



July 29, 2004

Washington State's Petroleum Refining Industry Economic Contribution

1. Report Overview

Washington's five major petroleum refiners produced more than 20,000 jobs and nearly a billion dollars in personal income for Washington State in 2003. The report that follows describes the industry and explains how 1,725 direct refinery jobs affect the state economy.

Petroleum refining is a high-wage industry, paying its employees in Washington State an average of more than \$80,000 in 2003 (see appendix A). Refinery jobs and their income spur additional jobs in upstream industries that supply crude oil, contract labor for plant maintenance and repair, and office supplies and equipment to the refineries. Together, these direct and indirect jobs and their income result in increased personal consumption expenditures throughout the economy. The sum of all these effects is the economic impact of petroleum refining on the Washington State economy.

In this report these economic effects are calculated and described, along with the additional tax effects of the industry on state and local revenue bases. Petroleum product consumption and production in Washington is summarized, as are the downstream transportation, wholesaling, and retailing jobs and wages necessary to move products to market.

This report draws upon data from several key sources: the Washington Refiners Survey, conducted by the Washington Research Council (WRC), 2001–2003 (see appendix A); the WRC-REMI model of the Washington State economy (see appendix B); the Energy Information Administration, U.S. Department of Energy; the Washington State Employment Security Department; and the Washington State Department of Revenue.

2. Summary of Findings

Washington's five refineries make up nearly 4% of the United States' refining capacity. In 2003 they processed nearly 576,800 barrels of crude oil per day, producing 256,600 barrels of gasoline per day. Gasoline, diesel oil, and jet fuel are the largest finished product

categories, representing 44%, 23%, and 12%, respectively, of total production.

According to the refiners survey, the five major refineries employed 1,725 workers in 2003, paying them an average annual wage of \$80,357, about twice the Washington State average.

As illustrated in figure 2.1, these jobs have a total employment multiplier of 11.68, meaning that each direct refining job generates an additional 10.68 jobs in the state, for a total employment effect of 20,148 jobs resulting from the five refineries.

Petroleum refining is extraordinarily capital intensive, the major reason for its high jobs multiplier. The WRC-REMI model, which is used here to determine the economic impact of the industry, calculates that each petroleum job adds \$539,500 of state personal income, a total

income contribution of nearly \$1 billion to the state economy.

The industry is also highly taxed and regulated, producing a stable source of tax and fee revenues for state and local

government. The five refiners paid \$226.5 million in state and local taxes in 2003, a 33% overall increase from 2001 (appendix A).

The WRC-REMI model calculates that each direct refining job results in \$20,905 in sales and use collections and \$30,876 in business and occupation (B&O) tax revenues, for a total of \$36.1 million in sales and use taxes and \$53.3 million in B&O receipts. In addition, the refiners paid \$12.8 million in property taxes in 2003 and \$2.3 million in regulatory fees (appendix A).

Finally, petroleum refineries have an excellent worker safety rating and contribute generously to the communities in which they are located. In 2002 refineries averaged just 11.1 injuries or illnesses per 10,000 full-time workers. This low rate compares with an average of 72.4 per 10,000 full-time workers for nondurable goods manufacturing (BLS 2004).

The five refiners and their employees contributed \$775,000 to various community causes in 2003. The firms themselves contributed about 69% of this, with the balance provided by firm-sponsored employee giving (appendix A).

3. Oil Refining in Washington State

Building and development of the industry. The oil refining industry in Washington State began in the mid-1950s with construction of refineries by Shell in Anacortes (Skagit County) and Mobil at Cherry Point (Whatcom County). Following closely in 1957, Texaco built in

FIGURE 2.1

Summary of multipliers and economic impacts			
Refining jobs	Multiplier	Indirect & induced economic effect	Major petroleum refiners total economic impact
	11.68	18,423 jobs	20,148 jobs
1725 jobs	\$539,500	\$736,482,500 personal income	\$930,637,500 personal income
	\$20,905	\$31,898,125 retail sales & use taxes	\$36,061,125 retail sales & use taxes
	\$30,876	\$21,099,100 B&O taxes	\$53,261,100 B&O taxes
Source: WRC-REMI Model 2004			

Anacortes, and U.S. Oil constructed its refinery on the Tacoma Tideflats. In the early 1970s, in anticipation of the crude that would begin flowing from Alaska's North Slope, Atlantic Richfield (Arco) built its refinery at Cherry Point. This plant remains one of the nation's newest refineries. Ownership of all these facilities has been fluid over the years, but today Washington's refining activity is concentrated at the four major plants in Whatcom and Skagit counties and the U.S. Oil plant in Tacoma. See map and table 3.1.

Federal restrictions. Oil companies invest tremendous sums in their facilities in order to maintain their assets, to increase refining capacities, and to remain viable in a highly competitive global industry. In the 1970s, Washington's older oil refineries embarked on major plant

TABLE 3.1

Firm	Year constructed	Location	Major products	Capacity (barrels per day)	2003 production (barrels per day)
BP Cherry Point (formerly ARCO)	1971	Whatcom County, northwest of Ferndale	gasoline, deisel oil, jet fuel, calcined coke	225,000	210,830
Conoco Phillips Ferndale (formerly Tosco, BP Oil, and Mobil Oil)	Mid-1950s by General Petroleum (subsidiary of Socony-Mobil)	Whatcom County, west of Ferndale	gasoline, diesel oil, jet fuel, liquid petroleum, residual fuel oil	92,000	84,900
Shell Oil (formerly Equilon Enterprises and Texaco)	1957	Skagit County, five miles east of Anacortes	gasoline, diesel oil, jet fuel, propane, coke, sulfur	145,000	143,384
Tesoro (formerly Tesoro Northwest and Shell Oil)	1955	Skagit County, on March Point	gasoline, diesel oil, turbine & jet fuel, liquid petroleum gas, residual fuel oil	115,000	109,000
U.S. Oil	1957	Pierce County, Tacoma Tideflats	gasoline, diesel oil, jet fuel, marine fuel, gas oils, emulsified & road asphalt	44,350	35,000

Source: WRC Refiner Survey 2004, EIA (2004b)

modifications in anticipation of the Alaskan crude. Plans for new port facilities on Puget Sound to receive supersized tankers and new pipelines to carry Alaskan oil on to the Midwest were debated. But in 1977, before these plans could be finalized, the Marine Mammal Protection Act came up for reauthorization in Congress. Washington's then-senior senator, Warren Magnuson, preempted these plans by attaching an amendment to the reauthorization bill prohibiting construction of new ports east of Port Angeles.

Geographic isolation.

This decision sealed Washington's isolation

from the rest of the country's petroleum supplies by preempting pipeline construction to the upper Midwest that would have provided the Northwest with easier access to eastern and Midwest distribution systems.

Today, Washington's five refineries make up 3.7% of the nation's total refining capacity (EIA 2004b). With this state accounting for 2.1% of national petroleum consumption, in-state refineries produce quantities more than sufficient for Washington's needs (EIA 2003a).

Dependence on in-state refining. Other areas of the country—the Midwest and the East—are connected to a larger distribution system that allows their short-term petroleum supply disruptions to be accommodated more easily than those in the West or in Washington State, in particular. The West, which is not connected to the

Midwest pipeline systems, gets its crude primarily from the Gulf of Mexico through pipelines from Texas to the California markets, and from Alaska's North Slope by tanker into Anacortes and Cherry Point. To a lesser extent, Washington refineries also receive crude from Alberta, Canada, by pipeline.

Nationally, plant obsolescence and federal and state regulations requiring cleaner product and production processes have resulted in 104 plant closures since 1982 (EIA 2004a). The remaining 159 refineries are more efficient, with nearly as much total refining capacity as was available in 1982. However, the increased demands of a growing population and economy and an increasing array of “boutique” fuels required by federal and state regulations strain current capacities, and the price effects are being felt throughout the country.

This increasingly constrained supply-demand relationship combines with the West Coast's isolation to produce an economy in Washington that is unusually dependent on its in-state refining capacity. It is this industry and its relationship with the larger Washington State economy that are described in the sections that follow.

4. Industry Impact Analysis

To understand the economic effect of an industry, analysts normally focus on the jobs the industry generates. To quantify the impact of Washington State's refineries on its economy, we use the WRC-REMI model to simulate a permanent decrease in refinery employment of roughly 5% and measure the resulting changes in total state employment, personal income, and gross product. Dividing these resulting changes by the change in refinery employment gives “multipliers” that are then applied to the industry's total employment to calculate total economic impact. For example, in 2003 the five refineries had 1,725 employees. With a multiplier of 11.68, the total impact of the refineries was 20,148 jobs. Similarly, the refinery activities resulted in \$539,500 of state personal income for every direct job, or a total statewide of \$930,637,500 in personal income.

The economic impacts of petroleum refining in Washington, however, are broader than those of most other sectors of the economy. If petroleum prices go up, the effects are felt in the price of food and other essential consumer goods, the costs of commuting, and the cost of moving goods to market for businesses throughout the economy. And, unlike products from other sectors, alternative petroleum supplies or substitute products are not readily available in the case of an emergency. In order to fully appreciate the economic value of the petroleum refining industry in Washington, the dire economic consequences possible in a catastrophic scenario must be acknowledged. Foreign product would have to be imported, increased dock and terminal capability would be required, product prices would increase in response to diminished supply availability and stability, and these increases would be felt throughout the economy.

In the sections that follow, Washington's petroleum refining industry is described under equilibrium conditions by summarizing

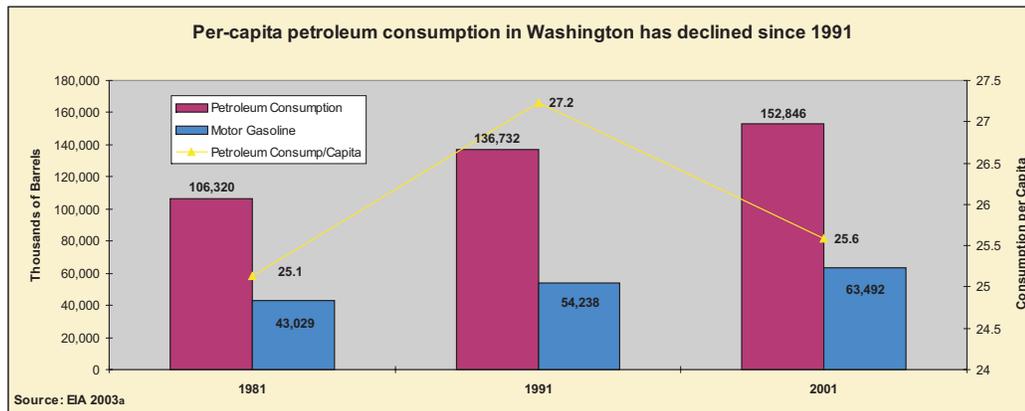
consumption (Section 5), production (Section 6), and the direct purchases of the five major industry refiners (Section 7). Based on these data, the WRC-REMI model calculates the effect of the five refineries on jobs, income, retail sales and use, and B&O taxes statewide.

Finally, in Sections 8 and 9 we provide employment, wage, and tax contribution information on the portions of the transportation, wholesaling, and retailing sectors that operate downstream of the refining process. These petroleum-related activities combine to assure that petroleum products get to their markets in Washington State and beyond. Although they would exist regardless of the presence of in-state refining, their inclusion here helps to give a complete picture of the petroleum industry in Washington State.

5. Petroleum Product Consumption in Washington

Washington households and businesses consumed nearly 153 million barrels of finished petroleum products in 2001, up 44% from 1981, according to the Energy Information Administration (2003a). This was about 2% of total U.S. consumption and about 6% of EIA's western

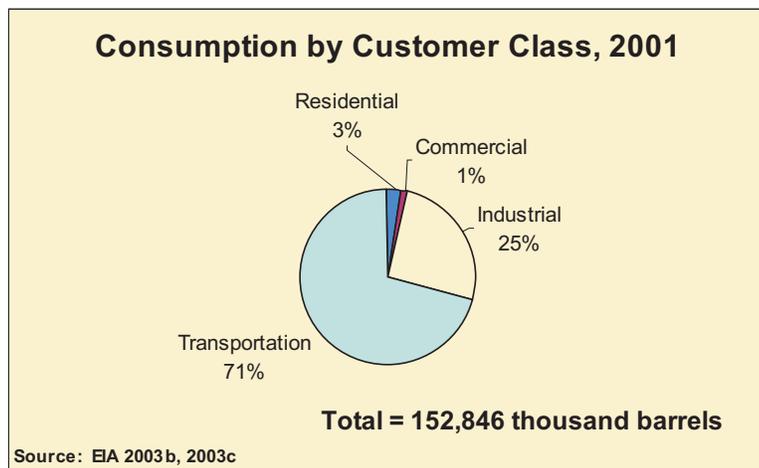
FIGURE 5.1



Petroleum Administration for Defense (PAD) District V that encompasses Washington, Oregon, California, Nevada, Alaska, and Hawaii. PAD District V represented 14% of total U.S. consumption in 2001.

As a result of population growth and slower consumption growth over the

FIGURE 5.2



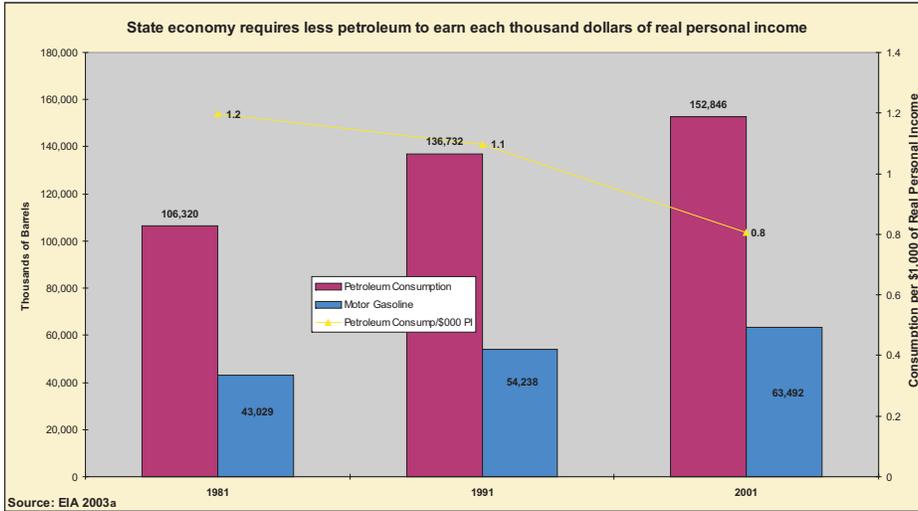
twenty-year period, per-capita petroleum product consumption in Washington grew from 1981 to 1991, then declined from 1991 through 2001. See figure 5.1.

The several broad classes of customers who purchase petroleum products help to explain the state's consumption patterns. Residential and commercial customers reduced their demand for petroleum products over the twenty-year period by 22% and 38%, respectively (EIA 2003b, 2003c).

Transportation and industrial customers, on the other hand, increased their consumption—55% and 43%, respectively—over the twenty-year period. As

shown in figure 5.2, by 2001 transportation and industries customers together account for 96% of total petroleum product consumption in Washington State.

FIGURE 5.3



The state economy (as measured by real state personal income) grew at a faster rate than overall petroleum consumption. Therefore, as shown in figure 5.3, even though petroleum consumption grew, the state economy required less petroleum product for every dollar of economic output. This largely reflects the tremendous growth of software and other high-tech and information-based sectors of the economy, which produce significant economic wealth with relatively little petroleum product.

FIGURE 5.4

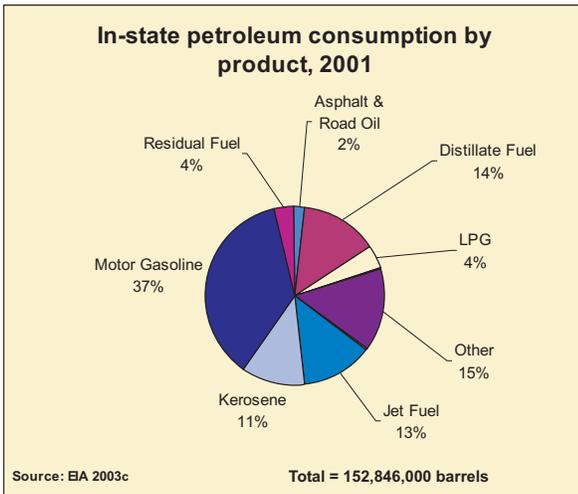


Figure 5.4 shows that motor gasoline was, by far, the largest category of consumption at 37% of the total. Consumption of gasoline grew by more than 20.5 million barrels over the twenty-year period, a 48% increase. Even so, gasoline consumption declined as a share of the total, from 41% to 37%, largely due to the fuel-efficient technology incorporated into vehicle design since the 1970s.

6. Petroleum Production in Washington

The data that follow in Sections 6, 7, and 8, unless otherwise indicated, are the aggregated results of a survey of Washington's five major refiners (appendix A).

Finished products. Washington's refineries produced 583,100 barrels per day and more than a dozen different products in 2003. Gasoline, at nearly 255,600 barrels per day in 2003, is by far the largest product category, accounting for 44% of the total. Diesel oil and jet fuel are the next largest at 23% and 12%, respectively. Diesel production, in particular, grew nearly 10% from 2001 to 2003, to 134,800 barrels a day. See figure 6.1.

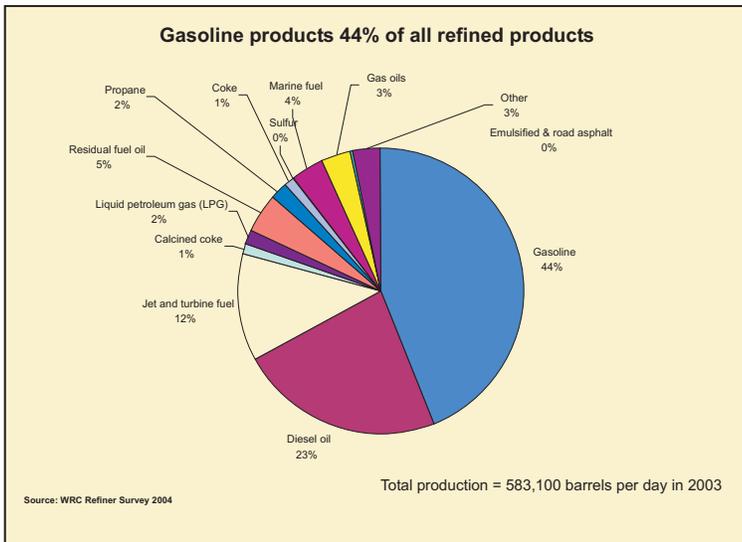
Gasoline accounts for about 50% of the refineries' total \$7.3 billion in output value in 2003. Again, diesel oil and jet fuel are next, accounting for 24% and 13%, respectively.

Nearly 61% of Washington refined product is used within the state. In 2003, 34% of total product was sold domestically outside Washington, with the remaining 6% delivered to foreign buyers. See figure 6.2.

Product transport. Finally, half of all products refined in Washington are shipped south by pipeline, primarily to Seattle and

Tacoma markets and on to Portland. (See map.) Of the remaining product, 38% is shipped by water, mostly to Portland and other destinations along the Columbia River, with the balance (12%) going out by other modes of transport.

FIGURE 6.1



7. Washington Refiners: Direct Purchases

Washington refiners spent \$7.5 billion in 2003. This section describes their main areas of expenditure.

Feedstock. Washington's petroleum refineries received nearly 576,800 barrels per day of crude oil and other feedstock inputs (e.g., butane, isobutene, and cat feed) in 2003. The total volume of feedstock required did not grow significantly between 2001 and 2003—less than 1/2 of 1%. Feedstock costs, however, grew by more than 22% from \$4.8 billion in 2001 to \$5.8 billion in 2003. The cost per barrel of crude explains most of this increase, as it grew by 22% over the period. See table 7.1.

Nearly 89% of crude oil and other feedstock came into the refineries by tanker in 2003, mostly from Alaska's North Slope. The remaining feedstock came mostly from Alberta, Canada, through pipeline. (See map.)

Labor. Washington's five oil refiners employ 1,725 workers and pay them extraordinarily well. According to the state Employment Security Department (ESD), average refinery pay is nearly twice the state average. The average annual wage for all Washington jobs in 2002 was \$38,244, compared with ESD's published average annual

wage for petroleum refining of \$73,588. By comparison, information from the refiner survey puts the 2002 average annual wage at \$74,547. The average annual wage in 2003 according to the survey was \$80,357. See figure 7.1.

This contrast is even more pronounced when comparing refining wages with total average wages in Whatcom and Skagit counties where the four largest refineries are located. The average

FIGURE 6.2

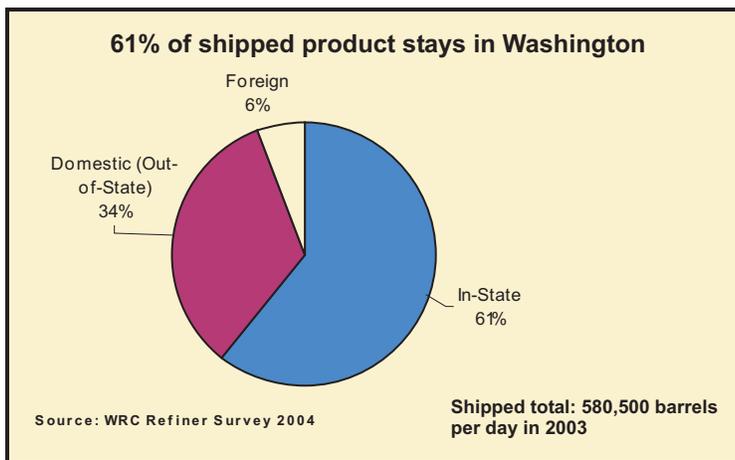


TABLE 7.1

Quantity and value of feedstock input	2001	2002	2003
Total feedstock inputs (thousands of barrels per day)	574.5	574.9	576.8
Crude oil	561.0	550.4	561.6
Other	13.5	24.5	15.2
Total value of feedstock inputs (thousands)	\$4,762,123	\$4,836,623	\$5,825,505
Crude oil	4,635,819	4,607,473	5,666,496
Other	126,303	229,150	159,009

Source: WRC Refiner Survey 2004

FIGURE 7.1

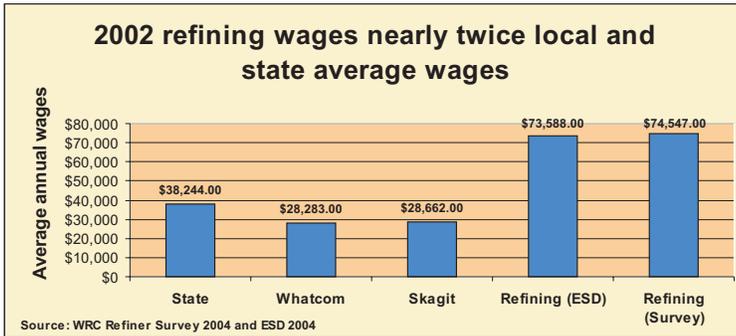
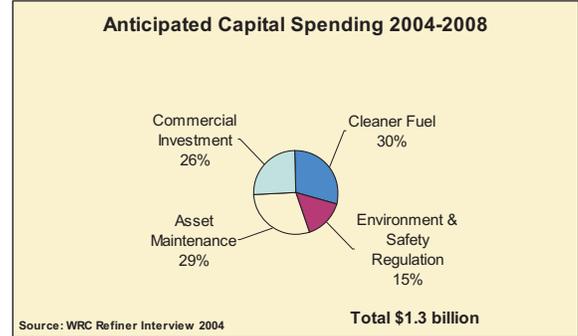
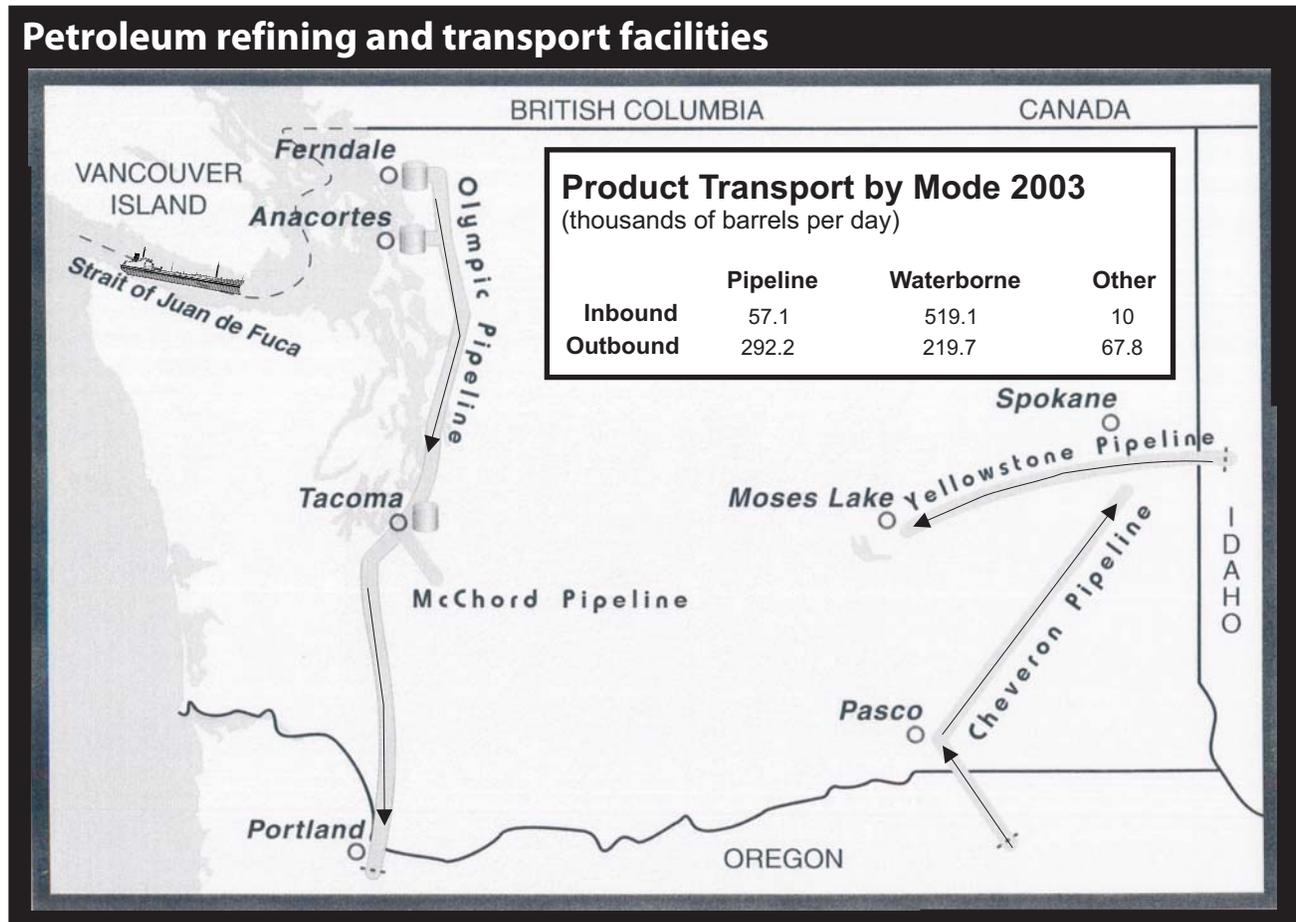


FIGURE 7.2



MAP



Refinery Employees Wages and Benefits 2003

1,725 FTE Workers

\$139 million in payroll
\$80,357 per worker

\$194 million in total compensation
\$112,554 per worker

Source: WRC Refiner Survey 2004

Contract Labor 2003

1,393 FTE Workers

\$165 million in wages

\$118,296 per worker

Source: WRC Refiner Survey 2004

annual wage in Whatcom County in 2002 was \$28,283, while in Skagit County it was \$28,662 (ESD 2004). The average wage at the four refineries in these two counties in 2002, by comparison, was \$75,861.

Refinery payrolls totaled nearly \$139 million in 2003, up 15% from 2001. Worker benefits grew by more than 47% over this period, totaling \$56 million in 2003. With total compensation of about \$194 million in 2003 (up nearly 21% from 2001), average employee compensation in 2003 was about \$112,554.

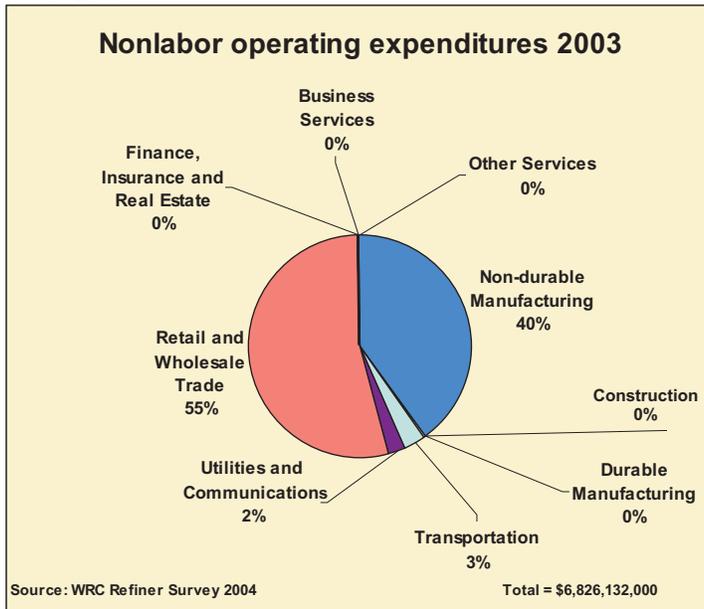
Contract labor. Washington's petroleum refiners regularly rely on contract workers to clean and service various parts of their plant facilities and equipment, as well as to conduct scheduled major repairs and upgrades. The number of workers varies from year to year—1,564 in 2001, 1,424 in 2002, 1,393 in 2003—but nonetheless represents a significant part of the employment base, especially in Whatcom and Skagit counties.

In 2003 refiners paid contract workers nearly \$165 million, an average of \$118,296 per worker. Most of these workers—98%—came from within Washington State. Although it is not always so, about 47% of the work in 2003, or \$77 million, was service and maintenance related, while 53%, or \$88 million, went toward capital repair and replacement. This cyclical work conforms to a planned schedule that is known well in advance. Over the next five years the refiners anticipate spending more than \$1.3 billion on these types of activities. As shown in figure 7.2, about 29%, or \$393 million, will be spent on maintaining the current plant facilities. Another 26%—about \$349 million—will be invested in staying competitive within their industry. And 45%—about \$592 million—will be spent retrofitting the plants to produce cleaner burning fuels and to conform with new environmental and safety regulations.

Nonlabor operating expenditures. Nonlabor operating expenditures are mostly for product—crude oil, intermediately processed crude (to be refined further into higher grade products), and chemicals and catalysts to be applied to the crude to produce various final products. These purchases show up in two categories: nondurable manufactured goods (primarily intermediate petroleum products and chemicals) and wholesale purchases (crude purchased from other divisions of the companies themselves, or in some cases from other companies). Combined, these two categories account for about 92% of all nonlabor operating expenditures. See figure 7.3.

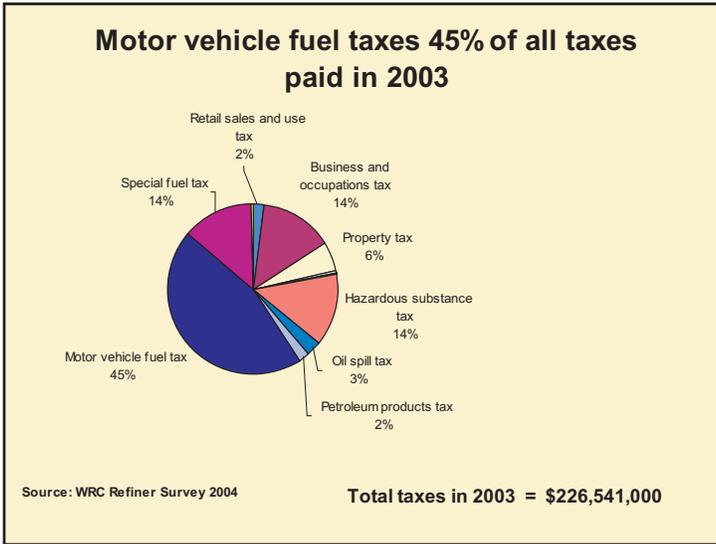
Significant amounts are also spent on utilities and transportation, which together account for \$349 million in 2003. Utilities expenditures, including electricity, gasoline, and communications, totaled \$152 million in 2003, and transportation totaled \$197 million. Transportation expenditures were primarily for waterborne and pipeline transport of in- and outbound product.

FIGURE 7.3



communications, totaled \$152 million in 2003, and transportation totaled \$197 million. Transportation expenditures were primarily for waterborne and pipeline transport of in- and outbound product.

FIGURE 7.4



Taxes. The five refiners contributed \$226.5 million in state and local taxes in 2003, up 33% overall since 2001. The motor vehicle fuel tax, which the refiners pay on each gallon of gasoline delivered, captured the largest share of total taxes paid—\$102.2 million, more than 45%. See figure 7.4.

Three categories of tax tied for second at 14% each: the state B&O tax, \$32.3 million; the hazardous substance tax, \$31.3 million; and the special fuels tax, \$30.7 million. Petroleum products and oil spill taxes combine at \$7.2 million to make up most of the balance.

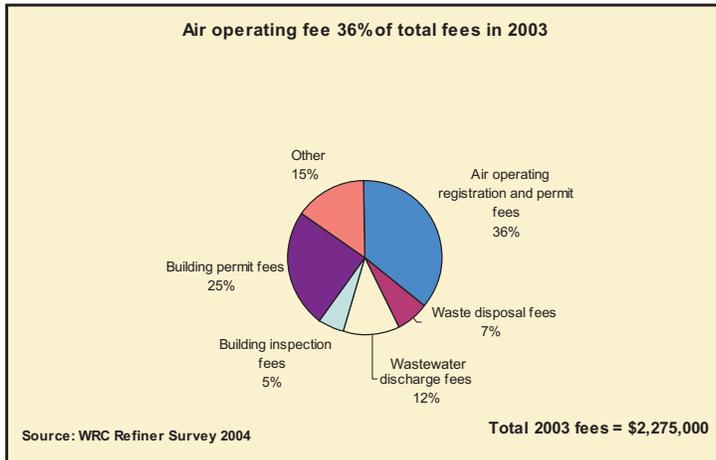
About one-third or \$75 million of these taxes are unique to the petroleum refining industry. For example, revenues from the oil spill tax are paid into a trust fund for oil spill cleanup. When the account is fully funded the tax is suspended; when it is short, the tax is resumed. The petroleum products tax revenues are used to fund the pollution liability insurance program, which assists owners of underground storage tanks in obtaining insurance for upgrading and replacing tanks and preventing leaks.

Fees. In addition, the refiners paid another \$2.3 million in regulatory fees in 2003. These included their air operating registration and permit fees (36%), waste disposal fees (7%), wastewater discharge fees (12%), and building inspection and building permit fees (30%). See figure 7.5.

These fees increased nearly 28% from 2001 when they were just \$1.8 million. The refineries spent \$693,000 on building inspection and building permit fees in 2003, up 95 percent

from \$338,000 in 2001 and likely signaling the increased level of building activity anticipated in the next several years.

FIGURE 7.5



8. Petroleum Refining Industry: Indirect and Induced Economic Impacts

The economic impact of refineries on the state's economy can be divided into three primary categories: direct, indirect, and induced effects (jobs, income, and taxes).

The direct effects are those in the industry itself—the refinery jobs and payroll and the taxes paid by the refiners.

Indirect economic effects have two subcategories. First, they include those jobs, wages, and taxes paid by upstream suppliers of the refineries—not only the suppliers of crude oil, but also the construction companies and contract workers used for plant maintenance and repair

and the office product and equipment suppliers, for example. These figures were captured in the survey completed by the five refiners.

The second subcategory of indirect economic effects includes the jobs, wages, and taxes paid by the suppliers of the suppliers; for example, the firm that leases a copier to the construction firm hired by a refinery for maintenance, or the firm that supplies material, tools, equipment, and office products to a local contractor serving a refinery.

Induced effects are the jobs, income, and taxes contributed by firms in industries that supply daily consumables and services—e.g., food, dry cleaning, banking—to workers holding the direct and indirect jobs.

The relationship between the direct jobs, income, and tax effects in an industry and their indirect and induced effects are captured by multipliers, which are calculated using the WRC-REMI model of the Washington State economy.

The **total employment multiplier** (TEM) for the petroleum refining industry is **11.68**. Applying this multiplier to the 1,725 direct refinery jobs in 2003 gives a total state employment impact of **20,148 jobs**.

This is an unusually large employment multiplier. In comparison, the Washington State Input-Output 1987 Study (1993) calculates that the

TEM for overall manufacturing is 2.74. Part of this difference arises because the input-output multiplier does not include the effects of an industry's investment spending. Were such investments to be ignored by the WRC-REMI model, the employment multiplier for petroleum refining would be only 8.82, which compares favorably with the input-output multiplier for petroleum refining of 8.879.

Three factors contribute to the industry's large multiplier. First, petroleum refiners pay high wages. As a result, the employment induced by refinery employee spending is relatively great.

Second, the petroleum industry ranks high in the ratio of in-state supplied intermediate inputs to labor income. For the typical industry this ratio is 0.82. For petroleum refining it is 2.96, ranking the industry second highest among the 38 industries included in the Washington input-output model (OFM 2004). For this reason, indirect employment is relatively high.

Third, petroleum refining is highly capital intensive. That is, wages represent a relatively small percentage of the industry's total added value. For the average industry, labor income is 64.2% of value added.

By comparison, petroleum refining labor income is just 19.7% of value added, the lowest percentage of any of the 38 industries in the Washington input-output model (OFM 2004). To support the industry's high capital intensity, the refiners have unusually high investment spending per employee. The indirect jobs associated with this spending contribute significantly to the industry's multiplier.

The WRC-REMI model calculates an imputed **total income multiplier** that shows that each refining job results in an additional

Petroleum Refining Additional Jobs

Direct jobs	1,725
Total employment multiplier.....	11.68
Indirect & Induced Job Impact.....	20,148 jobs

Source: WRC-REMI Model

Petroleum Refining Additional Income

Direct jobs	1,725
Total income multiplier.....	\$539,500 per job
Additional Personal Income.....	\$930,639,000

Source: WRC-REMI Model

\$539,500 of state personal income. At 2003 employment levels, this results in nearly a billion dollars—**\$930,639,000**—of **additional state personal income**.

In 2003 state and local sales taxes averaged \$0.03875 for each dollar of state personal income. With the income multiplier result of \$539,500, each petroleum refining job results in **\$20,905 in state and local sales taxes** or a total of **\$36,062,203**.

The Washington State Tax Structure Study Committee (2002) calculates that petroleum refining has the second-highest of all effective B&O tax rates (behind gasoline and electric utilities) when B&O taxes paid by suppliers are included. Total B&O taxes paid by refiners and suppliers would be 2.56 times the amount paid directly by the refiners. We adjust that ratio down to 1.65, however, to reflect the higher crude oil prices in 2003. The refiners reported paying \$32.3 million dollars in B&O taxes in 2003. Applying the 1.65 multiplier, then, **total B&O taxes** generated by petroleum refining in 2003 were **\$53.3 million or \$30,876 per direct job**.

**Petroleum Refining
Additional Retail Sales Taxes**

Direct jobs	1,725
Total retail sales tax multiplier	\$20,905 per job
Additional Retail Sales Taxes.....	\$36,062,203

Source: WRC-REMI Model

**Petroleum Refining
Additional B&O Taxes**

Direct jobs	1,725
Total B&O tax multiplier	\$30,876 per job
Additional B&O Taxes.....	\$53,261,100

Source: WRC-REMI Model

9. Washington Petroleum Industry: Downstream Activities

Washington's petroleum refiners rely on a number of industries to distribute their product to consumers. These include transportation (pipelines, barges, trucks, and rail) and transportation support facilities (terminals, stockyards, and bulk stations), wholesalers, and retailers (gasoline stations and fuel oil dealers).

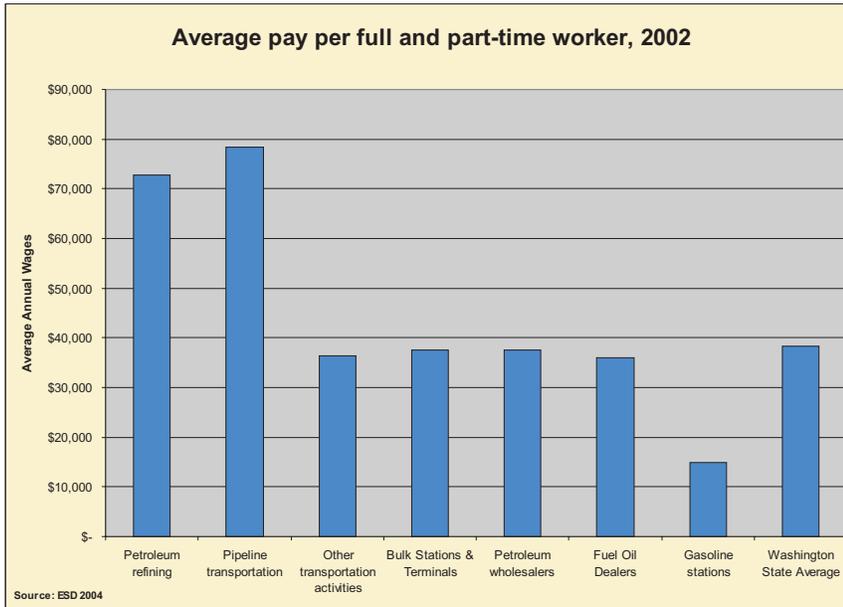
These downstream industries exist as a result of petroleum product consumption in our economy, not as a result of petroleum refining. Presumably, if the refineries were gone or if they had never existed in Washington,

finished petroleum products would be imported to terminal and stockyard facilities, transported to retail destinations within the state, and sold to consumers through systems much like those that currently exist, together with similar job, wage, and tax effects. Even so, their direct economic contribution is substantial and their role in the larger petroleum industry is crucial. This section describes the employment, wages, and taxes associated with these industries.

Of the total finished products produced by Washington's refineries, about half leave through pipeline to markets in Seattle and Tacoma and beyond. Another 38% goes by water to Seattle and Portland, with the remaining 12% of product shipped by rail or truck. About 61% of the value of this product—\$4.4 billion on average—is delivered to retailers for consumer sales within the state of Washington (appendix A).

Jobs and wages. According to detailed data reported to the state ESD for 2002, the most recent year for which such data are available, there were about 1,781 employers in these downstream industries. Together, they paid \$355 million in wages to 18,063 workers. These are all workers covered by ESD's unemployment insurance program for

FIGURE 9.1



these industries, so the number includes both full-time and part-time workers. Table 9.1 shows these data for each industrial classification with their corresponding Standard Industrial Classification (SIC) and the new North American Industrial Classification System (NAICS) codes. Similar data from this database are provided for petroleum refining for reference.

Among the downstream industries there are three broad tiers of employment and pay:

- Pipeline transport employs a few highly paid workers—175 workers make more than \$78,000 per year on average.
- Bulk stations and terminals, wholesalers, and fuel oil dealers employ about 3,381 workers and pay an average of \$35,000 to \$40,000 per worker per year.
- Gasoline stations generate a large wage bill with a lot of lower-wage and part-time jobs. In 2002, this industry's 1,521 employers paid total wages of \$217 million to 14,953 workers. Figure 9.1 shows average wages for refining and its downstream employment sectors.

TABLE 9.1

SIC code	NAICS code	Industry	Employer units	Wages paid	Average wages employees	Average wage per worker*
2911	324110	Petroleum refining	13	\$158,601,825	2,181	\$72,720
5171	424710	Petroleum bulk stations and terminals	25	23,079,387	615	37,527
5172	424720	Petroleum products wholesalers	98	45,647,283	1,217	37,508
46	486	Pipeline transportation	8	13,708,657	175	78,335
4789	488999	All other support act. for transportation	22	7,712,472	212	36,380
5411 & 5541	447110	Gasoline stations with convenience stores	1,365	185,954,875	12,983	14,323
5541	447190	Other gasoline stations	156	30,964,035	1,524	20,318
598	4543	Fuel oil dealers	94	48,249,083	1,337	36,088
5983	454311	Heating oil dealers	53	30,352,089	806	37,658
5984	454312	Liquefied petroleum gas dealers	23	17,338,992	499	34,747
5989	454319	Other fuel dealers	18	557,982	32	17,437
		Total transport and retail	1,781	355,315,772	18,063	19,671
		Total with refining		513,917,597	20,244	25,386

*Includes full and part-time workers
Source: ESD 2004

Taxes. The state DOR reports

excise tax data on these same industries (2004c). As shown in table 9.2, total excise taxes due from the downstream industries totaled \$390 million in 2003.

TABLE 9.2

	Combined excise tax return categories				% of Total (w/o Refining)
	Gross Income	Taxable Income	B&O Taxes Due	Total Excise Taxes Due	
Petroleum refining	\$9,882,316,278	\$8,982,643,271	\$43,514,945	\$114,038,545	
Pipelines	6,004,644	5,983,791	127,001	145,611	0
Pipeline terminals & stockyards	45,896,852	45,662,256	524,986	524,986	0
Petroleum bulk stations & terminals	4,218,212,534	3,379,340,073	28,358,465	4,882,140	1
Petroleum products wholesalers	4,218,212,534	3,379,340,073	28,358,465	32,926,819	8
Gasoline stations	15,482,985,862	4,851,958,441	262,859,407	333,861,093	86
Fuel oil dealers	523,013,150	343,032,112	15,759,260	17,738,496	5
Total downstream petroleum activities	24,494,325,576	12,005,316,746	335,987,584	390,079,145	100
TOTAL petroleum with refining	34,376,641,854	20,987,960,017	379,502,529	504,117,690	

Source: DOR 2004c

Gasoline stations paid nearly \$334 million in excise taxes or about 86% of the total industry excise taxes paid (excluding refining). Wholesalers (8%), fuel oil dealers (5%), and bulk stations and terminals (1%) made up the difference.

Appendix A: Washington State Petroleum Refiner Survey May 2004

Quantity and value of input			
	2001	2002	2003
Total feedstock inputs (thousands of barrels per day)	574.5	574.9	576.8
Crude oil	561.0	550.4	561.6
Other	13.5	24.5	15.2
Total value of inputs (thousands of dollars)	\$4,762,123	\$4,836,623	\$5,825,505
Crude oil	\$4,635,819	\$4,607,473	\$5,666,496
Other	\$126,303	\$229,150	\$159,009
Quantity and value of output			
	2001	2002	2003
Total product output (thousands of barrels per day)	580.5	575.2	583.1
Gasoline	239.9	246.0	255.6
Diesel oil	122.6	120.1	134.8
Jet and turbine fuel	78.0	81.9	70.6
Calcined coke	8.6	7.2	7.0
Liquid petroleum gas	10.8	11.1	10.1
Residual fuel oil	32.0	25.8	26.5
Propane	14.0	10.1	10.6
Coke	0.3	5.8	5.9
Sulfur	1.0	1.0	1.0
Marine fuel	29.1	27.0	22.8
Gas oils	22.5	21.8	18.9
Emulsified & road asphalt	2.0	2.0	2.0
Other	20.0	15.5	17.3
Total value of output (thousands of dollars)	\$6,318,125	\$5,732,174	\$7,328,577
Gasoline	\$2,974,586	\$2,763,163	\$3,652,428
Diesel oil	\$1,441,729	\$1,278,515	\$1,722,011
Jet and turbine fuel	\$852,694	\$819,063	\$951,325
Calcined coke	\$130,616	\$127,786	\$136,392
Liquid petroleum gas (LPG)	\$104,296	\$91,896	\$116,285
Residual fuel oil	\$230,689	\$217,292	\$270,189
Propane	\$65,774	\$42,287	\$65,772
Coke	\$27,906	\$27,443	\$28,211
Sulfur	\$327	\$447	\$1,077
Marine fuel	\$111,907	\$95,798	\$131,179
Gas oils	\$128,587	\$113,941	\$97,370
Emulsified & road asphalt	\$8,844	\$4,622	\$8,687
Other	\$240,171	\$149,921	\$147,653
Origin of inputs (thousands of barrels per day)			
	2003 Pipeline	2003 Waterborne	2003 Other
Crude oil	53.9	509.5	0.0
Other	3.2	9.6	10.0
Destination of output (thousands of barrels per day)			
	2003 In-State	2003 Domestic (Out-of-State)	2003 Foreign
Gasoline	156.2	101.9	0.1
Diesel oil	74.3	60.1	0.0
Jet and turbine fuel	51.2	14.1	7.4
Calcined coke	0.0	0.0	7.0
Liquid petroleum gas	10.0	0.3	0.0
Residual fuel oil	14.1	2.4	9.9
Propane	10.1	0.4	0.1
Coke	0.0	0.0	5.9
Sulfur	1.1	0.0	0.0
Marine fuel	18.6	1.0	0.0
Gas oils	7.4	9.0	2.4
Emulsified & road asphalt	1.5	0.0	0.0
Other	7.1	6.4	0.4

Mode of output transport (thousands of barrels per day)	2003 Pipeline	2003 Waterborne	2003 Other
Gasoline	176.1	66.1	16.1
Diesel oil	69.2	51.4	13.9
Jet and turbine fuel	41.4	25.5	5.8
Calcined coke	0.0	0.0	7.0
Liquid petroleum gas	0.0	0.0	10.4
Residual fuel oil	0.0	26.4	0.0
Propane	0.0	0.0	10.6
Coke	0.0	4.8	1.1
Sulfur	0.0	0.0	1.0
Marine fuel	0.0	23.3	0.0
Gas oils	0.0	14.2	0.5
Emulsified & road asphalt	0.0	0.0	1.0
Other	5.5	8.0	0.4
Employment and contract labor	2001	2002	2003
Total on-site employment (number of FTE employees)	1,690.0	1,723.0	1,725.0
Total payroll (thousands of dollars)	\$120,077	\$128,445	\$138,615
Total employee benefits (e.g. health, pension, social security, etc.)	\$37,744	\$45,738	\$55,540
Total contract labor (thousands of dollars)	\$177,326	\$157,879	\$164,810
Service and maintenance	\$74,115	\$79,333	\$76,921
Capital repair and replacement	\$103,211	\$78,546	\$87,889
Total contract labor (number of FTE workers)	1,563.9	1,423.5	1,393.2
Service and maintenance	629.0	626.0	554.5
Capital repair and replacement	934.9	797.4	838.7
Percent of contract labor from outside Washington State	30	47	2
Service and maintenance	11	41	1
Capital repair and replacement	34	51	1
Nonlabor operating expenditures (thousands of dollars)	2001	2002	2003
Total	\$5,824,167	\$5,665,190	\$6,826,132
Nondurable manufacturing	2,213,615	2,278,258	2,734,682
Petroleum	2,184,843	2,254,047	2,710,504
Durable manufacturing	3,296	3,253	3,719
Construction	9,704	10,267	18,025
Transportation	237,630	208,186	197,106
Rail	13,048	20,470	15,386
Trucking	9,406	7,421	5,426
Automobiles	20	20	20
Waterborne	134,321	109,873	119,299
Air	50	50	20
Other	56,220	46,819	30,325
Utilities and communications	195,663	115,644	151,646
Electricity	81,968	52,167	57,589
Gas	84,949	46,984	72,539
Retail and wholesale trade	3,144,413	3,029,843	3,697,492
Wholesale Trade	2,991,408	2,891,902	3,549,970
Finance, insurance and real estate	6,281	5,868	6,125
Business services	11,154	10,115	13,174
Other services	2,412	2,560	4,163
Total nonlabor capital expenditures (thousands of dollars)	2001	2002	2003
Equipment	86,360	74,435	75,678
Materials and supplies	18,115	22,885	29,470

Taxes	\$170,620	\$191,247	\$226,541
Retail sales and use tax	2,879	3,663	4,163
Business and occupations tax	31,264	24,289	32,252
Property tax	10,677	12,247	12,752
Unemployment compensation tax (state only)	493	493	640
Industrial insurance premium	329	329	379
Hazardous substance tax	32,697	24,028	31,280
Oil spill tax	7,566	6,596	6,806
Petroleum products tax	0	0	4,351
Motor vehicle fuel tax	56,264	93,049	102,169
Special fuel tax	24,078	24,721	30,715
Other	4,373	1,831	1,034
Regulatory fees	1,780	2,055	2,275
Air operating registration and permit fees	698	801	815
Waste disposal fees	171	135	152
Wastewater discharge fees	252	265	266
Building inspection fees	63	78	118
Building permit fees	292	435	575
Other	305	341	349
Estimated services and retail trade			
(thousands of dollars)			
	2001	2002	2003
Total food services	\$1,728	\$1,689	\$1,282
Associated with contract labor	1,000	1,114	834
Associated with business visitors	557	428	275
Total hotel and motels	2,847	2,822	2,471
Associated with contract labor	1,383	1,449	1,310
Associated with business visitors	668	582	458
Total other trade and Services	775	766	480
Associated with contract labor	498	543	326
Associated with business visitors	277	223	154
Contributions (in thousands of dollars)			
	2001	2002	2003
Total charitable contributions	\$1,304	\$878	\$775
Corporate	1,087	669	537
Firm-sponsored employee giving	217	209	238
Other	2001	2002	2003
Number of estimated business visitors	4,456	4,536	4,756
From Washington	1,620	2,592	3,240
From outside Washington	2,836	1,944	1,516

Appendix B: About the WRC-REMI Model

The Washington Research Council uses a model of the Washington State economy constructed especially for WRC by Regional Economic Models, Inc. Because it allows supply and demand to respond to changes in prices and wages, and permits substitution among factors of production, the WRC-REMI model is more elaborate than the standard input-output models commonly employed to estimate regional economic impacts (Treyz 1993).

The core of the standard input-output model is a catalog of interindustry purchases for the region in a base year, arrayed in an input-output matrix. The model assumes that as a specific industry's production increases or decreases, its purchases from the region's other industries will change proportionately. Likewise, the industry's employment will change by the same proportion that its output changes.

Based on these assumptions, the model traces the cascading effects as one industry's increase in output stimulates an increase in the output of other industries (and its own). These effects are distilled in multipliers that measure how a change in the demand for the output of one industry will affect the total output of the local economy, or how a change in the employment of one industry will affect the total output of the local economy (Chase, Bork, and Conway 1993).

But the standard input-output model is incomplete. It fails to model the numerous capacity constraints within the economy, the processes that set prices for goods and services and the responses of consumers and producers to changes in these prices. In the input-output model, industry and labor supply are perfectly elastic—so prices and wage rates do not matter.

Prices and wages do matter in the WRC-REMI model. The model divides the state into two subregions: the four central Puget Sound counties (King, Kitsap, Pierce, and Snohomish) and the balance of the state. There are 53 industrial sectors within each subregion. Within each subregion the model tracks interindustry transactions, much as an input-output model would.

Unlike an input-output model, however, the WRC-REMI model incorporates a number of significant behavioral responses to changes in prices and costs: The wage rate depends on the supply and demand for labor, migration and labor force participation rates respond to changes in wage rates, and consumer purchases of specific goods and services respond to changes in relative prices and personal income. In addition, producers substitute among production factors in response to changes in relative factor costs, market shares respond to changes in regional production costs, and investment rises in response to increases in output.

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