subidence at the site of 13 feet, the total run-up would be just below the rim of the 65-foot berm.
Run-up and subsidence estimates were considerably less for the smaller, more likely, earthquake scenarios that Zhang modeled. In either case, the study concluded that the height of the proposed design "exceeds the design level tsunami event."

Yet Zhang also says "all the results need to be taken with a grain of salt." Before the Japanese quake in 2011, he said, geophysicists had concluded that 15-meter-high waves were not possible at Fukushima.

Yet that's exactly what happened, resulting in cascading series of failures that ultimately resulted in the meltdown of three nuclear reactors.

**What happens if the power plant is inundated, or the transmission lines topple, so the LNG terminal loses power?**

The power plant will be elevated out of the expected tsunami zone. But during any earthquake, Braddock says, vibration sensors would initiate an automatic shutdown. LNG product in process would be released though a vent, and the plant's sensors, powered by backup generators, would continue operating.

Oregon's Department of Geology and Mineral Industries has asked Jordan Cove for an independent, peer-reviewed study of the interdependencies between the power plant and LNG terminal, and the potential for cascading failures.

**So what if there's a tanker full of LNG in berth when an earthquake or tsunami strikes?**

There's not enough time to get a tanker out to sea in a near-shore earthquake. The plan, instead, is to decouple it from the loading dock and have three tractor tugs hold it in the middle of the slip. Braddock said the slip is 47 feet deep, enough draft to prevent a grounding of the tanker when water recedes during a tsunami.

The maximum wave height modeled in Jordan Cove's tsunami study was 36 feet at the north end of the tanker slip. Combined with potential subsidence of 13 feet, the tanker could be bobbing in a run-up of almost 50 feet. Lesser scenarios still showed a combined run-up at the north end of the slip of nearly 30 feet.

That's a massive and very sudden surge, one potentially full of debris. And it's not clear how a tanker would fare -- even a double-hulled tanker that affords additional protection to the cargo tanks.

Braddock says the storage tanks and other structures would divert a tsunami coming over the North Spit around the tanker slip. The wave affecting the slip would be the one that comes up the shipping channel, which would hit the tanker on the bow.
"We don't see a situation where the tanker is forced out of the slip," Braddock said. "If anything, it keeps it within the slip but not exactly the way we thought it would."

Zhang's study does not reach that conclusion, and the Coast Guard doesn't analyze tanker security in a tsunami.

"I'm very skeptical that anything can be done in a near-shore tsunami" to protect the tanker," said Randy Clark, a security specialist with the U.S. Coast Guard. "There simply isn't enough time. ... There are no real regulations. There is no requirement to mitigate this risk."

-- Ted Sickinger

© 2014 OregonLive.com. All rights reserved.
Exhibit L
Pacific Connector Gas Pipeline Project

Appendix No. 10

Appendices to Resource Report No. 10

Alternatives

Pacific Connector Gas Pipeline Project

June 2013
Appendix 10H

Direct Pipe Feasibility Evaluation Haynes Inlet
(May 1, 2013)
May 1, 2013

Pacific Connector Gas Pipeline, LP
295 Chipeta Way
Salt Lake City, Utah 84108

Attention: Bethany Green

Subject: Direct Pipe® Feasibility Evaluation
Haynes Inlet Direct Pipe® Feasibility Evaluation
Coos County, Oregon
File No. 16724-001-08 Task 1200

GeoEngineers, Inc. (GeoEngineers) is pleased to submit this Direct Pipe® Feasibility Evaluation for the Haynes Inlet crossing as part of the Pacific Connector Gas Pipeline Project in Coos County, Oregon. The Vicinity Map, Figure 1, shows the general site location with respect to topography and the surrounding area.

We previously provided a horizontal directional drilling (HDD) feasibility analysis for this site. Our evaluations and recommendations are presented in the memorandum, “Haynes Inlet – Preliminary HDD Feasibility Analysis,” dated November 15, 2006.

The results of the HDD feasibility analysis indicated that the combination of construction limitations, and the presence of dry-hole conditions along the proposed profile directly beneath Highway 101, present a significant risk of failure if attempted using the HDD methodology. While current HDD technology and practices can largely overcome the length limitations presented in the HDD feasibility analysis, the potential for an unsupported dry-hole section under the highway pose a risk of severe hole instability during HDD operations.

PURPOSE AND SCOPE OF SERVICE

The purpose of our services was to evaluate the existing surface and subsurface soil and groundwater conditions at the site in order to evaluate the feasibility of using Direct Pipe® (DP) to install the proposed pipeline beneath Haynes Inlet. Our specific scope of services included the following:

1. Reviewed our geotechnical exploration and laboratory-testing programs previously completed at the site to develop opinions regarding the feasibility of DP.

2. Prepared a preliminary DP plan and profile layout for the Haynes Inlet DP site.
3. Completed a feasibility evaluation of the proposed Haynes Inlet DP alignment and profile. The evaluation considered:
   a. Proposed length and depth of the proposed DP, including the feasibility of a single, intersect, or land to water installations;
   b. Site geology and subsurface soil and groundwater conditions;
   c. Potential site limitations for the intersect and land to water installations; and
   d. Other site limitations.

4. Completed and submitted this feasibility report for the proposed DP installation summarizing our review of the geotechnical exploration and our evaluation of the feasibility of the DP method of installation.

SITE DESCRIPTION

Surface Conditions

The proposed DP installation is oriented in a generally east-west direction. The west end of the proposed DP installation is located at the southern end of the sand spit where the Jordan Cove LNG is planned. Site grades are relatively level; however, we understand that site grades will be raised near the entry point for construction of the facility.

The east end of the DP installation is located along moderately steep sloping terrain that is currently vegetated with mature timber. The alignment crosses Highway 101 approximately 700 feet west of the entry point. A few hundred feet west of the highway crossing, the ground surface descends steeply down to Haynes Inlet.

Subsurface Conditions

Regional Geology

The Coos Bay area is part of a north-dipping structural basin within the Coast Range physiographic province. Marine to fluvial sediments (some coal-bearing) were deposited in this basin from late Eocene to Pliocene time, and later compressed into folds with north-south axes (Baldwin and Beaulieu, 1973). During higher relative stands of sea level, the ocean cut terraces and deposited beach sands and related sediments; uplift has brought these to about 350 feet elevation. The last rise in sea level drowned the low-lying valleys, while dune sands partly blocked the outlet, forming Coos Bay and its sloughs.

Seismic Setting

Coos Bay is located in the western margin of the North American tectonic plate and near the boundary of the North American plate and the Juan de Fuca plate. The Juan de Fuca plate is moving downward relative to the North American plate along the Cascadia Subduction Zone that is located offshore of the Oregon, Washington and California coasts. The relative movements and deformation between these two plates causes strain near the plate margins. Earthquakes near the subduction zone can result from inter-plate movements that release strain as well as plate bending, plate arching and spreading. Earthquakes can also occur as a result of volcanic activity in the Cascade Mountains.
Thus, the project site is located within a potentially seismically active region and may experience ground shaking during an earthquake.

**Site Geology**

Haynes Inlet, Coos Bay and the peninsula between the east and west arms of Coos Bay are underlain by the deltaic marine sandstones, siltstones and coal beds of the upper Eocene Coaledo Formation (Beaulieu and Hughes, 1975). The thickness of this sedimentary rock sequence ranges from several hundred feet to over one thousand feet. This rock unit was not encountered in the explorations near the planned DP alignment. The Coos River delta, Coos Bay, and Haynes Inlet are mantled by a mixture of intertidal and alluvial deposits consisting of clay, silt and sand. Borings near the alignment encountered sediments ranging between medium stiff silt to medium dense to very dense fine sand with varied amounts of silt.

**Subsurface Explorations**

The subsurface soil and groundwater conditions at the proposed Haynes Inlet crossing were evaluated during a previous HDD feasibility evaluation by completing five borings to depths up to 110 feet below existing ground surface (bgs) elevation. Boring HIB-2 was drilled on the west side of the inlet while borings B-5, HIB-7, HIB-8, and HIB-9 were completed on the east side, as shown on Figure 2. At the present time, no borings have been completed along the alignment within Haynes Inlet.

Based on the samples obtained from the borings, the subsurface conditions observed in boring HIB-2 consisted of approximately 28 feet of very loose to medium dense sand overlying dense to very dense sand to the termination depth of the boring at 90 feet bgs.

Boring B-5 encountered approximately 7 feet of medium stiff silt overlying medium dense to very dense sand to a depth of about 42 feet bgs. Bedrock was encountered below a depth of about 42 feet and consisted of moderately weathered siltstone overlying slightly to moderately weathered sandstone. Rock Quality Designation (RQD) values in the siltstone 83 percent and generally between 60 and 100 percent in the sandstone.

The soils encountered in boring HIB-7 consisted of very stiff to hard silt and clay to a depth of approximately 22 feet overlying dense to very dense sand with varying amounts of silt and clay to the bottom of the boring at a depth of 75 feet bgs. Boring HIB-8 encountered stiff silt and clay to an approximate depth of 38 feet where very dense silty and clayey sand was encountered to a depth of 110 feet where the boring was terminated. The soil encountered in boring HIB-9 consisted of stiff silt and medium dense silty sand to a depth of approximately 34 feet where hard clay was observed to a depth of 65 feet where the boring was terminated.

**Groundwater**

We were not able to obtain a reliable measurement of the regional groundwater level in the borings because of the presence of drilling fluid in the borings. We anticipate that groundwater levels will be similar to the surface water elevations in Haynes Inlet and will fluctuate with tide, precipitation, site utilization and other factors.
DIRECT PIPE® PLAN AND PROFILE

We developed the conceptual DP plan and profile generally based on the previously evaluated HDD alignment. The conceptual plan and profile is shown in Figure 2. The proposed DP installation is approximately 5,718 feet in length. This length is beyond the current capabilities of DP for a single drive for the proposed 36-inch-diameter product pipe.

However, there are two potential options to complete the installation using DP technology. First, the proposed DP installation can be completed using a DP intersect using two 48-inch-diameter microtunnel boring machines (MTBM). This involves advancing a MTBM drive from both the west and east sides and meeting at the approximate mid-point in the alignment. One MTBM would then be retracted while the other MTBM is advanced with the product pipe.

Alternatively, two shorter 42-inch-diameter DP installations could be advanced from the west and east sides, each exiting within Haynes Inlet. An over-water tie-in of the product pipes could then be made from a barge rig. For the two shorter DP installation concepts, Figure 2 shows the west option DP installation is about 2,567 feet in length. The east option DP installation is approximately 2,551 feet in length. There is approximately 600 feet between the DP exit points to allow for the over-water tie-in operations, see Figure 2.

DIRECT PIPE® FEASIBILITY CONCLUSIONS

General

Based on the available surface and subsurface information, the proposed Haynes Inlet pipeline crossing appears to be feasible for a DP installation from a subsurface conditions standpoint. Additional evaluation will be required during the design phase to evaluate the installation and operating stresses on the pipeline. Based on the results of those evaluations, we can provide further recommendations regarding pipe grade and wall thickness.

Subsurface Conditions

Based on the borings completed near the site, the anticipated subsurface conditions are likely to consist of medium dense to very dense sand and potentially siltstone and sandstone bedrock. If an appropriate cutting head is selected for the MTBM, DP should be suitable for mining the anticipated soil and bedrock.

A mixed-face cutting head on the MTBM will likely be used to excavate through the soil and possibly bedrock. This allows the MTBM to excavate through both soil and rock. The primary risk factor for DP at this site is the potential for the MTBM to encounter hard and abrasive bedrock or boulders. While the presence of boulders and hard rock is not anticipated, this assumption should be confirmed through additional borings to be completed along the alignment in Haynes Inlet. The use of a mixed-face cutting head, if the crushing cone is appropriately sized, would also reduce the risk of DP installation failure should hard rock be encountered.

Direct Pipe Geometry

In order for a DP drive of the proposed lengths to be feasible, the MTBM diameter must be large enough to house the hydraulic power packs within the MTBM machine. The standard 36-inch-diameter MTBM is
not large enough to house the hydraulics within the MTBM, which reduces the maximum drive length to less than 1,000 feet.

In order to complete a DP installation of the length required for the over-water tie-in option, a larger 42-inch-diameter MTBM would have to be used. As a result, the overcut during the DP process would be approximately 6 inches. It should be noted that the relatively small overcut (6 inches) is significantly less than the 12 to 18 inches of overcut that is typically required for an HDD installation of 36-inch-diameter product pipe. Because this installation will be mostly under Haynes Inlet, a concrete coating could be added to the product pipe before installation to provide buoyancy control and effectively increase the outside diameter of the pipe. The concrete coating would also reduce the risk of installation damage to the product pipe. The magnitude of potential settlement, particularly under Highway 101, would have to be further analyzed during final design.

For the DP intersect option, the total length is approximately 5,718 feet. Even using the intersect method, the required drive lengths are beyond the capabilities of the 42-inch-diameter MTBM. If the DP intersect option is selected the installation would have to be completed with at least a 48-inch-diameter MTBM. This would result in an overcut of approximately 12 inches. Even though the overcut with a 48-inch-diameter MTBM is similar to what would be required for HDD, the annulus will be continually filled with lubrication fluid, reducing the potential for collapse and over mining.

**Workspace Considerations**

The required area for the launch workspaces is similar to a typical HDD entry workspace and there should be adequate space for the required equipment on the west side; however, the site might be more constrained on the east side, see Figure 2.

In general, surface conditions on the west side of the alignment are more conducive to laying out a pipe stringing and fabrication area. Because the DP installation will have to be completed from both the west and the east side, adequate workspace for pipe fabrication and stringing will have to secured east of the east launch point. As a result, we have shown the conceptual pipe stringing and fabrication area on both the west and east sides of the site. Whether the DP intersect option or the two shorter DP installations are selected, each workspace will have to be sufficiently sized to provide space for pipe fabrication and stringing.

Minor to moderate grading may be required to prepare workspaces in the workspace areas. In addition, it may be necessary to provide a stable working platform such as a timber mat or gravel workspace during construction, particularly if construction is completed during the wet winter season, or when heavy prolonged precipitation occurs. In addition, the construction of the timber mat or gravel access roads may be required to access the entry and exit points and the product pipe stringing area during the winter months or when heavy, prolonged precipitation occurs.

**LIMITATIONS**

We have prepared this report for use by Pacific Connector Gas Pipeline, LP, their authorized agents and other approved members of the design team involved with this project. GeoEngineers’ report is not intended for use by others, and the information contained herein is not applicable to other sites.
report, conclusions and interpretations should not be construed as a warranty of the subsurface conditions.

Variations in subsurface conditions are possible between the explorations. Subsurface conditions may also vary with time. A contingency for unanticipated conditions should be included in the project budget and schedule for such an occurrence. We recommend completing a detailed DP design for this project should it move forward, and that sufficient monitoring, testing and consultation be provided by GeoEngineers during construction to confirm that the conditions encountered are consistent with those indicated by the explorations, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork and pipeline installation activities comply with contract plans and specifications.

The scope of our services does not include services related to construction safety precautions. Our recommendations are not intended to direct the contractor's methods, techniques, sequences or procedures, except as specifically described in our report for consideration in design.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices in this area at the time the report was prepared. No warranty or other conditions, express, written or implied, should be understood.

Any electronic form, facsimile or hard copy of the original document (email, text, table and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, and will serve as the official document of record.

Please refer to Appendix B, titled “Report Limitations and Guidelines for Use,” for additional information pertaining to use of this report.

REFERENCES


We appreciate the opportunity to provide services to you for this project. Please contact us if you have any questions or wish to discuss this report.

Sincerely,
GeoEngineers, Inc.

Andrew E. Sparks, PE  
Senior Geotechnical Engineer

Trevor N. Hoyles, PE  
Principal

Attachments:
Figure 1. Vicinity Map
Figure 2. Site Plan and Profile
Appendix A. Field Exploration Program
   Figure A-1 - Key to Exploration Logs
   Figure A-2 - Explanation of Bedrock Terms
   Figures A-3 through A-7 - Logs of Borings
Appendix B. Report Limitations and Guidelines for Use

Disclaimer: Any electronic form, facsimile or hard copy of the original document (email, text, table, and/or figure), if provided, and any attachments are only a copy of the original document. The original document is stored by GeoEngineers, Inc. and will serve as the official document of record.

Copyright© 2013 by GeoEngineers, Inc. All rights reserved.
Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
3. It is unlawful to copy or reproduce all or any part thereof, whether for personal use or resale, without permission.
Data Sources: ESRI Data & Maps, Street Maps 2008
Bing Maps Road Basemap from ESRI Data Online
Transverse Mercator, Zone 10 N North, North American Datum 1983
North arrow oriented to grid north

Vicinity Map
Hayes Inlet Direct Pipe Feasibility Evaluation
Coos County, Oregon

Figure 1
Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. can not guarantee the accuracy and current of electronic files. The master file is stored by GeoEngineers, Inc. and serves as the official record of this communication.
3. Refer to the boring logs in the accompanying report for more detailed soil descriptions.

FOR DISCUSSION ONLY

SITE PLAN AND PROFILE
HAYNES INLET DIRECT PIPE FEASIBILITY
COOS COUNTY, OREGON