Oregon Physicians for Social Responsibility

Please see the attached documents for Oregon Physicians for Social Responsibility comments on the SSEIS for Kalama Methanol.

OREGON PSR PHYSICIANS FOR SOCIAL RESPONSIBILITY

October 9, 2020

To:
Director Laura Watson
Washington Department of Ecology
300 Desmond Drive SE
Lacey, WA 98503

Submitted via Ecology's web portal and email to laura.watson@ecy.wa.gov

Re: Comments on the Draft Second Supplemental Environmental Impact Statement (DSSEIS) for Northwest Innovation Works' Methanol Refinery and Export Terminal.

Director Watson:

It is becoming increasingly clear that climate change is one of the greatest human health crises the world has ever faced. Human-derived greenhouse gas emissions are increasing global temperatures and causing extreme weather events, harmful algal blooms, larger and more catastrophic wildfires, and more. These symptoms of a changing climate impact human health and safety in a wide range of ways, the most recent example being the unhealthy wildfire smoke and evacuations experienced by West Coast residents from California to British Columbia.

Northwest Innovation Works (NWIW) has for years attempted to market itself as a part of the solution to climate change even as they were caught giving contradictory accounts of the end

uses of the methanol that would be refined and exported at their proposed Kalama Methanol facility. Building this refinery and export facility in the small town of Kalama would both exacerbate the climate crisis and cause immediate impacts to the health and well being of Southwest Washington.

Oregon Physicians for Social Responsibility opposes the expansion of transport, storage, or shipment of fracked gas within the Pacific Northwest states on the basis of serious, credible threats to the health of our residents. Our commitment as health professionals to improving the health of the public and achieving equity in health outcomes demands that we clearly and unequivocally communicate the urgent need to transition away from fossil fuels to clean and equitable renewable energy sources.

To this end, we present our comments on the DSSEIS to the Washington Department of Ecology and request that the Shorelines permit for the Kalama Methanol Manufacturing Facility be rejected. Any other permits for this project and permission for this project must be denied as the facility is not in the best interests of the people of the State of Washington nor our fragile planet. We specifically call attention to the adverse health impacts of continued extraction, transport, processing and use of fracked gas, its impacts on catastrophic climate disruption, and omissions, inaccuracies, and faulty assumptions of the DSSEIS as the basis for our urgent request.

We urge Ecology to reject NWIW's proposal for the following reasons:

- **The proposal is inconsistent with the path laid out by the Intergovernmental Panel on Climate Change to reach global carbon neutrality by 2050.**
- **The Washington Tracking Network has identified the communities of Kalama and nearby Longview as among the most vulnerable in the state to the deleterious effects of climate change. The proposal, therefore, violates the tenets of environmental justice.**

- **The greenhouse gas life cycle analysis (LCA) relies on a highly speculative market analysis of fossil fuels and plastics, which dismisses out of hand the effects of regulation and facilitates business as usual, which we know will not prevent climate catastrophe.**
- **The mitigation plan is voluntary and will likely rely on discredited or questionable carbon sequestration or carbon offset schemes.**
- **Current pipeline infrastructure in the state will not be adequate to handle projected needs. The LCA omits any analysis of the GHG effects of the construction and operation of new gas pipelines**
- **Multiple air toxins will be emitted by the facility. The cumulative effects on the local population of emissions, especially in combination with PM 2.5, have not been adequately assessed.**
- **No plans to mitigate the substantial risk of fire and explosion due to earthquake have been identified.**
- **Labor camps to accommodate the influx of workers for construction pose substantial public health hazards and costs to local residents**

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Climate Catastrophe and Environmental Justice

In 2018 the IPCC issued a report that outlined how much carbon emissions needed to be reduced in order to keep global temperature rise to no more than 1.5 °C, the goal of the Paris Climate Agreement.[1] The scientific consensus is that a rise in temperature above 1.5°C would result in catastrophic and irreversible global warming. In order to reach this goal, climate scientists of the IPCC calculated that global carbon emissions would need to be reduced by 45% by 2030. This calculation is what lies behind the prediction that the global community had 12 years (now 10 years) to take the action necessary to put us on the path to carbon neutrality by 2050.[2]

In 2016 already, independent researchers drew on industry and governmental data sources to make the case that the current growth of fossil fuel production in the US if it continued unabated would prohibit achieving the IPCC goal of 1.5° C global warming.[3] This level of growth is precisely what the DSSEIS supports. In other words, even the most optimistic projections of total net global greenhouse gas emissions from the Kalama methanol refinery are inconsistent with reaching a goal of 45% reduction of carbon emissions by 2030.

It is unthinkable for our survival on this planet to plan to extract, transport, process and use fossil fuels for the next 40 years, the proposed lifespan of this facility, when there is overwhelming scientific evidence that we must make drastic reductions in greenhouse gas emissions immediately. Ecology's conclusion flies in the face of common sense, as we are assaulted by multiple public health emergencies: catastrophic climate disruption causing increased heat, droughts, wildfires, floods, unbreathable air, increased illness and deaths from heat, storms, vector borne diseases, a pandemic of lung disease aggravated by air pollution, economic loss, displacement of thousands of people, and loss of water, food, and ecosystem supports. The adverse effects of climate disruption

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[1] Masson-Delmotte, Valérie, et al, editors, "Global Warming of 1.5° C," Intergovernmental Panel on Climate Change, 2018, https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_Low_Res.pdf

[2] Berwyn, Bob, "What does '12 Years (Now 11 years) to Act on Climate Change Really Mean", Inside Climate News, August 27, 2019, https://insideclimatenews.org/news/27082019/12-years-climate-change-explained-ipcc-science-solutions

[3] Mutitt, G. (2016, September). *The Sky's Limit: Why the Paris Climate Goals Require a Managed Decline of Fossil Fuel.* Retrieved from Oil Change International: http://priceofoil.org/2016/09/22/the-skys-limit-report/

on human health are numerous, serious, cumulative and increasing as we forego opportunities to change our behavior and reduce greenhouse gas emissions. Figure 1 below from the CDC summarizes health impacts of climate change.

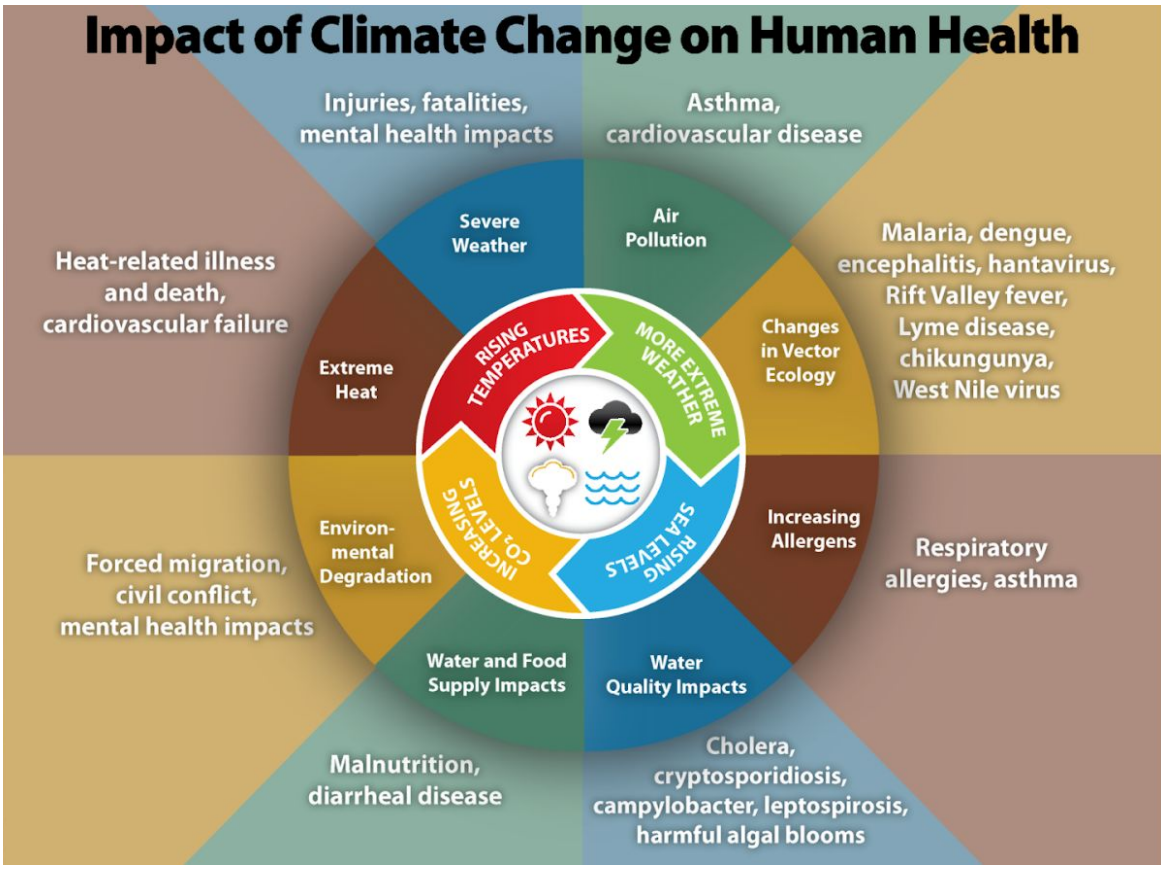

Fig. 1: Impact of Climate Change on Human Health (U.S. Centers for Disease Control and Prevention)

Furthermore, the adverse impacts of climate change will disproportionately affect low income, Black, indigenous, immigrant, houseless and other marginalized communities. Poor and underserved populations are at greater risks of illness and deaths due to heat related illnesses. They are also at increased risk of displacement, loss of jobs, homes and property resulting from the climate impacts of global warming.

Kalama, a small and beautiful rural town with a population of about 2,700 (2018), is nestled on the banks of the Columbia River in Cowlitz County. It is home to a busy and

thriving Port—the economic engine of the town—with miles of riverfront playground, beaches, public parks, and a marina that hosts many shops and restaurants. The Port's stated mission is "to induce capital investment in an environmentally responsible manner to create jobs and to enhance public recreational opportunities."[4]

Notwithstanding the fact that the Kalama Methanol refinery would be an eyesore—ugly, smelly and noisy—to this idyllic town and port, its climate impacts would have serious direct and adverse impacts on this vulnerable community, clearly an environmental injustice.

The Washington Tracking Network has identified those communities most vulnerable to climate change based on environmental exposure, environmental effects, population sensitivity, and socio-economic factors. Using this vulnerability index, Kalama has an index of 7 and nearby Longview 10 on a scale of 1-10 where 10 is highest.[5]

The disproportionate impact of climate change on Cowlitz County is related to the significant socioeconomic and health disparities experienced by its residents. These include a lower median income and higher percentage of persons living in poverty than Washington State as a whole. Cowlitz County has a higher age-adjusted mortality and higher mortality from cancer, cardiovascular and lung disease, diabetes and suicide than Washington State as a whole.[6]

The climate impacts to this community include an increase in the region's wildfires, which not only release more greenhouse gases into the environment but result in air pollution that has both short and long term impacts on health, especially the health of the most vulnerable—children, the elderly, and those with underlying health conditions.[7]

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[4] Port of Kalama, About Page, https://portofkalama.com/discover-port-of-kalama/about-the-port-of-kalama, accessed 6 October 2020.
[5] Oregon & Washington PSR, *Fracked Gas: A Threat to Healthy Communities.* June 2019.
[6] Oregon & Washington PSR, *Fracked Gas: A Threat to Healthy Communities.* June 2019.
[7] Oregon PSR, Airborne Particulate Matter and Public Health Fact Sheet (https://www.oregonpsr.org/environmental_health_factsheets)

A warmer climate results in warmer water which destroys salmon and fish habitat, resulting in a loss of important food sources and recreational opportunities. Higher temperatures mean a greater likelihood of water contamination and algal blooms. Heat-related illnesses and death, heat-related violence, drought related food insecurity, heavy rains, flooding, increased allergen-related illness, and vector-borne infectious diseases are all a result of climate change.

Importantly, the stress of all of the impacts of climate change, including displacement, results in anxiety depression, suicide, substance abuse, and violence, worse for those with underlying mental health conditions.[8] Cowlitz County's suicide rate is already higher than the State as a whole. We all just experienced a taste of how difficult it is to remain inside because of air pollution and grieving the loss of acres of our carbon-sequestering forests and favorite hiking and fishing areas. Others experienced far worse, losing their homes in the wildfires. This is just the beginning of what we are now calling "the new normal."

Environmental injustice as the result of climate change would have an outsized impact on Native Americans. The Affiliated Tribes of Northwest Indians[9] and the National Congress of American Indians[10] oppose fracked gas projects, sited near tribal lands and major population centers. Although the percentage of Native Americans living in Cowlitz County is about the same as that of the State of Washington, this project would affect their traditional activities, both cultural and economic. The climate effects on fish and salmon habitat would make fishing and other traditional activities along the shoreline of the Columbia River difficult if not impossible.

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[8] Oregon & Washington PSR, *Fracked Gas: A Threat to Healthy Communities*. June 2019.
[9] Indian Country Today, "Puyallup Battle LNG Facility in Tacoma", August 7, 2017. https://newsmaven.io/indiancountrytoday/archive/puyallup-battle-lng-facility-in-tacoma-Uas1XkEDVE-AKmnxc-cU1A/
[10] National Congress of American Indians. *Oppose the Siting of Liquefied Natural Gas Facilities in or Near Tribal Lands and Major Population Centers* (2018, October). Retrieved from National Congress of American Indians: http://www.ncai.org/resources/resolutions/oppose-the-siting-of-liquefied-natural-gas-facilities-in-or-near-tribal-lands-and-major-population-centers

Of further concern is that there has not been a complete cultural evaluation of the land that would be crossed by the 3-mile Kalama Lateral Pipeline for tribal cultural and burial sites, a violation of tribal rights.[11] The spiritual and mental health impacts to tribal members of both the failure to consult with them as well as the destruction of traditional cultural and burial sites cannot be overstated.

The climate-warming effects of the greenhouse gases generated by this project on the residents of Kalama, Cowlitz County and the Native American community is significant, unjust and cannot be mitigated.

Global Greenhouse Gas Emissions

The DSSEIS arrives at the remarkable conclusion that Kalama Methanol will result in a reduction in net global greenhouse gas emissions. The analysis, however, is highly speculative and unsupportable, projecting a future that is simply business as usual and which fails to take into consideration an entire array of contingencies. It excludes any effect of environmental regulation, here or abroad, and relies entirely on market-based assumptions. Its standard of comparison is not the best available technology for production of plastic, but rather the worst. Cloaked in the guise of unimpeachable "science", it does nothing more than support the gas industry claims that fracked gas is the answer to climate change. It is an odd stance for an agency whose mission it is to regulate the market in the interests of the public it serves.

The DSSEIS includes the key feature of an emission sensitivity model (ESM), the purpose of which is to delineate all possible greenhouse gas (GHG) emission outcomes from Kalama Methanol depending on:

1. alternate scenarios for the production of plastic in China
2. different end uses for the methanol produced, principally fuel

[11] Appendix B FERC Kalama Lateral Project Environmental Assessment, Northwest Pipeline LLC. Docket No. CP15-8-000

3. status of the global fossil fuel market and “other external forces”[12]

Many of the problems of previous drafts have been remedied in this analysis. For example, the analysis takes into consideration both the 20 and 100 year global warming potential (GWP) of methane; the GWP value for methane from the most recent Intergovernmental Panel on Climate Change (IPCC 5), and an upstream leakage (fugitive emission) rate as high as 3%. The use of these more conservative variables does not alter the outcome, however. The problems lie in other failures and omissions of the analysis.

To begin with, the ESM assumes that the market for plastics will continue to grow. Industry watchers do not agree. Carbon Tracker Initiative is an independent think tank which analyzes the impact of energy transition on capital markets for potential investors. They note that: “Policymakers in Europe and China are implementing much more stringent regulatory regimes [for plastics] using the five key tools of taxation, design rules, bans, targets, and infrastructure.”[13] Business Wire reported in 2018 that rising demand for plastics will face “significant new market pressures that threaten the future of plastics demand growth.”[14] In addition, the International Energy Agency predicted that the COVID-19 pandemic will reduce demand for plastic by around 4% in the near term.[15]

The oil industry[16] as well as the IEA[17] expect plastics to make up an increasing share of the demand for oil, or more specifically the petrochemicals refined from oil. Due to this,

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[12] DSSEIS, 2020
[13] Bond, Kingsmill, et al, *The Future is not in Plastics*, Carbon Tracker, September 2020, https://carbontracker.org/reports/the-futures-not-in-plastics/
[14] Business Wire, “As Global Plastics Demand Expands Rapidly, Sustainability is Key to Future of Plastics Industry, IHS Markit Says,”May 18, 2018. https://www.businesswire.com/news/home/20180518005048/en/As-Global-Plastics-Demand-Expands-Rapidly-Sustainability-is-Key-to-Future-of-Plastics-Industry-IHS-Markit-Says.
[15] International Energy Agency, *Global Energy Review 2020,* April 2020. https://www.iea.org/reports/global-energy-review-2020
[16] Carpenter, Scott, “Why the Oil Industry’s $4B Bet on plastics could backfire,” Sept 5, 2020, https://www.forbes.com/sites/scottcarpenter/2020/09/05/why-the-oil-industrys-400-billion-bet-on-plastics-could-backfire/#46edd08943fe
[17] International Energy Agency, “The Future of Petrochemicals,” October 2018. https://www.iea.org/reports/the-future-of-petrochemicals

all analyses predict that falling demand for plastic will result in downward impacts on both the production and the price of oil. As oil prices fall, feedstock for plastic production in China will gravitate to the cheaper, oil-derived naphtha-based olefin manufacture, displacing methanol. Ultimately this increases the net GHG calculus for Kalama Methanol as methanol is diverted to use as a fuel.

Nowhere is the scenario of reduced demand for plastic considered in the DSSEIS. The analysis does not "consider the possibility of new policies or market shifts to occur in the markets for fossil fuels or plastics. For example, a ban or phase-out of those products could have results that would alter the assessed impacts of the [Kalama Methanol refinery]." As further stated in the DSSEIS, "Scenarios with substantially different global policies (fossil fuel/plastics phase outs or bans for example) are too uncertain to include in this analysis." (DSSEIS, 2020) However, both investors and forward-looking segments of the fossil fuel and plastics industries themselves are taking into consideration, planning for and even aligning themselves with scenarios that Ecology claims are too uncertain to consider.

In effect, Ecology has chosen to exclude from analysis the very kinds of global changes that are needed to avert climate catastrophe. This is a clear abrogation of its responsibility to the public. It also flies in the face of current global trends. On September 22, 2020, for example, China pledged its intent to acquire 20% of its energy needs from renewables by 2025 and become carbon neutral by 2060.[18,19] On that same day, General Electric announced it will halt construction of any coal-fired plants.[20] One day later the governor of California signed an executive order that will ban the sale of gas-powered cars in the state by 2035.[21] It is puzzling how Ecology can consider these

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[18] Sengupta, Somini, "China, in pointed message to US, tightens its climate targets", *New York Times*, Sept 22, 2020, https://www.nytimes.com/2020/09/22/climate/china-emissions.html
[19] "RMI and ETC Salute China's Carbon Neutral Pledge, Rocky Mountain Institute, Energy Transitions Commission, September 23, 2020, https://rmi.org/rmi-and-etc-salute-chinas-carbon-neutral-pledge/
[20] Mufson, Steve and Dennis, Brady, "US companies make new vows to tackle carbon emissions, even as global action falls short," *The Washington Post,* Sept 22, 2020, https://www.washingtonpost.com/climate-environment/2020/09/22/climate-clock-week/?utm_campaign=wp_energy_and_environment&utm_medium=email&utm_source=newsletter&wpisrc=nl_green
[21] Grandoni, Dino, et al, "California to phase out sales of gas-powered cars by 2035", *The Washington Post*, Sept 23, 2020,

kinds of initiatives as more uncertain than the assumption of ongoing unfettered demand for fossil fuels. Ecology should at least consider the possibility that governments around the world will act to reduce reliance on fossil fuels or reduce the consumption of plastic.

The ESM also assumes that, once it recovers from the current pandemic-induced contraction, the market for methanol will continue to grow unabated for the next 40 years. Underlying this assumption are many more assumptions, even apart from the idea of continuous growth in the market for plastics. The ESM does not consider, for example, the possibility of another pandemic, or serial pandemics. Infectious disease and environmental experts tell us otherwise.[22,23] The adverse economic impacts of the current pandemic have been profound, particularly on the fossil fuel market. The International Energy Agency (IEA) predicted that 2020 will see a drop in demand for oil, coal and gas of respectively 9%, 8% and 5%.[24] Failure of the current pandemic to completely resolve and/or more pandemics to follow would create downward pressure on fossil fuel consumption and price that would profoundly alter the prospects of the methanol refinery as well as the calculus around GHG emissions. As discussed above, industry observers are warning of substantial stranded assets in the petrochemical industry. Kalama Methanol is likewise at risk.

The ESM further assumes global political and economic stability, that there will not be significant trade wars or disruptions in long-standing economic relationships, no significant social or political unrest which would further shape the choices of nation-states, and no significant military conflicts. But authoritarian governments are on

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https://www.washingtonpost.com/climate-environment/2020/09/23/california-electric-cars/?utm_campaign=wp_energy_and_environment&utm_medium=email&utm_source=newsletter&wpisrc=nl_green

[22] Lustgarten, Abrahm, *How Climate Change Is Contributing to Skyrocketing Rates of Infectious Disease,* Propublica, May 2020. https://www.propublica.org/article/climate-infectious-diseases

[23] Vaughan, Carson, *How do climate change, migration and a deadly disease in sheep alter our understanding of pandemics?* ENSIA and Food and Environment Reporting Network, September 3, 2020. https://ensia.com/features/pandemics-climate-change-migration-globalization-emerging-infectious-disease-covid19/

[24] IEA, 2020

the rise globally,[25,26] which will have profound but unpredictable consequences for future spheres of influence, military conflict, global migration, the organization of regional markets, trade relations and a host of other issues, all of which will, in turn, influence the supply and demand for fossil fuels.

An additional factor will be changes related to increasing climate-induced human migration. In 2018 the World Bank predicted that up to 143 million persons could be displaced by 2050.[27] A recent report from the Brookings Institute[28] notes some of the likely outcomes of this massive migration: “Intensifying intra- and inter-state competition for food, water, and other resources…; increased frequency and severity of disease outbreaks; increased U.S. border stress due to the severe effects of climate change in parts of Central America.” We have already experienced the downward economic impacts of disease outbreaks and conflicts over declining natural resources. These will likely continue into the future.

The ESM also takes at face value NWIW’s current statement of intent to target the plastics industry, a key factor underlying Ecology’s assumption that no more than 40% of methanol will be diverted for use as fuel. NWIW has already demonstrated its willingness to mislead the public about its intentions for marketing the methanol it generates.[29,30] In addition, for the first SEIS, the lifecycle analysis of methane emissions

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[25] World Politics Review, *What’s Driving the Rise of Authoritarianism and Populism in Europe and Beyond?*, September 11, 2020. https://www.worldpoliticsreview.com/insights/27842/the-rise-of-authoritarianism-and-populism-europe-and-beyond

[26] Beavers, Olivia, *National Security Experts Warn of the Rise in Authoritarianism*, The Hill, February 26, 2019. https://thehill.com/policy/national-security/431646-national-security-experts-warn-of-rise-in-authoritarianism-efforts

[27] Rigaud, Kanta Kumari, et al, Groundswell : Preparing for Internal Climate Migration. World Bank, Washington, DC. © World Bank, 2018. https://openknowledge.worldbank.org/handle/10986/29461

[28] Brookings Institute, “The Climate Crisis, Migration and Refugees,” 2019. https://www.brookings.edu/wp-content/uploads/2019/07/Brookings_Blum_2019_climate.pdf

[29] Aizhu, C. (2017, December 4). *China's CAS Plans Gas-to-methanol plant on U.S. West Coast.* Retrieved from Reuters: https://www.reuters.com/article/us-china-usa-gas-methanol/chinas-cas-plans-gas-to-methanol-plant-on-u-s-west-coast-idUSKBN1DZ0BH

[30] Solomon, M. (2019, April 19). *Controversial Kalama Methanol Plant May Be Misleading Public, Regulators.* Retrieved from Oregon Public Broadcasting: https://www.opb.org/news/article/methanol-plant-kalama-fossil-fuel-china/

for Kalama Methanol paid for by NWIW knowingly used outdated metrics to skew the results in its favor. It used the 2007 GWP of 25, (Erickson, 2018) which was scientifically recalculated and updated by the IPCC in 2018 to 34. The NWIW sponsored analysis also employed a methane fugitive emission rate of 0.32%, while the most recent science places the figure as high as 3%, as noted in the DSSEIS. (DSSEIS, 2020)

Apart from its problems with truth-telling and lack of allegiance to scientific integrity, NWIW, like all corporations, is beholden only to its investors and will market its methanol in whatever way it can to turn a profit, even if that means 100% of their product is used as fuel. Given that the plastics industry itself is subject to increasing regulatory demands, the assumption that only 40% of the methanol will end up being used as fuel is particularly untenable.

But most egregious of all is the total lack of consideration in the ESM for true alternatives to the climate-destroying fossil fuels. Coal-based production of plastics in China should not be our benchmark for comparison. Anything better than coal is not the policy that will spare the planet. We should benchmark climate-saving scenarios, for example, a ban on single-use plastics, which alone could reduce the production of plastics by up to 40% with a substantial positive impact on reducing global GHG production. GHG lifecycle analyses of global plastic production and disposal have been estimated to be equivalent to the GHG emissions of 189 500-megawatt coal power plants.[31]

Allowing the Kalama Methanol proposal to move forward locks the community of Kalama into supporting the fossil fuel industry, which is doing immeasurable harm to our planet. In 2016, independent researchers drew on industry and governmental data sources to make the case that the current growth of fossil fuel production in the US, if it

[31] Hamilton, Lisa Ann, et al, “Plastic and Climate: the Hidden Costs of a Plastic Planet,” Center for International Environmental Law, May, 2019, https://www.ciel.org/wp-content/uploads/2019/05/Plastic-and-Climate-FINAL-2019.pdf

continued unabated, would prohibit achieving the IPCC goal of 1.5° C global warming.[32] This level of growth is precisely what the DSSEIS supports.

One trend that seems not uncertain is the growth in demand for renewables. The IEA predicted, even in the context of a global pandemic, that solar will grow by 16% and wind by 12%.[33] Carbon Tracker notes that falling costs, improved technology, and growing demand to reduce pollution and avert climate disaster all favor a growth in the market for renewables.[34] Allied Market Research, which conducts market research for corporate entities (including Amazon, Google, Dow and Dupont, among others) predicts continuous robust growth in renewables at least through 2025 and cites the rise in government down-regulation of fossil fuels in both developed and developing nations as the chief driver.[35] The market relationship between fossil fuels and renewables is complex, but driving the price of fossil fuels down will likely depress the market for renewables, until the price of renewables falls below that of fossil fuels. The most worrisome aspect of a massive influx of methanol from Kalama Methanol into the Chinese market is that it will squeeze out the development or deployment of renewables and delay global transition to carbon neutrality.

The ESM purports to present the sum total of probable market scenarios for fossil fuels stretching into the next forty years. The driving assumption of the analysis is that the market for methanol will continue to grow for the next forty years. However, despite presenting a dizzying array of future scenarios, the analysis makes unsupportable claims about corporate behavior, makes highly speculative assumptions about fossil fuel market trends, and forecloses on the very opportunities we have to save our way of life in the Pacific NW.

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[32] Mutitt, 2016

[33] International Energy Agency, *Global Energy Review 2020,* April 2020. https://www.iea.org/reports/global-energy-review-2020

[34] Bond, Kingsmill, Was 2019 the peak of the fossil fuel era?", Carbon Tracker, May 1, 2020. https://carbontracker.org/was-2019-the-peak-of-the-fossil-fuel-era/

[35] Narune, Amit and Prasad, Eswara, "Renewable Energy Market by Type (Hydroelectric Power, Wind Power, Bioenergy, Solar Energy, and Geothermal Energy), and End Use (Residential, Commercial, Industrial, and Others): Global Opportunity Analysis and Industry Forecast, 2018–2025," Allied Market Research, May, 2019. https://www.alliedmarketresearch.com/renewable-energy-market

It seems unwise at best and at worst, reckless, to endorse a project that will spew tons of carbon into our air every year for 40 years based on a speculative version of the future. When faced with threats and uncertainty, the prudent response is to reverse harmful practices and instead invest in a renewable and equitable energy future.

Air Pollutants

Toxic air pollutant emissions caused by the Kalama Methanol refinery would include benzene, formaldehyde, acetaldehyde, nickel, ammonia, polynuclear aromatic hydrocarbons and diesel particulate matter. Several of these are known carcinogens. Individually, the estimated amounts released of each toxin would comply with current standards. But, there is no consideration of the cumulative effects of exposure to multiple cancer causing agents from different sources at once. There is no analysis of the increased exposures to these carcinogens when they are absorbed onto fine particulate matter and transported through the lungs to the blood and brain. What is the cumulative effect of exposure to a number of carcinogens combined? One can assume that the risks of cancers are increased. Exposure to even very small amounts of these toxins can increase the risk of cancers in the community as well as among workers exposed at the site and at neighboring worksites. Stating that the levels of exposure are below a certain standard is not the same as saying the risk of cancer is not increased.

According to the 2016 FEIS[36] that this DSSEIS supplements, the acceptable source impact level (ASIL) for Diesel Particulate Matter, based on Ecology's 2008 analysis, is 0.00333 micrograms per cubic meter of air which the FEIS states represents a negligible risk. In 2011, the US Environmental Protection Agency estimated the existing diesel particulate matter concentration in the Kalama site census tract at 0.61 micrograms per cubic meter of air. (EPA 2011) This is 183 times the ASIL, so we can assume that existing conditions in Kalama present more than a negligible risk to the health of workers and residents.

[36] Final Environmental Impact Statement, Kalama Methanol, Sept 2016. https://kalamamfgfacilitysepa.com/

We know that fine particulate matter (PM2.5) causes serious health problems including cancer, heart and lung disease, neurodevelopmental disorders and problems in pregnancy. Diesel emissions contain finer particles than PM2.5, known as black carbon, and can penetrate further into the lungs and into the bloodstream carrying toxic pollutants. It is also well established that reductions in exposure to black carbon have reduced the incidence of disease.[37] During construction and operation the methanol refinery would generate increases in diesel emissions in the Kalama area with increases in disease risk.

Elevated diesel emissions add to the other health threats from climate disruption such as increased extreme heat, storms, droughts, floods, wildfires, threats to our air, water, and food supplies. Amidst a respiratory pandemic we know that exposure to air pollution, and specifically fine particulate matter, increases susceptibility to the coronavirus.[38,39,40] We know that with climate related ecosystem disruption we are and will be exposed to greater risks of emergent and migrating diseases. We know that poor and underserved populations are at greater risks of illness and deaths due to heat related illnesses. We know that poor and underserved populations are at increased risks of displacement, loss of jobs, homes and property resulting from the climate impacts of global warming. The value of reversing course and denying permits for new fossil fuel facilities is clear not only in eliminating greenhouse gas emissions but also toxic pollutants like diesel which adversely affect our health.

Mitigation

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[37] Oregon & Washington PSR, *Fracked Gas: A Threat to Healthy Communities*. June 2019.
[38] Xiao Wu, Rachel C. Nethery, Benjamin M. Sabath, Danielle Braun, Francesca Dominici. Exposure to air pollution and COVID-19 mortality in the United States: A nationwide cross-sectional study. https://doi.org/10.1101/2020.04.05.20054502
[39] Petroni, Michael et al 2020 Environ. Res. Lett. 15 0940a9, Hazardous air pollutant exposure as a contributing factor to COVID-19 mortality in the United States
[40] Tung, Nguyen Thanh et al. "Particulate matter and SARS-CoV-2: A possible model of COVID-19 transmission." The Science of the total environment, vol. 750 141532. 5 Aug. 2020, doi:10.1016/j.scitotenv.2020.141532

Mitigation of greenhouse gas emissions is one of the main justifications for allowing the Kalama Methanol project to move forward. Mitigation does not reduce carbon emissions, and we have excellent evidence that we have no more time to allow any increases in those emissions if we are to avert the worst effects of climate disruption. Rather than permitting projects emitting more greenhouse gases and then attempting to offset them with carbon-sequestering or renewable energy projects at best, or purchasing carbon offsets at worst, we must not allow these emissions to begin with. We must increase carbon sequestration and renewable energy to "offset" the greenhouse gases that are already damaging our planet.

The DSSEIS indicates that "The project owner, NWIW, has proposed a framework Appendix D to account for and mitigate 100 percent of these direct and indirect greenhouse gas emissions on an annual basis for the life of the project, which is expected to be 40 years." We raise the following concerns with this proposal:

1. The "framework" proposed by NWIW is called a Voluntary Mitigation Program Framework. This is not mandatory nor a requirement by Ecology or Cowlitz County for its Shoreline or other permits and relies solely on the corporate goodwill of NWIW. We know that NWIW has a history of misleading the public; there is no reason to trust their promises.[41] We have no reason to believe that, once the facility and the pipeline are built and the facility is fully operational (having been granted the required permits and received grants and tax breaks), NWIW would continue to pay for mitigation.

2. NWIW proposes to mitigate 100% of all direct and indirect greenhouse gases emitted in Washington only. According to the DSSEIS (Table 3.5-14, p. 85), the amount of greenhouse gases emitted in Washington would be from 786,117 MT CO2e/yr (low estimate) to 1,421, 748 MT CO2e/yr (high estimate), which is less than 1/3 of the total greenhouse gases emitted by the project, 4.67 MMT CO2e/yr. This means that there is no plan for mitigation of the majority of

[41] Solomon, Molly, "Controversial Kalama Methanol Plant May Be Misleading Public, Regulators," *Oregon Public Broadcasting*, 19 April 2019
https://www.opb.org/news/article/methanol-plant-kalama-fossil-fuel-china/

emissions, both upstream and downstream, i.e. 1) fracking of gas to power the plant and for use to manufacture methanol, 2) transporting of methanol by ship to China, 3) manufacturing plastics, nor 4) burning methanol as fuel for transportation. Mitigation of less than one third of climate warming gases is not a substantive mitigation plan. Greenhouse gas emissions are a global, not local, problem.

3. The Voluntary Mitigation Program would be "governed" by a Board made up of "state, tribal and local governments, environmental and environmental health nonprofit organizations, and labor organizations." The accountability lies with the Department of Ecology and Cowlitz County. What does accountability mean? Would the "Framework" be set up such that NWIW would be expected to pay fines if it fails to meet the goals set by the Board? Because mitigation is voluntary and not mandated or required, neither Ecology nor Cowlitz County would have any legal authority to enforce mitigation. If fines were imposed, these would not mitigate the harm of greenhouse gases, and fines are frequently considered by corporations simply to be the cost of doing business.

4. The Board will "award and disperse funding for voluntary mitigation projects or, where necessary, the purchase of carbon credits." Although Appendix D does provide a methodology for calculating the budget for mitigation based on greenhouse gas emissions, how will the Board assure that NWIW is responsible for fully funding the mitigation work? Will NWIW ask that the Board raise some of the money for these projects or request reductions in fees or taxes from the State or County?

5. No specific projects or strategies were discussed except the purchase of carbon credits from U.S. carbon credit markets or voluntary U.S. carbon registries. Although the DSSEIS states that the priority for projects would be those that would benefit the local area, State of Washington, and the Pacific Northwest, the option for purchasing carbon credits is left open. Carbon registries may be

elsewhere and thus would not be of direct benefit to Washington. Given the ease of this option, it seems likely that NWIW would take advantage of this, such that there would be no direct benefit to local and Washington residents.

6. Even assuming that 100% of the greenhouse gas emissions attributable to Kalama Methanol could be mitigated, including those that occur outside of Washington state, mitigation of greenhouse gas emissions via the purchase of carbon offsets is not equivalent to avoiding the emissions of those greenhouse gases. Carbon offsetting, usually through the preservation of carbon-sequestering forests, is notoriously prone to fraud, unforeseen circumstances, and unreliable accounting of how much carbon dioxide is captured. Researchers have found that carbon sequestration gains from carbon offsets projects are often lost over time or inaccurately measured to begin with.[42] Even assuming that a forest offset project accurately offsets the emissions of a project like Kalama Methanol, a single forest fire can release nearly all of the sequestered carbon of a forest offset project. A study from the Stockholm Environmental Institute in 2015 found that 75% of the carbon offsets credits issued by the global offsets program Joint Implementation were unlikely to represent real reductions, and that if countries had cut pollution on-site instead of relying on offsets, global carbon dioxide emissions would have been 600 million tons lower.[43]

Corporations use the promise of mitigation to pretend they are reducing emissions. For example, carbon sequestration often means planting monoculture non-native trees, a

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[42] Song, Lisa and Moura, Paula. "Why Carbon Credits For Forest Preservation May Be Worse Than Nothing," *ProPublica.* 22 May 2019. https://features.propublica.org/brazil-carbon-offsets/inconvenient-truth-carbon-credits-dont-work-deforestation-redd-acre-cambodia/

[43] Kollmuss, Anja; Schneider, Lambert, and Zhezherin, Vladyslav. "Has Joint Implementation reduced GHG emissions? Lessons learned for the design of carbon market mechanisms." Stockholm Environmental Institute, August 2015 https://mediamanager.sei.org/documents/Publications/Climate/SEI-WP-2015-07-JI-lessons-for-carbon-mechs.pdf

destructive practice leaving forests more vulnerable to disease and wildfires.[44] We have good evidence that tree farms planted to replace logged forests burn hotter and leave a sterile landscape. It takes many years for newly planted trees to sequester significant amounts of carbon.

Most importantly the climate-changing effects of greenhouse gases cannot be mitigated. How can lost life from wildfires be mitigated? How can lost salmon due to the heating up of rivers and streams be mitigated? How can losses to the economy of the State from droughts, wildfires, floods, reduced snowpack, loss of wildlife and wildlife habitat be mitigated? These losses all result from continued use of fossil fuels including fossil gas, as is proposed for this methanol refinery.

Furthermore, any mitigation that is proposed must be based on demonstrated methods that are known and specified in detail by the applicant for a permit, with specifics about exactly what amounts of emissions each mitigation is known from experience to compensate. The Department of Ecology and the State of Washington cannot accept unsupported promises that may never happen or mitigation methods that fail. Given the uncertainty in the global markets for fossil fuels in the midst of an ever-worsening climate emergency, NWIW's funding mitigation over the course of 40 years, even for its Washington-based GHG emissions, is not based on reality in a market-driven economy. Mitigation must not be left to the voluntary good will of a major international corporation whose primary motivation is profit. Ecology must mandate reliable mitigation as a condition for granting permits, and the mitigation must include 100% of the greenhouse gas emissions generated by this project.

Considering only Washington emissions for mitigation is irresponsible. Washington does not exist in isolation from the rest of the country and the world. As we have seen with the COVID-19 pandemic, each entity that works for its own interests in isolation succeeds only in preventing control of an emergency that does not respect borders and jurisdictions. And, as we hear repeatedly, we are all in this together. If we do not

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[44] Ingalsbee, Timothy. *Incendiary Rhetoric: Climate Change, Wildfire, and Ecological Fire Management*. Firefighters United for Safety, Ethics, and Ecology, 2020 www:fusee.org, pg. 10. https://static1.squarespace.com/static/5e2c7d5a807d5d13389c0db6/t/5ecbfda2e8296a24e17436f5/1601670278230/Incendiary+Rhetoric_2020-6.pdf

combine our talents and resources to respond to emergencies as a planet full of people, we will not survive. It is that simple.

Fire and Explosion Risk from Earthquake

The proposed facility represents a substantial safety risk for workers and the Kalama community at large. The facility proposed by NWIW is far larger than what is currently in operation anywhere in the world. The plant would process massive quantities of fracked gas into liquid methanol. The highly flammable methanol would be stored on site in eight tanks, each capable of holding more than 8 million gallons of methanol.[45] Methanol has a very low flash point, 54 degrees F/12 degrees C, which is the lowest temperature at which its vapors will ignite and the maximum temperature at which the substance can be safely stored. This means that even at ambient storage temperatures, let alone hot weather or hot facility environments, a lot of vapor is produced, creating a high risk of fires or explosions. Methane is also extremely flammable and the combination of two volatile substances at the proposed plant compounds the risk of explosions and fires.

Under normal operating conditions, the risk of fire and explosion would be very low at the plant. However, due to its position on the Cascadia Subduction Zone the area is vulnerable to earthquakes. Experts estimate a 15% likelihood of a magnitude 9 earthquake in the region in the next 50 years[46] and a 42% likelihood of an earthquake up to a magnitude of 8.0 within the next 50 years.[47] Kalama, in other words, faces a 15 to 42% chance of experiencing a major quake during the lifetime of the methanol project. An earthquake of magnitude 8 would cause severe and widespread damage. A magnitude 9 earthquake would devastate the Northwest. The most severe impacts,

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[45] Luck, Melissa, "Risk of methanol explosion a hot topic in Kalama," *The Daily News*, Dec 10, 2016. https://tdn.com/news/local/risk-of-methanol-explosion-a-hot-topic-in-kalama/article_45a048f1-438e-52d1-b688-42364bed0c5a.html

[46] Goldfinger, Chris, et al, *The importance of site selection, sediment supply, and hydrodynamics: A case study of submarine paleoseismology on the northern Cascadia margin, Washington USA. Marine Geology,* 384, 4–46, (2017). https://doi.org/10.1016/j.margeo.2016.06.008

[47] Goldfinger, Chris, et al, Turbidite event history — *Methods and implications for Holocene paleoseismicity of the Cascadia subduction zone: USGS Professional Paper 1661-F.* (2012) https://pubs.usgs.gov/pp/pp1661f/

including soil liquefaction, landslides, and tsunamis, would fall on coastal areas.[48] In case of a tsunami, the immense force of the initial surge would carry marine vessels, other objects and debris inland, smashing coastal buildings and structures.[49] Weeks of inundation that could follow would compound the damage.

According to the Final Environmental Impact Statement (FEIS) for the Kalama methanol facility, sand and silt below groundwater levels at the site are susceptible to liquefaction. The FEIS estimated that liquefaction could occur as deep as 100 feet underground, which could cause soils underlying the refinery, dock and tank farm to spread and severely damage key infrastructure. The risks of earthquakes for pipelines in wildfire-prone forested areas include not just destruction of infrastructure but unmanageable wildfires in remote areas resulting from the release of gas. The destruction of communities with injuries and loss of life from a major earthquake could be compounded by catastrophic fires.

In an independent worst-case scenario analysis requested by Columbia Riverkeeper, a plane crash, terrorist attack, or a Cascadia Subduction Zone magnitude 9.0 earthquake, could rupture multiple tanks and if sparked, could possibly lead to an explosion in the remaining intact tank.[50] If catastrophic tank failure were to occur, leaking methanol could catch fire, and the vapor, if trapped, could cause an explosion that could shatter glass as far away as Longview and Rainier, destroy buildings within a six-mile radius and cause serious injuries in Kalama.

The Final Environmental Impact Statement for the Kalama project identifies seismic protections as part of construction plans; however, it states that a "ground improvement plan" will be designed as the project is being built, leaving questions about what such a

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[48] Harvey, H. *Fifty simulations of 'The Really Big One' show how a 9.0 magnitude earthquake in Cascadia could play out*, October 23, 2017. http://www.washington.edu/news/2017/10/23/50-simulations-of-the-really-big-one-show-how-a-9-0-cascadia-earthquake-could-play-out/

[49] Venturato, Angie, et al, *Tacoma, Washington, Tsunami Hazard Mapping Project: Modeling Tsunami Inundation. Pacific Marine Environmental Laboratory/National Oceanic and Atmospheric Administration*, January, 2007. https://www.pmel.noaa.gov/pubs/PDF/vent2981/vent2981.pdf

[50] Luck, 2016

plan would include and how it might protect workers and the surrounding community from consequences of a severe seismic event.[51] The risk of such an event is hardly trivial. Given the geologic vulnerabilities of the proposed site, a detailed engineering plan for meeting seismic standards should be vetted prior to construction to reassure residents that seismic standards can in fact be met.

New Fracking Wells and Pipeline

The refinery will use up to 320 million cubic feet of gas per day. This is more gas than is used by the region's biggest cities combined (See Figure 2). The amount of greenhouse gas emissions from the wells and pipelines supplying the refinery, i.e. "upstream" sources, are greater than that of the refinery itself. The upstream analysis of greenhouse gas (GHG) emissions comes from the estimates of GHGs generated by fracking and from the pipeline currently bringing gas to Washington. (DSSEIS, p. 80, Figure 3.5-12 below)

The refinery would become a destination for fracked gas produced by the American fracking industry and therefore serve to maintain or expand U.S. fracking operations. Fracking in the United States is already having a serious detrimental effect on health nationwide. One of the health impacts of fracking is potential exposure to the nearly 1 trillion gallons of wastewater brine produced by the U.S. fracking industry per year, nearly 10 times the amount of oil and gas that is extracted from the process of hydraulic fracturing.[52] This wastewater has high concentrations of naturally-occurring radioactivity, making it especially harmful for human exposure. Radioactive waste material from fracking is already impacting the Pacific Northwest, as evidenced by the February 2020 discovery of 2.5 million pounds of radioactive waste material that was dumped into the Arlington landfill in Oregon over the course of several years.[53]

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[51] Final Environmental Impact Statement, Kalama Methanol, Sept 2016. https://kalamamfgfacilitysepa.com/

[52] Nobel, Justin, "America's Radioactive Secret," *Rolling Stone,* January 21, 2020, https://www.rollingstone.com/politics/politics-features/oil-gas-fracking-radioactive-investigation-937389/

[53] Samayoa, Monica. "2.5M Pounds Of Radioactive Waste Illegally Dumped In Oregon Landfill", *Oregon Public Broadcasting*, 14 February 2020. https://www.opb.org/news/article/radioactive-fracking-waste-oregon-landfill-illegal-dump/

As noted by Columbia Riverkeeper it is likely that “another major fracked gas pipeline into the Pacific Northwest that would be triggered by NWIW’s massive fracked gas consumption.”[54] (Enclosure 1 Riverkeeper, et.al. Comments December 2018, p. 19-21) In 2018 the Northwest Industrial Gas Users (NWIGU) told the Oregon Public Utilities Commission that “our region is now experiencing high [gas] prices...not from an actual supply shortage but from an infrastructure constraint” (i.e. limited pipeline capacity into the Northwest). Riverkeeper, et.al. notes that the additional capacity required by the Kalama Methanol Refinery would “push the region over the threshold which a new regional pipeline would be constructed…”[55] (Enclosure 1 Riverkeeper, et.al. Comments December 2018, p. 19-21) The DSSEIS makes no mention of the probable need for additional gas and pipeline capacity nor is there an estimate of the amount of greenhouse gases that would be emitted from the construction of both new fracking wells and pipeline capacity. This is a serious omission that must be addressed by the DSSEIS. Additionally, the process of constructing a new gas pipeline in Washington State may not be feasible and could cause Kalama Methanol to be delayed or become a stranded asset, based on the history of delays and denials other gas pipeline proposals have recently experienced across the U.S.

[54] Enclosure 1 Riverkeeper, et.al. Comments December 2018, p. 19-21
[55] Enclosure 1 Riverkeeper, et.al. Comments December 2018, p. 19-21

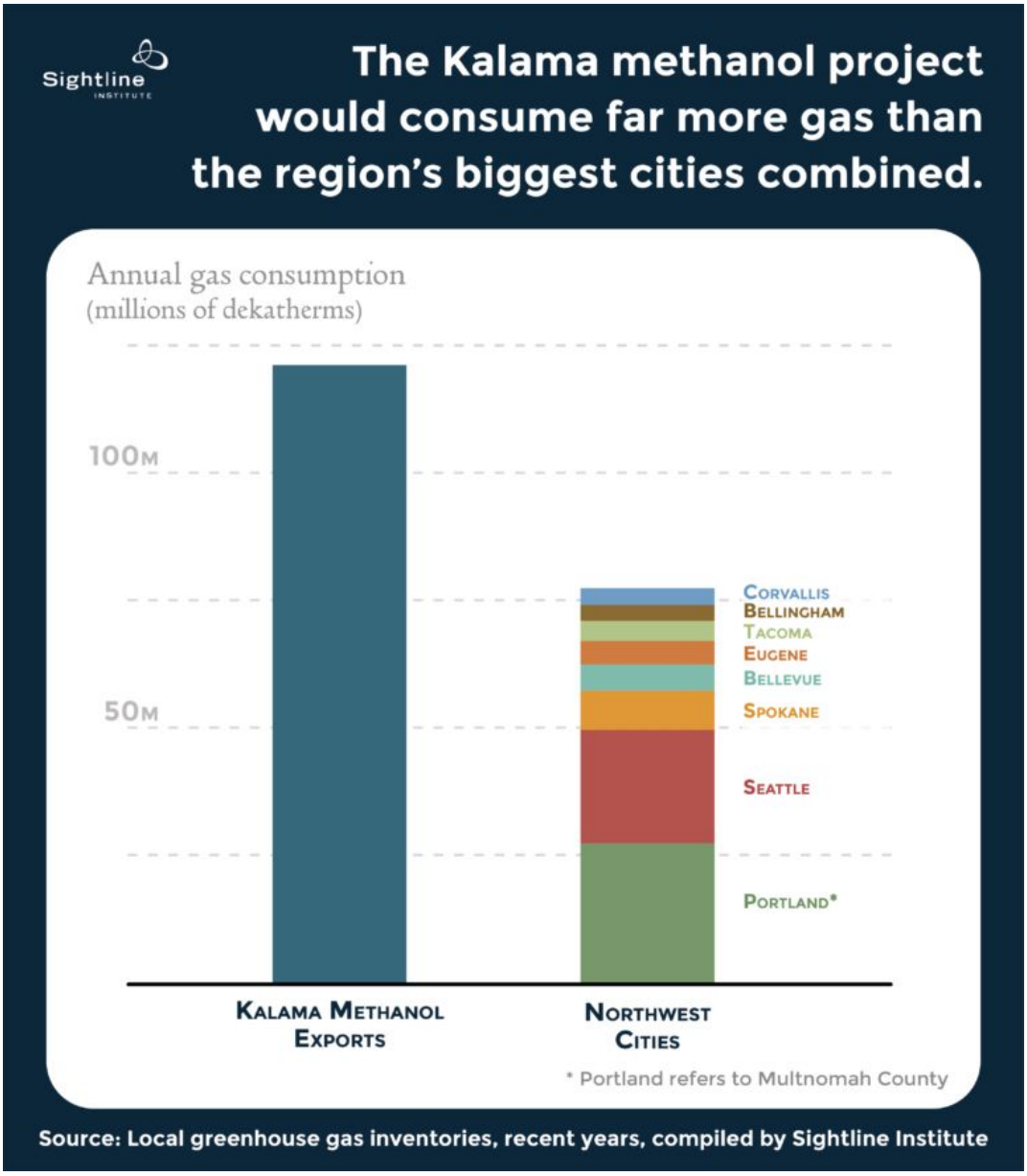

Fig. 2: Gas Consumption of Kalama Methanol Compared to Northwest City Consumption[56]

[56] de Place, Eric and DeStephano, Paelina. "What consumes more gas than many of Cascadia's cities combined?" *Sightline Institute.* 2 July 2018. https://www.sightline.org/2018/07/02/what-produces-more-gas-than-many-of-cascadias-cities-combined/

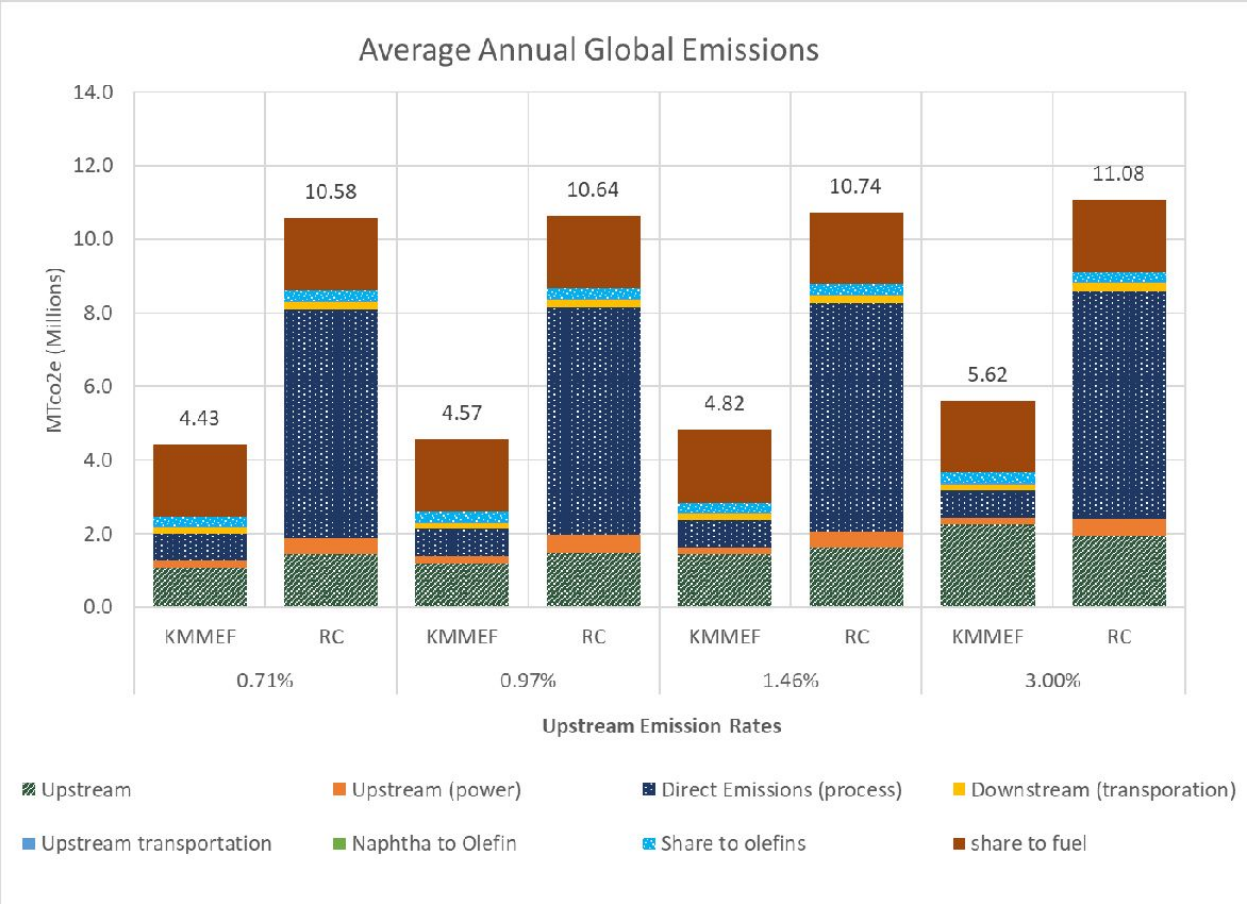

Figure 3.5-12. Average Annual LCA GHG Emission Estimates, with Kalama Methanol the RC Using Upstream Emission Rate of 0.71, 0.97, 1.46, and 3.0 -- page 80, DSSEIS

Temporary Labor Camps

Although the purpose of DSSEIS is to provide an accurate analysis of greenhouse gases generated by this Project, Ecology must consider the impacts to communities directly impacted by the Refinery. Greenhouse gases have no boundaries and vulnerable communities are at much greater risk of the health consequences of climate catastrophe.

Construction of the Refinery would bring a large influx of labor into the Kalama area. Temporary labor camps, so called “Man Camps” are often built to accommodate the

workforce. It has been well documented that the presence of extractive industries in a community place significant burdens on local infrastructure, public services and public health and increasingly on nearby tribal communities through increases in crime, drug use, assaults, kidnapping, sex trafficking, and sexually transmitted infections (STI)."[57] For example, North Dakota has reported a significant increase in cases of HIV/AIDS in the State's western oil fields.[58]

James Anaya, the United Nations special rapporteur, opened the meeting in 2014 of the UN Permanent Forum, stating "It has become evident…that extractive industries many times have different and often disproportionately adverse effects on indigenous peoples, and particularly on the health conditions of women." He detailed the effects on Native American women and girls, including increased rates of STIs and HIV/AIDS, physical assault, and sexual harassment and violence. He additionally noted that "contamination of indigenous lands and natural resources resulting from extractive activities has significant implications for reproductive health, having contributed in many cases to birth defects, delayed child development and disease among community members." In addition, he noted, the full range of health effects are yet to be determined, igniting fears among Native Americans about the unknown intergenerational effects that the contamination will have on their communities."[59,60].

The epidemic of "Missing and Murdered Indigenous Women," identified by many Human Rights groups, has found that "Native American women are murdered and sexually assaulted at rates as high as 10 times the average in certain counties in the United States—crimes overwhelmingly committed by individuals outside the Native American community. These crimes are particularly likely in remote settings where transient

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[57] Oregon & Washington PSR, *Fracked Gas: A Threat to Healthy Communities*. June 2019.
[58] Associated Press. "North Dakota HIV/AIDS rate rises with population growth" 13 October 2014. https://billingsgazette.com/news/state-and-regional/montana/north-dakota-hiv-aids-rate-rises-with-population-%20growth/article_a939fed6-f737-5cfb-957f-ab800673f4d7.html
[59] Oregon & Washington PSR, *Fracked Gas: A Threat to Healthy Communities*. June 2019.
[60] Anaya, James. Statement: Thirteenth Session of the United Nations Permanent Forum on Indigenous Issues, 2014. http://unsr.jamesanaya.org/?p=1170

workers - oil workers, for example - live in temporary housing units called “man camps” on and near Tribal lands.”[61]

Therefore, the impact of building new fossil fuel infrastructure, generating massive amounts of greenhouse gas emissions, on vulnerable communities, especially Native American women, would violate the principles of human rights and environmental justice.

Conclusion

The Kalama Methanol project would emit an unacceptably high level of greenhouse gases both inside and outside Washington state that are not mitigable in the ways that the DSSEIS outlines. Impacts on air pollution, water consumption, and environmental justice are also substantial. In order to safeguard the health of current and future Washingtonian generations and the livability of Kalama, the state of Washington must reject this project and move toward a clean, renewable, and sustainable energy future.

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[61] Cultural Survival Website https://www.culturalsurvival.org/country/canada

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December 27, 2018

Ann Farr
Port of Kalama
110 W. Marine Drive
Kalama, WA 98625

Sent Via Email to: SEIS@KalamaMfgFacilitySEPA.com

Re: Comments on the Draft Supplemental Environmental Impact Statement for Northwest Innovation Works' Methanol Refinery and Export Terminal.

Mrs. Farr:

The undersigned organizations (collectively "Commenters") have reviewed the Port of Kalama's ("Port") and Cowlitz County's ("County") Draft Supplemental Environmental Impact Statement and the accompanying lifecycle greenhouse gas study (collectively "DSEIS") for the

proposed Kalama methanol refinery and export terminal (the "proposal") and submit the following comments.

Commenters represent tens of thousands of members and supporters working to protect and restore Washington's environment and the Columbia River. Commenters' members and supporters work, live, and recreate in and along the Columbia River and the surrounding landscape near Kalama, the location of Northwest Innovation Works' ("NWIW") proposed methanol refinery and export terminal. Commenters and their members are deeply concerned by plans to construct a 100-acre methanol refinery, export terminal, pipeline, and associated facilities in and along the lower Columbia River. The project would undermine local and regional efforts to protect water quality, recover endangered and threatened species, support vibrant fishing communities, protect human health and safety, transition to a low-carbon economy, and combat climate change. NWIW's proposed methanol refinery is the latest in a disturbing trend of fossil fuel and petrochemical export terminals that would industrialize and pollute the lower Columbia River and increase Washington's contribution to climate change.

Commenters oppose NWIW's petrochemical refinery and export proposal because of its impacts on the Columbia River and our climate. Commenters call on Cowlitz County and the Washington Department of Ecology to deny NWIW's requested permits based on these agencies' authorities under the Washington Shorelines Management Act,[1] the substantive authority granted by the State Environmental Policy Act,[2] and the public trust doctrine.[3] Issuing permits for new fossil fuel infrastructure like NWIW's methanol refinery is the antithesis of addressing climate change—and the time to address climate change is now. Recent reports by the Intergovernmental Panel on Climate Change (IPCC)[4] and the U.S. Government[5] illustrate that severe climate change impacts could be felt by 2040, including "inundating coastlines and intensifying droughts and poverty."[6] A recent hot year, 2015, provided an unwelcome window into the near future of the Pacific Northwest if climate change continues unabated: "low stream levels and warm water resulted in fish die-offs; agricultural losses were between $633 million and $773 million in Washington alone; a combination of low snowpack and extreme precipitation deficit in spring and summer led to the most severe wildfire season in Northwest

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[1] *See* WAC 173-27-140(1) ("Review criteria for all development.") referencing RCW 90.58.020(1).
[2] RCW 43.21C.060.
[3] *See Illinois Cent. R.R. Co. v. Illinois*, 146 U.S. 387, 459–60 (1892).
[4] IPCC, *Special Report: Global Warming of 1.5 ºC* (October 1, 2018).
[5] U.S. Global Change Research Program, *Fourth National Climate Assessment, Volume II: Impacts, Risks, and Adaptation in the United States* (November 23, 2018).
[6] New York Times, *Major Climate Report Describes a Strong Risk of Crisis as Early as 2040*, (October 7, 2018).

history."[7] And Washington's critically important coastal areas are projected to experience sea level rise measured in feet, not inches.[8] Washington simply cannot respond to these immediate threats by permitting NWIW to build a massive new petrochemical refinery that would cause millions of tons of new climate pollution each year. As Fatih Birol, the executive director of the International Energy Agency recently said: "We have no room to build anything that emits CO_2 emissions."[9]

Incorporated by reference are all previous State Environmental Policy Act (SEPA) comments submitted by Columbia Riverkeeper and others on this proposal and exhibits thereto, including but not limited to comments on the scope of the SEIS. Because those documents are already in the Port and County's possession, Commenters do not attach them as exhibits to this letter but do request their inclusion in the record for the Supplemental EIS.

I. Washington State Environmental Policy Act.

In adopting SEPA, the Washington Legislature declared the protection of the environment to be a core state priority.[10] In SEPA, "[t]he legislature recognizes that each person has a fundamental and inalienable right to a healthful environment and that each person has a responsibility to contribute to the preservation and enhancement of the environment."[11] This policy statement, which is stronger than a similar statement in the federal counterpart of NEPA, "indicates in the strongest possible terms the basic importance of environmental concerns to the people of the state."[12]

The point of SEPA is to fully analyze the environmental impact of projects that have a significant impact on the environment.[13] The primary purpose of an environmental impact statement "is to ensure that SEPA's policies are an integral part of the ongoing programs and actions of state and local government."[14] SEPA "sets forth a state policy of protection, restoration and enhancement of the environment."[15] This is often characterized as the "look

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[7] Columbia Basin Bulletin, *Federal Climate Report Suggests More Warm Years Such As 2015 Will Be A Reality For Columbia Basin* (November 30, 2018).
[8] *See* Washington Coastal Resilience Project, *Projected Sea Level Rise for Washington State*, p. 6 (2018).
[9] The Guardian, *World has no capacity to absorb new fossil fuel plants, warns IEA* (November 12, 2018).
[10] RCW 43.21C.010.
[11] RCW 43.21C.020(3).
[12] *Leschi v. Highway Comm'n*, 84 Wn.2d 271, 279–80 (1974).
[13] RCW 43.21C.031(1).
[14] WAC 197-11-400.
[15] *Polygon Corp. v. City of Seattle*, 90 Wn.2d 59, 63 (1978); RCW 43.21C.010.

before you leap" concept, meaning that an agency must ensure that environmental effects are known and carefully considered before it is too late.[16]

The scope of impacts that must be examined in a SEPA document, similar to NEPA, includes direct, indirect, and cumulative impacts.[17] SEPA regulations define impact as "the effects or consequences of actions."[18] Agencies must "carefully consider the range of probable impacts, including short-term and long-term effects and shall include those that are likely to arise or exist over the lifetime of a proposal or, depending on the particular proposal, longer."[19] It is implicit in SEPA that an "agency cannot close its eyes to the ultimate probable environmental consequences of its current action."[20]

Under SEPA, an EIS must provide a reasonable set of alternatives: the preferred action and one or more alternatives (distinct and separate from mitigation measures).[21] The range of alternatives considered must be sufficient to permit a reasoned choice as opposed to the kind of constrained choices that lead to only one project or conclusion.[22]

II. The world's largest fracked gas-to-methanol refinery would have unavoidable significant adverse impacts under SEPA.

NWIW's methanol refinery would likely become the first or second single largest source and cause of GHG pollution in Washington,[23] increasing the state's total carbon footprint by 1 to 2 percent. The DSEIS' conclusion that NWIW's climate pollution is not "significant" at the state level defies logic. As set forth in our prior comments, this project would result in significant environmental impacts, including impacts from increased greenhouse gas (GHG) emissions—such as sea level rise and altered hydrologic cycles resulting in increased droughts, floods and storm events—as well as direct impacts from construction on local resources, including harm to marine life, including protected species, and marine ecosystems through increased vessel traffic and sediment deposition.

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[16] *See Marsh v. Oregon Natural Res. Council*, 490 U.S. 360, 371 (1989).
[17] WAC 197-11-792.
[18] WAC 197-11-752.
[19] WAC 197-11-060(4)(c).
[20] *Cheney v. City of Mountlake Terrace*, 87 Wn.2d 338, 344 (1976).
[21] WAC 197-11-440(5) and (6); *see also Organization to Preserve Agr. Lands v. Adams Cty.*, 128 Wn.2d 869, 913 (1996).
[22] *Solid Waste Alternative Proponents v. Okanogan Cty.*, 66 Wn.App. 439, 444–45 (1996) (citing *Methow Valley Citizens Council v. Regional Forester*, 833 F.2d 810, 815 (9th Cir. 1987), *rev'd on other grounds*, *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332 (1989)).
[23] *See* DSEIS, Table 3-1. Top 15 Individual GHG Emission Sources in Washington (2016).

The DSEIS—relying on a suspect coal displacement theory and a vague, unsupported promise of "voluntary" mitigation—concludes that NWIW's GHG pollution will have "no unavoidable significant adverse impacts" at the state or global levels.[24] As explained throughout this Comment, however, the DSEIS systematically minimizes and understates the true climate costs of NWIW's proposal. The many deficiencies in the DSEIS identified in this comment letter render the analysis incomplete and in violation of the Washington SEPA. The responsible SEPA officials must therefore revisit the "no unavoidable significant adverse impacts" determination and provider a full analysis of the adverse impacts this project would have on the environment, as SEPA requires.

III. The DSEIS violates SEPA by underestimating lifecycle GHG emissions.

There are several shortcomings of the life cycle analysis of the GHG emissions attributable to the proposal. As set forth below, the DSEIS' reliance on insufficient and misrepresented information renders the analysis entirely incomplete and suggests that the project would have much greater impacts than what is presented. Moreover, this insufficient analysis violates SEPA's mandate that an EIS contain a "reasonably thorough discussion of the significant aspects of a [proposal's] environmental impacts . . . ."[25] This standard boils down to the requirement that an EIS take a "hard look" at the proposal and its impacts on the environment and human health.[26] The self-serving life cycle analysis commissioned by NWIW does not meet this standard, for the following reasons.

a. The DSEIS' upstream methane leakage rate estimate is too low.

The DSEIS uses an implausibly low estimate of the amount of greenhouse gases that will be emitted by "upstream" activity, *i.e.*, producing, processing, and transporting gas to the Kalama facility. The DSEIS calculates these emissions using an estimate of the "leak rate," which is the percentage of the methane extracted from the ground that escapes to the atmosphere (whether through inadvertent leaks or through equipment that vents gas by design) before reaching its end use destination.[27] The DSEIS surveys a fraction of the available literature on methane emissions and selects a leak rate that is the absolute lowest, by far, of the provided

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[24] DSEIS, p. 3-31.
[25] *Toward Responsible Dev. v. City of Black Diamond*, No. 69418-9-I, 2014 Wash. App. LEXIS 197, at *1 (Ct. App. Jan. 27, 2014).
[26] *See Pub. Util. Dist. No. 1 of Clark Cnty. v. Pollution Control Hearings Bd.*, 137 Wash. App. 150, 158 (2007).
[27] DSEIS Appx. A, p. 117.

estimates: 0.32 percent.[28] Other estimates listed in the DSEIS are 3 to 7 times higher.[29] The 0.32 estimate cannot be reconciled with the wide body of peer reviewed literature regarding emissions from gas production[30] and reliance on that figure does not constitute the hard look that SEPA requires.

Most of the estimates cited in the DSEIS are either peer reviewed publications or readily available government reports, such as the EPA's annual greenhouse gas inventory.[31] The 0.32 figure, however, is simply cited as "GHGenius 2016." There reference list cites the general GHGenius website, which introduces the modeling tool, but nothing in the DSEIS identifies an actual report or publication. Not only is the .32 percent figure lower than the others provided in the DSEIS, but we are not aware of *any* peer reviewed or published government study of the gas lifecycle that adopts an estimate anywhere near this low.

The DSEIS fails to justify the disparity between the estimate it uses and other available estimates. The DSEIS asserts that the other cited literature concerns North America as a whole, but that gas production in British Columbia is lower-emitting.[32] This explanation is incomplete at best. The DSEIS does not provide any citation to actual data for portions of the upstream process beyond the wellhead.[33] Although the DSEIS generally cites aspirations for effective regulation of gas production in British Columbia, production throughout North America is subject to similar rules, and the DSEIS offers no support for the contention that these rules are more stringent or better enforced in British Columbia. And the body of the DSEIS tempers the claim that B.C. emissions are lower: when comparing scenarios in which the Project receives all gas from British Columbia vs. from North America generally, the DSEIS asserts this change would increase upstream methane emissions by 44 percent.[34] However, the peer reviewed or EPA estimates of North American gas production provide a leak rate that is 300–700 percent, not 44 percent, higher than the figure used in the DSEIS. Of these, the most credible is the highest estimate, which is the most recent, peer reviewed, and builds on prior data.[35]

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[28] DSEIS, p. 3-14; DSEIS Appx. A, pp. 117–18.
[29] DSEIS Appx. A, pp. 117–18.
[30] Exhibit 1, Alvarez, *et al.*, *Assessment of methane emissions from the U.S. oil and gas supply chain*, Science (2018); *see also* Tong *et al.*, *Comparison of Life Cycle Greenhouse Gases from Natural Gas Pathways for Medium and Heavy-Duty Vehicles*, 49 Environ. Sci. Technol. 12, p. 7126 (2015) (estimating methane leakage rates of 1.5–3.3 percent); *see also* Exhibit 2, Sierra Club, *Fracked Gas: Nothing "Natural" About It* (2018) (reviewing literature and estimating leakage rate of 3 percent).
[31] DSEIS Appx. A, pp. 117–18.
[32] DSEIS Appx. A, p. 118.
[33] DSEIS Appx. A, p. 118
[34] DSEIS Appx. A, pp. 48, 97.
[35] Exhibit 1; *see also* Tong *et al.* (2015) (estimating methane leakage rates of 1.5–3.3 percent).

b. The DSEIS methodology for calculating methane leakage is flawed and has been discredited.

Even the higher estimates cited in the DSEIS are almost certainly underestimates because they primarily rely on a "bottom-up inventory" methodology that multiple peer-reviewed publications have found to "systematically underestimate total emissions."[36]

"Bottom-up" studies use an estimate of the average emissions from an individual piece of equipment or an individual event, such as a high-bleed pneumatic device or a well completion, and multiply that per-component value by an estimate of the total number of components or events of that type (*i.e.* assuming that each well has X pneumatic controllers that emit Y tons of methane). A different method of estimating oil and gas sector methane emissions is a "top down" approach, where researchers measure the methane accumulation in the atmosphere in areas where oil and gas activity is occurring and then estimate the fraction of this methane attributable to emissions from oil and gas activity. For example, a researcher might measure methane concentrations upwind and downwind of gas activity and then subtract out the methane estimated to have been emitted from other sources. Certainty in source attribution has increased in recent years as scientists are better able to distinguish methane sources based on detected levels of co-occurring compounds such as ethane or isotopic composition of atmospheric methane.

Recently, peer-reviewed publications utilizing top-down techniques to estimate methane emissions from oil and gas have proliferated, and these studies provide compelling evidence that the aggregate methane emission estimates based on "bottom up" studies (such as those cited in the DSEIS) underestimate gas production methane emissions by a significant margin. For example, two studies in Colorado's Denver-Julesberg Basin concluded that, during gas production alone (not including emissions from downstream segments of the industry, like transmission and distribution), the gas leak rate was about 4%.[37] The same team of researchers found even higher methane leak rates in Utah's Uinta Basin, estimating escaped methane at 9 ±

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[36] Exhibit 1, p. 2; *see also* Brandt, *et al.*, *Methane leaks from North American natural gas systems Energy and environment*, 343 Science 6172 (February 14, 2014).

[37] Petron, *et al.*, *A new look at methane and non-methane hydrocarbon emissions from oil and natural gas operations in the Colorado Denver-Julesburg Basin*, 119:9 J. Geophys. Res. Atmospheres (June 3, 2014). This is consistent with an earlier study, by the same lead author, which estimated using top-down techniques that 2.3 to 7.7 percent of production was vented in the studied and concluded more generally that "the methane source from natural gas systems in Colorado is most likely underestimated by at least a factor of two." Petron, *et al.*, *Hydrocarbon emissions characterization in the Colorado Front Range: A pilot study*, 117:D4 J. Geophys. Res. Atmospheres 4304 (February 21, 2012).

3% of total production.[38] Other research has confirmed that this problem is not unique to the mountain west, and that North American emissions as a whole are understated.[39]

The peer reviewed literature offers compelling explanations for why bottom-up estimates are systemically too low. The bottom-up methodology relies on sampling methane leaks from various pieces of equipment under "ideal operating conditions."[40] However, evidence indicates that there are "a small number of 'superemitters'" with emissions that are much higher than anticipated by the emission factors used in the bottom-up estimates.[41] For example, one analysis of 75,000 components at five different facilities found that just 50 leaks and compressor seals were responsible for 58% of overall emissions.[42] These rare but severe leaks are unlikely to be represented in the data used to inform bottom-up calculations, which may be based on surveys of a few dozen, or even a hundred, components. This is especially so because site and equipment operators can be expected to operate especially diligently when they know they are being surveyed, such that "there are reasons to suspect sampling bias" in the surveys used to develop the emission factors used in bottom up analysis.[43] On the other hand, these superemitters are likely to be captured by top-down estimates.

In summary, the DSEIS's estimates of upstream emissions rely on a leakage rate that is doubly suspect: it is irrationally and drastically lower than the rates provided in the published literature cited by the DSEIS, but even those other estimates largely rely on a methodology that is known to systemically underestimate emissions. The SEPA "hard look" requires accounting for top-down studies of methane emissions and the flaws of bottom-up estimates.[44]

c. Assuming that NWIW's gas will come from the Montney shale formation in British Columbia does not pass SEPA's "hard look" test.

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[38] Karion, *et al.*, *Methane emissions estimate from airborne measurements over a western United States natural gas field*, 40:16 Geophysical Research Letters 4393 (August 27, 2013); *see also* J. Tollefson, *Methane leaks erode green credentials of natural gas*, Nature (January 2, 2013).
[39] Brandt *et al.* (2014) at pp. 733–35.
[40] Exhibit 1, p. 2.
[41] Brandt *et al.* (2014) at p. 733.
[42] EPA, *Cost-Effective Directed Inspection and Maintenance Control Opportunities at Five Gas Processing Plants and Upstream Gathering Compressor Stations and Well Sites*, Table 2 (March 2006).
[43] Brandt *et al.* (2014) at p. 734.
[44] *Toward Responsible Dev. v. City of Black Diamond*, 179 Wash. App. 1012 review denied, 180 Wash. 2d 1017, 327 P.3d 54 (2014) (unpublished opinion) ("Courts review an EIS as a whole and examine all of the various components of [the] agency's environmental analysis ... to determine, on the whole, whether the agency has conducted the required 'hard look.'").

Without a guarantee, or even any supporting documentation such as a completed contract, the DSEIS asserts that "NWIW will be contracting and receiving Canadian natural gas, primarily from the Montney formation in British Columbia."[45] Because the DSEIS provides no real evidence to support that the Montney formation will be the sole (or even primary) source of NWIW's gas for the next 40 years, a cynical reader might conclude that the project proponents selected the Montney field because it had a low reported methane leakage rate and because the British Columbian Ministry of Natural Gas Development government styles its self as "home to Best Practices"[46] for the fracking industry.

In reality, however, "is not clear why [NWIW's] assumption should "be expected to hold true for the 40-year lifespan of the Project, especially as United States natural gas production has increased substantially in recent years."[47] NWIW's massive new demand for fracked gas could "cause fuel shuffling that results in an increased use of non-Canadian natural gas for other projects."[48] Other sources of natural gas that the project could utilize would have a higher methane leakage rate, and therefore the DSEIS is using an unsupported assertion to minimize the potential emissions associated with the project, in violation of SEPA.

Even if the Montney region would ultimately supply a significant amount of NWIW's gas, the DSEIS' predictions about upstream methane leakage from this gas field are unlikely to hold true. First, as explained in Section III(b), above, the ultra-conservative "bottom-up" leakage rate estimates for the Montney field relied on in the DSEIS are unreliable and underestimate the actual leakage likely to occur. Second, most of the Montney field is actually in Alberta, and therefore not regulated by the British Columbian provincial government, undermining the DSEIS's reliance on the "Best Practices" that may be employed.[49]

d. The DSEIS obscures the climate pollution caused by making methanol into olefins.

NWIW's self-serving DSEIS attempts to have it both ways: on one hand insisting that this proposal is exclusively focused on producing olefins while on the other hand obscuring the

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[45] DSEIS Appx. A, p. 27.
[46] DSEIS Appx. A, p. 118.
[47] Exhibit 3, Washington Attorney General, *Comment to PSCAA on DSEIS for PSE LNG Project*, p. 1 (November 21, 2018).
[48] Exhibit 4, Washington Department of Ecology, *Comment to PSCAA on DSEIS for PSE LNG Project*, p. 1. (November 21, 2018).
[49] *See* Canadian National Energy Board, *Frequently Asked Questions - An assessment of the unconventional petroleum resources in the Montney Formation, West-Central Alberta and East-Central British Columbia* (Updated September 13, 2018).

climate pollution that would result from actually making NWIW's methanol into olefins.[50] The DSEIS states that the downstream GHG pollution caused by turning methanol into olefins would total 0.42 million tonnes of CO_2e, but that figure is "not reflected in the overall LCA conclusion."[51] The result of this omission is that the DSEIS repeatedly misrepresents the proposal's total direct and indirect emissions as 2.17 million tonnes CO_2e per year,[52] instead of 2.59 million tonnes. Thus, the DSEIS purposefully obscures a very significant source of downstream emissions and the overall impacts of the project, even though the GHG emissions related to olefin production are reasonably foreseeable if—taking NWIW at its word—the proposal would only produce methanol destined to become olefins.

SEPA does not allow NWIW to obscure the actual emissions attributable to the project by claiming that carbon emissions resulting from olefin production from methanol would be the same as olefins produced from coal. The excuse that the emissions "would occur either way" does not comport with SEPA's requirement to disclose a foreseeable indirect impact of making methanol to be turned into olefins.[53] And, as discussed below, this reasoning conflates the lifecycle analysis with NWIW's dubious "displacement" theory and makes it more difficult than necessary for the public and decisionmakers to understand the actual downstream climate pollution resulting from NWIW's proposal. Ignoring the foreseeable GHG emissions caused by turning methanol into olefins violates SEPA's requirement to take a hard look at a proposal's impacts.

IV. NWIW's market displacement theory does not pass SEPA's "hard look" test.

For the reasons below, NWIW's reliance on the theory that its methanol will displace the use of Chinese coal-derived methanol for the next 40 years does not constitute the "hard look" that SEPA requires. To comply with SEPA, an EIS must contain a "reasonably thorough discussion" of a proposal's environmental impacts, sometimes referred to as a "hard look."[54] The coal displacement theory is merely a loose association of unfounded assumptions selectively grouped together to prop up NWIW's proposal. As explained in the subsections below, these

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[50] *See* DSEIS, p. 3-19; *see also* DSEIS Appx A, p. 92 (lifecycle emissions would be "2.59 million tonnes of GHG emissions if the MTO facility is counted").
[51] *Id.*; *see also* DSEIS Appx. A, p. 92 (NWIW lifecycle emissions would be "2.59 million tonnes of GHG emissions if the MTO facility is counted").
[52] *See, e.g.,* DSEIS, pp. 1-6, 3-23; Fig. 3-12.
[53] *See* WAC 197-11-792 (explaining that the scope of an EIS includes direct, indirect, and cumulative impacts).
[54] *Toward Responsible Dev. v. City of Black Diamond*, 179 Wash. App. 1012 (2014); *see also Coalition for a Sustainable 520 v. U.S. Department of Transportation*, 881 F. Supp. 2d 1243, 1259 (W.D. Wash. 2012) (holding implicitly that "hard look" under NEPA sufficient for SEPA review).

assumptions, and the "displacement" theory they support, crumble when subjected to the "hard look" scrutiny that SEPA requires. Accordingly, **the displacement theory must be eliminated from any future SEPA analysis of this proposal**. Given the proposals' massive direct GHG emissions and the need for immediate GHG reductions to avoid the worst impacts of climate change, this unsupported theory is yet another attempt to paper over the proposal's actual impacts on our climate.

a. NWIW cannot predict or control the fluctuating fossil fuels prices that underpin its displacement theory.

NWIW's putative ability to "displace" coal-based methanol—without displacing other, lower GHG-intense sources of olefins like naphtha—is premised on NWIW's undisclosed assumptions about world fossil fuel prices. Even assuming, for the sake of argument, that NWIW would displace coal-based olefins under *current* fossil fuel prices, those prices are almost certain to change during the next 40 years in ways that NWIW can neither predict nor control. As the United States Court of Appeals for the D.C. Circuit recently noted, "projections of energy markets over a 25-year period are highly uncertain and subject to many events that cannot be foreseen, such as supply disruptions, policy changes, and technological breakthroughs."[55] Considering the radical and often unforeseen fluctuations in the prices of coal, crude oil, natural gas, and methanol that have occurred in the past decade, any projection that relies on those prices remaining static over the next 40 years is arbitrary and unhelpful.

b. NWIW's market analysis cannot accurately predict olefin production or consumption in China's planned economy.

The coal displacement theory is also unreliable because it ignores existing non-market forces—and cannot predict potential future non-market forces—that may significantly impact how olefins are produced and consumed in China. The Chinese economy is a planned economy, subject to government control over how, where, and when to produce and consume certain commodities.[56] The Chinese government has set aggressive air pollution and GHG reduction goals that are having, and will continue to have, a significant impact on the amount of coal mining, coal burning, and coal-to-olefins production in China. Additionally, the U.S. and China are engaged in an ongoing trade dispute which, via import tariffs, would directly affect the price of NWIW's methanol and its ability to displace other sources of methanol or olefins in Chinese markets. The DSEIS acknowledges some of these realities but does not explain how or why a classic supply curve—which does not account for some existing, and all future, non-market

[55] *Sierra Club v. United States DOE*, 867 F.3d 189, 194 (D.C. Cir. 2017).
[56] *See, e.g.,* DSEIS Appx. A, p. 59 (describing China's strict regulation of natural gas consumption by economic sector).

forces—provides a reasonable or helpful prediction of how China's planned economy would respond to increased methanol supply from NWIW.

Instead, the DSEIS states that the displacement "analysis is based on the assumption that no government subsidy is provided to the producer or the buyer and that the cash price of the product must cover the cost of production."[57] Under the existing circumstances, however—which involve escalating tariffs, massive financial support stateside for NWIW from state and federal agencies,[58] and a Chinese government with a history of subsidizing its own domestic industries—this assumption, and the displacement analysis it is intended to support, are not credible.

Specifically, the displacement analysis rests on the unsupported assertion that—if denied access to NWIW's product—China will simply increase its domestic coal-to-methanol production indefinitely to meet growing demand for methanol and olefins.[59] But China recognizes the problematic nature of its coal-to-methanol industry and is actively taking steps to reduce coal-to-methanol production and its GHG footprint.[60] NWIW's assumption that Chinese coal-to-methanol production will automatically rise to meet methanol and olefin demand is based on an irrational application of free-market principles to a planned economy. In reality, China is already acting to reduce coal-to-methanol production, appears likely to continue to do so without this project, and NWIW should not claim credit for "causing" reductions in coal-based methanol that are actually the result of Chinese domestic policy.

Alternatively, it is plausible that China would decide to produce and consume *more* coal-derived methanol, despite the market forces that NWIW foresees. The Final SEIS should discuss whether production and consumption of coal-based methanol in China is strictly market driven or whether it is driven "more by labor policy" and "social incentives," including China's government's desire to "foster downstream plastic processing as well as upstream coal mining employment in China's poorer interior regions."[61] If coal-based methanol production in China is not strongly linked to market forces, NWIW's production seems unlikely to influence the amount of coal-based methanol produced or consumed in China. Regardless, the SEIS needs to analyze

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[57] DSEIS Appx. A, p. 58.
[58] *See, e.g.,* Pacific Standard, *Taxpayers May Soon Be on the Hook for a $2 Billion Fracked Gas Refinery* (Nov. 7, 2018).
[59] DSEIS Appx. A, p. 58 ("[I]n the absence of attractive imported methanol, coal based domestic methanol production will continue to rise to meet growing industry needs based both in economic and market forces as well as policy direction.").
[60] DSEIS Appx. A, pp. 59–60.
[61] Center for International Environmental Law, *Fueling Plastics: How Fracked Gas, Cheap Oil, and Unburnable Coal are Driving the Plastics Boom*, p. 6 (2017).

the actual emissions associated with the project, and not attempt to minimize or ignore those emissions through an illogical and unsupported displacement theory.

c. NWIW's methanol production may add to other methanol and olefin production in China.

NWIW's entire claim to GHG reductions is based on its theory that NWIW's methanol will be consumed *instead of* coal-based methanol. But if the Chinese methanol-to-olefin industry consumes NWIW's methanol *in addition to* the available coal-based methanol, then NWIW's proposal would result in millions of tons of increased CO_2e pollution each year. Unfortunately, the market analysis in Appendix A of the DSEIS never explains why NWIW's plan to provide more and cheaper methanol to China's olefin producers will not just result in more overall methanol consumption.

First, the market analysis ignores the fundamental economic principle that increasing and cheapening the supply of a good usually results in increased demand for that good.[62] For instance, when crude oil production spikes and gasoline prices at the pump fall,[63] drivers respond, in part, by buying more gasoline.[64] Similarly, cheapening the production of olefins (by selling NWIW's cheap methanol to Chinese methanol-to-olefin plants) should decrease the market price of olefins, increasing the demand for olefins and their precursor—methanol. Accordingly, the DSEIS' assumption of a 1-to-1 displacement of coal-based methanol (and its GHG emissions) is likely incorrect because the DSEIS does not appear to account for increased olefin demand and consumption as a result of cheapening olefin production. In order to adequately address this issue, the final SEIS would need to examine the market for plastics and other end-uses for olefins. Unless the demand for plastics is static, and demand does not fluctuate in relation to price, cheaper plastics made from NWIW's cheaper methanol would result in increased plastics consumption and a concomitant increase in the GHG pollution associated with plastics manufacture.

Second, the displacement analysis does not deal realistically with China's rapidly expanding demand for methanol or the impact of that expanding demand on future GHG emissions. NWIW's market analysis essentially boils down to this statement: "the low delivered cost" of NWIW's methanol "will displace higher delivered cost product [Chinese coal-based methanol] *in a stable demand environment*."[65] But the demand for methanol in China is far from

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[62] *See* The Balance, *Elastic Demand with Its Formula, Curve, and Examples* (August 13, 2018).
[63] *See* The Balance, *How Crude Oil Prices Affect Gas Prices* (October 29, 2018).
[64] *See* New York Times, *When Gas Becomes Cheaper, Americans Buy More Expensive Gas* (October 19, 2015).
[65] DSEIS Appx. A, p. 80 (emphasis added).

stable. Elsewhere, the DSEIS admits that there is "rapid grow in Chinese methanol consumption"[66] and that "demand for methanol is growing."[67] The downfall of NWIW's theory is that, as demand for methanol in China continues to grow, the Chinese methanol-to-olefin industry will ultimately absorb both NWIW's production *and* all of the higher-cost methanol produced by Chinese coal-to-methanol plants. At that point, the GHG emissions from NWIW's proposal would add to, rather than displace, GHG emissions from China's coal-to-methanol plants. The SEIS must account for this potential increase, and analyze the impacts to the environment as SEPA requires.

NWIW essentially admits that increasing demand for methanol in China will, at some future date, undercut its coal displacement theory, as described in the preceding paragraph.[68] NWIW's response to this obvious deficiency in its market analysis is that—at any future level of increased methanol demand—NWIW's cheap methanol would still be displacing methanol made by some hypothetical future high-cost, high-GHG coal-to-methanol plant that would occupy the marginal position on the methanol supply curve.[69]

The first problem with NWIW's dismissal of the impact of increasing methanol demand on the displacement theory is that NWIW assumes that China would increase its coal-to-methanol production if methanol demand ever exceeds the capacity of China's existing coal-to-methanol facilities (plus imports). As explained in Section IV(b) above, China may not necessarily increase its coal-to-methanol production if methanol demand exceeds supply. China recognizes the problematic nature of coal-to-methanol, has already taken steps to limit its production, and could decide to prohibit the construction of any new coal-to-methanol facilities in the future (as China has prohibited natural gas-to-methanol facilities, albeit for different reasons). If China caps or restricts future coal-to-methanol production, the hypothetical future coal-to-methanol plant that NWIW envisions displacing would never have existed anyway and NWIW's GHG emissions will merely add to the emissions of the existing coal-to-methanol plants that would be operating at full capacity to meet increased methanol demand. Again, the DSEIS fails to account for this reasonably foreseeable outcome.

The second problem with NWIW dismissing the impact that increasing methanol demand will have on displacement is that, even if NWIW would displace some hypothetical future high-cost source of methanol, that source might not be a coal-to-methanol plant (as the DSEIS

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[66] DSEIS Appx. A, p. 64.
[67] *Id.* at p. 78.
[68] *See* DSEIS Appx. A, p. 80 ("As the methanol market continues to grow, some of this displacement of higher cost existing supply may be mitigated . . . .).
[69] *See* DSEIS Appx. A, p. 80 (asserting that, even at high levels of methanol demand, "the continued development of high cost CTM or CTO plants will be reduced").

assumes). As demand increases, the methanol provider on the margin of the supply curve could change from a coal-to-methanol plant to some other source of methanol with higher production costs than coal—but a smaller carbon footprint than NWIW. For instance, if the marginal supplier in a high-demand scenario turns out to be a facility that makes methanol via electrolysis powered exclusively by solar energy,[70] then NWIW's methanol would wind up "displacing" a lower-GHG source of methanol. Given rapidly increasing demand for methanol, constantly shifting fossil fuel prices and regulations, and rapidly evolving petrochemical technologies, it is not reasonable to assume that any particular source of methanol will be on the margin of the supply curve in three, five, fifteen, or forty years. Accordingly, NWIW's assertion that it will be displacing high-GHG coal-derived methanol for the entire lifetime of the Kalama proposal is mere salesmanship and cannot survive the "hard look" required by SEPA.

d. Cheap crude oil and naphtha-derived olefins may displace coal-based olefins independently of NWIW's proposal.

NWIW's displacement analysis, focused exclusively on the methanol-to-olefin market, conveniently side-steps the impact that naphtha-derived olefins may have on the production of Chinese coal-based olefins. If the cost of naphtha-based olefins dips (as a result of low crude oil prices) below the cost of coal-based olefins, then (by NWIW's logic) olefin consumers would purchase naphtha-based olefins to the exclusion of coal-derived olefins. Nevertheless, NWIW fails to explain what crude oil price would allow naphtha-derived olefins to undersell coal-derived olefins or why NWIW expects world crude prices to remain above that magic number for the next 40 years, especially in the current volatile market. One study found that coal-based olefin production in China became unprofitable—and olefin derived naphtha became even more profitable—when the world price of crude was less than $65 per barrel.[71] As of December 21, 2018, crude oil was trading at around $50 per barrel.[72] In fact, WTI crude has only barely climbed above $65 per barrel on a few occasions in the last four years.[73] The displacement theory NWIW has relied on disintegrates under that scenario because cheap crude oil and naphtha could easily remove the Chinese CTO industry with or without NWIW, a possibility conveniently ignored in the DSEIS.

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[70] *See, e.g.,* Uusitalo *et al.*, *Potential for greenhouse gas emission reductions using surplus electricity in hydrogen, methane and methanol production via electrolysis*, Energy Conversion and Management, Vol. 134, pp. 125–34 (February 2018).
[71] Exhibit 5, Qun *et al.*, *A comparison between coal-to-olefins and oil-based ethylene in China: An economic and environmental prospective*, 165 Journal of Cleaner Production 1351–1360, 1356 (2017).
[72] *See* Oilprice.com (last accessed December 21, 2018).
[73] *See* Macrotrends, *WTI Crude Oil Prices - 10 Year Daily Chart* (last accessed December 21, 2018).

NWIW's rejoinder is that the supply of "refinery co-produced olefins [*i.e.* naphtha-derived olefins] will not increase without an expansion in oil refining capacity,"[74] so Chinese coal-to-olefins will remain marketable because demand for olefins is increasing and there is not a sufficient supply of naphtha to meet that demand. The DSEIS, however, does not provide any data to support its implication that the current or future demand for olefins in China exceed existing naphtha-based olefin supplies. Further, NWIW incorrectly implies that world petroleum refining capacity is not expanding. It is, and growth in global demand for refined products, like naphtha, is tapering off at the same time.[75] With crude prices remaining low and refinery capacity increasing, cheap naphtha-based olefins could easily disrupt China's coal-to-methanol-to-olefins market. If cheap naphtha displaces coal as a raw material for olefins because of low crude prices, NWIW cannot reasonably claim credit for reducing the GHG footprint of China's olefin industry. The DSEIS therefore does not provide the "hard look" that SEPA requires.

Contrary to the impression generated by the DSEIS, most of the olefins consumed in China are not derived from methanol made from coal *or* fracked gas. The most significant source of olefins consumed in China is actually naphtha,[76] so comparing the GHG emissions produced by making olefins from naphtha versus NWIW's proposed method should be a key part of the DSEIS. Unfortunately, the DSEIS merely contains this terse statement: "The LCA evaluated the GHG emissions from [the naphtha-to-olefins] process and found it to have greater GHG emissions than the proposed project."[77] The apparent basis for this statement, found in Appendix A, does not rely on the best available peer-reviewed science. Appendix A asserts that making olefins from naphtha results in 2.32 kg CO_2e/kg olefin, while NWIW's process is slightly more efficient, emitting 1.85 to 2.26 kg CO_2e/kg of olefin.[78] This comparison overestimates the GHG intensity of producing olefins from naphtha and understates the GHG emissions from NWIW's olefins, making NWIW's proposal appear "greener" than making olefins from naphtha. The GHG intensity of NWIW's olefins is actually higher than reported in this comparison because, as explained in Section III, above, NWIW's estimated upstream methane leakage rate is likely an order of magnitude too low. Conversely, the GHG intensity of naphtha-based olefins reported in peer-reviewed literature is lower than the figure used in this comparison, a reality that the DSEIS acknowledges but fails to explain.[79] The final SEIS should compare olefin production from

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[74] DSEIS Appx. A, p. 141.
[75] *See* Bloomberg Buisnessweek, *Shale? Here's the Other Wave Washing Into the Oil Market* (March 6, 2018) (noting that the International Energy Agency predicted a 7 million gallon per day increase in refinery capacity by 2023).
[76] DSEIS Appx. A, p. 141 (acknowledging that "naphtha steam cracking has the largest share of the olefin market").
[77] DSEIS, p. 3-23.
[78] DSEIS Appx. A, Table 5.12.
[79] DSEIS Appx. A, p. 141.

naphtha versus fracked gas once the GHG emissions of production from naphtha and fracked gas are adequately quantified.

V. Additional Problems with the Life Cycle Analysis.

a. The DSEIS presents outdated and irrelevant information about methane's impact on our climate.

The DSEIS relies on outdated scientific information about methane's global warming potential (GWP). Specifically, the DSEIS uses a value for methane's GWP of 25, which is from the IPCC's 2007 Fourth Assessment Report (AR4), but it has since been updated by the IPCC's Fifth Assessment Report (AR5).[80] While some governments may still use the 2007 value to report GHG emissions for consistency, it would be arbitrary to ignore the latest science in a SEPA document assessing the actual impacts of the Kalama facility's GHG emissions.[81]

The DSEIS violates SEPA by exclusively using the 100-year GWPs. To disclose the near-term impact of emissions, the DSEIS should use the 20-year GWP instead of, or at least in addition to, the 100-year value.[82] As the IPCC explained, "The choice of emission metric and time horizon depends on type of application and policy context . . . ."[83] Twenty years is a far more relevant time scale for discussing climate impacts due to methane pollution than one hundred years. Reducing GHG emissions and impacts over these next 20 years is crucial because that is the time period in which our global society must take action to limit climate change: CO_2e emissions need to reach net zero around 2050 to have a 50 percent chance of limiting warming to 1.5 degrees Celsius.[84] Recent reports by the IPCC[85] and the U.S. government[86] also illustrate that severe climate change impacts could be felt as early as 2040 if current emission trends continue. Because avoiding these GHG thresholds and impacts are relevant policy goals, ignoring the 20-

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[80] DSEIS Appx. A, p. 4.
[81] *See W. Org. of Res. Councils v. U.S. Bureau of Land Mgmt.*, No. CV 16-21-GF-BMM, 2018 WL 1475470, at *16 (D. Mont. Mar. 26, 2018) (holding, in analogous context, that agency acted arbitrarily by only evaluating methane using outdated global warming potential).
[82] *See, e.g.,* Tong, *Comparison of Life Cycle Greenhouse Gases from Natural Gas Pathways for Medium and Heavy-Duty Vehicles*, 49 Environmental Science & Technology 12 (2015) (a study, cited in the DSEIS, that presented both the 20- and 100-year methane GWPs when describing the life cycle methane emissions from fracked gas production).
[83] IPPC, AR5, p. 87 (2014).
[84] Rogelj *et al.*, *Energy system transformations for limiting end-of-century warming to below 1.5°C*, Nature Climate Change, Vol. 5 (June 2015).
[85] IPCC, *Special Report: Global Warming of 1.5 ºC* (October 1, 2018).
[86] U.S. Global Change Research Program, *Fourth National Climate Assessment, Volume II: Impacts, Risks, and Adaptation in the United States* (November 23, 2018).

year GWP of NWIW's methane pollution violates SEPA's purpose, because it will result in uninformed decision-making. Moreover, in an analogous case in under the National Environmental Policy Act, a federal court decided that an agency acted arbitrarily by only evaluating the long-term GWP of methane pollution.[87] The DSEIS' proffered justification for using the 100-year GWP—"for consistency with International, United State and Washington reporting requirements"[88]—has little if any relevance to the merits of NWIW's proposal. Discussing the 100-year global warming potential of methane is not helpful to decision-makers or the public because the effects of, and meaningful responses to, methane emissions must occur much sooner.

The 20-year GWP of methane is used in the lifecycle analysis just once—buried on page 99 of Appendix A of the DSEIS. Even accepting the DSEIS' untenably low upstream methane leakage rate, using the 20-year GWP of methane brings the life cycle GHG emissions attributable to NWIW's proposal to around 3 million tons of CO_2e per year. That would make NWIW the second largest individual cause of GHG pollution in Washington, and the largest when TransAlta is decommissioned.[89] The DSEIS also misleadingly suggests that using the 20-year GWP of methane actually makes NWIW's proposal *better* for our climate in the near-term.[90] Here again, NWIW is relying on its dubious "coal displacement" theory, and some very aggressive estimates of coal-bed methane leakage, to obscure the methanol proposal's huge climate footprint. As set forth above, reliance on the coal displacement theory is arbitrary and capricious, and the DSEIS therefore fails to provide the "hard look" at methane emissions that SEPA requires.

b. The life cycle analysis should describe the GHG emissions from burning NWIW's methanol as fuel.

Based on the publicly available information, it is just as likely that NWIW's methanol will be burned for fuel as converted into olefins. While the DSEIS states—without any documentary evidence, guarantee, or enforceability—that NWIW "intended" for all of the methanol to be made into olefins,[91] Wu Lebin, president of the Chinese Academy of Sciences Holding Company (which controls NWIW) has recently and repeatedly told media outlets that some or all of NWIW's methanol could be used for fuel.[92] Given the growing demand for

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[87] *See W. Org. of Res. Councils v. U.S. Bureau of Land Mgmt.*, No. CV 16-21-GF-BMM, 2018 WL 1475470, at *16 (D. Mont. Mar. 26, 2018).
[88] DSEIS Appx. A, p. 4.
[89] *See* DSEIS, Table 3-1. Top 15 Individual GHG Emission Sources in Washington (2016).
[90] DSEIS Appx. A, p. 99.
[91] DSEIS, p. 3-23; DSEIS Appx. A, pp. ix, 1, 6.
[92] Columbia Riverkeeper *et al.*, *Scoping Comments on the New EIS for the Kalama Methanol Refinery*, p. 10 (March 1, 2018).

methanol for fuel and olefin production in China, either outcome is entirely plausible. The DSEIS, however, cannot merely rely on empty statements of intent, especially where those assertions have been undermined by statements made elsewhere by the project proponent. SEPA requires a hard look at the reasonably foreseeable consequences of each proposal, not the project proponent's intended consequences.

The GHG emissions resulting from using methanol to make fuel is quantifiable and the analysis of such emissions should be included as a foreseeable alternative end product and included in SEPA analysis. Moreover, NWIW's representations about the end use of the methanol are suspect because the company understands that the viability of its proposal likely hinges on NWIW's ability to distinguish methanol from LNG and other fossil fuel exports that are unpopular in the Pacific Northwest. Therefore, the final SEIS lifecycle analysis should contain an alternative that discloses the GHG emissions attributable to burning NWIW's methanol as fuel, as well as an alternative focused on turning it into olefins.

VI. SEPA requires the disclosure, and analysis of the impacts, of a new regional fracked gas pipeline.

Commenters reiterate their request, contained in multiple previous SEPA comments, that the final SEIS disclose and discuss the impact of a new regional gas pipeline that would be an indirect and/or cumulative impact of NWIW's Kalama proposal, as required by SEPA.[93] The DSEIS discusses non-GHG related changes and information updates to NWIW's proposal, as well as related actions like the Kalama Lateral Pipeline and electrical supply improvements.[94] Similarly, the DSEIS should have addressed new information on the construction of another major fracked gas pipeline into the Pacific Northwest that would be triggered by NWIW's massive fracked gas consumption.

a. A new regional gas pipeline into the Pacific Northwest would be an indirect impact of NWIW's demand for fracked gas.

A new regional fracked gas pipeline into the Pacific Northwest is an indirect effect of the Kalama methanol refinery that must be addressed in the EIS. "A proposal's effects include . . . indirect impacts caused by the proposal" and include the impacts resulting from growth—such as new regional pipeline infrastructure—caused by a proposal.[95] Given the nature of the Kalama methanol refinery and the state of the regional gas pipeline system, the most reasonable assumption is that gas supply for the Project will require expansion of the regional pipeline

[93] WAC 197-11-792 (requiring analysis of a proposal's indirect and cumulative impacts).
[94] DSEIS, p. 1-4.
[95] WAC 197-11-060(4)(d).

system.[96] As such, the expansion of the regional pipeline system necessitated by NWIW's massive gas demand is an indirect effect of the methanol refinery that must be addressed in the EIS.

New information supports Commenters' long-held assertion that the Kalama methanol facility would place a strain on regional pipeline capacity and ultimately cause a new regional pipeline to be built. A representative of the Northwest Industrial Gas Users (NWIGU) recently told the Oregon Public Utilities Commission that "our region is now experiencing high [gas] prices . . . not from an actual supply shortage but from an infrastructure constraint"[97] (*i.e.* limited pipeline capacity into the Northwest). Similarly, in early 2018, NWIGU told the Washington Utilities and Transportation Commission that the "Northwest Pipeline capacity into [the Puget Sound area] is fully contracted" and "the need for an expansion of Northwest Pipeline to meet growth in peak day demand" could occur within "a year or two."[98] The Northwest Gas Association's 2018 Outlook also demonstrates that the Pacific Northwest has a tight supply-demand balance under current circumstances.[99] Accordingly, the addition of 320,000 Dth/D of new demand from the Kalama methanol refinery would push the region over the threshold at which a new regional pipeline would be constructed, making a new regional pipeline an undisclosed indirect impact of NWIW's proposal in violation of SEPA.

b. A new regional gas pipeline into the Pacific Northwest would be a cumulative impact of NWIW's demand for fracked gas.

A new regional fracked gas pipeline into the Pacific Northwest is, at least, a cumulative impact of the Kalama methanol refinery that must be addressed under SEPA.[100, 101] The Washington Shorelines Hearings Board explained that SEPA requires agencies "to consider the effects of a proposal's probable impacts combined with the cumulative impacts from other

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[96] *See* Columbia Riverkeeper, *Supplemental Comments on Kalama Methanol Draft EIS* (September 12, 2016).
[97] Willamette Week, *A Natural Gas Pipeline Explosion in British Columbia Spikes Prices in Portland and Raises Questions About Oregon's Energy Future* (December 12, 2018).
[98] *See* Exhibit 6, NWIGU, *Comments on Puget Sound Energy's 2017 Final IRPs* (February 22, 2018).
[99] Northwest Gas Association, *2018 Outlook*, Appendix A5 (2018).
[100] WAC 197-110060(4)(e); WAC 197-11-330(3)(c) ("Several marginal impacts when considered together may result in a significant adverse impact."); *White v. Kitsap Cnty.*, SHB No. 09-019 at 17 (2009) (cumulative impacts of a proposed action together with the impacts of pending and future actions should be considered).
[101] *See also* Exhibit 7, Columbia Riverkeeper, *Letter to Army Corps of Engineers Regarding Cumulative Impacts of the Kalama Methanol Refinery* (August 9, 2018).

proposals. . . ."[102] As explained in more detail below, the incremental impact of the Kalama methanol refinery's demand for fracked gas—when added to the existing demand for fracked gas in the Pacific Northwest and the reasonably foreseeable demand from NWIW's proposed Port Westward methanol refinery—would necessitate the construction of a new regional fracked gas pipeline into the Pacific Northwest. A new regional gas pipeline into the Pacific Northwest is therefore a cumulative impact of the Kalama methanol refinery.

Together, the demand for fracked gas created by NWIW's proposed methanol refineries at Port Westward and Kalama would exceed our region's existing gas pipeline supply capacity, necessitating a new regional fracked gas pipeline. NWIW cannot reasonably dispute this fact because Clay Riding—long-time gas industry expert and Vice President of Energy Resources for NWIW—recently admitted it.[103] Gas industry documents supplied in Section VI(a), above, also explain that NWIW's proposed refineries, which would together likely exceed 600 dekatherms per day of fracked gas demand, would exceed the supply capacity of the regional gas pipeline system.

NWIW's additional gas demand is reasonably foreseeable because NWIW has a specific, active proposal to construct a fracked gas to methanol refinery at Port Westward, Oregon. As of today's date, the "Projects" page of NWIW's website explains that NWIW is "investing nearly $4 billion in the construction of facilities at the Port of Kalama in Washington State and Port Westward in Oregon State" and that "NWIW is working closely with the Port of St. Helens in Oregon to develop plans for a facility at the Port Westward Industrial Park." NWIW also has a detailed lease option agreement to allow construction and operation of the proposed methanol refinery at Port Westward.[104] And earlier this year, NWIW reaffirmed its interest in developing the proposed methanol refinery at Port Westward by negotiating an extension of its exclusive lease option until February 2020.[105]

The parameters of NWIW's proposal at Port Westward are sufficiently defined to allow the inclusion of the Port Westward methanol refinery's fracked gas demand in the cumulative impacts analysis for the Kalama methanol proposal. As NWIW president Vee Godley explained to Port of St. Helens Executive Director Doug Hayes on March 17, 2018:

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[102] *Quinault Indian Nation v. Hoquiam*, SHB No. 13-012c, Order on Summary Judgment, p.18 (Dec. 9, 2013)
[103] Personal communication between Clay Riding, Vice President of Energy Resources for NWIW, and Jasmine Zimmer-Stucky, Senior Organizer for Riverkeeper (May 25, 2018) (further documentation available upon request).
[104] *Lease Option Agreement between NWIW and Port of St. Helens*, pp.6–7 (February 12, 2014) (available upon request).
[105] *See* Port of St. Helens Resolution 2018-3 (February 14, 2018).

> "NW[IW] is in the process of developing a world scale state of the art methanol manufacturing facility at your Port Westward location producing 10,000 Tonnes per day of methanol for the dedicated use in the fine chemicals materials industries. To manufacture methanol, we have various utility and feedstock requirements including a requirement for approximately 210 megawatts of steady state power."[106]

The amount of methanol, and the electricity demand, referenced in Mr. Godley's letter are identical to the Kalama refinery proposal, so the fracked gas demand from both refineries should be similar if not identical. Additionally, correspondence from the Port of St. Helens to Columbia County described the exact location of the planned refinery and contained NWIW's representations about some details of the Port Westward and Kalama proposals.[107] Even though the Port Westward methanol refinery is neither fully permitted nor absolutely certain to be constructed, the availability of specific information and NWIW's prolonged interest make the Port Westward methanol refinery a "reasonably foreseeable" proposal for NEPA purposes that must be addressed in the cumulative impacts analysis for NWIW's Kalama methanol refinery.

VII. NWIW's proposed mitigation is misleading, incomplete, and violates SEPA.

The DSEIS impermissibly conflates the requirement to consider a range of alternatives with the requirement to consider mitigation measures. Alternatives analysis and mitigation requirements are two distinct concepts and requirements under both SEPA and its federal analog, the National Environmental Policy Act (NEPA). Both are necessary for compliance with the law. Yet the DSEIS conflates and muddles the requirements, using the ULE process "alternative"—and other "alternatives" such as shore power for berthed vessels—to pose as "mitigation." Conflating these two core EIS requirements violates SEPA and misleads the public and decision makers about the actual nature of the GHG mitigation that NWIW is proposing.

An EIS, or a supplement thereto, must provide a reasonable set of alternatives (the preferred action and one or more alternatives) as well as separate discussion of mitigation measures.[108] The section of an EIS that includes analysis of mitigation measures is "not intended to duplicate the [alternatives] analysis in subsection (5) and *shall avoid doing so to the fullest extent possible*."[109] Regarding mitigation, the EIS must "[c]learly indicate those mitigation measures (*not described in the previous section as part of the proposal or alternatives*), if any,

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[106] *Letter from Godley (NWIW) to Hayes (Port of St. Helens)* (March 17, 2018) (available upon request).
[107] *Email and attachments from Paula Miranda (Port of St. Helens) to Henry Heimuller (Columbia County)*, (April 10, 2018) (available upon request).
[108] WAC 197-11-440(5) and (6)
[109] WAC 197-11-440(6)(b)(iii) (emphasis added).

that could be implemented or might be required . . . ."[110] Alternatives and mitigation are further defined in the regulations as separate and distinct concepts.[111] Based on Washington regulations alone, the DSEIS' consideration of the ULE refining process as both an alternative production process and mitigation of the emissions from production violates SEPA.

Washington case law also demonstrates that the two concepts must be kept separate. In *Citizens for Safe and Legal Trails v. King County*, the court explained that while "alternatives" include analysis of alternatives for achieving the project purpose that may be less environmentally damaging than the preferred action, mitigation measures are to address environmental impacts after an alternative is chosen.[112] That is, any alternative may have environmental effects, and mitigation measures address the effects that will occur regardless of the choice of alternatives.[113]

Similarly, federal NEPA case law[114] addresses alternatives and mitigation analysis as two separate components, with mitigation analysis required in addition to discussion of alternatives. The Ninth Circuit recently stated that the discussion of mitigation measures in an EIS is intended to show how adverse environmental impacts that will occur after the construction of a project might be alleviated, regardless of whichever alternative is chosen.[115]

NWIW's continued reliance on this approach in the DSEIS is directly contrary to the plain requirements of Washington regulation and case law. The ULE process and the use of shore power cannot serve as both project alternatives and "mitigation." Doing so tests the logical definition of mitigation and merely incentivizes applicants like NWIW to manufacture alternatives that would have worse impacts than the preferred alternative and, rejecting them, call that "mitigation." The DSEIS's "mitigation" is just the choice between two manufacturing alternatives, both of which would create a huge increase in greenhouse gas pollutants from a new petrochemical plant.

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[110] WAC 197-11-440(6)(c)(iii) (emphasis added).
[111] *See* WAC 197-11-768 and 786.
[112] *Citizens for Safe and Legal Trails v. King County*, 118 Wn. App. 1048 (2003).
[113] *See Citizens for Safe and Legal Trails*, 118 Wn. App. at ¶ 9. *See also Victoria Tower Partnership v. City of Seattle*, 59 Wn. App. 592, 601 and 603 (1990) (holding that the primary function of an EIS is to first identify potential adverse impacts from an action to then enable the agency decision-maker to ascertain whether and to what extent to require mitigation or to deny the proposal).
[114] Washington courts will look to federal case law interpreting and applying National Environmental Policy Act ("NEPA") for guidance in interpreting and applying SEPA. *See, e.g.*, *ASARCO v. Air Quality Coal.,* 92 Wn.2d 685, 709 (1979); *Kucera v. State Dep't of Transp.,* 140 Wn.2d 200, 215-16 (2000); *Gebbers v. Okanogan PUD No. 1,* 144 Wn.App. 371 (2008).
[115] *Protect Our Communities Foundation v. Jewell*, 825 F.3d 571, 582 (9th Cir. 2016).

Besides being incomplete and misleading, NWIW's newly-disclosed "100 percent" mitigation proposal is completely devoid of substance or enforceability. SEPA guidance requires NWIW to "clearly identify the mitigation measures" NWIW is proposing and describe whether those measures as are mandatory or potential.[116] And Ecology recently reiterated its preference for GHG emission mitigation measures that are real, specific, identifiable, quantifiable, verifiable, and permanent.[117] NWIW's vague offer to mitigate a portion of its GHG emissions by paying for unknown, unspecified carbon credits from undisclosed carbon markets, banks, or funds does not meet any of these requirements. Vaguely promising partial "voluntary" mitigation, but failing to provide any details about that mitigation or its impacts, does not satisfy Ecology's SEPA guidance regarding mitigation or the "hard look" requirement.

Most of NWIW's sizeable carbon footprint would come from GHG pollution occurring outside of Washington's borders. In response, NWIW recently promised to mitigate "100 percent of its GHG emissions"—but only those that occur inside Washington.[118] This makes little practical sense and will not provide meaningful offsets to mitigate the impacts of the project. This further ignores the fact that NWIW's upstream and downstream GHG emissions will affect Washington's climate, natural resources, and communities in exactly the same way as NWIW's emissions that occur inside of Washington.

VIII. NWIW's proposal would add to the plastic pollution choking our oceans.

Plastic pollution, especially in the world's oceans, is a long-acknowledged problem and the focus of increasing global concern. A recent study concluded that, in 2010 alone, between 4.8 and 12.7 million metric tons of land-based plastic garbage found its way into our oceans.[119] And the "quantity of plastic waste available to enter the ocean from land is predicted to increase by an order of magnitude by 2025."[120]

If, as NWIW intends, its methanol would be made into plastic products, the SEIS should explain the amount and likely fate of those plastic products at the end of their useful life and the consequent impacts on the human environment. First, the SEIS should explain how much plastic would be generated from NWIW's methanol over the project's lifetime. The EIS should also explain how methanol-based plastic waste makes its way into the environment and, specifically,

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[116] Washington State Department of Ecology, *Publication No. # 98-114: State Environmental Policy Act Handbook*, p. 57 (2003).
[117] Exhibit 4, p. 2.
[118] DSEIS, p. 3-31.
[119] Jambeck, *et al.*, *Plastic waste inputs from land into the ocean*, 347 Science 769–771 (2015).
[120] *Id.*

the world's oceans. After being used, what percentage of plastics is recycled, put into landfills, burned, or reach the ocean?

To the extent possible, the SEIS should estimate how much of the plastic derived from NWIW's methanol would ultimately enter the ocean, based on the total volume of plastic produced over the project's lifetime, the likely destinations and uses of such plastic products, and the rate at which such plastics enter the world's oceans. Data presented in the article in the journal Science, "Plastic waste inputs from land into the ocean,"[121] may assist in making such calculations.

The SEIS should also examine the cumulative impact of how the growth of North American petrochemical facilities, like NWIW, affects the quantity of plastic trash entering our oceans. There is a direct link from cheap and plentiful North American shale gas to expanded plastics production, and from there to increased marine plastic pollution.[122] Even if the direct impact of NWIW's contribution to marine plastics pollution difficult to describe, NWIW is part of a continent-wide increase in the manufacture of plastics precursors driven by a glut of cheap shale gas. This industry growth will increase plastics production by 40 percent,[123] with corresponding and measurable increases in marine plastics pollution. The SEIS should therefore at least discuss the cumulative impact of marine plastics pollution from NWIW and similar facilities that are currently proposed or recently activated in North America.

IX. The Port, NWIW, and Life Cycle Associates' conflicts of interest undermine the DSEIS' conclusions.

The entities responsible for producing the DSEIS—the Port, NWIW, and Life Cycle Associates—each have significant financial incentives to produce a report showing the lowest possible climate impact. The political and regulatory realities surrounding this proposal are clear; Washington's leaders and public demand real action to address the worsening impacts of climate change. Admitting that this project would result in a massive net addition of greenhouse gas (GHG) pollution into our atmosphere would severely jeopardize the proposal's ability to obtain key permits and millions of dollars in public subsidies.

The financial incentives are clear. NWIW hopes to reap massive profits by arbitraging cheap North American fracked gas, exported in the form of methanol. According to NWIW's

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[121] *Id.*
[122] The Guardian, *$180bn investment in plastic factories feeds global packaging binge* (December 26, 2017).
[123] *Id.*

2013 projections, the project would generate $150 million of profit each year.[124] The Port is guaranteed at least $1.8 million in cash each year based on methanol wharfage alone, and this amount does not include rent or dockage fees also guaranteed to the Port.[125] Finally, Life Cycle Associates is substantially more likely to obtain similar lucrative contracts from project developers in the future if it under-estimates NWIW's climate impacts. Indeed, Life Cycle Associates' highly questionable analysis of the upstream methane emissions from the Tacoma LNG facility[126] likely enticed NWIW to retain the firm. Handing SEPA review over to these three entities is the regulatory equivalent of appointing the proverbial fox to guard the henhouse.

Unfortunately, but unsurprisingly, the financial interests of the project proponents and their consultant resulted in a self-serving and inaccurate assessment of the proposal's climate impacts. This bias permeates the entire DSEIS, but is highly visible when, for example, the DSEIS ignores the best available science about upstream methane leakage rates or switches between using the 20- and 100-year GWP for methane based on which portrays the proposal more favorably.

This conflict of interests was completely foreseeable and could have been avoided had the Washington Department of Ecology (Ecology) not abdicated its authority[127] to perform the SEPA analysis (or had the Washington Energy Facility Site Evaluation Counsel exercised its jurisdiction over this massive fossil fuel export facility). Despite these missteps, if the project proponents insist on carrying forward their flawed and self-serving analysis into a Final SEIS, Ecology should to prepare its own SEIS[128] to objectively describe the proposal's GHG emissions prior to deciding whether, and under what conditions, to approve the Shorelines Conditional Use Permit.

CONCLUSION

Please re-examine the DSEIS' misguided conclusion that the world's largest fracked gas-to-methanol refinery would somehow benefit our climate and have no significant adverse impacts on the Columbia River estuary or public health. NWIW's proposal—which, at its core, is no different than previously rejected coal, crude oil, and LNG export schemes on the

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[124] Exhibit 8. Pan-Pacific Energy Corp, *Port of Kalama Methanol Project Business Plan*, p.28 (Dec. 2013).
[125] *See Dock Usage Agreement between the Port of Kalama and NWIW Kalama, LLC*, §§ 1.10, 1.11, 4.1, and 4.2 (April 9, 2014).
[126] *See* Exhibit 3; *see also* Exhibit 4.
[127] WAC 197-11-938(9); *see also Letter from Vee Godley (NWIW) to Sally Toteff (Ecology)*, p. 1 (Aug. 25, 2015) ("Ecology could have taken on the SEPA lead agency duties for the Kalama proposal under WAC 197-11-938(9) given that the storage tanks' capacity exceeded 1,000,000 gallons") (available on request).
[128] As contemplated and authorized by WAC 197-11-600(3)(b) & (c).

Columbia—does not embody the "global transition to a carbon-free future"[129] that Washington State demands and deserves.

Sincerely,

Miles Johnson, Senior Attorney for Columbia Riverkeeper

Submitted on behalf of:

Columbia Riverkeeper
Sierra Club
Center for Biological Diversity
Stand.earth
Oregon Physicians for Social Responsibility
Food and Water Watch
Washington Physicians for Social Responsibility
350 PDX
Rogue Climate
350 Seattle
350 Tacoma
350 Eastside
Bark
Green Energy Institute
Center for Sustainable Economy
Cascadia Wildlands

Exhibits:

- Exhibit 1: Alvarez, *et al.*, *Assessment of methane emissions from the U.S. oil and gas supply chain*, Science (2018).
- Exhibit 2: Sierra Club, *Fracked Gas: Nothing "Natural" About It* (2018).
- Exhibit 3: Washington Attorney General, *Comment to PSCAA on DSEIS for PSE LNG Project* (Nov. 21, 2018).

[129] Governor Jay Inslee (quoted in Columbia Basin Bulletin, *Federal Climate Report Suggests More Warm Years Such As 2015 Will Be A Reality For Columbia Basin* (November 30, 2018)).

- Exhibit 4: Washington Department of Ecology, *Comment to PSCAA on DSEIS for PSE LNG Project* (Nov. 21, 2018).

- Exhibit 5: Qun *et al.*, *A comparison between coal-to-olefins and oil-based ethylene in China: An economic and environmental prospective*, 165 Journal of Cleaner Production 1351–1360, 1356 (2017).

- Exhibit 6: NWIGU, *Comments on Puget Sound Energy's 2017 Final IRPs* (February 22, 2018).

- Exhibit 7: Columbia Riverkeeper, *Letter to Army Corps of Engineers Regarding Cumulative Impacts of the Kalama Methanol Refinery* (August 9, 2018).

- Exhibit 8: Pan-Pacific Energy Corp, *Port of Kalama Methanol Project Business Plan* (Dec. 2013).

cc'd via email:

- Elaine Placido, Director, Cowlitz County Building and Planning Department
- Taylor Aalvik, Natural Resources Director, Cowlitz Indian Tribe
- Julie Carter, Policy Analyst, Columbia River Inter-Tribal Fish Commission
- Carl Merkle, Confederated Tribes of the Umatilla Indian Reservation
- Maia Bellon, Director, Washington Department of Ecology
- Perry Lund, Washington Department of Ecology, Shorelines Division
- Reed Schuler, Senior Policy Advisor to Governor Inslee, Climate & Sustainability

FRACKED GAS INFRASTRUCTURE:

A THREAT TO HEALTHY COMMUNITIES

A Special Report and Recommendations to the Governors of Oregon and Washington
by
Oregon Physicians for Social Responsibility
and
Washington Physicians for Social Responsibility

June 2019

AUTHORS:

Elijah Cetas, BAS

Sarah Cornett, BA

Rejean Idzerda, PhD

Patricia Kullberg, MD, MPH

Regna Merritt, PA, BS

Pat O'Herron, MD

Diana Rempe, PhD

Theodora Tsongas, PhD, MS

Ann Turner, MD

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EXECUTIVE SUMMARY

Introduction

- Six major fracked gas[1] infrastructure projects are proposed in Oregon and Washington, including pipelines, refineries, liquefaction, and export facilities.
- The locales targeted for these developments are economically stressed and suffer a disproportionate burden of underlying morbidity and mortality.
- The new gas infrastructure threatens to degrade the health of these communities.
- Massive increases in greenhouse gas emissions associated with the infrastructure would also contribute significantly to climate change.

Climate Change and Health

- Regional climate change effects include drought, floods, extreme weather events, forest fires, sea-level rise, and ocean acidification.
- Climate change related adverse health effects include traumatic injury, death, heart disease, lung disease, infectious disease, heat-related disorders, stress, and mental health disorders.
- Those most susceptible to the ill effects of climate change include low income and immigrant persons, communities of color, babies, pregnant women, the elderly and those with chronic disease.

Communities at Risk

- Communities targeted for gas infrastructure development have lower median household incomes and higher unemployment rates.
- Residents also suffer higher rates of overall mortality, premature mortality, cancer, cardiovascular disease, and lung disease.
- Nearly all targeted communities are rated as those most vulnerable to climate change.
- Tribal communities would suffer disproportionate impacts on their traditional economic, spiritual, and cultural practices.

[1] The major share of so-called natural gas entering the Pacific Northwest, the chief component of which is methane gas, is extracted through the unconventional process of hydraulic fracturing or "fracking." Throughout this document it will be referred to as "fracked gas."

Air Pollution

- The full extent of air pollution due to the fracked gas industry is under-researched and inadequately understood due to a lax regulatory environment, inadequate air quality monitoring, and industry secretiveness.
- Documented toxic emissions from fracked gas transport and processing facilities include diesel particulate matter, nitrogen oxides, carbon monoxide, volatile organic compounds, polycyclic aromatic hydrocarbons, formaldehyde, ozone, and heavy metals.
- These air toxics are linked to cancer; cardiovascular, pulmonary, neurological, hormonal and developmental disorders; and poor pregnancy outcomes.

Water Pollution

- Local economies are dependent on abundant clean and fresh water for human consumption, agriculture and livestock, manufacturing, transportation, energy production, and recreation.
- Fracked gas infrastructure consumes massive quantities of water while discharging thousands of chemicals, with known adverse health effects, including cancer, into waterways and drinking water systems.
- Pipeline construction and operation can increase turbidity, remove riparian vegetation and increase stream temperatures, increasing the risk of harmful algae blooms and loss of drinking water.
- Construction and operation of pipelines and processing plants and/or related dredging degrade aquatic habitat for commercially and culturally important fish, shellfish, and other wildlife.

Noise Pollution

- Fracked gas infrastructure is associated with high levels of both intermittent and continuous noise.
- Exposure to high levels of noise is linked to hearing loss, hypertension, reduced learning and productivity, hormonal disruption, and heart disease.
- Construction activities are exempt from noise regulation in both Oregon and Washington.

Natural and Human-caused Disasters

- Fracked gas and its products are highly flammable and explosive; gas pipelines have a particularly poor safety record.

- Fracked gas infrastructure in the Pacific Northwest is uniquely vulnerable to the risks of earthquake, tsunami, inundation, and wildfire.
- Fires, explosions, and vapor clouds lead to traumatic injury and death as well as toxic releases into air and water.

Occupational Health and Safety

- The gas industry is exempt from disclosing the chemicals they use and from most federal statutes protecting worker health and safety.
- Workers in the fossil fuel industry are exposed to myriad health risks and are killed on the job at rates four to seven times higher than other industries.
- Workers in the fracked gas industry are vulnerable to industrial accidents, exposure to benzene, hydrogen sulfide and other toxins, silicosis, and exposure to radiation and noise.

Temporary Labor Camps

- Temporary labor camps associated with fracked gas facilities impose outsized impacts on local infrastructure, public services, and public health through increases in crime, drug use, assaults, kidnapping, sex trafficking, and sexually transmitted infections.
- Native American communities, especially women and girls, have suffered disproportionately from these impacts.

Health Effects of Hydraulic Fracturing (Fracking)

- Most of the gas piped into Oregon and Washington is fracked gas.
- The fracking process degrades the environment of surrounding communities through toxic contamination of air and water with hundreds of chemicals with known associations to cancer, heart and lung disease, developmental disorders, and poor pregnancy outcomes.

INTRODUCTION

Planet Earth, according to the October 2018 special report from the Intergovernmental Panel on Climate Change (IPCC),[2] has now already warmed by 1.0° C above pre-industrial levels. The report, by the United Nations body for assessing the science related to climate change, reiterates the need to limit global warming to 1.5° C to avoid rendering large swaths of the world uninhabitable with devastating effects on human health and well-being.

But according to a January 2019 report by Oil Change International, "Between now and 2030, the United States is on track to account for 60 percent of world growth in oil and gas production, expanding extraction at least four times more than any other country."[3] Independent researchers drew on industry and governmental data sources to make the case that this level of production would prohibit achieving the IPCC goal of 1.5° C global warming.[4]

The Pacific Northwest figures large in the gas sector's plans for transporting, refining, processing, liquefying, and exporting fracked gas and its products. The fracking boom in the U.S., along with growing Canadian extraction of gas, has produced an abundant supply of cheap gas[5] which has outstripped domestic markets, leading corporate owners to seek overseas markets, primarily in Asia. To the gas industry, the West Coast is ideally situated for the development of processing and export facilities. Six separate proposals in Oregon and Washington, if brought to completion, would entail massive increases in global fracked gas consumption and greenhouse gas (GHG) emissions and would accelerate the pace of global warming.[6] [7] [8] This unprecedented expansion of fracked gas infrastructure on the lands, waterways, and coastlines of the Pacific Northwest presents unacceptable risks to the health of our communities, both local and global.

[2] (Intergovernmental Panel on Climate Change, 2018)
[3] (Trout, January, 2019)
[4] (Mutitt, 2016)
[5] (U.S. Energy Information Administration, n.d.)
[6] (DePlace E. &., 2018)
[7] (Erickson, Towards a Climate Test for Industry: Assessing a Gas-based Methanol Plant, 2018)
[8] (Stockman & McGarry, Jordan Cove and Pacific Connector Pipeline Greenhouse Gas Emissions, 2018)

The Projects

Proposals for new fracked gas infrastructure include:

- Jordan Cove Liquefied Natural Gas (LNG) project, also known as the Jordan Cove Energy Project, in Coos Bay, Oregon, which proposes to receive up to 1.2 billion cubic feet of gas per day and export up to 7.8 million metric tons of LNG annually to markets in Asia.[9] The LNG facility would be located on the north spit of Coos Bay, 7.5 miles upstream from the mouth of the channel. Less than a quarter mile across the waterway lies the town of North Bend and the Southwest Regional Airport. The 500-acre parcel of land on which the facility and terminal would be sited also lies on the traditional territory of the Coos Tribe, Siletz Tribe and others.

- Jordan Cove LNG includes construction of the Pacific Connector Gas Pipeline (PCGP), a three-foot diameter, 229-mile pipeline through four rural counties in southwest Oregon, which would transport up to 1.2 billion cubic feet of fracked gas per day to the Jordan Cove facility. The pipeline would stretch between the town of Malin in Klamath County to Jordan Cove in Coos County, slashing through pristine wilderness areas of southwest Oregon, multiple drinking watersheds, as well as hundreds of farms, ranches, and small towns and the traditional territories of many tribes, including the Klamath, Yurok, and Karuk tribes who oppose the project. Eminent domain would need to be deployed to force hundreds of local landowners to accommodate the pipeline.
- Curzon Energy coal bed methane extraction wells, which involve an unconventional extraction process distinct from hydraulic fracturing. Curzon owns 47,000 acres of coalbed gas accumulations in rural Coos County where they have drilled 5 wells and laid 4 miles of pipeline.[10] As of December 2018 the project has been suspended due to lower than expected yields.[11] However, an April 2019 report to investors states that deeper drilling and exploration in Coos County is proceeding.
- Kalama Methanol Refinery, the world's largest methane to methanol refinery in the Port of Kalama, Washington, which would produce up to 3.6 million tons of methanol annually for export to China.[12] [13] The company, Northwest Innovation Works (NWIW), also proposes a

[9] (Draft Environmental Impact Statement for the Jordan Cove Energy Project, 2019)
[10] (Curzon Energy, n.d.)
[11] (Proactiveinvestors, 2018)
[12] (Final Environmental Impact Statement: Kalama Manufacturing and Marine Export Facility, September 2016)

methanol refinery of similar size in Port Westward, Oregon.[14] The refinery in Kalama would be sited on the Columbia River at the north end of the Port of Kalama Marine Park, about 2 miles from downtown Kalama and less than 1 mile from residences. The project includes construction of a new 3-mile pipeline, the Kalama Lateral Pipeline.

- The second NWIW proposed methanol refinery would be constructed at Port Westward, in the Columbia River Estuary, which includes juvenile salmon habitat. It could be located about 8 miles away from the town of Clatskanie and in the midst of prime agricultural land.
- Pacific Coast Fertilizer, a proposed fertilizer plant in Longview, Washington, would utilize 50 million cubic feet of methane per day to produce anhydrous ammonia-based fertilizer for local markets.[15] The plant would be located on the Mint Farm Industrial Park which lies in close proximity to residential neighborhoods.
- Puget Sound LNG in Tacoma, Washington, which would produce up to 500,000 gallons of LNG per day for use primarily as a domestic commercial marine fuel.[16] [17] The facility is being constructed on 33 acres of the Blair-Hylebos Peninsula in the Port of Tacoma, directly on top of traditional and culturally important Puyallup Indian tribal lands. The site is also adjacent to 3 sites still undergoing clean-up processes related to historic industrial contamination. The project will require construction of 5 miles of connecting gas pipelines.

A map illustrating the locations of these facilities can be found here.

The gas industry also hopes to expand local residential and commercial markets for gas through smaller projects like the Williams Company upgrade of the North Seattle Lateral Pipeline. This seemingly modest project would have the potential to increase carbon pollution in Washington State by as much as 5%, while attracting less regulatory attention.[18]

No hydraulic fracturing (fracking) wells are currently operational or proposed in either Oregon or Washington. According to the U.S. Energy Information Administration neither Oregon

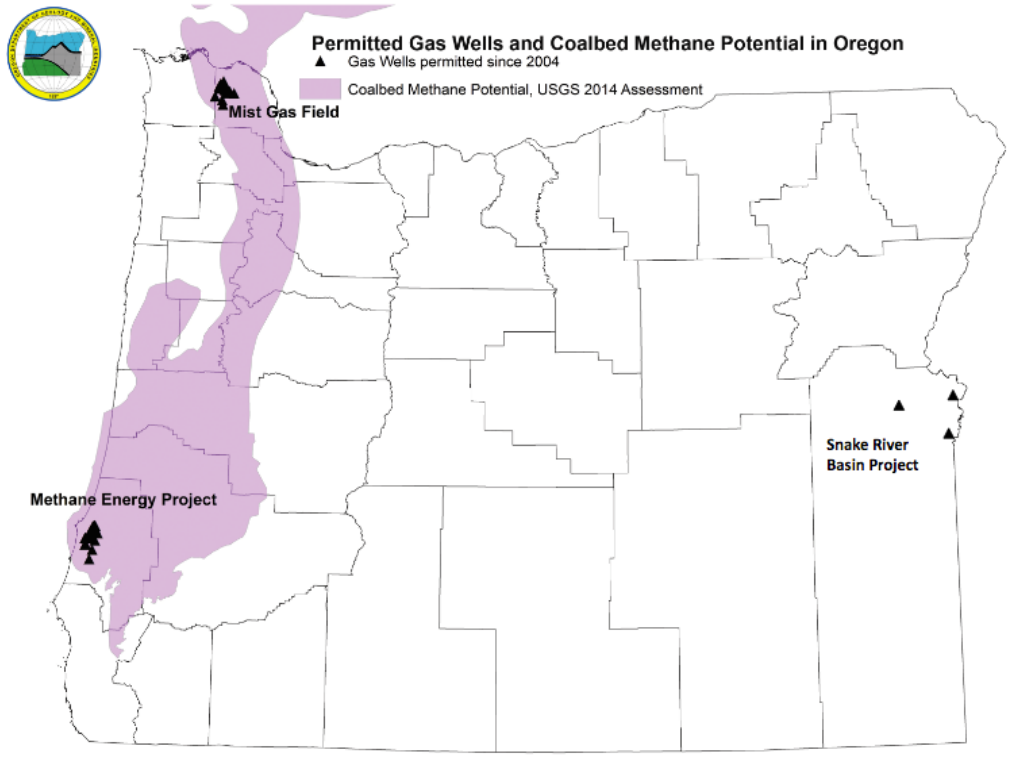
[13] (Draft Supplemental Environmental Impact Statement: Kalama Manufacturing and Marine Export Facility, 2018)
[14] (Zimmer-Stucky, 2018)
[15] (DePlace E. &., 2017)
[16] (Final Environmental Impact Statement: PSE LNG, 2016)
[17] (Draft Supplemental Environmental Impact Statement: Proposed Tacoma Liquefied Natural Gas Project, 2018)
[18] (DePlace E. , Small Seattle Pipeline Expansion would mean Big Carbon Pollution Increase , 2019)

nor Washington has significant gas reserve potential for fracking.[19] Oregon has only one gas producing site near the town of Mist in Columbia County, which deploys conventional drilling to extract gas from porous sandstone. The Snake River Basin is thought to be another source of gas reserves. Three permits have been issued for conventional gas drilling in the area, but no drilling has taken place.[20]

No gas has been produced in the state of Washington for decades.[21] However, the Pacific Coal Region lies along the western and eastern flanks of the Cascade Range, extending from Canada into southern Oregon.[22] The coal beds are known to contain methane, which could be extracted through an unconventional process called coal bed methane extraction. Coal bed methane extraction does not entail injection of fracking fluids under pressure, but does result in accumulation of many of the same toxic fluids and presents similar problems with aquifer and groundwater contamination. The only proposed unconventional gas extraction project in the Pacific Northwest is Curzon's coal bed project, noted above. Figure 1 illustrates the location of the coal beds and currently permitted projects in Oregon.

[19] (U.S. Energy Information Administration, n.d.)
[20] (Oregon Department of Geology and Mineral Industries, 2019)
[21] (Washington State Department of Natural Resouces)
[22] (U.S. Environmental Protection Agency, 2004)

Figure 1



Oregon's only producing gas field, near the town of Mist in northwest Oregon, has been producing gas from a sandstone reservoir since 1980. The reservoir is so permeable that hydraulic fracturing has never been required to economically produce gas. The US Geological Survey recently published an assessment of coalbed methane gas potential. Hydraulic fracturing may be required to develop those resources.

In 2019, the Oregon Legislature passed a 5-year moratorium on fossil fuel fracking, which was signed by the governor on June 17th, 2019.[23] The moratorium exempts coalbed extraction wells with existing permits, like the Curzon project. Also in 2019, the Washington Legislature passed a permanent ban on fracking, which the governor has signed into law.[24]

The Corporations

The corporate entities behind fracked gas infrastructure proposals claim that jobs and tax revenue would benefit host communities.[25] [26] [27] [28] Rarely, if ever, do their calculations include the economic losses and human suffering associated with the projects through toxic contamination of air, land and water; human-caused and natural disasters; displacement of economic activities such as

[23] (Oregon State Legislature, n.d.)
[24] (Washington State Legislature, n.d.)
[25] (Jordan Cove LNG, n.d.)
[26] (North West Innovation Works, n.d.)
[27] (Pacific Coast Fertilizer, n.d.)
[28] (Puget Sound Energy, n.d.)

fishing, recreation, and tourism; desecration of culturally and historically significant sites; and loss of habitat and despoliation of the environment. All of these deleterious effects are associated directly or indirectly with increased sickness and death in affected communities.

Corporate sponsors additionally claim that the net effect of these projects would be a *decrease* in global greenhouse gas emissions,[29] [30] [31] [32] an assertion challenged by several independent scientific researchers.[33] [34] [35] [36] [37] [38] [39] [40] Intentionally or not, companies frequently base their claims on outdated or corporate-sponsored data. For example, the lifecycle analysis of methane emissions for the Kalama methanol refinery, paid for by NWIW, uses the 2007 global warming potential metric (GWP) of 25,[41] which was scientifically recalculated and updated by the IPCC in 2018 to 34.[42] The NWIW sponsored analysis also employs a methane fugitive emission rate of 0.32%, while the most recent science places the figure at 2.3% or higher.[43]

Similar misleading metrics were applied in the lifecycle analysis (LCA) of Puget Sound LNG included in the 2019 Final Supplemental Environmental Impact Statement (FSEIS), which employed, for example, only a 100-year time frame for estimating GHG effects of methane rather than including a time frame of 20 years. [44] This in itself reduces the apparent GWP of methane by nearly threefold. The erroneous metrics and unrealistic assumptions result in analyses that are deeply flawed and a gross underestimate of the actual impact of the facilities on global warming.

The lifecycle analysis for Kalama's methanol refinery additionally asserts that 100% of the refined methanol would replace dirtier coal in the manufacture of plastics in China, a claim that is impossible to support.[45] At the same time the chairman of the Chinese parent company of Northwest Innovation Works told Reuters that the company wants to "drive use of methanol as a transportation

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[29] (Hoard, 2018; Ecology and Environment, Inc, 2019)
[30] (Northwest Innovation Works, n.d.)
[31] (Pacific Coast Fertilizer, n.d.)
[32] (Ecology and Environment, Inc, 2019)
[33] (Erickson, Towards a Climate Test for Industry: Assessing a Gas-based Methanol Plant, 2018)
[34] (Mutitt, 2016)
[35] (Stockman & McGarry, Jordan Cove and Pacific Connector Pipeline Greenhouse Gas Emissions, 2018)
[36] (Trout, January, 2019)
[37] (DePlace E. , 2016)
[38] (Byrnes, 1990)
[39] (Sanders, 2012)
[40] (Stockman, Burning the Gas 'Bridge-fuel' Myth, 2017)
[41] (Erickson, SEI Comments on Kalama DSEIS, 2108)
[42] (Intergovernmental Panel on Climate Change, 2018)
[43] (Alvarez, 2018)
[44] (Ecology and Environment, Inc, 2019)
[45] (DePlace E. &.-D., 2018)

fuel for cars and ships" in China.[46] In early 2019 Columbia Riverkeeper came into possession of documents that revealed how NWIW is selling the project to investors as a source of fuel for China, not for use in the plastics industry.[47] The evidence calls into question the entire lifecycle analysis for the project and illustrates the company's willingness to mislead or outright lie to the local community and regulators.

Citizens in Tacoma have faced the additional aggravation of both public and private entities that are reluctant to or outright refuse to share information about the LNG facility, which is already under construction in the heart of their community without the proper permits in place.[48] Tarika Powell, an environmental lawyer and researcher with Sightline Institute, testified in court about this issue and related violations of the public's "right to know."[49] Much farther south, Oregon's Department of Environmental Quality (DEQ) took Jordan Cove LNG to task for failing to respond to their requests for specific information.[50]

The fossil fuel industry is notorious for promoting misleading and erroneous information.[51] Perhaps not all the corporations seeking a toehold in the Pacific Northwest engage in duplicity, utilize outdated science, or withhold information, but they have amply demonstrated a lack of ethics, transparency, and integrity. Communities in Oregon and Washington are justifiably wary of partnering with them.

The gas industry is, in addition, a poor investment for communities to make. Supply is at an all-time high and prices at an all-time low. The record amount of gas produced over the past decade has been at a loss and gas companies are in debt.[52] [53] The industry's attempt to force prices up by increasing demand, that is, by expanding their markets in Asia through export from west coast terminals, will only backfire. As gas prices go up, they will not be able to compete with cheaper renewable energy sources, whose prices continue to fall.[54] Local communities would then be stuck with dirty and unprofitable infrastructure, saddling their economies with the costs of decommissioning and clean-up.

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[46] (Aizhu, 2017)
[47] (Solomon, 2019)
[48] (Hanchard, 2017)
[49] (Powell T. , Sightline Testifies at Hearing for Tacoma LNG Protesters, 2018)
[50] (Oregon Department of Environmental Quality, 2018)
[51] (Hope, 2019)
[52] (Mikulka, The Inevitable Death of Natural Gas as a 'Bridge Fuel", 2019)
[53] (Mikulka J. , 2019)
[54] (Mikulka, The Inevitable Death of Natural Gas as a 'Bridge Fuel", 2019)

The fracked gas industry has capitalized on decades of de-regulation, tax favors, and weakening of both the public sector and citizen rights to flood the market with cheap gas, accelerate the pace of global climate change, and degrade our health and well-being. Local communities targeted for new fracked gas infrastructure are confronted with a false choice between a healthy economy and a healthy environment. In fact, the two go hand-in-hand, but the fracked gas industry has no contribution to make to either.

The Communities

Proposed projects could directly harm hundreds of thousands of persons, including:

- Hundreds of farms, ranches, and small towns in rural SW Oregon
- North Bend and Coos Bay Oregon, which have yet to recover from the collapse of the fisheries and timber trade
- Residents of prime agricultural land around Port Westward, Oregon
- Port towns of Kalama and Longview, which struggle to find their economic footing
- The city of Tacoma, still in recovery from its toxic industrial past
- Native American communities of both Oregon and Washington

Almost without exception, the port cities and towns and rural areas targeted for fracked gas infrastructure development are those which have been left behind in the economic expansion following the Great Recession of 2008. Compared to statewide averages, these locales are characterized by higher unemployment rates, lower median household incomes, and a disproportionate burden of morbidity and mortality, including cancer, heart, and lung disease; people in these communities are sicker and they die younger. All of these locales are, or were, places of stunning natural beauty and abundant natural resources like native forests, wildlife, fish, shellfish, and clean water.

Native American communities would bear additional adverse impacts on their cultural heritage and traditional economic activities. Many tribal nations of both Oregon and Washington are deeply opposed to projects constructed on tribal lands that impact their livelihoods and threaten their ways of life.

Private landowners in the path of the Pacific Connector Gas Pipeline would also face devaluation of their property, environmental degradation of their lands, and increased risks of fire, explosion, and toxic spills. For the pipeline to be built, property would need to be seized from

reluctant landowners through declarations of eminent domain. In its 2016 denial of the pipeline project, the Federal Energy Regulatory Commission concluded that the public benefits of the project did not justify the use of eminent domain.[55]

Most of these communities are desperate for jobs and tax revenue and are understandably eager for economic development. Economic prosperity is a necessary condition for healthy communities. Any benefits of fossil fuel infrastructure, however, represent short-term economic gains at most. If benefits come at all, they would be at the expense of short- and long-term economic losses, environmental degradation, increased global warming, and increased rates of sickness and death.

The construction and operation of these facilities alone would exact a toll including:

- Toxic pollution of air, water, and land
- Noise pollution
- Increased risk of natural and human-caused disasters
- Occupational health and safety risks
- Adverse impacts of large, temporary encampments of workers

These targeted communities have the most to lose. They are among the areas where the adverse health impacts of climate change will hit the hardest. In addition, local authorities lack resources and expertise to adequately evaluate the welter of technical data presented in the proposals. When debates are dominated by technical issues, more fundamental issues become obscured. Who benefits? Who loses? Who assumes the risks to safety and health? How do these projects square with local cultures, values, and ways of life? These are questions that are too often lost or ignored, but they are the questions basic to the future communities want to build for themselves.

A Just Transition

The precautionary principle of public health holds that when an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically.[56]

[55] (Federal Energy Regulatory Commission, 2016)
[56] (Vu, 2017)

In accordance with the precautionary principle, the American Public Health Association has called for a cessation of all unconventional (which includes fracking) gas and oil exploration and development. The APHA notes that: "In contrast to the precautionary principle employed through most of Europe, the United States employs a risk-based approach wherein, in most cases, companies utilizing unconventional drilling and its associated technologies are issued drilling permits and extraction is conducted before there is a full understanding of potential risks to the environment and human health."[57]

The states of Oregon and Washington are uniquely positioned to put the brakes on the expanded production and export of fracked gas. Gas that cannot be processed and exported or otherwise brought to market is gas that is no longer profitable to produce. State resources and policies should alternatively aim at a just transition to clean and renewable energy, sources that impose far less risk to health and safety. (U.S. Environmental Protection Agency, n.d.)

The EPA defines environmental justice as the "fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. This goal will be achieved when everyone enjoys the same degree of protection from environmental and health hazards, and equal access to the decision-making process to have a healthy environment in which to live, learn, and work."[58]

A just transition means ensuring that nobody is left behind in the shift from fossil fuels to a clean energy economy. It includes deep investments in clean and green economic opportunities for stressed and at-risk communities. A just transition would include:

- Dedicating funds to help communities affected by climate change
- Government support for workers who lose their jobs in the phase-out of fossil fuel facilities
- Upgrading and weatherization of existing buildings to achieve energy efficiency, safety, and affordability
- Repairing and upgrading public infrastructure such as bridges, roadways, and water systems
- Building or upgrading power grids to provide efficient and affordable electricity
- Investing in renewable power sources
- Supporting family farming and investing in sustainable farming

[57] (American Public Health Association, 2018)
[58] (U.S. Environmental Protection Agency, n.d.)

- Investing in public transit and zero-emission vehicle infrastructure and manufacturing
- Restoring ecosystems through land preservation and reforestation
- Cleaning up existing hazardous waste and abandoned sites

Oregon and Washington are two of eighteen states that signed on to the U.S. Climate Alliance, pledging to "accelerate new and existing policies to reduce carbon pollution and promote clean energy deployment."[59] Allowing the Pacific Northwest to become a national hub for processing and shipment of fracked gas and its products flies in the face of this pledge. Promotion of fracked gas only delays the necessary transition to clean energy.[60] Expansion of fracked gas infrastructure locks communities into decades of dependence on fossil fuel that crowds out development of cleaner, safer alternatives.[61]

The adverse effects of global climate change are already upon us and will only worsen in the coming years in the absence of vigorous and sustained reductions in GHG emissions. The effects will land hardest on the youngest, the oldest, the sickest, and most economically stressed among us. These same individuals and communities should not be forced out of economic necessity to tie their futures to a polluting and dying fossil fuel industry.

Climate change mitigation, on the other hand, would produce immediate health benefits for our communities.[62] Promoting healthy communities is a key strategy toward mitigation of, preparation for, and recovery from climate-related events and disasters. Denying the fracked gas industry access to our lands and our waterways is a necessary step toward building the healthy communities that will help ensure our future prosperity.

[59] (United States Climate Alliance: About Us, n.d.)
[60] (Staddon P L, 2015)
[61] (Trout, January, 2019)
[62] (Vossler M. , Thomas, Kitchell, Idzerda, & Cornett, 2018)

RECOMMENDATIONS

Oregon Physicians for Social Responsibility and Washington Physicians for Social Responsibility oppose any expansion of transport, storage, or shipment of fracked gas within our states on the basis of very serious, credible threats to the health of our residents. Further, we call upon the governors of Washington and Oregon, as well as agencies in both states, to deny permits that facilitate the expanded production, transport, storage, and/or handling of fracked gas. Our commitment as health professionals to improving the health of the public and achieving equity in health status demands that we clearly and unequivocally communicate the urgent need to transition away from fossil fuels to clean and equitable renewable energy sources.

We further endorse the many recommendations of the American Public Health Association regarding all activities associated with unconventional (fracked) gas,[63] including:

- No new development of fracked gas infrastructure.
- A strategic phase-out of existing fracked gas infrastructure, consistent with CO2 reduction goals and minimization of harm to communities economically dependent on fracked gas infrastructure.
- Requirements that energy companies disclose and receive approval for all chemicals proposed for use in fracked gas infrastructure.
- Monitoring of air, soil, and water quality impacted by ongoing fracked gas activities, during the period of phase-out and following shut-down, until recovery is achieved.
- Establishment of a registry for active surveillance of community and worker health affected by fracked gas-related activities.
- Immediate cessation of fracked gas activities if negative human health or environmental effects are observed, until further evidence indicates that operations can be safely resumed.

[63] (American Public Health Association, 2018)

CLIMATE CHANGE AND HEALTH

Analyses of current scientific evidence predict the following impacts of climate change on the Pacific Northwest: [64] [65] [66] [67]

- An overall warming trend
- More extreme heat events
- Significant loss of snowpack
- Increased drought
- Increased flooding
- Higher intensity and increased distribution of wildfires
- Sea-level rise
- Increased ocean acidity

These effects will have wide-ranging impacts on the health and well-being of Pacific Northwest communities, as summarized in Figure 2 from the Fourth National Climate Assessment (NCA4).[68]

[64] (May, 2018)
[65] (Hamilton, 2009)
[66] (Vynne, 2011)
[67] (Snover, 2013)
[68] (Ebi, 2018)

Figure 2

Social, Economic, and Environmental Impacts of Climate Change

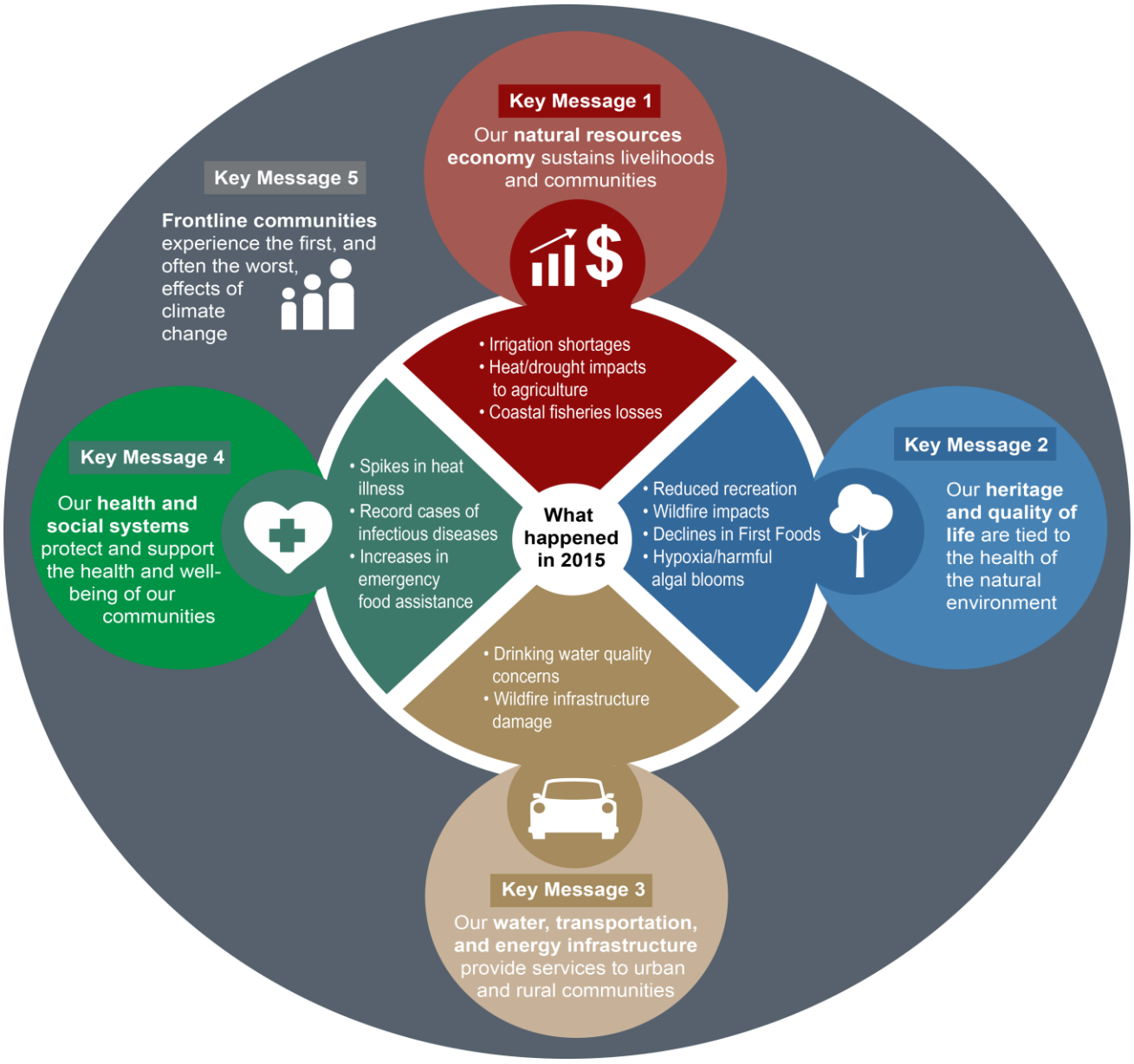
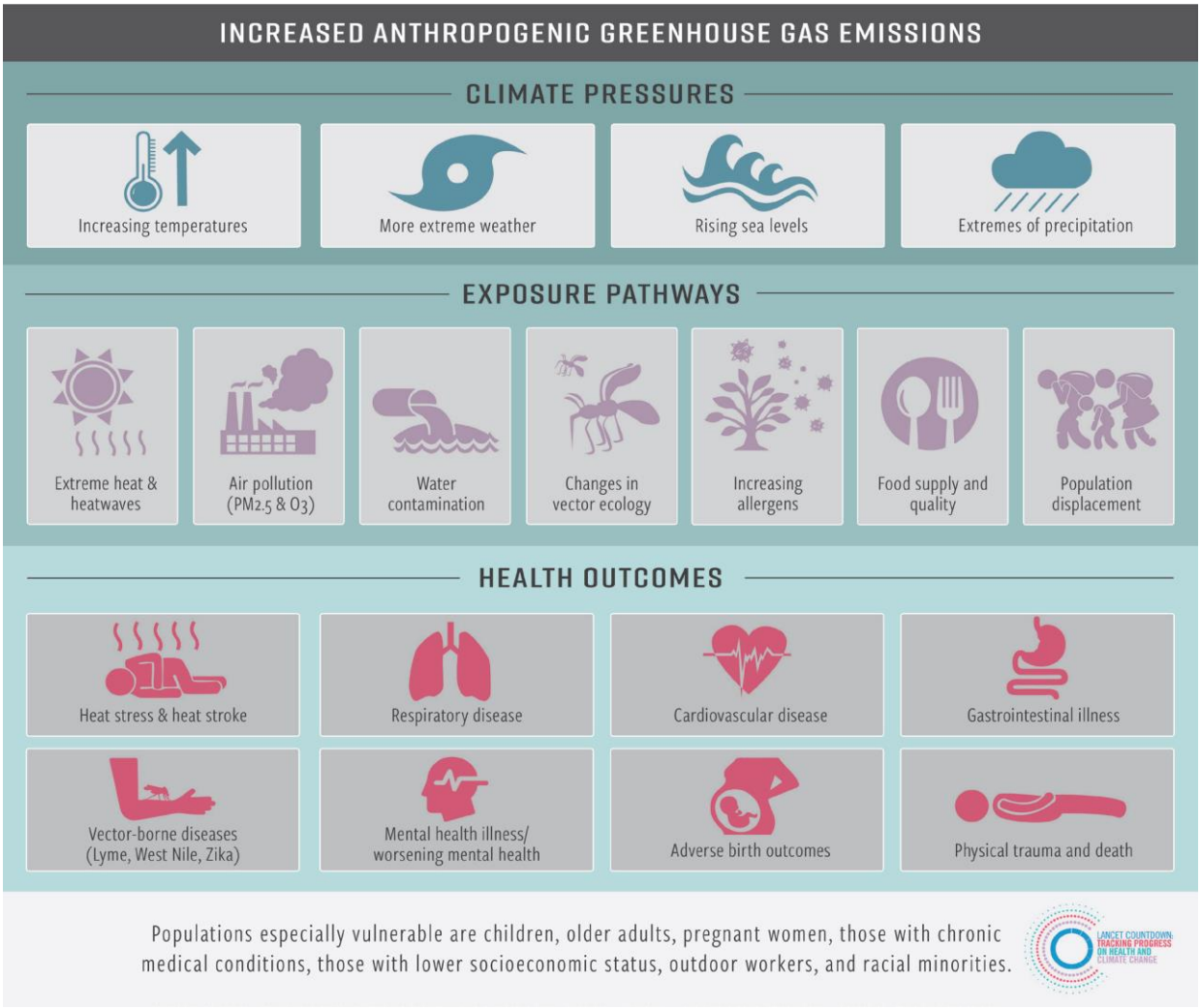


Figure 3 from the Lancet Countdown on Climate Change and Health[69] summarizes the effects of climate change on health outcomes.

Figure 3

Health Effects of Climate Change



Multiple studies have identified those persons and communities most at risk for adverse outcomes of climate change in Oregon and Washington.[70] [71] [72] [73] [74] [75] Table 1, adapted from these reports, summarizes the major health risks of climate change and the populations most at risk.

[69] (Salas, 2018)
[70] (Ebi, 2018)
[71] (Salas, 2018)
[72] (Haggarty B. e., 2014)

Table 1: Climate Change Health Effects and Susceptible Populations: Pacific Northwest		
	Outcomes	**Susceptible Populations**
Heat related illness	Heat rash, heat cramps, heat exhaustion, heat stroke	Very young and very old, pregnant women, people with chronic disease, socially isolated, houseless, outdoor workers
Heat related death	Heart attack, stroke, renal failure, heat stroke, respiratory failure	Very young and very old, people with chronic disease, socially isolated, houseless, outdoor workers
Heat related violence	Homicide and intentional injury	Children and young adults especially in communities with pre-existing higher rates of interpersonal violence
Heat related air pollution and ozone formation	Chest pain, coughing, throat irritation, exacerbation of emphysema, bronchitis and asthma, cancer and cardiopulmonary death	Children, those living in areas with pre-existing air pollution, persons with pre-existing cardiac and respiratory conditions
Drought related food insecurity	Hunger and malnutrition	Low income, communities of color, pregnant women, children
Smoke pollution from wildfires	Asthma, bronchitis, pneumonia, cardiopulmonary disease, motor vehicle crash, injuries, death	Very young and very old, those with pre-existing respiratory and cardiac disease, vehicle operators, passengers
Drought and heat related harmful algal blooms	Toxic contamination of drinking water affecting liver, skin, gastrointestinal tract, nervous system	Residents dependent on affected water systems
Wildfires	Accidental injury and death	Those who live or work in fire-prone areas
Heavy rains	Accidental injury and death	Those who live, work or attend school near or on unstable slopes, including houseless
Flooding	Accidental injury and death, water borne disease, exposure to toxins	Those who live, work or attend school in low lying areas, including houseless
Weather related increase in mold, pollens and other allergens	Exacerbation of asthma and allergic rhinitis	Those with pre-existing allergic disorders
Infectious disease	Vector borne disease, food and water borne disease, fungal disease	Low income, those with pre-existing chronic disease, very young and very old, immune-compromised
Stress related to extreme weather events	Anxiety, depression, suicide, substance abuse, violence	Those with pre-existing mental health disorders and pre-existing socioeconomic stressors
Stress from weather-related displacement	Anxiety, depression, suicide, substance abuse, violence	Low income, residents of flood- and fire-prone areas, coastal communities

[73] (Haggarty B. , 2015)
[74] (Washington Environmental Health Disparities Map, n.d.)
[75] (Snover, 2013)

COMMUNITIES AT RISK

Malin is a tiny farming town near the border with California in Klamath County, Oregon, a community of about 800 persons, which grew up on the cattle and timber trade. Grains and potatoes, along with cattle, are now the principle commercial crops. (All population figures cited are from the 2017 US Census Bureau population estimates.[76]) As the crow flies it's about 200 miles west and north, across public, private, and tribal forests, ranches, and farms to the closely related coastal towns of Coos Bay and North Bend, where some 26,000 people make their home. After white settlement, the local economy was based on the timber and fishing industries, which fell into decline in the late twentieth century. The last major lumber mill closed in '89. Since then the main economic activities have been tourism and recreation, remnants of the timber and fishing trades and agriculture.

Much farther north, lies the Columbia River Port of Kalama. The port is among the busiest on the west coast[77] and is a key economic engine of the town, which is home to 2,700 persons. About a dozen miles downstream sits Longview, another former lumber town of nearly 40,000 persons. Like North Bend, Longview has struggled to recover from the late 20th century decline in the timber trade as well as the closure of an aluminum mill. Across the river on the Oregon side and another 15 miles downstream is the rural town of Clatskanie, population 1,800. The Port of Columbia County administers Port Westward, an industrial port on the salmon-bearing river. This is primarily farm and forest country.

Farther north yet on the southern reach of Puget Sound lies the city of Tacoma, home to 213,000 people. The city has a mixed economic base of industrial, transport, manufacturing, tourist, retail and service sectors, including a busy container-handling port, many high-tech companies, an oil refinery, and a paper and pulp mill. Two Superfund sites with ongoing clean-up activities, the unfortunate legacy of its industrial past, are located on Commencement Bay within the city.

These are the communities, historically dependent on rich natural resources, that are now targeted by the fracked gas industry. What they also have in common are depressed economies with higher rates of poverty and unemployment compared to statewide averages. Local governments are cash-strapped. Their residents suffer higher rates of death and disease (see Tables 2 through 6

[76] (United States Census Bureau, n.d.)
[77] (World Port Source, n.d.)

below). Most suffer additional burdens of toxic industrial and commercial waste and pollution. They are some of the region's most vulnerable locales to adverse effects of climate change.

Native American Communities

Living within these locales are also a number of Native American communities. Across the country tribal communities often find themselves frontline communities, those places first and hardest hit by the deleterious effects of the fossil fuel industry and its associated climate change effects. Proposed fracked gas infrastructure would have an out-sized effect on these communities. Adverse impacts on the spiritual and traditional ways of life are not trivial. They result in emotional harm, in addition to economic harm, both of which degrade quality of life and lead to increases in morbidity and mortality.

Sovereign tribal nations in both Oregon and Washington have registered complaints about the failure of corporate and governmental entities to adequately consult the tribes about impacts on their lands, waters, people, cultural and spiritual practices, and sacred grounds. A 2019 report from the Government Accountability Office validated those allegations[78] The GAO report verified what House Natural Resources Chairman Raúl Grijalva (D-Ariz.) has long heard from tribal nations. "Avoiding discussions until after decisions are made is not consultation," Grijalva said.[79]

Six tribal nations, including the Confederated Tribes of the Grand Ronde Community of Oregon; the Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians; the Klamath Tribes (Klamath, Modoc, and Yahooskin); the Yurok Tribe; the Karuk Tribes; and the Cow Creek Band of Umpqua Tribe of Indians, have filed motions to intervene in the Jordan Cove project, citing potential excavation and destruction of important burial and other sacred sites.[80] [81] They note potential habitat destruction due to construction and operation of the facility and the threat to traditional fishing and shellfish harvesting activities of the tribes. Five federally recognized tribes oppose the project, including the Klamath Tribes, the Yurok Tribe, the Karuk Tribe and the Tolowa Dee-Ni. In March of 2019 the Siletz Tribe also voted to formally oppose the Jordan Cove project and pipeline, citing multiple environmental concerns: "We really cannot support a project that's potentially this degrading to the environment and to sensitive habitat for several species, and could compound the

[78] (U.S. Government Accountability Office, 2019)
[79] (Yachnin, 2019)
[80] (Confederated Tribes of Coos, Lower Umpqua & Siuslaw Indians, 2013)
[81] (Klamath Tribes Tribal Council, 2017)

disastrous effects of a Cascadia earthquake. We don't believe this project will continue our tradition of being good stewards of our land, which we need to protect in all ways that we can."[82]

The Puyallup Indian Reservation is located directly south of Puget Sound LNG. The Puyallup Indian Tribe opposes Puget Sound LNG, citing concerns over pollution of water, unearthing toxic contaminants in the soil, and further degradation of local fish habitat which has already suffered the toxic effects of prior industrial activities.[83] [84] Affiliated Tribes of Northwest Indians[85] and the National Congress of American Indians[86] also oppose this and other fracked gas projects.

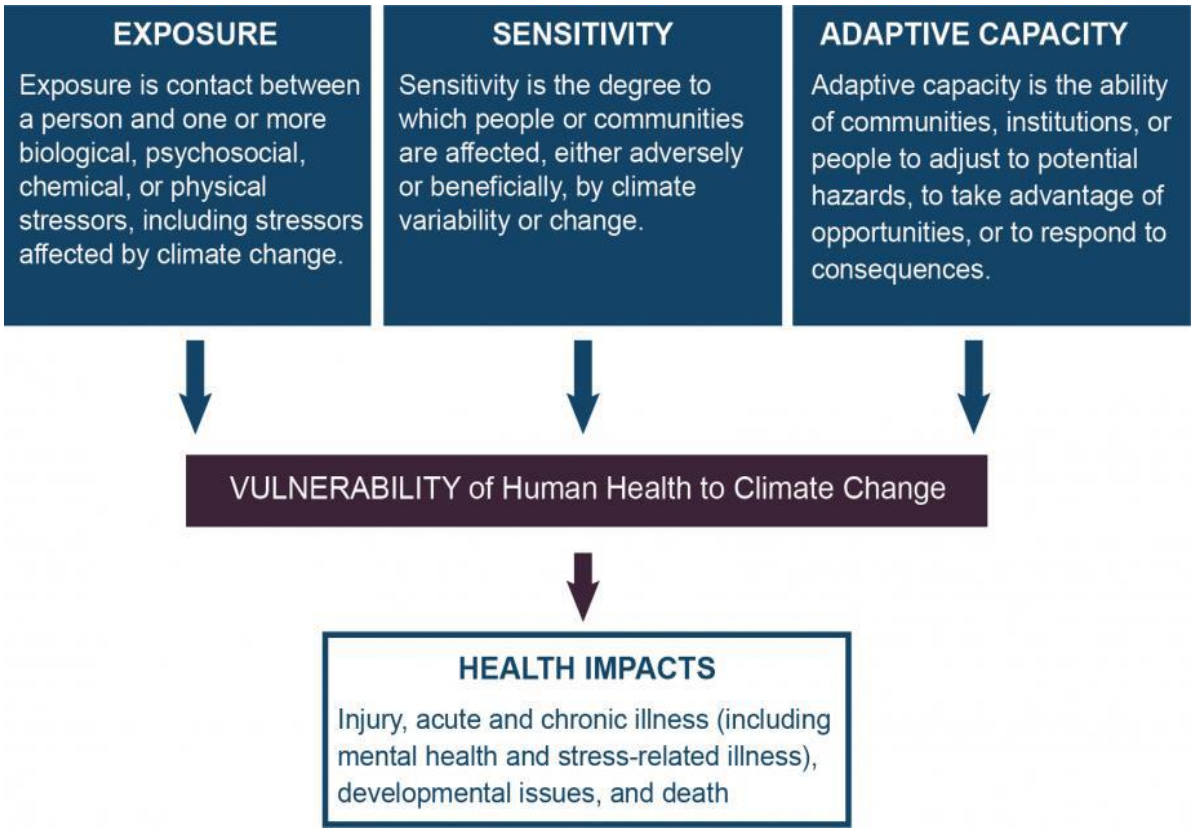
Climate Change Susceptibility

The U.S. Global Change Research Program is a federal program mandated by Congress to conduct scientific assessments of the global environment. They determined that vulnerability to the adverse health effects of climate change depend on three factors: exposure, sensitivity, and adaptive capacity, which are illustrated in Figure 4.[87] All three factors are at play in the cities, towns, and rural locales that would host new fracked gas infrastructure.

[82] (The News Guard, 2019)
[83] (350 Tacoma, 2018)
[84] (Mapes, 2018)
[85] (Indian Country Today, 2017)
[86] (National Congress of American Indians, 2018)
[87] (Crimmins, 2016)

Figure 4

Climate Change Susceptibility



Researchers at Portland State University combined demographic variables of income, race, education, employment, and age with exposure variables to toxic air pollution.[88] The resulting index score identifies communities by census tract in Oregon that are most at risk to the effects of climate change. In Figure 5 the vulnerability index score is given as a percentage; a higher percentage reflects greater vulnerability.

[88] (Zapata, 2017)

Figure 5

Census Tracts Most Vulnerable to Climate Change in Oregon

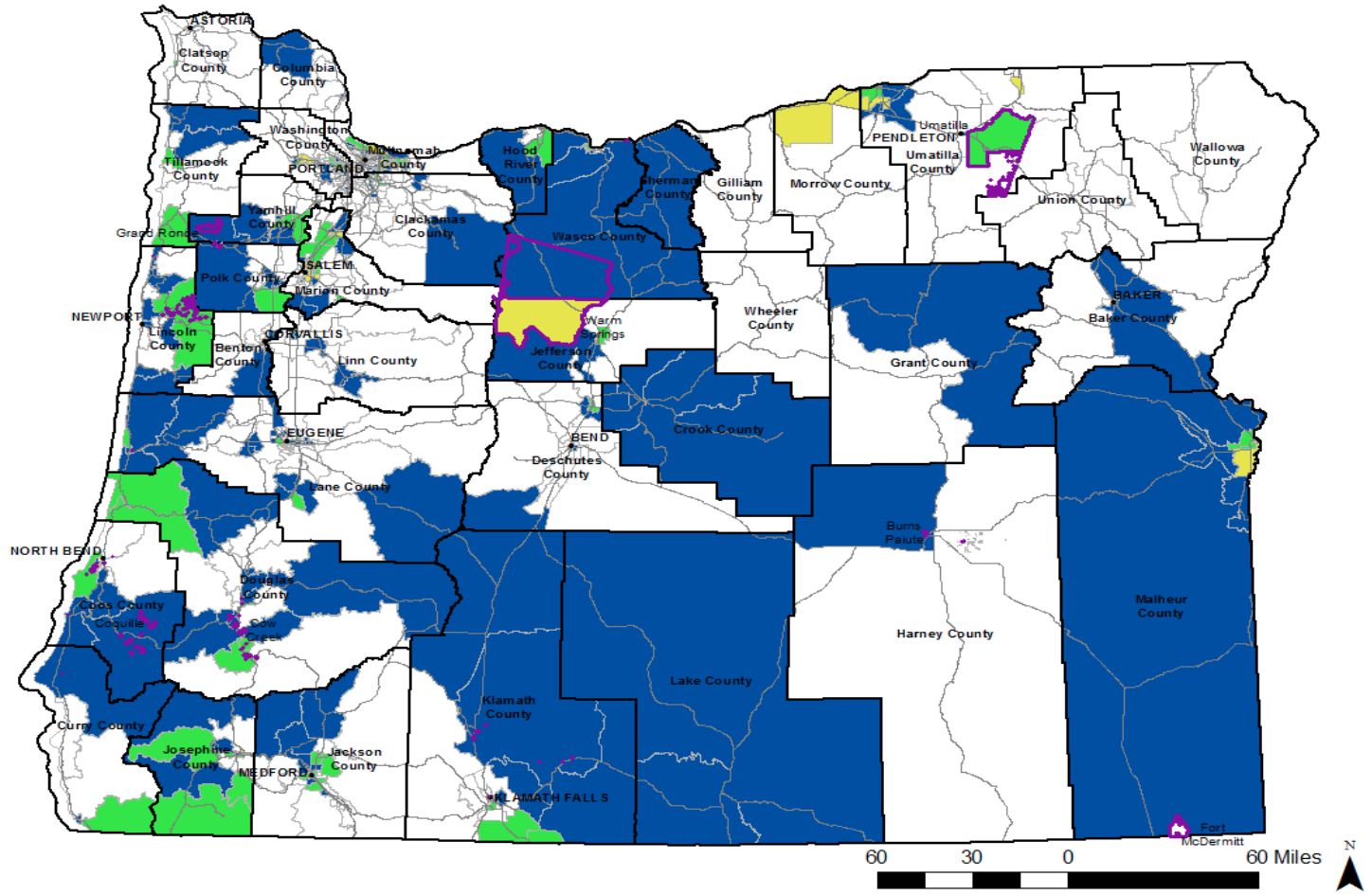


Figure 5*: Top 10%, 25%, and 50% of Census Tracts Most Vulnerable to Climate Change in Oregon.* *GIS data source: US Census Bureau and State of Oregon. Index scores are based on data from: U.S. Census American Community Survey (ACS) 2011-2015 5- year estimates and the National Air Toxics Assessments (NATA) 2011. Purple indicates Indian reservations, village, and towns.*

	Top 10%		Top 25%		Top 50%

Figure 6 identifies economically distressed areas and the top 50% of Census Tracts Based on the Vulnerability Index. Figure 7 overlays this map with the location of already existing greenhouse gas emitting facilities.

Figure 6

Economically Distressed Areas of Oregon

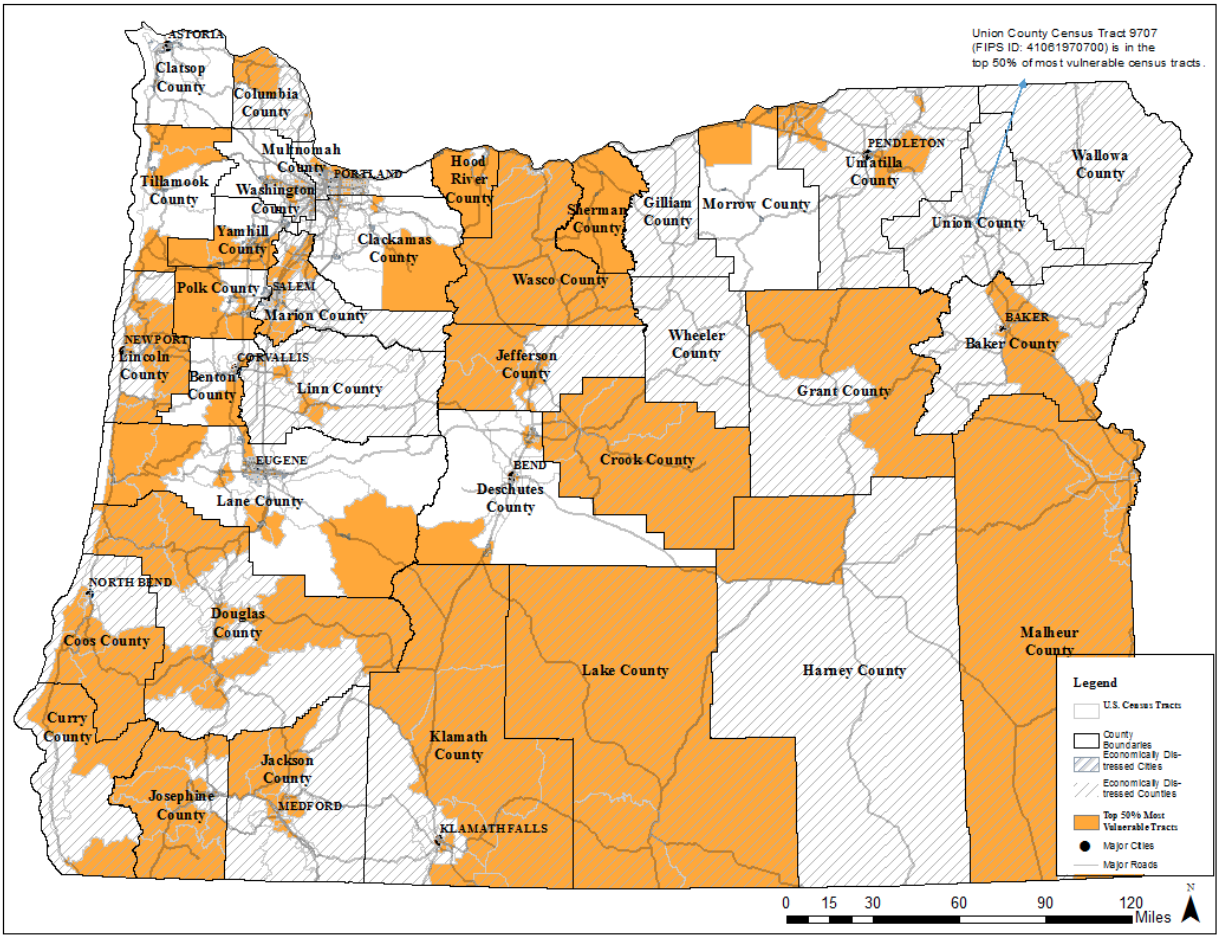


Figure 6: Economically Distressed Areas and Top 50% of Census Tracts Based on Vulnerability Index. *GIS data source: US Census Bureau and State of Oregon. Index scores are based on data from: U.S. Census American Community Survey (ACS) 2011-2015 5- year estimates and the National Air Toxics Assessments (NATA) 2011.*

Figure 7

Distribution of Greenhouse Gas Emitting Facilities in Oregon

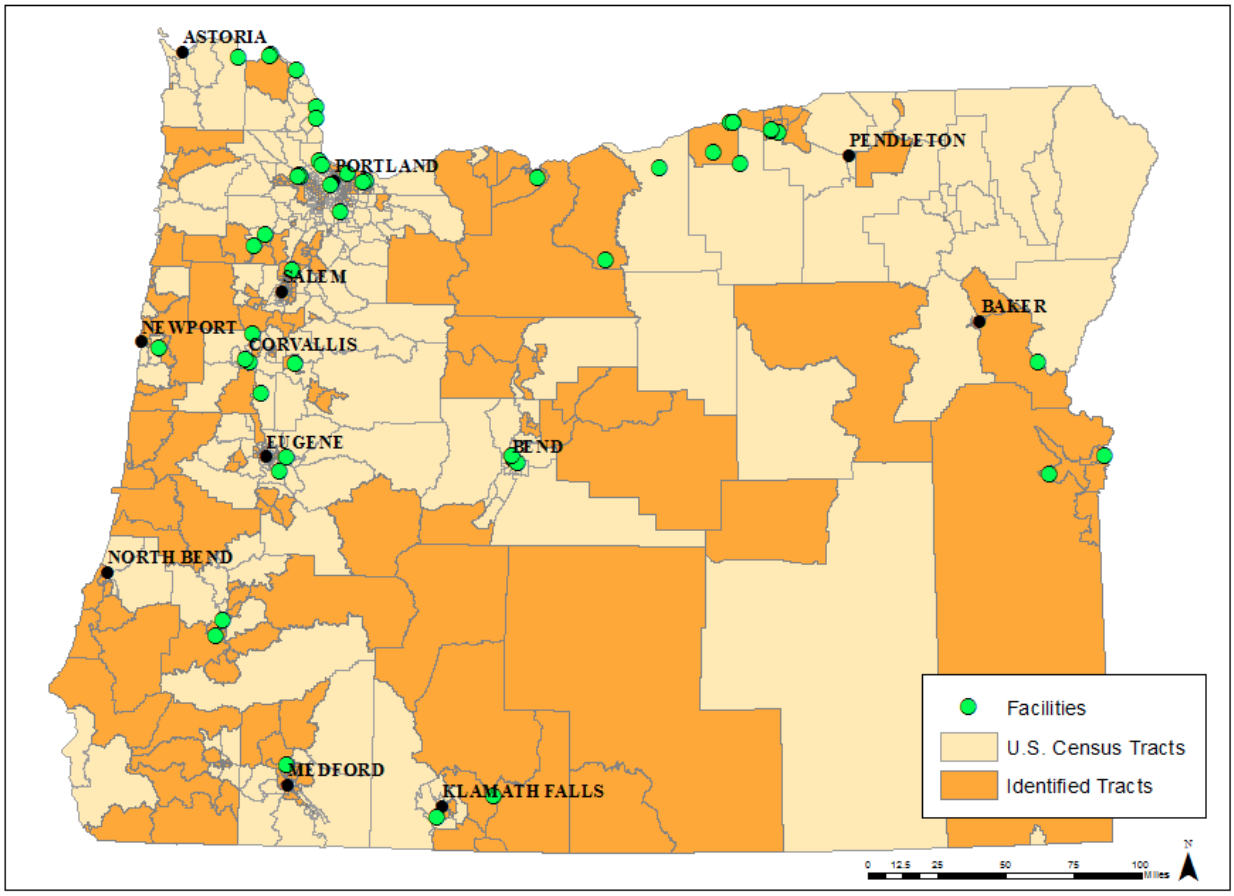


Figure 7: Distribution of Greenhouse Gas Emitting Facilities in Relationship to U.S. Census Tracts Identified as Most Vulnerable to Climate Change. *All facilities with Air Quality Permits from the Oregon Department of Environmental Quality that produced over 25,000 metric tons of CO_2e emissions in 2015. Data source: Oregon Department of Environmental Quality 2015 Greenhouse Gas Facility Emissions (2017b). Most vulnerable to climate change census tracts include the top 50% of census tracts with the highest vulnerability index score.*

The Washington Tracking Network similarly identified those communities in Washington most vulnerable to climate change based on a vulnerability index.[89] This index combined nineteen variables in four areas:

- *Environmental Exposures:* nitrous oxides; diesel emissions; ozone concentration; particulate matter; proximity to heavy traffic roadways; toxic release from facilities

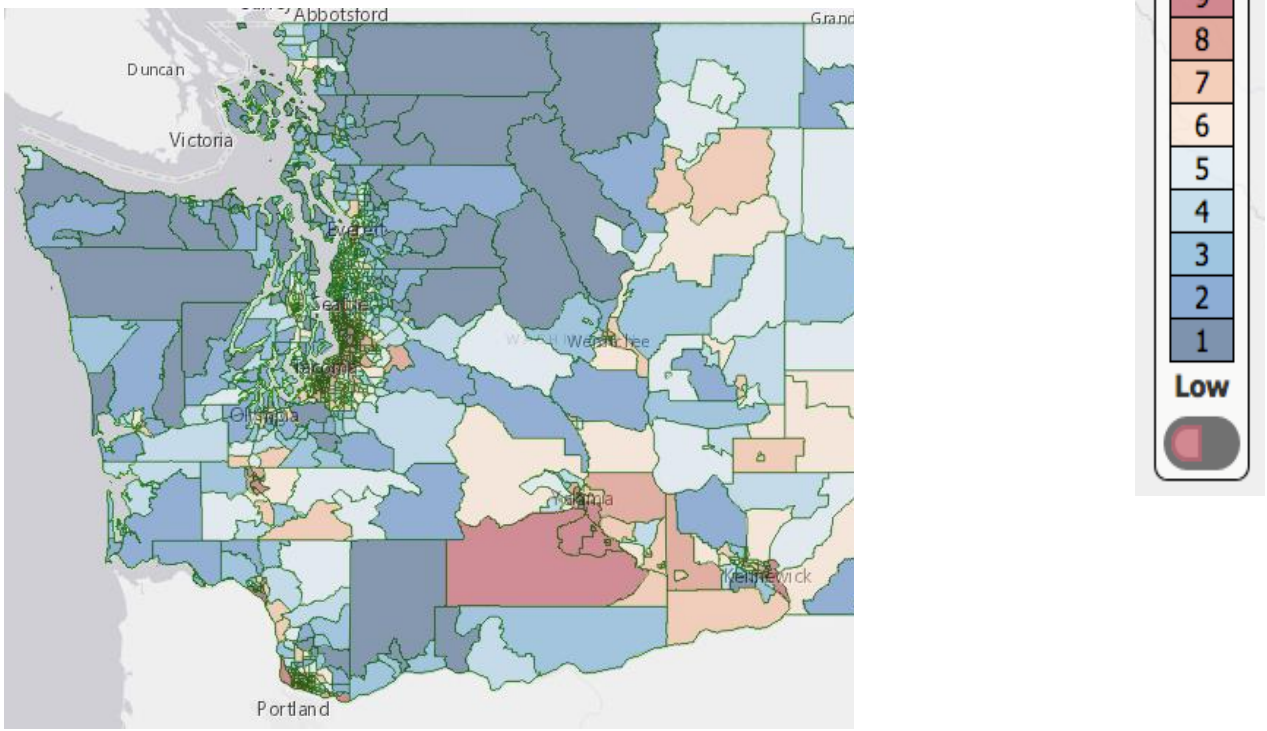
[89] (Washington Environmental Health Disparities Map, n.d.)

- *Environmental Effects*: lead risk from housing; proximity to hazardous waste treatment, storage, and disposal facilities; proximity to superfund sites; proximity to Risk Management Plan facilities; wastewater discharge)
- *Sensitive Populations*: death from cardiovascular disease; low birth weight
- *Socioeconomic Factors*: limited English; no high school diploma; poverty; race - people of color; transportation expense; unaffordable housing; unemployed

Figure 8 depicts Washington State as a whole.

Figure 8

Washington State: Climate Change Vulnerability Index



Figures 9 and 10 zoom in on Pierce and Cowlitz Counties respectively, where three major fracked gas projects are currently proposed or are in progress. In Figure 9, the Port of Tacoma (the site for the LNG facility) is located on the finger-like peninsulas jutting out into Puget Sound in the middle of the map.

Figure 9
Tacoma: Climate Change Vulnerability Index

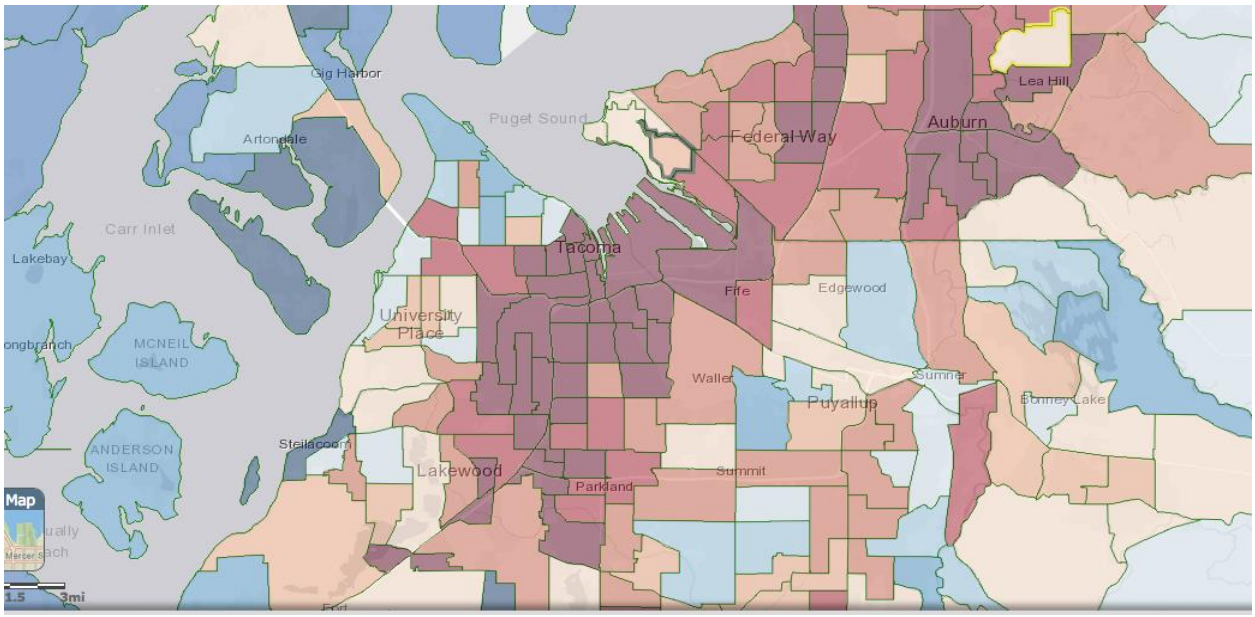
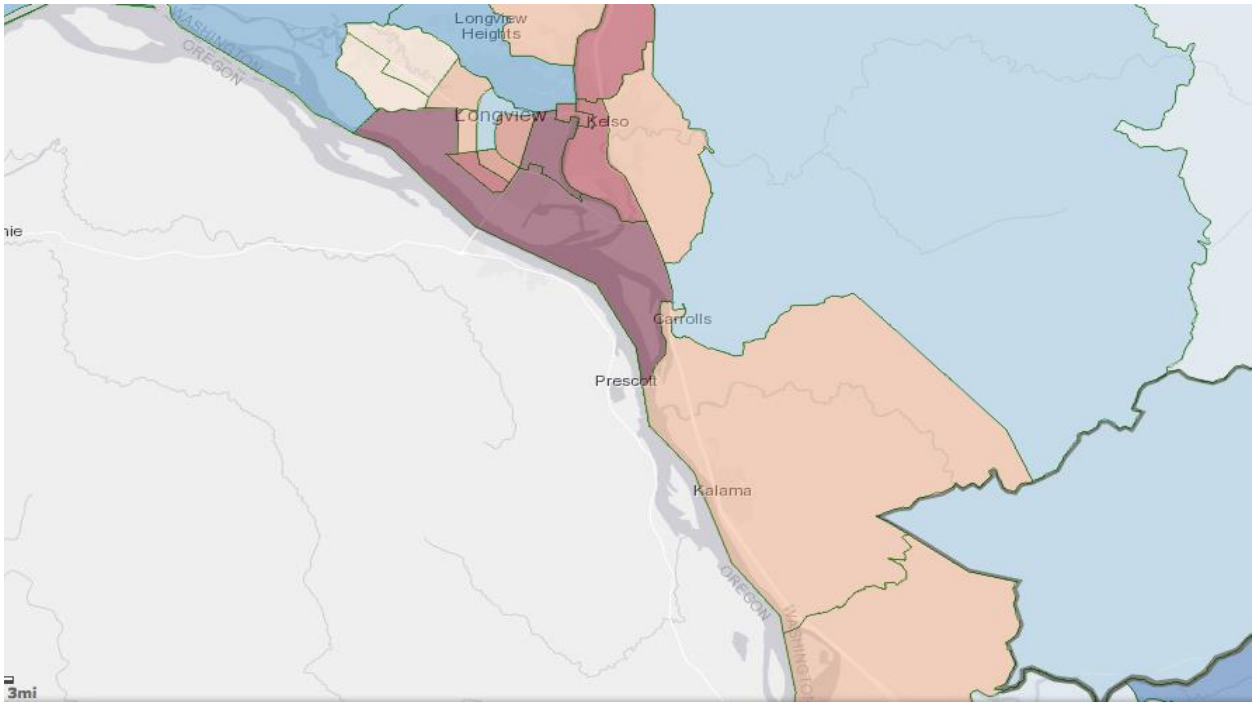


Figure 10

Kalama and Longview: Climate Change Vulnerability Index

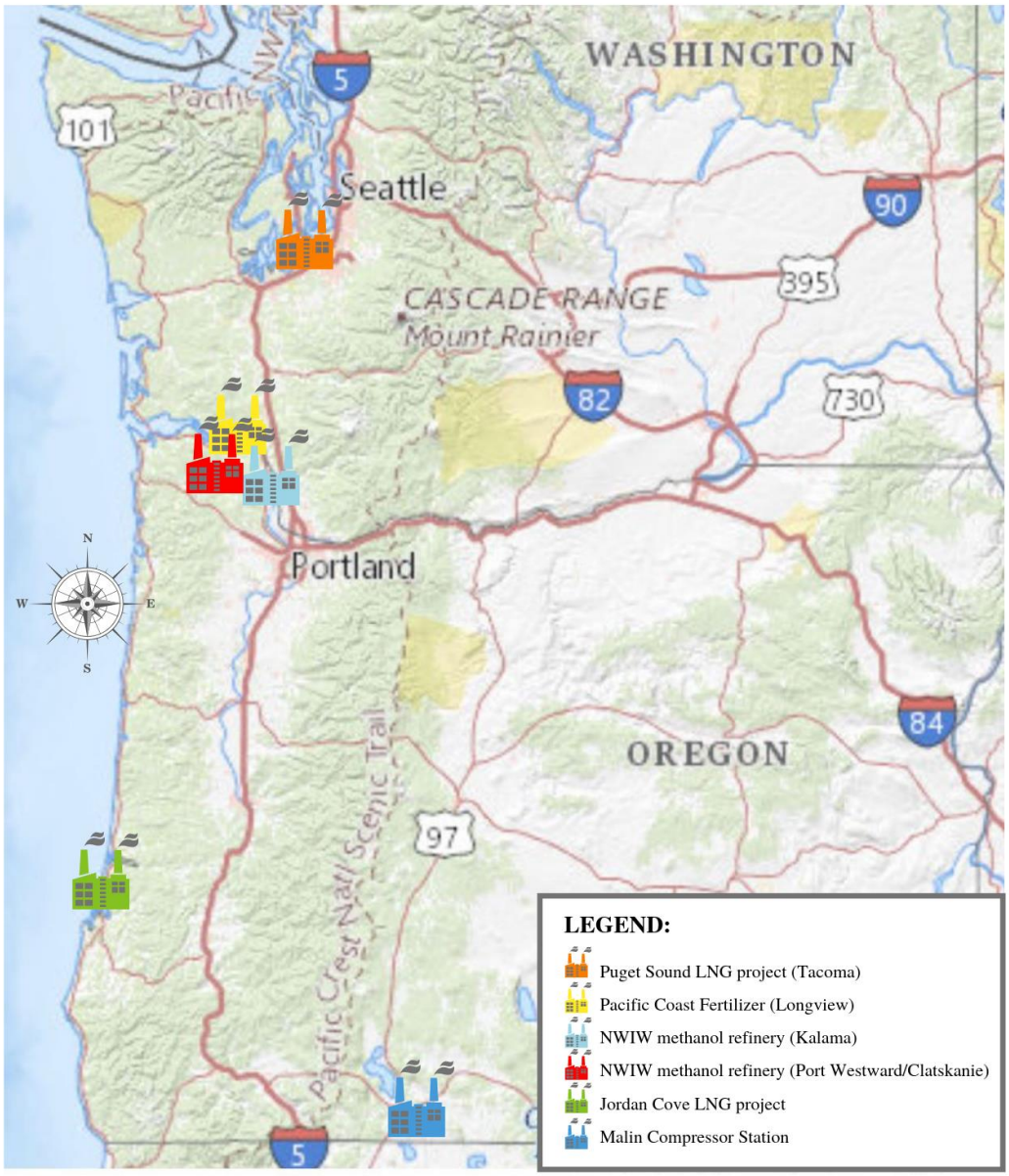


Social and Economic Profiles of Regions at Risk

Figure 11 maps the location of currently proposed major fracked gas infrastructure in Oregon and Washington**.**

Figure 11 Proposed Fracked Gas Infrastructure Oregon and Washington

Proposed Fracked Gas Infrastructure in Oregon and Washington State



Underlying map sourced from USGS
(https://viewer.nationalmap.gov/advanced-viewer/)

The counties where new fracked gas infrastructure is proposed have some of the worst social, economic, and health profiles compared to statewide averages, especially Cowlitz County (Pacific Coast Fertilizer and Kalama methanol refinery), Coos County (Jordan Cove LNG) and Klamath County (PCGP).

The affected counties tend to have small populations of immigrants or persons of color with the exception of Klamath County, which has a large Native American and Latinx population.

Table 2: Demographics: Race, Ethnicity, Language[90] (2017 Population Estimates)

	% Non-Hispanic African American alone	% American Indian and Alaskan Native alone	% Asian alone	% Native Hawaiian /Other Pacific Islander alone	% Hispanic or Latino	% Non-Hispanic White alone	% Who Do Not Speak English at Home
Oregon State	2.2%	1.8%	4.7%	0.4%	13.1%	75.8%	15.2%
Columbia	0.6%	1.5%	1.1%	0.2%	5.2%	88.5%	4.0%
Coos	0.8%	2.9%	1.3%	0.3%	6.5%	85.2%	5.1%
Douglas	0.5%	2.1%	1.1%	0.2%	5.9%	87.8%	3.8%
Jackson	0.9%	1.6%	1.5%	0.4%	12.9%	80.9%	9.5%
Klamath	1.0%	4.9%	1.2%	0.2%	13.1%	77.8%	8.3%
Multnomah	6.0%	1.4%	7.9%	0.7%	11.6%	69.9%	20.0%
Washington State	4.2%	1.9%	8.9%	0.8%	12.7%	68.7%	19.1%
Cowlitz	1.0%	2.0%	1.6%	0.4%	9.0%	83.7%	7.3%
Pierce	7.5%	1.7%	6.7%	1.7%	10.9%	67.0%	14.2%

[90] (U. S. Census Bureau, n.d.)

Each of these counties has higher rates of unemployment and lower high school graduation rates, as depicted in Table 3.

Table 3: Social and Economic Factors

	Unemployment*	Median Household Income**	Persons in Poverty ***	High School Graduation****
Oregon State	3.9%	$56,119	13.2%	75%
Columbia	4.9%	$57,449	12.3%	73%
Coos	5.3%	$40,848	19.9%	58%
Douglas	5.2%	$44,023	14.9%	64%
Jackson	4.8%	$48,688	14.3%	75%
Klamath	6.3%	$42,531	19.2%	72%
Washington State	4.3%	$66,174	11.0%	81%
Cowlitz	5.6%	$49,804	16.4%	79%
Pierce	4.9%	$63,881	10.2%	84%

*Oregon Unemployment, 11/18[91]; Washington Unemployment, 11/18[92]
** 2013-2017, in 2017 dollars[93]
*** Percentage of persons living in poverty from the Small Area Income and Poverty Estimates[94]
**** Percentage of ninth-grade cohort that graduates in 4 years, 2014-2015[95]

[91] (State of Oregon Employment Department, n.d.)
[92] (Employment Security Department: Washington State, n.d.)
[93] (U. S. Census Bureau, n.d.)
[94] (U. S. Census Bureau, n.d.)
[95] (Robert Wood Johnson Foundation, n.d.)

Adult and child mortality are higher in nearly every locale. Infant mortality is particularly high in Klamath County.

Table 4: Mortality [96]			
	Premature Age-adjusted Mortality*	Child mortality**	Infant Mortality***
Oregon State	310	40	5
Columbia	330	30	#
Coos	420	50	#
Douglas	390	60	6
Jackson	330	40	4
Klamath	390	60	9
Washington State	290	40	5
Cowlitz	390	50	5
Pierce	330	50	5

*Premature age-adjusted mortality: Number of deaths among residents under age 75 per 100,000 population (age-adjusted) 2010-2013.
**Child mortality: Number of deaths among children under age 18 per 100,000, 2010-2013.
***Infant Mortality: Number of all infant deaths (within 1 year), per 1,000 live births.
2006-2012
no data available

[96] (Centers for Disease Control and Prevention: National Center for Health Statistics, n.d.)

Over all death rates are higher in targeted counties, sometimes strikingly so, and especially for cancer, heart and lung disease, and suicide (a marker for community socio-economic stress).

Table 5: Oregon: Age-adjusted Death Rate per 100,000, by County [97] *

	All Causes	All Cancer	Heart Disease	Stroke	Chronic Lung Disease	Diabetes	Homicide	Suicide
State Total	834.1	198.4	191.8	68.8	49.1	66.6	3.3	15.0
Columbia	940.3**	228.7**	214.1**	74.3	58.4	66.4	2.3	18.7
Coos	949.9**	224.1**	226.3**	66.4	59.9**	78.8**	4.7	22.6**
Douglas	905.5**	209.5	203.0	63.0	62.4**	78.5**	3.4	16.7
Jackson	830.8	199.0	186.4	71.5	51.4	61.3	3.3	20.4**
Klamath	947.3**	204.8	217.6**	56.4**	70.5**	79.1**	4.6	23.3**

* Age-adjusted death rate per 100,000 population, 2017
** Statistically significant difference

Table 6: Washington: Age-adjusted Death Rate per 100,000, by County *

	All Causes	All Cancer	Major Cardiovascular Disease	Chronic Lung Disease	Diabetes	Homicide	Suicide
State Total	690.0	157.0	187.6	39.9	22.5	3.4	15.6
Cowlitz	820.0	189.5	202.4	64.1	36.7	#	24.2
Pierce	760.0	170.3	205.8	46.5	22.9	4.9	17.6

*Age-adjusted death rates per 100,000 population, 2015 [98]
data unavailable
Note: measures of statistical significance not available

These are locales that are already experiencing the deadly intersections of depressed economies, environmental degradation, and ill health. Fracked gas infrastructure will not bring the hoped-for economic prosperity necessary for healthy communities. It will only further degrade living conditions.

[97] (Oregon Health Authority, n.d.)
[98] (Washington State Department of Health, n.d.)

Stress and Mental Health

Often neglected in the discussion of impacts on communities targeted for major fracked gas infrastructure development is the associated psychological stress. Mental health impacts arise from proposals to build fracked gas infrastructure due to uncertainty of risks to health, life, property, security, sense of well-being, and inability to plan for the future. Noise exposures during construction and operation of fracked gas terminals also have the potential to increase stress and exacerbate mental health disorders among workers and nearby residents.

The threat of loss of land and property through eminent domain puts people in the path of proposed pipelines into long-term limbo, having to wait for many years to determine whether a project will go through. While they wait, they are reluctant to make changes or improvements to their homes, are unable to plan for the future, and are confronted with impossible decisions about whether to sell or lease right of way to their land, whether to leave or stay. Many poorer communities have been divided by the prospect of windfall profits for some but not all of the community. Confounding the profit motive is the threat of damage to health, environment, ecosystem supports, and cultural values. Threats of accidents or toxic releases increase concerns about the location of schools, hospitals, residences, and other businesses.

Residents of communities experiencing large influxes of temporary labor are caught between the lure of jobs and the threat of physical harm from toxic emissions to air and water, or from accidental releases, explosions, and fires. Added to those uncertainties, temporary labor influxes put stress on the resources of communities such as fire, police, and health care, and infrastructure such as roads, water, and sewage systems. Communities are faced with unforeseen burdensome expenses, with further loss of comfort and well-being.

For Native American communities, the prospect of loss of valued resources and traditional values after centuries of forced migration and marginalization is a source of increased mental and physical stress. Furthermore, increases in violence, assault, and disappearances among Native American women and girls have been documented near fossil fuel infrastructure projects. Threats to well-being, safety, and security are threats to mental as well as physical health and marginalized communities, including tribal nations, are disproportionately affected by these adverse impacts.[99]

[99] (Hayes, 2018)

AIR POLLUTION

Toxic air pollutants (TAPs), also known as hazardous air pollutants, are agents known or suspected to cause cancer or other serious health effects, such as lung and heart diseases, adverse effects on reproduction, or birth defects. They are often measured by lifetime cancer risk and respiratory hazard index. As the scientific understanding of TAPs has evolved, levels considered "safe" have consistently gone down. The standards for U.S. air quality have been set under considerable influence of industry and the standards set by the World Health Organization are often significantly lower and more protective.

Current National Ambient Air Quality Standards (NAAQS), established by the U.S. Environmental Protection Agency (EPA), cover only six air pollutants, known as criteria air pollutants: nitrogen dioxide (NO2), sulfur dioxide (SO2), carbon monoxide (CO), ozone, particulate matter (PM10 and PM2.5), and lead.[100] Fracked gas installations are known emitters of many of these air pollutants and many others. Ambient air quality standards do not exist for these additional pollutants, though Oregon DEQ has ambient benchmarks for some of them.

Safe levels of air pollutants are often assumed to fit all persons. Estimates of risk may be based solely on healthy adult exposure with no consideration for differences due to gender, race, age, size or pre-existing health conditions. In addition, emissions for any one air pollutant may comply with air quality standards, but that single pollutant benchmark fails to take into account the cumulative effects of exposure to several pollutants at once (which is by far the usual case) or how one pollutant might increase the power or the effect of another. For example, the potency of air-borne carcinogens is increased when they are adsorbed onto fine particulate matter and transported through the lungs to the blood and brain and placenta. Stating that the levels of exposure are below a particular standard is not the same as saying the risk of harm is not increased. Any amount of exposure to a carcinogen increases the risk of cancer. Lastly, for some air pollutants no level of exposure exists which does not harm human health. A prime example is fine particulate matter (PM10 and PM2.5), a major pollutant associated with fracked gas infrastructure which causes a host of health problems.

In 2010 the American Heart Association (AHA) revised and reissued its position on fine particulate matter: "The overall evidence is consistent with a causal relationship between particulate

[100] (U.S. Environmental Protection Agency, 2015)

matter 2.5 exposure and cardiovascular morbidity and mortality. This body of evidence has grown and has been strengthened substantially… [and] because the evidence reviewed supports that there is no safe threshold, it appears that public health benefits would accrue from lowering PM2.5 concentrations even below present-day [EPA standards] … to optimally protect the most susceptible populations."[101] The American College of Obstetricians and Gynecologists along with the American Society of Reproductive Medicine;[102] the American Academy of Pediatrics;[103] and the World Health Organization[104] have also issued statements calling for prompt action to revise air quality standards and reduce public exposure to toxic air pollutants, especially particulate matter.

Beyond extraction, every stage of fracked gas transport, storage, combustion, refinement, and processing is responsible for levels of air pollutants that threaten public health. Common air toxics produced over the life-cycle of fracked gas include:

- *Volatile organic compounds* (VOC), organic chemicals that form vapors easily. VOCs contribute to the formation of ozone and smog.
- Ground level *ozone,* formed from nitrogen oxides (NO_x) and VOCs. While ozone is a key constituent of the upper atmosphere, ground level ozone is created by human activities (largely the combustion of fossil fuel) and is a constituent of smog.
- *Particulate matter* (PM), tiny particles of solid or liquid suspended in a gas. The burning of fossil fuels (particularly diesel) in vehicles, power plants, and industrial processes generates significant amounts of particulate matter. PM is often referred to by size: PM10 and PM2.5.
- *Nitrogen oxides* (NO_x), expelled from high temperature combustion. They can be seen as a brown haze above or as a plume downwind of cities.
- *Carbon monoxide* (CO), a colorless and odorless gas. It is a product of combustion of fuel such as gas, coal, or wood.
- *Formaldehyde,* a VOC that is listed by the International agency for Research on Cancer (IARC) as a known cause of nose and throat cancer.

[101] (Brook, 2010)
[102] (American College of Obstetricians and Gynecologists, 2013)
[103] (Kim, 2004)
[104] (World Health Organization, 2013)

- *Benzene,* also a VOC, a colorless, flammable liquid with a sweet odor. Benzene is a natural part of crude oil and gasoline (and therefore motor vehicle exhaust), as well as cigarette smoke. It is classified by IARC as a known carcinogen.
- *Polycyclic aromatic hydrocarbons* (PAH), a particular type of volatile organic compound produced by the thermal decomposition of organic matter, such as in engines and incinerators or when biomass burns in forest fires. It is a prime carcinogen in cigarette smoke. Examples of PAHs include naphthalene and benzo[a]pyrene, which is classified by the IARC as a known carcinogen.

In both Oregon and Washington air quality is monitored primarily for particulate matter in the larger cities and towns, industrial sites, and transportation corridors.[105] [106] Very few sites monitor for carbon monoxide, nitrogen oxides, sulfur dioxide, ozone, or lead. Toxic air pollutants rarely monitored. In Oregon, no air quality monitoring stations exist in Coos or Columbia Counties.

[105] (Oregon Department of Environmental Quality, 2019)
[106] (Washington State Department of Ecology, n.d.)

Table 7 summarizes the key health effects of toxic air emissions associated with fracked gas.

Table 7: Health Effects of Air Pollutants Associated with Fracked Gas Infrastructure	
Air Pollutant	**Health Effects**
Volatile organic compounds	Cancer, watery eyes, coughing, nausea, skin irritation, eye, nose and throat irritation, frequent headaches, damage to the liver, kidney and central nervous system
Ozone	Lung damage, inflammation of the lining of the lung, chest pain, coughing, throat irritation, worsening of bronchitis, emphysema, and asthma
Particulate matter	Strokes, heart disease, autism, attention deficit hyperactivity disorder, Alzheimer's Disease, lung cancer, worsening of bronchitis, emphysema, and asthma
Nitrogen Oxides (NO_x)	Lung inflammation, increased lung infections
Carbon Monoxide	Short term: headache, dizziness, nausea; unconsciousness and death (at high levels of acute exposure) Long term: heart disease
Formaldehyde	Nasopharyngeal cancer, watery eyes, burning in eyes, nose and throat, wheezing, nausea, skin irritation
Benzene	Cancer: acute myelogenous leukemia, other blood cancers (leukemias and lymphomas), anemia, myelodysplastic syndrome
Polycyclic Aromatic Hydrocarbons	Testicular, skin and colon cancer, cataracts, kidney and liver damage, birth defects, developmental disorders, hormonal disruption

Table 8 summarizes types of fracked gas infrastructure with best documented emissions of air pollutants and is not an inconclusive list.

Table 8: Air Pollutants Associated with Fracked Gas Infrastructure

	Particulate Matter	Volatile Organic Compounds	Ozone	NOx	CO	Other
Compressor stations; pipelines	yes	yes (formaldehyde, benzene, hexane)	unknown	yes	yes	sulfur dioxide, lead
LNG facilities	yes	yes	yes	yes	yes	unknown
Methanol refining	yes	yes (benzene, formaldehyde, PAHs)	unknown	unknown	yes	ammonia, nickel
Ammonia production facilities	yes	yes	unknown	yes	yes	unknown

Jordan Cove LNG

The air quality status of the local environment is unknown. According to the JCEP Final Environmental Impact Statement (FEIS), the closest monitoring sites for criterion air pollutants are in Eugene and Lane County. For all monitored air pollutants, emissions at the plant are expected to fall well below NAAQS.[107]

The LNG facility will also emit Hazardous Air Pollutants. In the Coos Bay area ambient levels of HAPs were last measured in 2005, in terms of lifetime cancer risk, and again in 2011, using the respiratory hazard index. Levels were found to be low, although no safe levels have been established for these hazardous air pollutants. The 2017 JCEP Resource Report 9 notes that the LNG

[107] (Office of Energy Projects: Federal Energy Regulatory Commission, 2019)

terminal will be a source of HAPs, emitting 8.1 tons per year and 3.1 tons per year of n-hexane, a known neurotoxin as well as many others including benzene, formaldehyde, polycyclic aromatic hydrocarbons, arsenic, cadmium, and mercury.[108]

Compressor Station of the Pacific Connector Gas Pipeline

Compressor stations provide the force which propels gas through pipelines. They emit significant amounts of air pollution, both from the operation of the engine which powers the pump as well as from venting. When the pressure in the pipeline exceeds levels meant to ensure safety (by not creating dangerous pressure on the pipeline), the contents of the pipeline are vented intentionally and directly into the ambient air. Fugitive leaks may occur as well. Compressor stations and meter stations, which also vent methane, VOCs and PM, are often located every 40 to 100 miles along fracked gas pipelines. A meter station is proposed for Coos County as part of the Jordan Cove LNG project. The Klamath Compressor Station for the Pacific Connector Gas Pipeline would be located in a rural area with 16 homes in the vicinity. Two compressor stations related to existing large pipelines are already located near this proposed compressor station.

In New York State a study on the health effects of the emissions from 18 fracked gas compressor stations found that, collectively, these sites released 40 million pounds of 70 different contaminants over a 7-year period (the seventh largest point source of air pollution in the state for that time period). The largest emissions (by volume) were nitrogen oxides, carbon monoxide, volatile organic compounds (VOC), formaldehyde and particulate matter.[109]

Studies of gas compressor stations in Pennsylvania and New York demonstrated that compressors emitted highly variable plumes of methane that spread downwind and were measurable a full mile away at levels that could expose nearby residents, especially during temperature inversions.[110] High levels of methane, especially in an enclosed space, can cause suffocation, loss of consciousness, headache and dizziness, nausea and vomiting, weakness, and loss of coordination.

High levels of formaldehyde were found near compressor stations in Arkansas, Pennsylvania, and Wyoming. Formaldehyde is a byproduct of incomplete combustion from the gas-fired engines. It is also created when fugitive methane, which escapes from compressor stations, is exposed to sunlight. Other hazardous air pollutants detected near compressor stations in this study were benzene

[108] (Jordan Cove LNG, 2017)
[109] (Russo, 2017) https://www.albany.edu/about/assets/Complete_report.pdf
[110] (Payne, 2017) doi: 10.1016/j.scitotenv.2016.12.082

and hexane. One air sample collected near a compressor station in Arkansas contained 17 different volatile compounds.[111]

According to the JCEP Resource Report 9, monitoring stations in proximity to the proposed route focus primarily on monitoring of PM10 and PM2.5 (related to particulate matter emissions from wood heating in the region). No stations monitor for SO2 and NO2 in the multi-county area of southern/southwestern Oregon and northern California. Monitoring for CO was performed in Medford through 2010, after which the monitor site was closed. Per this report, NAAQS are met at the Klamath Compressor Station and along the path of the PCGP with the exception that approximately 4.3 miles of pipeline would be located within the Klamath Falls PM2.5 nonattainment area (out of compliance with NAAQ standards) and approximately 300 feet of pipeline would be located within the PM10 maintenance area (formerly out of compliance).

Hazardous air pollutants (HAPs) are also generated both with construction and operation of the Compressor Station and Pipeline, primarily formaldehyde. The JCEP Resource Report 9 states that these levels meet current standards, although no safe levels have been established.

During 2014 and 2015, Klamath Falls experienced elevated PM2.5 ambient concentrations due to wildfires in southern Oregon.[112] During the 2018 fire season the highest concentration of wildfires in the state was in Southern Oregon and air quality alerts were issued to residents of Klamath Falls.[113] However, the DEIS for Jordan Cove does not consider cumulative effects of toxic pollution from fires with ongoing toxic emissions, particularly from compressor stations.[114]

Kalama Methanol Refinery

Methanol refining is an industrial process that emits significant amounts of air pollution. Methanol itself is toxic when ingested or inhaled. It affects the nervous system, particularly the optic nerve, and is the toxin responsible for the cases of blindness from drinking homemade spirits (moonshine). Principle TAPs from the refinery would include nitrogen oxides, sulfur dioxide, carbon monoxide, and VOCs. PM2.5 emissions from the refinery are particularly worrisome because no safe level exists for these pollutants.

[111] (Macey, 2014) doi: 10.1186/1476-069X-13-82
[112] (Jordan Cove LNG, 2017)
[113] (Linares, 2018)
[114] (Office of Energy Projects: Federal Energy Regulatory Commission, 2019)

According to the FEIS, all toxic air emissions beyond the industrial site itself would fall within limits set for Washington State. Within the physical confines of the operation, however, the levels of PM2.5 would exceed standards by five-fold. (Table 4.6[115]) The emission estimates assume the use of Ultra-Low Emissions (ULE) technology which, according the FEIS, is expected to decrease the emissions of GHGs and toxic air pollutants.

Two possible technologies for producing methanol from methane are considered in the Final Environmental Impact Statement. Combined reformer (CR) technology is currently deployed in all large-scale methane to methanol refineries worldwide. The alternative proposed for the Kalama methanol plant is ULE, which would reduce PM2.5 emissions by about 60%. However, while ULE technology has been used to produce other chemicals from methane, it is a new technology for methanol production and has only been deployed in one small methanol plant in Australia. It has never been applied at any full-scale methanol production facility. Table 9 (reproduced from the FEIS[116]) displays total expected annual emissions from normal facility operations, based on the two different technologies.

Table 9: Air Pollutants from Methanol Refinery

Pollutant	Combined Reformer	Ultra-Low Emissions
nitrogen oxides (NOx)	124 tons/year	75 tons/year
carbon monoxide (CO)	584 tons/year	72 tons/year
particulate matter (PM)	161 tons/year	64 tons/year
sulfur dioxide (SO2)	46 tons/year	46 tons/year
volatile organic compounds (VOC)	105 tons/year	54 tons/year

[115] (Final Environmental Impact Statement: Kalama Manufacturing and Marine Export Facility, September 2016)
[116] (Final Environmental Impact Statement: Kalama Manufacturing and Marine Export Facility, September 2016)

Diesel exhaust is another source of concern. During construction and operation of the terminal, diesel exhaust emissions will arise from construction and support vehicles, generators, and marine vessels servicing the terminal. It is composed of various pollutants including VOCs, NO_x, and PM2.5 and is carcinogenic. But to estimate cancer risk of diesel emissions at the refinery the FEIS drew on a 2002 EPA statement that "human-response data [related to diesel exhaust] are considered too uncertain to derive a confident quantitative estimate of cancer unit risk."[117] In fact, in 2012 the IARC (World Health Organization) upgraded its classification of diesel particulate matter to a known and certain carcinogen.[118]

Anhydrous Ammonia

Anhydrous ammonia (NH3) is a common nitrogen containing fertilizer used in industrial agriculture to promote rapid plant growth. Its agricultural use results in significant contributions to worldwide GHG emissions. NH3 is also used as a refrigerant and is a key chemical in the illicit production of methamphetamine. Numerous thefts of NH3 have occurred for the purposes of producing methamphetamine resulting in leaks and releases due to improper handling and storage.

Exposure to anhydrous ammonia can cause severe eye, nose and throat irritation, breathing difficulty, wheezing, chest pain, pulmonary edema (fluid build-up in the lungs), burns, blisters, and frostbite. According to The Centers of Disease Control and National Institute of Occupational Safety and Health, exposure is fatal at concentrations as low as 300 parts per million.

The production of ammonia is energy intensive and accounts for 1-2% of worldwide energy use and 3% of worldwide greenhouse gas emissions.[119] But Cornell University and the Environmental Defense Fund recently released a study demonstrating that methane gas emissions from fertilizer plants are "vastly underestimated" and may be as much as 100 times higher than the self-reported estimates of the industry.[120] This industrial process also releases other types of air pollution.

The proposed Pacific Coast Fertilizer plant, which would be sited in Longview, Washington's Mint Farm Industrial Park, would produce anhydrous ammonia using fracked gas. The Draft EIS (DEIS) is expected in the spring of 2019. However, toxic emissions would be similar to

[117] (Final Environmental Impact Statement: Kalama Manufacturing and Marine Export Facility, September 2016)
[118] (International Agency for Research on Cancer, 2012)
[119] (Lehigh University, 2018)
[120] (Garris, 2019)

the Dyno-Noble Fertilizer plant in nearby St Helens, Oregon, which emits particulate matter, nitrous oxides, carbon monoxide, and VOCs.[121] The proposed Longview plant is expected to produce four to six times as much fertilizer per year, compared to the Dyno-Noble plant, with a proportional increase in the amount of toxic emissions.

Puget Sound LNG

Toxic emissions, as modeled for the Puget Sound LNG FEIS, do not exceed the critical statutory thresholds for air pollution.[122] For reasons elaborated above this does not ensure that air quality would not be degraded and harmful to both workers and the community. Emissions from construction, which include stirring up contaminants in the earth from prior industrial activities, would create a toxic mix of nitrous oxides, carbon monoxide, sulfur dioxide, PM2.5, volatile organic compounds, and other toxic air pollutants (TAP).

Operations of the facility would result in emissions from the pretreatment heater, enclosed ground flare, emergency flare, LNG vaporizer, 1600KW backup diesel generator as well as fugitive emissions from pipelines and storage tanks and refrigerant leaks and losses. These emissions would include the same pollutants as listed above for construction, plus sulfuric acid.

Tacoma-Pierce County was out of compliance with National Ambient Air Quality Standards (NAAQS) for PM2.5 for several years. Compliance was attained in March of 2015 (daily PM2.5 = 33 micrograms per cubic meter/one-year average; threshold for non-compliance = 35).[123] As this same report notes, however, serious adverse health effects are experienced at levels below the NAAQS. The LNG facility would only add to this problem.

Methane has been promoted as a "clean" fuel for maritime vessels, particularly in comparison to diesel. But measurements of the gaseous and particulate emissions of a cruise ferry on the Baltic Sea using a dual-fuel engine showed that LNG is not such a clean fuel for ships.[124] Methane made up about 85 percent of the vessel's hydrocarbon emissions. Particulate emissions showed substantial amounts of volatile and nonvolatile particles, both of which are hazardous to human health.

[121] (Oregon Department of Environmental Quality)
[122] (Final Environmental Impact Statement: PSE LNG, 2016)
[123] (Washington State Department of Ecology, 2016)
[124] (Anderson, 2015)

WATER AND LAND POLLUTION

Clean, fresh water is one of the most important and abundant natural resources in the Pacific Northwest. It is also one of the region's features that attracts the gas industry, which requires staggering amounts of water for construction and operation of its infrastructure, especially refineries. At the same time, the infrastructure threatens to pollute and degrade watersheds and waterways that communities and wildlife rely upon. Adverse impacts on land are closely related and include loss of farmlands, wetlands, and forest and despoilment of the natural beauty of the Pacific Northwest.

Oregon and Washington economies are highly dependent on reliable water and water systems for human consumption, agriculture and livestock, manufacturing, transportation, energy production, and recreation. Clean water is essential to our environmental health, for trees and vegetation, wetlands, aquatic life, and human health. Drought related to climate change has already negatively impacted lands and water systems in the Pacific Northwest.

As noted by the Oregon Department of Environmental Quality, "Many studies have shown that it is more cost-effective to prevent pollution in the environment than to remove it through treatment or to implement restoration." [125] Reducing or eliminating pollutants through protection and prevention can:

- lower treatment and maintenance costs for public water providers
- improve long-term viability of groundwater drinking water sources
- reduce the need for equipment replacement or upgrades
- reduce risks associated with many contaminants (including ones known to be toxic, persistent, and/or bio-accumulative)
- promote long-term assurances of a safe and adequate drinking water supply
- help protect property values and preserve the local and regional economic growth potential
- enhance public confidence in their drinking water
- reduce the need for expensive treatment in both surface water and groundwater

Alternatively, pollution of drinking water associated with fracked gas infrastructure may saddle water providers and ratepayers with costly new monitoring and treatment systems.

[125] (Oregon Department of Environmental Quality Environmental Solutions: Watershed Management Section, 2018) https://www.oregon.gov/deq/FilterDocs/SurfaceWaterResourceGuide.pdf

Pacific Connector Pipeline

The proposed Pacific Connector Pipeline (PCP) has vast potential to degrade water quality and quantity on public, private, and tribal land for drinking water and other beneficial uses. The project would directly harm approximately 480 Oregon rivers and streams by clearcutting through riparian areas, building new roads to access these rivers, damming and diverting water, cutting trenches and laying a 36-inch pipeline directly through riverbanks and riverbeds. Horizontal drilling beneath the wild and scenic Rogue, Umpqua, Coquille, Coos, and Klamath Rivers could result in pollution of waters with toxic drilling fluids. At least twelve public drinking water sources are located in watersheds to be transected by the proposed pipeline. (See Appendix III for detailed information.)

The pipeline would slash a 95-foot wide swath through forest, ranch, and farm land and would also cross the popular recreational hiking trail, the Pacific Crest Trail. Clear cuts along the trail and elsewhere would be permanently maintained by cutting and spraying fertilizers, herbicides and pesticides.

During construction, testing of the pipeline to determine if it will hold gas would utilize enormous quantities of fresh water in areas that are designated as drought affected. For example, the Klamath Basin and those who rely on Klamath water (irrigators, tribal communities, endangered species, wildlife refuges, and associated wildlife) already experience extreme strain on water resources. Testing could require over 60 million gallons of fresh water. If the project re-uses water to test multiple segments of pipe, it would still consume at least 16 million gallons of water.[126] Discharged test water would be contaminated with materials used to construct the pipeline.

According to the Oregon DEQ and the Oregon Health Authority, water contamination "depends on three major factors: 1) the occurrence of a land use/activity that releases contamination, 2) the location of the release, and 3) the hydrologic, ecological, and/or soil characteristics in the source area that allow the transport of the contaminants to the waterbody and thereby the intake."[127]

Human factors affecting water quality include:

- All activities and facilities within riparian areas
- Road locations and conditions, especially stream crossings, and roads near streams, on steep slopes, and with drainage systems connected to the stream network

[126] (Draft Environmental Impact Statement for the Jordan Cove Energy Project, 2019)
[127] (Oregon Department of Environmental Quality Environmental Solutions: Watershed Management Section, 2018)

- Stormwater runoff from contaminated lands, for example, with high phosphorus or nitrogen content
- Recently managed forestland which has been harvested, replanted, and treated with herbicides.
- Quarries, construction, and other industrial sites
- Hazardous material sites
- Solid waste landfill sites

Each of these factors is associated with the proposed pipeline.

Some landscapes are more sensitive to disturbances and contamination has greater potential to impact the water supply.[128] Sensitive areas include:

- Riparian areas
- Springs, seeps, and wetlands
- Steep slopes (>70-85%)
- Floodplains
- Areas with high soil erosion or runoff potential, for example, disturbed or bare soil
- High water table areas
- Areas of high soil permeability
- Areas within 1000 feet of rivers and streams.

The proposed pipeline would pollute streams, wetlands and riverbeds; blast rock and hillsides; clear-cut and destroy vegetation in each of these sensitive areas within municipal watersheds. Potential adverse impacts include:

- increased water temperature from loss of forest cover and riparian area buffers
- increased erosion from loss of forest cover and riparian areas leading to increased sediment and turbidity
- increased use of chlorine due to higher turbidity levels, leading to increased chemical by-products that carry their own health risks
- contamination of water and soil by oil, lubricants, and chemicals
- movement of non-native species into watersheds on tires of vehicles, on boats, and equipment

[128] (Oregon Department of Environmental Quality Environmental Solutions: Watershed Management Section, 2018)

- fires due to construction and blasting accidents and rupture or failure of the pipeline
- wildfire leading to pipeline explosion leading to larger wildfire
- water contamination through accidental application of fire suppressants/retardants
- post-fire slope failures, debris flows, landslides, increased turbidity, loss of drinking water, increased cost for replacement of drinking water, increased costs for water treatment
- disruption of surface water connection with groundwater (from blasting and water diversions)
- disruption of groundwater connection with wells and surface water (from blasting and water diversions)
- contamination of water by herbicides like picloram (to maintain right-of-way free of vegetation on and near the pipeline route) which could persist in the groundwater for years
- contamination of water by intensive use of fertilizers to re-plant cleared area around pipeline
- increased incidence of harmful algal blooms

Construction and operation of the pipeline would also degrade habitat for aquatic life, especially the endangered Coho salmon, with negative impacts on fishing and traditional activities of tribal communities. Habitat degradation would occur through loss of forest canopy, removal of riparian vegetation, decreased summer flows, warming of water, and addition of fertilizers/nutrients to encourage re-growth of vegetation on certain properties following installation of the pipeline.

These same effects would increase risk of harmful algal blooms (HAB). According to the Centers for Disease Control and Prevention, HAB can produce toxins that cause illness in people, companion animals, livestock and wildlife.[129] Exposures to the toxins can occur when people or animals have direct contact with contaminated water by:

- Swimming
- Breathing in aerosols (tiny airborne droplets or mist that contain toxins) from recreational activities or wind-blown sea spray

[129] (Centers for Disease Control and Prevention, n.d.)

- Swallowing toxins by drinking contaminated water or eating contaminated fish or shellfish

Human and animal illnesses and symptoms vary depending on the nature and length of exposure and the particular HAB toxin involved. Common toxins include cyanotoxins which can be toxic to the nervous system, liver, skin, or the gastrointestinal tract. No human deaths in the United States have been caused by cyanotoxins; however, companion animal, livestock, and wildlife deaths caused by cyanotoxins have been reported throughout the United States and the world.[130]

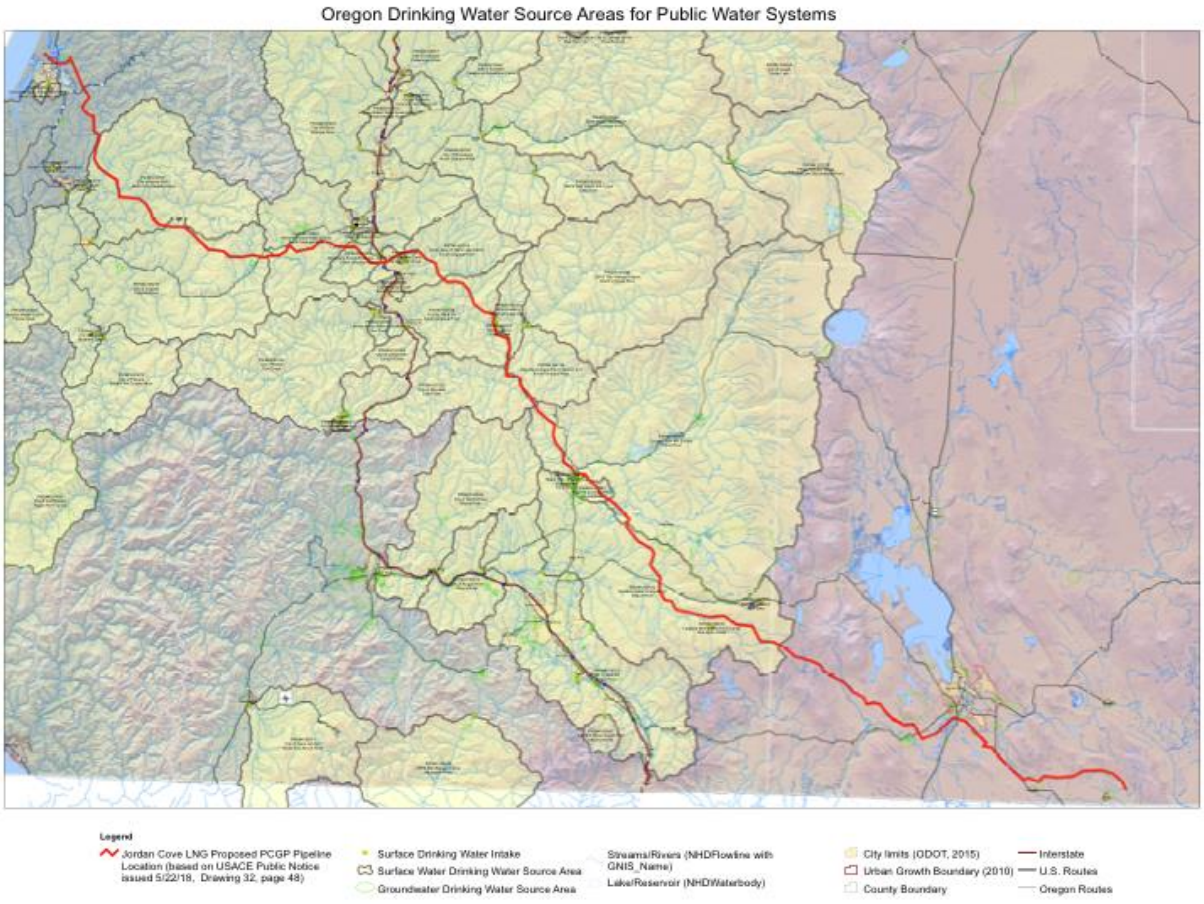
During the summer of 2018, a state of emergency was declared by Governor Brown when the drinking water supply for the City of Salem was tainted by HABs. Eight drinking watersheds in SW Oregon that would be transected by the PCGP are today at risk for HAB.[131] The construction and maintenance of the proposed Pacific Gas Connector Pipeline would greatly exacerbate that risk.

The following map illustrates the course of the proposed pipeline and the many drinking watersheds that would be directly disturbed and degraded by the project. Many more drinking water sources could be damaged if a fire associated with the PCP were to start in a small watershed, jump a ridge and burn out of control within and/or beyond the larger Rogue, Umpqua, Coquille, Klamath or Coos watersheds.

[130] (Centers for Disease Control and Prevention, n.d.)
[131] (Oregon Health Authority, 2018)

Figure 12

Pacific Connector Gas Pipeline and Drinking Water Sheds



According to the Jordan Cove DEIS, "If a groundwater supply is affected by the Project, Pacific Connector would work with the landowner to provide a temporary supply of water; if determined necessary, Pacific Connector would provide a permanent water supply to replace affected groundwater supplies."[132] The same claim is made for mitigation for a temporary or permanent loss of surface water supplies. Replacement of a permanently contaminated aquifer or surface water drinking source would, however, require trucking in bottled water or piping it in from an alternative source. This would be costly, difficult, and in some cases impossible. It would represent a permanent erosion of quality of life as well as significant reduction in land value. Lack of an affordable and reliable source of clean water renders a landscape uninhabitable over the long term.

[132] (Draft Environmental Impact Statement for the Jordan Cove Energy Project, 2019)

Jordan Cove LNG

Construction and operation of the terminal would require massive dredging operations in the Coos Bay Estuary, which is critical habitat for Coho salmon and is home to thriving oyster farms, traditional shellfish gathering areas, as well as other aquatic and estuarine life. Dredging and disposal of dredged material will increase turbidity, degrade the shoreline and the bay and negatively impact habitat in the area.

The project would remove roughly 6 million cubic yards from the Coos Bay Estuary. A related channel deepening project would increase the overall dredging to 18 million cubic yards in the estuary, and would be one of the largest dredging proposals in Oregon's history.[133] Suspended sediment will make the water murky and increase turbidity. Dredging of this scope would stir up contaminated sediments from past industrial activities, including polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), heavy metals, petrochemicals, pesticides and other persistent and toxic contaminants. These could enter the food chain, accumulate in the tissues of animals and fish and present significant health risks to people consuming these foods. Contaminated sediments also pose a major threat to shellfish such as oyster beds, a major local industry.

Endangered Oregon Coast Coho salmon would be negatively impacted. Impacts on one stock of salmon can degrade fishing throughout Southern Oregon and Northern California, threatening loss of livelihood and food source to communities in the region. Diminished access to salmon and shellfish would especially harm tribal nations and their protected resources, exacerbating injustices to these and other communities that rely on aquatic resources for their livelihoods.

LNG vessel traffic in Coos Bay would further interfere with ocean-based fisheries.[134] The Dungeness crab fishery is consistently the most valuable single species commercial fishery in Oregon, making the crustacean's well-being of special significance to the economy of Coos Bay and the State of Oregon itself.[135] According to Professor Sylvia Yamada, Assistant Professor of Senior Research in the Department of Zoology at Oregon State University, Coos Bay is a crucial "nursery" habitat for the Dungeness crab.[136] The highest number of juvenile crabs are found in soft sediments and eel grass beds of estuaries, where the young crabs find food and shelter from predators.

[133] (Oregon Department of Environmental Quality, n.d.)
[134] (Rogue Climate, 2019)
[135] (Knoder, 2018)
[136] (Yamada, 2019)

Not only would the turbidity during the construction phase of the LNG terminal negatively impact the ecological community, the ongoing dredging to maintain the berth and shipping channels would continue to disturb the ecosystem. In a study by Professor Yamada designed to simulate a dredging operation, she found that 45 - 85% of the Dungeness crabs exposed to the operation died. Over the four-year estimated construction period, Dungeness crabs would face repeated exposure to dredging activities that could substantially increase their rates of mortality.

Michael Graybill is the former manager of the South Slough National Estuarine Research Reserve, a fisherman, and current resident of Coos Bay. He testified in public hearings in January of 2019 that individual boats involved in commercial fisheries including the Dungeness crab, salmon and pink shrimp work as a fleet.[137] When Dungeness crab season opens and weather conditions permit, the boats in the fishery head toward sea in unison. Particularly in winter, which is commercial crab season, boats at sea monitor weather conditions and the effects on the bar. In declining or marginal weather conditions, the fleet of boats reverses direction and heads together for the bar. Their safe return can consume the entire window of suitable incoming high tide conditions. When the tide reverses and begins to ebb, conditions on the bar deteriorate rapidly. Boats that miss this window are forced to ride out the storm at sea until the next high flood tide. Adding LNG ship traffic would negatively impact the existing use of the navigation channel by the fishing fleet. Closing the bar for the necessary thirty minutes over high tide to accommodate passage of an LNG carrier risks stranding one of the fishery fleet boats at sea in bad weather, a serious if not life-threatening outcome.

Coal Bed Methane Extraction

Oregon DEQ issued a Discharge Elimination System permit in 2007, which was renewed in 2012 and remains active until 2020. While in some coal bed methane (CBM) developments wastewater is reinjected back into the ground, the Coos County project is permitted to treat and then discharge wastewater into the Davis Slough five miles south of Coos Bay.[138] The discharge is contaminated with a number of hazardous chemicals that may include benzene, toluene, ethyl-benzene and heavy metals including arsenic, cadmium, lead, mercury, and copper. Although

[137] (Graybill, 2019)
[138] (Oregon Department of Environmental Quality, 2018)

extraction is currently suspended, the pre-existing Curzon wells are exempt from the 2019 5-year moratorium on gas fracking in Oregon.[139]

Kalama Methanol Refinery

The methane to methanol refinery would be the largest methanol plant in the world, and it would sit on the banks of the Columbia River, adjacent to wetlands and overlying the alluvial aquifer associated with the Columbia and Kalama rivers and from which the City of Kalama draws its water. The refinery will significantly impact water resources during both construction and operation.

During construction stormwater and surface runoff would be discharged into the Columbia River and adjacent wetlands, carrying sediment, debris, fuel, oil, grease, and other hazardous pollutants that could affect water quality, especially if accidental spills occur.[140] Dredging to accommodate shipping vessels and installation of concrete and steel pipes will cause turbidity in the Columbia River, which can be harmful to aquatic life. Dredging could also disturb sediments, releasing accumulated hazardous chemicals into the water.

During operations, real and potential adverse impacts on water resources include:

- Degradation of water quality of the aquifer due to contaminated stormwater runoff and accidental spills of methanol or other hazardous chemicals
- Increased vessel traffic on the Columbia River with increased potential for toxic spills
- Consumption of the vast quantities of fresh water

Toxic spills of bunker fuel or methanol into the Columbia from ships, as well as toxic spills at the refinery of chemicals used in producing methanol and waste products such as heavy metals could contaminate the underlying aquifer, which supplies drinking water to the thousands who live nearby. Neither the FEIS or Draft Supplemental EIS (DSEIS) seriously examine this possibility.

A healthy Columbia River basin is essential to northwest fisheries and to the Columbia River tribes who rely on the fish for food, cultural, and spiritual resources. In addition, at a time when Southern Resident killer whales are on the verge of extinction, impacts on Chinook salmon and other fisheries in the Columbia River basin must be considered.[141] Yet the FEIS gives short shrift to the issue, mentioning fish rarely and whales not once. The FEIS concedes that increased marine traffic "would have the potential to result in cumulative impacts to wildlife and fisheries resources,

[139] (Loew, Oregon Senate passes 5-year fracking moratorium for oil, natural gas, 2019)
[140] (Final Environmental Impact Statement: Kalama Manufacturing and Marine Export Facility, September 2016)
[141] (Nations of Yakama, Umatilla, Warms Springs and Nez Perce, n.d.)

including increased potential for the introduction of invasive species, ship strikes, and wake stranding."[142] Despite this, the FEIS made no attempt to quantify these impacts on fisheries. It goes on to say the refinery will increase the overall risk of spills and erosion impacting not only fish, but the riparian and aquatic vegetation as well.

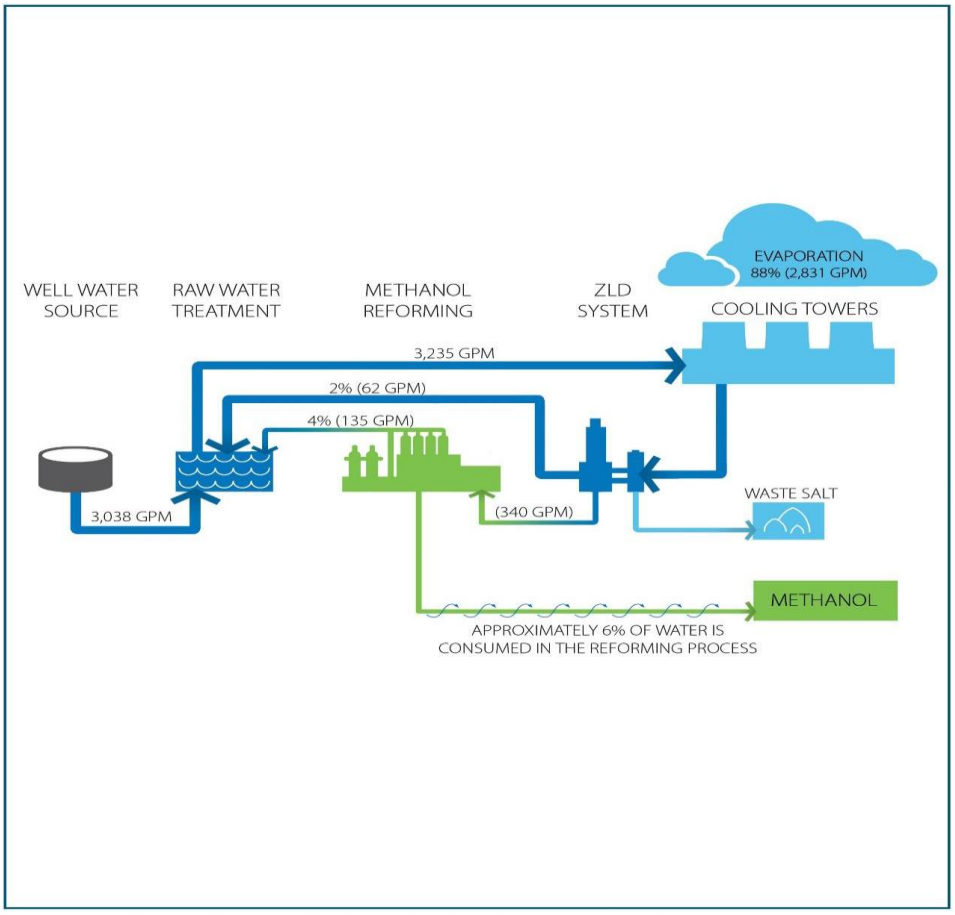
Endangered Southern Resident killer whales are in decline. With only 78 animals remaining, they are among our nation's most endangered species.[143] According to the National Oceanic and Atmospheric Administration (NOAA), the threats facing the Southern Residents are reduced prey (Chinook salmon), vessel traffic, noise, and toxic contaminants and spills. These are the very impacts, identified in the FEIS, that the refinery operations would have on the Columbia River. It would indirectly harm whales by putting further pressure on their primary food source, the Chinook salmon that spawn in many western rivers, but in the greatest numbers in the Columbia. Southern Residents rely most heavily on this particular source.

Methanol refineries consume huge quantities of fresh water. The proposed refinery at Kalama would use as much as 5 million gallons/day and would require construction of a new groundwater collector well that would dip into the underlying alluvial aquifer, the water source that supplies the City of Kalama. Nearly 90% of the water (2831 gallons/min) would be lost as evaporation from the cooling towers. The typical Kalama household of four uses 250 gal/day, and the population of Kalama is 2700, which means the refinery alone would consume more than seven times the amount of water used by the residents of Kalama.[144] Figure 13 illustrates the proposed industrial water use cycle. The largest share of the water used would be discharged as water vapor, which is itself a greenhouse gas.

[142] (Final Environmental Impact Statement: Kalama Manufacturing and Marine Export Facility, September 2016)
[143] (National Oceanic and Atmospheric Administration, 2018)
[144] (City of Kalama, n.d.)

Figure 13

Kalama Methanol Plant Industrial Water Cycle



Industrial Water Cycle with Zero Liquid Discharge (ZLD)
Figure 5-5

KALAMA SEPA
Manufacturing & Marine Export Facility

As conceded in the FEIS, "Groundwater levels could be affected by the operation of the proposed well, which could affect water supplies at other wells located in the alluvial aquifer."[145] It concluded that water supply would be sufficient, based on tests showing that a pumping rate of up to 6,600 gallons/minute would have no discernible drawdown on the aquifer. The new well would draw at 3440 gallons/min, so the tests exceeded the proposed draw rate by less than two-fold.

According to the Climate Impacts Group, climate change in our region will bring decreased water for irrigation, fish, and summertime hydropower production; increased conflicts over water;

[145] (Final Environmental Impact Statement: Kalama Manufacturing and Marine Export Facility, September 2016)

and increased urban demand for water.[146] The Fourth National Climate Assessment predicts a decrease in summer precipitation by up to 30 percent and low stream flows west of the Cascades.[147] The massive fresh water consumption of the methanol plant would only add to the growing pressure on water resources from drought predicted in the coming decades.

All of these concerns apply to the proposed refinery at Port Westward, which would, in addition, require a controversial re-zoning of more than 800 acres of prime agricultural land for industrial use,[148] which would only add to adverse impacts on agriculture predicted by current climate change science.[149]

Longview Anhydrous Ammonia Plant

Pacific Coast Fertilizer has proposed an anhydrous ammonia manufacturing facility in Longview at the Mint Farm Industrial Park, which borders residential neighborhoods and sits a half-mile from the Columbia River. The facility will manufacture 1,650 tons of ammonia per day, consuming about 2.5 million gallons of water and discharging about 1 million gallons of wastewater.[150] The cooled liquid ammonia will be stored on site for subsequent delivery to west coast destinations by truck and to international markets by marine vessels, with an estimated 12 to 15 ships per year transiting the Columbia River.

The Longview ammonia facility would be located less than fifteen miles from the proposed Kalama methanol refinery, along the same stretch of the Columbia River, raising many of the same concerns. An EIS is under way for the ammonia facility, which will provide more details about its impact during construction and operation.

During construction stormwater and surface runoff would carry sediment, debris, fuel, oil, grease, and other hazardous pollutants, with the potential that these contaminants would find their way to the Columbia River and/or the aquifer, which supplies the drinking water for residents of Longview.

Operation of the facility raises similar concerns enumerated for the Kalama methanol plant, including:

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146 (Snover, 2013)
147 (Ebi, 2018)
148 (Zimmer-Stucky, Conservation Groups File Lawsuit to Protect Important Farmland, Salmon Habitat Near Controversial Columbia River Port, 2018)
149 (Ebi, 2018)
150 (DePlace E. &., 2017)

- impacts on water quality of groundwater due to contaminated stormwater runoff, accidental spills of ammonia or hazardous chemicals used in its manufacturing, and discharge of wastewaters, including contamination of the drinking water for local residents
- impacts on the Columbia River due to increased vessel traffic and the potential for toxic spills
- consumption of large quantities of fresh water required for ammonia manufacturing

These two facilities alone would consume 7.5 mill gallons/day, or about three times the amount of water consumed by all the residents of Longview and Kalama combined.

Anhydrous ammonia poses additional risk to the Columbia River and Northwest fisheries. Extremely small quantities of ammonia can kill freshwater fish. A small-scale tractor accident in 2016 spilled ammonia into an Indiana creek, killing at least 500 fish and in 2004 a larger ammonia pipeline spill killed 25,000 fish in a nearby Kansas creek.[151] In 2001, a tanker spill near West Milton, Ohio created a "two-mile plume of anhydrous ammonia in Ludlow Creek," killing 103,300 fish.[152] As noted in this report by the Center for Effective Government, accidents involving ammonia plants are not rare. From 1998 to 2013, almost 1,000 accidents have occurred at 678 facilities storing large quantities of anhydrous ammonia in the United States.

Puget Sound LNG

Puget Sound Energy has begun building an unpermitted LNG facility on the Blair-Hylebos Peninsula on Commencement Bay and where the Chinook Landing Marina, owned by the Puyallup Indian Tribe, is also located. Elements of the project will cross two drainage basins and two watersheds.[153] The LNG will be used for fueling maritime vessels and other purposes.

Both construction and operation raise concerns about water pollution. As detailed in the FEIS, construction will entail substantial in-water work, including the demolition and removal of a pier, a dock, and a catwalk, and the installation of 150 piles to build a trestle and loading platform. These activities carry the risk of erosion and sedimentation, along with migration of debris and sediment, all very damaging to salmon and other marine life. Construction stormwater and surface runoff carrying sediment, debris, fuel, oil, grease, and other hazardous pollutants could find their

[151] (DePlace E. &., 2017)
[152] (Plagakis, 2013)
[153] (Final Environmental Impact Statement: PSE LNG, 2016)

way to groundwater or Commencement Bay. Existing subsurface contamination could also spread into groundwater during construction. Advisories already exist that limit the quantities of fish from Commencement Bay and nearby waters that can be safely eaten.[154] Further pollution would harm fish, killer whales, and other marine life, with negative consequences for the Puyallup Indian Tribe, whose land overlaps with the facility site.

Operation of the facility carries the same risks of contaminated stormwater and surface runoff. More serious risks are associated with bunkering (fueling) of vessels with LNG on the waterways, which include barge-to-ship bunkering, truck-to-ship bunkering, along with pipeline transfer of LNG. The bunkering operations entail risks of spills of the barge and truck diesel fuels, as well as a risk of an LNG spill. Marine traffic will increase, contributing to the risk of spills from collisions. Barge and truck fuels are particularly dirty, making spills or leaks especially damaging to the groundwater and Commencement Bay. The impacts on the waterways have not been fully addressed in the FEIS with respect to the Puyallup Indian Tribe activities and resources, as well as marine wildlife including fish and Southern Resident killer whales.

A major accidental spill into the waterways or Commencement Bay could happen during fueling, as a result of collision with another ship or due to intentional (e.g. terrorist) activity. The spilled LNG would create a spreading, evaporating pool that could ignite. According to the Sandia National Laboratories, a collision causing a small to medium spill would likely lead to a fire that would cause damage and injury within a half mile radius; a larger spill (e.g. due to intentional breach) would cause damage and injury more than a mile away. [155] These are unlikely scenarios but must be considered due to the proximity of residential areas of Tacoma and the Puyallup Tribal lands and cultural resources.

Industry and U.S. Coast Guard guidelines specify that LNG port terminals be located in remote areas of ports, not near civilians, narrow waterways, or other facilities that could produce sparks.[156] [157] The siting of the LNG facility on the Blair-Hylebos Peninsula violates each of these conditions. The U.S. Coast Guard has not yet approved the Waterway Suitability Analysis report for this facility.[158]

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[154] (Washington State Department of Health, n.d.)
[155] (Hightower, 2004)
[156] (Hay, n.d.)
[157] (U.S. Coast Guard, 2008)
[158] (Final Environmental Impact Statement: PSE LNG, 2016)

Tacoma's Commencement Bay was declared a Superfund site in 1983. After decades of cleanup and the recovery of critical populations of birds, fish, and other marine animals,[159] construction and operation of an LNG processing and bunkering facility only threatens to undo those environmental gains. Portions of the LNG site are already contaminated with industrial solvents from Occidental Chemical (OxyChem). The OxyChem Superfund cleanup is incomplete, raising concerns about whether construction activity would facilitate further water pollution from OxyChem's legacy pollution.[160]

NOISE POLLUTION

Construction and operation of fracked gas terminals, methanol refineries, anhydrous ammonia plants, compressor stations, metering stations, and pipelines expose workers and nearby residents to high levels of noise with significant adverse health impacts. The World Health Organization (WHO) estimates at that least one million years of healthy life years are lost every year in western European countries because of environmental noise.[161]

Goines and Hagler noted in their review of noise pollution that noise violates one of the six guaranteed constitutional rights, the right of domestic tranquility. They stated "the potential health effects of noise pollution are numerous, pervasive, persistent, and medically and *socially significant*" and identified seven adverse effects of noise: [162]

- hearing impairment
- interference with spoken communication
- sleep disturbances
- cardiovascular disturbances
- disturbances to mental health
- impaired task performance
- negative social behavior and annoyance reactions

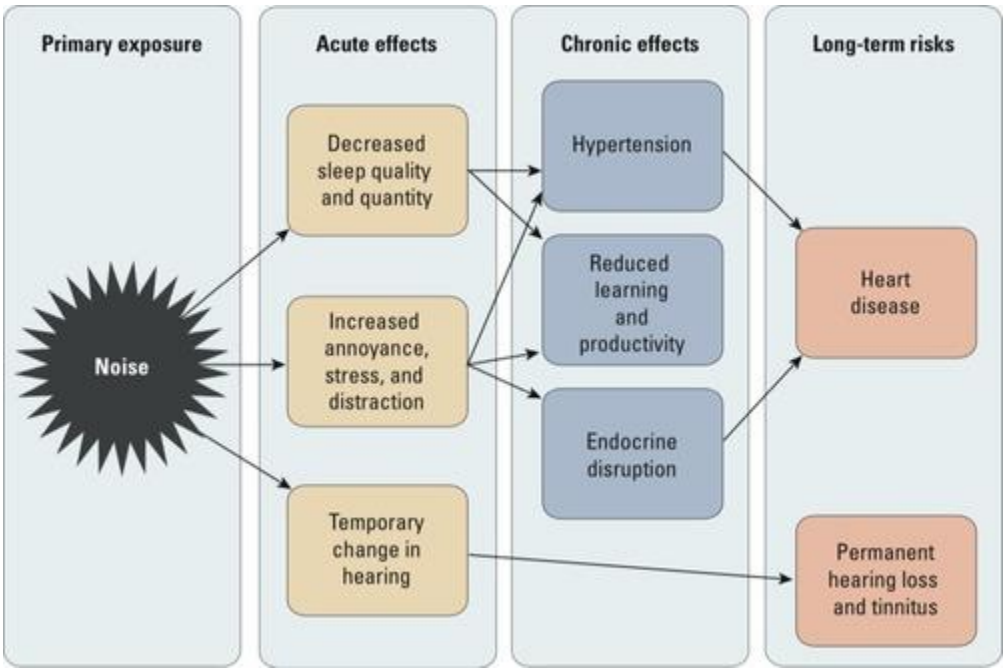
[159] (National Oceanic and Atmospheric Administration, 2018)
[160] (DePlace E. , Who Should Pay for Tacoma's Last Big Cleanup?, 2017)
[161] (World Health Organization, 2011)
https://www.who.int/quantifying_ehimpacts/publications/e94888.pdf?ua=1
[162] (Goines, 2007) https://www.ncbi.nlm.nih.gov/pubmed/17396733

The populations most vulnerable to these effects include those with chronic disease, fetuses, infants and young children, and the elderly.[163]

Hammer, et.al. notes these effects in Figure 14. [164]

Figure 14

Health Effects of Noise Pollution



Noise pollution adversely affects health primarily by increasing stress. Experienced as annoyance and distraction, noise activates our "fight and flight" hormones, increasing blood pressure and heart rate, ultimately causing hypertension, ischemic heart disease (angina and heart attack) and stroke.[165] [166] People in noisy environments experience a subjective habituation to noise, but their cardiovascular system does not habituate.

Noise at night similarly triggers a stress response with the same consequences. Activating the sympathetic nervous system (adrenalin), noise decreases the quality and quantity of sleep, changing the stage of sleep from deep sleep to a less restorative lighter stage.[167] Increased levels of stress hormones—epinephrine, norepinephrine, and corticosteroids—result in increased blood pressure,

[163] (Goines, 2007)https://www.ncbi.nlm.nih.gov/pubmed/17396733
[164] (Hammer M.S., 2014)
[165] (Hammer M.S., 2014)
[166] (Münzel, 2018)
[167] (Muzet, 2002)

heart rate, cardiac output, and vasoconstriction and disruption of circadian rhythms. Ultimately the health consequences are hypertension and ischemic heart disease.[168]

- Continuous noise in excess of 30 decibels (dB) disturbs sleep. For intermittent noise, the more frequent the events the higher the likelihood of awakening.[169]
- Sleep disturbance, characterized by difficulty in falling asleep and frequent awakenings, when experienced over a long period of time can lead to less productivity at work, greater need for health care services and increased risk of injury.[170]
- In addition to resulting in less restful sleep, sleep disturbance due to noise has been associated with changes in the body's inability to regulate blood pressure and other changes in the cardiovascular system.[171] The 2018 WHO Environmental Guidelines detail evidence of the cardiovascular and metabolic effects of environmental noise.[172]
- Extended exposure to high noise levels can lead to inflammation and oxidative stress which can increase the risk of heart disease, such as coronary artery disease, hypertension, stroke, diabetes, and heart failure.[173]
- Adverse health effects are related to total noise exposure from all sources rather than the noise from any single source.[174]

Stress experienced by members of the community comes not only from the noise itself and disrupted sleep but from having no control over their environment. In Ohio, interviews of 34 residents living near sites of unconventional gas development reported significant psychological stress from noise pollution and, in some instances, considered moving from the area.[175]

A version of sound, referred to as low frequency noise (LFN), since it is in a range typically not audible to most people, has also been shown to adversely affect health. A systematic review of seven observational studies between 2000 and 2015 found associations between exposure to LFN and self-reported annoyance, as well as various other symptoms including hypertension, sleep-related problems, concentration difficulties and headache, in the adult population living in the

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[168] (Sforza E., 2004)
[169] (Berglund B. a., 1995)
[170] (Colton, 2006) https://www.ncbi.nlm.nih.gov/pubmed/20669438
[171] (Berglund B. e., 1999) https://apps.who.int/iris/handle/10665/66217
[172] (World Health Organization, 2018) http://www.euro.who.int/en/health-topics/environment-and-health/noise/environmental-noise-guidelines-for-the-european-region

[173] (Münzel, 2018)
[174] (Goines, 2007)
[175] (Fisher, 2018) https://doi.org/10.1016/j.jenvp.2017.12.008

vicinity of a range of LFN sources.[176] [177] [178] WHO, in their 2018 Environmental Noise Guidelines, recommend that LFN be further studied.[179]

Noise Regulation

Regulation of the level and duration of noise at the federal, state, and local levels is not sufficient to protect the American public from the negative health impacts of noise pollution.

- In 1972, the Noise Control Act was passed by Congress, declaring, "… it is the policy of the United States to promote an environment for all Americans free from noise that jeopardizes health and welfare."[180]
- In 1974, the Environmental Protection Agency (EPA) estimated that nearly 100 million Americans lived in areas where the daily average noise levels exceeded those identified as being safe.[181]
- In 1982, the government abruptly terminated federal funding for the Office of Noise Abatement and Control. The lack of funds threw total responsibility for noise control to the states.[182] [183]
- The EPA recommends average outdoor noise levels < 55 dB and indoor levels <45 dB.[184]
- The most recent WHO noise guidelines, based on systematic reviews of the current science on connections between noise and health, consider average daily exposure levels and night time specific levels based on noise from road traffic, railways, aircraft, wind turbine, and leisure activities. The guidelines recommend < 30 dBA in bedrooms at night for optimal sleeping and 40 dBA outside of bedrooms to prevent adverse health effects of noise. Daytime noise recommendations range from 45-54 dBA.[185] (An A-weighted sound level (dBA) is the sound level in decibels which more closely approximates the frequency response of the human ear and correlates better with subjective reactions to noise.)[186]

[176] (Baliatsas, 2016)
[177] (Leventhal, 2004)
[178] (Berglund B., 1996)
[179] (World Health Organization, 2018)
[180] (Goines, 2007)
[181] (U.S. Environmental Protection Agency, 1974)
[182] (Shapiro, 1991)
[183] (Bronzaft, 2000)
[184] (U.S. Environmental Protection Agency, 1974)
[185] (World Health Organization, 2018)
[186] (Beranek, 1992)

- Oregon and Washington specifically exempt construction activities from noise regulations. They also may exempt the operations of the facilities, as well.[187] [188]

Jordan Cove LNG

The proposed LNG terminal would be located in Coos Bay, near the town of North Bend, the Southwest Regional Airport, residential areas, camping and recreational areas (Oregon Dunes Recreational Area). These areas already experience higher than recommended levels of noise, primarily from transportation sources. Both construction and operation of the terminal will add to the existing noise levels.

Construction is projected to take five years with the greatest noise generated in year three. (All information and data about noise sources, levels and duration is derived from Resource Report 9 submitted by JCEP to FERC June 2017.)[189] Noise would be generated from heavy construction equipment and vehicles, pile driving and dredging of the bay, all of which may occur simultaneously and at night**.** Pile driving would be the dominant noise source and would occur over a two-year period 20 hours per day, creating intermittent high intensity noise that would be intrusive, annoying, and disturbing to the local community, wildlife, and fish. Peak construction activities would result in intermittent noise levels of 129 dBA during the day and 125 dBA at night. Existing ambient noise levels are reported to range from 53-65 dBA, measured at Noise Sensitive Areas (NSA), levels which are already above recommendations, especially at night (>40-45 dB). (NSAs are those areas adjacent to a proposed activity which would be adversely affected by excessive noise levels, for example, homes, hotels, hospitals, schools and churches.) Construction activities are predicted to increase average noise levels significantly, up to 7.6 dB.

Once built the terminal will operate continuously day and night, 7 days a week, generating noise from compressors, combustion and steam turbines, and generators as well as idling tankers and ground flares. Current noise levels from vehicle traffic, recreational vehicle use, boat traffic, ocean surf, and aircraft are significant, 53-65 dBA at NSAs, measured in May 2017. These areas are residential, camping and recreational. Although it is stated in Resource Report 9, that the terminal

[187] (Oregon Administrative Rules)
[188] (Washington Administrative Code)
[189] (Jordan Cove LNG, 2017)

will increase noise levels minimally (0-2.9 dBA), this increase is significant, additive and unremitting, with night time noise levels above recommended levels.

Additional noise sources that were not considered in the Resource Report are dredging and channel maintenance in Coos Bay and potential extension of a runway at the Southwest Oregon Regional Airport, with a significant increase in air traffic noise.

According to Margaret Corvi, Director of the Department of Natural Resources of the Confederated Tribes of Coos, Lower Umpqua, and Siuslaw, pile driving noise and noise from both the construction and operation of the terminal will make tribal cultural practices, such as fishing and harvesting shellfish, unattractive and decrease access to food and economic resources.[190] Pile driving in particular would create levels of intermittent noise significant enough to have behavioral effects on fish and marine mammals, further degrading fishing and harvesting of shellfish. It would also decrease recreational activity for both local residents and visitors to the area, with negative impacts on the local economy.

Pacific Connector Gas Pipeline and Compressor Stations

Construction and operation of the compressor station and pipeline would generate significant noise, all of which is exempted from the Oregon state noise regulations. Environmental health researchers at the University of Maryland's School of Public Health studied noise generated by a compressor station, finding that residents living near a compressor station are potentially exposed to noise levels that are higher than the recommended U.S. EPA levels of 55 dBA (outdoor/daytime) and 45 dBA (indoor/night time). They emphasize that environmental exposures from these stations, including noise, are a significant public health concern and a source of stress for nearby residents in communities like Doddridge County, West Virginia, where researchers conducted this study.[191]

The Klamath Compressor Station (KCS) would be located in a rural area with sixteen residences within a one-mile radius and will require twelve to eighteen months to build. Average combined construction noise levels at 1500 feet would be 60 dBA, well above recommended noise levels both during the day and especially at night.

KCS would operate 24 hours per day, 7 days per week, generating continuous noise levels that exceed Oregon regulations, which prohibit raising the noise level more than 10 dBA. This

[190] (Corvi, 2018)
[191] (Boyle M. e., 2017)
https://www.tandfonline.com/doi/abs/10.1080/15459624.2017.1316386?journalCode=uoeh20

would occur despite acoustical mitigation measures. Blowdowns (venting of gas) would also occur, both scheduled and emergency, generating high levels of startling intermittent noise. Two metering stations would also be located very near the KCS and generate additional noise.

Construction of the 229-mile pipeline includes Horizontal Directional Drilling (HDD) at six river crossings. Existing noise levels at five of six of these crossings are greater than 55 dBA. HDD will only add to noise levels above those recommended by the EPA. Construction of the pipeline will also include blasting which will generate very high intermittent levels of noise.

The operation of high-pressure gas transmission systems also creates continuous low and extra-low frequency soundwaves in the communities they transverse. These noises are known as "flutter" and "hum." Low frequency noise (LFN) and vibrations are believed to cause cranial distress, ringing ears, mood swings, throat and digestive problems and psychiatric disturbances. Residential exposure to LFN may increase the adverse effects of higher frequency noise, because most walls in buildings do not attenuate LFN.

Kalama and Port Westward Methanol Refineries

Northwest Innovation Works proposes building twin methane to methanol refineries at the Port of Kalama and Port Westward along the Columbia River over a three-year period. A three-mile pipeline is also proposed for the Kalama methanol refinery. The refinery itself would be located near residential areas in both Washington and Oregon and recreational facilities (Camp Kalama). Little specific information is available for the plant at Port Westward.

Construction of the Kalama manufacturing facility and marine terminal would generate noise from typical construction activities and would be limited to daytime hours. (All information and data about noise sources, levels and duration is derived from Kalama methanol refinery FEIS.)[192] It would involve pile driving, which generates much more annoying impulsive noise. Average levels overall, however, are predicted to be < 60dBA at NSAs.

Operation of the Kalama refinery would generate noise 24 hours per day, seven days per week. At the various NSAs, noise levels from operations would all be < 50 dBA and increase the existing noise levels by < 10 dBA (range 0-12). According to the FEIS, existing noise levels are 40-72 dBA. The added noise from the refinery would increase current levels by >10 dBA at only one NSA. Despite generally meeting current legal standards, the night time noise levels exceed

[192] (Final Environmental Impact Statement: Kalama Manufacturing and Marine Export Facility, September 2016)

recommended levels. Levels of noise, however, are legally permitted to exceed 70 dBA at the borders of the project in the industrial area.

Although in compliance with regulatory standards, construction of the Kalama refinery would generate high levels of impulsive noise, especially from pile driving. Operation of the refinery would generate significant noise levels adding to noise levels in the area, which already exceed EPA and WHO noise levels recommended at night.

Construction of the Kalama Lateral Pipeline (KLP) would generate levels of noise above current legal standards and very close to residences in Kalama, both intermittent from blasting into rock and continuous from horizontal directional drilling under I-5 and the BNSF railway.

Longview Anhydrous Ammonia Plant

Pacific Coast Fertilizer plans to build the plant over a three-year period in the Mint Farm Industrial Park, Longview Washington, in 61 acres in an area zoned for heavy industrial use. However, it is located only several thousand feet from residential neighborhoods in Cowlitz County. 42% of Longview's youth live within 1.5 miles of the proposed facility.[193]

Although analysis of noise levels has not been done as yet (a full EIS is planned), operation of the facility would be continuous 24 hours per day, 7 days per week, and include loading 100-200 trucks per week.

Puget Sound LNG

This complex project is already generating noise from the construction of the terminal (without permits) on the Blair-Hylebos Peninsula in the Port of Tacoma very near the heart of the city of Tacoma.

The Puyallup Indian Tribe marina is 1,000 feet away and the nearest home is just over 2,000 feet away. (All information and data about noise sources, levels and duration is derived from the Final Environmental Impact Statement.)[194] The FEIS states that the existing noise environment is high and consistent with an industrial marine port. Noise levels are high both from construction work, 80-90 dBA at 50 feet away and pile driving, 100 dBA at 50 feet. The noise pollution is particularly harmful to the endangered Southern Resident killer whales.

[193] (Zimmer-Stucky, Protect Longview's Kids, Neighborhoods from Anhydrous Ammonia, 2018)
[194] (Final Environmental Impact Statement: PSE LNG, 2016)

No measurements are reported in the FEIS of noise levels in noise sensitive areas. The FEIS also does not quantitate noise levels for the associated construction projects: Golden Given Limit Station, updating the Frederickson Limit Station, and building two new distribution pipeline segments.

Operation of the LNG Facility and the Tote Marine Fueling system will include day and night mooring and loading of bunkering barges and the operation of pumps, compressors, vaporizers, fans, and blowers. Noise levels are not reported in the FEIS. Noise effects of the operation of Golden Given Limit Station are not reported in the FEIS, as the pipelines are expected not to generate noise because they would be underground and under functional roadways.

NATURAL AND HUMAN-CAUSED DISASTERS

Fracked gas infrastructure is extremely vulnerable to natural and human-caused disasters. Earthquakes, floods, and other events create serious risks of explosions, fires, vapor clouds, and leaks that can release toxic pollutants into air and water and harm workers and communities in the vicinity of infrastructure used to transport, process, store, and export fracked gas.[195]

Local, state, and federal regulations create important requirements for energy companies to anticipate and prevent accidents and incidents in which workers, the environment, and other people could be harmed. As the fracked gas industry changes and adopts new technologies, however, researchers point to a lack of understanding and oversight by regulatory bodies to ensure safety.[196]

Proposed fracked gas projects in the Pacific Northwest must be evaluated with regard to the additional risk associated with susceptibility to earthquake, tsunami, and wildfire. These projects pose significant health risks for employees, emergency responders, and nearby residents, including burns, physical injury, toxic exposure, and death.

Natural Disasters: Earthquake and Tsunami

The Pacific Northwest is vulnerable to earthquakes due to its position on the Cascadia Subduction Zone.[197] Experts estimate a 42% likelihood of an earthquake up to a magnitude of 9.0 in the zone within the next 50 years, an area that encompasses every proposed gas infrastructure project

[195] (Physicians for Social Responsibility and Concerned Health Professionals of New York, 2018)
[196] (Powell T. a., 2016)
[197] (Pacific Northwest Seismic Network)

in Oregon and Washington.[198] An earthquake of that magnitude would devastate the Northwest; the most severe impacts, including soil liquefaction, landslides, and tsunamis, would fall on coastal areas.[199] In case of a tsunami, the immense force of the initial surge would carry marine vessels, other objects and debris inland, smashing coastal buildings and structures.[200] Weeks of inundation that could follow would compound the damage.

The volatility and potential for combustion at fracked gas processing and storage facilities makes these sites particularly vulnerable. As examples:

- Soil liquefaction has caused significant damage at other industrial port facilities in the U.S., Mexico, and other countries.[201]
- The LNG/LPG (liquefied petroleum gas) storage plant in Chiba, Tokyo Bay was cracked by the 2011 Tohoku-Fukushima earthquake, producing a fireball and blaze that took 11 days to extinguish.[202]
- In February 2018, an earthquake shut down an LNG project in Papua New Guinea, damaging equipment and foundation supports and forcing evacuation of hundreds of workers.[203]

The risks of earthquake on pipelines in wildfire prone forested areas are not just destruction of infrastructure but unmanageable wildfires in remote areas resulting from the release of gas. The destruction of communities with injuries and loss of life from a magnitude 9.0 earthquake could be compounded by catastrophic fires.

Natural Disasters: Flooding and Sea-Level Rise

Many industrial ports that house fracked gas facilities will experience effects of sea-level rise due to climate change within 50 to 100 years. Estimates quantifying sea-level rises vary; however, scientists and researchers understand that these impacts will likely cause industries which operate near coastlines to adjust their infrastructure and could hinder operations significantly.[204]

Sea-level rise will impact the coasts of Oregon and Washington and their industrial port areas. A 2018 report from the University of Washington's Climate Impacts Group projects relative

[198] (Goldfinger, 2012)
[199] (Harvey, 2017)
[200] (Venturato, 2007)
[201] (Werner, 1998)
[202] (French Ministry of Ecology, Sustainable Development and energy , 2011)
[203] (Reuters, 2018)
[204] (Christodoulou, 2018)

sea-level rise to reach from 1.5 to 3.3 ft in Tacoma by 2100.[205] Their report acknowledged that earthquakes can significantly alter sea-level and cause changes in land elevation, leading to further encroachment of water and flooding issues.

In 2017, Hurricane Harvey and ensuing flooding negatively impacted oil refineries and gas storage terminals. According to a Reuters article, 27 million cubic feet of fracked gas was released due to flooding. An environmental group found that 31 additional spills at oil and gas wells, pipelines and storage tanks occurred. Because energy companies are not legally required to report wastewater spills, it is likely that the true costs of toxic spills and leakage of oil and gas were not fully accounted for.[206]

Human-caused disasters: Accidents

Fracked gas accidents are neither trivial nor rare. The majority of fires and explosions are associated with pipeline failure. Pipelines are subject to various types of internal corrosion, including "sweet corrosion," related to CO2, or "sour corrosion," due to hydrogen sulfide, both of which are usually present in fracked gas and constitute the major cause of pipeline and storage tank leaks.[207]

The U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration recorded 858 serious incidents involving pipelines from 1996 to 2016, with 347 fatalities and 1,346 injuries.[208] Absent meaningful regulation, the extent of pipeline leakages with explosive potential remains unknown.[209]

- In January 2019, a gas pipeline ruptured in rural Nobel County, Ohio. The 120 ft fireball destroyed one home, injuring a 12-year old boy. In the year prior, the Texas Eastern Transmission Pipeline exploded in the same county. In April 2016 that same pipeline had exploded in Salem Township, Pennsylvania, producing a 50- by 12-foot crater and a fireball that "obliterated a home, melted a road and sent a 26-year old man to the hospital with third-degree burns over 75% of his body." [210]
- On First Nation lands near Prince George, British Columbia, a 36-inch gas pipeline ruptured in October, 2018, causing a massive fire. No one was hurt, but 100 members of the Lheidli

[205] (Miller I. e., 2018)
[206] (Flitter E. , 2017)
[207] (Popoola, 2013)
[208] (US Department of Transportation: Pipeline and Hazardous Materials Safety Administration, n.d.)
[209] (Glick, 2018)
[210] (Nobel, 2019)

T'enneh First Nation were forced from their homes and the gas supply to one million customers was threatened. [211] The cause of the rupture is, as of this writing, undetermined.

- On August 9, 2018, in Midland, Texas, odorless gas leaking from a dime-sized hole in a nearby pipeline spontaneously ignited, killing a three-year old girl and seriously injuring her sister and parent.[212]
- In 2017, a deadly explosion in Firestone, Colorado from odorless gas leaking from an out-of-use pipeline which was not fully shut off killed two people in their homes and hospitalized two more.[213]
- In Seattle in 2016, a fracked gas line exploded injuring nine firefighters and destroying multiple businesses. When the line was shut off in 2004, it was not properly capped and gas had been flowing through it for a dozen years.[214] The explosion resulted in a $1.5 million fine against Puget Sound Energy (PSE) for 17 violations.
- In 2012 a fracked gas pipeline ruptured and burned in Sissonville, West Virginia destroying three houses and damaging several others. According to the investigation, the surface of the pipe was heavily corroded at the point of rupture.[215]
- Also in 2012 a pipeline at a compressor station near Wellington, Utah was scored by a backhoe and later burst, causing fire and explosion that destroyed the facility and injured two workers on site. [216]

The most common cause of pipeline failure is internal corrosion, related to "sour corrosion" from hydrogen sulfide or "sweet corrosion" related to carbon dioxide, both of which are common contaminants of fracked gas.[217]

Landslides have recently been identified as an additional cause of pipeline failure, especially when pipelines are constructed in steep and rocky terrain.[218] The advisory issued by the Pipeline and Hazardous Materials Safety Administration cited seven significant accidents related to landslides, most of which resulted in toxic releases. They included:

[211] (Shore, 2018)
[212] (Soraghan M. a., 2018)
[213] (Finley, 2017)
[214] (Lacitis, 2017)
[215] (National Transportation Safety Board, 2014)
[216] (Mills, 2012)
[217] (Popoola, 2013)
[218] (Pipeline and Hazardous Materials Safety Administration, 2019)

- A January 29, 2019 rupture in West Virginia following a landslide that displaced a pipeline by 10 feet.
- A 2016 spill in North Dakota caused by a landslide.
- A 2016 explosion of a gas pipeline in Montecito, California related to local floods and landslides.

Compressor stations also have explosive potential.

- On January 30, 2019 in rural Armada Township, MI, an equipment malfunction at a fracked gas compressor station caused a dramatic fire and an explosion that was felt miles away.[219]
- When a compressor station north of Watford City, ND, exploded in December 2015, drywall cracked and knocked pictures off the walls of homes about a mile away. Locals described it as "like a truck had hit the house going 75 mph" or like someone "had picked up the house and dropped it."[220]

Accidents and spills at LNG facilities are less common and the dynamics and hazards are poorly understood. A comprehensive review of research into the LNG production chain examined vapor production, vapor dispersion, and mechanisms of combustion, noting the "intrinsic process safety issues" of LNG. The authors described various threats to human safety, including pool fires, jet fires, and vapor cloud explosions.[221]

A Congressional Research Service (CRS) study in 2008, when the United States was a net importer of LNG, stated that LNG infrastructure is "inherently hazardous" citing thirteen serious accidents at onshore LNG terminals.[222] According to another CRS report in 2009, certain LNG hazards are not "understood well enough to support a terminal siting approval." Potential risks included pool fires and flammable vapor clouds. The analysis pointed out the need for additional LNG safety research,[223] a need which was again noted as recently as 2014.[224]

- Less than five years ago, an explosion at the Williams Company Inc LNG facility in Plymouth, Washington injured workers and brought attention to the imprudence of siting massive gas tanks near population centers. The explosion, felt up to six miles away, sprayed shrapnel 300 yards, punctured one of the large LNG storage tanks, caused gas leaks for over

[219] (Hicks, 2019)
[220] (Robinson, 2016)
[221] (Ikealumba, 2014)
[222] (Parfomak, 2008)
[223] (Congressional Research Service, 2009)
[224] (Ikealumba, 2014)

24 hours and required the evacuation of residents living within two miles.[225] Shrapnel injured four employees and a fifth worker was hospitalized for burns. Fumes from the facility sickened local residents and emergency responders. At the time, the authorities worried that "a second blast could create a 0.75 mile 'lethal zone' around the plant."[226]

- In 2018 LNG leaked into a space between the inner and outer walls of a storage tank at the Sabine Pass LNG export facility in Cameron Parish, Louisiana, creating cracks in the carbon steel outer tank wall that allowed gas to escape.[227] Because of the potential for a catastrophic accident, threatening 500 workers and contractors at the facility, as well as nearby communities, the federal Pipeline and Hazardous Materials Safety Administration ordered the shut-down of the two tanks.

Although explosions involving methanol, a product of methane, are rare, they also occur.[228]

- In 2006 in Daytona Beach, FL, two employees were killed in an explosion while attempting to remove a steel canopy above a methanol storage tank.
- In 2012, a methanol ship in Malaysia exploded, presumably after it was struck by lightning.
- Again in 2012, an explosion and fire occurred while workers unloaded methanol from a train in Garland, Texas.
- An explosion in a Chinese chemical plant was triggered in 2015 when a welder ignited methanol.

Human-caused Disasters: Acts of Terrorism

The possibility of terrorist attacks against fracked gas infrastructure, especially LNG facilities, have been noted for well over a decade. In 2003, as part of a larger investigation of potential terrorist targets in wake of the 9/11 attacks, the Congressional Research Service provided a background report to the U.S. Congress on the security of LNG terminals in the United States. The CRS identified LNG tanker ships and storage infrastructure as "vulnerable to terrorism," noting that tankers could be turned as weapons against coastal cities and that inland LNG facilities are typically located near large population centers. The CRS further noted that the public cost of security for LNG

[225] (Powell T. , 2016)
[226] (Schneyer, 2014)
[227] (Schleifstein, 2018)
[228] (Luck, 2016)

shipments, via Coast Guard escorts of tankers through coastal shipping channels, was considerable ($40,000-$80,000 per tanker).[229] The cost, nearly two decades later, would be much higher.

The 2008 CRS study cited above identified security of tankers, terminals, and inland storage plants as issues of concern. Serious risks include pool fires with intense heat, which can occur when LNG spills near an ignition source; flammable vapor clouds that can drift until reaching an ignition source; and a rapid phase transition that can generate a flameless explosion.[230] The possibility of terrorist attacks involving LNG facilities was noted again by the CRS in 2009.[231]

Acts of terrorism that target fracked gas infrastructure, though unlikely, continue to be of concern. In a 2017 discussion of the threats of maritime terrorism, recent scenarios of an attack included the hijacking of an LNG carrier and then "exploding it as a floating bomb or utilizing it as an impact weapon against port facilities."[232]

Jordan Cove LNG

In November 2017, the Oregon Department of Geology and Mineral Industries (DOGAMI) detailed their concerns about Jordan Cove LNG and the Pacific Connector Gas Pipeline. Because the projects would be located in a high seismic hazard area and the tsunami inundation zone, DOGAMI listed concerns about duration of shaking, soil settlement and liquefaction, landslides, tsunami scour, and tsunami debris, all of which could cause infrastructure to fail and present significant safety hazards. An additional DOGAMI concern is the potential for LNG tankers to become "ballistics in the Bay" in the event of a large earthquake and tsunami.[233]

DOGAMI maps indicate that the Jordan Cove LNG terminal would be located in a place at risk for inundation by a local tsunami and that the docking area for LNG tankers would be in an area subject to both distant tsunamis and at maximum risk in the event of a local tsunami.[234] [235] In addition, road access to the spit where the LNG terminal would be located is just above sea level. Subsidence from a great earthquake could destroy vehicle access to Jordan Cove, preventing escape from a subsequent tsunami and preventing access by emergency responders. Goldfinger and

[229] (Congressional Research Service, 2003)
[230] (Parfomak, 2008)
[231] (Congressional Research Service, 2009)
[232] (Meng Wee, 2017)
[233] (Avy, 2017)
[234] (Oregon Department of Geology, n.d.)
[235] (Miller C. , 2013; Havens, 2019)

coauthors have concluded that the chance of a magnitude >8 earthquake in the Coos Bay area off southern Oregon in the next 50 years is 40%.[236]

In January 2015, Jerry Havens, professor of chemical engineering at University of Arkansas and James Venart, emeritus professor of mechanical engineering at University of New Brunswick, both experts in LNG hazards, fire science, and catastrophic explosions, commented to the Federal Energy Regulatory Commission that the proposed Jordan Cove LNG terminal exposes the public to risk of fire and explosion. The mix of refrigerants used to chill the gas and the heavy hydrocarbon impurities in pipeline gas that are stripped out and stored on-site pose a threat of catastrophic accidents involving unconfined hydrocarbon vapor cloud explosions (UVCE).[237]

In response to the March 2019 DEIS Dr. Havens reiterated his concern about UVCEs, noting: "If the magnitude of the possible overpressures [is] estimated using actual data (experience) available for UVCEs (rather than predicted with the FLACS theoretical model), the UVCE hazard would be clearly indicated as a serious major hazard at the [Jordan Cove facility]. *UVCEs at numerous similar heavy hydrocarbon handling/storage facilities have resulted in destruction of the facilities as well as injuries and deaths beyond the plant boundaries* [Emphasis in original]. [238]

Of additional concern is the proximity of the proposed shipping channel and LNG facility to residential and industrial areas, which puts the safety of many people at risk. According to the March 2019 DEIS, consideration must be given to "Zones of Concern". It states, "As LNG marine vessels proceed along the intended transit route, the estimated zones of concern would extend over resources such as residential and industrial areas, military installations, and also non-residential areas accessible to the public such as parks." [239]

As mapped in the March 2019 DEIS, Hazard Zone 1 mostly overlies water and encompasses coastal areas in Charleston and Coos Bay with potential impacts to commercial vessels, recreational vessels, fishing vessels, Cape Arago Dock, North Bay Marine Industrial Park, and Roseburg Forest Products Facility.

Hazard Zone 2 covers a broader swath of coastal areas along Charleston, Coos Bay, Barview, and North Bend with potential impacts to multiple residential buildings, commercial buildings, industrial buildings, numerous RV parks, numerous recreational areas and boat launch ramps,

[236] (Goldfinger, 2012)
[237] (Mandel, 2016)
[238] (Havens, 2019)
[239] (Draft Environmental Impact Statement for the Jordan Cove Energy Project, 2019)

Marine Research Center, Charleston Marina, South Slough Bridge, Coast Guard Sector Charleston, Charleston Fire District Stations 1 and 3, Madison Elementary School, Sunset Middle School, Coos Bay Fire Department Station 2, and the Southwestern Oregon Regional Airport.

Hazard Zone 3 includes larger portions of Charleston, Coos Bay, Barview, and North Bend and includes Coast Guard Group North Bend, Railroad Bridge, Oregon Dunes Recreational Park, Southwestern Oregon Community College. Clearly, thousands of residents are at varying risks for burns, injury, and death in the event of an accident or intentional act with rupture of an LNG ship and/or related Jordan Cove storage facility and a large release of gas.

The close proximity of the Southwest Oregon Regional Airport to the LNG facility presents additional hazards. The airport serves Coos Bay and North Bend with commercial flights out of Denver and San Francisco. Daily operations include general aviation, air freight, and Coast Guard activities. The flight approach is usually over the bay and the north spit. In May 7, 2019 The Federal Aviation Administration (FAA) issued 13 Notices of Presumed Hazard for this project. According to the March 2019 DEIS, "Permanent and temporary structures at the LNG terminal as well as LNG carrier operations in the Federal Navigation Channel would exceed FAA obstruction standards and there is a potential significant impact to the safe air operations of the Southwest Oregon Regional Airport if a resolution cannot be settled between Jordan Cove and FAA."[240]

If the resolution, which is being negotiated out of public view, does not mandate reductions in the heights of storage tanks, cranes, vessel stacks, and other structures to conform with the maximum allowed under FAA regulations, the only options would be to re-route air traffic over populated areas (a solution that is considered too risky by the Southern Oregon Regional Airport, according to the DEIS), or the addition of lights and markings on the obstructing structures, which leaves the actual hazards in place.

Though the potential for accidental collision of an aircraft into a storage tank at the facility is small, the consequences would be catastrophic. The DEIS notes that the storage tanks are not designed to withstand such an impact without perforation, which would result in fire and explosion.[241]

[240] (Draft Environmental Impact Statement for the Jordan Cove Energy Project, 2019)
[241] (Draft Environmental Impact Statement for the Jordan Cove Energy Project, 2019)

Pacific Connector Gas Pipeline

Remote and populated areas of Oregon could be impacted by earthquakes with significant damage to the pipeline and release of flammable and explosive methane gas and volatile organic compounds (VOC) to the air. The proposed pipeline would be located directly under the North Bend McCullough Bridge, the main artery and highway (Hwy 101) entering the town of North Bend. An earthquake and subsequent liquefaction could rupture that pipeline, releasing these pollutants. Any ignition source could precipitate fires.

Aside from earthquake and corrosion, naturally occurring wildfires themselves may result in pipeline damage or rupture, for example, by falling timber.

Massive and difficult to control wildfires related to pipeline failures would severely impact the dry, rugged lands and the people who live there. Fires can cause erosion, landslides, and debris flows affecting rivers and streams. Wildfires often burn out of control and damage small, large, and contiguous watersheds that support multiple beneficial uses of water. Remote areas may not be easily accessible to emergency response.

Over half the pipeline route crosses lands that are mapped by the U.S. Forest Service as having moderate to very high wildfire risk.[242] Firefighters United for Safety, Ethics and Ecology, (FUSEE), who oppose the project, further note that clear-cuts around the pipeline would fill in with grasses, shrubs and weeds, which ignite more easily than forest. Greater exposure to sun and wind would increase fire intensity and rate of spread, making the pipeline route into a quick-burning fuse that would allow fire to race through forested areas.

The PCGP would also be constructed in terrain subject to landslides and the construction of the pipeline itself would increase the risk of landslides, which are themselves a cause of pipeline failure.

Kalama Methanol Refinery

The Kalama methanol plant would process large quantities of fracked gas into liquid methanol. The highly flammable methanol will be stored on site in eight tanks, each capable of holding more than 8 million gallons of methanol.[243]

[242] (Firefighters United for Safety, Ethics and Ecology, 2019)
[243] (Luck, 2016)

- Methanol has a very low flash point, 73 degrees F, which is the lowest temperature at which its vapors will ignite. This means that even at ambient storage temperatures, let alone hot weather or hot facility environments, a lot of vapor is produced, creating a high risk of fires or explosions. The combination of two volatile substances at the proposed plant, methane plus methanol, compounds the risk of explosions and fires.
- According to the Final Environmental Impact Statement (FEIS), sand and silt below groundwater levels at the site are susceptible to liquefaction. The FEIS estimates that liquefaction could occur as deep as 100 feet underground, which could cause soils underlying the refinery, dock and tank farm to spread and severely damage key infrastructure.[244]
- The Draft Supplemental Environmental Impact Study (DSEIS) for the Kalama project identifies seismic protections as part of construction plans; however, it states that a "ground improvement plan" will be designed as the project is being built, leaving questions about what such a plan would include and how it might protect workers and the surrounding community from consequences of a severe seismic event.[245]
- In an independent worst-case scenario analysis requested by Columbia Riverkeeper, a plane crash, terrorist attack, or a Cascadia Subduction Zone magnitude 9.0 earthquake, could rupture multiple tanks and if sparked, could possibly lead to an explosion in the remaining intact tank.[246] If catastrophic tank failure were to occur, leaking methanol could catch fire, and the vapor, if trapped, could cause an explosion that could shatter glass as far away as Longview and Rainier, destroy buildings within a six-mile radius and cause serious injuries in Kalama.
- The facility proposed by Northwest Innovation Works is far larger than what is currently in operation anywhere in the world. Given the lack of experience with this technology and the fact that it is sited in an area at risk for both earthquakes and tsunamis, it seems prudent to consider the catastrophic, albeit unlikely, risk scenarios.

[244] (Final Environmental Impact Statement: Kalama Manufacturing and Marine Export Facility, September 2016)
[245] (Draft Supplemental Environmental Impact Statement: Kalama Manufacturing and Marine Export Facility, 2018)
[246] (Luck, 2016)

Puget Sound LNG

The proposed LNG plant in the Port of Tacoma will produce, store, and bunker marine vessels with LNG. The facility presents risks for fires and unconfined hydrocarbon vapor cloud explosions. Located within an urban population center, Puget Sound LNG presents grave dangers.

The plant has two close neighbors. The Port of Tacoma lies to its south and employs 10,000 people and has a resident population of 1,300.[247] Just north is the residential neighborhood of Northeast Tacoma, with a population of 17,000.[248] Many people live, work, and travel less than half a mile away from the plant. Also located less than 2 miles away is the Northwest Detention Center operated by U.S. Immigration and Customs Enforcement (ICE). ICE has an evacuation plan, but the plans are considered "sensitive" and have not been released even to the Tacoma Fire Department.[249] In the event of a sudden and major disaster, like an earthquake, tsunami, and/or LNG explosion, the safe evacuation of inmates would be difficult if not impossible.

Tacoma citizens and the Tacoma News-Tribune have repeatedly requested access to safety modelling information from Puget Sound Energy (PSE), the local energy utility which promotes the LNG project. PSE refused until ordered twice by Pierce County Superior Court and sued to prevent its release.[250] According to the FEIS in a section entitled: Thermal Radiation & Vapor Dispersion Safety Modeling, "The risks of fire and explosions have been modelled, but they are covered by a non-disclosure agreement and for security reasons are considered critical energy infrastructure and are not to be released to the public."[251]

Critics have identified multiple issues:

- A report modeling three tsunami scenarios prepared by the Washington State Department of Natural Resources found that a magnitude 7.3 earthquake could lead to a tsunami with waves enveloping the Port and reaching five kilometers into the City of Tacoma.[252]
- PSE points to the multilayered steel and concrete materials used to build the 149-foot, 8-million-gallon storage tank. However, local environmental researchers and advocates

[247] (Puget Sound Regional Council, 2013)
[248] (Northeast Tacoma, Tacoma WA Demographics, n.d.)
[249] (Henterly, 2015)
[250] (Martin, 2018)
[251] (Final Environmental Impact Statement: PSE LNG, 2016)
[252] (Venturato, 2007)

identified that a "tank-breach" scenario was not run in modeling of potential project incidents and spills, citing leaks from a similar LNG facility in Louisiana.[253]

- The siting study calculated that a tank fire in which the roof was destroyed could have a flame more than 200 feet high. [254] Such a fire is impossible to extinguish, and how long such a fire could burn is unknown. The only recourse would be to evacuate the area.
- A report prepared for the City of Tacoma by Cascadia Consulting and University of Washington researchers projecting climate change impacts in Tacoma found that the industrial Tideflats area, where the Puget Sound LNG facility is located, is vulnerable to sea-level rise. It names the Port of Tacoma as vulnerable to high risk of flooding due to climate impacts and rising sea-levels. Consequently, the risk of accidental gas releases due to flooding and storm surges must be considered.
- The report additionally identified the Tideflats area as vulnerable to landslides, which poses additional risks to the LNG facility.[255]
- Ecology and Environment Inc, Global Environmental Specialists and Braemer Engineering, the firms that prepared the FEIS, recommended additional mitigation measures to "protect worker and public health and safety."[256] Why workers and citizens would be at risk is not specified nor are the mitigation measures.
- An environmental consultant retained by the Puyallup Indian Tribe, Dr. Ron Sahu, found a number of inadequacies in the Puget Sound LNG siting study:[257]
    - The Report assumes spills or leaks will be contained in a 10-minute time frame. A 10-minute leak duration is unsupported by PSE documentation. Previous experience with an LNG facility explosion in Washington State shows that leaks can persist more than 24 hours.[258]
    - Leaks were assumed to occur only from pipelines two inches or larger.
    - The report ignored failures of refrigerant storage vessels and risks from handling refrigerants. Refrigerants are among the more volatile substances that would be stored in the facility.

[253] (Hay, n.d.)
[254] (Nunnally, 2016)
[255] (Parvey, 2016)
[256] (Final Environmental Impact Statement: PSE LNG, 2016)
[257] (Sahu, 2018)
[258] (Powell T. , Williams Companies Failed To Protect Employees in Plymouth LNG Explosion, 2016)

- The report failed to assess the possibility of a vapor cloud explosion. In 2016, longtime LNG and fracked gas industry researchers were quoted in a trade publication discussing risks from explosions and vapor clouds as understudied: "We believe these additional hazards have been discounted without sufficient scientific justification in spite of multiple international reports during the last decade of catastrophic accidents involving unconfined hydrocarbon vapor cloud explosions."[259]
- Regarding the report's analysis on the size of vapor barriers, Dr. Sahu noted that, "The analysis assumes that a chain link fence will provide an effective vapor barrier."
- In their interview with E&E news, engineering professors Jerry Havens and James Venart expressed dismay at the lack of regulations and safety standards concerning vapor releases and the potential for combustion in proposed LNG facilities.[260]

Even when designed and operated safely, gas releases may occur as a part of normal LNG bunkering operations, making each operation a potential fire hazard. These gas releases present a particular danger when facilities are sited at busy ports. An analysis by Sightline Institute revealed that the Puget Sound LNG "facility would be flanked by two oil facilities on a busy industrial peninsula that is difficult to evacuate in an emergency and in close proximity to several marinas, unrelated ship traffic, and other port businesses and employees."[261] This is in direct conflict with the recommended best practices that LNG operations be located in the most protected and secure location in the port; preferably in a remote area of the port that is not frequented by other port users.[262]

Given that the project site is only 30 acres (1/20 of a square mile), it is unreasonable to assume that leaks and explosions can be contained within the site. It almost certainly poses a threat beyond the site boundaries.

[259] (Mandel, 2016)
[260] (Sahu, 2018)
[261] (Powell T. a., 2016)
[262] (Society of International Gas Tanker and Terminal Operators, 2003)

OCCUPATIONAL HEALTH AND SAFETY

When fossil fuel export projects are proposed, supporters emphasize economic opportunities, particularly job creation. What is left out of the discussion is how dangerous and unhealthy these jobs can be. Workers in the fossil fuel industry are exposed to myriad health risks and are killed on the job at rates four to seven times higher than other industries.[263]

The many detrimental health impacts of oil and gas field work are well studied and documented, including benzene exposure;[264] [265] silicosis;[266] endocrine disruption;[267] radiation and noise exposure;[268] exposure to hydrogen sulfide;[269] and increased overall mortality rates, especially due to work-related motor vehicle accidents. [270] [271]

With remarkable disregard for public health, the oil and gas industry, specifically, is exempt from disclosing the chemicals they use and from most federal statutes protecting worker, resident and environmental health, including, but not limited to, the Clean Water Act, Clean Air Act, Compensation and Liability act and the Toxic Release Inventory.[272] Despite high mortality rates from fire and explosion, the oil and gas industry is also exempt from OSHA regulations called process safety management (PSM), which regulate industries to prevent workplace explosions.[273]

Diesel emissions expose large numbers of fossil fuel workers to known respiratory hazards. The US Department of Transportation (DOT), responsible for the health and safety of interstate truck and bus drivers, has neither a standard for diesel emissions nor other health standards with explicit exposure limits.[274] Nor does OSHA have any standard specifically for exposure to diesel exhaust.[275] Only a small proportion of the thousands of chemicals present in the gas and particulate matter of diesel emissions is covered by OSHA standards, and most of these standards require only that specified limits not be exceeded over an 8-hour work shift. Components in the gas phase rarely

[263] (AFL-CIO, 2018)
[264] (Lombardi, 2014)
[265] (Esswein E. e., 2014)
[266] (Bang, 2015)
[267] (O'Neill, 2014)
[268] (Witter, 2014)
[269] (Cribb, 2017)
[270] (AFL-CIO, 2018)
[271] (Olsen, 2014)
[272] (Colborn, 2011)
[273] (Soraghan M. , 2015)
[274] (American Public Health Association, 2014)
[275] (U.S. Department of Labor: Occupational Safety and Health Administration, n.d.)

exceed their limits. Their greatest potential threat comes from their adsorption onto diesel engine particulates, bringing them deep into the lungs. This exposure is unlimited and unregulated. Similarly, for environmental contaminants, components taken separately rarely exceed their limits, but their threat is increased when combined with simultaneous exposure to other contaminants.

The oil and gas industry is currently exempt from much of OSHA's noise standards as well, despite numerous health risks to workers from noise levels resulting from drilling, heavy equipment, diesel engines, and pipe-fitting operations.[276]

Fire and Explosions

According to numbers compiled by Energywire, the oil and gas industry employs less than 1% of the U.S. workforce but is responsible for nearly 10% of occupational deaths from fire.[277] Between 2009 and 2013, the sector had the highest rate of mortality from fire and explosions of any private industry, and the second highest of all occupations, behind only firefighting.[278]

- In Seattle in 2016, a gas line exploded injuring nine firefighters and destroying multiple businesses. The line was supposed to have been shut off in 2004, but the contractors hired by Puget Sound Energy failed to properly cut and cap the line and gas had been flowing through it for 12 years.[279]
- On August 1, 2018 outside Midland, Texas, two pipelines began leaking at their intersection. Five workers from the pipeline companies, Kinder Morgan and Navitas Midstream, and two local firefighters responded to the leak by attempting to shut off the flow. A fire ignited and a series of explosions followed. All seven workers were hospitalized and one later died of his injuries. No report has yet determined the cause of the explosion.[280] One week later a different pipeline exploded, killing a three-year old child in her home.
- The Williams Company's LNG storage facility in Plymouth, Washington is the largest in the Pacific Northwest, with two fourteen-million-gallon storage tanks. (See section "Natural and Human Caused Disasters" above for more) At eight a.m. on March 31, 2014, fracked gas inside the LNG processing station ignited, creating a series of rolling

[276] (Witter, 2014)
[277] (Soraghan M. , 2015)
[278] (Soraghan M. , 2015)
[279] (Lacitis, 2017)
[280] (San Angelo Standard-Times, 2018)

explosions that fragmented equipment, sent 250 pounds of metal flying up to 900 feet away, and lit the facility on fire. Four employees were injured from the shrapnel, and one was burned. Before the explosion, plant operators had temporarily dismantled the site's safety monitors, so the plant continued to operate and leak fracked gas through the emergency. Company officials requested that employees repeatedly reenter the facility to manually shutdown dangerous equipment. Though more than a hundred emergency responders arrived on-site, they were unable to enter the facility for eight hours until the wind changed enough to drive out the flammable fracked gas. The extreme cold of LNG also made plugging the leaks time intensive: holes would freeze over until ambient temperature melted enough to begin leaking again. Despite the five injured employees, the company recorded only one injury in the official report months later because federal regulations only mandate that oil and gas producers report injuries leading to death or overnight hospital stays.[281]

Deadly Gases and Airborne Hazards

The production, transport and storage of fracked gas exposes workers and adjacent communities to numerous toxic air pollutants during each stage of its life cycle: drilling, well completion and fracking; transport by rail, pipeline or ship; liquefaction, refining, processing, and storage. Airborne toxins pose more serious risks for workers, as likelihood and severity of exposure increases significantly with proximity to operations, as well as during particular stages of production.[282]

Common hazardous air pollutants emitted during fracked gas production, processing, and transport include, among others: volatile organic compounds (VOC) like benzene, toluene, ethylbenzene, and xylene; formaldehyde; hydrogen sulfide; carbon monoxide; sulfur oxide; diesel particulates; ozone; and radon gas.[283] [284]

[281] (Powell T. , 2016)
[282] (McKenzie, Human health risk assessment of air emissions from development of unconventional natural gas resources, 2012)
[283] (Shonkoff S. e., 2014)
[284] (McKenzie, Human health risk assessment of air emissions from development of unconventional natural gas resources, 2012)

Researchers in Colorado found, during the extraction process alone (fracking), companies used 944 different products, which together contained 632 different chemicals. Of these chemicals: [285]

- More than 75% affect skin, eyes, and other sensory organs, as well as respiratory and gastrointestinal systems
- 40-50% affect the brain and nervous systems
- 37% affect the endocrine system
- 25% cause cancer and mutations

Still largely unstudied on their own, these chemicals can also combine and potentially form new reactants when exposed to air, high temperatures, and other variables of the extraction process.[286]

Hydrogen Sulfide

- Hydrogen sulfide, or "sour gas", is one of the most common and dangerous byproducts of oil and gas production, causing acute and chronic breathing issues, neurological defects, and death. It can also corrode metal, making storage dangerous. In high concentrations the gas deadens a person's sense of smell, making it undetectable.[287] [288]
- A study in the Alberta tar sands found that of workers interviewed, 35% experienced high exposure levels, and 10% had at some point been "knocked down" (lost consciousness) by the gas.[289]
- Hydrogen sulfide is regulated in many states producing oil and gas, but according to Energy Wire's reporting, in the years 2013 and 2014 alone, five workers died from exposure in the fracking fields. In 1975, the gas was responsible for the deaths of nine in Denver City, Texas.[290]

[285] (Colborn, 2011)
[286] (Kaden, 2015)
[287] (Kaden, 2015)
[288] (Lee, 2014)
[289] (Hessel, 1997)
[290] (Lee, 2014)

Volatile Organic Compounds

- Between 2010 and 2015 at least nine workers died from close proximity to hydrocarbon vapors, also known as volatile organic compounds (VOC), trapped in fracked gas storage containers.[291]
- All petroleum contains potentially lethal levels of VOCs. But according to a study by the National Institute for Occupational Safety and Health (NIOSH), VOC exposure in fracked gas is more unpredictable and often more dangerously concentrated than in conventional oil and gas production.[292] Exposure to these trapped gases can lead to sudden loss of consciousness and death.[293]
- An investigation by Energywire found that one of the ways workers are taught to avoid these sudden exposures is by "testing the wind" before they open the hatch.[294]
- Workers face these risks during all routine container tests—at the fracking site, during transport, and at processing facilities.[295]

Silicosis

- Exposure to silica dust is a well-known hazard in mining, construction, sandblasting, and other industries. It is a known lung carcinogen.
- In hydraulic fracturing, intensive blasting of sand and the general lack of regulation creates conditions where silica exposure can become extremely hazardous.
- A study by NIOSH of eleven fracking sites in five states found that full-shift silica exposure exceeded the threshold for safe levels, sometimes by ten times or more. Wearing a respirator was ineffective in preventing significant exposure.[296]
- The huge amount of sand required by hydraulic fracking has led to a surge of intensive sand mining in parts of Minnesota and Wisconsin. This has in turn led to higher health risk for miners, and likely their communities as well due to the ambient silica dust released during the extraction process.[297]

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[291] (Harrison, 2016) https://www.cdc.gov/mmwr/volumes/65/wr/mm6501a2.htm
[292] (Esswein E. e., 2014)
[293] (NIOSH-OSHA, 2018)
[294] (Soraghan M. , SAFETY: Poisoned by the Shale? Investigations Leave Questions in Oil Tank Deaths, 2014)
[295] (Harrison, 2016)
[296] (Esswein, Occupational Exposures to Respirable Crystalline Silica During Hydraulic Fracturing, 2013)
[297] (Korfmacher, 2013) https://doi.org/10.2190/NS.23.1.c

- Recently, the American Thoracic Society called for greater recognition of the harm of silicosis, citing its prevalence, seriousness and yet underrepresentation in occupational health cases.[298]
- Silicosis risks will occur during construction of fracked gas pipelines, processing, and storage facilities.
- A report by researchers in Quebec found that, while all major construction projects expose workers to silica, pipeline laborers had some of the highest risks of silicosis exposure due to their frequent use of jackhammers, masonry saws, and other dust producing heavy machinery.[299]

Diesel Engine Exhaust

- Workers encounter diesel engine exhaust (DEE) from heavy machinery throughout gas production and transport. Diesel exhaust components include carbon monoxide, nitric oxide, nitrogen dioxide, sulfur oxides, and polycyclic aromatic hydrocarbons, as well as fine particulate matter.
- When NIOSH conducted a full shift study of diesel exhaust exposure at multiple fracking sites, they found the mean exposure over time (17 µg/m3, ranging from 0.1–68 µg/m3) near to the state of California's maximum safe exposure level (20 µg/m3). 10% of their measurements exceeded this limit.[300]
- DEE is a recognized carcinogen and cause of lung cancer.[301] U.K. researchers have estimated DEE to be the third largest contributor to occupationally induced lung cancer (after asbestos and silica) and estimate DEE is responsible for up to 6% of all lung cancer deaths.[302]
- Diesel fumes not only impact workers at close proximity, but create regionally hazardous air quality.

[298] (Deslauriers, 2016)
[299] (Beaudry, 2013)
[300] (Esswein E. e., Measurement of Area and Personal Breathing Zone Concentrations of Diesel Particulate Matter (DPM) during Oli and Gas Extraction Operations, Including Hydraulic Fracturing, 2018)
[301] (Benbrahim-Tallaa, 2012)
[302] (Vermeulen, 2013)

Radiation

- Radon is a component of fracked gas, but its concentration levels can far exceed safe levels as a result of the extraction process. These concentrations can then travel with the gas and dissolve into the mixed fluids, or "slurry", produced during the disposal of fracking wastes.[303]
- Radon will remain in the gas and disposal slurry until the radioactive isotopes fully decay, creating a long-term exposure risk for both workers and downstream consumers.[304]
- Radon is second only to tobacco as a cause of lung cancer. [305]

Noise

- These risks are higher with fracking than conventional gas production due to the greater scale and length of time when workers are exposed to noise during horizontal drilling and other unconventional extraction methods.[306]

Jordan Cove LNG

The majority of jobs offered by the Jordan Cove project will come during the short-term construction of the facility (which is true of each of the proposed fracked gas projects). In its Resource Report 1, the parent company Pembina estimates an average of 1,023 construction employees per month over a five-year construction period. Work would include pile driving and dredging of the bay, road and infrastructure construction, and building the processing facility itself.[307]

While not a definitive accounting of all occupational risks, Jordan Cove exemplifies the specific risks to workers' health posed by projects of this scale:

- Acute and continuous exposure to diesel fumes, VOCs, and other toxic emissions from heavy construction machinery, high levels of bus and truck traffic, and the presence of two large diesel-fired generators as well as two black diesel backup generators.

[303] (Steinhäusler, 2004)
[304] (Kaden, 2015)
[305] (Al-Zoughool, 2008)
[306] (Kaden, 2015)
[307] (Jordan Cove Energy Project L.P., 2017)

- Nighttime use of vehicles and heavy equipment: dredging and pile driving of the bay is expected to occur 24 hours per day over two years. Many of the workers would be temporary and come from out of county, likely commuting long distances and leading to higher risk of over-exhaustion and vehicular death.
- High noise exposure would occur from ongoing and wide use of heavy machinery.
- Silica exposure from high levels of dust produced in concrete work, dredging, and masonry.

When completed, the facility would require 180 permanent positions.[308] Employees at the terminal will similarly experience constant high noise level exposure and possible over-exhaustion from nighttime operations. They are also at risk of acute and deadly exposure to VOCs, benzene, and methane during routine testing and maintenance of the gas storage tanks.

The greatest risk for workers at Jordan Cove comes from potential fires and explosion from unknown or unrepaired leakages, exemplified by the explosion at the William's Company LNG storage facility in Plymouth, Washington. These risks are augmented by the possibility of earthquake and tsunami.

Pembina has promised to build what they call the Southwest Oregon Regional Safety Center (SORSC) near the terminal, including a "security center" and an "emergency operations center". They have also promised to build a fire station nearby in a separate facility, staffed with industrial firefighters.

However, as the explosion in Plymouth demonstrated, significant safety issues were not necessarily mitigated by the presence of firefighters; in fact, the firefighters and trained LNG employees who responded to the situation in Plymouth could not immediately act due to continued leakage of explosive fumes. The root problem of the above case was not a lack of firefighters or emergency crews, but the degradation of storage equipment, employee error, proximity of flammables, and scale of the facility.

Pacific Connector Gas Pipeline

Pipeline construction workers will experience many of the same risks as those at Jordan Cove: high diesel fume exposure, long and irregular hours including nighttime work and commuting, continual noise pollution, and high risk of silica dust exposure from digging equipment.

[308] (Draft Environmental Impact Statement for the Jordan Cove Energy Project, 2019)

Pipeline monitors, likewise, face what can be lethal exposure to methane, VOCs, and other noxious gasses potentially released during maintenance at compressor stations, as well as during any leak repair.

Because the PCGP will transport fracked gas in unprocessed, pressurized form there would be continuous risk of leaks and explosions. If a pipeline failure occurs, Pacific Connector employees and local emergency responders would be responsible for resolving the problem at their own risk. Pacific Connector Gas Pipeline LP writes in their "Resource Report No. 11, Reliability and Safety" that they would plan for this by sharing information with existing safety organizations. They do not, however, plan to provide emergency training in the case of gas leakage, or pay for more emergency equipment, suggesting the burden of risk will fall on local emergency responders and local jurisdictions.

In addition, in many places along the pipeline, the company has only promised to patrol and check for leaks once per year.[309]

Climate change has already dramatically increased the number and severity of wildfires in Oregon. According to Firefighters United for Safety, Ethics and Ecology (FUSEE), over half the 229-mile long pipeline would cross through lands already designated by the U.S. Forest Service as having moderated to very high wildfire risk.[310] The result will be a pipeline that functions like a quick-burning fuse, causing, in case of a spill and ignition, major wildfires in the surrounding area. Firefighters responding to the disaster would face a dangerous double-risk: the need to suppress the pipeline explosion as well as suppressing the fires that would threaten surrounding communities and themselves.

Kalama Methanol Refinery

The proposed Kalama methanol refinery would be the largest in the world, producing 3.6 million metric tons of methanol a year and consuming nearly three times as much fracked gas as Portland and Seattle combined.[311] According to the Northwest Innovation Works Safety Report, the site would convert crude fracked gas to methanol and water using heat and metallic compounds to break down the gas, releasing numerous toxic waste materials, such as hydrogen sulfide.[312]

[309] (Jordan Cove LNG, 2017)
[310] (Firefighters United for Safety, Ethics and Ecology, 2019)
[311] (DePlace E. &., 2018)
[312] (AcuTech, 2016)

In 2014, the Chemical Safety and Hazard Investigation Board (CSB), an independent federal investigative agency, compiled a report on the hazards of methanol, finding that workers' health and safety risks include: [313]

- Handling of catalyst material. In unprocessed form fracked gas is largely composed of methane, but conversion to the intermediary synthetic gas introduces a high percentage of carbon monoxide, a known asphyxiate. The hazards of other catalyst materials are less well known. In their Safety Report, the company acknowledges, "some of these compounds may be toxic if inhaled and some may have potential to self-heat and combust when exposed to the atmosphere under certain circumstances." Removal would depend on workers navigating a complex process of purging gasses, preventing dust kick-up, and moving through confined spaces.[314]
- Acute exposure to methanol. Methanol is a known poison and can easily enter through the skin and eyes, or from ingesting contaminated food or water. High doses can cause blindness or death and a range of impacts on the central nervous system, including headaches, dizziness, lethargy, seizures, and coma.
- Chronic exposure to methanol. Repeated or chronic exposure to low levels of methanol may cause birth defects, produce inflammation of the eye (conjunctivitis), recurrent headaches, giddiness, insomnia, stomach disturbances, and visual failure. The most noted health consequences of longer-term exposure to lower levels of methanol are a broad range of effects on the eye. Inflammatory changes and irritation of the skin (dermatitis), occurs with chronic or repeated exposure to methanol.[315]
- General handling of methanol. Methanol is flammable, burns easily, and has a higher density than air, so that it pools and collects near the ground following a spill. This tendency makes cleanup difficult, as the gas does not dissipate without good ventilation.
- Fire and Explosion. Methanol is widely used in a number of settings: commercial, industrial, institutional, and at home. A report compiled of known methanol incidents in thirteen countries over a fifteen-year period found that industrial workplace accidents comprised the highest percentage (31%, n=28), with fire and explosions accounting for 90% of those incidents, with 23 workers injured and 6 killed. The only higher mortality

[313] (Medina, 2014)
[314] (AcuTech Consulting Group, 2016)
[315] (National Institute for Occupational Safety and Health, n.d.)

rate was in transportation, with 57 fatalities in 26 incidents. One third of all incidents documented in the report had no known cause.[316]

Longview Anhydrous Ammonia Plant

Pacific Coast Fertilizer's proposed plant in Longview would employ about 100 people in the processing of fracked gas to anhydrous ammonia for nitrogen fertilizer. The Centers for Disease Control and Prevention (CDC) report that anhydrous ammonia can be extremely hazardous to work with, expanding rapidly into the air upon release.[317] Exposure to anhydrous ammonia can cause severe eye, nose and throat irritation, breathing difficulty, wheezing, chest pain, pulmonary edema (fluid build-up in the lungs), burns, blisters, and frostbite. According to the CDC and National Institute of Occupational Safety and Health, exposure is fatal at concentrations as low as 300 parts per million.

Accidents occur frequently from storage and transport of the substance. A report in 2013 found that over a fifteen-year period almost 1,000 accidents occurred at 678 facilities, with over a fifth of these facilities having multiple accidents. These resulted in 19 deaths and 1,651 injuries.[318]

Puget Sound LNG

Puget Sound Energy's proposed facility in Tacoma would be an LNG terminal for refueling ships. Called "bunkering," this new and unregulated process depends on a number of "best case scenarios" to ensure the LNG doesn't spill or volatilize, damaging physical structures and injuring workers.[319]

A 2015 report from the American Bureau of Shipping outlines the numerous unique hazards of the fueling system, including risk of "serious injury to personnel in the immediate area if they come in contact with cryogenic liquid" and "brittle fracture damage to steel structures exposed to cryogenic temperatures". Like all LNG terminals, gas may also release throughout the storage and transfer process, creating an ambient fire-hazard at the facility and acute risk of methane asphyxiation for workers.[320] If built as proposed and without regulation, worker protection from

[316] (Medina, 2014)
[317] (Centers for Disease Control and Prevention)
[318] (DePlace E. &., 2017)
[319] (Powell T. a., 2016)
[320] (American Bureau of Shipping, 2015)

these hazards would be almost entirely at the mercy of the safety plan of Puget Sound Energy and their business partners.

TEMPORARY LABOR CAMPS

Construction of oil and gas infrastructure, including processing plants, export terminals, extraction sites and pipelines, requires a large influx of labor with frequently unforeseen impacts on local communities. The influx of labor necessitates temporary housing and makes demands on local communities to provide for and adjust to the sudden increase in population and need for services. Frequent reports in the past ten years have documented burdens on local infrastructure, public services and public health and increasingly on nearby tribal communities through increases in crime, drug use, assaults, kidnapping, sex trafficking, and sexually transmitted infections (STI).

- In Williams County, North Dakota, in the Bakken Shale, increases in crime have corresponded with the flow of oil. The infusion of cash has reportedly attracted career criminals who deal in drugs, violence, and human sex trafficking. In 2014 the *Williston Herald* portrayed the rapid rise of "violent crimes that result in the immediate loss of an individual's property, health or safety, such as murder, larceny and rape." With fewer than 100 law enforcement personnel, crime in Williams County "has risen in kind with the county's population, but funding, staffing and support training for law enforcement has not."[321]
- According to the North Dakota Health Department, the number of HIV and AIDS cases in North Dakota more than doubled between 2012 and 2014, and cases were shifting to the state's western oil fields, where 35-40 percent of all new cases occurred. Previously, only 10 percent of cases were in that region.[322] This trend followed on the heels of an upsurge in sexually transmitted chlamydia cases in the same region. The North Dakota state director of disease control, Kirby Kruger, attributed the uptick in HIV cases to the drilling and fracking industry and attempted to spread HIV prevention messages at the

[321] (Bell, 2014) Retrieved from http://www.willistonherald.com/news/modernized-slavery/article_84e257d8-3615-11e4-a4f8-001a4bcf887a.html

[322] (Associated Press, 2014) Retrieved from http://billingsgazette.com/news/state-and-regional/montana/north-dakota-hiv-aids-rate-rises-with-population- growth/article_a939fed6-f737-5cfb-957f-ab800673f4d7.html

"man camps" that house young male workers in the oil industry.[323] Human sex trafficking accompanied the fracking boom, but a shortage of medical professionals hampered response to the public health crisis, according to Kruger, who noted that it was difficult to hire nurses and medical staff who could live in the area on a public health wage.

- In 2017 the Southwest Pennsylvania Environmental Health Project established a voluntary public health registry to track and analyze impacts of shale gas development on people living near gas production facilities. According to a spokesperson, "The vast majority of independent science is looking at [shale gas development] and saying something's not good there. We need to know more … The findings of this registry will allow the health care community to be more informed about what problems people are experiencing when they walk into their offices."[324]
- Sexually transmitted infections (STI) can increase through sexual mixing patterns associated with labor migration. A longitudinal, ecologic study was conducted from 2000–2016 in a prolific shale gas region situated in Ohio. Reported cases of chlamydia, gonorrhea and syphilis by county and year were obtained from the Ohio Department of Health. All 88 counties were classified as none, low, and high shale gas activity in each year, using data from the Ohio Department of Natural Resources. Compared to counties with no shale gas activity, counties with high activity had 21% increased rates of chlamydia and 19% increased rates of gonorrhea.[325]

One of the underreported effects of the fracking boom is the strain on the area's healthcare system. Motor vehicle accidents and deaths, for example, are many times higher for oil and gas workers than workers in other industries, leading to over-burdened hospitals and emergency response services. One study found oil and gas workers died from work-related motor vehicle accidents 8.5 times more frequently than other wage and salary workers.[326]

The Methodist Healthcare Ministries executive report of the South Texas Community Needs Assessment describes the consequences of the fracking boom on healthcare in rural Texas counties near the Eagle field shale (EFS) area. Results include:

[323] (Heitz D. , 2014)
[324] (Hopey, 2017)
[325] (Deziel N.C., 2018) https://doi.org/10.1371/journal.pone.0194203
[326] (Retzer, 2013)

- Increased STIs (rates of chlamydia in part of the EFS area is 365 per 100,000 people—compared to a national average of 84 per 100,000).
- Increases in the number of uninsured patients, as much work in the oilfield is done by subcontractors who do not have health insurance. Additionally, workers in the industries that have grown to provide services to oil field workers are generally uninsured. At a single site in the study, the percentage of uninsured patients grew from 60 percent in 2011 to 74 percent in 2013. Across the study, self- pay, and charity cases increased 11%.
- Increases in heat exhaustion, dehydration, sleep deprivation, exposure to oil and gas spills, and accidents.
- Increase in traffic accidents. In one county, accidents increased 412% between 2009-2011.

The impact on hospitals has also been described in the Bakken oil field region of North Dakota.

- Trauma services have increased in some rural areas by over 1000%. Half these trauma visits are attributed to oil field injuries, though many are drug overdose related.
- In North Dakota between 2012-2014 HIV/AIDS cases doubled. 35% occurred in the western oil fields, the site of large "man camps" which had already seen a significant increase in chlamydia cases.

Native Americans

Reports are emerging of disproportionately severe trauma to tribal communities near temporary labor camps. In January 2014, James Anaya, the United Nations special rapporteur, opened the meeting of the UN's Permanent Forum stating: "It has become evident … that extractive industries many times have different and often disproportionately adverse effects on indigenous peoples, and particularly on the health conditions of women." He detailed the effects on Native American women and girls, including increased rates of STIs and HIV/AIDS, physical assault, and sexual harassment and violence. He additionally noted that "contamination of indigenous lands and natural resources resulting from extractive activities has significant implications for reproductive health, having contributed in many cases to birth defects, delayed child development and disease among community members." In addition, he noted, the full range of health effects are yet to be

determined, igniting fears among Native Americans about the unknown intergenerational effects that the contamination will have on their communities.[327]

A 2016 opinion piece in the *Boston Globe* exposed the risks Native American women faced due to the Dakota Access Pipeline: "It also endangers women and girls. That's because, in this country as around the world, extractive industries create so-called 'man camps,' places where male workers often work twelve-hour days, are socially isolated for weeks or months at a time, and live in trailers in parks that extend for miles. Many men retain their humanity, but as advocacy organizations like First Nations Women's Alliance have noted, these man camps become centers for drugs, violence, and the sex trafficking of women and girls. They also become launching pads for serial sexual predators who endanger females for miles around."[328]

In 2014 the U.S. Justice Department Office on Violence Against Women awarded three million dollars to five rural and tribal communities to prosecute crimes of violence against women and provide services to victims of sexual assault, domestic violence, and stalking in the Bakken Region of North Dakota and Montana.[329] Rationale documented by tribal leaders, law enforcement, and the FBI included, "rapid development of trailer parks and modular housing developments often referred to as 'man camps'; abrupt increase in cost of living, especially housing; rapid influx of people, including transients, in a previously rural and stable community; constant fear and perception of danger; and a lost way of life. Local and tribal officials and service providers reported that these changes have been accompanied by a rise in crime, including domestic and sexual violence."[330]

To address the community health and safety harms linked to temporary labor camps of extractive industries, the British Columbia Ministry of Aboriginal Relations and Reconciliation funded a research project in 2017, carried out in consultation with First Nations. The project noted that "increased domestic violence, sexual assault, substance abuse, and an increased incidence of sexually transmitted infections (STIs) and HIV/AIDS due to rape, prostitution, and sex trafficking are some of the recorded negative impacts of resource extraction projects, specifically as a result of

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[327] (Rickert, 2014). http://nativenewsonline.net/currents/un-special-rapporteur-oil-gas-mining-operations-brings-increased-sexual-violence/

[328] (Nagle, 2016)

[329] (U.S. Department of Justice, 2014) Retrieved from http://www.justice.gov/opa/pr/associate-attorney-general-west-announces-3-million-grants-address-violence- against-women

[330] (U.S. Department of Justice, 2014) Retrieved from http://www.justice.gov/sites/defaultfiles/ovw/legacy/2014/04/25/fy2014-initative-for-the-bakken-region-enhanced-services-for-victims.pdf

the presence of industrial camps and transient work forces." The objectives of the project were to stimulate dialogue and to develop detailed protective steps for Nations, government, and industry in advance of the initiation of planned extraction projects in the region, in order to prevent violence against women and other life changing negative effects linked to the industrial camps.[331]

Jordan Cove LNG and Pacific Connector Gas Pipeline

Jordan Cove LNG has applied for a permit for a 2100-person temporary labor camp to be built on the north sand spit in Coos Bay during construction of the fracked gas processing plant. Access would be limited to one way in and out. Access for emergency responders and escape for visitors and personnel in case of emergencies would be inadequate and present a serious danger.

Proposed temporary housing would be serviced by new utilities including water supply and waste disposal. Will proposed utilities be adequate to handle a large influx of workers? If not, there is potential for negative impacts on the waters of Coos Bay, the estuary, and the ocean shore with the potential for contamination of soils and water as well as significant stress on the public water system by significantly increased usage. The large influx of labor will likely also place increased stress on the police, fire, and health resources of Coos Bay, North Bend, and surrounding communities.

Many temporary labor camps may be needed to build the proposed Pacific Connector Pipeline, especially in rural areas in and near tribal lands, raising concerns of increased risks to rural communities of communicable diseases, crime, drug use, assaults, and homicides. Local communities do not have the resources or the ability to protect their community members, and public health resources are insufficient to respond to the projected adverse health impacts.

HEALTH EFFECTS OF HYDRAULIC FRACTURING

Hydraulic fracturing (fracking) for gas is a remarkably dirty and dangerous industry with sometimes devastating effects on neighboring communities. The majority of the gas piped into Oregon and Washington is fracked gas, which has been extracted at substantial cost to the communities that surround fracking sites. West Coast fracked gas infrastructure would help perpetuate the development of fracking for gas that harms communities nationwide and in Canada.

[331] (Gibson, 2017) Retrieved from http://www.thefirelightgroup.com/thoushallnotpass/wp-content/uploads/2016/03/Firelight-work- camps-Feb-8-2017_FINAL.pdf

Heath effects of fracking operations include air and water pollution, human-caused disasters, and threats to occupational health and safety. The deleterious effects of temporary labor camps associated with construction of fracked gas facilities are discussed above.

Air Pollution

Fracking for gas is associated with health-threatening levels of air pollution. Numerous studies have documented high levels of air pollutants that cause cancer as well as pulmonary and neurological diseases. Distant effects of fracking related emissions are seen as well, particularly via ground level ozone and smog.

Air pollutants include volatile organic compounds, ozone, particulate matter, nitrogen oxides, carbon monoxide, formaldehyde, benzene, and polycyclic aromatic hydrocarbons (see section Air Pollution above for further description of toxics).

Air samples gathered near fracking sites in Arkansas, Colorado, Pennsylvania, Ohio, and Wyoming were found to contain eight highly toxic chemicals. The most common airborne chemicals detected included two known human carcinogens (benzene and formaldehyde) and two potent neurotoxicants (hexane and hydrogen sulfide). In 29 out of 76 samples, concentrations far exceeded federal health and safety standards, sometimes by several orders of magnitude. Further, high levels of pollutants were detected at distances exceeding legal setback distances from wellheads to homes. Highly elevated levels of formaldehyde, for example, were found up to a half-mile from a wellhead. In Arkansas, seven air samples contained formaldehyde at levels up to 60 times the level known to raise the risk for cancer.[332]

Whole air samples collected throughout the Barnett Shale basin in Texas contained benzene, hexane, and toluene at levels two to fifty times greater than the local background and similar to those seen in other intensely drilled shale basins in Colorado and Utah.[333]

Between 2009 and 2014, ethane emissions in the Northern Hemisphere increased by about 400,000 tons annually, the bulk of it from North American oil and gas activity, according to research by an international team led by the University of Colorado Boulder. Ethane contributes to the creation of ground-level ozone pollution (smog), a known human health hazard.[334]

[332] (Macey, 2014) doi: 10.1186/1476-069X-13-82
[333] (Marrero, 2016) doi: 10.1021/acs.est.6b02827
[334] (Helmig, 2016) doi: 10.1038/ngeo2721

Approximately two percent of total global ethane emissions (250,000 tons of ethane/year) originate from the Bakken shale oil and gas field. These emissions directly impact air quality across North America by contributing to the formation of ground level ozone and smog. Surface-level ozone is linked to respiratory problems, eye irritation, and crop damage. Additionally, as a greenhouse gas, ethane is the third-largest contributor to human-caused climate change. Up until 2009 global ethane levels were decreasing, but have risen following the shale gas boom.[335]

Aerial infrared camera surveys "of more than 8,000 oil and gas wells in seven U.S. regions found that well pads emit considerably more methane and volatile organic compounds (VOC) than captured by earlier inventories. Moreover, these emissions were widely and unpredictably variable from site to site and from well to well. Over 90 percent of total airborne emissions from well pads originated with vents and hatches on aboveground storage tanks."[336]

In response to health concerns by local residents, a research team from University of Cincinnati and Oregon State University found high levels of air pollution in heavily drilled areas of rural Carroll County, Ohio. Air monitors showed 32 different hydrocarbon-based air pollutants, including the carcinogens naphthalene and benzo[a]pyrene.[337]

Researchers found that drilling and fracking in Utah's Uintah Basin emit prodigious amounts of volatile organic air pollutants, including benzene, toluene and methane, all of which are precursors for ground-level ozone (smog). Multiple pieces of equipment on and off the well pad, including condensate tanks, compressors, dehydrators, and pumps served as the sources of these emissions. This research shows that drilling and fracking activities are the cause of the extraordinarily high levels of winter smog in the remote Uintah basin—which regularly exceed air quality standards and are similar to that of downtown Los Angeles.[338]

Residential areas in intensely drilled northeastern Colorado have high levels of fracking-related air pollutants, including benzene and ozone.[339]A Colorado School of Public Health study based on three years of monitoring at Colorado fracking sites found a number of toxic petroleum

[335] (Kort, 2016) doi: 10.1002/2016GL068703
[336] (Lyon, 2016) doi: 10.1021/acs.est.6b00705
[337] (Oregon State University: Environmental Health Sciences Center, 2014) http://ehsc.oregonstate.edu/air/62PAH
[338] (Warneke, 2014) doi: 10.5194/acp-14-10977-2014
[339] (Thompson C. R., 2014) doi: 10.12952/journal.elementa.000035

hydrocarbon air pollutants near gas wells including benzene, ethylbenzene, toluene, and xylene. These air toxics are linked to neurological and respiratory diseases and cancer.[340]

Measured levels of air pollution associated with fracking are already alarming. Research suggests additionally that emissions and associated health risks have been grossly understated due to the extensive scope of fracking and the variable nature of fracking-caused emissions. Researchers with the Southwest Pennsylvania Environmental Health Project showed that methods do not adequately measure the intensity, frequency, or durations of community exposure to the toxic chemicals routinely released from drilling and fracking activities. They found that exposures may be underestimated by an order of magnitude, as mixtures of chemicals, local weather conditions, and vulnerable populations are not taken into account.[341]

Water Pollution

Contamination of water with toxic fracking fluids is widespread and well-documented in dozens and dozens of scientific studies. Contamination has affected rivers and streams, surface and groundwater, and many sources of drinking water. Hydraulic fracturing is exempt from key provisions of the Safe Drinking Water Act and fracking chemicals are protected from public scrutiny as trade secrets.[342] Known toxins can be legally injected into the ground near aquifers or directly into the aquifers themselves. Most states that host fracking operations do not require routine monitoring of groundwater aquifers near drilling and fracking operations.

The EPA's six-year, $29 million study on fracking and water resources documented in detail the widespread deleterious impacts on drinking water at each stage of the fracking process.[343] Contamination has resulted from spills of fracking fluid and fracking wastewater; discharge of fracking waste into rivers and streams; and underground migration of fracking chemicals, including gas, into drinking water wells. Depletion of aquifers caused by water withdrawals has also created water shortages.

According to an important compendium on fracking risks compiled by Physicians for Social Responsibility and Concerned Health Professionals of New York: "Repudiating industry claims of risk-free fracking, studies from across the United States present irrefutable evidence that

[340] (McKenzie L. M., 2012) doi: 10.1016/j.scitotenv.2012.02.018
[341] (Brown, 2014) doi: 10.1515/reveh-2014-0002
[342] (Physicians for Social Responsibility and Concerned Health Professionals of New York, 2018)
[343] (U.S. Environmental Protection Agency, 2016)

groundwater contamination occurs as a result of fracking activities and is more likely to occur close to well pads. In Pennsylvania alone, the state has determined that more than 300 private drinking water wells have been contaminated or otherwise impacted as the result of drilling and fracking operations over an eight-year period."[344] The U.S. Agency for Toxic Substances and Disease Registry (ATSDR), determined that the chemical contamination of some private water wells in Dimock, Pennsylvania rendered the water unsuitable for drinking.[345]

More than 1000 chemicals have been confirmed as ingredients in fracking fluid, including dozens of known reproductive and developmental toxins. In addition, fluids contain heavy metals, radioactive elements, brine, and volatile organic compounds (VOC), which pose additional threats to surface and groundwater.

A 2017 study cited in the compendium found that "spills of fracking fluids and fracking wastewater are common, documenting 6,678 significant spills over a period of nine years in four states alone. In these states, between two and sixteen percent of wells report spills each year. About five percent of all fracking waste is lost to spills, often during transport."[346] In some watersheds, widespread downstream contamination has occurred with radioactive elements, heavy metals, endocrine disruptors, and toxic disinfection byproducts, which alter the ecology and chemistry of water flows, with adverse effects on aquatic biodiversity and populations of sensitive fish species, such as brook trout.

Researchers in Texas found 19 different fracking-related contaminants—including cancer-causing benzene—in hundreds of drinking water samples collected from the aquifer overlying the heavily drilled Barnett Shale.[347] In Pennsylvania, a solvent used in fracking fluid was found in drinking water wells near fracking operations. The solvent is known to cause well casing problems.[348] In California, state regulators admitted that they had mistakenly allowed oil companies to inject drilling wastewater into aquifers containing clean, potable water.[349] A 2017 study found that fracking wastewater discharged into rivers and streams through treatment plants created dozens of

[344] (Physicians for Social Responsibility and Concerned Health Professionals of New York, 2018)
[345] (Agency for Toxic Substances and Disease Registry: CDC, 2016)
[346] (Physicians for Social Responsibility and Concerned Health Professionals of New York, 2018)
[347] (Hildenbrand, 2015) doi: 10.1021/acs.est.5b01526
[348] (Llewellyn, 2015) doi: 10.1073/pnas.1420279112/-/DC Supplemental
[349] (Long, 2015)

brominated and iodinated disinfection byproducts that are particularly toxic and "raise concerns regarding human health."[350]

The Pennsylvania Department of Environmental Protection determined that fracking wastewater that had leaked from a storage pit contaminated groundwater and rendered a natural spring used for drinking water in Greene County undrinkable.[351] In Arkansas, researchers found that water withdrawals for fracking operations can deplete streams, threaten drinking water supplies, damage aquatic life and impact recreation.[352] [353]

Using geochemical and isotopic tracers to identify the unique chemical fingerprint of Bakken region brines (the naturally occurring salty water that lies underground and is brought to the surface through fracking), a Duke University study found that accidental spills of fracking wastewater have contaminated surface water and soils throughout North Dakota where more than 9,700 wells have been drilled in the past decade.[354] Contaminants included salts as well as lead, selenium and vanadium. In the polluted streams, levels of contaminants often exceeded federal drinking water guidelines. Soils at spill sites showed elevated levels of radium. The study concluded that "inorganic contamination associated with brine spills in North Dakota is remarkably persistent, with elevated levels of contaminants observed in spill sites up to four years following the spill events." In a comment about this study, lead author and Duke University geochemist Avner Vengoshsaid, "Until now, research in many regions of the nation has shown that contamination from fracking has been fairly sporadic and inconsistent. In North Dakota, however, we find it is widespread and persistent, with clear evidence of direct water contamination from fracking."[355]

After residents complained about its foul taste, a 2016 study by Stanford University scientists determined that fracking fluids had contaminated the drinking water in the town of Pavillion, Wyoming.[356] Contaminants included the carcinogen benzene and neurotoxic toluene. In the Pavillion area, operators sometimes fracked directly into underground sources of water.[357]

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[350] (Liberatore, 2017) doi: 10.1021/acs.estlett.7b00468
[351] (Niedbala, 2018) https://observer-reporter.com/news/localnews/w-va-company-fined-million-for-violations-at-well-sites/article_cc1ce344-faec-11e7-84ca-076df3832f29.html
[352] (Entrekin, 2018) doi: 10.1021/acs.est.7b03304
[353] (American Chemical Society, 2018) https://www.sciencedaily.com/releases/2018/01/180131095656.htm
[354] (Lauer, 2016) doi: 10.1021/acs.est.5b06349
[355] (Nicholas School of the Environment, Duke University, 2016)
[356] (DiGiulio, 2016) doi: 10.1021/acs.est.5b04970
[357] (DiGiulio, 2016)

In an interview about the research, lead author DiGiulio said that his findings raise concerns about similar water pollution in other heavily fracked regions. "Pavillion isn't geologically unique in the West, and I'm concerned about the Rocky Mountain region of the U.S. The impact on [underground drinking water sources] could be fairly extensive. Pavillion is like a canary in a coal mine and we need to look at other fields."[358] Co-author Jackson noted, "There are no rules that would stop a company from doing this anywhere else."[359]

Other potential health impacts of water contamination from fracking include pre-term birth, pregnancy complications and childhood cancer. West Virginia researchers found endocrine-disrupting chemicals in surface waters near wastewater disposal sites.[360] [361] These types of chemicals can hurt the developing fetus even when present at very low concentrations. A Johns Hopkins study looked at records of 9,384 women with newborns who lived near fracking sites and found a 40% increased chance of having a premature baby and a 30% risk of having the pregnancy be classified as "high-risk".[362] Premature babies accounted for 35% of infant deaths and prematurity is a known cause of life-long disabilities.

A Yale team identified 55 known or possible carcinogens that may be released into air and water from fracking operations. Of these, 20 are linked to leukemia or lymphoma.[363] A 2017 Colorado study found higher rates of leukemia among both children and young adults living in areas dense with gas and oil wells.[364]

Each frack uses about 25,000 gallons of chemicals, including known human carcinogens, neurotoxins, and endocrine disrupting chemicals which contaminate water and soil. Table 9 is a partial list of commonly used chemicals and their health effects.[365]

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[358] (Banerjee, 2016) https://insideclimatenews.org/news/29032016/fracking-study-pavillion-wyoming-drinking-water-contamination-epa
[359] (Jordan, 2016) http://news.stanford.edu/2016/03/29/pavillion-fracking-water-032916/
[360] (Kassotis, 2016) doi: 10.1016/j.sci.tenv.2016.03.113
[361] (Bienkowski, 2016) http://www.environmentalhealthnews.org/ehs/news/2016/april/in-w.-virginia-frack-wastewater-may-be-messing-with-hormones
[362] (Casey, 2016) doi: 10.1097/EDE.0000000000000387
[363] (McKenzie L. M., Childhood hematologic cancer and residential proximity to oil and gas development, 2017) doi: 10.1371/journal.pone.0170423
[364] (Elliot, 2017) doi: 10.1016/j.scitotenv.2016.10.072
[365] (U.S. Department of Energy)

Table 10: Hydraulic Fracturing Chemicals

Chemical	Type of Additive	Why Used	Non-fracking Uses	Health Problems
Hydrochloric (muriatic acid)	Acid	helps dissolve rock, and make cracks	swimming pool chemical, toilet bowl cleaner	severe burns to skin, GI and respiratory tract
Polyacrylamide	Reduces friction	minimizes friction in the pipes	water treatment, soil conditioner	nervous system damage, carcinogen
Methanol	Corrosion inhibitor	prevents corrosion; winterizing agent	used as solvent and in biodiesel	wood alcohol--can cause blindness and death
Ethylene glycol	Scale inhibitor	prevents scale in pipes	anti-freeze	poisonous
Glutaraldehyde	Biocide	kills bacteria that might be corrosive to pipes	disinfecting medical equipment	commonly causes throat and lung irritation, and asthma
n,n-Dimethyl formamide	Corrosion inhibitor	prevents pipe corrosions	plastics	liver damage, high blood pressure
Isopropanol	Surfactant	increases viscosity of the fluid	rubbing alcohol, glass cleaner	contact irritation, headache, dizziness
Ammonium persulfate	Breaker	delays breakdown of polymer chains	bleaching, plastics mfg.	respiratory distress, burning on contact

Noise Pollution

A review analyzing the relevant scientific literature on the potential public health impacts of ambient noise related to unconventional (fracked) oil and gas development found that “oil and gas activities produce noise at levels that may increase the risk of adverse health outcomes, including

annoyance, sleep disturbance, and cardiovascular disease." The review included focus on vulnerable populations, including children, the elderly, and the chronically ill.[366]

In California, noise from well stimulation was associated with both sleep disturbance and cardiovascular disease in a dose-response relationship (the louder the noise, the greater the adverse effect).[367]

In cooperation with The Colorado Oil and Gas Conservation Commission, researchers at Colorado State University performed area noise monitoring at 23 oil and gas sites throughout Northern Colorado. Current noise mitigation strategies reduced noise levels. However, the reduction was not sufficient to reduce the noise below the residential permissible noise level (55 dBA).[368]

Human-caused Disasters

The fracking process itself has been shown to increase seismicity and precipitate earthquakes in communities near drilling sites.[369] Scientists have linked surges in gas production and injections of wastewater, a key part of the fracking process, to earthquakes with magnitudes as high as 5.8 in Ohio, Arkansas, Texas, Oklahoma, Kansas, and Colorado, states with significant fracking operations.[370] Both the U.S. Geological Survey (USGS) and state geological agencies such as the Oklahoma Geological Survey now acknowledge that earthquakes can be caused by wastewater injection. Emerging evidence suggests that risk of earthquakes can continue to rise for years after waste injection and cannot be prevented through "proper" fracking protocols or by solely limiting the rate or volume of injected fluid.[371]

[366] (Hays, 2016) doi: 10.1016/j.scitotenv.2016.11.118 (Shonkoff S. B., 2015)
[367] (Shonkoff S. B., 2015) http://ccst.us/publications/2015/vol-II-chapter-6.pdf
[368] (Radtke C., 2017) doi: 10.1080/15459624.2017.1316386
[369] (Physicians for Social Responsibility and Concerned Health Professionals of New York, 2018)
[370] (Physicians for Social Responsibility and Concerned Health Professionals of New York, 2018)
[371] (Physicians for Social Responsibility and Concerned Health Professionals of New York, 2018)

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regional/montana/north-dakota-hiv-aids-rate-rises-with-population- growth/article_a939fed6-f737-5cfb-957f-ab800673f4d7.html
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APPENDIX I: METHANE GAS BASICS

So-called "natural" gas is a fossil fuel formed by forces acting on organic material trapped deep beneath the surface of the earth. It is widely used for household heating and cooking, to generate electricity, and as feedstock to produce various chemicals and materials.

Fracked gas is both highly flammable and explosive.[372] In a confined space, such as a tank or a pipeline, and when combined with oxygen, fracked gas becomes explosive. It will burn when oxygen concentrations reach five to fifteen percent. It burns extremely hot, at a temperature of 3500° F. Exposure to fracked gas in a confined space will also cause asphyxiation.[373] For this reason, the odorless gas is often artificially odorized to facilitate detection.

Up to 95% of fracked gas is composed of methane, a colorless, odorless, and highly flammable gas. Methane is one of the most ubiquitous organic compounds on earth and is present in the air we breathe. Compared to oil and coal, methane burns more cleanly, emitting virtually no nitrous oxide, sulfur dioxide, particulate matter or other pollutants. For this reason, it is often cited as a clean energy source and a bridge fuel to renewable energy, a judgment that fails to take into account the GHG effects of methane.[374]

Methane is generated and released into the atmosphere through both human activity, such as the fossil fuel industry, landfills and manure management systems, and natural or biogenic processes such as animal digestion and fermentation in oxygen-poor environments like wetlands. Human caused activity accounts for 50-65% of total U.S. emissions of methane per year.[375] The fossil fuel industry alone accounts for 39% of emissions.[376]

Gas Extraction

Natural gas is extracted through both conventional and unconventional processes. In conventional production, wells are dug into underground basins where the gas has collected in large volumes and simply flows out through the well. Unconventional production is used to extract gas that is trapped in coal beds, sand or shale in tiny pockets or fissures. In hydraulic fracturing, or fracking, large volumes of water are mixed with sand and various chemicals and injected into wells

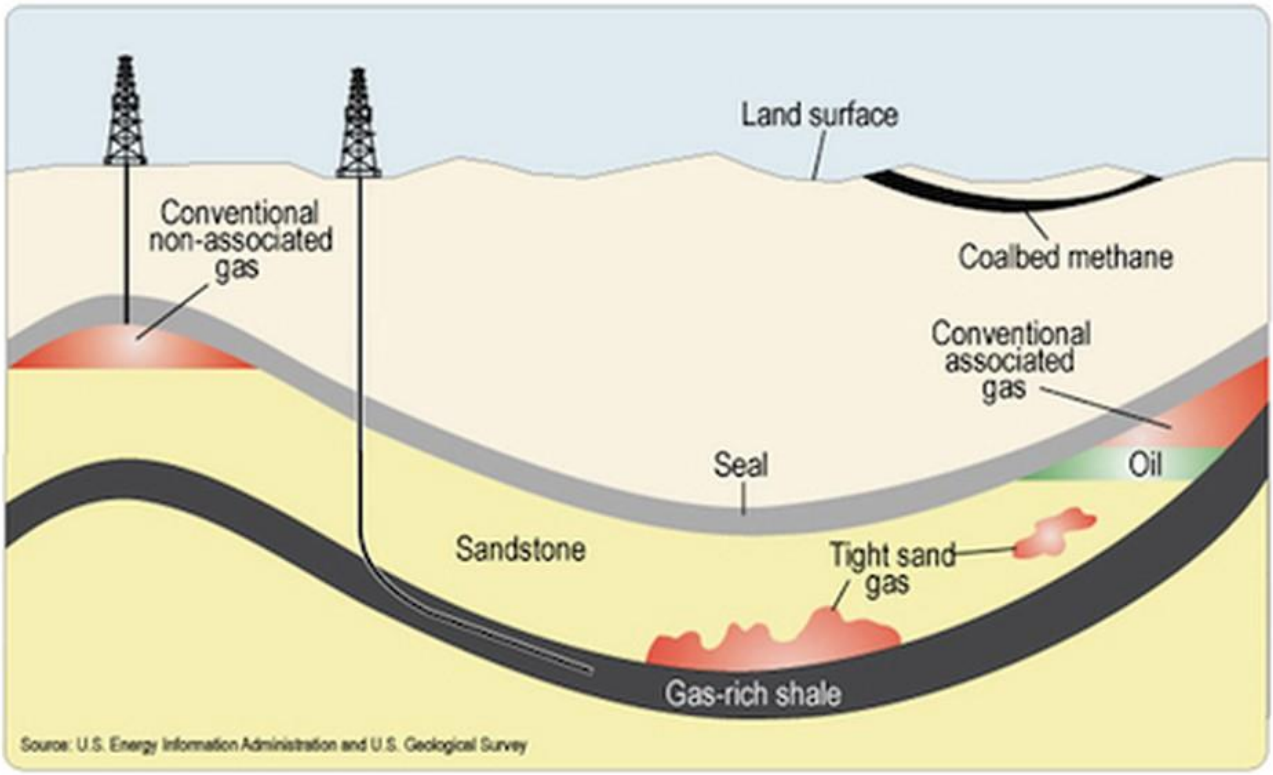
[372] (U.S. Department of Transportation, 1995)
[373] (U.S. Department of Transportation, 1995)
[374] (Stockman, Burning the Gas 'Bridge-fuel' Myth, 2017)
[375] (Miller S. M., 2013)
[376] (U. S. Environmental Protection Agency)

at high pressure to fracture or split apart the material in which the gas is embedded. This allows the gas to escape. Coal bed extraction, also an unconventional process but distinct from fracking, usually involves pumping water out of the coal bed which releases the trapped gas, but may also involve pumping chemical- and sand-laced water into the well, before pumping it back out again to release the gas.

Figure 15 illustrates some of the differences in gas extraction processes.

Figure 15

Methane Gas Deposits



Today two-thirds of gas comes from fracking, a proportion that continues to rise.[377] Although the corporate entities behind the proposed gas infrastructure in Oregon and Washington cannot specify with any certainty, it is expected that the vast majority of the gas supplied to any new facilities in Oregon and Washington would be fracked gas from both the U.S. and Canada.

[377] (U.S. Energy Information Administration, 2018)

Greenhouse Gas Emissions and Global Warming Potential

Methane is the second most abundant GHG[378] after carbon dioxide (CO_2) and accounts for one-third of human-caused global GHG warming.[379] Methane is much more effective at trapping heat than CO_2, but while CO_2 persists in the atmosphere for millennia, methane degrades into CO_2 over about twelve years.

Global warming potential (GWP) is a metric which was developed to compare the GHG effects of different gases over time compared to the same amount of CO_2. A 2018 report from the Intergovernmental Panel on Climate Change (IPCC) estimates methane's 20-year GWP value at 86 and 100-year GWP at 34.[380] This means that a single molecule of methane traps 86 times more heat than a single molecule of CO_2 over a 20-year time period. Because of its rapid degradation compared to CO_2, its GWP is less when measured over a 100-year time frame.

When assessing the impact of a fracked gas facility on global warming it is critical to perform a lifecycle analysis. This analysis examines not just GHG emissions from the operation of the facility itself, but also the upstream extraction and pipeline transmission of the gas, the downstream export of the gas and the final use of the gas at its destination.[381]

Methane emissions are both unintentional (fugitive) and intentional, such as flaring and venting. Gas companies are not legally required to report their rates of fugitive emissions, but multiple independent environmental scientists have studied the problem. The most recent peer-reviewed analysis of fugitive emissions from U.S. gas production identifies an average methane leakage rate of 2.3%.[382]

Liquefied Natural Gas

Natural gas can be liquefied in order to render it more compact and safer to store and transport. When cooled to -260° F the gas becomes a liquid and its volume contracts 600 times. When contained, liquefied natural gas (LNG) is neither flammable nor explosive. Structural failure of equipment, however, can result in human injury from exposure to extremely cold temperatures.[383]

[378] (U. S. Environmental Protection Agency)
[379] (Powell T. , Methane's 20- and 100-Year Climate Effect is Like 'CO2 on Steroids', 2019)
[380] (Intergovernmental Panel on Climate Change, 2018)
[381] (Powell T. , Studying Full Methane Life Cycle Critical to PNW Climate Policy, 2019)
[382] (Alvarez, 2018)
[383] (U.S. Department of Transportation, 1995)

When LNG leaks or spills, it pours onto the ground like a liquid, but as soon as it warms a few degrees it re-gasifies into a vapor cloud, which slowly rises from the ground as it warms and begins to mix with oxygen. It can then explode into a fireball.

APPENDIX II: THE SOCIAL DETERMINANTS OF HEALTH

Communities in Oregon and Washington that are most susceptible to the adverse effects of climate change include communities of color, immigrants, low income persons and the houseless. These communities already bear a disproportionate burden of sickness and premature death (health outcome disparities) related to a long history of systematic socioeconomic deprivation. They very often bear the additional burden of living in unhealthy environments that are poorly prepared to withstand adverse climate events.

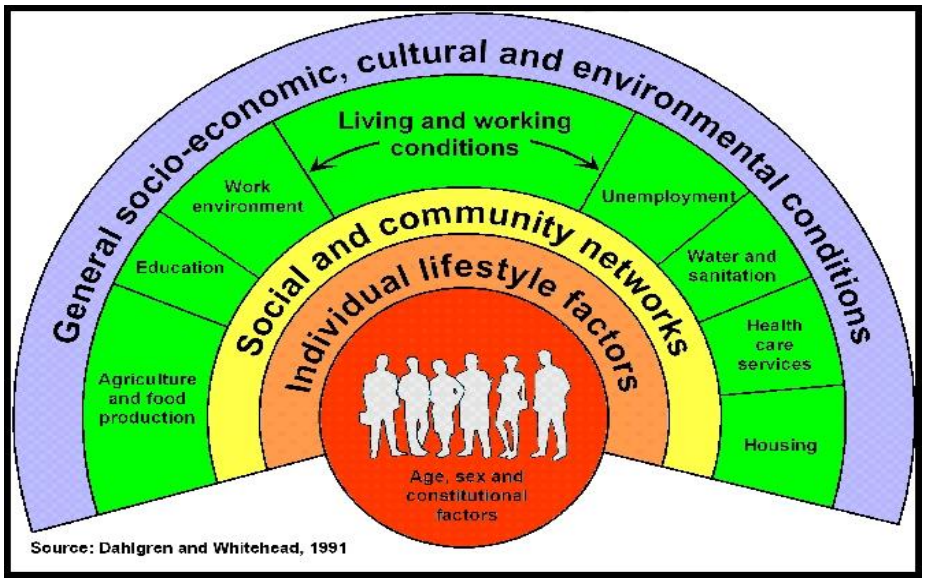
The most important drivers of these health outcome disparities are the social determinants of health.[384] [385] These include factors such as low education, unemployment, lack of access to health care, exposure to industrial pollutants and toxins, substandard housing, racism, poor social cohesion and political disenfranchisement. Socioeconomic status alone (defined by income and education) is a potent predictor of health outcomes.[386]

Health outcomes are determined by a complex interplay between individual and social factors. The most widely accepted model is represented in Figure 16, which is adapted from the 1991 paper for the World Health Organization on the social determinants of health by Dahlgren and Whitehead.[387]

[384] (Adler, 2002)
[385] (Marmot, 2007)
[386] (Adler, 2002)
[387] Dahlgren and Whitehead, "Policies and Strategies to Promote Social Equity in Health."

Figure 16

Social Determinants of Health



Social and economic factors account for more than two-thirds of health outcomes.[388] If disparities in social determinants were eliminated, disparities in health outcomes would be wiped out as well. In other words, differences in health cannot be explained away by differences in biological factors (age, gender or genetics) between those who are white alone, formally educated, financially secure and living in healthy environments and those who are not. Some researchers estimate that social, political and environmental conditions have a greater impact on well-being and longevity than either clinical care or individual behavior.[389]

Adverse impacts of climate change are a threat multiplier. They tend to stress most those communities already environmentally, socially and economically stressed. The Fourth National Climate Assessment (NCA4) noted that reducing greenhouse gas emissions would benefit the health of Americans not only in the long term, but also in the short run.[390] The co-benefits of climate change mitigation are detailed in a report by Washington Physicians for Social Responsibility.[391]

Communities can be characterized by their physical and social conditions and access to services. In a healthy community, housing units are in good repair, free of mold, vermin, lead paint and other toxics, and adequately heated and cooled. Litter, graffiti and vandalism are absent. The

[388] Schroeder, "We Can Do Better: Improving the Health of American People."
[389] Hernandez and Blazer, "The Impact of Social and Cultural Environment on Health."
[390] (Ebi, 2018)
[391] (Vossler M. , Thomas, Kitchell, Idzerda, & Cornett, 2018)

neighborhoods include common spaces, green spaces and an ample tree canopy. Bikeways, walkways and parks are safe and easy to access. The air and water are free of pollutants. Health clinics, schools, healthy food outlets and public transportation are all nearby. The neighbors know each other, trust each other and are willing to help out. Residents tend to remain in the neighborhood over a span of years. Crime rates are low and civic engagement is high. People are more likely to volunteer and more likely to vote.

A growing body of literature supports the hypothesis that living in a healthy neighborhood promotes mental and physical health and longevity and that poor conditions increase morbidity and premature mortality.[392] Improving neighborhood conditions has salutary effects on both mental and physical health.

[392] (Srinivasan, O'Fallon, & Dearry, 2003)

APPENDIX III: WATERSHEDS IN OREGON AFFECTED BY PCGP

The Pacific Connector Gas Pipeline would require blasting and clearcutting a 75 to 95-foot right-of-way across steep terrain and through soils with high potential for erosion and landslides. It would remove trees and streamside vegetation along more than 485 Oregon streams and rivers. It would warm waters and introduce nutrients, increasing the risk of Harmful Algae Blooms (HAB). It would also increase the risks of human-caused fire and wildfire.

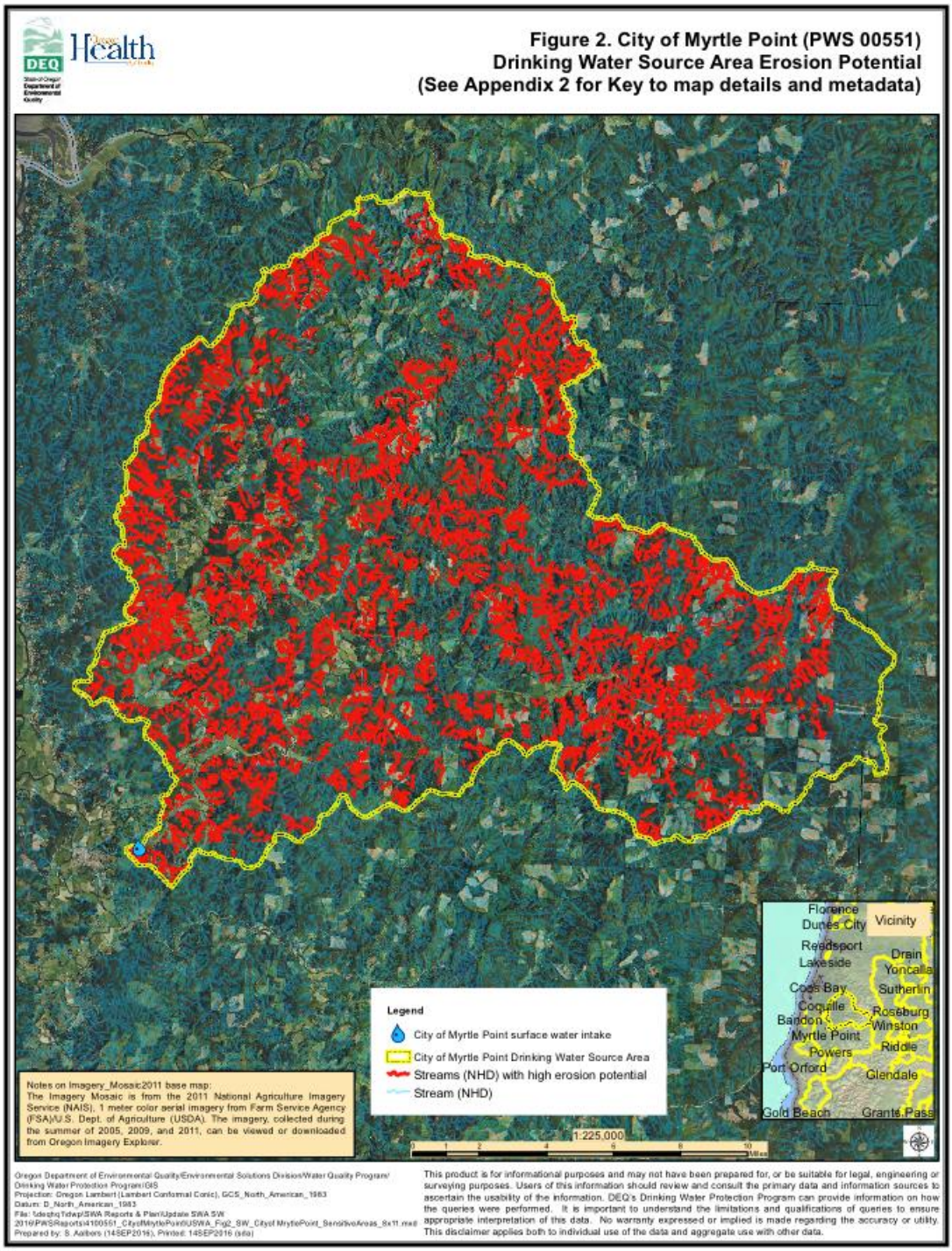
Watersheds that would be degraded by this project include, but are not limited, to those that provide water to the City of Coquille, Myrtle Point, Myrtle Creek, Medford, Eagle Point, Central Point, Jacksonville, Phoenix, Talent, Shady Cove, Anglers Cove, Tri-City JW and SA, Clarks Branch Water Association, Country View MH Estates, Lawson Acres Water Association, Glendale, Roseburg Forest Products – Dillard, Winston Dillard Water District, Tiller Elementary School, Latgawa Methodist Church Camp, Milo Academy, and Lake Creek Learning Center. Over 156,750 Oregonians rely on safe drinking water from these systems.

Many of these systems are already sensitive to contaminants of concern, including risk of erosion, turbidity, microbiological contamination, and harmful algal blooms. Many have already invested in expensive technology to clean and disinfect water.

The map below demonstrates the drinking watershed for Myrtle Point, one of the many areas in SW Oregon that is susceptible to elevated erosion potential from ground disturbance and vegetation removal and would face increased risk with construction and operation of the Pacific Connector Gas Pipeline. Steep slopes are identified for 117 miles of the proposed pipeline. 94 miles of the pipeline would be located in soils with high or severe erosion potential. Maps at this fine scale for specific watersheds are available from Oregon DEQ. Erosion leads to increased turbidity levels which can present costly challenges for human health, water treatment and water delivery.

Figure 17

City of Myrtle Point, Oregon: Drinking Water Source Area Erosion Potential



Below are excerpts from Oregon DEQ/Oregon Health Authority Source Water Assessments and/or information published by municipal water providers. Description of watersheds include sensitive areas and potential sources of contamination. In many cases they include potential pollutants from erosion and landslides, high soil permeability, stream miles in erodible soils, high soil erosion potential present, shallow landslide potential and landslide deposits. It is staggering to contemplate the damage that could be done by this massive project, the Pacific Connector Gas Project.

Medford Water Commission (PWS 4100513) provides water to Medford and provides wholesale water to cities of Eagle Point, Central Point, Jacksonville, Phoenix, Talent and the Lake Creek Learning Center

Source: Rogue River and Big Butte Springs
Jackson County
Serves 131,867 (includes those served by wholesale customers)

Oregon DEQ/Oregon Health Authority (OHA) Updated Water Source Assessment demonstrates:

A. Potential Pollutants: 8 hr time of travel in Drinking Water Source Area with 203 stream miles

- Stream miles in erodible soils: *156*
- High Soil Erosion Potential: *77%*
- Shallow Landslide Potential: S*ee DEQ*
- Landslide Deposits: *limited areas throughout watershed* include earth and debris slides, flows, slumps, falls and complex landslide types. (Does not include rock material landslide deposits.)

B. Potential Pollutants: Full Surface Drinking Water Source Area with 6,909 stream miles

- Stream miles in erodible soils: *5,244*
- High Soil Erosion Potential: *76%*
- Shallow Landslide Potential: *See DEQ*
- Landslide Deposits: *areas throughout watershed* include earth and debris slides, flows, slumps, falls and complex landslide types. (Does not include rock material landslide deposits.)

Potential Harmful Algae Bloom (HAB) **risk criteria/factors identified in Medford's Drinking Water Source Area** by DEQ in June 2018:

- Previous HAB Advisory
- DEQ Water Quality Limited Listing indicating the waterbody needs TMDL for Algae and aquatic weeds, pH, dissolved oxygen
- OHA DWS sampling location for cyanobacteria toxin (2011-2017)
- Waters of potential concern for HAB

C. Groundwater wells: Drinking water source area 88.68 acres

City of Coquille (PWS 4100213)

Source: Coquille River

Serves 3,866 people

Potential pollutants from erosion and landslides (See Table 1: Drinking Water Source Area Land Use and Susceptibility Analysis Summary from DEQ 2016 Source Water Assessment):

- Stream miles in erodible soils: *1,488.69* (Coquille River) *4.74* (Rink Creek)
- High Soil Erosion Potential: *41.4%* (Coquille River) *99.6* (Rink Creek) (% stream miles with high erosion located within 300' of stream)
- Shallow Landslide Potential: S*ee DEQ*
- Landslide Deposits: *Multiple landslide deposits are present* and points are mapped throughout the Coquille watershed; Limited landslide/deposit near Rink Creek intake

Potential Harmful Algae Blooms (HAB) **risk criteria/factors identified in City of Coquille's Drinking Water Source Area** by DEQ in June 2018:

- DEQ Water Quality Limited Listing indicating the waterbody needs TMDL for Dissolved Oxygen, Chlorophyll-A
- Multiple Water Quality Listings (Source: OR DEQ Water Quality Assessment (DEQ/WQ - 10/31/2014) and DEQ Source Water Assessment 2016)

Myrtle Point (PWS 4100551)
Source: North Fork Coquille River
Serves 2,600 people

DEQ/OHA Source Water Assessment 2016 (excerpts):

Potential Pollutants: 8 hr time of travel in Drinking Water Source Area with 203 stream miles

- Stream miles in erodible soils: *1,011.54*
- High Soil Erosion Potential: *47%* (% stream miles with high erosion located within 300' of stream)
- Shallow Landslide Potential: *See DEQ*
- Landslide Deposits: *Multiple landslide deposits are present* and points are mapped throughout the watershed

Potential Harmful Algae Bloom (HAB) **risk criteria/factors identified in Myrtle Point's Drinking Water Source Area** by DEQ in June 2018:

- DEQ Water Quality Limited Listing indicating the waterbody needs TMDL for Dissolved Oxygen
- Sampling point for cyanobacteria toxin (2011-2017) Multiple rivers and streams are already listed as Water Quality Limited (See Water Quality Analysis 10.31.2014)

Winston Dillard Water District (PWS 4100957)
Source: South Umpqua River
Douglas County
Serves 8,000 people

DEQ Source Water Assessment 2003 (excerpts):

There are eleven other public water systems located upstream of the Winston-Dillard intake that obtain their drinking water from the South Umpqua River or its tributaries. This source water assessment addresses the geographic area providing water to Winston-Dillard's intake (Winston Dillard's portion of the drinking water protection area) between Winston-Dillard's intake and the next upstream intake for Roseburg Forest Products.

Risks for the system, according to the Water Summary Brochure: A total of 36 potential contaminant sources were identified in Winston-Dillard's drinking water protection area. 0f these, 34 are located in the sensitive areas and 29 are high-to- moderate risk sources within "sensitive areas". *The sensitive areas within the Winston- Dillard drinking water protection area include areas with high soil permeability, high soil erosion potential, high runoff potential and areas within 1000' from the river/streams. The sensitive areas are those where the potential contamination sources, if present, have a greater potential to impact the water supply.*

Potential Harmful Algae Bloom (HAB) **risk criteria/factors identified in Winston- Dillard's Drinking Water Source Area by** DEQ in June 2018:

- Previous HAB Advisory
- DEQ Water Quality Limited Listing indicating the waterbody needs TMDL for Algae and aquatic weeds, Chlorophyll-A, pH, Dissolved Oxygen
- OHA DWS sampling location for cyanobacteria toxin (2011-2017)

Roseburg Forest Products-Dillard (PWS 4194300)
Source: South Umpqua River
Douglas County
Serves 2,000 people

From 2003 Source Water Assessment Summary Brochure (excerpts):

RISKS FOR THE SYSTEM:

A total of 18 potential contaminant sources were identified in Roseburg Forest Products' drinking water protection area. Of these, 17 are located in the sensitive areas and 14 are high-to-moderate risk sources within "sensitive areas". *The sensitive areas within the Roseburg Forest Products drinking water protection area include, but are not limited to, areas with high soil permeability, high soil erosion potential, high runoff potential and areas within 1000' from the river/streams. The sensitive areas are those where the potential contamination sources, if present, have a greater potential to impact the water supply.*

Potential Harmful Algae Bloom (HAB) **risk criteria/factors identified in Roseburg Forest Products - Dillard Drinking Water Source Area** by DEQ in June 2018:

- Previous HAB Advisory
- DEQ Water Quality Limited Listing indicating the waterbody needs TMDL for Algae and aquatic weeds, Chlorophyll-A, pH, Dissolved Oxygen

Clarks Branch Water Association (PWS 4100548)
Source: South Umpqua River
Douglas County
Serves 140 people

DEQ Water Source Assessment Summary Brochure 2003 (excerpts):

RISKS FOR THE SYSTEM:

A total of 36 potential contaminant sources were identified in Clarks Branch's drinking water protection area. Of these, 35 are located in the sensitive areas and 32 are high-to- moderate risk sources within "sensitive areas." (Maps are available from the 2003 Source Water Assessment.) *The sensitive areas within the Clarks Branch drinking water protection area include, but are not limited to, areas with high soil permeability, high soil erosion potential, high runoff potential and areas within 1000' from the river/streams. The sensitive areas are those where the potential contamination*

sources, if present, have a greater potential to impact the water supply.

Potential Harmful Algae Bloom (HAB) risk criteria/factors identified in Clarks Branch Drinking Water Source Area by DEQ in June 2018:

- Previous HAB Advisory
- Water Quality Limited Listing indicating the waterbody needs TMDL for Algae and aquatic weeds, Chlorophyll-A, pH, dissolved oxygen
- Waters of potential concern for HAB

Tri-City JW and SA (PWS 4100549)
Source: South Umpqua River Douglas County
Serves 3,500
Number of connections: 1,500

DEQ Source Water Assessment 2003 (excerpts):

RISKS FOR SYSTEM:

A total of 40 potential contaminant sources were identified in Tri-City Water District's drinking water protection area. Of these, 37 are located in the sensitive areas and 32 are high- to moderate-risk sources within "sensitive areas". *The sensitive areas within the Tri-City Water District drinking water protection area include, but are not limited to, areas with high soil permeability, high soil erosion potential, high runoff potential and areas within 1000' from the river/streams. The sensitive areas are those where the potential contamination sources, if present, have a greater potential to impact the water supply.*

Potential Harmful Algae Bloom (HAB) **risk criteria/factors identified in Tri-City JW and SA Drinking Water Source Area** by DEQ in June 2018:

- Previous HAB Advisory
- DEQ Water Quality Limited Listing indicating the waterbody needs TMDL for Algae and aquatic weeds, Chlorophyll-A, pH, dissolved oxygen
- OHA DWS sampling location for cyanobacteria toxin (2011-2017)

Hiland Water Co. Shady Cove (PWS 4101520)
Source: Rogue River
Serves 975 people
Due to the close proximity of intakes on the Rogue River, the following April 24, 2018 assessment of Anglers Cove/SCHWC addresses Hiland Water Co. Shady Cove.

Anglers Cove/SCHWC (PWS 01483)
Source: Rogue River
Jackson County
Serves 80 people

DEQ/OHA Source Water Assessment April 24, 2018 (excerpts):

Due to the close proximity of intakes on the Rogue River, this assessment addresses Anglers Cove/SCHWC and Hiland Water Co. Shady Cove.

Country View Mobile Home Estates also has an intake on the Rogue River upstream of these intakes and there are a number of public water systems downstream that also depend on Rogue River for their drinking water. For watersheds with more than one intake such as the Rogue Subbasin, all protection areas for intakes upstream of the water system's intake are included in their drinking water source area. Activities and impacts in upstream drinking water protection area also have the potential to impact downstream water users.

A. Potential Pollutants: 8 hour Time of Travel for Drinking Water Source Sub-Basin of Rogue

- Drinking Water Source Area: *219 sq. mi*
- Stream Miles in Drinking Water Source Area: *1,288*
- Stream Miles in Erodible Soils: *1,227*
- High Soil Erosion Potential Percent: *96%* (% stream mi with high erosion located w/in 300' of stream)
- Shallow Landslide Potential: *See DEQ*
- Landslide Deposits: *Limited areas throughout watershed* includes earth and debris slides, flows, slumps, falls and complex landslide types. (Does not include rock material landslide deposits.)

B. Full Source Water Source Area Rogue Basin upstream of intake

- Drinking Water Source Area: *6,229 sq. mi*
- Stream Miles in Drinking Water Source Area: *4,717*
- Stream Miles in Erodible Soils: *3,558*
- High Soil Erosion Potential Percent: 75% (% stream mi with high erosion located w/in 300' of stream):
- Shallow Landslide Potential: *See DEQ*
- Landslide Deposits: *Limited areas throughout watershed* includes earth and debris slides, flows, slumps, falls and complex landslide types. (Does not include rock material landslide deposits.)

Potential Harmful Algae Bloom (HAB) **risk criteria/factors identified in Hiland Water Co. Shady Cove and Anglers Cove/SCHWC Drinking Water Source Area** by DEQ in June 2018:

- Previous HAB Advisory
- DEQ Water Quality Limited Listing indicating the waterbody needs TMDL for Algae and aquatic weeds, pH

Country View Mobile Home Estates (PWS #4100808)

Source: Rogue River plus a well
Jackson County
Serves 132 people

Oregon Source Water Assessment Report (excerpts):

In the Country View Mobile Home Estates watershed, the results of the susceptibility "analysis" include the distribution of 22 identified *high-to-moderate risk sources within the areas of highly permeable soils, high erosional soils, high runoff potential soils, and within the 1000' setback from the streams.*

A. Potential Pollutants: 8 hr time of travel in Drinking Water Source Area

- Stream miles in Drinking Water Source Area: 1,334
- Watershed Source Area: 227.86 sq mi
- High Soil Erosion Potential: *95%*
- Shallow Landslide Potential: *See DEQ*
- Landslide Deposits: *Limited areas throughout watershed* includes earth and debris slides, flows, slumps, falls and complex landslide types. (Does not include rock material landslide deposits).

B. Potential Pollutants: Full Surface Drinking Water Source Area

- Watershed Source Area: *1,146.6 sq mi*
- Stream miles in Drinking Water Source Area: *4,613*
- Stream miles in erodible soils: *3,156*
- High Soil Erosion Potential: *68%*
- Shallow Landslide Potential: *See DEQ*
- Landslide Deposits: *Limited areas throughout watershed* includes earth and debris slides, slumps, falls, and complex landslide types. (Does not include rock material landslide deposits).
- Well Protection Area: *0.51 sq mi*

Excellent maps are available in DEQ's Updated Water Source Assessment (April 2018).

Potential Harmful Algae Bloom (HAB) **risk criteria/factors identified in Country View MH Estates Drinking Water Source Area** by DEQ in June 2018:

- Previous HAB Advisory
- DEQ Water Quality Limited Listing indicating the waterbody needs TMDL for Algae and aquatic weeds, pH, dissolved oxygen
- OHA DWS sampling location for cyanobacteria toxin (2011-2017)
- Waters of potential concern for HAB

Tiller Elementary, SD #15 (PWS 4192139)
Source: South Umpqua River
Serves: 60 people

DEQ Source Water Assessment Summary 2003 (excerpts):

RISKS FOR THE SYSTEM:

A total of eighteen potential contaminant sources were identified in Tiller Elementary's drinking water protection area. Sixteen of these are located in the sensitive areas and twelve are high-to-moderate risk sources within "sensitive areas". *The sensitive areas within the Tiller Elementary drinking water protection area include areas with high soil permeability, high soil erosion potential, high runoff potential and areas within 1000' from the river/streams. The sensitive areas are those where the potential contamination sources, if present, have a greater potential to impact the water supply.*

City of Glendale (PWS 4100323)
Source: South Umpqua Subbasin: Cow Creek (permanent), Mill Creek (emergency), Section Creek (emergency)
Douglas County
Serves 872 people

2003 Source Water Assessment (excerpts):

The drinking water for the City of Glendale is supplied by three intakes located on Cow Creek, Mill Creek and Section Creek.

RISKS FOR THE SYSTEM:

A total of 45 potential contaminant sources were identified in City of Glendale's drinking water protection area. All of these are located in the sensitive areas and 40 are high-to- moderate risk sources within "sensitive areas". *The sensitive areas within the City of Glendale drinking water protection area include areas with high soil permeability, high soil erosion potential, high runoff potential and areas within 1000' from the river/streams. The sensitive areas are those where the potential contamination sources, if present, have a greater potential to impact the water supply.*

Potential Harmful Algae Bloom (HAB) **risk criteria/factors identified in Glendale's Drinking Water Source Area** by DEQ in June 2018:

- DEQ Water Quality Limited Listing indicating the waterbody needs TMDL for Dissolved Oxygen

Additional Threats to Drinking Water

Applications of herbicides, including picloram, to clear and maintain a right-of-way free of vegetation on and near the pipeline route increase risks to safe drinking water.

Picloram, in particular, is quite persistent in the environment. According to the EPA:[393]

- Picloram has a high potential to contaminate surface water by runoff from use areas.
- Picloram is highly soluble in water, resistant to biotic and abiotic degradation processes, and mobile under both laboratory and field conditions. It is stable to hydrolysis and anaerobic degradation, and degrades very slowly with half-lives ranging from 167 to 513 days.
- Eventual contamination of groundwater is virtually certain in areas where picloram residues persist in the overlying soil. Once in groundwater, picloram is unlikely to degrade, even over a period of several years.

[393] (U.S. Environmental Protection Agency, 1995)