Position Statement on Crude Oil Transport and Storage

To Governors of Washington & Oregon

From Concerned Washington & Oregon Health Care Professionals*

Energy companies have proposed increases in oil-by-rail transport and storage in the states of Washington and Oregon with subsequent ocean shipments from Pacific Northwest ports. While there was no movement of oil-by-rail in Washington three years ago, dramatic increases in oil extraction from the Bakken fields in North Dakota and Montana and from Canadian oil/tar sands have occurred with significant increases in oil-by-rail traffic. If current proposals are allowed to proceed, the volume of oil-by-rail coming into Washington would increase from the current 19 trains per week to as many as 137 trains per week, each about 1.5 miles long. Each would carry approximately 2.9 million gallons of volatile crude to be stored, in some cases refined, and then exported to other states. This is a larger daily volume than would flow through the proposed Keystone XL pipeline. Trains also carry Bakken oil through Oregon to California, and barges carry it from Oregon ports on the Columbia River to Washington and California refineries via the Pacific Ocean. If the federal crude oil export ban were lifted, the number of crude-by-rail trains and barges traveling through Washington and Oregon could increase significantly more than currently projected.

The known risks associated with oil-by-rail transport, oil tank storage, and oil export by vessel pose an unacceptable threat to human health and safety. As concerned Washington and Oregon health care professionals, we are deeply troubled by the public health and safety impacts of these proposals.

A thorough review of data published in peer-reviewed medical journals and other reliable sources is summarized below, and the findings are discussed in greater detail in Appendices A-F.

* Statement prepared by Washington & Oregon Physicians for Social Responsibility, released February 2015

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Summary of Major Risks

Major health risks of the proposed oil-by-rail transport, storage, and vessel export in Washington and Oregon include:

1) Delay of emergency vehicles (See Appendix A, Appendix B)

- Proposed routes in WA could cause emergency services delays in up to 93 towns and cities;[114] and
- In Oregon, 88 communities currently have at-grade crossings over which unit oil trains operate.[77]

2) Oil rail car fires, spills, explosions and derailments (See Appendix A)

- Bakken crude is more volatile and flammable than most other crude oil;[88]
- Most is carried in hazardous tank cars (DOT-111s) prone to puncture, spills and fires in train accidents;[23, 73]
- Nine significant train derailments have occurred in North America since July 2013,[114] one of which resulted in multiple fatalities and injuries;
- Between June 2011 and December 2013, train derailments occurred on average every 3.5 days in the Northwest;[27]
- Three million Washington residents and more than half a million Oregon residents live within a recommended evacuation zone as defined by the US Department of Transportation;[108, 114] and
- Rescue and cleanup crews face risks of toxic exposures, in addition to risks of fires. (See number 5 below)

3) Adverse health impacts of train noise (see Appendix A)

- Train noise in populated areas is associated with significant sleep disturbance;[1]
- Increased cardiovascular events including myocardial infarction and arrhythmia are associated with nighttime noise and noise exposure greater than 90 decibels (in the range of train horns);[95,100] and
- Adverse cognitive performance and increased psychiatric illness have been observed in children exposed to noise.[45]

4) Oil storage tank spills, fires and explosions (See Appendix B)

- Major fires and explosions of petroleum products have occurred at storage terminals within the past 10 years (e.g., Hertfordshire, England, 2005; Raleigh, Mississippi, 2006);
- Should a fire or explosive event occur at proposed sites located in close proximity to schools and residential areas, injuries and deaths would likely occur; and
- Several proposed storage tank sites would be located in an earthquake and tsunami zone,[37] increasing the risk of spills, fires and explosions.

5) Oil spills during loading and vessel transport (See Appendix C, Appendix D)

- Crude oil exposure during spill and cleanup increases the risk of neurotoxicity, cancer, lung disease, loss of cognitive function, and endocrine disruption in humans;[13, 21, 63]
- Dispersant chemicals used in cleanup are also highly toxic and associated with increased risks of cancer, lung and endocrine diseases.[66, 103]

6) Increased air pollution, including diesel particulate matter (See Appendix A)

- Accounts for the majority of air-toxic cancer risks in the Puget Sound area;[33, 90]
- Increased risks of cancers, particularly lung and breast cancer;[6, 9, 18, 26, 29, 32, 98, 117]
- Lower infant birth weight and increased risk of respiratory death in first year of life;[22, 75, 121]
- Impaired pulmonary development and increased risk of lung disease in infants,[55] children,[16, 36, 123] and adolescents;[36]
- Increased risk of neurodevelopmental and behavioral disorders in children;[8, 15, 74, 82, 83, 93, 111, 112]
- Increased risk of asthma diagnosis, exacerbation of symptoms, and asthma-related hospitalizations;[11, 16, 25, 41, 46, 81, 98, 99, 104]
- Increased risks of acute cardiovascular and cerebrovascular events;[10, 14, 30, 65, 69, 70, 84, 85, 87, 92, 97, 118, 119]
- Enhanced reactions to airborne allergens and immune system impairment;[38, 47, 67] and
- Increased risks of acute and chronic obstructive lung disease,[46] systemic inflammation, and overall risk of disease and mortality.[6, 29, 30, 61, 70, 87, 89]

7) Increased water pollution (See Appendix E)

- Cancer, digestive, and reproductive health risks associated with oil-contaminated drinking water sources;[3, 4, 105]
- Reduced short- and long-term viability of food sources, including salmon and shellfish;[51, 94, 114] and
- Pollution of tribal fishing resources.[20, 39, 80, 114]

8) Contributions to climate change-induced injury and disease (See Appendix F)

- Increased heat related illness and health care costs; [54, 57, 68]
- Increased extreme weather events with associated injuries and deaths;[5, 52, 54, 72]
- Food supply disruption;[64]
- Spread of infectious diseases;[64] and
- Disproportionate adverse effects on low income and communities of color.[52]

As Washington and Oregon health care professionals, we oppose the transport by rail and the storage and shipment of crude oil 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 transport, storage and handling of crude oil by rail and/or barge.

Appendices:

Appendix A:
Summary of Health Risks for Crude-by-Rail Transport

1. Delay of Emergency Vehicles:

- A total of 93 cities and towns and approximately 3 million Washington residents live on or near the crude-by-rail train routes. Crude-by-rail train routes pass through 38 heavily populated cities and towns in Washington, delaying traffic and emergency vehicle routes.
- In Oregon, 88 communities, including the state's largest, have at-grade crossings over which unit trains now operate. Mile-long oil trains can potentially operate over 403 crossings (ODOT, 2015).
- Emergency vehicle delay at railroad crossings could result in increased fatalities. Five to ten minute delays in emergency medical service (EMS) can critically alter chances for survival, particularly in the case of cardiovascular and respiratory emergencies as well as trauma. The additional blocked traffic at train crossings could make the difference between life and death.
- Example: Individual commercial streets in Aberdeen would be blocked for 17 minutes per train, given their length and mandated 5 mph speed within the city. A projected increase of 6-10 trains per day, multiplied by 17 minutes each, means a total blockage time of 12-20 hours per week.

2. Rail Car Fires and Explosions:

- The Pipeline and Hazardous Materials Safety Administration has concluded that crude oil from the Bakken Shale region of North Dakota is more flammable and more dangerous to ship than crude oil from other regions (2014).

  Train Derailment Statistics & Bakken Explosion Events
  - Trains carrying crude oil on major US railroads have increased from 9,500 carloads in 2008 to 415,000 carloads in 2013 (US DOT, 2014).
  - In 2013 the US Department of Transportation reported 154 rail car "failures" and 116 "episodes" involving tank cars carrying crude oil (US DOT, 2014).
  - The Sightline Institute has tracked derailments in the Northwest from June 2011 through December 2013. Their calculations map 276 reported derailments over a 31-month period – an average of 8.9 derailments per month, or one every three-and-a-half days (de Place & Abbotts, 2014).
  - The heads and shells of DOT-111 tank cars, which carry much of the nation's crude-by-rail, can almost always be expected to breach in derailments that involve pileups or multiple car-to-car impacts (NTSB, 2012).
  - Severe accidents involving oil train derailments have increased significantly in recent years, resulting in explosions, fires, and multiple deaths. Recent incidents include:
    - July 2013: a 79-car train carrying Bakken crude oil derailed in Lac-Mégantic, Quebec, killing 47 people.
    - December 2013: several explosions sent flames and mushroom clouds into the air when a 106-car train derailed in Casselton, North Dakota.
    - April 2014: a train derailed into the James River in Lynchburg, Virginia, sending burning volatile compounds into the water.

3. Increased Air and Diesel Particulate Matter (DPM) Pollution:

- Diesel exhaust from train engines is made up of a number of substances with gaseous and soot (particulate) components. Gaseous components include carbon monoxide, nitric oxide, nitrogen dioxide, sulfur oxides, and polycyclic aromatic hydrocarbons (PAHs). Diesel exhaust particulate is comprised of carbon particles, organic components (including PAHs), and trace metals. Individuals living in proximity to trains are vulnerable to inhalation of diesel gases and particulate matter.
- The World Health Organization's (WHO) International Agency for Research on Cancer (IARC) specifically classifies diesel engine exhaust as "carcinogenic to humans" (Simon, 2013).
- Fine particulate matter, categorized as less than 2.5 microns ($PM_{2.5}$), is especially harmful to humans because of its potential to deeply penetrate the alveoli of the lungs, resulting in lung inflammation. Additionally, exposure to particulate matter and gaseous pollutants such as benzene and PAHs is linked to systemic inflammation, increasing risk of disease and mortality (Avogbe et al., 2004; Dominici et al., 2006; Mustafic et al., 2012; Pieters et al., 2012).
- The US Environmental Protection Agency (EPA) placed the Puget Sound area in the top 5% nationally for potential cancer risk from air toxics (1996).
- DPM poses the largest potential cancer risk of all air toxics in the Puget Sound area (PSCAA, 2011).
- Fetuses, infants, children, the elderly, and those with preexisting disease or impaired immune systems are particularly vulnerable to health impacts from DPM air pollution.
- Even low levels of DPM below current federal standards have been linked to adverse health effects in children, the elderly, and other vulnerable populations (EPA, 2009).

Given this information, it is not surprising that many studies have demonstrated adverse health impacts associated with exposure to ambient air pollution in general and to diesel particulate matter specifically, including:

Cancer
- Increased cancer rates, particularly lung and breast (Beeson et al., 1998; Crouse et al., 2010; Demetriou et al., 2012; Dockery et al., 1992; Wei et al., 2012)
- DPM contributes 78% of the risk for cancer from airborne toxics in the Puget Sound area (PSCAA, 2015)
- Increased biological markers associated with risk of lung cancer (Demetriou et al., 2012)
- Increased oxidative DNA damage predictive of cancer risk (Avogbe et al., 2004)

Cardiovascular Diseases
- Higher rates of heart attack and stroke (Chen et al., 2013; Dominici et al., 2006; Lue et al., 2013; Mustafic et al., 2012; Qian et al., 2013; Wellenius et al., 2012; Shaw et al., 2013; Brook et al., 2010)
- Increased cardiovascular disease, overall mortality and morbidity for short- and long-term $PM_{2.5}$ exposure (Brook et al., 2010)
- Increased hospitalization for cardiac arrhythmias (Peters et al., 2000)

- Increased probability of hospitalization for acute myocardial infarction (Mustafic et al., 2012; Peters et al., 2001)
- Increased ischemic heart disease, arrhythmias, congestive heart failure (Dominici et al., 2006) and biomarkers (HRV) associated with cardiac morbidity and mortality (Pieters et al., 2012)

Cerebrovascular Diseases

- Increase in hospital admissions for strokes (Dominici et al., 2006; Lue et al., 2013; Wellenius et al., 2005)
- Significant increase in stroke mortality (Chen et al., 2013; Qian et al., 2013)
- Increased risk of stroke associated with increased exposure to fine particulate matter ($PM_{2.5}$), black carbon, and nitrogen dioxide (Wellenius et al., 2012)
- Increased risk of stroke and death from stroke for postmenopausal women (Miller et al., 2007)

Neurodevelopmental Disorders

- Higher rates of neurodevelopmental disorders in children (prenatally exposed) such as autism spectrum disorder (ASD), attention deficit hyperactivity disorder (ADHD), lowered IQ, and adverse behaviors (Becerra et al., 2013; Chiu et al., 2013; Newman et al., 2013; Perera et al., 2013; Perera et al., 2009; Roberts et al., 2013 Volk et al., 2013; Volk et al., 2011).
- Increased behavioral symptoms such as anxiety, depression, social problems, rule breaking, and aggression in children (Perera et al., 2013)

Pulmonary Diseases and Disorders

- Respiratory deaths in infants during first year of life and lower infant birth weights (Woodruff et al., 2006; Dadvand et al., 2012; Olsson et al., 2013)
- Impaired lung development in children (Gauderman et al., 2004; WHO, 2005)
- Impaired pulmonary development in adolescents and measurable airway inflammation (Gauderman et al., 2004)
- A 6% higher risk of infant bronchiolitis (Karr et al., 2009) and significantly increased risk of asthma diagnosis with early life exposure to traffic-related air pollution (Clark et al., 2010)
- Increased frequency and severity of asthma attacks in children (Slaughter et al., 2003)
- Overall decreased lung function (WHO, 2003)
- Increased asthma rates and exacerbation of preexisting asthma and chronic obstructive pulmonary disease (COPD) (Carlsten et al., 2011; Gowers et al., 2012; Delamater et al., 2012; HEI Panel, 2010; Trasande & Thurston, 2005; Simon, 2013)
- Worsening asthma symptoms and increased hospitalization (Delameter et al., 2012; Gowers et al., 2012; HEI Panel, 2010; Pandya et al., 2002)

Reproductive and Developmental Disorders

- Reduced sperm quality in men exposed to air pollution, particularly diesel exhaust (De Rosa et al., 2003)

- Disruption of normal sexual differentiation during fetal development, including 2.42% higher odds of male cryptorchidism (undescended testes) amongst babies of fathers exposed to diesel exhaust before conception (Kurahashi et al., 2005)
- Increased congenital heart, lung, and immune system anomalies in children (Gauderman et al., 2004; Vrijheid et al., 2011)
- A 10 microgram increase in DPM (2.5) is associated with a 3.4% increase risk in daily mortality (Laden et al., 2000)
- In 2005 the World Health Organization published a summary of the health risks of air pollution on childhood health and concluded that "sound evidence already exists for a causal link between air pollution and children's health" (WHO, 2005, p.7)
- In the same document the WHO recommended that policy makers take measures to reduce childhood exposure to air pollution (WHO, 2005)

Multi-System and Overall Mortality

- Increased cardiovascular, pulmonary, and overall mortality (Dockery et al., 1993; Pope et al., 2002)
- Long-term exposure linked to decreased life expectancy from cardiopulmonary mortality (Krishnan et al., 2012; WHO, 2014)

4. Adverse Health Impacts of Train Noise and Vibration:

- Environmental noise pollution is a growing concern, and several studies have documented negative health consequences of chronic noise including sleep disturbance, cognitive impairment, cardiovascular disease and psychiatric disorder (Goines & Hagler, 2007; Babisch, 2005).
- Noise and vibrational effects from rail traffic vary from idling, screeching, and horn sounding. Horn sounding poses the most significant to risk to human health.
- The U.S. Department of Transportation's "Train Horn Rule" (49 CFR Part 222) requires engineers to sound train horns at 96 to 110 decibels (dB) fifteen to twenty seconds in advance of all public grade crossings (US DOT, 2005).
- The World Health Organization's "Guidelines on Community Noise" (1999) states that sleep disturbances and risk of adverse health effects of noise have been observed at 45 dB or less, recommending that noise events exceeding 45 dB be "limited if possible" (p. 8).

Despite public safety mitigation in some urban areas where quiet zones have been established, a growing body of research demonstrates that continuous noise, as well as intermittent nocturnal noise and vibrations, result in sleep disturbances and can cause impaired cognitive function and cardiovascular effects.

Sleep Disturbance

- Studies have demonstrated that outside nocturnal noise >50 decibels (dB) is associated with sleep disturbance, that railway noise has greater impacts than road noise, that intermittent noise is more sleep-disruptive than continuous noise, and that even one railway noise event during sleep significantly decreases rapid eye movement (REM) sleep (Aasvang et al., 2011; Carter, 1996).
- A recent case-control experimental study found that train transportation noise and subsequent vibrations led to a significant acceleration of heart rate of at least 3 beats

per minutes in 79% of sleeping participants after experiencing high-vibration periods produced from trains passing. These nocturnal heart rate accelerations are believed to potentially affect long-term cardiovascular health for populations living in close proximity to railroads with frequent rail traffic (Croy et al, 2013).

- Millions of people living along these rail lines will be at risk for disrupted sleep and associated health risks from proposed rail traffic volume (Kim et al., 2012; Hume et al., 2012).

Cardiovascular Effects

- New epidemiological studies support previous evidence that night-time noise and noise in excess of 90 decibels are associated with cardiovascular disease including risk of acute coronary events, myocardial infarction, arrhythmia, accelerated hypertension, and stroke (Hume et al., 2012),
- More specifically, the elevation of stress hormones such as epinephrine and cortisol resulting from high decibel noise exposure increases endogenous risk factors of heart disease from both short-term and chronic exposures (Ising & Kruppa, 2004; Selander et al., 2009; Sørensen et al., 2011; Sørensen et al., 2012).

Impaired Cognitive Function and Mental Health Effects

- Another less well appreciated risk of high decibel rail noise and vibration exposure is the impact on mental health and cognitive function.
- Sleep disturbance resulting in fatigue increases risk of hypertension, arrhythmia, and risk of accidental injury.
- Elevated noise is associated with cognitive impairment in children, as well as exacerbation of mental health disorders including depression and anxiety (Lercher, et al. 2003; Haines et al., 2001; Hygge et al., 2002).
- The health implications of chronic and nocturnal noise from increased rail traffic are highly likely and will impact human health in multiple areas and all age ranges (Goines & Hagler, 2007; Babisch, 2005).

Appendix B:
Summary of Health Risks for Oil Tank Storage

5. Oil Storage Tank Spills, Fires and Explosions:

- Three companies have plans to build facilities to receive, transfer, store and ship crude oil from Hoquiam, WA. US Development Group has detailed plans for a 42,000,000-gallon tank farm; their proposal has received initial approval by the WA Department of Ecology. Imperium proposes a 30,240,000-gallon tank farm, and Westway Group proposes a 42,000,000-gallon tank farm. The US Development proposal would site eight 5,250,000-gallon tanks within about 1,900 feet of the Hoquiam High School and only slightly farther away from both the middle and elementary schools. The two other tank farms are just south of the city commercial center but adjacent to each other. The proposed Imperium project would locate nine 3,360,000-gallon tanks immediately adjacent to an existing biodiesel production facility and its tank farm. Adjacent to the biodiesel site would be the proposed Westway project with five 8,400,000 gallon tanks. Existing storage tanks on the Westway site already include four tanks utilized for other liquid products including ethanol.
- Tesoro-Savage Petroleum Terminal (Tesoro-Savage) proposes to construct a facility in Vancouver, WA, to receive crude oil by rail and transfer it to vessels on the Columbia River. The "Vancouver Energy Distribution Terminal" would include six crude oil storage tanks. Annual throughput for each of the tanks would be 868,700,000 gallons per year, for a total facility throughput of over 5.2 billion gallons per year (Tesoro-Savage Application, 2013). The Tesoro-Savage tank farm and related rail traffic would be located near Vancouver's Fruit Valley neighborhood and a proposed waterfront development to include permanent housing. This would be the largest oil-by-rail facility in the nation (Florip, 2014).
- In Anacortes, WA, Shell Puget Sound Refinery proposes to expand access to its existing refinery for crude-by-rail to augment decreasing supplies coming by tanker from Alaska. The crude oil unloading facility would be served by a railroad extension from the existing BNSF rail line. Shell anticipates it would receive one unit train per day, with each unit train hauling 102 rail cars, or 612 incoming fully loaded cars per week. This unloading facility would be served by a 15-mile spur from the BNSF line near Mount Vernon and Burlington, running through heavily populated residential areas in proximity to the rail line.
- In Oregon, Global Partners, which was operating in 2014 with two 3,800,000-gallon tanks, has received a permit which allows expansion to include four 4,500,000-gallon tanks and the handling of over 1.8 billion gallons of crude oil annually. This facility is located on the Columbia River (OR DEQ, 2014).
- Oil storage tanks of varying sizes are at risk of fires and explosions from both man-made and natural causes. Man-made fires and explosions have resulted from maintenance errors (Smith County, MS, 6/5/2006; Baton Rouge, LA, 5/28/14) and inadequate venting of combustible vapors. Natural causes have included lightning-induced explosions (Baytown, TX, 9/14/14) and spontaneous explosions (Meadville, PA, 8/19/13).

There are at least two categories of potential causes of fires and related explosions at oil storage terminals: A) man-made causes including equipment failure, and B) natural causes including earthquake and tsunami.

A. Tank Fires from Equipment Failure or Other Man-Made Causes

There is an inherent risk of fire when handling, transporting, and refining crude oil. Further, Bakken crude has a large component of light hydrocarbons, making it highly volatile (Pipeline and Hazardous Materials Safety Administration, 2014).

Fires and explosions in tanks holding petroleum products are quite common and well documented throughout the industry. While many have been caused by human error, some have occurred because of inherent risks from equipment, technology, and the highly combustible nature of these fossil fuels. This is why oil storage tanks are most commonly sited away from population centers.

Case Study #1: Hertfordshire, England, December 11, 2005
The Hertfordshire Oil Storage Terminal (a.k.a. Buncefield Oil Depot) was the fifth largest oil-products storage facility in the United Kingdom. One of the gasoline storage tanks over-filled. A switch should have detected that the tank was full and shut off the supply, but it failed to operate properly. The switch failure should have triggered an alarm, but it also failed. Hundreds of gallons of gasoline spilled through the roof vent, down the side of the tank and onto the ground. The overflow resulted in the rapid formation of a rich fuel and air vapor cloud, triggering a so-called fuel-air explosion. The explosion was presumed to have been ignited by an electric generator or the depot's fire pumping system (COMAH, 2011). The resulting fires burned for 5 days. As a result of the event, 240 people visited accident and emergency departments. Of these 187 were emergency services workers, 17 were oil depot workers, and 40 were members of the public. Sixty-six had respiratory complaints, and 38 injuries were recorded (Hoek et al., 2007). The Buncefield Depot was located far from a residential area. Had this event occurred within a town, presumably many more injuries and even deaths would have been reported.

Case Study #2: Raleigh, Mississippi, June 5, 2006
The Partridge-Raleigh oilfield is located in rural Smith County, Mississippi. Three workers died and a fourth was injured in a fire caused by human error. Welders were attempting to connect oil tanks via pipes, when the welding torch sparked vapors escaping from one of the tanks. The fire traveled from one tank to another through connecting pipes. The explosion threw the workers from the top of the tanks. The US Chemical Safety and Hazard Investigation Board determined that a number of errors were made, including unsafe work practices such as utilizing a lit torch to determine the presence of flammable vapor instead of testing with a gas detector. Other hazards that contributed to the fire included neglecting to remove residual oil in the tanks prior to welding in the area (US CSB, 2007).

B. Natural Causes, Including Earthquake and Tsunami

For terminals at Washington and Oregon ports, earthquakes and subsequent tsunamis pose the risk of dislodging crude oil storage tanks from their foundations.

The Port of Grays Harbor resides within the potential zone of impact from a tsunami. While the US Development Group engineering study addresses the structural requirements for its eight proposed tanks to withstand an earthquake (Shannon & Wilson, 2013), it does not address the structural requirements to withstand a subsequent tsunami.

The USGS Professional Paper 1661-B, Local Tsunami Hazards in the Pacific Northwest from Cascadia Subduction Zone Earthquakes, reports the following: “Comparing the results in this study at specific sites where previous inundation models have been formulated, the range in tsunami amplitude offshore Grays Harbor, WA, 2 to 7 meters, is slightly lower compared to the offshore amplitudes predicted by Preuss and Hebenstreit (7-8 meters)” (Geist, 2005).

Considering that the US Development’s engineering study (Shannon & Wilson, 2013) showed that soils in the tank farm area up to depths of 150 feet or more consist of “outwash from alpine glaciation”, meaning unstable sand, gravel, silt, etc. – and the recommended depth for pilings as support foundations would extend only a few feet into the “dense to very dense” alluvium (not bedrock) – one could argue that the foundation structures for the storage tanks would be very unlikely to withstand a tsunami wave of up to 24 feet. Structural integrity could be further compromised by the fact that the groundwater depth begins at only 17 feet below the surface.

Oil tank dislodgement from a massive tsunami increases the likelihood of subsequent fire and related explosions involving multiple tanks, discharging massive quantities of highly flammable crude oil into the area and the ocean.

Appendix C:
Summary of Health Risks for Oil Export by Marine Vessels

<u>6. Oil Spills during Vessel Loading and Transport:</u>

- A total of eight or more Panamax-sized ships, each carrying 16 million gallons of oil, are proposed to make 16 or more crossings per month transporting petroleum products out of Bellingham, Anacortes, Grays Harbor, and offshore from the mouth of the Columbia River between Washington and Oregon.
- Washington has a history of major oil spills including a 239,000-gallon tanker spill at Port Angeles in 1985; a 231,000-gallon barge spill in Grays Harbor in 1988; a 130,000-gallon refinery spill in Anacortes in 1991; and a 600,000-gallon refinery spill in Tacoma in 1991.

Health Impacts of Crude Oil Exposure

- Crude oil is a complex mixture of thousands of chemical compounds, many of them harmful to human health and the environment. These include but are not limited to: benzene, cadmium, toluene, ethylbenzene, xylene, and polycyclic aromatic hydrocarbons (PAHs). Some oil contains other hazardous chemicals such as the bioaccumulative neurotoxin mercury. Many of these chemicals have potential to damage organ systems through a variety of mechanisms including endocrine disruption and fetal mutations. They potentiate a number of diseases including cancer and can cause multi-generational birth defects (CDC, 1999).
- Volatile organic compounds (VOCs) found in unrefined petroleum, including benzene and toluene, readily enter the atmosphere, where they can be easily inhaled. Once they enter the body, they can be stored in fat, dissolve into cell membranes, and reside on mitochondria in the cell nucleus. This "change in viscosity" of the cell nucleus affects DNA transcription and replication and therefore has the potential to cause malignancy in any organ.
- Health implications of human exposure to crude oil constituents vary from individual to individual based upon multiple factors: time and duration of oil exposure, route of exposure, interaction with dispersant cleanup chemicals, use of personal protective equipment, wave action, heat, previous exposure to crude oil chemicals, medications used at the time of exposure, and pre-existing medical conditions.
- Exposure can occur directly through inhalation of contaminated air or dermally via skin contact with contaminated air or water. It can also occur indirectly via consumption of seafood or water.

A recent review summarized research of acute and long-term adverse health effects from exposure to eight major oil spills prior to 2010 (Levy and Nassetta, 2011).

Acute health effects among cleanup workers and community residents included:

- Respiratory symptoms (throat irritation, cough, shortness of breath)
- Eye symptoms (irritation and sore, itchy and/or reddened eyes)
- Headache
- Skin symptoms (irritation, itching, rashes, skin lesions)
- Nausea
- Dizziness
- Tiredness and fatigue

Chronic health effects included:

- Psychological disorders (generalized anxiety disorder, post-traumatic stress disorder (PTSD), lack of energy, and depression)
- Respiratory damage (impaired lung function; reductions in forced vital capacity, forced expiratory volume, forced expiratory flow, and maximum voluntary ventilation)
- Endocrine biomarkers (significant decrease in plasma cortisol concentrations in all groups and significant decrease in prolactin concentrations of workers performing high pressure cleaning)

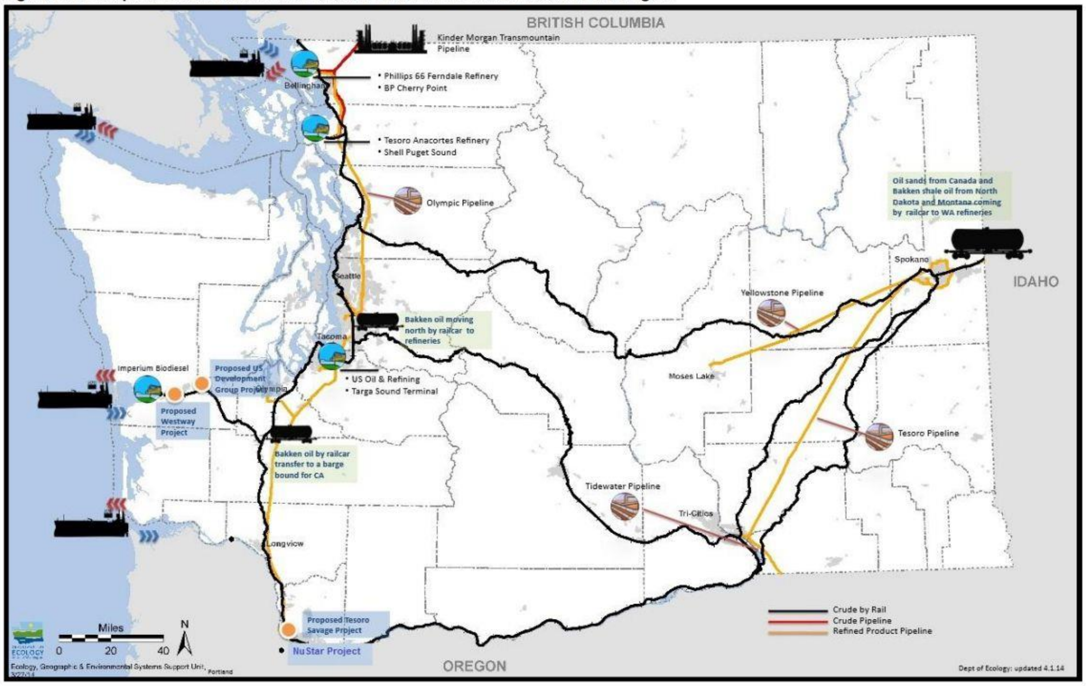
Toxicity of Oil Spill Cleanup Chemicals

- Clean-up response to the 2010 Deepwater Horizon explosion and resulting oil spill in the Gulf of Mexico involved the application of an unprecedented 1.84 million gallons of a chemical dispersant known as Corexit to subsea and surface waters. Little was known about Corexit toxicity or its environmental impacts prior to the spill.
- Collectively, the 57 ingredients in oil dispersant products listed by the EPA as appropriate for oil spill response at the time of the Deepwater Horizon incident were shown to be a myriad of known or suspected toxins with capacity to impact every organ system of the human body: 5 are linked to cancer; 33 are potential, suspected, or known skin irritants and toxins; 33 are eye irritants; 11 are respiratory toxins; 10 are kidney toxins; 8 are reproductive toxins; 7 are liver toxins; 6 are neurotoxins; 5 are toxic to the immune system; 4 are blood toxins; 3 are associated with asthma; and 1 is toxic to the endocrine system (Toxipedia Consulting Services, 2011).
- A recent study of 247 BP Gulf oil spill clean-up workers published in the *American Journal of Medicine* found the workers were at an increased risk of developing cancer, leukemia and other illnesses; also, "clean-up workers exposed to the oil spill and dispersant experienced significantly altered blood profiles, liver enzymes, and somatic symptoms” (D’Andrea & Reddy, 2013).
- The use of Corexit 9500A dispersant during the BP cleanup increased the toxicity of exposure by up to 52 times over crude oil alone (Martinez et al., 2013).

Appendix D:
Washington & Oregon Oil Transport Routes & Oil Spill Response Plans

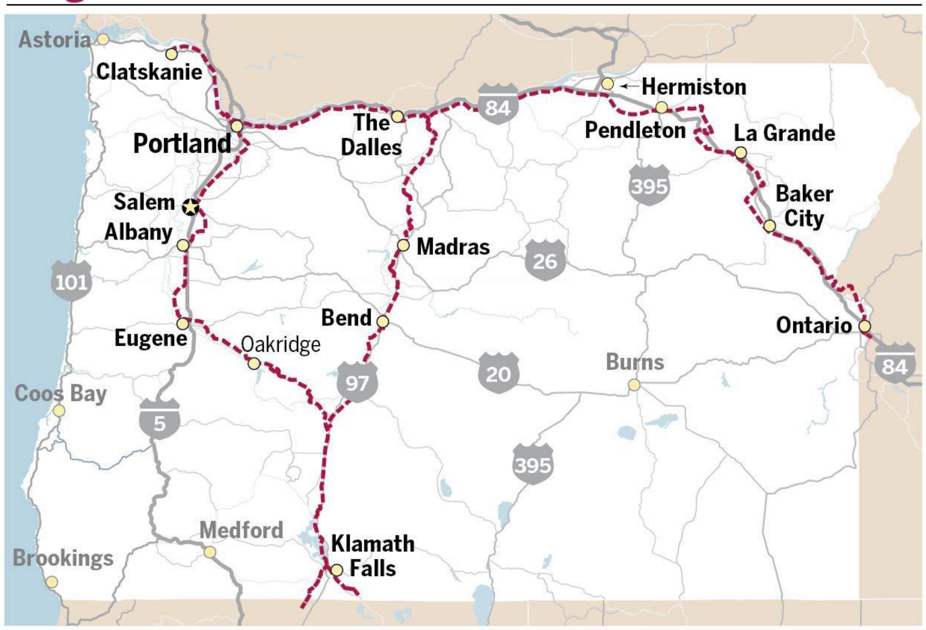
Conceptual Model of Potential Future Oil Movement in and out of Washington:

Figure 6: Conceptual Model of Potential Future Oil Movement into and out of Washington



Rail Routes in Oregon:

Oregon's oil train routes



Source: ODOT DAN AGUAYO/THE OREGONIAN

Overview of Routes in Washington and Oregon

- Primary routes and proposals include transporting tar sands oil from Canada and Bakken shale oil from North Dakota and Montana, entering Washington near Spokane. The crude-by-rail would then continue on multiple routes across the state, passing through heavily populated cities and towns and along the entire I-5 Washington corridor. The trains will travel along dozens of rivers and streams including the Columbia River and past resource-rich areas including farmland, forests and the Columbia Gorge before storage near uniquely sensitive areas including city centers and a wildlife refuge, before export to refineries via marine vessels along the Pacific coast.
- Final refinery and/or export destinations in Washington include Bellingham (Phillips 66 Ferndale Refinery and BP Cherry Point), Anacortes (Tesoro Refinery and Shell Puget Sound), Tacoma (US Oil & Refining and Targa Sound Terminal), Grays Harbor (Imperium Biodiesel, proposed Westway and US Development facilities), and Vancouver (proposed Tesoro Savage Project and proposed NuStar Energy terminal conversion). Crude oil tank storage facilities are proposed for Grays Harbor and Vancouver.
- In Oregon, facilities in Clatskanie (Global Partners LP) and Portland (Arc Logistics Partners LP) handle and/or store crude oil. Crude oil is not refined in Oregon. Trains carry Bakken crude oil from Washington into Oregon, then through Portland to Global Partners in Clatskanie, where it is stored and later loaded onto barges that travel down the Columbia River to the Pacific Ocean and on to Washington and California refineries. Trains carrying Utah crude oil enter eastern Oregon bound for Arc Logistics Partners LP in Portland. Trains carry Bakken oil along the Columbia River, south along Deschutes River to Bend, and then continue south to California. Oil trains travel through Portland, Salem and Eugene en route to Klamath Falls and California.
- The Washington State Department of Ecology (WA DOE) *Marine & Rail Oil Transportation Study* shows crude-by-rail train routes passing 38 heavily populated Washington cities and towns (over 3,000 people per square mile) and at least a dozen other towns with population densities of 2,500 to 3,000. A total of 93 Washington communities and at least 3 million residents live in close proximity to crude-by-rail routes (WA DOE, 2014).
- In Oregon, 88 communities, including the state's largest, have at-grade crossings over which unit oil trains operate. Nearly half a million Oregon residents reside within a half mile of these tracks. Four hundred and twenty-six at-grade crossings currently have the potential for mile-long trains to operate over them (ODOT, 2015).
- Each unit train may have 100-125 railcars, be up to 1.5 miles long and hold approximately 2.9 million gallons of crude.
- Currently there is no legal limit to the number of oil trains that can travel through Washington or Oregon in a specific timeframe, and there have been limits on public disclosure (Davis, 2014).

Responding to an Oil Spill in Washington State

- A Department of Ecology study in 2004 found that a major oil spill could cost Washington's economy $10.8 billion and impact 165,000 jobs (DOE, 2011).
- The Department of Ecology currently lists 30 Oil Spill Contingency Plans for Washington State for Facilities, Pipelines, Refineries, and Vessels. Many of these will need to be updated and adapted to incorporate new oil storage and export proposals: www.ecy.wa.gov/programs/spills/preparedness/cplan/cpmanagers.htm
- Preliminary findings of the *Marine and Rail Oil Transportation Study* reflect an overall lack

of adequate training, resources, design and regulatory oversight to properly respond to an oil spill given current proposals (WA DOE, 2014). Findings and recommendations included:

  - The Facility Oil Handling Regulation, Chapter 173-180 WAC, has not been updated for spill prevention standards since 1994. Ecology should update these standards to reflect modern spill prevention procedures based on handling volume (p. 64).
  - “[N]one of the current crude by rail trains are subject to requirements for comprehensive response plans.” And, “[r]ailroad spills are not currently covered by state approved oil spill contingency plans…” (p. 67).
  - “Equipment necessary for oil spill containment, responder health and safety monitoring and fire suppression during a crude oil emergency response are insufficient in much across much [sic] of Washington” (p. 70).
  - In a survey of the state's 278 fire districts near crude by rail routes, 62% “believe that their departments are not sufficiently trained or do not have the resources to respond to a train derailment accompanied by fire” (p. 70).
  - An overwhelming majority of first responders surveyed “are not aware of the response strategies or resources in place by the railroads should an incident take place” (p. 71).
  - Because crude by rail transport is fairly new to the US and Canada, there are few, if any, studies analyzing the risk of accidents and spills from crude-by-rail (p. 81).

Responding to an Oil Spill in Oregon

- Oregon has not initiated a study or investigation of the state’s response preparedness for potential derailments and spills at the scale of Washington, which recently published preliminary findings of the *Marine and Rail Oil Transportation Study* (WA DOE, 2014).
- A "Hazardous Material By Rail Rulemaking Advisory Committee" began meeting in August 2014 to deal with notification issues for emergency responders.
- The Chief of the Eugene-Springfield Fire Department, Randall Groves, stated that three major criteria should factor into any future rule making related to crude-by-rail: prevention and mitigation accidents, response to a derailment or fire, and recovery and clean-up after an accident. Groves’ memorandum suggested that a new, uniform response plan for Oregon is anticipated but not yet available (Groves, 2014).

Furthermore, research and technology for cleaning up oil spills is still lagging despite lessons learned from recent events, as stated in the 2011 National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling report:

> *“The technology available for cleaning up oil spills has improved only incrementally since 1990. Federal research and development programs in this area are underfunded. In fact, Congress has never appropriated even half the full amount authorized by the Oil Pollution Act of 1990 for oil spill research and development. In addition, the major oil companies have committed minimal resources to in-house research and development related to spill response technology.”* (p. 269)

Additional Washington and Oregon oil spill response resources may be found on the Region 10 Regional Response Team and the Northwest Area Committee website:
http://www.rrt10nwac.com/NWACP/Default.aspx

Appendix E:
Overview of Water Pollution Risks & Sources

7. Water Pollution from Oil Contamination:

Crude and diluted bitumen oil spills resulting from train derailments, oil-loading accidents, and storage leaks pose a serious public health risk to downstream drinking water systems as well as primary Washington and Oregon food sources, including salmon and shellfish. The health risks of contamination by Bakken crude versus diluted bitumen from tar sands oil vary due to differences in toxic components as well as their environmental persistence and adherence properties. Nevertheless, significant risks to drinking water and food security are associated for any type of oil spill. Primary water pollution health risks include: A) drinking water contamination, B) damage to and loss of food sources, and C) pollution of subsistence and tribal fishing resources.

A. Drinking Water Contamination

Drinking water intake sources along the Columbia River exist in Kennewick, Longview, Pasco, and Richland. These, in addition to several inland wells and aquifers, are at risk of oil spill contamination due to the proposed transport of oil-by-rail across Washington State to the proposed Tesoro storage and loading facility in Vancouver (WA DOE, 2014).

In Oregon, residents of St. Helens and Boardman rely on the Columbia River as their primary drinking water source (OHA, 2015). A nearby oil spill could degrade their drinking water.

The US Environmental Protection Agency defines a principal or sole source aquifer as one supplying at least 50% of drinking water consumed in the area overlying the aquifer. “These areas may have no alternative drinking water source(s) that could physically, legally and economically supply all those who depend on the aquifer for drinking water” (EPA, 2012). One sole-source aquifer is located in the Spokane area (DOE, 2014), where all trains enter WA State. Environmental monitoring of drinking water safety in the face of potential oil spills should include current baseline data and levels of concern for oil and oil byproducts.

Contamination of drinking water by oil and its byproducts has the potential to persist for years and poses numerous risks to human health. Research on the health impacts of oil contamination has been largely limited to areas outside the US where significant oil spills have polluted primary drinking water sources. In Nigeria, Africa’s largest oil producer and most populated nation, oil spill responses have been erratic and minimal. The United Nations Environment Programme found that families have been drinking from oil contaminated groundwater wells with carcinogenic benzene levels 900 times over the World Health Organization guidelines. They estimate clean up will take at least 30 years (UNEP, 2011).

Oil spills in Ecuador, the Niger Delta, and Kuwait have resulted in thousands of miles of land contaminated with crude oil and byproducts. Researchers found that oil ingested in these countries either directly through drinking water contamination or indirectly through consumption of oil-contaminated livestock increased the incidence of cancer and digestive problems across populations (Armstrong et al., 2001). Pregnant women who ingested oil-contaminated water in Ecuador were also found to have spontaneous abortion rates 2.34 times higher than a nearby control group (Armstrong et al., 2002).

B. Damage to and Loss of Food Sources

Numerous communities rely on fish and shellfish from inland waterways, the Columbia River, and marine waters along Washington and Oregon's coastlines. Oil contamination from a spill during transport, storage and transfer – whether it be an inland or an ocean spill – would be extremely detrimental to the public health and economic viability of coastal wetlands, marine ecosystems, and critical food sources in our states. Immediate effects may be toxic to fish and other marine life, resulting in mass mortality. Other effects will manifest long-term, poisoning the organic substrate, interrupting food chains, and reducing the reproductive capacity of fish and shellfish exposed to oil pollution. The viability of salmon along these waterways is a specific concern.

When oil is spilled into water, the type of oil, its relative density and composition determine the rate and volume of spread into the water. An oil slick may be formed on the surface of the water, or it may be dissolved or dispersed into the water dependent upon wave currents and vessel traffic, temperature, wind force, and cleanup interventions such as the use of dispersant products. Oil containing volatile organic compounds will partially evaporate, becoming denser and more viscous, and increasing flow resistance. Eventually the oil will emulsify with particulate matter and sink, the remainder forming sticky tar balls, which then decompose from light exposure (photo-oxidation) and biodegrade via microorganisms at the bottom of the food chain. The biodegradation rate varies based on temperature as well as nutrient and oxygen availability.

The physical and chemical properties of diluted bitumen, such as tar sands oil from Canada, in the case of a spill include greater probability of sinking or submerging into water, increasing in the presence of sediment and turbulence. This makes diluted bitumen spill risk of greater concern in rivers such as the Columbia due to larger sediment volumes, shallower depths, and higher currents. Polycyclic aromatic hydrocarbons (PAHs) from diluted bitumen that reaches streams and rivers could have a significant adverse effect on spawning fish (WA DOE, 2014). When considering the safety of fish and seafood in the event of an oil spill, ongoing contamination in the Gulf of Mexico from the BP spill offers evidence of oil's detrimental health effects on fish and marine life, for which BP has been fined federal penalties up to $13.7 billion under the Clean Water Act (Guardian, 2015).

Another public health concern regarding ocean spills and food safety is current federal risk assessment levels for seafood contamination. A 2012 evaluation examined the Food and Drug Administration's (FDA) risk criteria for accumulated polycyclic aromatic hydrocarbons (PAHs) in seafood after the BP spill. As stated previously, PAHs accumulate in the food chain and are known carcinogens and developmental toxicants. The evaluation found that PAH levels of concern set by the FDA for Gulf shrimp after the BP spill were 53% higher than recommended for vulnerable populations such as pregnant women and children (Rotkin-Ellman et al., 2012).

C. Pollution of Subsistence and Tribal Fishing Resources

Current oil transport proposals present potentially significant public health implications for tribal lands and fishery habitats. Fisheries associated with tribes' Usual and Accustomed Areas (U&A) are at significant risk. The 2014 preliminary findings from the Washington State Marine & Rail Oil Transportation Study stated, "Nearly all of the 29 tribes of Washington State and several bordering tribes have the potential for impacts related to either rail and/or marine incidents associated with the crude marine and rail transportation and associated facilities in their traditional use areas, ceded lands, or treaty U&As" (WA DOE, 2014, p. 37).

Long-term health impacts after the 1989 Exxon Valdez oil spill to the Alaskan fishing community of Cordova, Alaska, where 50% of the economy was comprised of commercial fishing, included significantly higher levels of social disruption and psychological stress as a result of the disturbance in their food source and livelihood (Curry et al., 1992; Gill & Pico, 1996). Post traumatic stress disorder (PTSD) was also found to be higher in native Alaskan families who had subsisted on natural resources and land contaminated by the spill (Palinkas et al., 2004). Many of the tribal nations living in Washington and Oregon near proposed oil transport and storage sites are renewable resource communities similar to native communities in Alaska, for whom fishing is not only an income source but also a primary food source and a major component of cultural identity.

Appendix F:
Summary of Health Risks from Climate Change

8. Climate Change-related Injury and Disease:

Beyond the more apparent hazards of oil transport, storage and export, there is an undeniable connection between increased fossil fuel usage and its impact on climate change and health. The science is clear that the earth is warming and that people, through the burning of massive quantities of fossil fuels, are the main cause of this rapid increase in global temperatures. Heat trapping and warming temperatures are a result of increases in atmospheric greenhouse gases, which efficiently absorb heat from the earth's surface and prevent outgoing thermal energy from radiating back into space. The crude oil carried by trains into WA and OR, when eventually burned, will significantly add to an already dangerous burden of greenhouse gases being emitted into the atmosphere.

Numerous studies, reported in leading scientific and medical journals, show that ongoing changes to our climate are correlated with: changes in rainfall patterns; worsening heat waves; an increased frequency and magnitude of extreme weather events, droughts, and fires; a rise in sea levels; increased potency of allergens; and the spread of infectious diseases – all of which pose a real and serious threat to human health. Unless global carbon emissions start to fall within the next decade, we can expect to see further and more drastic changes in our climate, and related adverse health impacts all over the world.

Populations that could be most vulnerable to health impacts of climate change include those with:

- Demographic vulnerability: People with existing illnesses, people with disabilities, older adults, mothers, infants, children, people with low socioeconomic status, linguistically or socially-isolated populations, immigrants and refugees, communities of color, and American Indians
- Occupational vulnerability: Wildland firefighters, outdoor workers, growers, ranchers and farmworkers, emergency responders and health care workers
- Geographic vulnerability: Urban and suburban areas, coasts, steep slopes, and private water systems (Haggerty et al., 2014)

Health Impacts of Increased Ground Level Ozone

- Ground level ozone increases with hot weather, vehicle and diesel exhaust, gasoline vapors, and other outdoor air pollutants. Ground level ozone is known to irritate the respiratory tract, cause premature aging of the lungs, and has been linked to the development of asthma and exacerbation of existing asthma cases. In fact, people who spend more time being active in the outdoors working or playing are at greater risk for adverse health effects from ozone exposure than those who spend more time inside or are sedentary (McConnell et al., 2002; Gent et al., 2003).
- Asthma currently affects over 9% of Washington adults (ages 18 and older), and over 110,000 youth in Washington suffer from asthma. The Centers for Disease Control ranks asthma prevalence in Washington State residents as higher than the national average. In 2010, $73 million was spent on hospitalization costs for asthma-related illness in Washington. Asthma is the primary cause of school-age absenteeism nationally and is

associated with reduced quality of life, depression, and suicidal ideation (WA DOH, 2013).

- In Oregon, an estimated 10.8% of adults and 7.8% of children have asthma. Oregon has a higher burden of asthma than the overall US and was among the top six states with the highest percentage of adults with asthma in 2011. Children 0-4 years and females have the highest rates of asthma hospitalizations. In 2011, the total cost of asthma hospitalizations was more than $28 million, with an average of over $14,000 per hospitalization (Garland-Forshee & Gedman, 2013).
- The University of Washington's Climate Impacts Group has estimated that ozone levels will rise due to climate change and increases in train, auto, bus, and truck transportation in the state. Ozone levels are expected to increase by 16% in Spokane County and 28% in King County by midcentury (2045-2054) from 1997-2006, increasing the risk for deaths by cardiovascular disease, asthma, and lung cancer. They also estimate an increase in ozone-related deaths by 17% in Spokane County and 27% in King County during the same time period (Jackson et al., 2010).
- Health related costs of current ozone air pollution nationally were an estimated $6.5 billion in 2008 and will continue to rise without change in regulatory controls (Knowlton et al., 2011).

Health Impacts of Increased Extreme Weather Events and Wildfire

- Extreme weather events with associated injuries are already being witnessed globally. Precipitation extremes including heavy rainfall, flooding, and droughts are projected to increase in all regions of the US (IPCC, 2012).
- Floods account for approximately 98 deaths per year in the US and are the second deadliest of all weather-related hazards (Ashley & Ashley, 2008; NOAA, 2012).
- Steep slopes and intense rainfall can trigger landslides that result in injury and death.
- Smoke from wildfires is associated with cardiopulmonary disease, ischemic heart disease, asthma, bronchitis, pneumonia, cancer and motor vehicle crash injury (Haggerty et al., 2014).

Health Impacts of Shifting Disease Ranges

- Climate change is associated with the spread of vector- and water-borne disease and illness. Vectors such as fleas, ticks, and mosquitoes transmit pathogens that cause diseases including Lyme, dengue fever, West Nile virus, and Rocky Mountain spotted fever.
- Large-scale weather shifts in temperature, precipitation, and humidity can result in vector adaptation or geographic expansion, increasing the number of people at risk for acquiring vector-borne diseases.
- Water-borne illnesses such as pediatric gastrointestinal infections have also been associated with extreme weather events, large-scale flooding, and water source contamination (Luber et al., 2014).

Food Security and Vulnerable Populations

- An anticipated decline in crop yields, livestock, and fish production from extreme weather, changes in rainfall patterns, and ocean acidification is predicted to raise global food prices, resulting in food shortages.
- Elevated atmospheric carbon dioxide is also associated with decreased plant nitrogen concentration, resulting in decreased protein content of existing plants.
- Mental health disorders and anxiety around climate-related disease and illnesses are an additional concern for health care providers (Luber et al., 2014).
- Air pollution and climate change will continue to disproportionately affect minorities and lower socio-economic populations both in the US and worldwide. Those least responsible for the atmospheric content of carbon and other pollutants are positioned to bear the most significant brunt of their ill effects, including increased respiratory and infectious illness, extreme weather events and food shortages.

Medical Approach to Climate Change: The Precautionary Principle

The Intergovernmental Panel on Climate Change unequivocally states that a substantial and ongoing reduction in greenhouse gas emissions is necessary to prevent further imbalances in earth's climate and subsequent climate-related disease and illnesses (McCoy & Hoskins, 2014). As medical doctors and healthcare providers, we firmly invoke The Precautionary Principle in consideration of proposed substantial expansion of crude oil transport and storage projects. The Precautionary Principle – a substantial component of public and environmental health practice – states: "should an activity raise threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relations are not fully established scientifically" (Wingspread Conference, 1998).

The proposed increases in oil-by-rail transport and storage projects in Washington and Oregon externalize massive long-term threats to human, environmental, and economic health in our states in favor of short-term financial incentives. The reality of these projects in their totality pose significant risks to the health and livelihood of future generations and the viability of our planet.

Appendix G:
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