Creating a Statewide Commodity Flow Forecast from National FAF2 Data

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ABSTRACT

As part of the planning effort leading up to the development of a statewide Freight Plan, the Oregon Department of Transportation (ODOT) developed a statewide commodity flow forecast. The methodology used to create this Oregon Commodity Flow Forecast (Oregon CFF), aimed to address the limitations of existing forecasts – inconsistent and separate databases for different modes, lack of transparency in data and assumptions, and data gaps – in a consistent methodology based on national and local data sources, and be able to meet the tight timelines. This paper will document the work done by the consulting team and the agency to create a statewide forecast that addressed these limitations.

The project team decided to build on the Federal Highway Administration (FHWA) Freight Analysis Framework (FAF2) national commodity flow forecast. The FAF2 commodity flow forecast was chosen because FAF2 is national in scope, highly regarded in terms of capturing interstate and international flows, uses a relatively recent base year (2002), and provided a quick way to complete a forecast in time for the Oregon Freight Plan work.

FAF2 provides freight flows in tons or dollar value between 130 FAF2 regions encompassing the US for the year 2002 plus forecasts from 2010 to 2035 in five year increments. The desired final product for the Oregon CFF was a county-county level flow forecast for truck, rail, marine, air, and pipeline modes. In order to transform the coarse FAF2 zone flows (2 zones cover Oregon) into counties within Oregon, the data was disaggregated. Since the FAF2 dataset contains the whole United States, flows with at least one trip ends within Oregon were disaggregated from FAF2 zones to Oregon counties.

Each of the freight modes was disaggregated separately. In the case of truck flows, this was done based on county employment and IMPLAN inter-industry coefficients of what commodities are made and used by each industry. For rail flows, the FAF2 flows were compared to the Surface Transportation Board’s Rail Carload Waybill data set which contains county level detail of origin and destinations. The overall numbers were found to be comparable, so the Waybill data for 2002 was used as the base, and the FAF2

growth rates were applied to forecast the future years. The other modes relied on local data to allocate FAF2 flows to specific Oregon facilities (rail stations, airports, marine ports, or pipeline terminals), including US Corps of Engineers Waterborne Commerce data and the Oregon Energy Report. Zones outside of Oregon were aggregated from FAF2 zones to "Other Domestic" and "Other International" categories. Special consideration was made for air mail and fish commodities using the knowledge of industry experts. Using the Rail Waybill data and other sources required a conversion in commodity categories, because FAF2 uses the Standard Classification of Transported Goods (SCTG)TG and other sources used the Standard Transportation Commodity Code classification.

Once the data was disaggregated to represent county-county commodity flows, the FAF2 future year forecast numbers were adjusted down to account for the economic downturn that occurred after the forecast was prepared. One of the challenges of working with the FAF2 data is the inability to adjust or quantify the FAF2 underlying economic forecasts, particularly the optimistic economic conditions and low fuel price assumptions. These poses some limitations that must be taken into account.

The Oregon CFF 2002 to 2035 forecast provides a basis for understanding the primary freight movements today and in the future under existing conditions. In several instances circumstances are likely to change, and the detail and transparency provided in Oregon CFF can provide a starting point for evaluating such changes.

INTRODUCTION

As part of the planning effort leading up to the development of a statewide Freight Plan as a component of the Oregon Transportation Plan, the Oregon Department of Transportation (ODOT) has invested in an update to the statewide commodity flow forecast. This forecast will meet the needs of ODOT's first multi-modal Statewide Freight Plan with guidance from the Economic and Freight Working Group, and it will support modeling and analysis done by the ODOT Transportation Planning Analysis Unit (TPAU) and other future ODOT freight planning activities.

This report provides an overview of the methodology used to create this Oregon Commodity Flow Forecast (Oregon CFF), which aims to address the limitations of existing forecasts – inconsistent and separate databases for different modes, lack of transparency in data and assumptions, and data gaps – in a consistent methodology based on national and local data sources.

The Oregon CFF is a county level commodity flow forecast in tons and vehicles (where applicable) for truck, rail, marine, air, and pipeline modes from 2002 to 2035. Factors to convert the results to dollar value are also provided. The approach builds on the Federal Highway Administration (FHWA) Freight Analysis Framework (FAF2) national commodity flow forecast, which disaggregates the data to the sub-state level using local data and expertise on historical and forecast economic and modal trends. Local data is included to either verify that the national forecast provides accurate data for Oregon, or to modify or supplement the national data, as well as to disaggregate the data to the county level.

METHODOLOGY

The Oregon CFF approach of building on the FHWA FAF2 national commodity flow forecast was chosen because FAF2 is national in scope, highly regarded in terms of capturing interstate and international flows, uses a relatively recent base year (2002), and provides a quick way to complete a forecast in time for the Oregon Freight Plan work anticipated for Fall 2009. However, the inability to adjust or quantify the FAF2 underlying economic forecasts, particularly the optimistic economic conditions and low fuel price assumptions, poses some limitations that must be taken into account, which are partially addressed through adjustments noted herein. This section discusses the methodology and data sources used to develop the Oregon CFF, including the FHWA FAF2 dataset and disaggregation of each model to sub-state level within Oregon.

FHWA FAF2 Forecast Dataset

The key source for the Oregon CFF is the FAF2, published by FHWA in 2002. FAF2 provides freight flows in tons or dollar value between 130 FAF2 regions encompassing the US for the year 2002 plus forecasts from 2010 to 2035 in five year increments. The mode is distinguished as well as 43 commodities classified by Standard Classification Transported Goods (SCTG) codes. FAF2 is based on the national Commodity Flow

Survey, which only captures freight flows of 50 miles or more; therefore short-distance flows, which are less important in analyzing freight flows at the statewide level, are underrepresented in the FAF2 dataset.

FAF2 does not make explicit assumptions about future mode split. The mode split for every commodity derived in the base year is kept constant in forecast years, and the mode split only changes if the share of a commodity grows or declines. For instance, if the amount of coal shipped in the US declines in a given year, the, that share of the rail mode also declines because most coal is currently shipped by rail.

FAF2 flows are provided in 43 SCTG commodity classes. For this study, the commodities were converted into the Standard Transportation Commodity Code (STCC) classification for two reasons. First, flows by truck were transformed into actual truck trips, using payload factors provided by Battelle (2002) given in STCC commodity classifications. Further, the Rail Waybill Data from the Surface Transportation Board, which is used to disaggregate rail flow forecasts, is provided in STCC categories.

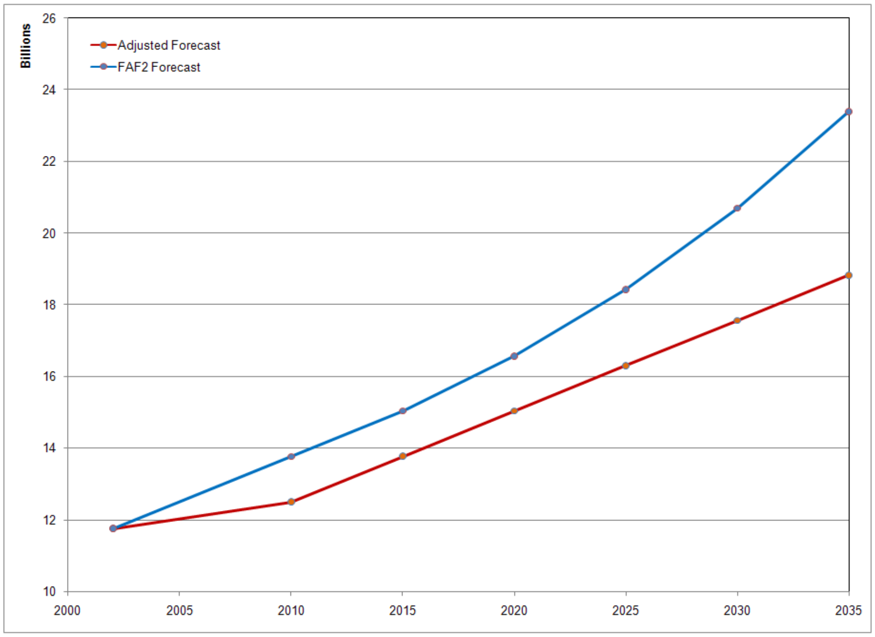
The SCTG-to-STCC conversion used for the truck and rail modes is based on 1999 IMPLAN[1] freight data compiled for the 2002 ODOT Bridge Limitation Study. The conversion process allocates each SCTG flow into multiple STCC flows in a many-to-many mapping, where each of the 43 SCTG categories is split into multiple STCC categories.

For the air, water, and pipeline modes a more simplistic one-to-many mapping process is used.[2] This approach is better suited to the select commodities moved by these modes, where the many-to-many proportional allocation would result in some commodity tonnage that is not transported by air, water or pipeline.

The FAF2 forecasts for the years 2010 through 2035 are based on an economic forecast provided by Global Insight in 2002, specifically for FAF2. This underlying economic forecast is proprietary and unavailable for further analysis or adjustment. A paper by Battelle (2007) summarizes the forecasts' key assumptions on macro-economic growth. This economic forecast leads to fairly optimistic FAF2 growth rates for freight in the US, as shown by the blue line in Figure 1 which shows the growth of truck flows (in tons) as an example.

[1] IMPLAN, (Impact analysis for Planning), is a static model based on input-output modeling structures, adapted for geographic areas down to the county level.
[2] For instance, for Oregon trucks STCG 13 "Nonmetallic minerals n.e.c." corresponds to 67% STCC 32 "Clay, concrete, glass, or stone product" and 33% STCC 14 "Nonmetallic ores, minerals, excluding fuel." However for air, SCTG 13 is likely only to correspond to STCC 14, as the heavier STCC 14 commodity is unlikely to travel by air.

Figure 1: Original and Adjusted FAF2 Total Truck Commodity Growth Rates (Btons)



After 2015, FAF2 proposes an exponential growth of trucks flows, almost doubling the tons shipped by truck from 2002 to 2035, which appears too optimistic for two primary reasons. First, the current economic downturn could not have been foreseen when the FAF2 flows were released in 2006; the first forecast year 2010 is likely to generate significantly fewer truck trips then proposed by the FAF2 forecast. Second, Battelle (2007) assumes constant fuel prices until 2035, but the expected depletion of the oil reserves will most likely result in significant fuel cost increases that will affect truck flows more severely than rail or water flows. Though there is little consensus on the actual mode split after the oil price shock seen in recent years, it is likely to limit growth in freight traffic overall.

The red line in Figure 1 represents a more conservative growth rate for truck flows used in the Oregon CFF work, as compared with the FAF2 growth rate. The years 2005 and 2010 have been scaled down to account for the current economic downturn, consistent with the Oregon Office of Economic Analysis (OEA) recent forecast (Global Insight, April 2009), which assumes a 1.8% growth rate, relative to the 5% growth rate in FAF2. For future years after 2010, a linear growth rate was assumed, consistent with the nearly linear FAF2 growth rate from 2002 to 2015. The same 2% rate has been applied to FAF2 forecast freight flows from 2015 onward, as compared with the more optimistic 3% growth rate in the out-years of the OEA Global Insight forecast. This down-scaling only affects the total tonnage volume, as the flow patterns given by FAF2 remain unaffected. The resulting ratio of adjustment for FAF2 data for all modes was applied and is shown in Table 1.[3]

Table 1: Adjustment to FAF2 Growth Rates for All Modes

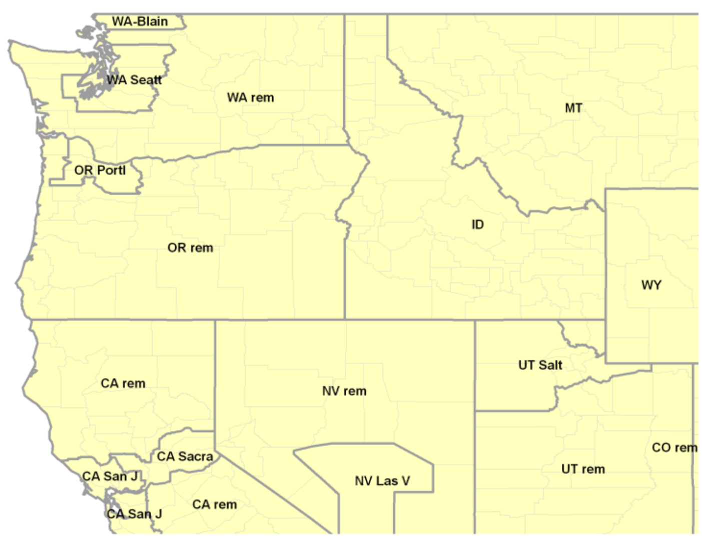
Year	Adjustment to FAF2 Growth Rate
2010	0.907703
2015	0.915536
2020	0.907576
2025	0.88464
2030	0.848849
2035	0.804833

While the effects of the economic downturn and fuel price changes on the air, rail, water, and pipeline modes are less certain than the effects on the truck mode, it was determined that all modes are impacted by the overly generous forecasts and thus are all impacted using the factors noted above. The impacts of fuel prices on rail, water and air are disputed and even more uncertain than for trucks. Therefore, while the FAF2 flows were down-scaled for all flows, it is important to recognize the uncertainties in these adjustments.

Modal Disaggregation

FAF2 regional zones are relatively coarse, as shown in Figure 2. Oregon is covered by two zones: Oregon Portland and Oregon Remainder. The Oregon Portland zone includes the Oregon portion of the Portland-Vancouver region covering Multnomah, Washington, Clackamas, and Yamhill Counties. The remaining 32 Oregon counties are included in the Oregon Remainder zone.

Figure 2: FAF2 zones and counties



For those trip ends within Oregon, the FAF2 commodity flows for each mode were disaggregated from FAF2 zones to Oregon counties. In the case of truck flows, this was done based on county employment and IMPLAN inter-industry coefficients, while other modes relied on local data to allocate FAF2 flows to specific Oregon facilities (rail stations, airports, marine ports, or pipeline terminals). Zones outside of Oregon were aggregated from FAF2 zones to "Other Domestic" and "Other International" (including Canada and Mexico) categories.[3] These methods and data are described in more detail below.

County Employment/IMPLAN Disaggregation Method (used for truck mode)

To increase spatial resolution, truck flows between 130 US FAF2 zones were disaggregated to flows between 3,241 US counties. Even though the disaggregation of flows in the eastern part of the US does not improve precision of Oregon flows, disaggregating all flows the same way enables a coherent method to be applied throughout the country and allows capture of through truck traffic.

Employment was used as a weight for the truck flow disaggregation to counties as counties with more employment are assumed to produce and attract more trucks. Within Oregon, nonfarm employment forecasts from the OEA Global Insight forecast (June 2009) were used for the following sectors: construction, natural resources, and mining; manufacturing; transportation, trade, and utilities; information; financial activities; professional and business services; educational and health services; leisure and hospitality; other services; and government. Oregon agriculture employment by county was added based on 2007 U.S. Department of Agriculture data.

The use of employment by industry type combined with inter-industry coefficients allows the allocation of the origins and destinations of flows to counties with the corresponding employment type. For instance, SCTG25 (logs and other wood in the rough) is produced in those counties that have agricultural employment; similarly, this commodity is shipped to those counties that have employment in industries consuming these types of products. The approach makes use of inter-industry coefficients, referred to as "make" and "use" coefficients, developed from 2007 Oregon IMPLAN input/output tables. These coefficients indicate the commodities each industry makes and uses in its production process.

For instance, if there is a flow of SCTG07 (other foodstuff) being shipped from FAF2 zone A to FAF2 zone B, and the IMPLAN data indicates that this commodity is produced by two industries: 3% by agriculture and 97% by manufacturing, then the employment of all counties in FAF2 zone A is used to distribute the origin of that flow over all counties, weighted by the make coefficients derived from IMPLAN data. In this example, the share of the origin of this flow for county C in FAF2 zone A is described by the following equation:

[3] For example, a container of goods originating in Asia bound for Salem Oregon, would be represented as an International "SEA" flow with origin Asia FAF region and destination 'Oregon Remainder' and an gateway of Tacoma port. For the Oregon CFF, this is further broken down into an 'Other International' trip by water that we ignore, and a 'domestic' truck trip from "Other Domestic" (Tacoma) to Marion County (Salem, OR). Further, each different commodity within the container would be treated as a separate annualized flow between these trip ends.

$$sf_{c\in A} = FAF_{A,B} \cdot \frac{0.03 \cdot agEmp_c + 0.97 \cdot manEmp_c}{\sum_{z\in A} 0.03 \cdot agEmp_z + 0.97 \cdot manEmp_z}$$

$sf_{c\in A}$	Share of flows originating in county c which is located in FAF2 zone A
$FAF_{A,B}$	FAF2 flows from FAF2 zone A to FAF2 zone B
$agEmp_c$	Employment in agriculture in county c
$manEmp_c$	Employment in manufacturing in county c

To disaggregate the destination of this flow, the use coefficients derived from the IMPLAN data are applied with the same procedure.

This disaggregation is applied to commodity flows where the origin or destination is within Oregon. No detailed employment forecast at the county level are available outside of Oregon so 2002 total employment is used to disaggregate flows with an origin and/or destination outside of Oregon, and the Global Insight employment forecast is used for future years. No forecast for agricultural employment is available for Oregon or outside of Oregon, so this employment type is kept constant over time.

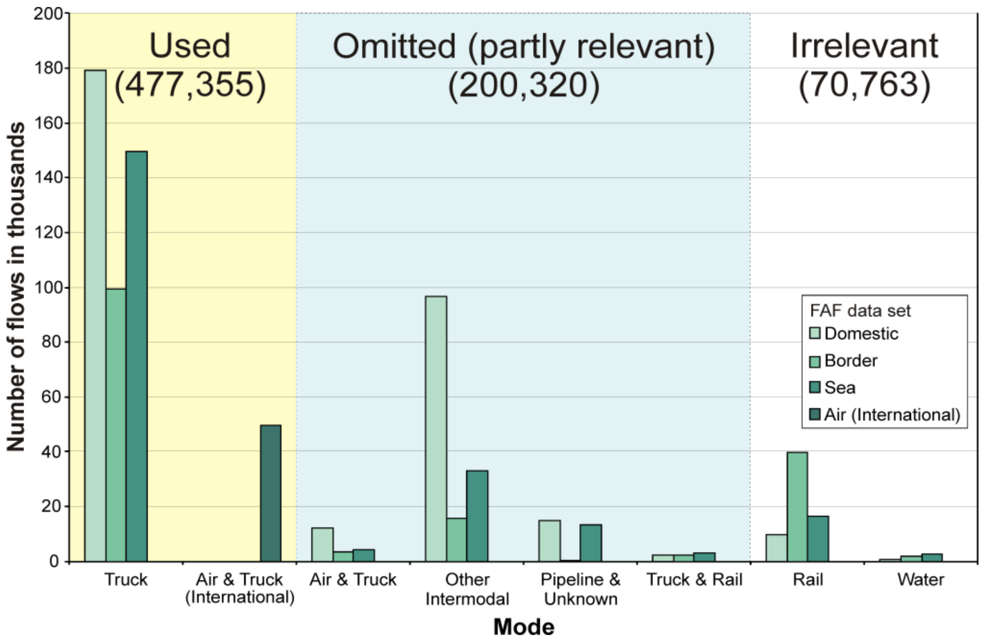
The mode split forecasted in FAF2 should be used with care. In FAF2, the modal split is a function of the commodity composition. For each commodity, the modal split remains unchanged throughout the years. If, for instance, a commodity that is dominated by rail declines over time, the share of rail drops accordingly. No true mode choice is simulated within FAF2. The mode shift reported in FAF2 indicates the demand for modes but is not constrained by capacity, costs, or existence of modal alternatives.

Intra-county trips are not included in the data, and FAF2 data sources tend to under-represent short trips. Additionally, water flows on the Columbia River that do not utilize Oregon's Ports are not included. These limitations are of minimal consequence in the statewide view of freight movement within Oregon that is the goal of this effort.

Trucks

The FAF2 data distinguishes modes and mode combinations. For truck representation, only the mode 'Truck' and the domestic part of the international flow 'Air & Truck' were used, as shown in Figure 3. Combinations such as 'Truck & Rail' or domestic 'Air & Truck' were omitted assuming that the longer part of that trip is made by rail or air, and only a small portion of the trip relies on truck transportation; further the data set is not specific enough to distinguish which part of the trip is made by which mode. Of the 200,320 flows omitted, likely only a small portion of these trips are made by truck, and this shortcoming is assumed to be acceptably small. Data for land-border crossings included the portion of the trip from the border crossing to the domestic destination or from the domestic origin to the border crossing. Likewise, sea and air freight was included as a trip to or from the domestic port or airport. Truck trips to distribute air mail to each Oregon county, not included in FAF2, were added based on the OEA 2002 population distribution and forecast.

Figure 3: FAF2 Truck Data Used in the Oregon CFF

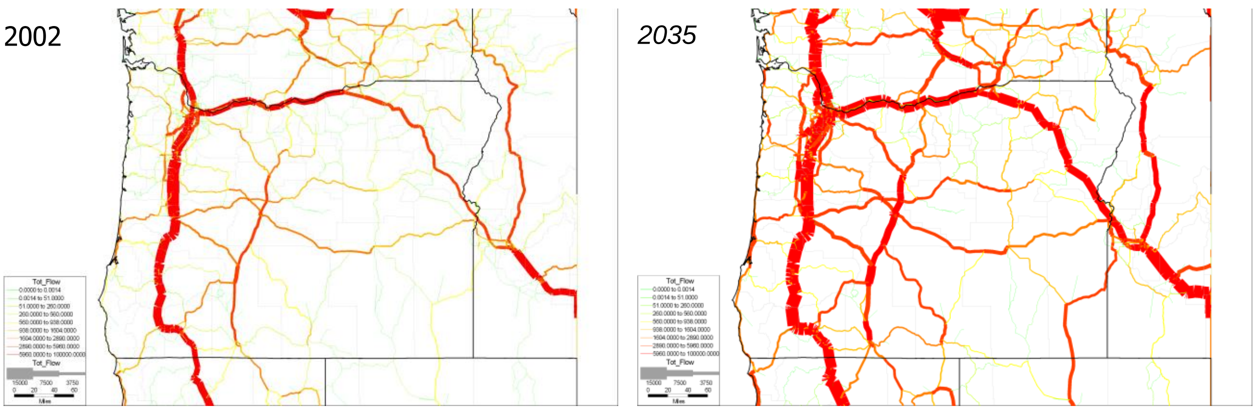


For the dominant modes, truck and rail, the Oregon CFF provides not only tonnage by origin-destination flows, but also vehicle flows on network links. After disaggregating the flows, commodity-specific payload factors (Battelle 2002: 29) were used to convert FAF2 goods flows in tons into number of truck trips. An average empty-truck rate of 19.4% was assumed for all flows based on US Census Bureau truck data (2008). The annual FAF2 flows were converted to flows of an average weekday. Flows were divided by 365.25 days and then a factor of 1.048 was applied to transform Annual Average Daily Traffic (AADT) into Annual Average Weekday Traffic (AAWDT), based on national truck data. Finally, trucks were split into the two truck types: medium-heavy duty trucks weighing below 26,000 pounds and heavy-heavy duty trucks weighing 26,000 pounds and above. The share of each truck type depends on the distance of the truck flow – a longer distance implies a larger share of heavy-heavy duty trucks. The share of each truck type for five distance classes is based on the 2002 Vehicle Inventory and Use Survey (VIUS), published by the US Census Bureau (2004).

The resulting truck vehicle flows were assigned to the US highway network using the TransCAD software and US network. It should be noted that these truck trips no longer retain the tonnage and commodity information of the origin-destination flows. Assigning flows from one county to another requires designating one point within each county as the origin or destination of the flow, with geographic centroids commonly used for these points. In many cases, however, the geographic centroid of the county does not match the activity center in that zone, so the centroid of the largest city within each county was used instead to ensure that the representation of flows within every county is more realistic. During assignment, Medium-Heavy Duty (MHD) trucks are assumed to have a passenger car equivalent (PCE) of 1.5, Heavy-Heavy Duty (HHD) trucks are assumed to have a PCE of 2.5. This accounts for the additional space trucks use on the road in comparison to autos. Additionally, to make trucks sensitive to congestion in the assignment step, a volume delay function is used with adjusted coefficients (α = 1 and β = 6, in the Bureau of Public Roads volume-delay function). The truck flows were validated against traffic counts from Oregon's Automatic Traffic Recorder stations (ODOT 2009).

Figure 4 identifies the truck trips (vehicles) assigned to the Oregon network in base year 2002 and forecast year 2035. Some adjustment of FAF2 flows was required to replicate the higher flows on the north-south I-5 corridor versus the east-west I-84 corridor.

Figure 4: Oregon CFF Truck Assignment Results (vehicles)



Rail

The rail mode data obtained from the FAF2 dataset was compared to Oregon's confidential historical 2002 Rail Waybill dataset obtained by ODOT from the Surface Transportation Board. The Rail Waybill data was used to identify the pattern of flows in the 2002 base year, while the correlation provided a way to apply the FAF2 growth rates to the base year waybill data.

The Rail Waybill data trip ends (origin or destination) inside of Oregon were grouped by Freight Station Accounting Code (FSAC), specific to a station and a rail line, and the county code; trip ends outside of Oregon were identified by state name (including Canadian provinces). The data was further classified as the FAF2 Oregon Portland zone (Clackamas, Multnomah, Washington, or Yamhill Counties), FAF2 Oregon Remainder zone (all other counties), Portland Sea Port, Other Oregon Sea Port, or Rest of World to correspond with the categories in the FAF2 dataset.

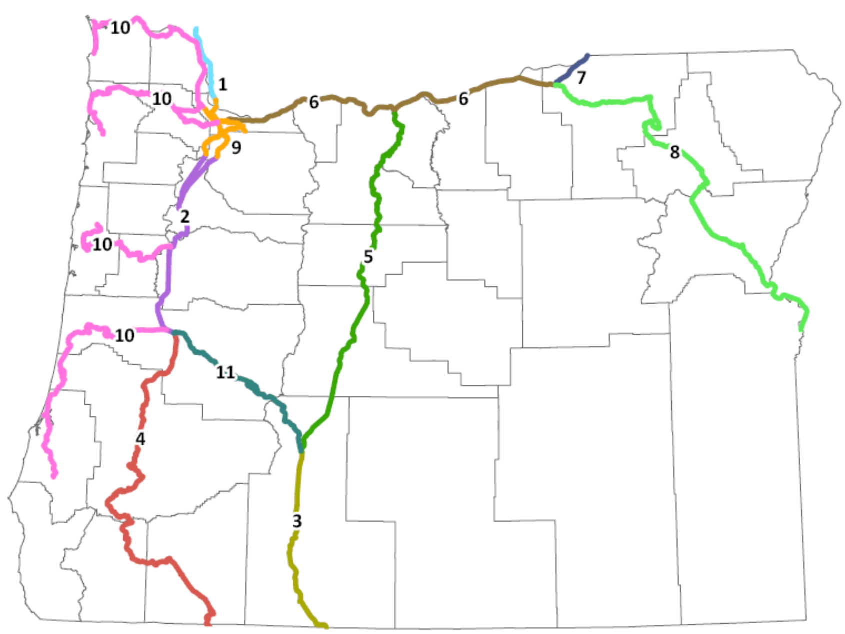
The Rail Waybill dataset is specific to Oregon and contains trips with an Oregon trip origin or destination, as well as trips that travel through Oregon without stopping for re-classification (i.e., trips from Washington to California). The FAF2 data covers the entire nation, and although it was possible to isolate the Oregon trip ends, it was difficult to identify rail through trips that do not stop for re-classification. It was therefore assumed that the origin-destination pairs (by county code, which is common between the two data sets) that appeared in the Rail Waybill data should be used instead of the same origin-destination trips from the FAF2 data. The total amount of through tonnage extracted from the Rail Waybill data was slightly larger (13,448 Ktons) than the tonnage in the same origin-destination pairs of the FAF2 data (12,083 Ktons). It should be noted that the Rail waybill dataset only includes traffic volumes that are reported by the Class I railroads (BNSF and UP). Traffic that moves locally on a shortline railroad or between multiple shortline railroads is not included in the dataset. For the base of year 2002, this volume is very small but is expected to grow in future years.

Because theses total amounts of tonnage are very close, the more geographically accurate and spatially disaggregated Rail Waybill data was used for the Oregon CFF baseline 2002 data.

The FAF2 dataset was used to calculate growth rates specific to each commodity from 2002 to 2035, which were applied to the base year rail waybill data. The total value of the future forecast was again very close to the FAF2 total tonnage forecast. The tonnage forecast maintains the city name for the Oregon rail stations and a US Census Bureau Federal Information Processing Standard (FIPS) code which identifies the county, for each trip end.

As with trucks, rail mode tonnage flows were assigned to the rail network, and the origin-destination tonnage data was aggregated by city or county. In addition to tonnage, rail cars were retained from the base year waybill dataset. Since the rail mode utilizes a pre-existing network of track infrastructure, it is logical to evaluate the tonnage flow by corridor; the dominant pre-existing corridors in Oregon are shown in Figure 4. A uniform method was employed to assign the flows to the network, such that any flow starting and ending on the corridor was included in the full corridor flow.

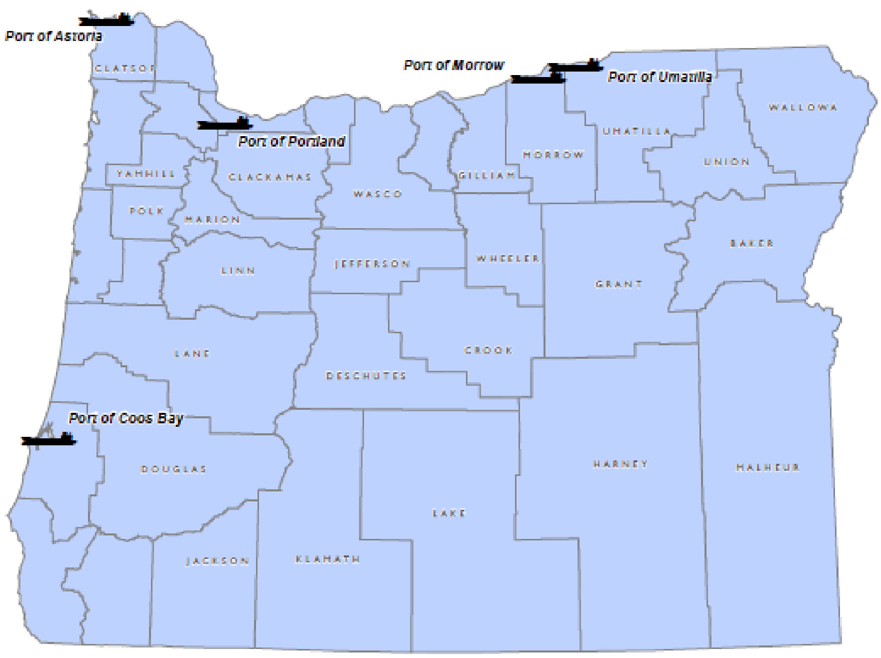
Figure 4: Oregon Rail Corridor Network (coastal lines grouped in #10)



Water

The Oregon CFF includes the Marine Ports shown in Figure 5 – including two coastal ports, a collective set of facilities in the Portland Harbor, and two ports upstream on the Columbia River. The Port of Newport was not included as it currently accommodates only limited commercial freight movement.

Figure 5: Oregon Ports



*Note: The Port of Newport was not included as it currently accomodates only limited commercial freight movement.

The water flows in the Oregon CFF rely on the FHWA FAF2 dataset for base year flows and growth rates. This dataset includes domestic and international marine flows that connect to land modes covered elsewhere in the Oregon CFF, to reach the true origin or destination points often outside of Oregon. The FHWA FAF2 dataset commodities (SCTG) were converted to STCC categories using a simplified one-to-many relationship.

The FAF2 data was disaggregated to ports within Oregon, using the US Corps of Engineers Waterborne Commerce reports, and data from the Port of Portland website. Through flows on the Columbia River, which is largely served by Washington and Idaho ports, and along the coast are not included in the Oregon CFF.

The FAF2 dataset water flows were aggregated to four regions: Other Domestic, Other International, Oregon Portland, and Oregon Remainder. In doing so, the true origin, destination, intermodal flow is lost.[4] All Oregon Portland FAF2 flows were assigned to "Portland Harbor" with flows to and from multiple ports within the three-county region

[4] For instance, an international import by sea to the Port of Portland that is shipped inland by rail or truck would be translated into two trips, an "Other Intl" trip to the "Portland Harbor", and a second trip from "Portland Harbor" to "Other Dom". The international origin is lost in the second leg of the trip.

on the Columbia and Willamette Rivers. Auto commodity flows, missing from the FAF2 dataset, were added to Portland Harbor flows as imports from Asia, which is consistent with Port of Portland statistics (613 Ktons forecast for 2010), and assumes the 1993-2008 3.5% annual growth rate in auto imports. Fuel flows were also missing, and were added to internal and outbound domestic flows (577Ktons and 3082ktons, respectively in 2002), assuming a growth rate consistent with OEA population forecasts.

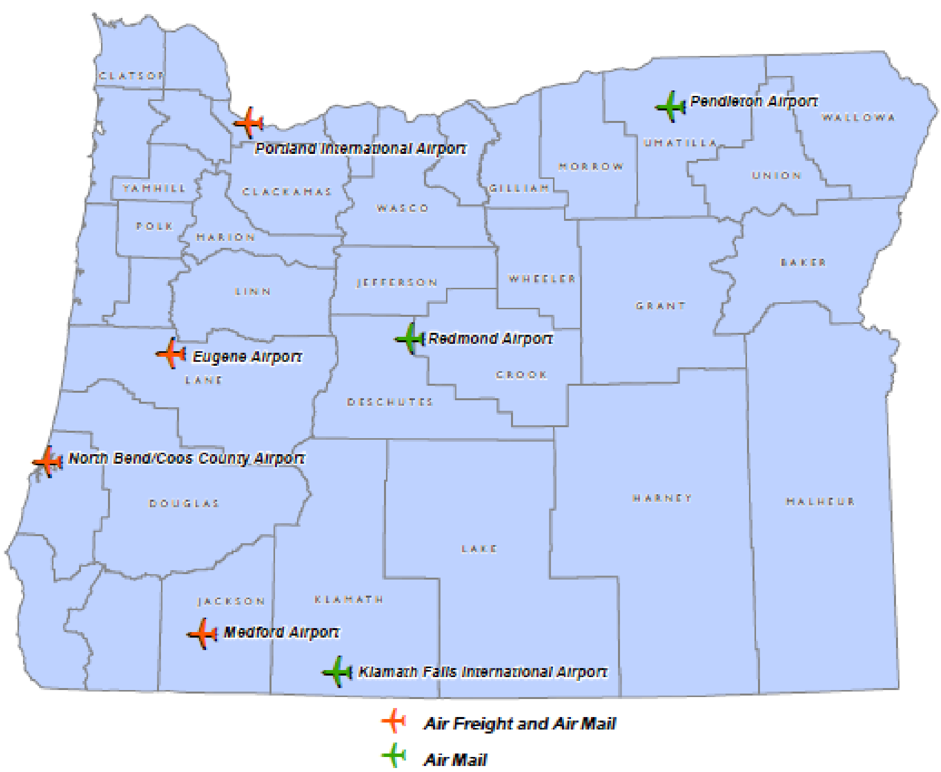
FAF2 water flows were allocated among the Oregon coastal ports in Coos Bay and Astoria to roughly match the commodity mix from the 2002 Waterborne Commerce data. Newport was not included, as no data was provided in this dataset.

Remaining FAF2 flows were then allocated to the upper Columbia River ports in Umatilla and Morrow based on local expert understanding of flows largely serving this agricultural region (fertilizers, feed, fuel, grain, and agriculture products).

Air

Portland (PDX), Medford (MFR), Eugene (EUG), and North Bend/Coos County (OTH) airports serve air freight, while Redmond (RDM), Klamath Falls (LMT), Pendleton (PDT) airports primarily carry air mail services. The locations of these airports are shown in Figure 6.

Figure 6: Oregon Airports



The air mode commodity flows in the Oregon CFF rely on FHWA FAF2 dataset for base year flows and growth rates. This dataset includes both domestic and international air flows. The FHWA FAF2 dataset commodities (SCTG) were converted to STCC categories using a simplified one-to-many relationship.

FAF2 data include shipments that typically weigh more than 100 pounds that are shipped by air by commercial or private aircraft, not including express shipments.[5] The 2006 Portland/Vancouver Trade Capacity Analysis (Trade Study) shows air and express mail flows (STCC44) as 0.2% of Portland/Vancouver tonnage in 1997 (467 Ktons).

These small package flows are felt to be less important in a statewide freight view, and it should be noted that the limited data on mail and express shipping is also not very precise. The Port of Portland noted a significant shift in the reported air mail tonnage statistics when FedEx won the US Postal Service (USPS) contract and the actual mail volume for USPS was co-mingled with FedEx's freight volumes. Despite an increasing shift of consumer spending to on-line retail, small package carriers (integrators – FedEx and UPS) have experienced express volume declines since 2002.

The FAF2 data was disaggregated to airports within Oregon, using airport air cargo and mail on/off tonnage statistics for 2007 and 2008 from websites and airport master plans. FAF2 flows were aggregated to flows between four regions: Other Domestic, Other International, Oregon Portland, and Oregon Remainder. In doing so, the true origin, destination, and intermodal flow are lost (see note under water flows above). Since total FAF2 2002 tonnage for the state was a reasonable match to 2008 airport statistics, after adjusting for different years' data, no overall adjustment was needed. Factors were applied to each aggregated flow among the state's airports to roughly balance 2002 inbound and outbound flows at each airport. Internal flows between PDX and other Oregon airports also had to be significantly reduced. The resulting 2035 flows are not very well balanced, for Oregon Remainder airports in particular, due to varying growth rates on FAF2 flows by commodity.

The Oregon Remainder FAF2 zone was split into the three non-Portland airports using factors. A significant portion of FAF2 region Remainder flows were shifted to PDX, because although total tonnage for the state was reasonable, there were not enough PDX flows. All Oregon Remainder international flows were assigned to Medford (MFR).

FAF2 does not include air mail flows, so air mail was added (assigned to STCC 50), based on tonnage statistics by airport in 2008. The growth in air mail was assumed to match statewide population annual growth of 1.3% from 2002 to 2035 and was assumed to travel to PDX before/after reaching other state airports.

Pipeline

The pipeline flows in the Oregon CFF rely on FHWA FAF2 dataset for base year flows and growth rates. The FAF2 data was disaggregated to pipelines within Oregon using

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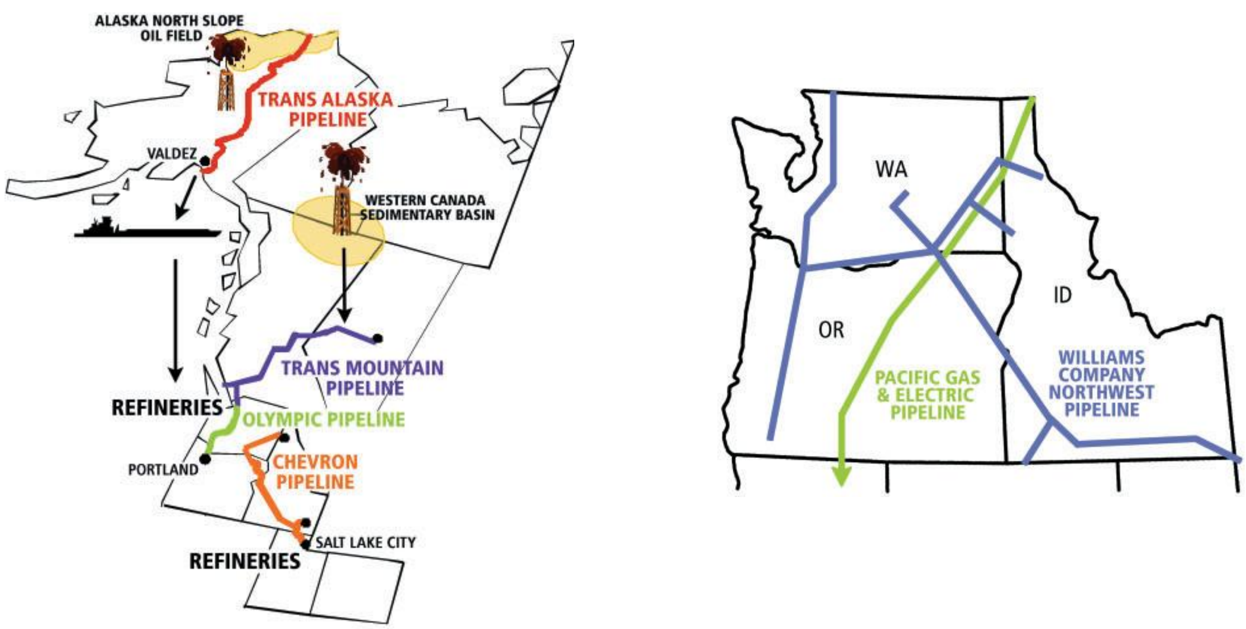
[5] This would exclude FedEx's <100 lb package volume which comprises approximately 99% of its total airfreight volume to or from Oregon (average package weight is approximately 35 lbs.) and UPS' <100 lb package volume which comprises approximately 97% of its total airfreight volume to or from Oregon (average package weight is approximately 8 lbs). FedEx packages going in and out of Oregon generally pass through the main sort facility in Portland. Similarly, UPS sort facilities are in Portland, Tualatin, Roseburg and Hermiston.

the 2007-2009 State of Oregon Energy Plan, and the websites of Oregon Department of Energy, Kinder Morgan Company, and various energy providers, as well as contact with representatives of these organizations. Natural gas was distributed among Oregon counties based on OEA population forecasts.

Pipeline flows cover two basic commodities: petroleum (SCTG17, SCTG18, and STCC29, which includes gasoline, jet fuel and diesel fuel) and natural gas (SCTG19, STCC13), which were treated separately. All other commodities in the FAF2 "Pipeline & unknown" mode were dropped, as non-pipeline flows. Petroleum is further distributed locally by trucks and barges, but these local trips are not included in the Oregon CFF. Natural gas was assumed to be distributed via local pipeline to each county from the nearest branch line.

Petroleum and natural gas pipeline networks for the Pacific Northwest are shown in Figure 7. FAF2 Petroleum flows (SCTG17 and SCTG18) were mapped to these pipeline routes, and volumes were scaled (0.79 factor applied to Olympic pipeline flows) to match Oregon Department of Energy data. Within Oregon petroleum flows consisted of the Kinder Morgan pipeline from Portland to Eugene, and it was assumed that a constant 34.6% share of the Olympic pipeline flow to Portland tank farms continues to be piped on to Eugene based on information from Kinder Morgan staff.

Figure 7: Pipeline Networks: Petroleum (left) and Natural Gas (right)



COMPARISON TO OTHER FORECASTS

This section summarizes the completed Oregon Commodity Flow forecast and compares it to the following studies:

- Prior Oregon Commodity Flow Forecast (Global Insight base year 1997)
- Panama Canal Expansion Impact
- Port of Portland Portland/Vancouver Trade Capacity Analysis (Global Insight base year 1997)
- Oregon Agriculture statistics

The Oregon Commodity Flow forecast is dominated by truck flows, as shown in Table 2, with a share of roughly 72 to 78%. All modes retain a stable share over the forecast period. Air remains less than 0.1% in terms of overall tonnage, but represents six to 11% of flows in terms of value of all state freight movements. The Oregon CFF numbers obscure the importance of air in the state freight system as the ability to ship products by air is critical to seamless delivery of high-value products for business, industry, and personal uses. Such key commodities moved by air range from pharmaceuticals (e.g., blood and organs) to other time-sensitive deliveries (e.g., legal documents, auto parts).

The compound average growth rate (CAGR) of all Oregon freight averages 1.9% annually in tonnage, but goods are becoming more valuable, showing a 3.0% growth in value over the 2002-2035 period. Air and water grow faster than average, while pipeline and rail grow slower. For comparison, Oregon's Office of Economic Analysis (OEA) forecasts of annual employment (June 2009) and population (2004) growth from 2003 to 2035 are 3.2% and 1.3%, respectively.

As summarized in Table 3: 2002-2035 Oregon Commodity Flow by Commodity GroupTable 3, the top commodities shipped in terms of tonnage include: farm and associated food products, forest and associated wood/paper products, coal/fuels, clay/stone/glass, and waste/scrap/misc shipments. Other sizeable commodities are transportation equipment and machinery, metal/metal products, and rubber/plastics. Of the larger commodities, forest and related wood/paper products as well as construction materials show lower than average growth, while equipment and rubber/plastics show higher than average growth.

Table 2: 2002-2035 Oregon Commodity Flow by Mode

Mode	2002	2010	2035	Growth Rate 2002-2035	Mode split 2002-2035	
Tonnage (1000s)						
Truck	259,213	294,458	508,331	2.1%	75%	78%
Rail	39,008	47,314	64,289	1.5%	11%	10%
Water	34,835	47,926	60,296	1.7%	10%	9%
Pipeline	13,599	13,436	17,401	0.7%	4%	3%
Air	236	288	767	3.6%	0.1%	0.1%
TOTAL	346,892	403,423	651,083	1.9%	100%	100%
Value (Millions of $ in 2002$)						
Truck	$159,878	$185,862	$411,465	2.9%	73%	72%
Rail	$15,631	$16,906	$27,434	1.7%	7%	5%
Water	$22,467	$31,660	$60,798	3.1%	10%	11%
Pipeline	$7,307	$6,828	$9,530	0.8%	3%	2%
Air	$13,253	$17,575	$61,408	4.8%	6%	11%
TOTAL	$218,536	$258,830	$570,635	3.0%	100%	100%

Notes: Growth Rate = Compound annual growth rate 2002-2035.
Excludes tonnage traveling through Oregon without an Oregon origin or destination.

Table 3: 2002-2035 Oregon Commodity Flow by Commodity Group

Description	2002	2010	2020	2030	2035	Growth Rate*
Stone Minerals Ores	104,699	133,514	160,062	175,073	176,970	1.6%
Food Products	66,944	79,864	100,530	120,270	129,290	2.0%
Petroleum Coal	52,836	54,344	69,013	85,150	93,385	1.7%
Forest Wood Products	48,849	47,484	55,287	57,022	57,033	0.5%
Pulp Paper Wood Products	8,434	9,137	11,333	12,781	13,357	1.4%
Chemical Products	17,354	21,721	28,080	34,624	38,210	2.4%
Metals	8,204	10,166	13,016	15,890	17,437	2.3%
Manuf	3,504	4,251	6,301	9,031	10,763	3.5%
Machinery Transp	3,310	3,858	5,626	8,360	9,904	3.4%
Instruments	3,554	5,193	7,700	11,579	14,344	4.3%
Misc	15,473	17,751	26,410	38,010	45,173	3.3%
Waste	13,731	16,139	24,420	36,829	45,218	3.7%
TOTAL	346,892	403,423	507,777	604,618	651,083	1.9%

Notes: Growth Rate = Compound annual growth rate 2002-2035.
Excludes tonnage traveling through Oregon without an Oregon origin or destination.

Prior Commodity Flow Forecast

The most recent detailed study of Oregon's statewide commodity flow patterns was prepared by Global Insight in 2004. This prior forecast was used in the 2006 Oregon Transportation Plan (OTP). This section compares that prior commodity flow forecast with the results of this work.

In the base year, which was 1997 for the prior Global Insight commodity flow forecast and 2002 for the current FAF2 work, the Global Insight forecast is quite a bit higher in both tonnage and value terms (value numbers may reflect dollars in different year constant dollars). Global Insight had overall growth of 1.7% for 1997 to 2030 as compared with the FAF2 forecast of 2.2% for 2002 to 2035, with some variance by mode (see Table 4). Global Insight has lower water growth rates and holds the pipeline flows fixed (0% growth).

The following tables use 2030 as the forecast year since it was included in the current ("Oregon CFF") and previous ("Global Insight") commodity flow forecasts and will be used as the point of comparison.

Table 4: Global Insight and FAF2 Forecast (Mtons)

	Oregon CFF			Global Insight			
Mode	2002	2030	Growth Rate 2002-2030	1997	2000	2030	Growth Rate 1997-2030
Tonnage (MTons)							
Truck	259,213	466,782	2.1%	330,027	341,778	631,172	2.0%
Rail	39,008	61,395	1.6%	55,225	56,971	100,606	1.8%
Water	34,835	59,216	1.9%	38,266	35,238	45,092	0.5%
Pipeline	13,599	16,601	0.7%	10,713	10,713	10,713	0.0%
Air	236	624	3.5%	318	329	747	2.6%
Total	346,892	604,618	2.0%	434,549	445,029	788,330	1.8%
Value ($M)							
Truck	159,878	353,660	2.9%	399,272	419,364	1,114,936	3.2%
Rail	15,631	25,126	1.7%	70,583	72,889	138,403	2.1%
Water	22,467	52,989	3.1%	30,233	31,091	40,023	0.9%
Pipeline	7,307	8,939	0.7%	3.816	3,816	3,816	0.0%
Air	13,253	47,077	4.6%	3.232	3,316	10,536	3.7%
Total	218,536	487,790	2.9%	507.136	530,477	1,307,715	2.9%

Growth Rate = Compound annual growth rate 2002-2035.

Global Insight and the Oregon CFF forecast a similar growing truck share, and the rail and air shares are also consistent between the two forecasts. Global Insight shows smaller and declining water and lower pipeline forecast than the Oregon CFF.

As shown in Table 5, the variation in growth rates can be attributed in large part to the FAF2's much higher forecast for tonnage heading out of the state of Oregon.

Table 5: Global Insight and FAF2 Forecast, by Flow Direction

	Oregon CFF (Mtons)			Global Insight (Mtons)			
Flow	2002	2030	Growth Rate 2002-2030	1997	2000	2030	Growth Rate 1997-2030
Inbound	86	131	1.3%	215	222	386	1.8%
Internal	198	367	1.9%	77	76	132	1.6%
Outbound	63	152	2.8%	85	87	148	1.7%

Growth Rate = Compound annual growth rate 2002-2035.

In both forecast sets, base year major commodities are stones/minerals/ores, food products, and fuels, as shown in Table 6. GI shows a higher share of forest/wood products, while the Oregon CFF shows higher shares for miscellaneous commodities and waste. Overall growth rates are very similar between the two forecasts, although there are some differences by commodity; specifically Oregon CFF exhibits higher growth for manufacturing products, chemicals, miscellaneous products and waste, and a much lower forest/wood products growth rate. The Global Insight forecast did not separately forecast Commercial Fish (Live Fish) commodity flow.

Table 6: Global Insight and FAF2 Commodity Share

		Commodity Mix (% of total)		Growth Rate	
STCCs	Description	Oregon CFF 2002	Global Insight 1997	Oregon CFF 2002-2035	Global Insight 1997-2030
10,14,32	Stone Minerals Ores	27%	20%	1.6%	1.3%
1,9,20,21	Food Products	20%	21%	2.0%	1.9%
11,13,29	Petroleum Coal	14%	9%	1.7%	1.9%
8,24	Forest Wood Products	9%	27%	0.5%	1.5%
25,26,27	Pulp Paper Wood Products	2%	4%	1.4%	1.7%
28	Chemical Products	6%	5%	2.4%	1.8%
33,34	Metals	3%	3%	2.3%	2.5%
22,23,30,31, 39	Manufacturing products	2%	2%	3.5%	2.6%
37	Machinery Transportation	2%	2%	3.4%	3.7%
35,36,38	Instruments	2%	1%	4.3%	3.9%
19,41, 44-45	Miscellaneous	7%	4%	3.3%	2.1%
40	Waste	7%	2%	3.7%	2.4%
	TOTAL	100%	100%	1.9%	1.8%

Growth Rate = Compound annual growth rate 2002-2035.

Portland/Vancouver Trade Capacity Study

The Port of Portland commissioned Global Insight to prepare a Portland/Vancouver Trade Capacity Analysis (Trade Study) for the bi-state metro region in 2006, covering air, water, truck, and pipeline. The comparison with the Oregon CFF is complicated by the fact that the Trade Study includes both Oregon and Washington sides of the Portland-Vancouver region, while FAF2 includes an four-county Oregon-only Portland zone (Multnomah, Washington, Clackamas, and Yamhill Counties), and Vancouver is grouped with the rest of Washington State (outside Seattle and Blaine, Washington). Additionally, the Trade Study uses SCTG commodity classification, rather than the STCC codes used in the Oregon CFF. An effort to add the Vancouver share of flows to the Oregon CFF would require some in-depth analysis of the Trade Study and other relevant data sets such as Washington traffic counts, origin-destination truck surveys, rail waybill data, and employment by industry data.

As expected the Trade Study, which covers both Vancouver and Portland, includes quite a bit more tonnage - 261Mtons in 1997 as compared with 188Mtons in 2002 for the Oregon CFF within the Portland Harbor - with the difference representing the Washington side of the Metro area, and the inclusion of some local trips (express shipments) absent or under-reported in the Oregon CFF. After accounting for the different commodity classifications, the mix of commodities in the Portland region compares favorably between the two studies as shown in Exhibit 15. Oregon CFF shows more stones/minerals/ores and waste, while having slightly less food/forest products in the base year. Growth rates are largely consistent. Oregon CFF has lower growth for stone/minerals/ores, forest/wood growth, metals, and machinery rate, and higher growth for fuels and manufacturing products.

Exhibit 15: Commodity Mix of Port Trade Study and Oregon CFF

		1997 Portland/Vancouver Trade Study		2002 (Portland Only) Oregon CFF	
STCCs	Description	Share	Growth Rate	Share	Growth Rate
10,14,32	Stone Minerals Ores	20%	2.0%	34%	1.3%
1,9,20,21	Food Products	25%	2.1%	18%	2.0%
11,13,29	Petroleum Coal	16%	1.6%	14%	2.1%
8,24	Forest Wood Products	12%	1.6%	8%	1.0%
25,26,27	Pulp Paper Wood Products	3%	1.8%	2%	1.5%
28	Chemical Products	8%	2.1%	8%	2.0%
33,34	Metals	4%	3.2%	3%	2.1%
22,23,30, 31, 39	Manufacturing products	3%	2.4%	1%	3.0%
37,	Machinery Transportation	2%	4.4%	1%	2.9%
35,36,38	Instruments	1%	4.0%	1%	3.7%
19,41, 44-45	Misc	0%	5.9%	0%	4.5%
40	Waste	7%	3.7%	9%	0.5%
	TOTAL	100%	2.2%	100%	1.7%

Growth Rate = Compound annual growth rate 2002-2035.

CONCLUSIONS

The Oregon CFF examines all commodity flow modes using a methodology derived from the FHWA FAF2 national commodity flow forecast. The Oregon CFF forecasts have undergone scrutiny from:

- The consultant teams' modal experts and quality assurance and control process,
- Port of Portland economic and planning staff,
- The Freight and Economy Working Group, and
- Comparisons with other efforts, including the Port of Portland's Trade Study.

The Oregon CFF method is transparent in its assumptions and data sources; the inability to alter the underlying FAF2 economic forecasts is a potential shortcoming, but the FAF2 commodity growth assumptions have shown a strong resilience in the face of close scrutiny. The Oregon CFF should provide a solid basis for ODOT freight planning work, including a strong basis for the upcoming multi-modal Oregon Freight Plan and a sound foundation for the evaluation of alternative scenarios.

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