COMMODITY FLOW ANALYSIS FOR THE PORTLAND METROPOLITAN AREA

Collection and Analysis of Commodity Flow Information Project

Work Area D -- Development of the Tactical Model Methodology, Assumptions, and Factors

Revision 2

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The purpose of this report is to summarize the methodology and assumptions for building the tactical model component of the Portland Commodity Flow Project. Each section includes a general description of what was done and a list of assumptions and factors used. The tactical model is still being fine-tuned and may undergo changes in factors or assumptions as more information is collected. The process documented here may be modified in the future.

Data from the strategic model database are the primary inputs to the tactical model. These data are reported in tons (also available in TEUs) and stratified by commodity group, primary mode, origin, destination, truck sub-mode (for some modes), containerized/non-containerized, and year (1996 to 2030).

1.1 – 1.4 Allocation of Flows to Truck Sub-modes

As described in the Cambridge Sytematics (CS) document, the total numbers of tons were summed by commodity, mode, and direction. These flows were then separated by primary mode. Where available, the flows were further stratified by truck sub-mode. The sea_truck, air_truck, and truck only groups directly or indirectly had truck sub-mode identified in the ICF database. Where truck sub-mode was not available, the Port provided some guidance to determine the factors.

Mode	Commodity	Private	LTL	TL
Rail_truck	All	50%	25%	25%
Sea_rail_dray	All	50%	25%	25%
Barge_truck	All	0%	0%	100%

1.5 Application of Weekday Factor

As recommended by CS, a simple 1/264 factor was used to reduce annual flows to daily. No seasonal adjustments were made.

2.1 Allocation of Flows with local Origins/Destinations to TAZs

Metro Data Resource Center was able to provide 1996 Employment data by 2-digit SIC. They were grouped as follows:

SIC Employment Group	SICs
Agriculture/Farming/Forestry (AGFF)	1-9
Mining (MIN)	10-14
Construction (CON)	15-17
Manufacturing (MAN)	20-39
Transportation/Communications/Public Utilities (TCPU)	40-49
Wholesale (WHLS)	50-51
Retail (RET)	52-59
Finance/Insurance/Real Estate (FIRE)	60-67
Service (SERV)	70-89
Government (GOV)	91-97

With CS guidance, the employment sectors that were likely to generate or attract freight were identified. Those SIC groups were the following:

- Agriculture/Farming/Forestry (AGFF)
- Mining (MIN)
- Construction (CON)
- Manufacturing (MAN)
- Transportation/Communications/Public Utilities (TCPU)
- Wholesale (WHLS)

The flows were allocated to regional TAZs using these SIC employment totals.

Beginning with this step (2.1), all steps are performed in the EMME/2 software environment.

2.2-2.5 Allocation of Flows to Terminals and Other Regional "Gateways"
Those flows that entered or left the region at specific sites such as railyards, barge terminals, marine facilities, the airport, and external points were assigned one trip end at those places. Based on discussions with the Port staff, percentages were determined to allocate flows to each of the specific rail, barge, ship, and air facilities.

Rail flows were allocated equally to the three main railyards in the region. All commodities were given the same percentage.

Railyard	Percent of Total Rail_Truck Flows
Albina	33%
Brooklyn	33%
Wilbridge	33%

Ship to truck flows were given commodity-specific distribution percentages for Portland vs. Vancouver, as per Port staff designations. These marine facilities included Portland and Vancouver locations along the Willamette and Columbia Rivers. Within Portland or Vancouver, the flows were allocated equally among the zones specified.

Commodity	Import % Portland	Import % Vancouver	Export % Portland	Export % Vancouver	TAZs
Farm Products	80	20	70	30	6,846, 925,970, 971
Metallic Minerals & Coal	40	60	40	60	25,925, 970,971
Non-metallic Minerals	100	0	70	30	25,925, 970,971
Chemicals	80	20	95	5	25,925, 970,971
Petroleum Products	95	5	70	30	25,26, 925,970, 971
Stone, Clay, Concrete, Ceramic, or Glass	100	0	70	30	25,26, 950,852, 912,925, 970,971
Food, Fish, & Marine Products, Tobacco	80	20	99	1	925,970, 971
Lumber or Wood Products, Furniture	80	20	80	20	25,26, 970,971
Pulp, Paper, & Printed Matter	N/A	N/A	N/A	N/A	N/A
Primary & Fabricated Metal Products	80	20	70	30	851,925, 970,971
Machinery & Electrical Equipment	80	20	70	30	19,25,26, 925,970, 971
Transportation Equipment	80	20	70	30	925,926, 971,971
Misc. Manufactures, Instruments, Ordnance	80	20	70	30	925,970, 971
Textiles, Apparel, Leather, and Products	80	20	70	30	19,25,26, 925,970, 971
Waste by-Products	80	20	70	30	925
Courier Services (packages)	N/A	N/A	N/A	N/A	N/A

Barge flows were allocated in a similar fashion:

Commodity	**Inbound % Portland**	**Inbound % Vancouver**	**Outbound % Portland**	**Outbound % Vancouver**	**TAZs**
Farm Products	70	30	94	6	6,846, 925,970, 971
Metallic Minerals & Coal	83	17	94	6	25,925, 970,971
Non-metallic Minerals	83	17	94	6	25,925, 970,971
Chemicals	83	17	94	6	25,925, 970,971
Petroleum Products	93	7	94	6	25,26, 925,970, 971
Stone, Clay, Concrete, Ceramic, or Glass	83	17	94	6	25,26, 950,852, 912,925, 970,971
Food, Fish, & Marine Products, Tobacco	83	17	94	6	925,970, 971
Lumber or Wood Products, Furniture	83	17	94	6	25,26, 970,971
Pulp, Paper, & Printed Matter	N/A	N/A	N/A	N/A	N/A
Primary & Fabricated Metal Products	83	17	94	6	851,925, 970,971
Machinery & Electrical Equipment	83	17	94	6	19,25,26, 925,970, 971
Transportation Equipment	83	17	94	6	925,926, 971,971
Misc. Manufactures, Instruments, Ordnance	83	17	94	6	925,970, 971
Textiles, Apparel, Leather, and Products	83	17	94	6	19,25,26, 925,970, 971
Waste by-Products	83	17	94	6	925
Courier Services (packages)	N/A	N/A	N/A	N/A	N/A

External highway points are gateways for flows entering or leaving the region by truck. The ICF database identified three external directions (North, South, and other). The I-5 north external, in Clark County, was designated the gateway for all North flows; the I-84 east external for all Other flows; and the I-5 south external for all South flows. All other

external points were assumed not to carry any significant truck traffic for external points, as defined by ICF.

2.6 Linking of flow Origins and Destinations

Proportions used to determine distribution of flows between origins and destinations were determined by the employment allocations made in step 2.1.

3.1 – 3.3 Linkage of Commodity Flows to Reload Facilities or Terminals

As recommended in the CS document, all LTL flows from non-truck primary modes were allocated to reload facilities. The Port suggested designating all LTL flows for reload, so 100% of the truck-only LTL flows were also directed to reload and truck terminals. In addition, 3% of the TL/Private flows are routed through reload facilities. Port staff indicated that a small fraction of shipments transported by private trucks are reloaded. No unique factors were obtained for the separate commodity groups.

3.4 - 3.6 Allocation of LTL Flows to Reload Facilities

All LTL flows were routed through reload facilities, truck terminals, or distribution centers based on the proportion of expected total daily truck-ins and -outs. First, a list of reload facilities, truck terminals, and distribution centers was constructed to form the universe of all possible intermediate destinations for these flows. This list included the location (TAZ) of each site and number of employees. Other size variables, such as number of freight doors and square footage, that could have been used to estimate activity was included in the database, but not complete for all locations. Thus, the number of employees was used with the count data collected at select locations to estimate daily ins/outs at each facility in the database.

Where available, actual count data was used. For all remaining sites, a factor of 1.75 truck ins/outs per employee was used to estimate activity. The daily ins/outs at each location were summed by TAZ. This data was then used to allocate the LTL flows to the possible intermediate destinations around the region. The same proportions were used to "back into" determining the allocation of the "second" leg of the flow from the reload facilities to the destination TAZ.

3.7 Modeling Pickup and Delivery Tours

Insufficient data were available to simulate pickup and delivery tours. This version of the model does not contain additional processing to replicate this type of trip. However, the zonal goods are picked up by fractions of trucks. The fraction being determined by the commodity load factor.

4.1 – 4.2 Apply Heavy Truck Flow Fractions to Remove Flows Made by Non-Heavy Trucks

Highway vehicle classification counts were used to develop average percentages of heavy versus non-heavy trucks on the system. This, combined with average weight carried by each truck type, produced split factors for flows carried by each truck type. The heavy and non-heavy truck count split was 70% and 30%, respectively. This translated to 92% of flows being carried by heavy trucks and the remaining 8% on medium trucks.

4.3 Apply Flow to Truck Trip Factors

Separate commodity class tons to truck trip factors were obtained for the heavy and medium trucks using data from the VIUS (Vehicle Inventory and Use Survey) which was provided to us by Cambridge staff.

Commodity Group	Heavy Trucks		Medium Trucks	
	Trips < 50 miles	Trips 50 to 500 miles	Trips < 50 miles	Trips 50 to 500 miles
Farm Products	19	22	6	11
Metallic Minerals & Coal	23	23	12	16
Non-metallic Minerals	23	23	12	16
Chemicals	18	21	6	12
Petroleum Products	21	24	5	10
Stone, Clay, Concrete, Ceramic, or Glass	23	23	12	16
Food, Fish, & Marine Products, Tobacco	18	20	4	7
Lumber or Wood Products, Furniture	16	19	3	8
Pulp, Paper, & Printed Matter	18	19	4	9
Primary & Fabricated Metal Products	18	20	4	7
Machinery & Electrical Equipment	17	19	3	5
Transportation Equipment	17	18	3	5
Misc. Manufactures, Instruments, Ordnance	13	17	2	5
Textiles, Apparel, Leather, and Products	17	19	3	7
Waste by-Products	11	16	5	5
Courier Services (packages)	17	19	7	10

These values were in-line with the Port's estimate of average FEU weight overall of 21 tons/FEU.

Based on discussions with Port staff, all TL/PVT flows were assigned to heavy trucks, except for those with origins/destinations in high density, central city areas. We assumed that flows with origins/destinations in the central city are transported primarily by medium trucks. All LTL and TL/PVT flows were put in medium trucks for those TAZs.

5.1 (5.3) Estimate Additional Vehicle Trip Segment Trip Ends (Unbalanced)

Each matrix of commodity flows was reviewed to determine unbalanced trip origins and destinations. For any given zone, if the origins did not equal the destinations, the smaller

of the two was increased to match the other. The purpose of this step is to partially account for empty truck moves.

5.2 (5.3) Estimate Additional Vehicle Trip Segment Trip Ends (Balanced)
Certain movements such as repositioning and container maintenance require the addition of more truck trips to the trip table(s). However, at this point, there were limited data to estimate such trips. The only additional trips generated in this step were LTL trips to make up the difference between the reload and truck terminal counts (summed by TAZ) and the volumes produced by the tactical model.

6.1 Estimate Through Truck Trips
External-to-external flows which do not involve a mode change inside the region are not included in the strategic model database. Trip tables for medium and heavy external-to external moves were developed independently of the tactical model and then combined with the other trip tables just before assignment.

7.0 Estimate Truck Trip Table by Time of Day
Peaking factors were developed using regional highway count data and reload facility counts. A weighted average of all vehicle classification counts was used to develop the following factors:

A.M. 2-Hour: 12.6% of all day
Midday 1-Hour: 8% of all day, region wide; 5.6% at reload facilities
P.M. 2-Hour: 9.4% of all day

7.1 Assign AWD Truck Trips to Network
For initial review, a multi-class assignment was run using heavy trucks, medium trucks, and passenger cars as the three vehicle classes. All commodity groups were added together to form the two truck trip tables. If necessary, individual commodity class trip tables, could be assigned separately. However, software limitations prohibit all 16 commodity groups to be assigned at the same time without some aggregation.

Before assignment, the truck trip tables are converted to passenger car equivalents (PCEs). This is done to account for the extra space trucks take up on the road and the extra time they take to stop at intersections and accelerate on inclines.

The network also includes separate volume delay functions for the heavy trucks. That is, they are assigned an extra delay or cost when traveling on a non-freeway link in the system. This encourages the larger vehicles to use the freeway links, which more accurately reflects their true route choice.

Roadway counts were used for validation purposes. Model generated assigned trips are compared to observed counts. There are 80 counts locations included in the data set. The freeway volumes matched fairly well with counts (most within 10%, a few over 20%) and the arterials were generally a little low compared with counts. We believe this is due to the under-representation of pickup and delivery tour intermediate stops.

8.0 Evaluation Measures

There are numerous evaluation measures that can be extracted from the outputs of this model. For example, the I-5 Trade Corridor Project is using the new tactical model outputs along with the passenger car model results to evaluate scenarios in the I-5 corridor between I-84 and I-205 in Clark County, Washington. Here are some of the evaluation measures being used to analyze truck flows for this project:

- Demand
  - Link Volumes by Commodity
  - Trip Table District "Squeezes"
- Network Speeds and Travel Times
- Select Link Analysis
- Vehicle Miles Traveled
- Vehicle Hours Traveled
- Vehicle Hours of Delay

These measures and others can be used to compare scenarios and the impact of different highway projects on the different commodity groups.

9.0 Future Enhancements

The Commodity Flow Project and the models developed from that effort are a significant step forward in our ability to model truck trips in the region. The stratification of commodities will be an important feature of this tool for planners as they undertake projects that require economic analyses or focus on one (or more) specific commodity type. The identification of reload facilities and the routing of LTL trips through these locations add precision in the modeling of truck movements.

The assumptions and results represent a first-pass at the development of Portland regional truck trip tables. There is room for improvement in a variety of areas. The addition of more count/survey work and/or research in the following areas would be beneficial to the overall performance of the model:

- Tonnage-to-truck conversion factors, by primary mode
- Separate medium/heavy proportion for reloaded freight
- Secondary trip generation rates / pickup & deliver tours
- Origin/Destination distribution patterns
- Time of day factors
  - By commodity
  - By primary mode

Port and Metro staff have been communicating with members of the air cargo community to gain more understanding about load factors for the air sector. We hope to continue fine-tuning this tool as more information is collected.