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TO THE OFFICE OF GRADUATE STUDIES:

The abstract and thesis of Paul M. Slyman for the Master of Science in Geography were presented February 21, 1996, and accepted by the thesis committee and the department.

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ABSTRACT

An abstract of the thesis of Paul M. Slyman for the Master of Science in Geography presented February 21, 1996.

Title: Oregon's Oil: A Geographic View of Petroleum Distribution and Associated Risks

Since no local crude oil sources exist, every drop of petroleum consumed in Oregon originates from outside sources and is distributed multi-modally to consumers. As population continues to increase and oil sources dwindle, this reliance may add financial and environmental risks to Oregonian's quality of life. This paper examines Oregon's oil distribution system, and analyzes the risks oil movements pose in the state.

A comprehensive understanding of oil distribution in Oregon can best be gained geographically. Pipelines, ships, barges, railroads and trucks play different roles in this system, yet data for these transport modes are maintained by different groups and unstandardized. Therefore, the data must be normalized to present a map of how oil is being moved around the state. This study sets all levels to a barrels (42 U.S. gallons) per month (assumed 30 days) standard.

Oil's role in the economy of our state, most noticeably in the sale of motor gasoline, creates different types of risk. The most obvious risk results from transportation, and Oregon is plagued daily by unintended releases. A second type of risk, supply risk, exists because of our reliance on the petroleum networks of Alaska, Washington and California, and was evident during the 1974 oil embargo. Lastly,

economic risk should theoretically be present since Oregon is a downstream consumer from adjacent states. During times of shortages, Oregon should be at the mercy of those who provide its supply. The data do not support this, but suggest that oil is purely a global commodity, and price and supply are determined worldwide in response to typical marketing forces.

The distribution systems detailed herein are dynamic, and outside forces such as the proposed export of Alaskan crude oil, the increased exploration of offshore oil fields, and the development of a cross-Cascades pipeline may alter this scheme. Oregonians can ensure the most effective petroleum distribution systems only by understanding them and their associated risks.

OREGON'S OIL: A GEOGRAPHIC VIEW OF PETROLEUM DISTRIBUTION
AND ASSOCIATED RISKS

by

PAUL M. SLYMAN

A thesis submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE
in
GEOGRAPHY

Portland State University
1996

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CHAPTER I

INTRODUCTION

A comprehensive understanding of how oil is distributed to end users in Oregon can best be gained through a geographic view. This study analyzes the oil distribution systems within Oregon and evaluates the risks posed by those systems. No study of this sort is presently available. Maps depicting the transportation types and corridors provide holistic appreciation of how oil gets from its source to consumption.

This study begins with a look at where we get oil as a nation. Since the United States consumes one fourth of the world's petroleum, we must remain cognizant of the short and long term supplies. Texas is the major supplier of oil products to the United States, and together with Alaska provides one third of U. S. needs. California, Louisiana, and Oklahoma provide the bulk of the remaining domestic supply. Imports, which satisfy half of the U. S. petroleum demand, arrive chiefly from Latin America as well as the Middle East.

The study's focus then shifts to where we get oil as a state. Since the Oil Producing Exporting Countries (OPEC) oil embargo of 1974, and the ensuing development of the Trans-Alaska Pipeline, Oregon has remained dependent on Prudhoe Bay crude oil to quench its fossil fuel thirst. This Alaskan oil journeys through an 800 mile pipeline, then into super tankers bound for refineries in Washington and California. Since there are no refineries within Oregon, eventually it makes its way here as a

refined product traveling via pipeline, barge, self propelled vessel, or tank truck. These incoming activities function as "inputs" to the state's oil budget. Once in Oregon, oil is transported to gas stations, industries, marinas, homes, and many other places that rely on petroleum as a source of primary or back up energy. These activities function as "movements" to the state's oil budget.

This thesis quantifies these activities, and includes both volumes and number of trips per transport mode. Some modes are readily quantified, while others are more challenging. Separate chapters detail the roles performed by pipeline, ships, facilities, tank trucks and railroads. The analysis follows the oil to the "tank truck level" of detail. The oil is not observed to the ultimate level of a home, gas station, or automobile.

Pipelines, which offer the biggest input, are easily counted, and their volumes transported are often available in barrels per hour. Self propelled tank vessels, also known as "supertankers," provided our only source of oil several decades ago, but now visit Oregon only ten times monthly delivering almost one third of the state's need. Tank barges play enormous roles by delivering specialty products from adjacent states, providing bunker fuels to awaiting ships, and moving oils within the river system. Tank trucks carry the smallest volumes but make by far the most frequent trips. Quantifying the transportation patterns of these trucks is difficult, though a 1987 flow study conducted by the Public Utility Commission sought to assess the movement of hazardous materials within the state. Railroads are the only distribution mode not

utilized. Although Oregon enjoys an elaborate rail system servicing many corners of the state, rail is not employed in the oil transportation scheme. Reasons for this are unclear, but most likely it is a function of the inexpensive alternative of using tank trucks. As the population continues to increase, population centers change, or oil prices increase, this rail system may figure more prominently in the future.

Risks, both economic and transportation, are evident in Oregon's oil budget, with the transportation risks far more visible than the economic risks. The transportation risks are quantified through several sources, and predominantly include tank truck, ship and barge mishaps that lead to the spilling of oil. While these affect the environment, this study shows that they are too small to influence the overall oil budget.

Price and supply risk should theoretically be present since Oregon is a downstream consumer from adjacent states. During times of shortages or embargoes, Oregon should be at the mercy of those who provide its supply. As such, any policies, tariffs, or regulations upstream users impose on the oil industry should theoretically be passed on to Oregonians in the form of price increases. Data support supply risk but not price risk. Rather, data suggest that oil is purely a global market, and its price is determined worldwide in response to typical marketing forces such as supply and demand. Comparisons of West Coast prices to U. S. prices, as well as comparisons of Oregon and Washington prices indicate that Oregon is at no greater economic risk than other states during significant "petroleum related events" such as the Exxon Valdez spill

or the Kuwait oil fires. Like anywhere, when significant petroleum related events occur, or there is a perception that they will occur, prices tend to increase.

GLOBAL OVERVIEW

Oil and oil based products play tremendous roles in the economies of the world, and particularly the United States. The United States, in 1992, consumed an average of 17,033,000 barrels per day, representing roughly 25% of the world total of 66,744,000 barrels per day. This was enough to provide every man, woman and child with approximately 3 gallons daily. Japan came in a very distant second place with 5,454,000 barrels consumed, or less than one third the U. S. total for a per capita rate of 1.8 gallons per day (Energy Information Administration, International Energy Annual 1992, Table 8, January 1994). Further per capita comparisons not shown in this study only serve to emphasize the heavy dependence on petroleum by American citizens.

Fortunately for the U.S., domestic sources of oil do exist. However, these reserves are being methodically depleted, and the nation is becoming ever more dependent upon outside sources. The following figure indicates there is little if any correlation between the amount of petroleum a country consumes and the amount it holds in reserves. Such a relationship makes it opportune for oil rich nations to export their resources in attempts to develop economic parity.

Figure 1. Geographic disparity between proven crude oil reserves and oil consumption based upon 1990 figures (Sources: American Petroleum Institute, Basic Petroleum Data Book Vol XIII, No. 3, Section II, Table 4, 9/93, and Energy Information Administration, International Energy Annual 1992, Table 8, January 1994).

This shows the geographic disparity between those that have oil and those that need oil. The movement, or distribution, of this oil affects every country and state, whether they are on the sending end (and subject to environmental or aggression

factors), receiving end (and subject to economic factors), or just on the thoroughfare (and perhaps subject to both).

OREGON OVERVIEW

Oregon, much like the United States, is a large consumer of petroleum products in relation to its crude reserves. To date, Oregon has yet to establish one proven reserve of crude oil, yet it continues to grow in population and increase the disparity between oil usage and domestic supply. This increasing gap, with no corresponding domestic supply, may increase stresses on the quality of life in Oregon.

Since no local crude sources exist, every drop of oil consumed in Oregon originates from an outside source. This outside source is primarily the Alaska North-Slope range, and the path the petroleum takes as it makes its way to Oregon consumers is anything but direct. The oil is pumped from the earth near the Beaufort Sea, in 42" steel piping across three mountain ranges, through the earth, and over permafrost, eventually completing its 800 mile journey in Valdez, Alaska. This journey merely serves to get oil to a position where it can be transported for refining. Oil in its natural form (termed "crude oil") is of little use to consumers until it has been refined. It is during the refining process that the raw material is transformed into its various fractions that power modern machinery, including everything from lawn mowers to electrical generation plants. This refining occurs in neighboring states, but not in Oregon.

It is difficult to assess why Oregon has no refineries, however, Oregon is not unique in this situation. While the majority of states do contain natural sources of crude oil and refineries, densely populated New England is without both. Some states, such as Washington, Hawaii, Minnesota, Wisconsin, Georgia, Delaware, and New Jersey, are without crude oil but do have refining capabilities. A few (Florida, Missouri, Nebraska, and South Dakota) have sources of crude oil, but export that oil for refining. This is becoming increasingly more important as states adopt taxation schedules such as the nickel-per-barrel taxes enacted in Washington, Alaska, and California, which assess a five cent tax on every barrel of crude oil entering their state.

Of states west of the Rocky Mountains, Oregon and Idaho are the only two lacking both an oil source and refineries. Idaho has useful neighbors in Montana and Utah which boast both substantial oil supplies and refining capability. Oregon, on the other hand, has approximately three times the population of Idaho with no such adjacent neighbors, as California has tremendous oil supplies, and Washington must import all of its crude.

Refineries locate in the vicinity of either supplies or markets (Lindsay, 1956), and few refineries have been constructed since the 1950s and 1960s. With no major population source, no nearby crude supplies, and restricted channel depth of the Columbia River, Oregon was understandably bypassed in favor of Puget Sound when refineries were constructed in the Northwest.

CRUDE OIL EXPLORATION AND PRODUCTION

It has been argued the greatest risk in the oil business is the financial risk to the companies that make their livelihood in the industry. Oil exploration and production involve risk, which can be simplified into: (1) finding oil; and (2) ensuring that the oil is of a quality and quantity demanded by the prevailing market. Such financial risk is not quantified in this study, but it does influence the global petroleum market.

Crude Oil Overview

Crude oil on Alaska's North Slope had been identified in the 1960s, but cheap imports rendered extraction and production of this source unattractive. Adding to this unattractiveness was the engineering challenge of transporting oil from Prudhoe Bay to end users in the lower 48 states. Early into the 1974 OPEC price hikes, large oil companies with the assistance of the U. S. government, elected to construct a pipeline crossing the Brooks Range, the Alaska Range, and the Chugach Mountains. This endeavor became the largest engineering feat of the decade, but unfortunately for U. S. alternative energy policy, it also overshadowed the development of alternative fuels. Like the United States, other nations have adopted efforts to secure supplies of non-OPEC crude in attempts to minimize their economic vulnerability. Naturally this forces OPEC (whose share in world production dropped from 57 % in 1975 to 36% in 1990) to examine ways to increase exports (Fellman, 1990).

Crude oil is a mixture of chemical compounds comprised of hydrogen and carbon atoms (“hydrocarbons”), which must be separated to be made useful. The unique characteristics of each of these compounds aid in their separation by a distillation process. This process takes a batch of crude oil, heats it to a particular temperature, and allows a portion to boil off. After awhile the boiling ceases and that which has boiled off is collected. The temperature is then increased to the same batch of crude until boiling recommences. This boil off is also collected, although separate from the first step. The entire process continues, with the temperature applied to the crude increased at each step, until only the heaviest product remains.

This distillation process (refining) serves to separate the crude at various “cut points” corresponding to the temperatures at which they boiled. Although all crude oils differ, typical cut points provide products such as:

	90°F	propane and butane
90°F →	220°F	gasoline
220°F →	315°F	naptha
315°F →	450°F	kerosene
450°F →	650°F	gas oil
650°F →	800°F	heavy oil
800°F		residue

These products can be blended, or used directly in the capacity they are needed.

Based upon the crude oil, large percentages of light, and generally more expensive,

products may be distilled. These are referred to as “light crudes” as opposed to “heavy crudes” containing a larger percentage of the heavy fractions which supply a greater proportion of the residual and gas oils favored by industrial users. Approximately three fourths of crude refined in the United States is turned into light distillates such as motor gasoline.

Refinery Overview

Rather than refine the crude oil in Alaska, then export the finished products, the industry prefers to construct refineries near the end user. Like any bulk industry, transportation of a uniform product (e.g. crude oil) can be achieved more easily and cheaper than transportation of many products (e.g. kerosene, gasoline, and diesel). The logistics of separating cargoes and delivering specific cargoes to specific locations can increase costs. Furthermore, crude oil supplies from any given locale are finite. Therefore, although refineries situated in Alaska may be able to refine crude supplies from all over the world, a local market for their output may not always exist. In this sense, refineries exploit a particular crude source, and upon its depletion, look for crude sources elsewhere to fuel their operations. Should the replacement crude source differ substantially from the initial crude source in chemical composition, the refinery adjusts to provide the appropriate final products.

Distribution Overview

For off-site refining, crude oil is shipped in large ocean going ships known as super tankers. Along the West Coast, these tankers deliver their cargo from Valdez to refineries in Southern California, Northern California, and Puget Sound. The Southern Californian refineries are centered in Long Beach and import crude supplies from Alaska, as well as off the California Coast. The Northern California (San Francisco Bay) and Puget Sound refineries are adjusted primarily to accept Alaskan crude.

Once these crude oils are refined into consumable products, they are distributed to the market. This distribution includes the use of self-propelled tankers, barges, railroads, trucks, and pipelines in various combinations. Oregon relies on the use of all but railroads to distribute bulk petroleum.

SEARCH FOR CRUDE OIL SOURCES IN OREGON

With the boom in oil usage in the early 1900s, many states quickly realized that securing a stable source of crude would be in their financial interests. Oregon saw abundant oil being produced in California and initiated studies to secure a supply of crude within its borders.

Overview

When searching for petroleum, geologists first look for oil seeps. Since oil is generally lighter than water, any underground sources of oil float on the groundwater, and have a tendency to make their way to the surface. Oil seeps in any of the petroleum

regions of the world have been known of and talked about by local inhabitants centuries before the development of petroleum. Seeps in California were known to the Native Americans long before the arrival of white and Spanish settlers.

Given a lack of oil seeps, geologists look for favorable conditions to indicate presence of underground petroleum. First, for any region to be productive, it must have beds that can be a source of petroleum. Such beds must be porous enough to hold the oil and yet when tapped must allow oil to flow to a well. Beds of impervious material must overlay this reservoir so as to prevent too much upward movement of the oil. Folding of these beds into synclines and anticlines allows petroleum to concentrate in the tops of domes, thus easing extraction.

Oregon Oil Exploration on Land

Exploration for oil in Oregon began in earnest in 1902, when A.C. Churchill drilled two wells near Newberg, and was rewarded with a small flow of non-flammable gas. For the following two decades, over 40 wells were drilled, the largest of which was in Ontario when gas forced sand and mud to be blown all over the drilling derrick. After World War I, another 45 more wells were drilled, none of which produced. Following World War II, and the escalating demand for motor gasoline, major companies (Phillips, Richfield, Texaco) began to invest in Oregon. Again, their searches revealed no commercially viable quantities (Olmstead, 1989).

Oil Exploration in Western Oregon. Geologists formerly believed that Western Oregon was largely made of rock formations of similar geologic age to the successful

oil districts of Southern California. In 1919, the Oregon Bureau of Mines and Geology (now termed the "Oregon Department of Geology and Mineral Industries") optimistically commissioned a study to determine oil presence in the western portion of the state.

Four transects were completed from the coast to the Cascade Range to determine the geologic structure of the region and predict the potential for oil. Surveys were distributed to local residents to determine the presence of natural seeps, which would offer quick indications of petroleum. Eaton & Arthur (1920) reported a large natural seep in the North Fork of the Yamhill River, and found clear oil floating on the water's surface. Samples were taken and analyzed to contain 2% foreign matter (water, insects, and dead leaves), with the remaining 98% analyzed as kerosene of the commercial grade "lantern oil". This seep was apparently either a hoax or Oregon's first recorded oil spill.

The study failed to give any encouragement that Western Oregon would have areas in which petroleum exists in commercial quantities. One geologist, Chester Washburne, theorized, "As the surface of rocks of this region are generally saturated with circulating groundwater that reaches the surface in the rainy season, it is not unreasonable to think that the water has washed out all of the free oil of the rock than can be removed by water displacement" (Eaton & Harrison, 1920, p. 25). In other words, the heavy precipitation in this region may have washed out any free oil. In California, oil regions are not broken by volcanic intrusions as are found in Oregon. The lack of satisfactory geologic indications such as confirmed oil seeps, and the

generally broken conditions of formations, led researchers to dismiss any comparisons with Southern California's oil rich terrain.

Leasing and drilling increased in the late 1960s and culminated with a commercial gas discovery in 1979 near Mist in Columbia County. Subsequent drilling resulted in the discovery of additional pools of gas. A pipeline connecting these fields to a regional natural gas distribution network was completed by Northwest Natural Gas in 1980, and although this was not as valuable as petroleum, it marked the beginning of domestic gas production in Oregon. Exploration continues for additional fields in many parts of the state, yet viable quantities of petroleum have yet to be found.

Oil Exploration in Eastern Oregon. A study was conducted in Eastern Oregon in the 1920s led by Yale geologist John Buwalda. This plateau region is underlain by volcanic rocks in the form of lava flows and interstratified tuff and volcanic ash beds. These lavas made their way to the surface from fissures and after their deposition, they were warped, folded, and faulted.

Buwalda examined 15 separate regions of Oregon east of the Cascade range. The districts included the Columbia River Gorge, The Dalles, Dufur, Pendleton, John Day, Blue Mountains, La Grande, Prineville, Harney Valley, Beulah, Bend, Klamath Falls, Lakeview, SE Oregon, and Ontario. Drilling for oil had already been accomplished in the Dalles, Dufur, Burns, Klamath Falls, and Ontario. These wells had struck small quantities of gas, but all quickly dissipated. Traces of oil had been reported but no verifiable quantities in which crude was brought to the surface existed.

Buwalda (1921) concluded that Eastern Oregon was also an “improbable” source of crude oil. His judgment was based upon the absence of typical oil seeps, the freshwater origin of the sedimentary strata, the volcanic nature of rocks underlying the sediment, and perhaps most importantly, the many failures to locate oil.

Oil Exploration Offshore Oregon

During the 1960s and 1970s, exploration continued onshore and extended offshore for the first time. Major oil companies completed seismic work and elected to drill eight offshore wells. In 1964, leases were made for state and federal property off Oregon’s coast. The eight wells, like their many onshore counterparts, again discovered no commercially viable quantities of crude. After several years and \$75,000,000, the leases were dropped in favor of onshore leases (Olmstead, 1989).

STUDY METHODOLOGY

Oil is seldom found where it is consumed. On a global scale, this was demonstrated in Figure 1 of this report. On a nationwide scale, Alaska represents a superb demonstration. Having the greatest amount of crude oil reserves (when the Arctic National Wildlife refuge is included), Alaska has not only the lowest overall consumption, but at 270 stations, also the fewest number of gasoline outlets. Oregon, with five times the population, has almost 2000 gas stations and consumes about five times more petroleum. Delivering petroleum from the fields to the consumers, or source to use, is where distribution becomes important.

The following chapters detail this distribution system in Oregon. Pipelines, ships, barges, facilities, railroads and trucks all play different roles in this system, yet these roles are nowhere clearly articulated. Data for these transport modes are maintained by different groups and unstandardized, and hence drive the presentation of this report. Pipelines and facilities are stationary components of the system and chapters detailing them are largely textual. Ships, barges and trucks are moving components of the system and their chapters are primarily graphs. The data for all chapters must be normalized to present a useful picture of how oil is being moved around the state. This study sets all levels to a barrels (42 U.S. gallons) per month (assumed 30 days) standard to allow for meaningful comparisons.

Data used for this study came from many sources, primarily the federal and state governments. For most of the analysis, data for the three year period 1992-94 were used as they were not only available and recent, but also provided a convenient comparison to data for the 1974 oil embargo. Since Oregon is neither a major population center, nor a major market in the petroleum industry, much of the data that is available for other states was unavailable for Oregon.

This study places numbers both on the volumes in each of the processes and the frequency of occurrences. Consumption of oil (perhaps termed “outputs”) is not analyzed. The analysis is conducted around “inputs” and “movements” of oil, which represent the distribution system at work in Oregon.

CHAPTER II

OIL PIPELINES IN OREGON

OVERVIEW

Pipelines serving Oregon in varying capacities provide the single largest input to the oil budget. These include pipelines which import oil from outside the state, pipelines which move oil within the state, and a pipeline which passes through the state without providing oil. They therefore serve the dual roles of inputs and movements to Oregon's oil budget.

The lack of any east-west oriented mountain ranges in the western portion of Oregon aids petroleum distribution. The Willamette Valley provides a flat, stable surface with minimal topographic relief for pipelines originating in Puget Sound terminating in Portland and Eugene. This network allows for 60% of Oregon's annual oil consumption to enter the state and transfer to the many tank farms situated along the lower Willamette River.

For pipelines to figure into Oregon's oil budget, they must bridge the gap between supply at one end and demand at the other. For example, the Olympic pipeline offers the refined petroleum from the Puget sound region to Portland and the surrounding area. The Santa Fe Pacific Pipeline offers a similar service to Eugene. The

Chevron Utah pipeline, on the other hand, merely passes through the northeastern corner of Oregon without loading or discharging. A summary of the pipelines and their characteristics follows:

TABLE I
OIL PIPELINES OPERATING IN OREGON

Petroleum Pipelines Operating in Oregon						
Name	Origin	Destination	Capacity	Tanks	Storage	Products
Olympic	Puget Sound	Portland	140000	2	4000	Various
Santa Fe Pacific	Portland	Eugene	52200	15	83388	Gas, Diesel
Chevron	Portland	PDX Airport	7500	na	na	Jet fuel
Kaneb	Umatilla	Hinkle	10,000	2	52000	diesel
Chevron	Boise	Pasco	32000	0	0	Various
notes: Capacity is listed in barrels per day. Tank storage is listed in barrels.						

The pipelines fill specific niches in the transportation needs of the state. Some provide tremendous amounts of product on a continuous basis, while others are used only sporadically.

Olympic Pipeline

No doubt the largest, and most sophisticated pipeline serving Oregon, the Olympic pipeline began initial construction in 1965 to link refineries in the north Puget Sound area to bulk oil facilities around Portland. All operations are remotely controlled through the Renton control center which operates 24 hours a day.

Olympic receives products directly from four refineries--Arco at Cherry Point, British Petroleum at Ferndale, and Shell and Texaco at Anacortes. The system consists of various size mainlines in its upper stretches, then a 14 inch mainline to complete its journey from Renton to Portland. Along its almost 400 mile route, the pipeline supplies the cities of Seattle, Tacoma, Tumwater, Vancouver, Linnton, and Portland. The Sea-Tac Airport also receives product from this line.

Products are moved through this pipeline at a rate of four miles per hour by pumping stations located in the Washington cities of Allen, Woodinville, Renton, Spanaway, Vail, and Castle Rock. Once in Oregon, the pipeline supplies many facilities with various products including premium gasoline, regular gasoline (leaded and unleaded), jet fuel, diesel fuel, and heating oil. In Linnton, deliveries are made from the 14 inch mainline into tankage owned by GATX. At the Portland Delivery Facility, deliveries are made from the 14 inch mainline directly to Arco and Time Oil terminals and to Shell, Chevron, Union, McCall and Texaco terminals through manifold valves (Olympic Pipeline Spill Contingency Plan, 1993).

The capacity of this pipeline is 144,000 barrels per day, and it typically operates at full capacity (Personal conversation w/ Olympic Pipeline Company, August 1995).

Santa Fe Pacific Pipeline

The Portland area reception stations described above also function as delivery stations for the Santa Fe Pacific pipeline stretching from Portland to Eugene. Eight

separate transfer lines (one from each facility) meet at the pipeline's Portland Pump Station, where a single eight inch line begins its 115 mile southward journey.

Remote control pump stations exist in Fargo, Salem, and Morgan, with distribution terminals operating in Albany and Eugene. The capacity of this pipeline is 52,000 barrels per day, although it more typically averages 35,000 barrels per day, of which 2,000 barrels is taken off in Albany (ODOE, 1992).

Chevron Utah Pipeline

The Chevron Utah Pipeline, built in 1951, crosses the northeastern corner of Oregon on its journey from Salt Lake City, Utah, to Pasco, WA. The crude for this pipeline originates in the Rangely Oil Field in northwestern Colorado, and approximately 34,000 barrels per day are collected and pumped to the Chevron refinery in north Salt Lake. The Salt Lake to Pasco system is comprised of four segments: Salt Lake - Boise segment (lines 1 and 2), Pocatello lateral segment, and Boise - Pasco segment.

The Salt Lake - Boise segments run parallel and are distinguished merely by their products carried. Line #1 carries diesel fuels, heating oil and jet fuel. Line #2 carries regular, unleaded, and supreme gasolines. These are both eight inch pipelines spanning 320 miles.

The Pocatello segment similarly consists of an eight inch line traveling 55 miles from Boise to Pocatello. Oil is stored here by bulk facilities operated by four shippers who truck it to local destinations.

The Boise - Pasco segment consists of 240 miles of eight inch pipe carrying all grades of petroleum products from the Boise storage facilities to the Pasco marine terminals. From Adams, OR, to Pasco, the line is looped , which adds an additional 80 miles of six inch line to the capacity (Chevron Pipeline Prevention Plan, 1993).

Although this pipeline severs the northeast corner of Oregon from Ontario to Pendleton, no product is currently taken off this pipeline in the state. Terminals were once located in Baker City and Adams. Because of dwindling demand, the Baker terminal has been removed and the Adams terminal has remained unused since September, 1990 (ODOE, 1992).

Chevron Airport Pipeline

The Chevron Airport Pipeline replaces a railroad depot connection and tank truck deliveries that used to provide the jet fuel necessary for airport operation. Constructed in 1971, it travels from the Chevron distribution facility in Portland nine miles to the Portland International Airport. The pump station consists of a single pump with metering facilities, and there are three sets of intermediate control valves for the eight inch line (Chevron Oil Spill Contingency Plan, 1993). The daily operation of this pipeline moves approximately 5,700 barrels eliminating 24 daily tank truck trips to the airport.

Kaneb Pipeline

The Kaneb Pipeline Operating Partnership owns a four and a half inch line carrying diesel fuel from the Tidewater Barge Lines Umatilla terminal to Union Pacific

Railroad's yard in Hinkle. Tidewater barges fill the 42,000 barrel tank in Umatilla where the diesel is then piped to a 10,000 barrel storage tank owned by the railroad to power its locomotives. This pipeline was constructed in 1979.

Figure 2. Locations of pipelines in Oregon.

RISK FROM OIL PIPELINES

Environmental Risk

Pipelines are often considered the safest mode of petroleum transport when evaluating the enormous volumes they move as compared to the number of spills occurring. In Oregon this has particularly been true with only one spill over forty two gallons reported since 1988. A worldwide view does not paint the same favorable picture. Worldwide spill data for 1994 reveals that of the 25 largest releases, 10 were from pipelines. The remaining 15 were from self propelled vessels, barges, and bulk oil facilities combined. These pipeline spills are often the result of an outside action such as digging, or flooding, as was the case in the many Houston pipeline spills last year. However, the 1995 catastrophic pipeline spill in Russia, which has still not been quantified, is theorized to be the result of poor engineering and maintenance.

Oregon is not without its pipeline risk. The Olympic pipeline from Puget Sound passes underneath the Columbia River near Sauvie Island, approximately 100 yards from two natural gas pipelines. Although buried to a depth of twelve feet where possible, the line is subject to ships anchoring directly above. The area directly above this burial is not a designated anchorage. However, vessels prefer it for its wide berth and convenience to the many terminals in Portland and Vancouver, and they often anchor nearby. Given the combination of the strong Columbia River currents, coupled with the sandy substrate, the opportunity for anchors to drag is evident. Such dragging could easily damage the pipeline, causing a rupture and subsequent release. Fortunately

the pipeline has remotely operated valves from its Renton, Washington, control center which could be secured in such an event. However, the valves must be closed sequentially, and it takes approximately ten minutes to follow the sequence. At a pumping rate of 144,000 barrels per day, the absolute minimum amount of product lost from a rupture to this pipeline would allow 42,000 gallons of product to be released.

The Santa Fe Pacific, Kaneb, and Chevron Airport pipelines also provide environmental risk. These lines move significantly smaller quantities of petroleum than the Olympic Pipeline, and are not buried in way of ship anchorages. Spills from them would most likely result from unauthorized digging or movements of the earth's crust.

The Chevron Utah pipeline, traversing the northeastern edge of Oregon, presents risk with no benefit. The 32,000 barrels per day pumping through this line present an exposure to Oregon natural releases, but offer no benefit since all the product is destined for Washington.

Economic Risk

Petroleum pipelines are regulated federally by the Department of Transportation Research and Special Projects Administration (DOT-RSPA). Any changes to these regulations would apply universally and consequently place the states on equal footing for economic risk. Along the West Coast, state regulations are also enforced for spill prevention and response. These regulations require extensive planning, equipment purchases and exercising and increase the operating costs of the pipelines. Since the federal regulations apply universally, and West Coast states all maintain similar

regulations, economic risk is not readily evident. However, since the Olympic pipeline provides Oregon with 60% of its needed petroleum, any extended delays in operation would have severe economic effects on the oil supply network.

A proposal has been made to establish a pipeline crossing the North Cascade Mountain Range near Ellensburg, Washington, to provide the Pasco, Washington, area with petroleum. The present schedule has the pipeline securing necessary permits and rights-of-way over the next eighteen months, then completing construction during the following year. Initial output of the pipeline is scheduled for 65,000 barrels per day. While this pipe does not enter Oregon, it does present ramifications to the shipping industry. As described in the following chapter, 65 barge trips upriver to Pasco occur monthly. These trips will all but be eliminated by the construction and operation of the pipeline, which will significantly hamper the economic viability of the Columbia River petroleum barging industry. Not as readily apparent, but also a threat, will be the ramifications to the tank vessels calling on Portland. As the cross Cascades pipeline goes into operation, it will free up capacity of the existing Olympic pipeline by allowing product to be transported directly to Pasco, rather than to Portland and then to Pasco. This change allows Olympic to send more Portland-destined product through the existing pipeline, which will reduce the need for outside shipments.

Given the global nature of the petroleum industry, these pipeline developments will most likely not be offset by a price decrease for petroleum users in the Pasco area. Therefore, the economic risk primarily takes the form of lost jobs with the decline of the upriver petroleum barging fleet.

CHAPTER III

SHIPPING IN OREGON

OVERVIEW

Large quantities of oil are moved by vessels in Oregon's waters, which includes both self propelled and non-self propelled (barge) vessels. These watercraft function in the roles of both inputs and movements to the distribution system. Oregon does not receive the crude-carrying super tankers similar to the familiar Exxon Valdez, but instead receives much smaller vessels carrying refined products from Puget Sound, Northern California, and Southern California.

The Columbia River, with its dredged depth of 40' limits the size of oil tankers desiring entrance, and necessitates the use of smaller tankers which transport products from refineries in Puget Sound or Northern California. The riverbed is primarily sandy which allows for the occasional tanker grounding without the risk of catastrophic spills.

On the coast, deepwater ports exist in Coos Bay and Yaquina Bay. Coos Bay uses this capability to perform the role of petroleum distribution hub within its region, and is served by large oceangoing tank barges entering two to three times monthly. Yaquina Bay has failed to secure any waterborne oil distribution service, and uses its deepwater port capability to receive occasional lumber ships.

The basaltic Cascade Mountain Range cuts a north-south boundary dividing the western one third of Oregon and Washington from their remaining portions to the east. Crossing this range has historically been treacherous, and were it not for the presence of the Columbia River Gorge, oil transport and distribution would be significantly hampered. The Gorge serves as the only sea level east-west crossing of the Cascade Range, and as such it has enabled barge traffic to supply the inland portions of Oregon with needed petroleum. Other river limitations include the presence of the Oregon City Falls, located near West Linn on the Willamette. These falls prevent commercial vessels from provisioning upriver portions of the Willamette.

Typically, the super tankers carrying crude oil travel from Valdez, Alaska, to one of the three destinations mentioned above for refining. Following the refining process, smaller product-carrying tankers move the oil up and down our west coast to the distribution facilities. Far smaller than the 1,000,000 barrels carried in the super tankers, these coastal tankers typically hold 300,000 barrels since the depth of the Columbia River (maintained to 40 feet) does not allow tankers of greater size to enter. Occasionally super tankers in need of repair enter the Columbia to proceed to the Swan Island Ship Repair yard, but do so very carefully in an unloaded condition.

Oil moved into Oregon on barges is done on large ocean going barges, which can often load 75,000 barrels. These barges typically move heavy fuel oils since such products cannot be transferred by the Olympic pipeline. Once oil is to be distributed inside the river system, it is transferred to other smaller barges. Such barges average 15,000 barrels capacity for those used to transfer propulsion fuels to awaiting vessels

and 40,000 to 50,000 barrels capacity for those used to transfer from facility to facility.

The distinction between these transportation patterns is discussed later.

SELF PROPELLED TANKERS

The self propelled tankers function as an input to Oregon's oil budget. These tankers generally operate in a "liner route," meaning they routinely travel between scheduled ports. Occasionally, "tramp" tankers, which operate whenever they can find a job, visit Oregon, although not as frequently as the liner trade.

The tankers calling on the Columbia River and the coast travel between refineries in California and Washington to deliver products. Those coming from California supplement the minute amount of products imported via truck from the south. Those coming from Washington augment the majority of product input which flows from the Olympic Pipeline. On rare occasions, a crude carrying tanker visits from South America to supply stock to the asphalt plants operated by Chevron Products Company on the lower Willamette River.

As the following graph depicts, tanker visits to Oregon average roughly ten monthly, all to the Columbia River area. Self propelled tankers have not called upon Coos Bay since August 1993. This corresponded with the implementation of federal response requirements which were followed the passage of the Oil Pollution Act of 1990, an amendment to the Clean Water Act. These requirements necessitated the purchase and maintenance of oil spill recovery equipment in Coos Bay. Rather than fund such a response organization, industry elected to cease deliveries by self propelled

tankers. Product has since been delivered two to three times monthly via oceangoing barge.

Figure 3. Destination of self propelled oil tankers in Oregon 1992-94. Coos Bay has not received a tanker since the implementation of the Oil Pollution Act of 1990 (Source: DEQ vessel movement data 1992-94).

Based upon these 10 monthly visits, average tanker traffic to the Columbia River equals approximately 100,000 barrels daily, as compared to almost 200,000 barrels daily from the Olympic Pipeline. However, the speed with which oil is moved by these vessels, while slow, is about three times that of the pipeline.

OIL BARGES

Barges function as both inputs and movements to Oregon's oil budget. Large oceangoing barges move products into the state's waters. Hauling smaller specialty shipments that would not warrant a full self propelled tanker, these barges routinely travel from ports in northern and southern California, as well as Puget Sound. Oil budget movements are accomplished by barges that operate entirely within the river system and are not engaged in a coastwise trade.

Oil Inputs by Barge

Barges providing inputs to Oregon are generally large ocean going barges operated by one of five barge companies, all of which are headquartered on the West Coast. Although the origin of these barge trips fluctuates over time, overall they are split evenly between Oregon and Washington.

Figure 4. Origin of oil barge inputs to Oregon. Refined products are moved from Washington and California into Oregon ports (Source: DEQ vessel movement data 1992-1994).

An examination of the percentages gives a clearer picture of the fluctuations between California and Washington originated shipments.

Figure 5. Origin of oil barges entering Oregon waters 1992-94 (Source: DEQ vessel movement data 1992-1994).

More predictable than the origin of these barges, is the cycle they follow in their deliveries shown in the following graph. The majority of vessels calling on the Columbia River versus Coos Bay obviously corresponds to the demand of these two geographic areas. On a monthly average, Coos Bay receives just 33,000 barrels of oil by barge, while the Columbia River receives 240,000 barrels (U.S. Army Corps of Engineers, Waterborne Commerce User Statistics, 1993).

Figure 6. Destination of oil barges entering Oregon waters 1992-94 (Source: DEQ Vessel Movement Data 1992-1994).

A comparison of the “Origin” and “Destination” information reveals that Coos Bay receives 79% of its barge shipments from Washington, 7% from California, and 14% from the Columbia River. The Columbia River, on the other hand, receives 48% of its barge shipments from Washington and 52% from California. This is curious considering geographically Coos Bay is closer to California than is the Columbia River.

The primary explanation for Coos Bay's traffic is one of contractual arrangements. Coos Bay facilities have a business relationship with oil suppliers in Puget Sound, and therefore originate their shipments in Washington. While this ensures Coos Bay a reliable source of oil, it renders them more vulnerable, and hence at greater risk, to Washington energy policies and availability than is the Columbia River.

Oil Movements by Barge

Once oil is within Oregon, it is transported through the Columbia River system by various barge fleets. This transport generally serves two purposes: to move product from one facility to another, and to move product from a facility to an awaiting ship. In Coos Bay, very few movements occur. Once product is at the facilities, it generally is moved to tank trucks for distribution. In the Portland area, the movements are more complex as product is moved upriver to supply the upper Columbia and Snake Rivers' needs, and downriver to supply commercial ships needing propulsion fuel.

Upriver movements exist to provide oil supplies to facilities lying outside the Portland metropolitan area. Oil distribution facilities exist in Umatilla, Oregon, Tri-Cities, Washington, and Clarkston, Washington, and use this barged oil to supply parts of eastern Oregon, Washington, and Idaho.

Historically, mariners brought oil barges upriver to supply these facilities, and grain barges downriver to supply the silos on the lower Columbia. Such trade routes necessitated an empty load at least one direction since grain and petroleum could not be loaded into the same tanks. Eventually, a combination barge was developed by local

shippers that allowed oil to be carried in lower tanks during the upriver transit, and then grain to be carried in an upper hopper during the downriver transit. Such an arrangement allowed the barge to maintain earning capacity during a round trip journey, and served to keep prices of both commodities low.

The Oil Pollution Act of 1990, passed in the wake of the Exxon Valdez spill, requires oil barges to be fitted with double hulls. This requires an inner hull that carries the oil, and an outer hull that serves as a void space between the vessel and the water. This requirement has rendered the combination barge, which efficiently served the Columbia River since the 1950s, unfeasible. Therefore, combination barges are methodically being replaced by large double hulled oil barges to move petroleum upriver, and hopper-configured barges to move grain downriver.

The following graph depicts the principal destinations for upriver transits of oil.

Figure 7. Upriver destinations for barges departing from Portland 1992-1994. These movements supplement the oil flowing to these locations through the Chevron-Utah pipeline (Source: DEQ Vessel Movement Data 1992-1994).

On average, this represents 65-70 trips per month, or more than two daily. The majority of trips are from Portland to Pasco, although about one trip occurs from Portland to Umatilla every two days, which has one oil distribution facility serving trucks and rail. The rail segment of this facility consists of a pipeline feeding a 10,000 gallon storage tank at the Hinkle rail yard. The remainder of the product stays at a tank farm for eventual distribution via truck. Barge trips to Pasco supply the Chevron and Tidewater tank farms, which also receive inputs from the Chevron Utah pipeline described earlier.

Occasionally barges move from Pasco downriver to the Portland area. These barges transport products from the Chevron pipeline-supplied facilities and provide them to the Portland facilities. Shipments such as these usually occur because of the need for specialized products only available through the Chevron pipeline, although, occasionally these shipments occur because of price differentials between the Chevron Pipeline and the petroleum supplies coming in to Portland (Personal communication with Tidewater Barge Lines, March 1995).

Barges also provide “bunker” fuel to ships visiting Oregon’s waters. “Bunkering” is an historical term derived from large coal storage compartments known as “bunkers” on early powered ships. Today the term generally refers to the refueling process on self propelled vessels. Ships receiving bunkers play a significant role as a “movement out of state” to Oregon’s oil budget. This role is primarily limited to heavy fuels, which are less costly, have high BTU (British Thermal Units), and are burned in ships’ boilers or engines.

In Oregon, ships receive bunker fuel either in Coos Bay or the Columbia River. Yaquina Bay, although a deep draft port, does not have the facilities to support a bunkering operation. Therefore, cargo ships calling on Yaquina Bay must also visit other ports to refuel. In Coos Bay, approximately three vessels receive bunker fuels monthly, and this has fluctuated over time. In recent years, the Columbia River has experienced a significant decline in vessels receiving fuel.

The 1992, 1993, and 1994 monthly average number of vessels receiving fuel were 100, 85, and 75 respectively. Considering each vessel receives 6,761 barrels of fuel, the decline represents a significant alteration to the overall oil budget. The number of vessels receiving bunkers appear independent of the overall trend of ships visiting the Columbia River, which has remained relatively unchanged, and perhaps slightly increased, over time. Data from 1992-94 indicate that the average number of vessels calling on the Columbia River has remained steady at 170 per month. Therefore, rather than the 58% of vessels receiving bunkers in 1992, we presently experience only 44%. The 25 vessels not receiving fuel represents 169,025 barrels, or 7,099,050 gallons of fuel monthly. At \$.80 per gallon, this amounts to \$5,679,240 monthly. Industry reasons for this decline generally point to heightened regulatory oversight on such operations. However, Oregon has no specific rules pertaining to the receiving or delivering of bunker fuels which would serve to increase their cost. The environmental will of the public is strong, however, and spills from ships receiving fuel are not tolerated. Therefore, this risk perception may be enough to deter ships from loading

bunkers. The availability of low cost fuels in Singapore and Mexico probably cuts into the Columbia River's market more than any environmental issue.

Despite this, it is interesting to note the healthy role Oregon does play in vessel bunkering. Nationwide figures from 1992 indicate that Oregon ranks a respectable seventh in states providing bunkers to vessels with 289,667,000 gallons (6,896,833 barrels) transferred. This follows the other west coast states with California leading the nation at 1,463,396,000 gallons (34,842,762 barrels) and Washington at 1,038,944,000 gallons (24,736,760 barrels) (National Petroleum News, Mid-June 1994). California and Washington both have huge shipping ports. By comparison, Oregon receives a small number of ship visits and ranked just twenty-second in total ship activity for 1993. California ranked third and fifth respectively (U.S. Army Corps, Waterborne Commerce User Statistics 1993). Therefore, compared to other states, Oregon barge and oil companies are seizing the opportunity to provide bunkering services to a large percentage of the commercial vessel traffic.

In Coos Bay, vessels receiving fuels do so at any terminal they are berthed. Along the Columbia River, vessels receiving bunker fuels do so at three principal stretches. These geographic locations are Astoria, Longview, Portland/Vancouver. Vessels receive the bunker fuels at these locations because they must either be moored or at anchor prior to receiving fuels, and these locations provide such services. Given the choice, vessels prefer to conduct bunkering at anchor since it saves them from having to pay additional moorage fees.

Generally, the receipt of fuels takes a secondary role to the transfer of cargo, therefore, vessels prefer to take care of cargo operations, then move to anchor to load bunkers. Since Portland/Vancouver is the largest loading port, it has the correspondingly highest bunker activity, followed by Longview and eventually Astoria. Portland has no anchorages due to the constricted channel in the Willamette, therefore, all vessels bunkering in Portland do so at a terminal following cargo operations. The chart below depicts the locations vessels receive bunker fuels, which functions as a “movement out of state” to the oil budget.

Figure 8. Locations of vessels receiving bunkers monthly average 1992-1994. Most bunkering is completed in the Portland/Vancouver area for convenience and cost savings (Source: DEQ Vessel Movement Data 1992-1994).

While all vessels receiving bunker fuels represent a movement of oil, it is apparent that significant differences exist in where they receive those fuels. Such

differences may not signify a critical element of the oil budget, but they offer information on the environmental risk involved per location, and the economic importance of various locations along the Columbia River.

RISK FROM SHIPPING

Environmental Risk

The environmental risk from shipping manifests itself in the form of spills subsequent to groundings, collisions, and transfer operations. Oregon's largest historic spills have all been from vessels. The first major waterborne spill was the 1978 grounding of the Motor Vessel (M/V) Toyota Maru who punctured a fuel tank on the lower Willamette River with the ship's anchor. This mishap allowed over 30,000 gallons of heavy fuel to spill. Following this was the grounding of the M/V Blue Magpie on north jetty of Yaquina Bay during a storm in 1983. This grounding not only led to the complete loss of the Blue Magpie, but allowed 80,000 gallons of mixed fuel products to damage Newport's beaches. The largest spill in Oregon history was the grounding of the self propelled tank vessel MobilOil, which in 1984, ran aground on Warrior Rock at Sauvie's Island's downstream tip. This navigation error caused the loss of 225,000 gallons of mixed petroleum products to damage the fragile Columbia River.

Perhaps more frustrating is the effect that offshore shipping may have on Oregon's environment without even entering the state's territorial sea. Tar balls routinely wash up on Oregon beaches that are most likely a result of passing ships cleaning tanks or pumping bilges far out to sea. Such crimes are difficult, if not impossible to prosecute, as the opportunity to catch such vessels is limited to crewmember confessions. Also problematic are spills occurring elsewhere that are

brought to Oregon because of the nearshore current. Following the 1991 Motor Vessel Tenyo Maru collision off Vancouver, B. C. , oil washed up as far south as Lincoln City, and response crews hastily worked to remove debris before it could become contaminated as well.

On average, Oregon experiences one large waterborne distribution related spill annually. Two relatively identical spills occurred almost six months apart in 1993 and 1994. The spills both resulted from bunkering mishaps involving a domestic barge line and foreign bulk cargo ships. The first spill involved the Motor Vessel Central and occurred the morning of June 3, 1993. The second spill involved the Motor Vessel An Ping 6 and occurred the morning of January 10, 1994. Cleanup for the M/V Central lasted three days, as opposed to cleanup for the M/V An Ping 6 which lasted 30 days. The remarkable difference in the cleanup time required for the spills can be attributed to the large variability in river discharge. The M/V Central spill occurring in early June with a river discharge of 325,000 cubic feet per second (cfs) stayed largely in the main channel of the river, avoided large portions of the shoreline, and proceeded downstream with the current. Consequently the cleanup lasted only three days. The M/V An Ping 6 spill, occurring under identical circumstances except sixth months later with a river discharge of 120,000 cfs, severely polluted the Washington shoreline, required a month long cleanup and cost significantly more in response. Property claims, although presently unavailable in detailed form, suggest far greater damages from the M/V An Ping 6 spill as well. The "large spill" for 1995 occurred on August 5, and involved

2000 gallons of heavy fuel oil being transferred from a barge to an awaiting ship on the lower Willamette.

Economic Risk

Economic risk from vessels is evident in the lack of control Oregon has over the international nature of the shipping industry. In addition to the economic risk from reduced bunkering described earlier, many ships visiting Oregon travel from all over the world, and are subject to a variety of regulatory regimes. For example, ship operations are influenced by their flag state, or nation issuing their certification, the port state, in this case the United States, international maritime rules, and local rules. Therefore, a tanker visiting Oregon from Washington not only must comply with flag state, port state, and international regulations, it must also comply with Washington state tanker regulations. Washington State is presently being sued by the International Tanker Owners Association (INTERTANKO) for establishing tanker regulations in excess of federal regulation. One ramification of such regulation is the increased cost of compliance, which is ultimately passed on to the consumer.

California likewise has tanker regulations which could economically affect Oregon. Tankers wishing to load products in California (and potentially bound for Oregon) are required to deploy oil spill containment boom prior to conducting operations. Such regulations, not federally regulated, make the cost of compliance in California more expensive. These costs, much like those experienced by tankers

passing through Washington waters, increase the ultimate cost of such products to consumers in Oregon.

CHAPTER IV

BULK OIL FACILITIES IN OREGON

OVERVIEW

Bulk oil facilities are the distribution hubs within Oregon's oil budget.

Functioning neither as inputs nor movements, they receive products from a source, store or blend the products, and distribute them. There are a few facilities, such as pulp and paper mills or energy facilities, that also receive bulk products, but use them entirely without distribution. These facilities function as merely oil consumers and are not part of the distribution system,

As discussed in previous chapters, a typical bulk distribution facility receives its supply by self propelled tanker, oceangoing barge or pipeline, then distributes that supply by tank truck, river barge or pipeline.

The lower Willamette River plays home to the majority of bulk facilities in Oregon. These facilities include companies in the business of distributing oil, pulp and paper mills receiving heavy fuel oil, and an asphalt refinery. For our purposes, those involved in the transportation of oil are the most pertinent and have the greatest affect on Oregon's oil distribution.

General Relationships

The “input” pipeline to these facilities is the Olympic pipeline from Puget Sound which supplies them with an average of 6000 barrels of light distillates per hour. The inputs coming from tankers and barges often carry heavier products that cannot be pumped through the pipeline. The “movement” pipelines are the Chevron Airport pipeline and the Santa Fe Pacific pipeline to Eugene which are discussed earlier. Product not transferred to these pipelines is distributed either by tank trucks to places such as gas stations, or by barges to ships and other facilities. River barges generally carry light products up the Columbia River to replenish facilities located in Umatilla, Pasco, and Clarkston, and bunker barges haul heavy products to ships moored or anchored in the lower Columbia and Willamette Rivers. Details of these distributions are available in the barge section of Chapter IV.

Aside from the Columbia/Willamette River system, two facilities serve Oregon’s coast and are located in Coos Bay. One of these facilities stores only heavy fuels to replenish visiting ships and provide local lumber mills with industrial fuels. The other facility receives lighter products by barge and distributes them through tank trucks to gas stations and homes throughout southwestern Oregon.

TABLE II
BULK OIL FACILITIES RECEIVING IMPORTS IN OREGON

Facility	Location	City	Tanks	Volume	Products
ARCO	Willamette RM 5	Linnton	29	582,831	Gas, Diesel
<i>Boise Cascade</i>	<i>Multnomah chnl</i>	<i>St. Helens</i>	<i>1</i>	<i>400,000</i>	<i>Fuel Oil</i>
Chevron	Willamette RM 8	Portland	179	1,518,146	Gas, Dsl, Jet
<i>Chevron Asphalt</i>	<i>Willamette RM 8</i>	<i>Portland</i>	<i>104</i>	<i>1,426,464</i>	<i>Charge Stock</i>
GATX	Willamette RM 5	Linnton	34	484,000	Gas, Diesel
<i>GATX (ex "Shell")</i>	<i>Willamette RM 8</i>	<i>Portland</i>	<i>164</i>	<i>616,607</i>	<i>Gas, Diesel</i>
<i>James River</i>	<i>Columbia RM 42</i>	<i>Wauna</i>	<i>1</i>	<i>40,000</i>	<i>Fuel Oil</i>
<i>McCall</i>	<i>Columbia RM 13</i>	<i>Astoria</i>	<i>4</i>	<i>100,500</i>	<i>Diesel</i>
McCall	Willamette	Portland	25	956,150	Gas, Diesel
Mobil	Willamette RM 5	Linnton	106	267	Gas, Lube
Newport Petroleum	Coos RM 12	Coos Bay	11	66,600	Gas, Diesel
<i>Owens Corning</i>	<i>Willamette RM 4</i>	<i>Linnton</i>	<i>7</i>	<i>91,710</i>	<i>Asphalt</i>
Pacific Northern	Willamette RM 6	Linnton	5	270,000	Gas, Diesel
<i>Portland Gen'l Electric</i>	<i>Columbia RM 52</i>	<i>Clatskanie</i>	<i>10</i>	<i>1,298,000</i>	<i>Diesel</i>
<i>Port of Portland</i>	<i>Willamette RM 8</i>	<i>Portland</i>	<i>15</i>	<i>155,722</i>	<i>Fuel Oil</i>
Texaco	Willamette RM 9	Portland	16	424,770	Gas, Diesel
Tidewater	Columbia RM 283	Umatilla	24	207,809	Gas
Time Oil	Willamette RM 3	St. Johns	33	742,876	Gas, Diesel
Time Oil	Willamette RM 5	Linnton	11	319,968	Gas, Diesel
Unocal	Willamette RM 8	Portland	26	870,379	Gas, Dsl, Jet
Unocal	Coos RM 13	Coos Bay	12	124,862	Gas, Diesel

notes:

"RM" is river mile, measured from the river's mouth upstream to source.

"Tanks" is the total number of aboveground storage tanks.

Total volumes are listed in barrels. 1 barrel = 42 gallons.

Facilities that are *italicized* are receptors only of water transported bulk petroleum, not distribution hubs.

Sources: Oil Spill Contingency Plans for facilities in Oregon.

Distribution Facilities

Distribution facilities are operated by oil companies in the business of transporting petroleum products. Such facilities, also called tank farms, consist of extensive above ground storage tanks, and associated piping and pumps to move the product. A large berm surrounds these tanks and acts as containment should failures occur. Generally these facilities offload to truck racks, or a large filling station, where tank trucks move the fuel to its final destination. These facilities may also offload to barges or other pipelines for long distance shipments.

Reception Facilities

Facilities that receive products only for their own use are reception facilities. These are not owned by oil companies, and are typically large industries such as wood products, paper mills, or electrical generation plants needing vast quantities of petroleum. These industries may have enormous storage capacities in some cases. The Portland General Electric generation facility located in Clatskanie has 1.3 million barrels of diesel fuel kept on reserve should their normal supply of natural gas become interrupted (Personal communication with PGE facility, March 1995). Such facilities receive their products by barge alone, since they are not serviced by pipelines, have fuel needs too big for tank trucks, and are incapable of receiving self propelled tank ships. Amounts of petroleum delivered to these facilities is therefore accounted for under "Barge Movements."

Figure 9. Oil facilities located on the lower Willamette River.

RISK FROM BULK OIL FACILITIES

Environmental Risk

Tremendous environmental risk exists in the bulk oil facilities since they represent enormous volumes of petroleum storage in a localized area of the state, and the failure of any one of them could have severe environmental ramifications. For example, the Chevron distribution facility has a storage capacity of 63,000,000 gallons and a catastrophic failure could result in a spill six times as large as the Exxon Valdez.

This risk is made slightly more apparent by the age and location of the facilities along the lower Willamette River. Many of these facilities have tanks still in use that were constructed in the 1920s, some of which were built prior to the perfection of welding technology. Therefore, they are either riveted, or crudely welded, both of which are susceptible to failure. More importantly, these tank farms are situated on a portion of the Willamette consisting largely of landfill including sandy dredge spoils, sawdust, and any other materials early industrialists saw fit to fill in the many "swamps" bounding the Willamette. Such fill is prone to liquefaction during earthquakes, and could ultimately lead to total tank failure. The Oregon Emergency Response System routinely employs this possibility in their annual earthquake exercise.

Operational spills from these facilities are rare since they function as merely storage receptacles and have few moving parts. A local facility did experience a 5000 gallon heavy fuel oil release November 3, 1995, following the failure of relief valve

pipng. This spill was contained entirely within the bermed area around the tanks and was quickly remediated.

Economic Risk

These facilities merely function as distribution hubs within the petroleum system and have no bearing on how much oil is brought into or used by the state. Since these facilities all lie within Oregon, and are subject to laws administered by the state, we experience little economic risk. Any changes to their costs of compliance will either be as a result of federal regulations, which would apply to every state, or state regulation, which would be self imposed. Therefore, unlike pipelines and vessels described earlier, economic risks from facilities, while possible, are largely within the control of Oregon.

CHAPTER V

OIL MOVEMENTS BY TANK TRUCK

OVERVIEW

Oil movements by truck serve as inputs, and movements to Oregon's oil budget. Inputs include those tank trucks bringing oil into the state from an outside source. Movements include the many trucks loading petroleum at the bulk facilities mentioned in the previous chapter. Quantifying the movements of these tank trucks to compare them to the other portions of the distribution system is difficult. Much of the data presented comes from a 1987 flow study (Oregon Public Utilities Commission, 1987).

This flow study was conducted by the Public Utility Commission of Oregon and the Oregon Department of Transportation in response to recommendations put forth by the Oregon Interagency Hazard Communication Council. The Hazard Communication Council's report proposed the need to quantify the level of risk to Oregon's citizens. The study's intent, therefore, was to provide information regarding the number and type of hazardous materials transported on Oregon highways.

To conduct the study, information from the movement of hazardous materials was gathered at eleven truck weigh scales. The locations included five scales on Interstates 5 and 84, three on U.S. highways and three on state routes. In surveying the truck movements, personnel stopped hazard placarded trucks, and examined shipping

papers for each specific material's name, identification number, quantity, container type, origin, destination, and routes traveled. The primary materials identified during the survey included petroleum products, hazardous wastes, sodium hydroxide, paints, and cleaning compounds. Only the shipments of petroleum products have been analyzed for the purposes of this research.

The survey was conducted in three phases, with the shipments assessed over a three day period for each phase.

Movements Within the State

Phase I of the survey, which provides information on movements, included assessing vehicles passing by the following weigh scales:

Scale	Roadway	Direction of Travel
Woodburn	I-5	South
Wyeth	I-84	East
Scappoose	US30	West
Brightwood	US26	East
Dayton	SR99W	South
Hubbard	SR99E	South
Tillamook	SR6	West

At each site, the survey of movements was conducted for 72 hours. In this initial phase, the survey was conducted on March 9-11, 1987, at Wyeth (I-84 Eastbound), Scappoose (US30 Westbound), and Dayton (SR99W Southbound). On

March 16-18, 1987, the survey was conducted at Woodburn (I5 Southbound), Hubbard (SR99W Southbound), Brightwood (US26 Eastbound), and Tillamook (SR6 Westbound). During Phase II, the same survey was repeated, only later in the year. The March 9-11 survey sites (Wyeth, Scappoose, Dayton) were examined on August 3-5, 1987. The March 16-18 sites (Woodburn, Hubbard, Brightwood, Tillamook) were examined on August 10-12, 1987. The number of trips, the products transported, and the locations examined are identified in the following table.

TABLE III
MONITORING STATIONS FOR OIL MOVEMENTS IN STATE

Station		Gasoline	Flam NOS	Av Gas	Diesel	Comb NOS	Total
Wyeth	Trips	43	3	1	23	3	73
<i>Eastbound</i>	Vol	8429	1284	5117	6759	6422	28011
	Total	362447	3852	5117	1554576	19266	546139
Scappoose	Trips	48	2		26		76
<i>Westbound</i>	Vol	9015	12780		7246		29041
	Total	432720	25560	0	188396	0	646676
Brightwood	Trips	53			36	9	98
<i>Eastbound</i>	Vol	8065			6276	6000	20341
	Total	427445	0	0	225936	54000	707381
Dayton	Trips	33			22	1	56
<i>Southbound</i>	Vol	8041			6325	8500	22866
	Total	265353	0	0	139150		413003
Hubbard	Trips	16			11	1	28
<i>Southbound</i>	Vol	7331			5937	6000	19268
	Total	117296	0	0	65307	6000	188603
Tillamook	Trips	9			4		13
<i>Westbound</i>	Vol	9894			6992		16886
	Total	89046	0	0	27968	0	117014
Woodburn	Trips	126	7	4	69	8	214
<i>Southbound</i>	Vol	9223	8580	9968	7466	6386	41623
	Total	1162098	60060	39872	515154	51088	1828272

Source: Public Utility Commission, 1987

Notes: "Flam NOS" is flammable cargo not otherwise specified.

"AvGas" is Aviation Gasoline.

"Comb NOS" is combustible cargo not otherwise specified.

Volumes are in gallons.

To assess the total petroleum related products moved through these survey sites during a three day period, the information may be summarized as follows:

TABLE IV
TRUCK MOVEMENT SUMMARY TABLE

Location	Trips	Volume in Gallons	Volume/Trip
Wyeth	73	546139	7481
Scappoose	76	646676	8508
Brightwood	98	707381	7218
Dayton	56	413003	7375
Hubbard	28	188603	6735
Tillamook	13	117014	9001
Woodburn	214	1828272	8543
Total/3 days	558	4447088	7969

These figures represent the average of two surveys, each conducted over a three day period. The volume per trip figure is computed to offer an increased understanding of the risk presented per truck. This runs from a low of 6735 gallons for trucks traveling through Hubbard, to a high of 9001 for trucks in Tillamook. Therefore, to obtain a monthly projection comparable to the pipeline, vessel and barge data, the figures were multiplied by ten (10) and converted to barrels.

TABLE V
TRUCK MOVEMENT MONTHLY PROJECTIONS

Location	Trips	Volume	Volume/Trip	Volume Bbls
Wyeth	730	5,461,390	7,481	130,033
Scappoose	760	6,466,760	8,509	153,970
Brightwood	980	7,073,810	7,218	168,424
Dayton	560	4,130,030	7,375	98,334
Hubbard	280	1,886,030	6,736	44,905
Tillamook	130	1,170,140	9,001	27,860
Woodburn	2,140	18,282,720	8,543	435,303
Total/month	5,580	44,470,880	7,970	1,058,830

These figures are better displayed graphically as follows:

Figure 10. Monthly projection of tank truck movements in Oregon.

It is clearly seen that the majority of movement occurs on I5 southbound through Woodburn. The 2140 trips more than doubles the 980 moving through the next busiest station in Brightwood. This represents the tank trucks that are transporting products from the Portland area bulk facilities throughout the rest of the metropolitan region. However, this figure does not represent the many tank trucks moving products within the metropolitan region, as many of those vehicles may travel inside the area bounded by Woodburn, and the adjacent weigh stations. Therefore, the study fails to accurately assess the amount of trips moving within the Portland region. Estimates for this amount are made in Chapter VII.

Movements into the State

Phase III of the study was completed to assess hazardous material movements entering Oregon from adjacent states. This phase utilized port of entry scales in the following locations:

Station	Roadway	Direction of Travel
Ashland	I5	North
Klamath Falls	US97	North
Ontario	I84	East
Ostrander, WA	I5	South

Surveys at these sites were conducted November 17-19. The Ashland and Klamath Falls sites were chosen to assess traffic entering Oregon from California and Nevada. The Ontario site was chosen to assess traffic entering Oregon from Idaho. The Ostrander, WA, site was chosen to assess traffic entering Oregon from Washington.

These sites were not without their limitations. The Ashland, Klamath Falls, and Ontario sites are all located some distance within the Oregon border. Therefore, surveys conducted here excluded shipments terminating in locations prior to the weigh station. Furthermore, it is difficult to conclude that the Klamath Falls survey station assessed traffic movements from Nevada since US97 leads from northern California into Oregon. The Ostrander, WA, site was also not without its shortcomings. It is located 50 miles north of Portland, as well as north of Kelso and Longview, WA. Therefore, shipments

originating in these cities, both of which maintain bulk oil and chemical facilities, would not be included in the study.

Surveys conducted led to the following data:

TABLE VI
MONITORING STATIONS FOR OIL INPUTS INTO OREGON

Station		Gasoline	Flam NOS	Av Gas	Diesel	Comb NOS	Total
Klamath Falls	Trips	2			5	1	8
<i>Northbound</i>	Vol	4806			3030	3400	11236
	Total	9612	0	0	15150	3400	28162
Ontario	Trips	3	1		2	2	8
<i>Westbound</i>	Vol	4018	6000		8100	6831	24949
	Total	12054	6000	0	16200	13662	47916
Ostrander, WA	Trips	5	3	14		3	25
<i>Southbound</i>	Vol	10696	6475	10005		6886	34062
	Total	53480	19425	140070		20658	233633
Ashland	Trips	17	19		13	5	54
<i>Northbound</i>	Vol	7544	4878		6299	12000	30721
	Total	128248	92682	0	81887	60000	362817

Source: Public Utility Commission, 1987

Notes: "Flam NOS" is flammable cargo not otherwise specified.

"AvGas" is Aviation Gasoline.

"Comb NOS" is combustible cargo not otherwise specified.

Volumes are in gallons.

Since only one period of three days was used, no averaging was conducted when assimilating the data. The above figures can be summarized into a three day total as follows:

TABLE VII
TRUCK INPUT SUMMARY TABLE

Location	Trips	Volume in gals	Volume/Trip
Klamath Falls	8	28162	3520
Ontario	8	47916	5990
Ostrander	25	233633	9345
Ashland	54	362817	6719
Total/3 days	95	672528	7079

The volume per trip figure is computed to offer an increased understanding of the risk presented per truck. This runs from a low of 3520 gallons for trucks in Klamath Falls, to a high of 9345 gallons for trucks traveling through Ostrander. This volume in Ostrander represents the highest per trip amount throughout the study. These figures, like the truck movement information, were multiplied by ten and converted to barrels to make average monthly projections comparable to the vessel and barge data:

TABLE VIII
TRUCK INPUT MONTHLY PROJECTIONS

Location	Trips	Volume	Volume/Trip	Volume Bbls
Klamath Falls	80	281,620	3,520	6,705
Ontario	80	479,160	5,990	11,409
Ostrander	250	2,336,330	9,345	55,627
Ashland	540	3,628,170	6,719	86,385
Total/month	950	6,725,280	7,079	160,126

The movements of petroleum through these towns can better be displayed as graphically. Klamath Falls and Ontario receive a similar number of tank trucks monthly, however, those passing through Ontario carry almost twice the amount of petroleum.

Figure 11. Monthly projection of tank truck entries into Oregon.

The majority of movements occur on Interstate 5 northbound through Ashland with 540 monthly trips. However, as discussed earlier, some petroleum inputs terminating south of this port of entry may not be included in the study.

Figure 12. Monitoring stations for tank truck movements in Oregon.

RISK FROM TANK TRUCKS

Environmental Risk

Although tank trucks, generally carrying less than 10,000 gallons, represent the smallest potential spill, on a per-incident basis they pose the greatest environmental risk to petroleum distribution. The Office of State Fire Marshal, in its 1994 Annual Report of Hazardous Material Incidents in Oregon, indicated that 184 spills involving petroleum tank trucks occurred, of which 77 involved diesel and 66 involved gasoline. These spills totaled 7392 gallons, or an average of 51 gallons per incident.

Spill risk from the other potential sources (pipelines, ships, barges, and railroads) are all limited to particular geographic corridors. For example, any spill from the Santa Fe Pacific pipeline will occur within the right of way secured by the pipeline, and spreading could be predicted by the topography, proximity to water, and substrate material. Likewise any spill from an oil barge will occur within the waterbody used by that barge. Tank trucks, on the other hand, travel to the remotest corners of the state, and spills from their accidents can pollute pavement, roads, wetlands, ditches, streams, or any combination. This will only become more apparent as Oregon's population increases in areas such as Bend not served by other petroleum distribution modes. Furthermore, tank trucks carry all grades of petroleum products, including everything from light distillates to asphalt, so planning for their response is difficult.

Response to releases from tank trucks is often conducted differently from other sources. Since spills from tank trucks generally impede traffic, the primary response is

to restore the roadway to its unimpeded condition as expeditiously as possible.

Unfortunately, this at times leads to the hosing down of polluted roadways into storm or other drains which ultimately harm the environment. This contrasts with spills from other transportation modes which often damage areas unseen by the general public.

Therefore, response protocols in these areas examine the environment's ability to recover, and serve to enhance that ability. This often means taking little or no action and allowing natural processes to degrade the petroleum. For example, gasoline spilled by a tank truck on a roadway poses a threat to public safety and impedes the orderly movement of traffic. This gasoline is removed by the most expeditious means, often high volume flushing, without regard to its fate or downstream environmental consequence. A similar spill of gasoline in a tank farm would be allowed to aerate in the tank farm until the light ends have evaporated and the product poses no safety or toxic threat.

Economic Risk

The majority of tank trucks serving Oregon operate wholly within the state. They are therefore subject to economic burdens, such as the petroleum load fee for the highway fund, placed upon them by state regulations. Any economic risk Oregon sees from this is self imposed, rather than a ramification from international or adjacent state policies. We do however, receive tank trucks that are importing products from Washington and California. Such trucks would be subject to those state regulations, and the corresponding costs of compliance, as well. For example, were California to impose

a high petroleum distribution fee on tank trucks, then those providing inputs to Ashland or Klamath Falls, may pass that economic burden on to their customers. This places those customers at some level of economic risk and should this burden exceed that amount which those customers are willing to pay, the distribution system would have to adjust for supply shortfalls.

CHAPTER VI

RAILROADS IN OREGON

OVERVIEW

Oregon enjoys an extensive railroad system providing coverage to most portions of the state. However, no bulk petroleum is transported by rail and it therefore functions as neither an input, nor movement to the oil distribution system. This chapter briefly describes the routes of major rail service throughout Oregon.

The major rail lines serving Oregon include the Southern Pacific, Union Pacific, and Burlington Northern. Southern Pacific operates primarily north-south with a line from Portland to Springfield. This line then forks into three. One travels to the western edge of Oregon along State Route 26 then moves south into Coos County terminating in Myrtle Point. The middle fork continues from Springfield along I5 south to California. The eastern fork travels along State Route 58 into Klamath Falls and then into California.

Union Pacific operates a major east-west route departing Portland and traveling through the Columbia River Gorge, where it branches in Hermiston. Here, one line travels north into Washington, while the other continues southerly and eventually exits the state in Ontario.

Burlington Northern operates a north-south line beginning in Astoria, then traveling southeast along State Route 30 into Portland. This eventually follows the Southern Pacific leg south to Springfield. A separate leg of Burlington Northern begins at a junction with Union Pacific east of the Dalles, then travels south along State Route 97 through Bend, where it eventually joins Southern Pacific in Chemult.

Smaller lines (termed "shortlines") are operated by the Willamette Valley Railroad, Klamath Northern, Union Rail of Oregon, Port of Tillamook, Lake County operated by Great Western, Willamina and Grand Ronde, Oregon Pacific and Eastern, East Portland Traction, City of Prineville, Longview Portland, Mount Hood, and Oregon Eastern.

Railroads are utilized for shipments of hazardous materials and small quantities of oil products. These movements were reported to the public utilities commission in 1992. Reports included products moved by Standard Transportation Commodity Code (STCC) and amounts moved but were only detailed to the extent they inform the Public Utilities Commission of general types of products moved. More detailed reports, although useful, would apparently give away excessive business information, and are not submitted (Personal communication with Public Utilities Commission, May 1995).

Bulk oil movements are not conducted by railroad in Oregon. Southern Pacific Railroad maintains oil product storage facilities at rail terminals in Eugene, Portland, and Klamath Falls, yet all are inactive (ODOE, 1992). Although rail transport is less expensive than truck transport, it is not used for several reasons. Rail transport represents defined, limited access distribution capabilities. Many of the population and

high use centers served by rail are also served by either barge or pipeline--both of which offer a cheaper alternative. Areas not served by barge or pipeline but by rail usually do not have the demand for such large shipments and their needs can be met by tank truck (Personal communication w/ GATX, May 1995). Therefore, railroads, like cargo ships, are heavy users of petroleum, but do not participate in its distribution.

Figure 13. Routes of major railroads operating in Oregon.

RISK FROM RAILROADS

Environmental Risk

Since railroads carry no bulk petroleum as cargo, their environmental risk is reduced. However, railroads carry tremendous volumes of diesel for the operation of their own engines. Generally, each locomotive carries a 3100 gallon “saddle tank” to provide that engine with fuel. For long hauls, this saddle tank is augmented by a tank car that can refuel the locomotive.

Railroads are often situated adjacent to river beds. While such positioning provides a flat track surface, it renders them susceptible to flood and ground movement risk. Compounding this risk is the exposure seen by the stream or riparian areas when spills from locomotives occur.

Oregon's largest railroad spill occurred after the 1993 Southern Pacific train derailment into outside of Eugene. This derailment allowed 6100 gallons of diesel fuel to enter Yoncalla Creek, threatening a local water drinking water reservoir and the federally protected Western Pond Turtle. Cleanup lasted nearly one month and included the use of skimming equipment, oil absorbent materials, monitoring wells, and auxiliary water supplies.

Economic Risk

Economic risk from railroads does not figure into Oregon's oil budget since they are presently not utilized. Were railroads to be used in the distribution process, risk

would be evident given the interstate nature of the railroads, and the opportunity for price influences from adjacent states.

CHAPTER VII

TRANSPORT COMPARISONS

Normalizing data from pipelines, self propelled tank ships, barges, and tank trucks presented in the previous chapters to fit a barrels per month standard allows for a comparison of modes. Such a comparison provides an “average month snapshot” of petroleum distribution in Oregon.

TABLE IX

MONTHLY OIL DISTRIBUTION AVERAGES BY TRANSPORTATION MODE IN OREGON

Transport Mode	Trips	Input Bbls/Month	Trips	Movement Bbls/Month
Tank Truck	950	160,125		
Tank Truck			5580	1,058,830
Oil Pipeline	1	3,816,666		
Oil Pipeline			2	1,650,000
Self Propelled Tankship	10	1,754,416		
Self Propelled Tankship				
Oil Barge (to Coos Bay)	2	33,250		
Oil Barge (to Columbia)	8	240,000		
Oil Barge (to Upriver)			65	1,486,916
Oil Barge (Bunkering)			75	569,500
Totals		6,004,457		4,765,246

The difference between Input Barrels per Month and Movement Barrels per Month is 1,239,211 barrels. This is not an amount that keeps piling up in Portland month after month. Rather, this amount accounts for that not counted during the truck distribution study, which only monitored petroleum movements outside the metropolitan area. Given Oregon's population distribution, it can be assumed with relative confidence that this surplus is being moved along the metro area roadways to supply home oil tanks, gasoline stations, boat marinas, industries, and other users.

This information summary should be useful to energy planners, risk analysts, and businesses, and citizens interested in petroleum distribution in our state, as well as planning for future distribution challenges. Viewed as a map, the results better show that the various components must be linked to function as a system and serve Oregon's citizens.

Figure 14. Monthly summary of petroleum movements in Oregon. Based upon figures analyzed within this paper.

The make up of this summary may change in the upcoming years with the proposed development of Olympic Pipeline Company's Cross-Cascades Pipeline. This 220 mile underground pipeline will deliver 65,000 barrels daily of motor gasoline, diesel fuel and aviation fuel from Western Washington refineries to Central and Eastern Washington (Olympic Pipeline Company News Release 1995). The proposal also includes a truck distribution terminal near Ellensburg and several small pump stations along the route. When complete in 1998, this will not only alter the movement of barges to these upriver locations, it may also alter the products flowing through the existing Olympic pipeline to Portland.

Some Washington environmental organizations fear this pipeline may one day turn Puget Sound into a major oil port. Presently Puget Sound refineries are supplying Washington and Oregon with much of their fuel needs. When this pipeline is complete, it will have the capability of linking with the existing Chevron Utah Pipeline which originates in the Rangely oil field in northwestern Colorado. Such a link may allow the Chevron Utah pipeline to carry products backward from its original design and move them from Pasco, WA, to Salt Lake City instead of vice versa. This operation would increase the demand for crude oil shipments to the Puget Sound refineries. As these shipments increase, so does the environmental risk to Puget Sound waters.

In addition to understanding the micro supply and distribution systems in Oregon, it is also worthwhile to understand a few elementary facts regarding the macro system in the United States to appreciate the risks posed by world events. In 1993, the United States imported 3,111,990,000 barrels of oil or roughly half of its petroleum needs. The remainder was produced domestically, primarily by Texas, Alaska, California, Louisiana and Oklahoma who combined to produce 2,494,674,000 barrels (API Basic Petroleum Data Book, Jan 1995). Of the imported oil, the vast majority (or 2,972,000 barrels per day) came from Latin American countries--principally Venezuela and Mexico. The Middle East provided 1,852,000 barrels per day, West Africa (primarily Nigeria) provided 1,311,000 barrels per day, and Canada provided 1,175,000 barrels per day (Energy Information Administration, 1994).

Based upon 1993 data, Texas provides the single largest input to the U.S. oil budget, at 752,282,000 barrels, followed by Alaska with 577,494,000 and Saudi Arabia with 467,753,000 barrels. Venezuela surpassed Saudi Arabia in June of 1994 as the primary foreign supplier of oil to the United States. The following graph depicts the role played by various states and countries in the 1993 U. S. oil budget.

Figure 15. Top 10 suppliers of oil to the U. S. oil budget in 1993. Sources are split almost exactly between domestic supplies and imports (Source: API Basic Petroleum Data Book, Jan 1995).

This graph offers a clear view of the risk, or how vulnerable, the United States is to particular world events. For example, the Iraqi invasion of Kuwait had little, if any effect on our nation's present oil budget. However, economic or cultural problems in Latin America would have much more serious ramifications since Venezuela and Mexico combine to provide eighteen percent of our national needs. Perhaps overshadowing these is the dependence the United States has on the enormous roles

played by Texas and Alaska, which both out supply Saudi Arabia and satisfy one third of U. S. needs.

As it relates to Oregon, we are extremely dependent upon the resources of Alaska, which make their way to us via California and Washington. However, we do not rely upon the supplies from Texas or the Midwest. Severe changes to the supplies available from Alaska may affect how oil is supplied and priced in Oregon.

CHAPTER VIII

UNDERSTANDING AND MANAGING RISK

The amount of risk experienced by a state fluctuates with the level of resource activity within that state. Timber provides a good example of this for Oregon, where the state has long enjoyed a healthy integrated industry from extraction to production to distribution. The rewards of such control allowed Oregonians to enjoy low lumber prices, abundant supplies, and healthy job markets, but the drawbacks are becoming evident in clear cut forests, damaged ecosystems, and silted streams. As the available timber declines, so do the employment opportunities for loggers.

Likewise, "oil states" such as Alaska and Texas with primary petroleum industries such as extraction, may experience little economic risk because of their indigenous supply, but greater environmental risk associated with removing hydrocarbons from the ground. States such as Washington with secondary petroleum industries such as refining experience slightly less environmental risk since drilling and extraction do not exist, but live with environmental threats from the operation of major refiners. Conversely, they should be able to partially shield themselves from price increases as they can purchase crude oils on the spot market. States such as Oregon, involved in tertiary petroleum activities such as distribution do not realize the same environmental risk as those that are refining or extracting, but should experience greater

economic risk with the reliance on petroleum exports from adjacent states. It is only through understanding this risk that it can be managed.

ENVIRONMENTAL RISK

Since Oregon's involvement in petroleum includes no primary nor secondary industries, the majority of environmental risk comes from transportation. Oregon, like all states, is polluted daily by unintended transportation-related releases. Quantifying these releases becomes problematic for several reasons. Spills to surface water are reported to the U. S. Coast Guard in Washington D. C., which maintains a nationwide database. Often these spills receive no response as cleanup becomes unfeasible given the swift currents of the Columbia and Willamette Rivers.

In addition to federal notification, all spills are reported to the Oregon Emergency Response System (OERS) in Salem, which acts as a clearinghouse for initial notification. This would seemingly be a good source of annual spill data, however, OERS consolidates all petroleum and hazardous material spills together into hazardous substances, and it is therefore impossible to extract meaningful information regarding petroleum distribution. This is compounded with the fact that their volume estimates are based purely on initial reports, which often vary from the final assessment.

Transportation related incidents are included in the Office of the State Fire Marshal's annual report of Hazardous Material Incidents in Oregon. This summation stems from the reports made to them throughout the year by responsible parties,

concerned citizens, law enforcement personnel, and accident victims, and does the most thorough job of assessing the daily losses of petroleum from land-based-distribution related spills. Data from 1994 indicated that 184 spills from tank trucks involving petroleum products occurred, of which 77 involved diesel and 66 involved gasoline. These spills totaled 7392 gallons, or 616 gallons (14.6 barrels) per month (Office of State Fire Marshal, 1994 Annual Report of Hazardous Material Incidents in Oregon). Based upon this data, one transportation related petroleum spill occurs every two days in Oregon, releasing 20 gallons (.5 barrel). These releases are not included in the oil distribution budget as they are already accounted for when they are transferred to a tank truck, pipeline, or barge. Assessing the “seriousness” of these spills is challenging as explained below.

Assessing the “seriousness,” or level of environmental consequence, is often difficult. In the most economic sense it is conducted through natural resource damage assessments, which are historically based upon contingent valuation methods. Such methods assess a value to injured species based upon market prices, public perceptions, and scientific bases for their “worth.” Easy valuations can be made for market species (e.g. salmon) noticeably damaged and easily understood by the general populace. The contingent valuation method has more difficulty assessing the worth of non-market species (e.g. nutria) and relies on questionnaires for value estimation.

Outside of the natural resource damage assessment process, the level of environmental consequence is simply a function of the oil type and size and the

characteristics of the affected ecosystem. When oil is released to the environment, its characteristics determine how it experiences spreading, evaporation, dispersion, emulsification, dissolution, oxidation, sedimentation, and biodegradation.

The oil type will determine if it is a non-persistent oil, which is composed of light petroleum fractions and will tend to dissipate rapidly from the surface, or a persistent oil such as residual fuel oil which will dissipate more slowly. The main physical properties which affect the behavior of spilled oil are its specific gravity, distillation characteristics, viscosity and pour point. Oils with a low specific gravity such as gasoline are non-persistent and readily incorporated into the environment, yet pose acute toxic threats to animals coming in contact. Persistent oils, generally with high specific gravities, do not provide the same toxic affects to animals, but remain in the ecosystem longer and pose mechanical threats such as matting of feathers or fur. Spill size will have a direct relation on the environment's ability to assimilate the pollutant.

Ecosystem characteristics determining the "seriousness" of a spill include the resident species and their sensitivity to hydrocarbons and the level of natural activity from winds, waves and surface runoff. A little oil in a sensitive area can do as much harm as a large quantity on a desolate rocky shore. The tanker Braer spill occurring off the Shetlands dumped five times the amount of crude oil than the Exxon Valdez, yet did so in a high energy environment along a rocky shoreline. Cleanup lasted but a few days as the oil was assimilated into the environment through dispersion, dissolution and

evaporation, and follow-up bioassays indicate little damage. Cleanup for the Exxon Valdez spill lasted over two years and is still being evaluated for long term affects.

Given this, quantifying the “seriousness” of tank truck spills in Oregon becomes perplexing, although it can be approximated that the 7000 gallons spilled annually poses no significant long term threat to the health of Oregonians or the environment when compared with the many other pollutant sources.

ECONOMIC RISK

Economic risk refers to the opportunity for a commodity's price or supply to fluctuate in response to forces beyond Oregon's control. Since Oregon has little control over its inputs of petroleum, economic risk is prevalent. Also part of economic risk is the employment risk associated with extractive (primary) industries reliant upon natural resources. As described in the logging example at the beginning of this chapter, primary industry employment fluctuates with the level of natural resource supply. Secondary industries, such as saw mills or oil refineries, are better suited to shield themselves from this employment risk by securing outside supplies of natural resources.

Supply Risk

Following World War II, Oregonians decided to renew their interest in securing a domestic source of petroleum. As part of this renewed interest, Chester Sterrett, Manager of the Industries Department of the Portland Chamber of Commerce, completed a study on the fuel oil requirements of Oregon and Southern Washington.

Many of the figures determined by Sterrett are meaningless today given the regions economic and population growth, but many of his ideas ring true.

In 1950, all of the fuel used in the lower Columbia River area was brought in from California tankers. The Portland area suffered restricted deliveries of fuel during the previous decade, primarily on account of the demand from war industries. Sterrett, desiring fuel shortages to be a thing of the past, reported, "On account of increased industrialization of the Pacific Northwest, the whole economy of the region would be disrupted if supply of fuel were cut off or reduced." He continued, "One thing is certain: the lower Columbia River area, for maximum safety and future industrial growth, must encourage, as soon as possible, fuel supply sources other than offshore tanker supply" (Sterrett, 1950, p. 5).

His pleas were not only heard, but met in the development of the Olympic Pipeline in the mid 1960s. This pipeline is not immune to fluctuations in the world petroleum supply, however. The OPEC oil embargo of the mid 1970s created worldwide shortages. Since petroleum is a world commodity, even nations and states with domestic sources of oil were affected. The following graph shows Olympic pipeline activity in the 1970s.

Figure 16. Olympic Oil Pipeline Activity 1972-1976 (Source: Oregon Department of Transportation, 1979).

Although it does not appear there was a significant change during the mid 1970s embargo, when the barrels are examined as a percentage change from year to year, the severity of the embargo is more evident. The following graph shows the decrease in oil movements in 1974, which followed on the heels of a increase the previous years.

Figure 17. Olympic Pipeline Activity Displayed in Percentage Change 1972-1976 (Source: Oregon Department of Transportation, 1979).

During this period the Chevron pipeline in Eastern Oregon was also providing inputs into Oregon's oil budget on the average of 1500 barrels annually. However, these inputs were not enough to alter the change seen in the 1974 figures.

Seven states actually increased their consumption during this period. Alaska, Connecticut, Hawaii, Louisiana, Oklahoma, and Wyoming consumed more petroleum in 1974 than in the previous year. Of those seven, all but Connecticut and Hawaii have extensive petroleum reserves, and shielded themselves from necessary cutbacks using

their indigenous supplies and refining capabilities. Connecticut and Hawaii somehow managed to secure reliable sources of supply in the face of the embargo.

Price Risk

The 1974 oil crisis not only altered the amount of oil entering Oregon, it also affected its price. A gallon of gasoline cost thirty-five cents throughout the early 1970s, and quickly increased to fifty-one cents in 1974. This pattern was evident in Portland, as well as other West Coast cities, and the United States. From 1974 on, the price continued to gradually increase, although not at the rate it did during the OPEC embargo.

Twenty years later, changes still occur following a significant “petroleum related event.” Gasoline prices typically fluctuate with the driving season, which is defined as mid-summer through Labor Day. These fluctuations are simply a case of supply versus demand, as can be seen in home heating oil prices, which increase during the winter, but are held low throughout the remaining year. Several “petroleum related events” provide evidence of the price vulnerability of the oil industry, and how consumers become affected by events that appear completely unrelated to them. Often, the magnitude of the petroleum involved is unrelated to the magnitude of the price change. Rather the magnitude of the price change may be related to media coverage, public interest, market opportunity.

The grounding of the Exxon Valdez occurred in late March 1989, and prices increased not only on the west coast, but throughout the United States. Although most

portions of the United States do not receive a drop of Alaskan oil, consumer prices were still affected. Later that year an Exxon refinery in Louisiana suffered a catastrophic explosion, killing two, and forcing evacuations. A small spike in the U.S. price occurred, although the west, which already had its share of Exxon news, appeared unaffected. Saddam Hussein invaded Kuwait the following summer, and as it appeared he was going to control Kuwaiti oil, prices shot up throughout the U.S. and the West Coast, even though the West Coast receives not a drop of Middle Eastern crude. Once the U.S. invaded the Persian Gulf and removed Iraqi troops, prices quickly fell.

Figure 18. Gasoline prices were affected to greater degrees depending upon the nature of "petroleum related" casualty. The Exxon Valdez spill forced prices up across the United States. A swift victory in the Persian Gulf by U. S. Forces led to a rapid decline in prices throughout the U.S. even though much of the country receives no oil from that region (Source U.S. Federal Highway Administration).

While Oregon may experience supply risk as a result of its lack of crude oil, it does not appear vulnerable to price risk brought on by world or local events any greater than the states on the upstream end of its oil supplies.

ECONOMICS VERSUS ENVIRONMENT

Supply obviously affects the level of risk experienced economically and environmentally. Depending upon the individual, low economic risk with high environmental risk may be acceptable. In other words, some may prefer the threat of oil well blowouts and crude oil spills to the benefits secure oil sources and prices.

For straight production, Texas tops the list today at 619,088,000 barrels of oil produced during 1993. Following in descending order are Alaska (577,494,000), California (293,089,000), Louisiana (138,673,000), and Oklahoma (96,624,000). Louisiana's respectable 138,673,000 barrels in 1993, or roughly twice the needs of Oregon, represented a sharp decrease from the previous year, when they produced 420,555,000 barrels, or seven times the needs of Oregon. Trends such as this increase Louisiana's employment risk.

Reserves of oil are extremely important. Texas also leads the U.S. in total reserves with 6,171,000,000 barrels confirmed in 1993. Rounding out the list are Alaska, California, Louisiana, and Oklahoma (API Basic Petroleum Data Book, 1995). Alaska has a reserve situated under the Arctic National Wildlife Refuge which would bolster its total to well above that of Texas. However, permission to extract the reserves has not been granted because of environmental considerations and risks.

Worldwide Price Comparisons

Overall, motor gasoline taxes in the United States are extremely low. Even with the average state tax included, the U. S. tax on a gallon of gasoline is one seventh that of Japan, or one tenth that of Germany. The following figure depicts this disparity.

Figure 19. Tax price per gallon assessed in major countries of the world. Prices are in U.S. dollars using recent conversion factors (Source: Federal Highway Administration Monthly Reports from States, July 1995).

Such tax disparities give quick confirmation the U. S. governments desire to keep motor gasoline a cheap energy source. Such policies may undermine the incentive

for alternative fuel and alternative transportation developments. Outside of the United States, the rights to oil are normally vested in the state. This means that the right to explore requires some form of grant or consent from the state in which the rights have been vested. (Jones, 1988) Since no such policies exist within the United States, petroleum exploration and production is strictly profit driven, and low taxes are deemed necessary to keep profits high and encourage oil development.

Local Price Comparisons

The low economic risks are rarely passed on to consumers in the form of low prices. Oregon's state motor gasoline tax rate is 24 cents per gallon. This is added to a federal gasoline tax of 18.4 cents. Along the West Coast, the Washington and California state gas taxes are 23 cents and 18 cents respectively. Connecticut leads the nation with the highest rate of 32 cents per gallon and Georgia anchors the list with 7.5 cents per gallon. The national average is 20 cents per gallon (Federal Highway Administration Monthly Motor Fuel Reports by State, July 1995).

Given this, one would expect a gallon of gasoline in Oregon to cost more than that same gallon in Washington. Not only is the state tax higher, but self serve gasoline is prohibited in Oregon, and the fuel must be transported by one of the modes described earlier. Gasoline prices for a major city in each state were monitored and published until 1977 by a private concern. When the private concern ceased, the Federal Highway Administration began collecting the same information except on a major population center basis. Therefore, information exists for areas such as New York City, Los

Angeles, Chicago, Dallas, and Washington D.C. Unfortunately, pricing information was not maintained for smaller areas such as Portland or Seattle. The information for areas such as these could be approximated based upon Department of Labor statistics and their consumer price indexing. For western states, the consumer price index is limited to category A (small) cities, or category C (large cities).

Beginning in January 1994, data collection on a per state basis commenced again, and is purchased from a private concern by the Federal Highway Administration. This data allows for a comparison of recent prices in Oregon and Washington for not only gasoline, but home heating oil as well.

Figure 20. Price per gallon (excluding taxes) for motor gasoline and home heating oil for Oregon and Washington January 1994 - present (Source: Federal Highway Administration Monthly State Summaries July 1995, and National Petroleum News June 1995).

Gasoline and home heating oil play very different roles in petroleum economics.

Gasoline accounts for almost half of all products sold, and is subject to the finest in marketing efforts available. Home heating oil is sold in smaller quantities each year as houses to convert to other forms of heat. It also is not marketed by major oil companies with any of the consumer based effort that motor gasoline is subject to. The information

in the graph above suggests that not only does distribution play a minor role in the pricing of oil products, but demand serves as the overriding factor. This is evident in the very deliberate price fluctuations of home heating oil, and the distinct decrease during summer months, followed by the winter increase. Perhaps more interesting is the price difference between motor gasoline in Oregon and Washington, which indicates that this product is similarly priced in both states, even though greater distribution and labor costs are incurred in Oregon.

These pricing figures indicate that oil prices do not adhere to local differences between source and use. Rather oil is a worldwide commodity, and crude prices are affected in response to many activities. Such responses keep "oil states" from enjoying the low prices typically associated with indigenous supplies, and allows "non-oil states" such as Oregon, to enjoy similarly priced petroleum. This further benefits "non-oil states" in that they do not have to live with environmental risk associated with the primary extractive industries. In other words, Oregon gets to enjoy petroleum products at the same, if not lower, prices as states who control their entire supplies, yet is not burdened with the environmental risks of extraction and production. This appears to be a favorable position for Oregon or similar states.

The distribution systems detailed in this analysis are not static, and outside forces such as the export of Alaska North Slope Crude oil, the increased exploration of the Arctic National Wildlife Refuge or California offshore oil fields, and the future development of a cross-Cascades pipeline may all serve to alter this scheme.

Oregonians can ensure the most efficient, effective reliable and safe petroleum

distribution systems only through a comprehensive understanding of how we get oil from source to use. A geographical analysis provides this understanding.

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