2040 PORTLAND FREIGHT PLAN

2040FREIGHT
EXISTING CONDITIONS REPORT

July 2021

CITY OF PORTLAND, OREGON 1851

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PORTLAND BUREAU OF TRANSPORTATION

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Picture 1.1: Arial image of cars and freight trucks dirivng on freeway ramps. The Portland downtown skyline is visible in the background. [Source: Oregon Depatment of Transportation (ODOT)]

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Picture 1.1: *A white FedEx truck parked on the curb of a street. A person on a bicycle is riding through the bike lane to the left of the FedEx truck. [Source: Minneapolis Public Works Streets]*

PREFACE

The 2040 Portland Freight Plan is an update of the City's Freight Master Plan adopted by the Portland City Council in 2008 and is part of a larger effort by the City of Portland's Bureau of Transportation to incorporate freight mobility considerations in execution of the agency's planning, operations, design, and implementation programs. The 2040 Portland Freight Plan will provide a strategic road map for achieving outcomes that support the City's long-term objectives for managing freight movement and commercial delivery based on the core principles of safety, mobility, economy, state of good repair, equity and the environment.

This technical report assesses and reports on the current (i.e. existing conditions) movement of goods by trucks in the City of Portland, including truck traffic volume, delay, travel patterns, and safety. Several data sources were used in this analysis including Metro's Regional Travel Demand Model, truck classification counts, 5-year collision history, and the Freight Analysis Framework (FAF) data provided by the Federal Highway Administration (FHWA). From these data sources, locations with potentially high congestion levels, safety concerns, and lengthy travel time delay were identified, primarily focused on non-freeway locations where truck traffic may experience regular (recurring) congested conditions on City streets. Where available, the differences between off-peak hour (12:00- 1:00 PM), PM peak hour (5:00 - 6:00 PM), and all- day traffic were analyzed to better understand when issues may be occurring and to lay the groundwork for solutions that address these issues. The existing conditions analysis provides the baseline for which the future 2040 analysis will be compared against in a future report.

The focus of the current report is on the existing conditions (year 2015) for truck traffic in the City of Portland. These analyses are critical to developing an understanding of the existing impediments to freight movement and are one of many elements of the City's 2040 Portland Freight Plan, including: developing solutions and strategies to improve freight mobility; recommending freight mobility performance indicators and measures; and recommending an action plan.

Future reports will be prepared for the 2040 Portland Freight Plan describing facilities, conditions, innovations, trends, and needs in a manner that tells the story of the freight sector and its contribution to the City's economy. Further, information about the major demographic, economic, freight generation, land use, transport, supply chain, new technologies and trade trends will be developed to highlight the full picture of freight movement in the City of Portland.

The contents of this document do not necessarily reflect views or policies of the City of Portland.

1. OVERVIEW OF FREIGHT IN PORTLAND

With its location at the confluence of the Willamette and Columbia rivers as the approach the ocean, the City of Portland developed as a freight hub with marine, rail and air terminals. As Portland has grown, freight continues to be an important part of the economy.

In the last 10 years, population and employment have grown by as much as 12% and 13%, respectively[1]. **Table 1** shows recent employment in various industries at the city and regional (Metropolitan Statistical Area) level. Overall, some of the industries with heavy freight activities have grown since 2008, indicating growing demand for related jobs to support the economy community needs. Both manufacturing and utilities have decreased within the City at an average annual rate of 0.6 percent and 1.0 percent respectively. This is a departure from the regional growth of these industries as both have seen an average annual increase in the MSA. The transportation and warehousing industry accounts for the highest total growth of the industrial sectors in the City between 2008 and 2019, with an increase of 3,911 jobs. Agriculture and mining have seen the highest percentage growth of any sector in the state or region, though the total jobs in these sectors is still low. These statistics and other evidence related to significant growth in e-commerce, demonstrate the

1 https://data.census.gov/cedsci/advanced

Table 1. Employment by Industry

SECTOR	TOTAL IN CITY (2019)	% IN CITY (2019)	TOTAL IN MSA (2019)	% IN MSA (2019)	AVERAGE ANNUAL GROWTH RATE IN CITY 2008 - 2019	AVERAGE ANNUAL GROWTH RATE IN MSA 2008 - 2019
Manufacturing	28,482	6%	131,400	11%	-0.6%	0.6%
Transportation & Warehousing	27,676	6%	42,600	3%	1.4%	1.7%
Wholesale Trade	21,344	5%	56,900	5%	0.4%	0.3%
Construction	22,146	5%	75,000	6%	1.7%	1.8%
Utilities	2,362	1%	2,500	0%	-1.0%	0.8%
Agriculture & Mining	1,242	0%	1,400	0%	13.3%	-1.2%
Office Sectors	139,243	30%	365,000	30%	1.4%	1.3%
Institutional Sectors	110,114	24%	253,600	21%	2.4%	2.1%
Retail and Consumer Services	111,584	24%	288,600	24%	1.7%	1.5%
Total	**464,413**	**100%**	**1,218,200**	**100%**	**1.5%**	**1.4%**

Source: Bureau of Labor Statistics. Quarterly Census of Employment and Wages and Current Employment Statistics, 2019.
CES Education data was adjusted to include public and private establishments.

Table 2. Freight Analysis Framework Data Summary for Portland OR-WA (OR Part)

	2015 (FAF4)		2017 (FAF5)	
	THOUSAND TONS	MILLION DOLLARS ($)	THOUSAND TONS	MILLION DOLLARS ($)
Total Origin	79,518	120,799	96,272	104,880
Total Destination	88,238	110,181	124,950	124,506
Total Flow	167,756	230,980	221,222	229,386
Percent Growth*	**-**	**-**	**32%**	**-0.7%**
Total Imports	2,927	11,603	4,463	13,213
Total Pass-Through Imports	1,032	6,233	2,258	8,103
Total Exports	9,078	6,108	13,364	6,087
Total Pass-Through Exports	2,718	1,994	5,831	3,737

Source: Bureau of Transportation Statistics and the Federal Highway Administration. National Transportation Research Center. 2015. ***Freight Analysis Framework 4.*** https://faf.ornl.gov/fafweb/Extraction1.aspx

Bureau of Transportation Statistics and the Federal Highway Administration. National Transportation Research Center. 2017. Freight Analysis Framework 5. https://faf.ornl.gov/faf5/dtt_total.aspx

Pass-through imports and exports are those that are imported via Portland but have origins or destinations outside of Oregon.

importance of goods movement and freight related activities and the need for proactive planning for safe and efficient truck flows through the city.

1.1 Regional Commodity Flow

Beside the growth shown in jobs in freight related industries, the overall tonnage and value of goods transported from/to the city has increased significantly too. **Table 2** provides a summary of the data obtained from the FAF estimates for analysis years 2015 and 2017 for all modes of transportation including truck, rail, water, multiple modes and mail, air and pipeline[2]. At the time of this study, the provisional FAF5 data was released, which includes preliminary data for year 2017 only based on the results of the 2017 Commodity Flow Survey[3]. The complete FAF5 data is expected to be released in full, including future forecast years, later this summer. The 2015 data are from on FAF4 data base, which is estimated based on 2012 Commodity Flow Survey (CFS). The change in national and global supply chain international trade are reflected in the two surveys. There has been some updated and refinements in new FAF5 assumptions[4].

From 2015 to 2017, there was a 32 percent increase in total tonnage of freight flows from and to the Portland Metro region. However, the dollar value of

2 The Freight Analysis Framework (FAF) is a national annual freight commodity flow database, made publicly available by the U.S. DOT. It is updated annually by combining data from modal freight statistics and the Commodity Flow Survey (CFS). The last CFS was conducted in 2017, however the results have not yet been published. The analysis in this section is based on the FAF4 database and 2012 CFS. FAF consists of 132 FAF regions in U.S. There are two zones in Oregon: the Oregon Metropolitan area and the rest of the state. FAF also includes eight foreign regions for imports and exports. Data is available for freight commodities carried by all modes by tonnage (in thousand tons) and value (in million dollars) for imports, exports, and total flows. In addition, the top freight commodities are highlighted from a list of Standard Classification of Transported Goods (SCTG) . FAF also provides the modes of transportation used between domestic origins and destinations, and between zones of entry or exit and foreign origins or destinations.

3 https://www.bts.gov/faf, released March, 2021.

4 Standard Classification of Transported Goods Codes. 2021. Bureau of Transportation Statistics. Available at https://www.bts.gov/sites/bts.dot.gov/files/2021-02/FAF5-User-Guide.pdf

the flows between 2015 and 2017 remains almost constant. Different trends in tonnage and dollar value might be due to a change in the price of goods, combination of total goods, or assumption in FAF methodology.

It is important to note that the FAF4 forecasts are estimated pre-COVID19 pandemic and some of the major global trade agreements and tariff changes. Adjustments might be required to account for the economic impacts of pandemic and the change in supply chain. However, these forecasts still provide good information about the long-term trends.

The Portland/Vancouver region is the fourth largest freight hub for international trade on the West Coast behind Los Angeles/Long Beach, Seattle/Tacoma and San Francisco/Oakland[5]. Total imports and exports to the region are shown in **Table 2**. The top commodities imported to the Portland Metro region are shown in **Figure 1-1** and **Figure 1-2**. These commodities are summarized based on Standard Classification of Transported Goods (SCTG) Codes as reported by Commodity Flow Survey (CFS) every five years[6].

As seen in these figures, Nonmetal mineral products, base metals, and motorized vehicles were the top imports by weight in 2017. When analyzing imports by value, motorized vehicles far exceed other import commodities in 2017, with electronics and machinery second and third.

The commodities imported to the Portland region come from various regions around the world. About 51% of the imports to the Portland region in 2017 are from Eastern Asia and only about 1% come from Africa and the Rest of Americas as depicted in **Figure 1-3**.

Although Portland has access to both major BNSF and Union Pacific (UP) rail lines, given the portfolio of high value commovdities imported to the ports (motorized vehicles, electronics, textile, etc..), trucking is still the main mode of transportation to distribute imported commodities to their final destinations. As illustrated in **Figure 1-4**, 84% of the imports are distributed by trucks from the port of entry to their final destinations.

5 FAF4 summary tables accessed at https://faf.ornl.gov/fafweb/Extraction1.aspx

6 https://www.bts.gov/archive/publications/commodity_flow_survey/classification

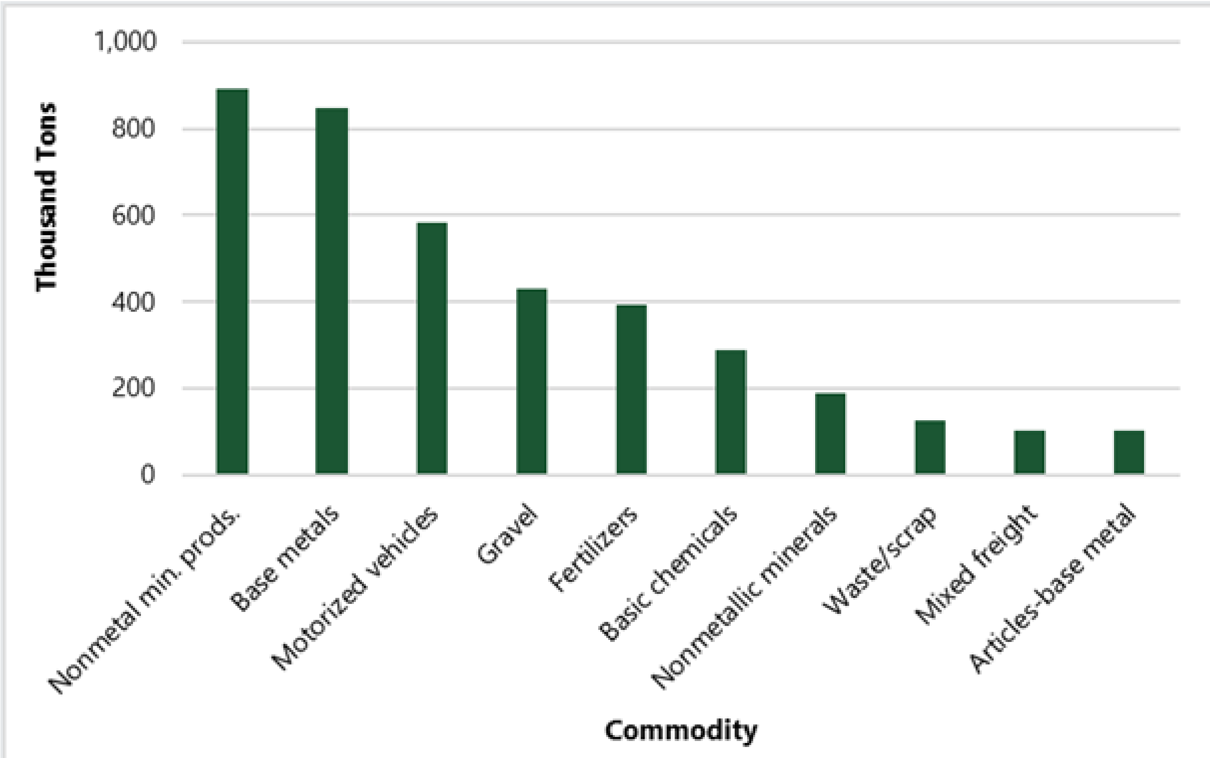
Unlike the largest ports along the West Coast, Port of Portland dominant operation is exports. In 2015, the exports by tonnage were triple those of imports. This shows another aspect of the importance and role of freight in the regional economy. As shown in **Figure 1-5** and **Figure 1-6,** cereal grains are the most exported commodity by tonnage in the Portland Metro region in 2017 but in terms of value, motorized vehicles are dominant.

More than 49% of the exports from the Portland region are destined for Eastern Asia and less than 1% reach Mexico and Africa as shown in **Figure 1-7**.

Trucking is the dominant mode for export commodities as well. About 69% of exports are transported by truck to the port as shown in **Figure 1-8**. However, since the top export commodity from the Portland metro region is grain, the share of rail transport for export commodities is higher relative to imports (14% for export relative to 4% for imports). Railroad is the competitive mode to transport bulk commodities over long distances. Due to the importance of barge transportation for bulk goods along the Columbia, water, at 16%, carries a significant portion of exports to Portland as well.

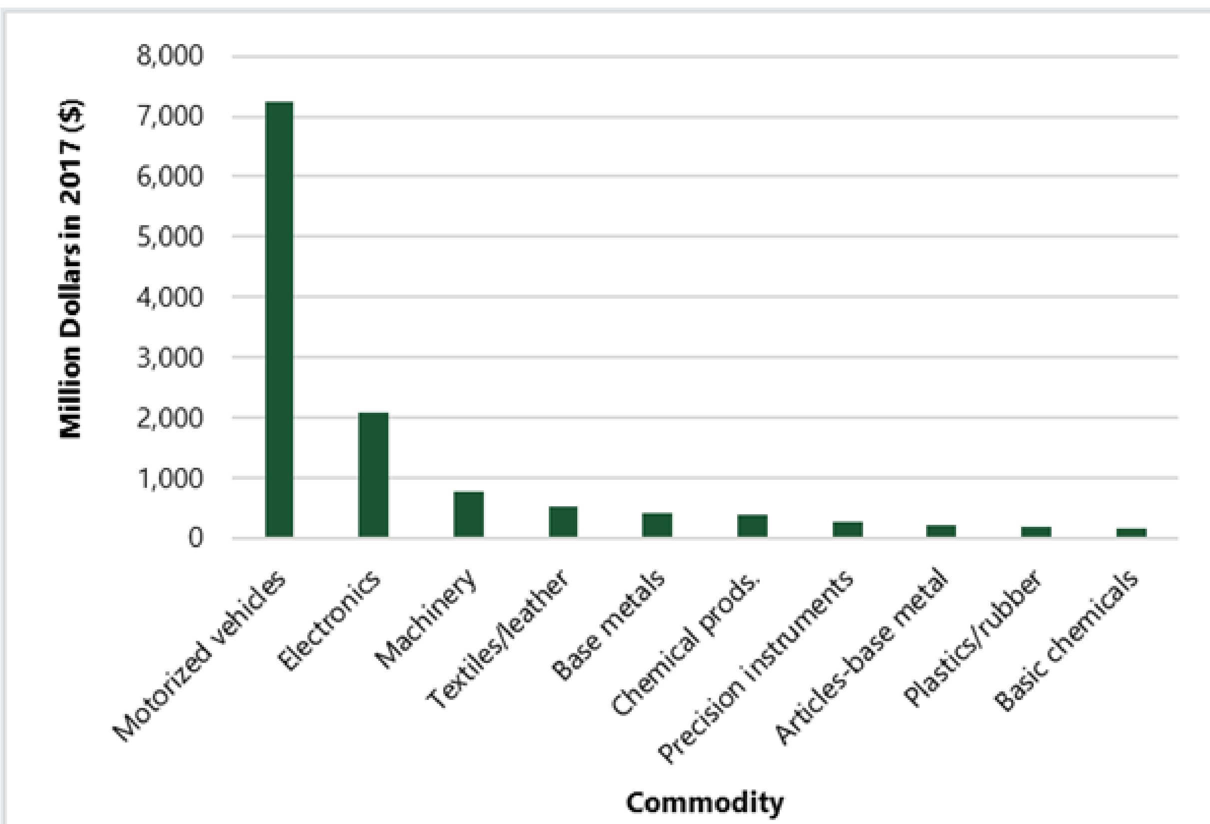
Picture 2.1: *A white and black freight truck driving through a road. The truck is transporting 'HUB' canned beverages. [Source: PBOT]*

Figure 1-1. Top 10 Import Commodities by Tonnage (2017)



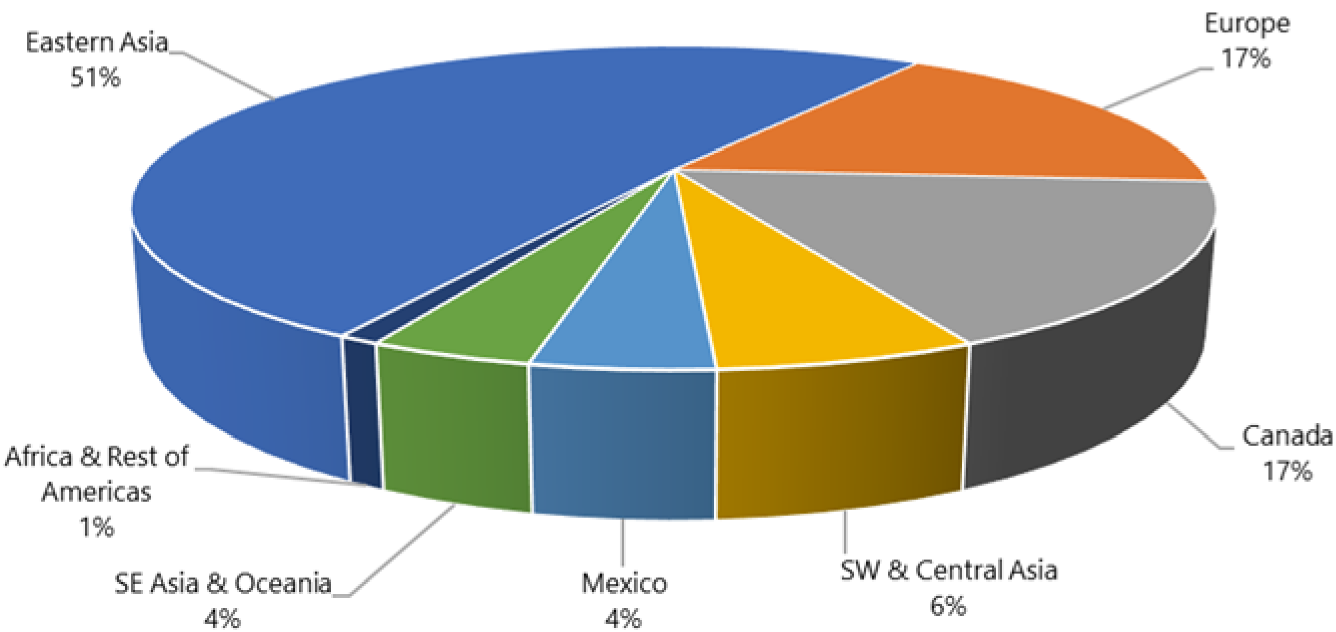
Source: Bureau of Transportation Statistics and the Federal Highway Administration. National Transportation Research Center. 2017. *Freight Analysis Framework 5*. https://faf.ornl.gov/faf5/dtt_total.aspx

Figure 1-2. Top 10 Import Commodities by Value (2017)



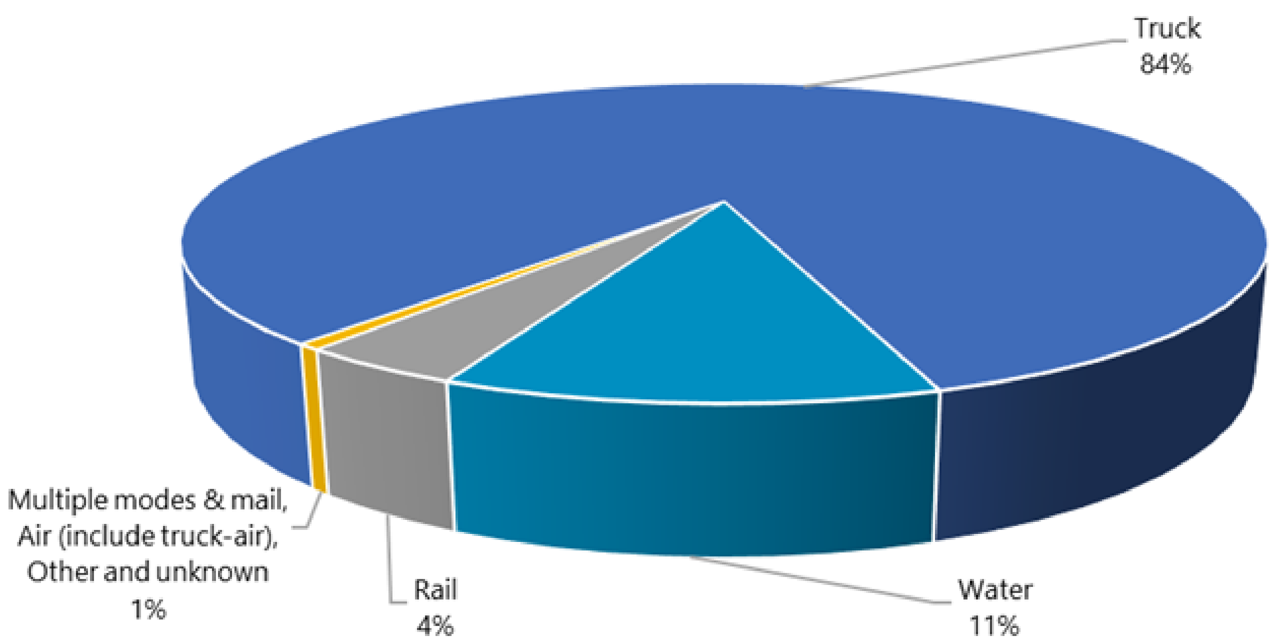
Source: Bureau of Transportation Statistics and the Federal Highway Administration. National Transportation Research Center. 2017. *Freight Analysis Framework 5*. https://faf.ornl.gov/faf5/dtt_total.aspx

Figure 1-3. Origins of Imported Commodities by Tonnage % (2017)



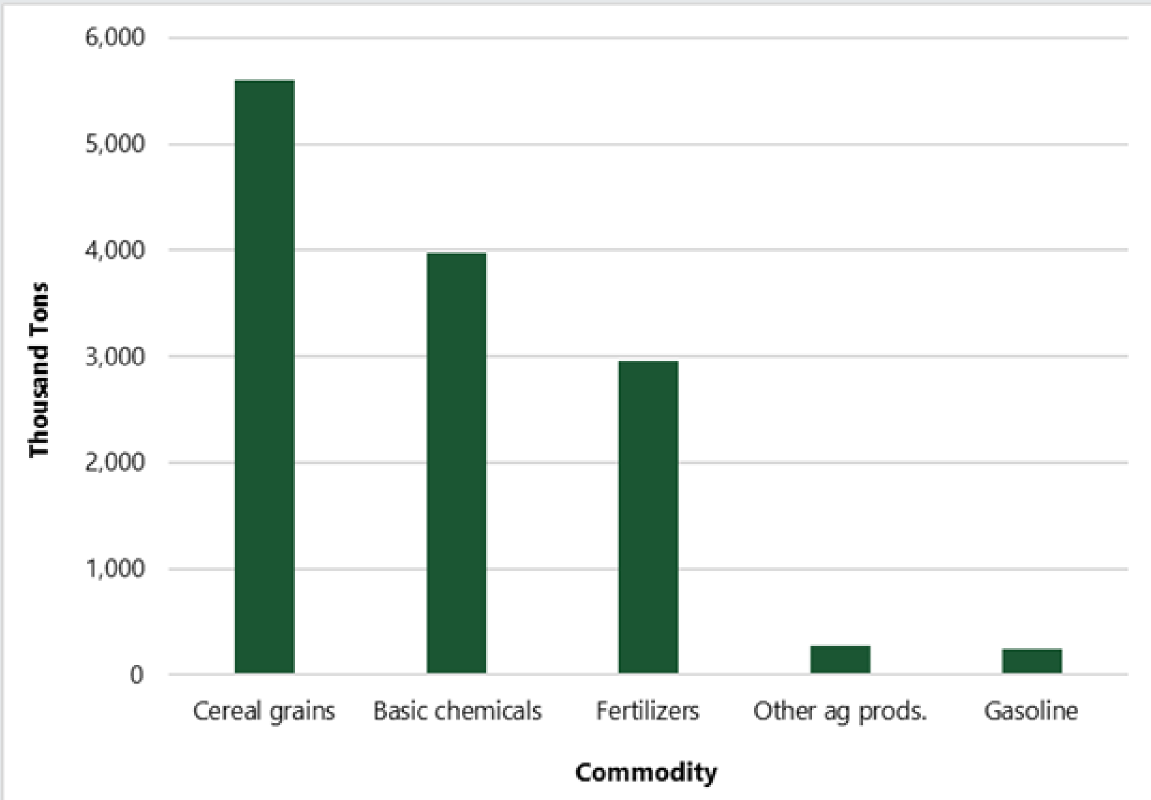
Source: Bureau of Transportation Statistics and the Federal Highway Administration. National Transportation Research Center. 2017. *Freight Analysis Framework 5*. https://faf.ornl.gov/faf5/dtt_total.aspx

Figure 1-4. Domestic Mode of Transportation for Imports % (2017)



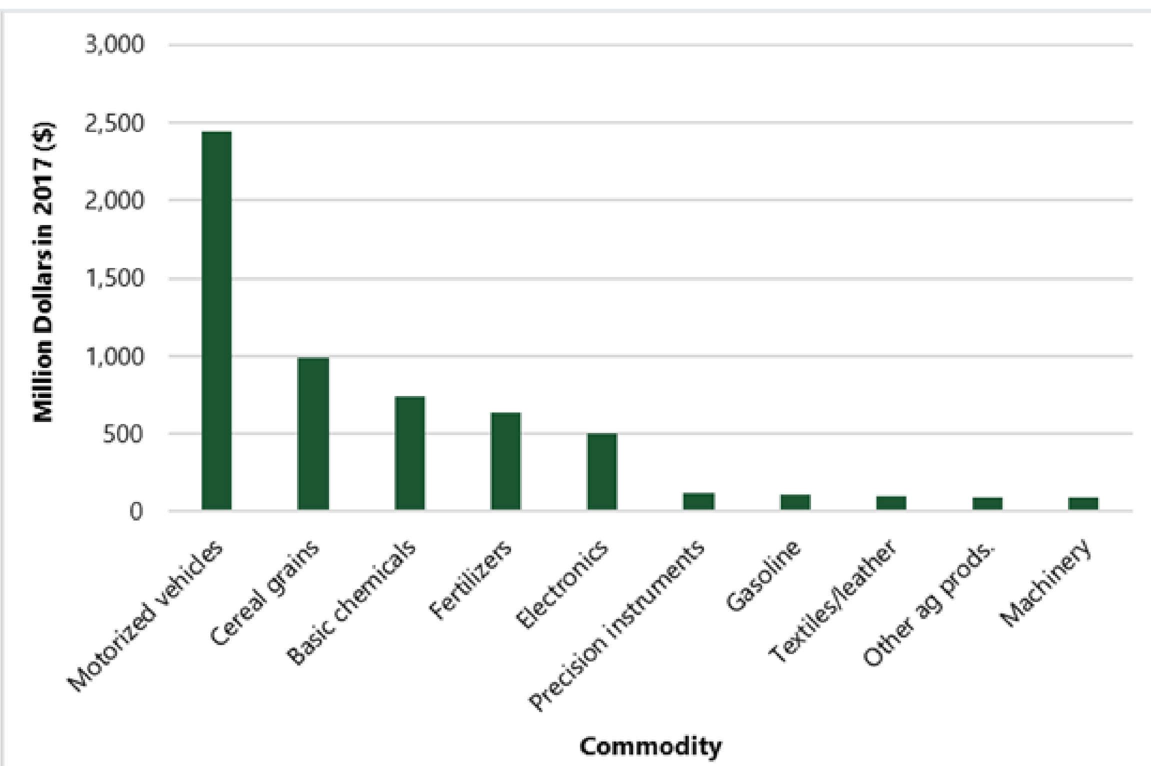
Source: Bureau of Transportation Statistics and the Federal Highway Administration. National Transportation Research Center. 2017. *Freight Analysis Framework 5*. https://faf.ornl.gov/faf5/dtt_total.aspx`

Figure 1-5. Top 10 Export Commodities by Tonnage (2017)



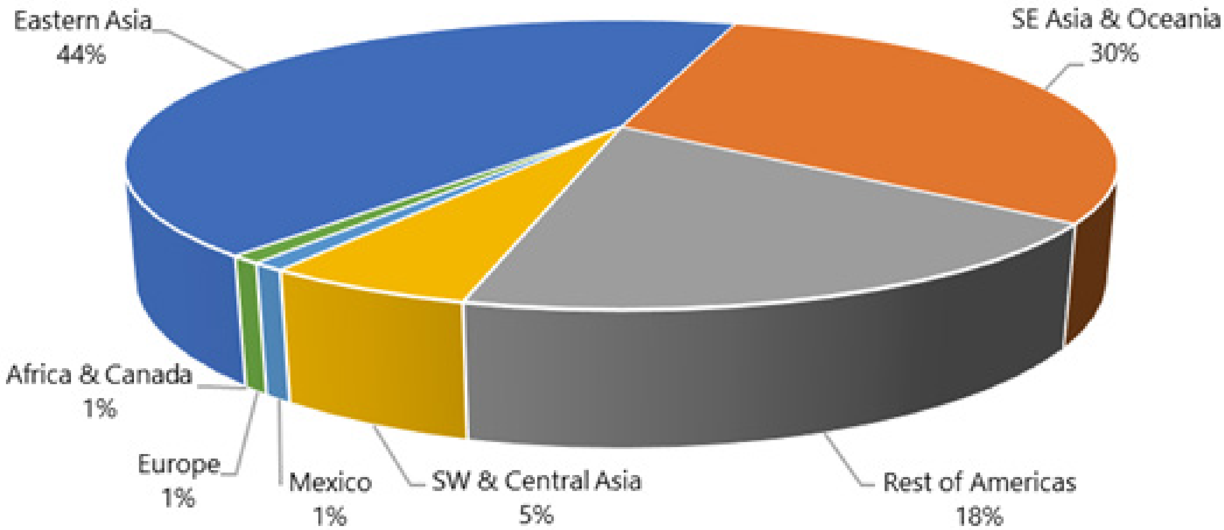
Source: Bureau of Transportation Statistics and the Federal Highway Administration. National Transportation Research Center. 2017. *Freight Analysis Framework 5*. https://faf.ornl.gov/faf5/dtt_total.aspx

Figure 1-6. Top 10 Export Commodities by Value (2017)



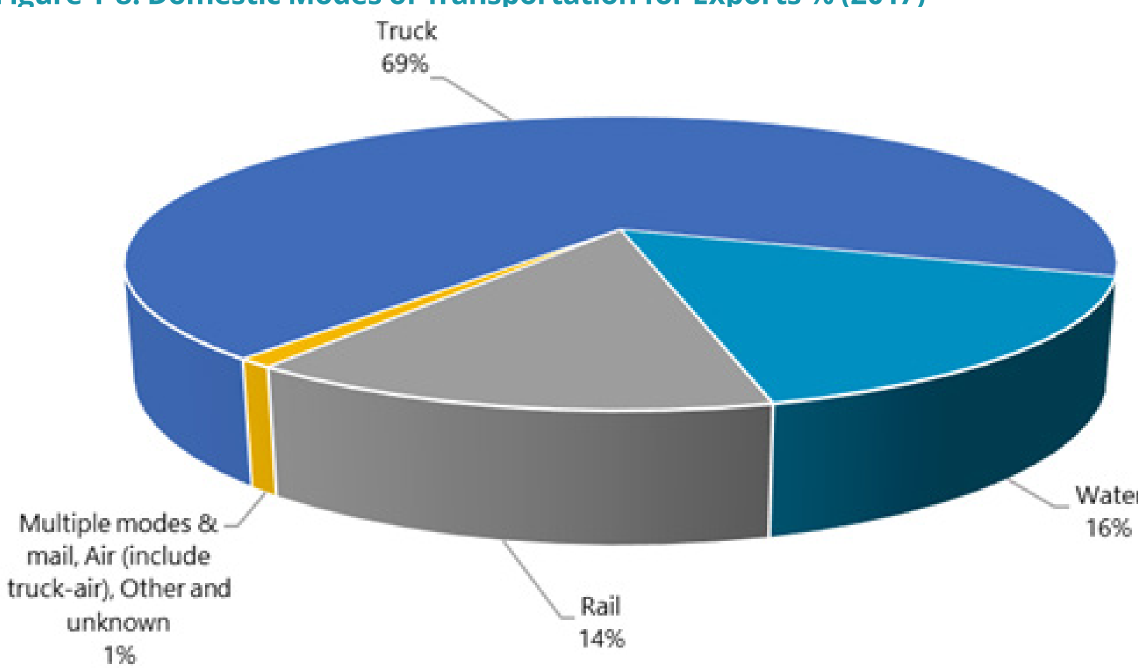
Source: Bureau of Transportation Statistics and the Federal Highway Administration. National Transportation Research Center. 2017. *Freight Analysis Framework 5*. https://faf.ornl.gov/faf5/dtt_total.aspx

Figure 1-7. Export Commodities Destinations by Tonnage % (2017)



Source: Bureau of Transportation Statistics and the Federal Highway Administration. National Transportation Research Center. 2017. *Freight Analysis Framework 5*. https://faf.ornl.gov/faf5/dtt_total.aspx

Figure 1-8. Domestic Modes of Transportation for Exports % (2017)



Source: Bureau of Transportation Statistics and the Federal Highway Administration. National Transportation Research Center. 2017. *Freight Analysis Framework 5*. https://faf.ornl.gov/faf5/dtt_total.aspx

Picture 3.1: Green, orange, and white freight trucks driving on a freeway lane. The lane and trucks are surrounded by orange traffic cones. [Source: ODOT]

2. TRUCKING DATA AND METHODOLOGY

The discussion in the last section demonstrated that trucking is the main mode for goods movement in the city. It is also the mode most within the city's control. To better understand the operation and challenges of truck movements, several data sources were assembled and reviewed, including the regional travel demand model, existing traffic counts, historical traffic archives, and ODOT's collision database. The focus of the analysis is on City streets and arterials rather than freeways which are under State jurisdiction.

2.1 Portland Metro Travel Demand Model Data

Travel demand data used in this report was obtained from the Metro Regional Travel Demand Model. The Metro Regional Travel Demand Model (hereafter called "the model") is a complete transportation forecasting model used for planning urban and regional movement of people and goods. The data were provided for the latest available model base year 2015, for the off-peak hour (12pm–1 pm), peak hour (5pm-6pm), and daily time periods. The model represents average weekday conditions. Model data include the following attributes, which are explained in more detail in the following sections:

- Total truck volumes
- Truck volumes by vehicle type (medium truck and heavy truck)
- Congested and posted speed
- Truck vehicle miles of travel (VMT)
- Truck hours of delay
- Volume-to-capacity ratio on roadway segments
- Zonal truck origins and destinations

The model represents trucks in FHWA class 5 and higher. Although, the smaller vans/trucks in FHWA class 3 are increasingly being used for last mile home delivery, they are not tracked as trucks in Metro's model. The difficulty of distinguishing the commercial vs. personal use of the class 3 vehicles in many data sets has introduced problems and lack of reliable and available data have been an obstacle for including these vehicles in travel demand models.

2.2 Traffic Volume Count Data

Traffic volume count data from 2015 to 2020 was obtained from the City of Portland's open GIS data portal. This data included total average daily traffic (ADT) at various locations throughout the City, along with truck percentages. This data was available at points along various roadways and may not be representative of conditions along an entire roadway segment. These counts were compared with the model data to provide a more complete picture of truck volume and percentage of traffic.

2.3 Collision Data

Collision data from 2014-2018 for the entire City was obtained from ODOT's Crash Data System. This data includes information about the parties involved in the collision, actions taken by the parties involved, and other circumstances surrounding the incident. Collisions that involved a truck were analyzed to determine whether there are any meaningful trends in the location and contributing circumstances related to locations of truck collisions.

2.4 Historic Travel Time Data

Truck travel time at different times of the day can be significantly affected by congestion on the roadway system. Historic motor vehicle speed data collected over the past three years were obtained from HERE (via the ESRI online world traffic service), based on GPS and cell phone data. This speed data was used to calculate truck travel time sheds from specific points in Portland that account for the level of typical congestion experienced on the City's streets.

2.5 Portland's Street Classifications

The City of Portland Transportation System Plan (TSP) designates freight streets and freight districts in the City. Freight districts are meant to accommodate the needs of high levels of truck traffic and intermodal freight in industrial and employment areas. Freight Streets are classified as follows[7]:

Regional Truckways are intended to facilitate interregional movement of freight. They support industrial and employment land uses with high levels of truck activity.

Priority Truck Streets are intended to serve as the primary route for access and circulation in Freight Districts, and between freight districts and Regional Truckways.

Major Truck Streets are intended to serve as principal routes for trucks in a transportation district. They support commercial and employment land uses that generate high levels of truck activity.

Truck Access Streets are intended to serve as access and circulation routes for delivery of goods and services to neighborhood-serving commercial and employment uses.

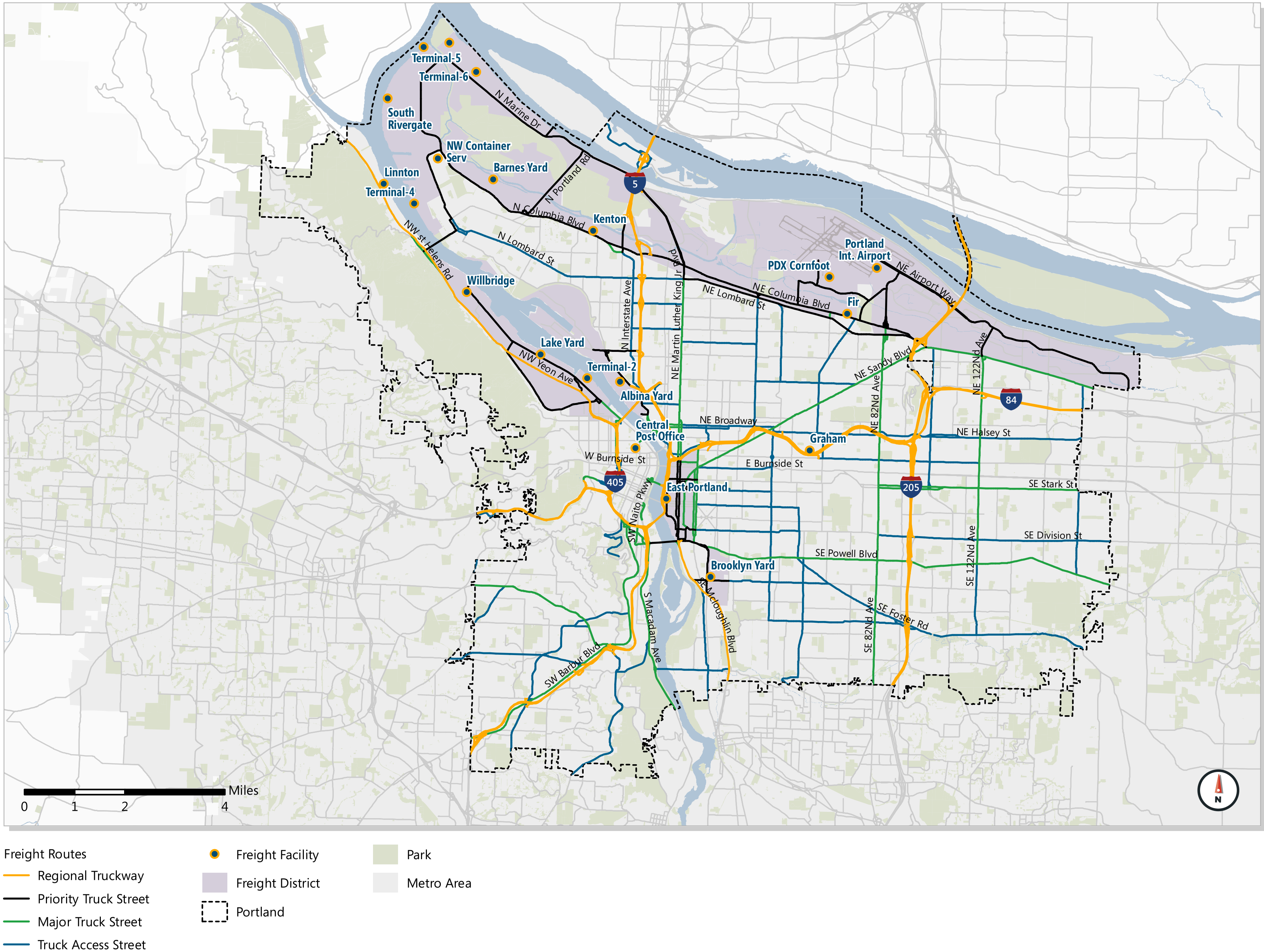
Local Service Truck Streets are intended to serve local truck circulation and access. All streets in Portland, outside of freight districts, not classified as Regional Truckways, Priority Truck Streets, Major Truck Streets, or Truck Access Streets are classified as Local Service Truck Streets.

The TSP also identifies the City's major marine, air, rail, and pipeline terminals, and warehouse and industrial districts which serve as origin and destination points for the local, national, and international freight that moves through and within the City.

Picture 4.1: *A white freight truck unloading goods in the middle of a street. A beige van drives by the truck. Mulitple cars parked on the street are visible in the background. [Source: unknown]*

7 Portland 2035 Transportation System Plan. March 2020.

Figure 2-1. Portland Freight Routes



Portland's freight districts, freight street classifications, and freight facilities such as port terminals and rail yards where goods are transferred between modes are shown in **Figure 2-1**.

2.6 Performance Measures

The existing conditions analysis identified and analyzed several different performance measures to understand the movement of trucks traveling to, from and within the City.

2.6.1 Truck Volume

The number of trucks traveling along a road segment during a specified time period was obtained from the model which differentiates between medium and heavy trucks. Medium trucks are defined as FHWA class 5-7, or single-unit trucks, and heavy trucks are defined as FHWA Class 8 and above, or trucks with one or more trailers. The truck classes are illustrated in Figure 2-2 below.

The FHWA vehicle classification scheme relies upon the identification of both the number of axles and the number of trailers in each vehicle. Automated methods for data capture (such as in-road sensors and supporting software) have commonly been developed with this information to record truck traffic on roadway networks. The American Association of State Highway and Transportation Officials (AASHTO) has developed another classification system that identifies trucks by their approximate height, width, and length. The classifications include:

- SU-30: 30.0-foot, single unit vehicles typical of most local delivery vehicles (2-4 Axles)
- WB-40 and WB-50: small tractor trailers with wheelbases in the 40.0-foot and 50.0-foot range (typically 3-5 Axles)
- WB-67: 67-foot wheelbase long haul trucks, sometimes called the interstate design vehicle that has an overall length on the order of 74.0-feet (typically 5 or more Axles).

AASHTO classification is used as standard for geometric design of highways and streets, while FHWA classification is commonly used in transportation planning and travel demand modeling[8]. There is not a one-to-one correspondence between these two classifications.

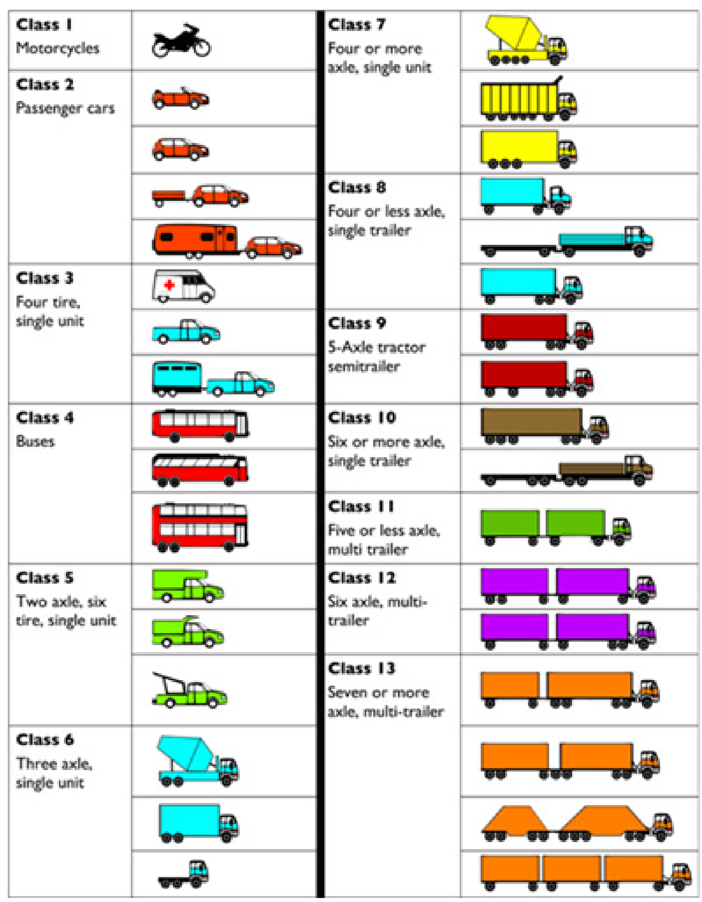
Note that model volumes go through a validating process, but they should still be taken as estimates and not exact volumes. Existing counts of passenger/service vehicles and truck volumes were also used and compared to the model volumes where possible to corroborate the findings.

2.6.2 Proportion of Trucks

The percent of trucks measures the share that truck traffic represents of total vehicle volume along a

8 Designing for Truck Movements and Other Large Vehicles in Portland, 2008 available at https://nacto.org/wp-content/uploads/2015/04/designing_truck_movements_large_vehicles_portland_portland.pdf

Figure 2-2: FHWA Vehicle Category Classification



Source: Federal Highway Administration. Office of Highway Policy Information. (2016) Traffic Monitoring Guide: Appendix C. U.S. Department of Transportation road segment during a specified time period.

2.6.3 Speed

The maximum speed limit for a specified section of a roadway is defined as posted speed. For the purposes of this report, posted speed is assumed to be uncongested or free-flow speed. Congested speed refers to vehicle speed experienced under congested conditions along a roadway. The ratio of congested speed from the model during both peak and off-peak periods) to posted speed provides insight into how much congestion there is on a roadway. As this ratio approaches 1.0, it indicates that vehicles can travel close to the posted speed while lower values indicate congested conditions.

2.6.4 Volume-to-Capacity Ratio (v/c)

A measure of the level of congestion on a roadway that compares the traffic volume along a roadway to its estimated capacity available to accommodate traffic volume and traffic movements. Volume-to-capacity (v/c) ratios approaching 1.0 indicate that congested conditions are present, and that there may be extended delays and queuing.

For delay and v/c calculation, truck volumes are converted to passenger car equivalents (PCE) in order to represent the impact of each truck on congestion and traffic[9]. Metro applied a factor of 1.7 to both medium and heavy trucks for this conversion.

2.6.5 Truck Delay

Delay is defined as the additional travel time experienced by a motorist or truck driver due to congestion. The model data for delay is provided in hours but for the purposes of this report, analysis results were converted to minutes. The reported truck minutes of delay includes the delay experienced on roadway segments and at intersections when the volume-to-capacity ratio on the roadway exceeds 0.9. This cutoff was used because traffic delays are primarily experienced at intersections or heavily congested segments.

2.6.6 Truck Vehicle Miles of Travel

Truck vehicle miles of travel (VMT) provides a measure of the amount of travel for all trucks within the City of Portland. VMT is calculated by adding up the miles driven by all the trucks on all the roadways in the City. This metric indicates travel demand and routing behavior and can be used to compare the amount of total travel in existing and future years even if trip lengths or number of trips change[10].

9 Pajecki, R., Ahmed, F., Qu, X., Zheng, X., Yang, Y., & Easa, S. (2019). Estimating Passenger Car Equivalent of Heavy Vehicles at Roundabout Entry Using Micro-Traffic Simulation. Frontiers in Built Environment, 5, 77.

10 Williams, T. A., Chigoy, B., Borowiec, J. D., & Glover, B. (2016). Methodologies used to estimate and forecast vehicle miles traveled (VMT).

Picture 5.1: A white freight truck driving through a street. Mulitple white, red, and black cars are driving in front of the freight truck. [Source: unknown]

3. TRUCKING IN PORTLAND

3.1 Truck Volume

As mentioned earlier, daily, peak, and off-peak truck volume in Portland is provided by Metro's regional travel demand model for all major roads in the City. Where daily truck count data was available, this was compared with the daily model data to verify the model outputs.

3.2 Daily Truck Volume

Daily truck volume from the model and the City's existing traffic counts portal are shown in **Figure 3-1** and **Figure 3-2.** The model and count data show significant truck traffic on both designated truck streets such as Lombard Street, Columbia Boulevard, Powell Boulevard, Martin Luther King, Jr. Boulevard, and 82nd Avenue, and on local truck access streets which require access for trucks but may not always be able to accommodate trucks comfortably.

Both the model and the portal counts show truck activity in Downtown Portland where there is only local truck access street designations, including the areas between I-405 and the Willamette River and from West Burnside Street to I-405. The Downtown truck traffic may be related to business deliveries and connections between freeways and City streets. W Burnside Street from west of the city limits into Downtown shows truck traffic in both the model and the counts, and trucks may be using this route as an alternative to US 26.

The Central Eastside freight district, between I-84 and SE Powell Boulevard, from the Willamette River to NE 12th Avenue, also has high daily truck traffic in both the model and the portal counts. The model does not show much truck traffic volume east of the Central Eastside to SE 82nd Avenue, except for slightly higher truck volumes on SE Division Street and SE Stark Street which are local truck access.

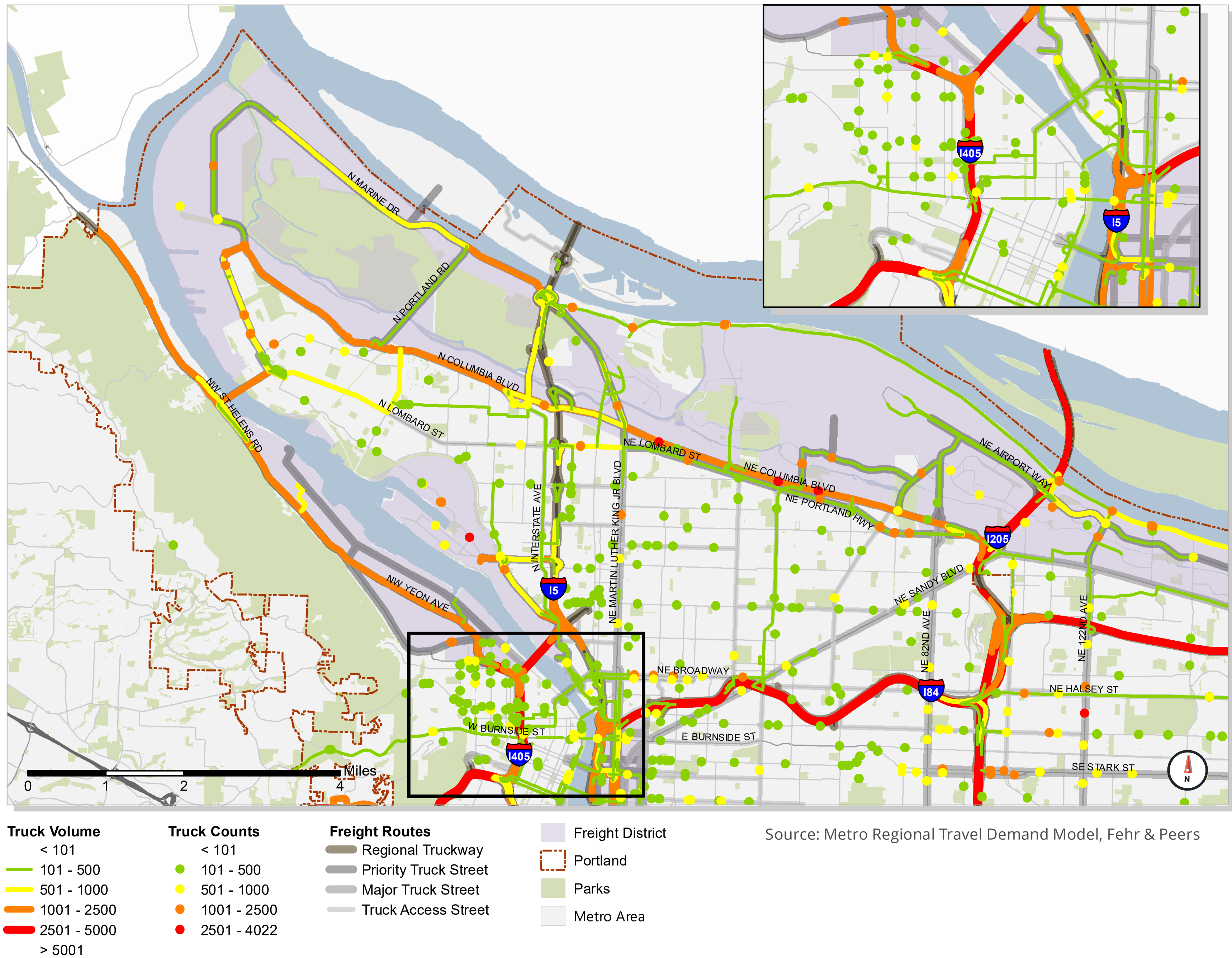
In North Portland, relatively high truck traffic volumes run on N Lombard Street and Columbia Boulevard in large part due to the location of Port of Portland and private terminals, warehouses, and manufacturing facilities. In the Northeast Portland district, there are also high levels of truck traffic volume further east along Columbia Boulevard all the way to the City's eastern limit at (NE 162nd to NE 185th Avenues) serving Portland International Airport, the Troutdale FedEx distribution center and the Amazon Fulfillment Center, as well as trips connecting to and from I-5, I-205 and I-84. Several streets adjacent to the freeways and major truck access streets also experience higher truck traffic volume than other local streets in their neighborhoods. These may be due to truck drivers seeking alternate routes around congested bottlenecks and in some cases because of being lost.

Also, in Northeast Portland, truck traffic is generated to and from the Swan Island Industrial area and the Union Pacific Albina Yard via NE Greeley Street, NE Going Street, Interstate Avenue, and I-5. Many local truck access streets near these facilities, including Willamette Boulevard, NE Fremont Street and NE Rosa Park Avenue, experience high truck traffic volume relative to their neighboring local streets, likely due to trucks cutting through those neighborhoods to avoid congestion. This area of the City does not have any north/south trucks streets outside of I-5 and OR 99W.

East of I-205, there are numerous routes showing truck traffic that are local truck access streets:

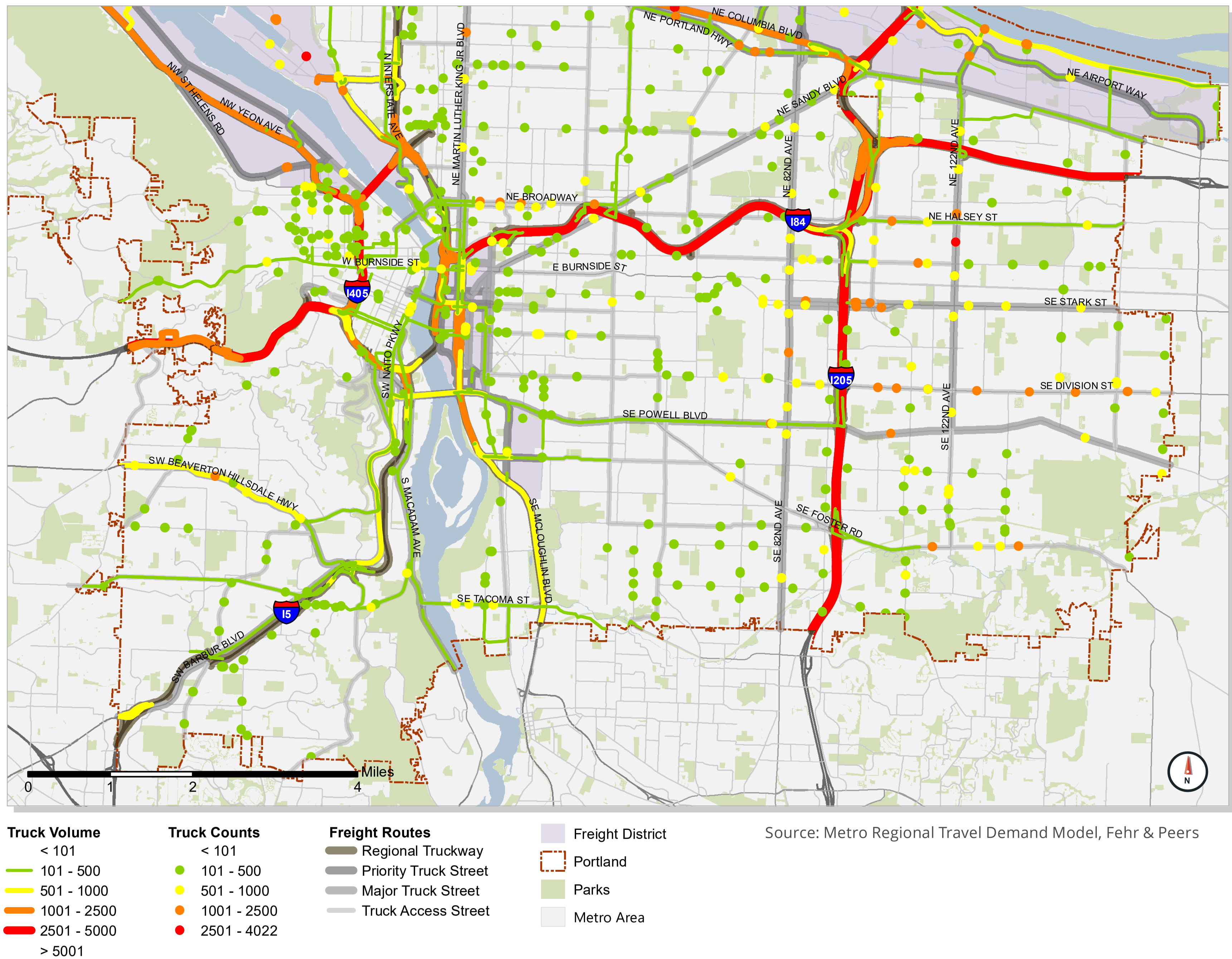
- NE Prescott Street between NE 102nd Avenue and NE 122nd Avenue
  - This runs parallel to NE Sandy Boulevard and traffic may be using NE Prescott Street when NE Sandy Boulevard is congested.
- NE Shaver Street from 122nd Avenue to Sandy Boulevard
  - A post office is located on the corner of NE Shaver Street and NE 122nd Avenue with the driveway on Shaver Street. It is likely that postal trucks use Shaver Street, and it is parallel to

Figure 3-1. Daily Truck Volumes (North)



Source: Metro Regional Travel Demand Model, Fehr & Peers

Figure 3-2. Daily Truck Volumes (South)



Source: Metro Regional Travel Demand Model, Fehr & Peers

Sandy Boulevard so it may see diversion traffic.

- NE Glisan Street from NE 122nd Avenue to NE 148th Avenue
  - West of 122nd Avenue is a truck access street, there may be enough homes and businesses east of 122nd Avenue that the freight route should be extended.
- SE 136th Avenue north of SE Foster Road
- SE Holgate Boulevard near SE 111th Avenue

The most direct east/west routes on the south side of the City are the Ross Island Bridge and the weight restricted Sellwood Bridge[11]. The Ross Island Bridge accommodates a high percentage of truck traffic due to its direct access to major north/south highways in the City including I-5, Naito Parkway, and OR 99W. The Sellwood Bridge, which was replaced with a new Sellwood Bridge in 2017, is typically traversed by medium truck traffic, which approach the bridge from OR 43 and SE Tacoma Street.

The model also shows relatively high truck traffic volume on SW Spring Garden Street, a local street east of I-5, and SE Johnson Creek Boulevard east of SE McLoughlin Boulevard. In the area west of I-205 and south of SE Foster Road, the counts indicate truck traffic on many of the local streets, including SE Flavel Street, SE Duke Street, and SE 92nd Avenue.

While the model and portal data show differences in certain areas, looking at the all-day truck traffic patterns from both sources confirms the truck usage on known truck corridors such as Columbia Boulevard. These data also highlight some local truck access streets that have truck traffic and that may need further study to identify if changes on truck access and limitations on these facilities are required.

3.3 Peak hour and Off-Peak hour Volume

As shown in **Figure 3-3** and **Figure 3-4**, total truck volumes from the model are generally higher during the off-peak hour than during the peak hour. Typically, freight and logistic facility operations are busier during off-peak periods and thus their deliveries frequently avoid travel in commute peak hours. Truck traffic is concentrated on the freeways and in freight districts, including Columbia Boulevard. According to the model, most truck traffic utilizes designated freight streets. However, the model also shows that over twenty trucks travel during both peak and off-peak hours along the following streets that are designated as local truck access only:

- SE Milwaukie Avenue between SE Powell Boulevard and SE Holgate Boulevard
- SW Naito Parkway between Barbur Boulevard and the Ross Island Bridge
- N Portsmouth Avenue between N Lombard Street and N Columbia Boulevard
- NE Marine Drive east of N Martin Luther King Jr Boulevard
- NE Lombard Place between NE Lombard Street and NE Columbia Boulevard.

Picture 6.1: *Two rows of cars idling in traffic. The cars are blue, black and gray. [Source: unknown]*

11 The new weight limit is 13 tons (or 26,000 pounds) for privately owned vehicles and 40 tons (80,000 pounds) for publicly owned vehicles. ORS 805.040 restricted use of the new bridge to motor vehicles with a gross vehicle weight rating of 26,000 pounds or less (unless they are government-owned) because privately-owned vehicles above that weight do not pay the vehicle registration fee that funded the bridge. http://www.sellwoodbridge.org/?p=frequently-asked-questions#new

Figure 3-3. Off-Peak Hour Truck Volumes

Source: Metro Regional Travel Demand Model, Fehr & Peers

Figure 3-4. Peak Hour Truck Volumes

Source: Metro Regional Travel Demand Model, Fehr & Peers

Table 3. Average Truck Percentage by Facility Type

FACILITY TYPE	OFF-PEAK HOUR	PEAK HOUR
Freeway	9.4%	3.7%
Arterial	7.6%	4.6%
Collector & Local	2.0%	1.2%

source: Metro Regional Travel Demand Model, Fehr & Peers

The following routes have over 20 trucks during only the peak hour:

- W Burnside Road from the western City boundary to I-405
- SW 30th Avenue from Beaverton Hillsdale Highway to SW Vermont Street

Peak hour truck traffic along W Burnside Street is likely due to diversion congestion on US 26. All day truck traffic counts corroborate that trucksw are using this route.

3.4 Proportion of Truck Traffic

According to the available traffic count data on City streets (not including freeways), trucks account for 7.8% of all traffic volume over the course of the day, though this count data is not available for all streets and mostly represents major arterials so it is not statistically representative of City truck traffic[12]. The Metro regional travel demand model estimates the average truck percentage for all roadway segments in Portland is 2.1% of all-day traffic, 1.5% during the peak hour, and 2.7% during the off-peak hour. For all non-freeway segments, trucks represent 1.4% and 2.3% of peak and off-peak traffic, respectively.

Table 3 provides more insight on the average truck percentage in the Portland area[13]. Freeways carry more trucks compared to City streets during the off-peak hour because a significant number of trucks are passing through Portland and do not have an origin or destination in Portland. During the peak hour arterials have a slightly higher percentage of truck traffic than freeways, but this likely reflects high personal vehicle volumes during the peak which reduces the total percentage of trucks. Freeways are also designed for truck traffic, all of the interstates in Portland are designated as a Regional Truckway freight route and may be more navigable for large vehicles than local streets. Streets carry higher truck traffic during the off-peak hours compared peak hour, because most deliveries and pick-ups occur during less congested times of day and trucks do not need to follow the typical morning and evening commute patterns of personal vehicles.

A comparison of the daily truck traffic percentage derived from the model data and truck counts is provided in **Figure 3-5**. To emphasize and summarize the arterials with the highest truck percentage from various sources we looked at locations where truck volume is more than 20 percent of total daily volume. The following roadway segments were identified by both sources to have the highest truck traffic percentages on City streets:

- N Marine Drive west of NE Martin Luther King Jr Boulevard
- N Lombard Street west of N Philadelphia Avenue
- N Columbia Boulevard west N Portland Road
- NW St Helens Road west of the St. Johns Bridge
- N Portsmouth Avenue
- N Halleck Street east of N Peninsular Avenue
- N Killingsworth Street east of N Interstate Avenue

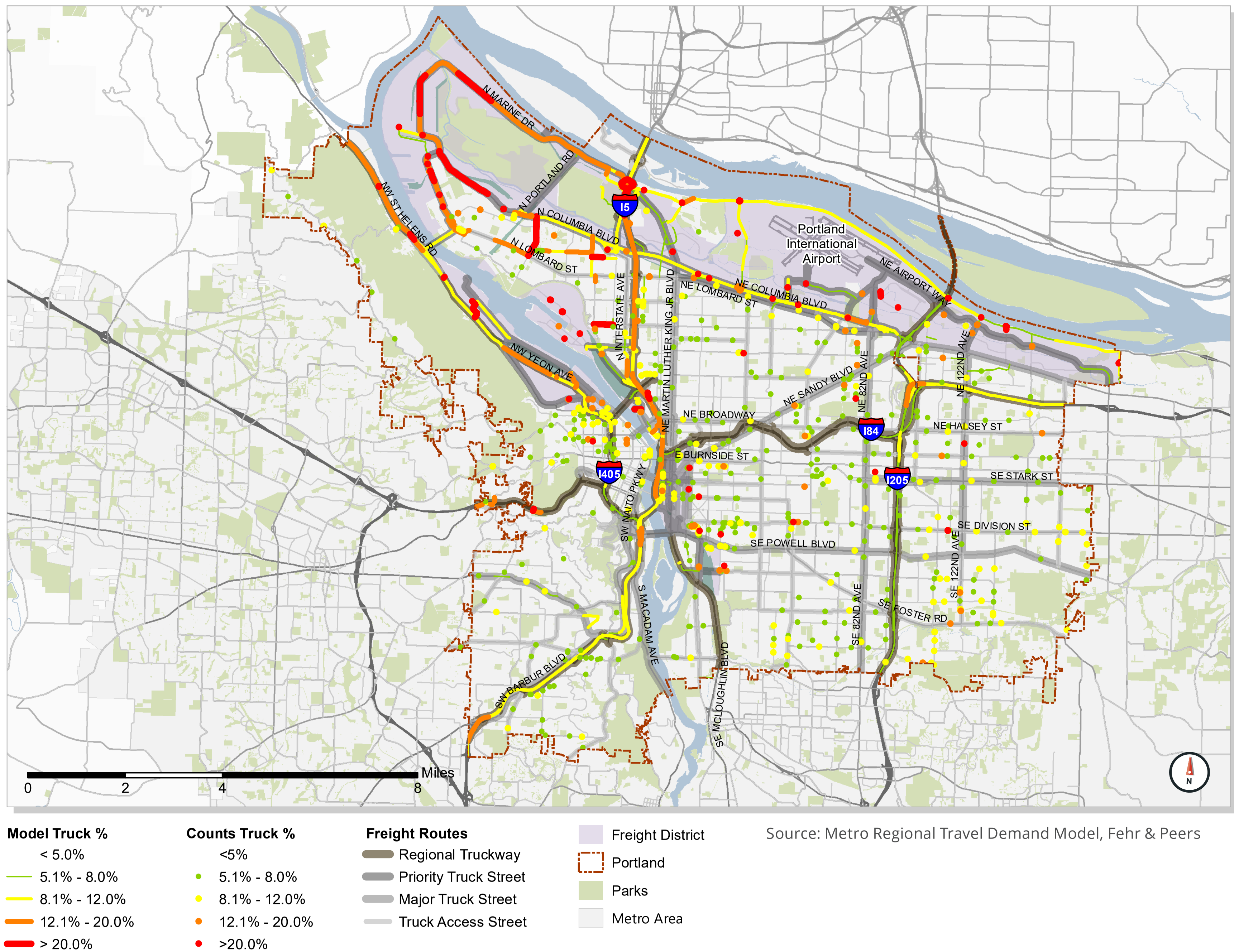
Other roadway segments where the count data indicate a truck percent over 20% includes:

- NE Columbia Boulevard
- NE 33rd Avenue north of NE Prescott Street
- NE Martin Luther King Jr Boulevard north of NE Vancouver Way
- NE Marine Drive east of I-205

12 The facility types utilized by the Metro model and referred to in this report do not articulate PBOT traffic classifications.

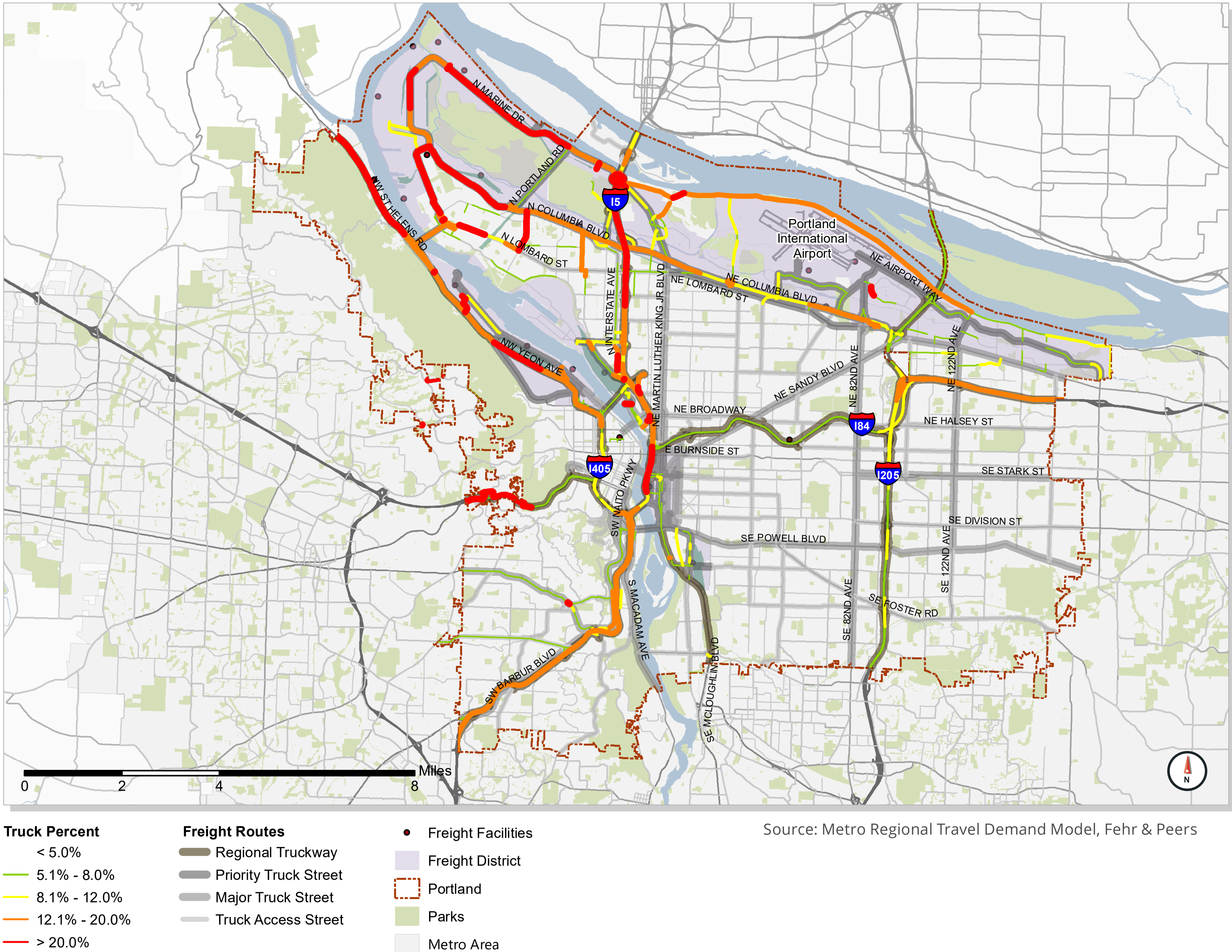
13 Facility Types are defined by the Metro model as follows: Freeway (type 10-19), arterial (type 20-29), collector/local (type 30-49), ramp (type 70-79).

Figure 3-5. Daily Truck Percentage (Model & Counts)



Source: Metro Regional Travel Demand Model, Fehr & Peers

Figure 3-6. Off-Peak Hour Truck Percentage of Total Traffic



Source: Metro Regional Travel Demand Model, Fehr & Peers

Table 4. Truck Hours of Delay by Facility Type in 2015

FACILITY TYPE	OFF-PEAK HOUR*	PEAK HOUR*
Freeway	22.3	51.6
Arterial	0.7	3.5
Collector & Local	1.5	3.5

Source: Metro Regional Travel Demand Model, Fehr & Peers.

- SE 122nd Avenue between NE Halsey Street and NE Glisan Street
- NE Basin Avenue
- N Channel Avenue

As seen in **Figure 3-6**, the highest off-peak truck percentages (over 13%) from the model occurred along the following roadway segments. Count data was not available along these locations:

- N Marine Drive west of NE 122nd Avenue
- N Lombard Street west of N Portsmouth Avenue
- N Columbia Boulevard west I-205
- N Portsmouth Avenue between N Lombard St and N Columbia Boulevard
- N Peninsular Avenue
- N Interstate Avenue from N Greeley Avenue to N Going Street
- NW St Helens Road west of I-405
- SW Canyon Court
- The intersection of SW Beaverton Hillsdale Highway and SW Capitol Highway

Truck percentage was lower in the model during the peak hour compared to off-peak, both a reflection of lower truck volumes and higher passenger vehicle volumes. This is likely because trucks may prefer to travel during off-peak hours to avoid higher congestion and delay along several roadways during peak commute hour. However, model data shows truck percentages over 13 percent of traffic occur during the peak hour along the following roadway segments:

- N Marine Drive west of N Portland Road
- N Lombard Street west of N Gilbert Avenue
- N Columbia Boulevard west N Portland Road
- N Portsmouth Avenue between N Lombard Street and N Columbia Boulevard
- N Interstate Avenue from Overlook Boulevard to N Skidmore Street
- N Expo Road
- The intersection of NE Columbia Boulevard and NE 33rd Drive
- US 26 off ramps at Skyline Boulevard and at Washington Park
- SW 30th Avenue

Many of the locations identified above are in industrial areas and are likely to have a higher truck to car ratio than other areas of the City due to the existing land use.

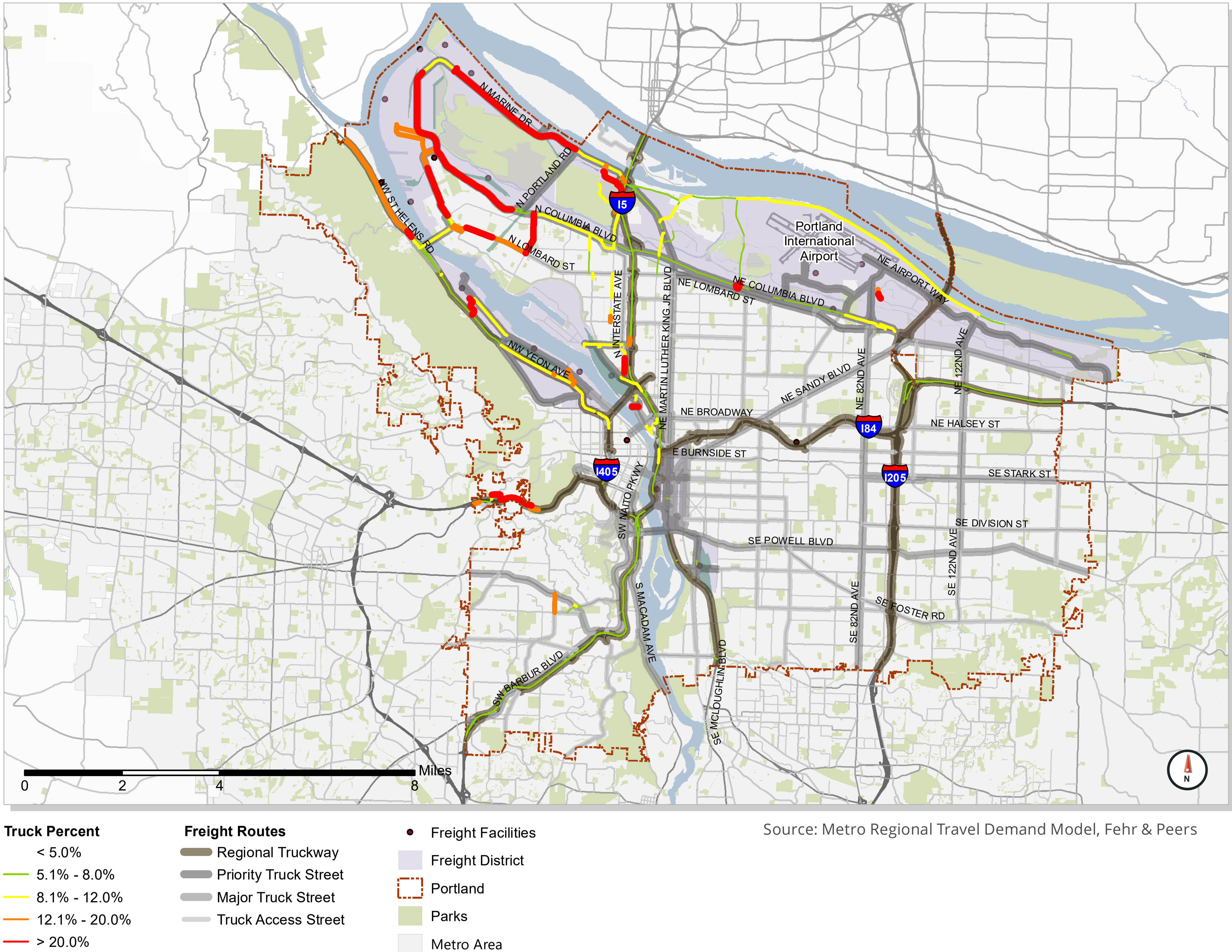
3.5 Travel Time and Delay

Typically, traffic bottlenecks or locations with significant delay occurs, where the ratio of congested speed to posted speed is less than 0.5, meaning vehicles are traveling less than 50 percent of the posted speed. Non-freeway locations in the off-peak hour that show speeds less than 50 percent of the posted speed. These include sections of SW Terwilliger Boulevard north of Oregon Health and Science University (OHSU), SE Powell Boulevard near McLoughlin Boulevard, SW Macadam Avenue north of the Sellwood Bridge, and SE Tacoma Street at the Sellwood Bridge as shown in **Figure 3-8** to **Figure 3-11**.

The total off-peak and peak hour truck hours of delay on roadway segments under existing conditions are shown **Figure 3-12** and **Figure 3-13**[14]. Total truck delay in excess of 60 minutes is seen on most freeways and highways including I-5, I-84, I-205 and US 26 during both the peak and off-peak periods. However, this condition is more prevalent during the peak hour. Streets with total truck delay in excess of 15 minutes in the off-peak hour include:

14 Delay in the travel model is calculated as total hours of delay experienced by all trucks traveling over a segment, when the volume-to-capacity ratio exceeds 0.9 on that segment.

Figure 3-7. Peak Hour Truck Percentage of Total Traffic

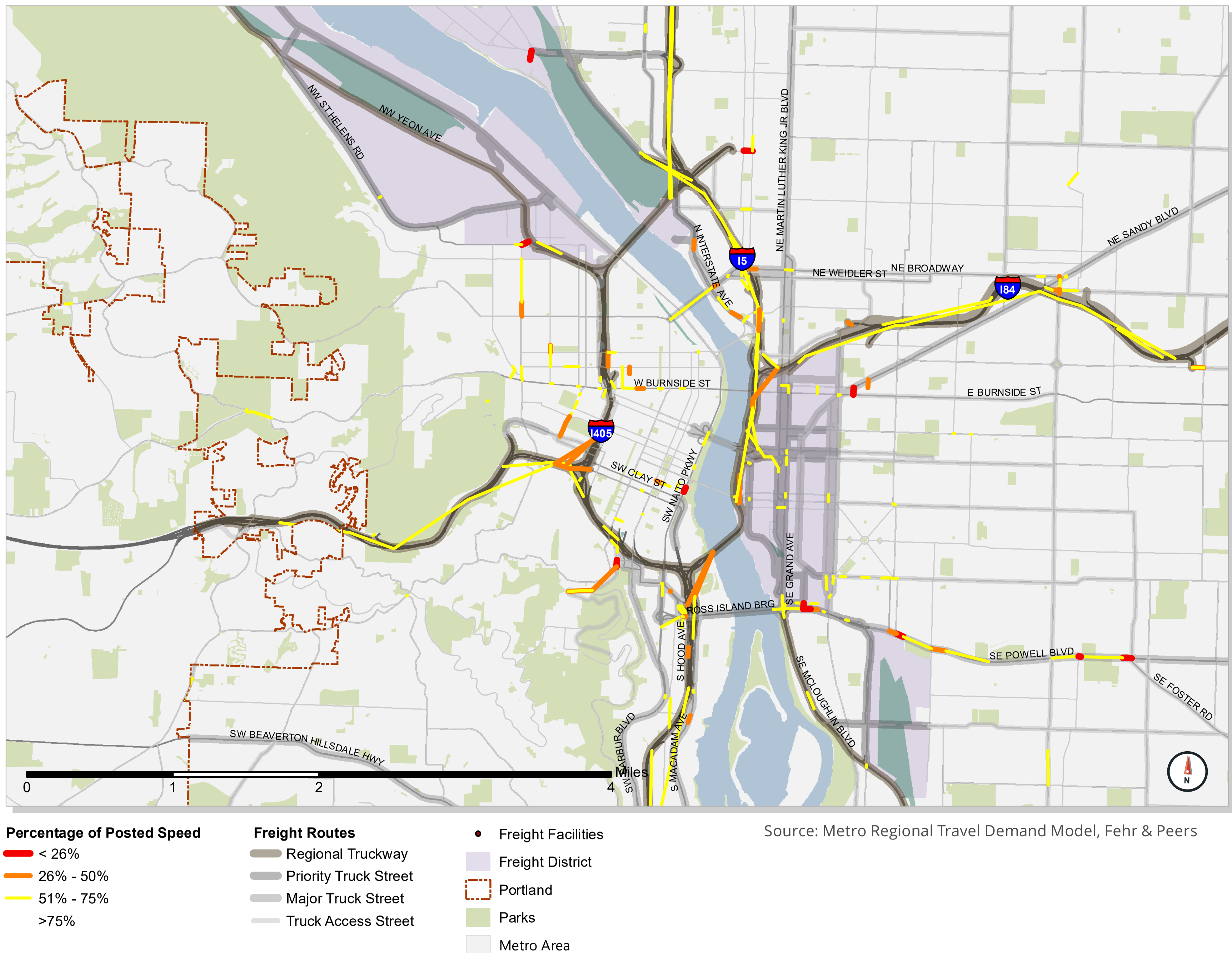


Source: Metro Regional Travel Demand Model, Fehr & Peers

Figure 3-8. Off-Peak Hour Congested Speed Relative to Posted Speed

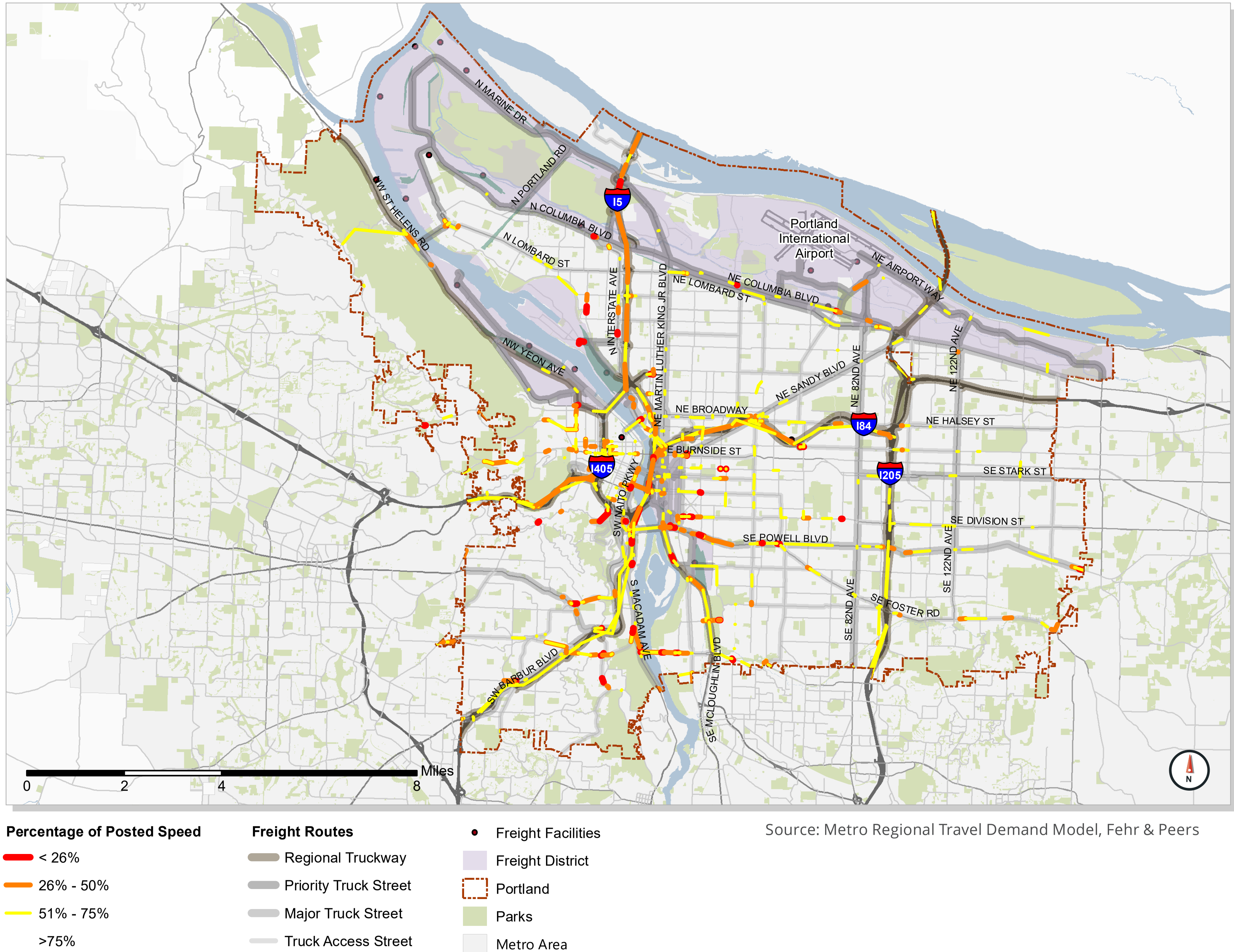
Source: Metro Regional Travel Demand Model, Fehr & Peers

Figure 3-9. Off-Peak Hour Congested Speed Relative to Posted Speed (Downtown)



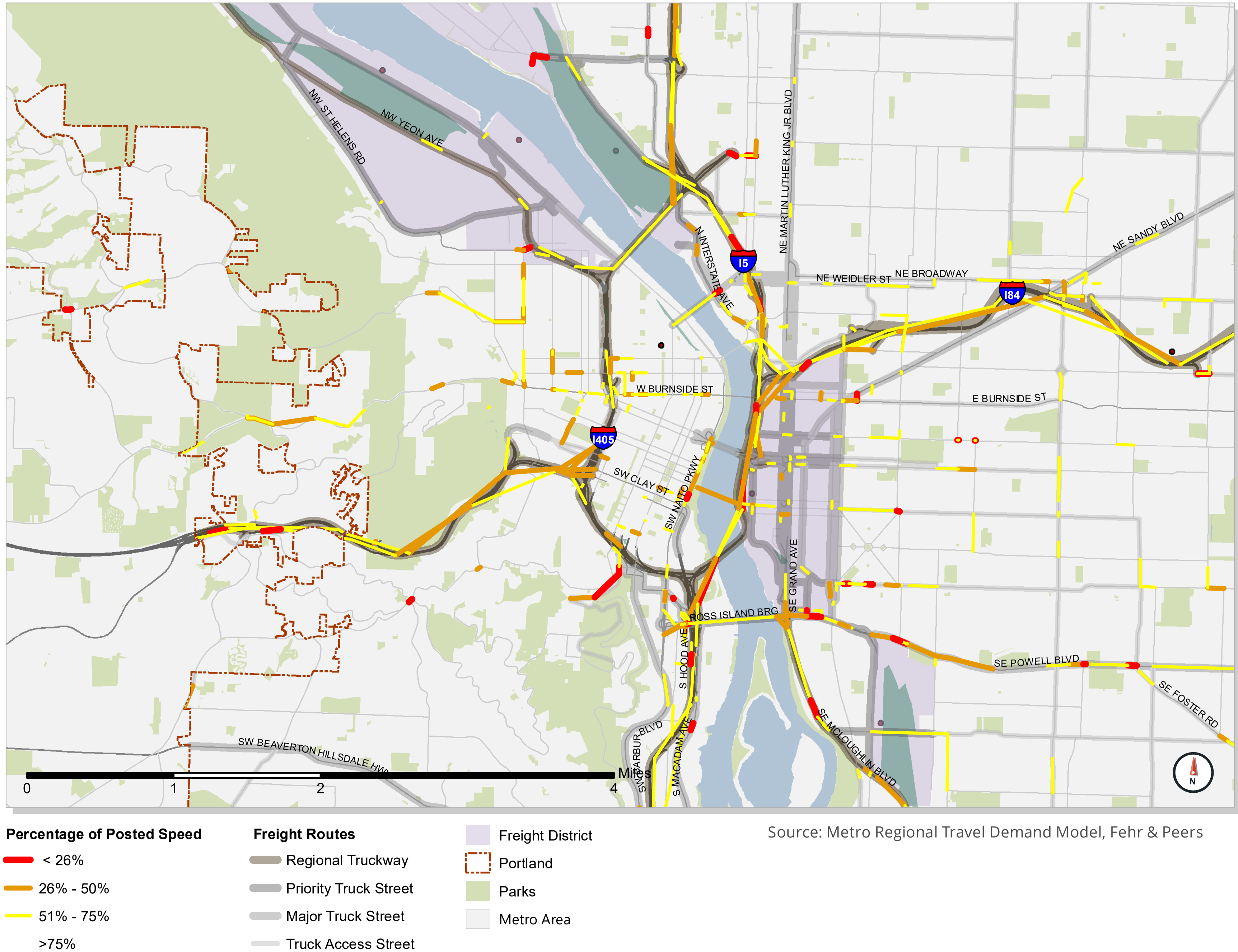
Source: Metro Regional Travel Demand Model, Fehr & Peers

Figure 3-10. Peak Hour Congested Speed Relative to Posted Speed



Source: Metro Regional Travel Demand Model, Fehr & Peers

Figure 3-11. Peak Hour Congested Speed Relative to Posted Speed (Downtown)

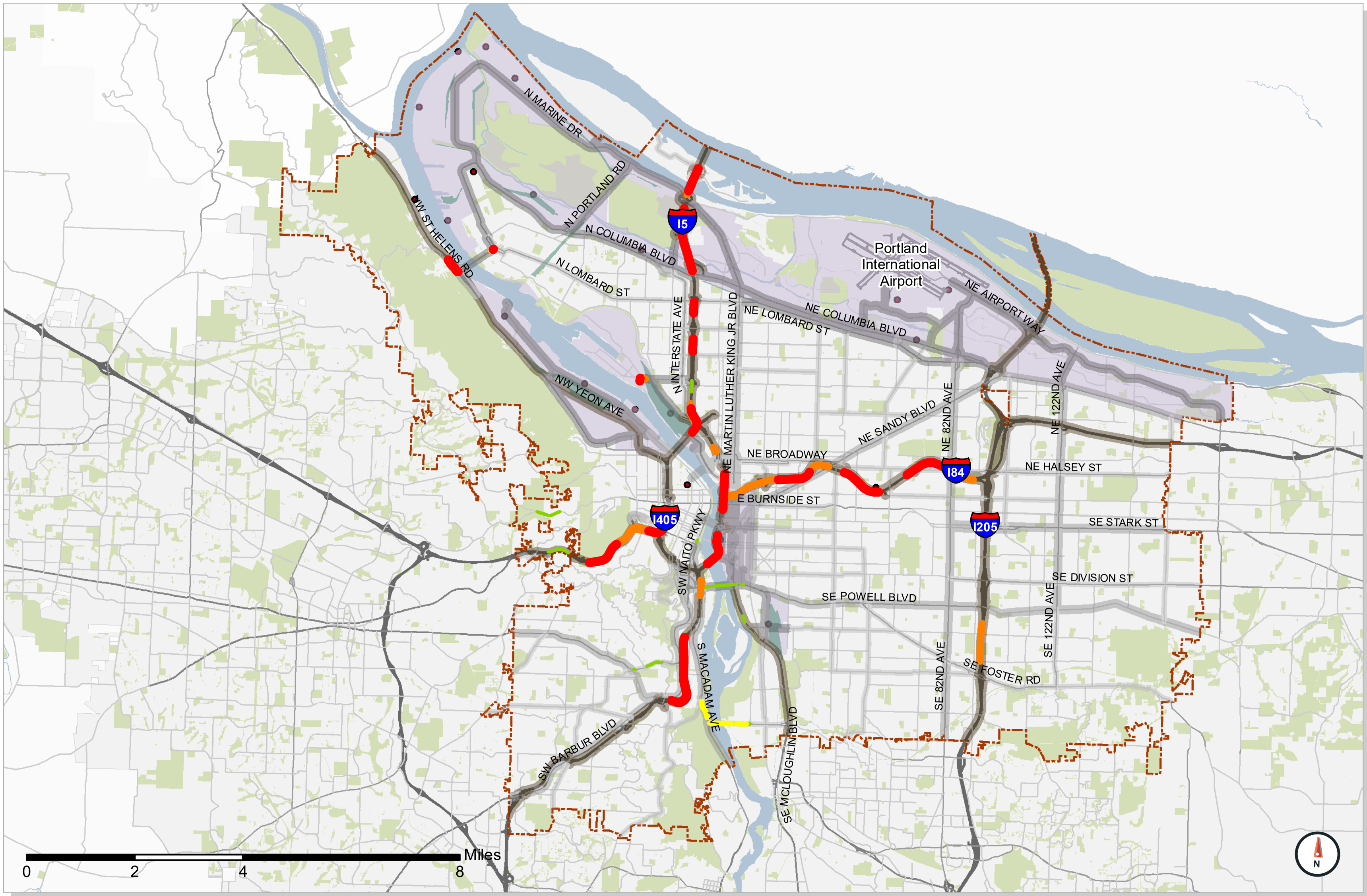


Source: Metro Regional Travel Demand Model, Fehr & Peers

Figure 3-12. Off-Peak Hour Truck Delay

Source: Metro Regional Travel Demand Model, Fehr & Peers

Figure 3-13. Peak Hour Truck Delay



Truck Delay (minutes)
- < 5
- 6 - 10
- 11 - 15
- 16 - 25
- 26 - 71

Freight Routes
- Regional Truckway
- Priority Truck Street
- Major Truck Street
- Truck Access Street

- Freight Facilities
- Freight District
- Portland
- Parks
- Metro Area

Source: Metro Regional Travel Demand Model, Fehr & Peers

Table 5. Volume-to-Capacity Ratio by Facility Type

FACILITY TYPE	OFF-PEAK HOUR (12:00 - 1:00 PM)		PEAK HOUR (5:00 - 6:00 PM)	
	AVERAGE	MAX	AVERAGE	MAX
Freeway	0.68	1.16	0.77	1.42
Arterial	0.45	1.11	0.56	1.56
Collector	0.20	1.36	0.28	1.86

- S Tacoma Avenue
- The east end of the St. John's bridge

In the peak hour streets with total truck delay in excess of 15 minutes include:

- S Tacoma Avenue
- NW St Helens Road (US 30) near the St. John's Bridge
- The St. John's bridge
- S Macadam Avenue

The total truck delay by facility type shown in **Table 4** also point out that trucks experience the most delay in Portland along freeways. These totals capture the delay only when the volume-to-capacity (v/c) ratio is greater than 0.9. The v/c ratio compares the traffic volume along a roadway to its estimated capacity available to accommodate traffic volume and traffic movements, and a v/c of 0.9 approximates a fairly congested condition. **Table 4** shows the worst conditions in the City, the total hours of delay for trucks under less congested conditions is much higher than this.

3.6 Volume-to-Capacity Ratio

The volume-to-capacity (v/c) ratio is a general indicator of congested conditions, including delays and queuing. V/c is a valuable performance measure, particularly for state and regional analysis. The City is exploring other measures and might benefit from a more detailed analysis based on observed travel time data from INRIX, HERE or other similar data sources. The model reports the v/c ratio of each roadway segment for each time period, and a summary of the v/c by facility type is shown in **Table 5** below. Also included in **Table 5** is the minimum and maximum v/c ratios to provide a measure of variability and also insight on the best and worst conditions along the facilities during the analyzed time periods.

About five percent of all roadway miles included in the model network in the City of Portland have v/c ratios greater than 0.95 in the peak hour. Some facilities are congested during both the peak and off-peak hours. The following arterial and local streets have a v/c ratio of 0.95 or higher during peak and/or off-peak periods:

- SE Tacoma Street from the Sellwood Bridge to SE Milwaukie Avenue
- SE Powell Boulevard between SE McLoughlin Boulevard and SE Milwaukie Avenue
- The intersection of N Philadelphia Avenue and N Lombard Street

During just the peak period these additional locations have a v/c ratio of 0.95 or higher:

- NW Germantown Road*
- W Burnside Road west of SW 48th Drive

Figure 3-14. Off-Peak Hour Volume to Capacity Ratio

Source: Metro Regional Travel Demand Model, Fehr & Peers

Figure 3-15. Peak Hour Volume to Capacity Ratio

Source: Metro Regional Travel Demand Model, Fehr & Peers

Table 6. Truck VMT Percent Distribution by Facility Type

FACILITY TYPE	PERCENTAGE OF TOTAL LANE MILES IN THE MODEL	OFF-PEAK HOUR (MD)	PEAK HOUR (PM)	DAILY
Freeway/Highways	13%	73%	65%	72%
Arterial	7%	9%	12%	9%
Collector & Local	77%	6%	21%	17%
Ramps	3%	2%	2%	2%

Source: Metro Regional Travel Demand Model, Fehr & Peers

- SW Capitol Highway east of Beaverton-Hillsdale Highway
- SW Taylor's Ferry Road from SW 48th Avenue to I-5*
- SW Multnomah Boulevard from SW 31st Avenue to I-5*
- SW Macadam Avenue north of the Sellwood Bridge*
- Ross Island Bridge
- SE Powell Boulevard 17th Avenue and SE 33rd Avenue*
- SE Bybee Road at SE Mcloughlin Boulevard*
- The Sellwood Bridge *

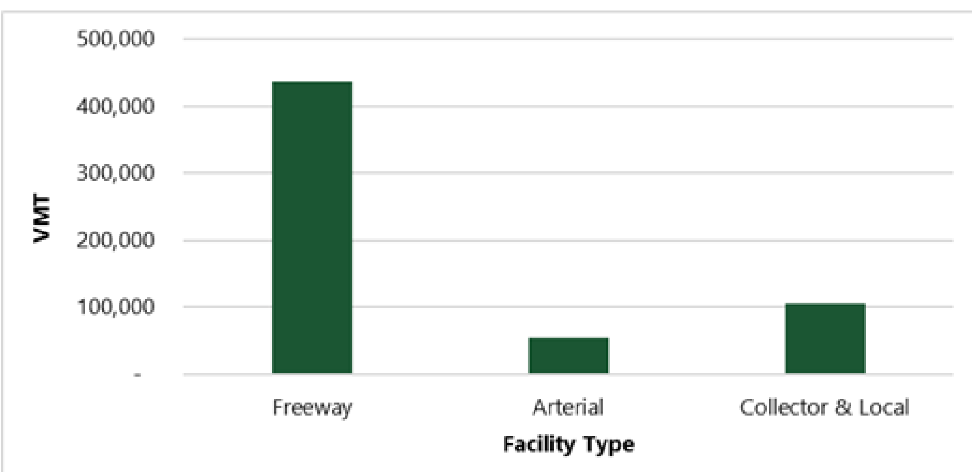
The locations listed above without an asterisk have more than 20 trucks during the time period identified (peak or off-peak hours). All locations except for SE Bybee Road and NW Germantown Road have at least 100 daily truck trips.

3.7 Vehicle Miles of Travel

Based on the model, a total of 45,087 off-peak, 23,296 peak, and 609,655 daily truck vehicle miles of travel (VMT) were calculated for all roadway facilities within the City of Portland. The average trip length for trucks is 26.6 miles[15]. This includes City streets, state highways and interstate routes. Truck

15 This is a system wide number and tracked as part of Metro's RTP performance measures and includes Clackamas, Multnomah, Washington and Clark counties.

Figure 3-16: Daily Truck VMT Distribution by Facility Type



Source: Metro Regional Travel Demand Model, Fehr & Peers

Table 7. Peak Hour Truck VMT Distribution by Speed Bin

SPEED BIN (MPH)	VMT	%
< 15	610	3%
15 - 25	2,669	11%
25 - 35	5,503	24%
35 - 45	9,218	40%
45 - 55	4,965	21%
> 55	332	1%

Source: Metro Regional Travel Demand Model, Fehr & Peers

VMT during the off-peak hour is almost twice that of the peak hour. This may be because there is less congestion on roadways during the off-peak hour period and trucks can travel farther distances. In addition, trucks try to travel earlier in the day and avoid evening peak, where possible. **Table 6** and **Figure 3-16** below show truck VMT distribution by facility type.

Significantly more truck vehicle miles of travel are shown along freeways than other facility types even though freeways only form approximately 13% of the total roadway miles in the model. This is attributed to the design of freeways being more accommodating to truck travel than other facility types, as well as facilitating external-external (through) travel. Arterial roadways make up only 7% of total roadways in the model and carry 9% to 12% of the truck VMT. Collector and local roads make up the largest percentage of roadway miles but are generally less utilized by trucks and are often not on the citywide freight network.

Table 7 shows VMT distribution across various speed bins based on the PM peak hour speeds obtained from the model data. A very small percentage of truck travel is accounted for on facilities where speed exceeds 55mph as shown in **Table 7**. This reflects the prevalence of congestion during the PM peak hour, particularly along freeways.

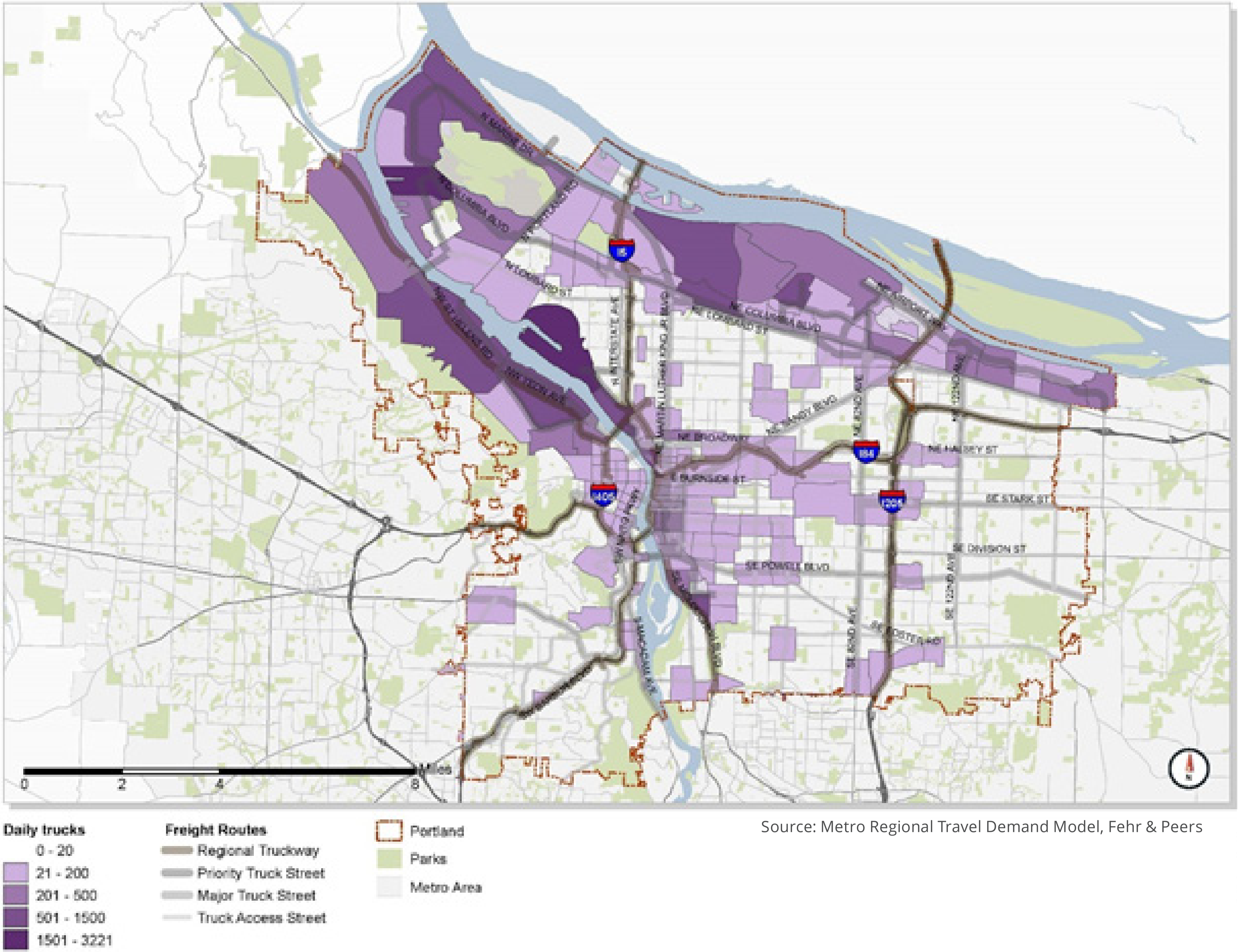
3.8 Truck Origin and Destinations

The daily total truck trip generation by area from the model can be seen in **Figure 3-17**[16]. 27 percent of the trips start and end within the City Boundary, while the other 73 percent of trips either start or end outside of the City boundary. Truck trip generation is concentrated in the freight districts along the Columbia and Willamette rivers, as well as the inner eastside between I-84 and SE Powell Boulevard.

Most of these destinations are served by one or more freight routes. However, the Downtown core has a high number of truck trips despite primarily being connected by local truck access streets (**Figure 3-2**). The neighborhoods south of I-84 and just west of NE 82nd Avenue also have a large number of truck trips, but truck routes do not directly connect these neighborhoods as seen in **Figure 3-17**. This area around the Mt. Tabor and Montavilla neighborhoods also showed high truck counts of 260-400 daily trucks on E Burnside Street and 200-600 daily trucks on SE Stark Street east of SE 82nd Avenue and may

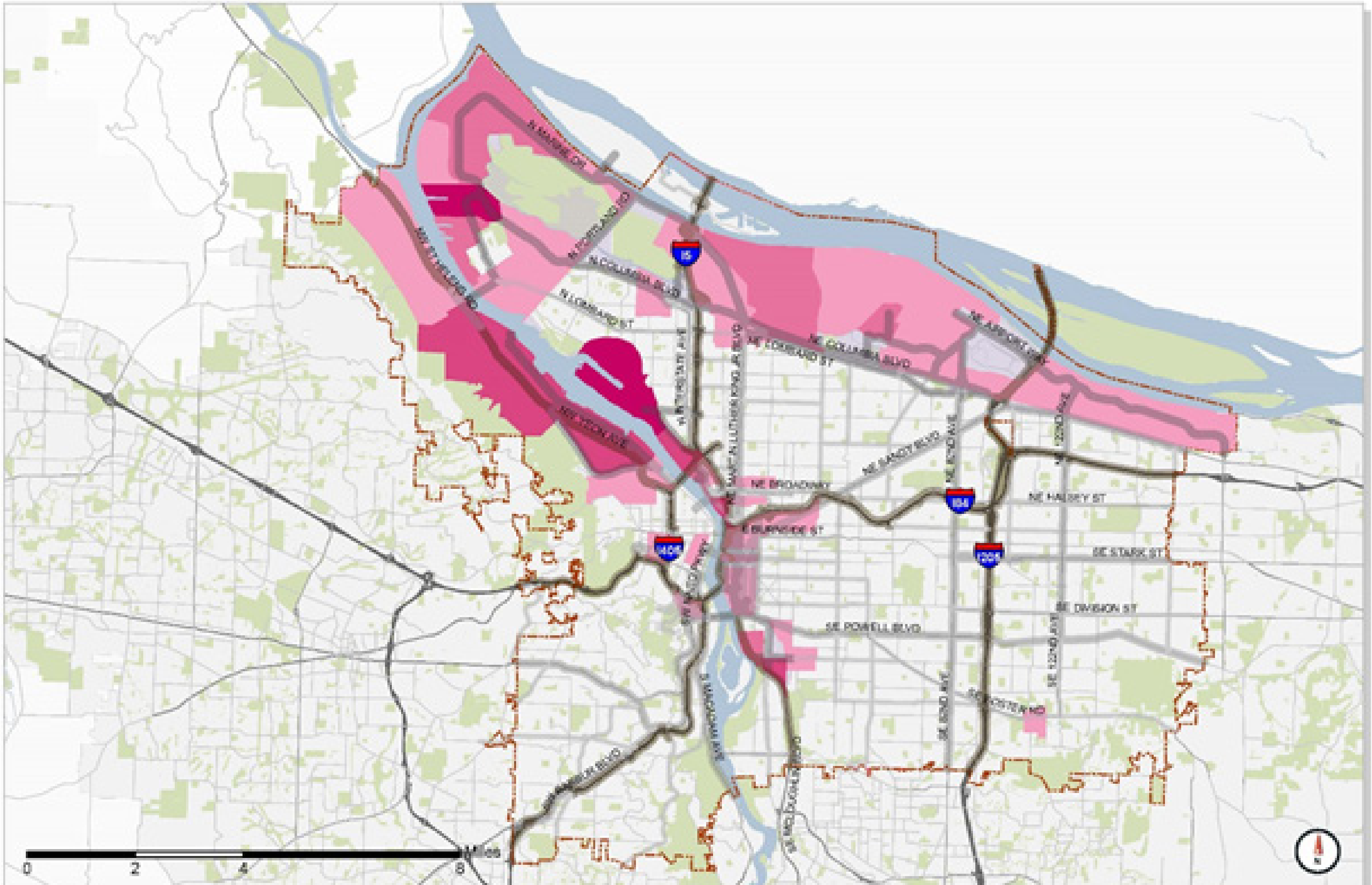
16 Trips originated or destined at each traffic analysis zone or TAZ.

Figure 3-17. Daily Truck Trip Origins/Destinations



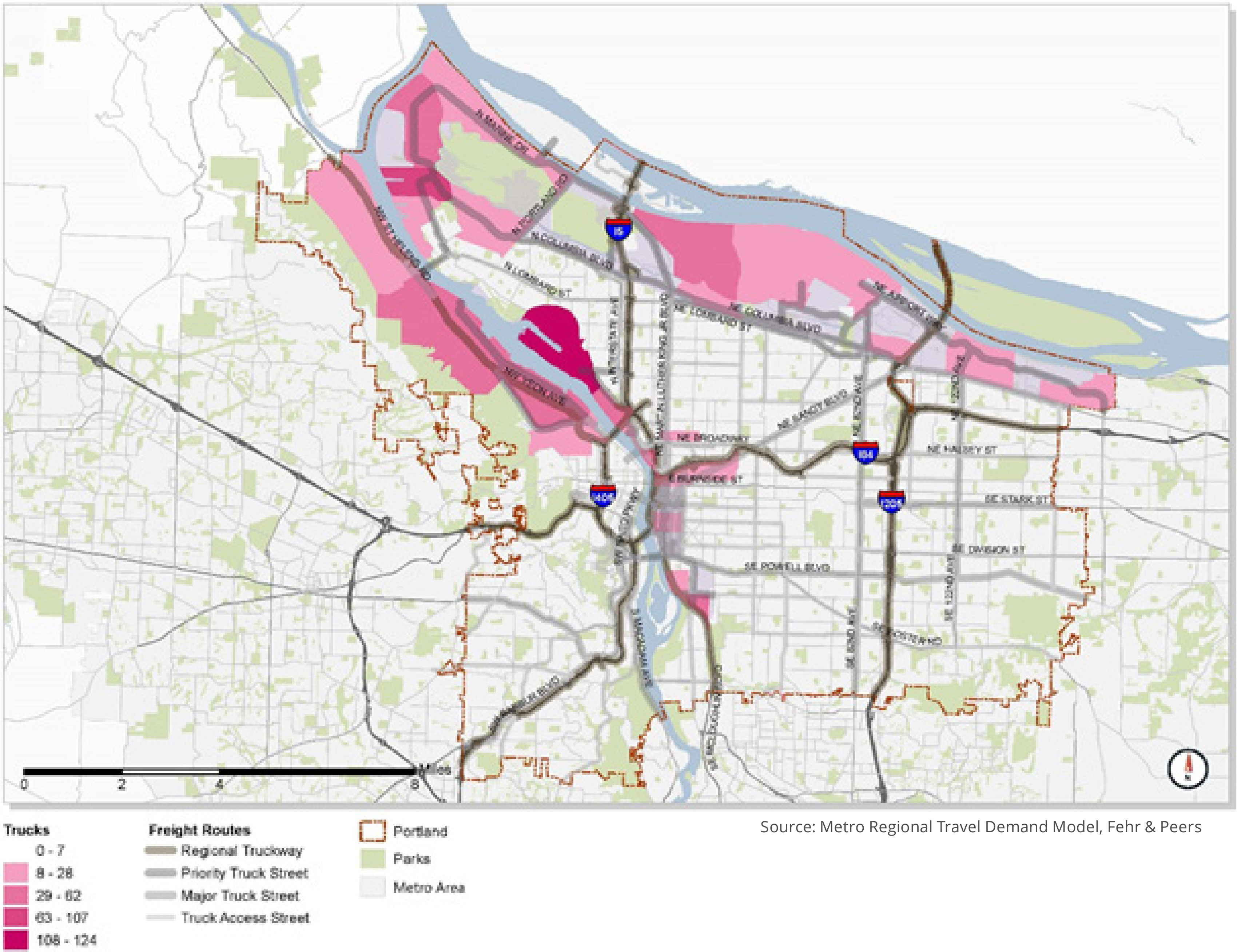
Source: Metro Regional Travel Demand Model, Fehr & Peers

Figure 3-18. Off-Peak Hour Truck Trip Origins/Destinations



Source: Metro Regional Travel Demand Model, Fehr & Peers

Figure 3-19. Peak Hour Truck Trip Origins/Destinations



Source: Metro Regional Travel Demand Model, Fehr & Peers

need to be reassessed to create new truck routes to serve these neighborhoods.

During the off-peak hour, trucks are concentrated in the North Portland Industrial Areas, Swan Island Industrial Park, the Union Pacific Railroad's Brooklyn Yard between SE McLoughlin Boulevard and SE Holgate Boulevard, and Albina Yard west of Greeley Avenue between N Going Street and the Fremont Bridge (**Figure 3-18**). Additionally, a large number of truck trips to the Downtown core and just north of the I-5/I-84 interchange near the Rose Quarter can be seen. All these locations have freight route access except for the Downtown area.

Truck trips are lower during the peak hour compared to off-peak hour for both heavy and medium trucks. The trip patterns are similar to the off-peak trips as can be seen in **Figure 3-19** and the highest trip locations are served by freight routes.

Within Portland, trips between the freight district along Willamette Boulevard around Swan Island, the North Portland Industrial Areas, the Union Pacific Brooklyn Rail Yard, and the area around the Rose Quarter represent the highest number of truck trips.

3.9 Truck Travel Sheds

The ability for trucks to travel to and from key freight hubs is important to an efficient freight system. The extents of travel within a given travel time were created for three freight activity hubs in Portland: Port of Portland's Terminal 6, the Swan Island Industrial Park, and the Union Pacific Railroad's Brooklyn Rail Yard. As shown in **Figure 3-20 to Figure 3-22**, the extents for off-peak (mid-day) and pm peak hour travel vary, showing how traffic conditions affect travel from these truck traffic generators. The maps were created based on traffic conditions shown in ESRI's world traffic service,

In the Swan Island Industrial Park, the off-peak travel sheds indicate that trucks can travel from the Industrial Park to outside the Portland city limits within 10-15 minutes. During the peak hour, the travel sheds are smaller, with access from Swan Island to Northeast and Northwest Portland and to the City of Vancouver boundary within 15 minutes but greater than 20-minute travel sheds to Southeast and Southwest Portland.

In the off-peak, a truck can travel from Terminal 6 to central Vancouver and to Northeast Portland within 15 minutes. While the extent of the travel shed to the north is about the same as from Swan Island, it is smaller to the south, west, and east than Swan Island as it is found further north in the City and has a more constrained travel network in the area surrounding Terminal 6.

During the peak hour, travel shed from Terminal 6 is much smaller. For trucks traveling away from the terminal, within 15 minutes they can reach across the Columbia River to Downtown Vancouver and most of North Portland, but it can take more than 30 minutes to reach the southern half of the City.

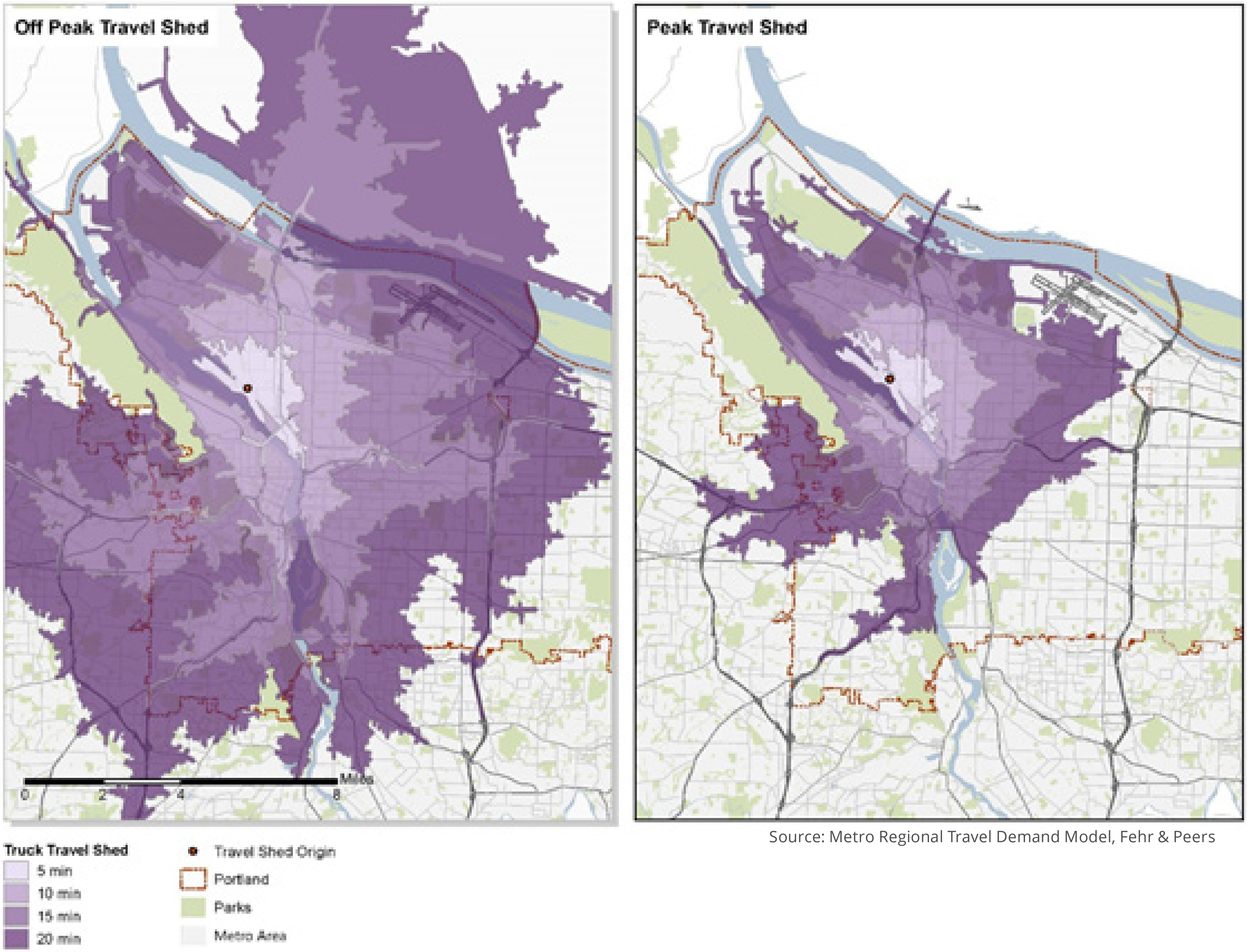
The Union Pacific Brooklyn Rail Yard is more centrally located than the other two locations and the travel sheds can more easily cover all of Portland. During the off-peak most of the City can be reached within 20 minutes. For trucks traveling away from the rail yard in the peak hour, the travel sheds are smaller, and they are not able to travel out of Portland to the north or reach the Port terminals within 30 minutes.

3.10 Last Mile Delivery

Last mile truck deliveries to homes and businesses have been increasing year over year as online shopping has become more popular with consumers. From 2009 to 2019, US e-commerce sales increased an average of 3.6% each quarter, growing from 3.8% of all retail sales to 11.3% of all retail sales[17]. This has necessitated that both retailers and delivery companies adjust their logistics and supply chains to keep up with the demands for same day and two-day shipping, increased returns of online merchandise, and perishable grocery and food deliveries. Many shippers and carriers have added staff and vehicles to their fleets to meet the increasing demands. Others have also moved operations to locations that

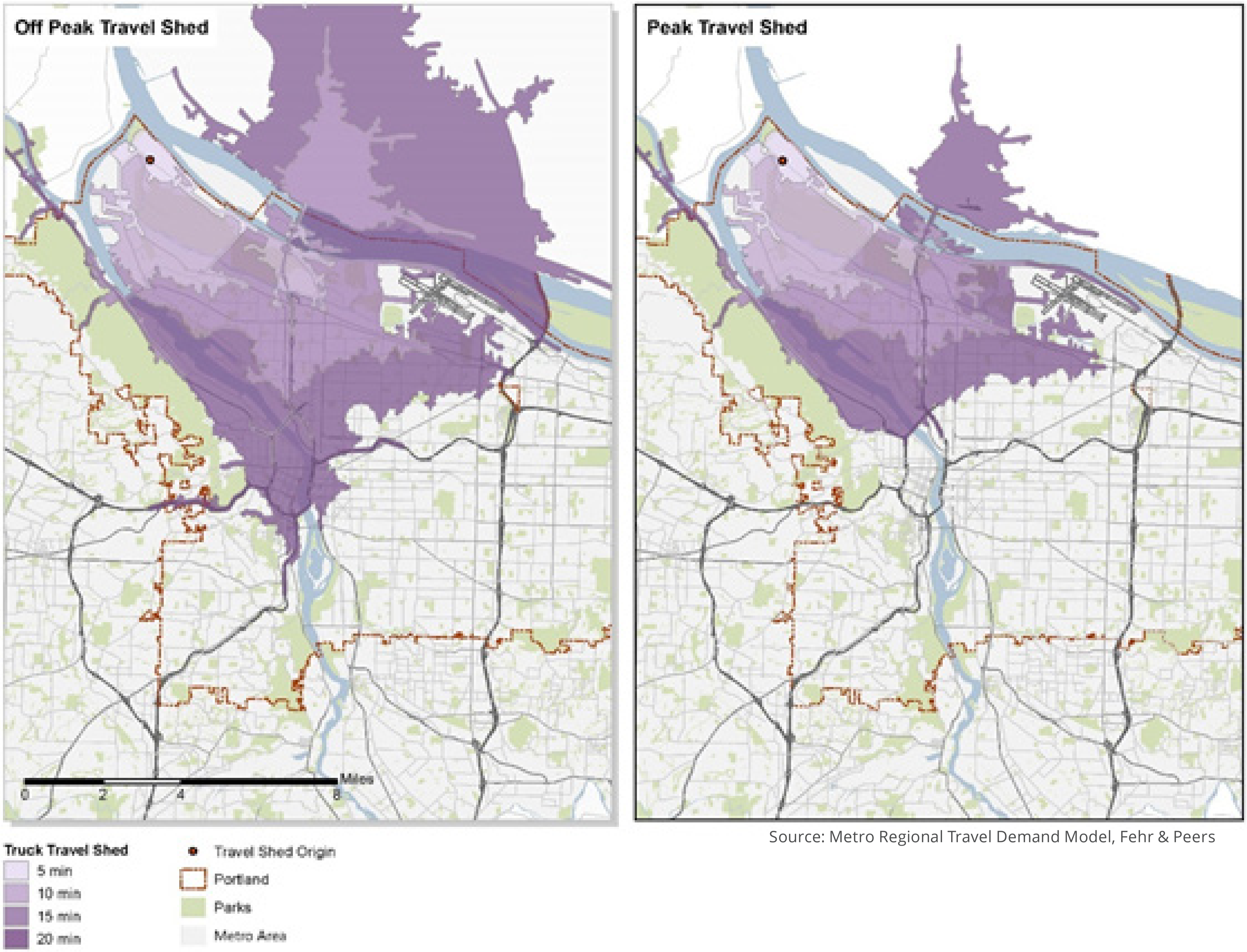
17 U.S. Department of Commerce. Estimated Quarterly U.S. Retail Sales (Adjusted): Total and E-commerce

Figure 3-20. Truck Travel Sheds Swan Island Industrial Park



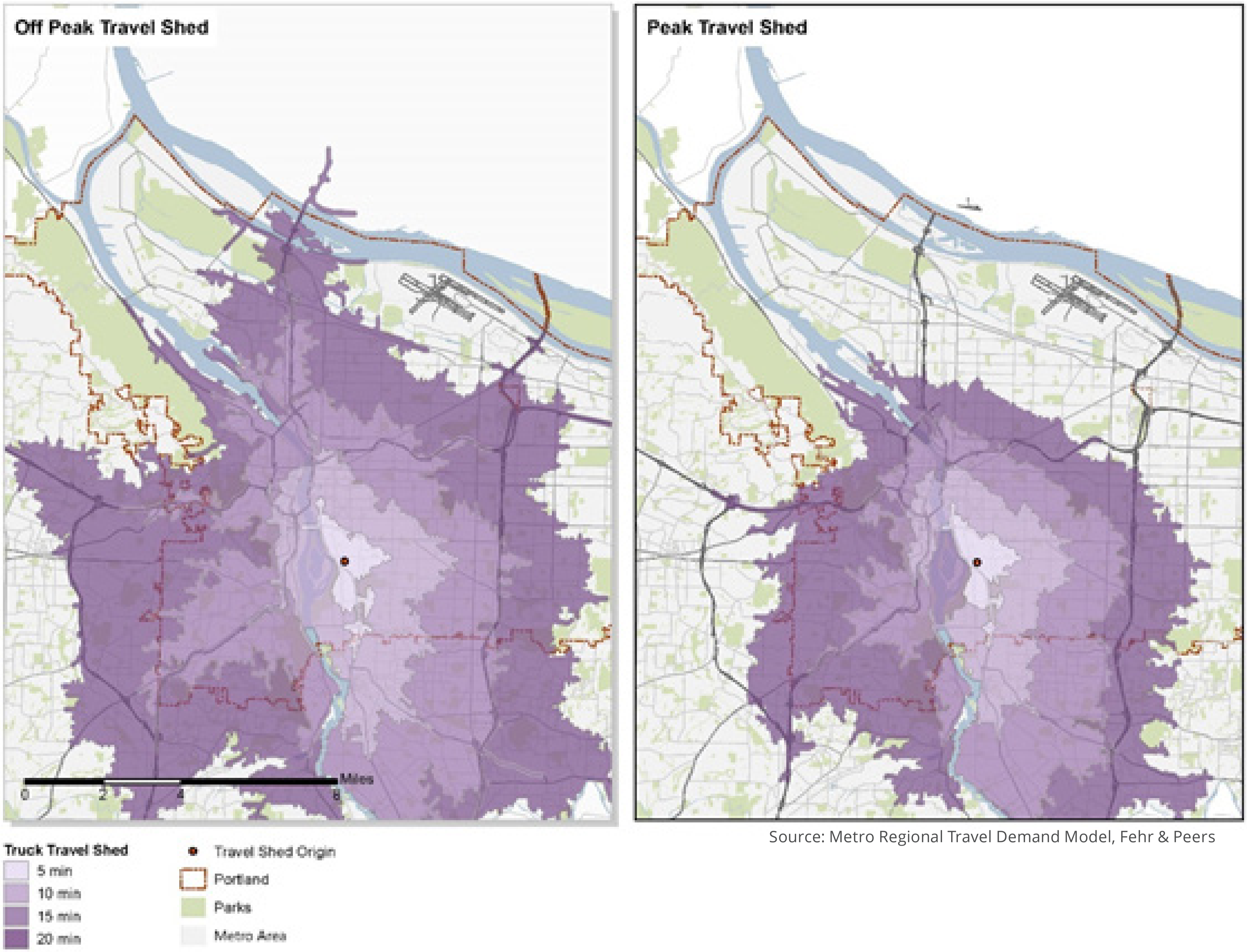
Source: Metro Regional Travel Demand Model, Fehr & Peers

Figure 3-21. Truck Travel Sheds Terminal 6



Source: Metro Regional Travel Demand Model, Fehr & Peers

Figure 3-22. Truck Travel Sheds Union Pacific Rail Yard



Source: Metro Regional Travel Demand Model, Fehr & Peers

are closer to their customers and other consumers to meet same-day and two-day deliver schedules. Finally, many shippers and carriers are completing handoffs from one vehicle to another to consolidate service areas, and a significant number are using passenger cars and bicycles to complete local deliveries.

The growing e-commerce market and demand for faster delivery have also meant that there are many more frequent and short truck trips than in the past, but with the rise in total truck trips, total truck VMT is increasing[18]. This has implications for Portland's transportation network, with the potential for increased congestion on the roads during both peak and off-peak periods, and higher competition for curb space in commercial areas, and in some densely populated residential neighborhoods. It also means that more trucks are circulating through neighborhoods to deliver goods, which may create an issue for residents' quality of life as well as creating potential safety, diesel pollution, and maintenance concerns as truck traffic increases on streets not designated for them.

3.10.1 COVID-19 Impacts on E-commerce and Last Mile Truck Deliveries

Even before the COVID-19 pandemic, on-line shopping had been rapidly increasing in the US and in Oregon over the last few years. With the shutdowns due to COVID, consumers have changed their shopping habits to adjust to stay-at-home orders, closed retail locations, and restaurants with no dine-in options. With these restrictions, e-commerce has become even more important and prevalent.

The US e-commerce sales for the second quarter of 2020 increased 31.8% from the first quarter of 2020, even when overall retails sales had decreased by 3.9%. This period also saw a 52.2% increase compared to the second quarter of 2019[19]. In the Portland Metro region, a recent survey found that the share of respondents that had three or more home deliveries a month increased from 50% before COVID to 74% during COVID[20]. Additionally, the share of respondents that had ten or more deliveries a month increased from 8% to 16% during COVID[21].

This increase in online sales and home deliveries could have many effects on the transportation system. An increase in last mile truck deliveries to neighborhoods could result in increased traffic congestion, diesel pollution, and circulation issues on neighborhood streets. There is mixed data on whether home delivery decreases vehicle trips and greenhouse gas emissions, especially with the demand for quick delivery times that necessitate extra truck trips. American Trucking Research Institute (ATRI) reported, "Growing package delivery volumes and more frequent truck trips along the supply chain serve to boost truck VMT" . While, household travel behavior research shows reduction of number of non-commute trips and overall household VMT reduction . With many businesses

18 Hooper, Alan and Dan Murray. E-Commerce Impacts on the Trucking Industry. American Transportation Research Institute. 2019.

19 U.S. Department of Commerce. Quarterly Retail E-Commerce Sales 2nd Quarter 2020.

20 Avinash Unnikrishnan, Miguel Figliozzi. A Study of the Impact of COVID-19 on Home Delivery Purchases and Expenditures, Working Paper, 2020.

21 Ibid.

Picture 7.1: *A United Postal Service (UPS) employee pulling an empty, gray dolly across a street. A black car is visible in the background. [Source: unknown]*

closed and an increase in work from home, there may be a decrease in business deliveries in the commercial centers. This shift in delivery patterns may also reduce competition for curb space in commercial centers and decrease greenhouse gases from idling vehicles.

While e-commerce sales were growing at significant rates prior to the pandemic, it is important to note that there are few consistent trends that we can rely on because there are so many unprecedented global events that dictate both product availability and customer confidence.

First and foremost is the pandemic forcing people to avoid contact at stores. Second is the contraction of the U.S. economy – which shrank 9.5% in the second quarter of 2020; the worst quarter decline ever – including the Great Depression when the economy shrank by 7.2% in one quarter . Further, the U.S. GDP shrank at an annual rate of 32.9% in the second quarter , and the unemployment rate fluctuated between 11.1% and 14.7% .

In other words, we need to exercise caution when reviewing data and anecdotes about the changes in the retail sector during the pandemic before reaching conclusions about what the future will bring.

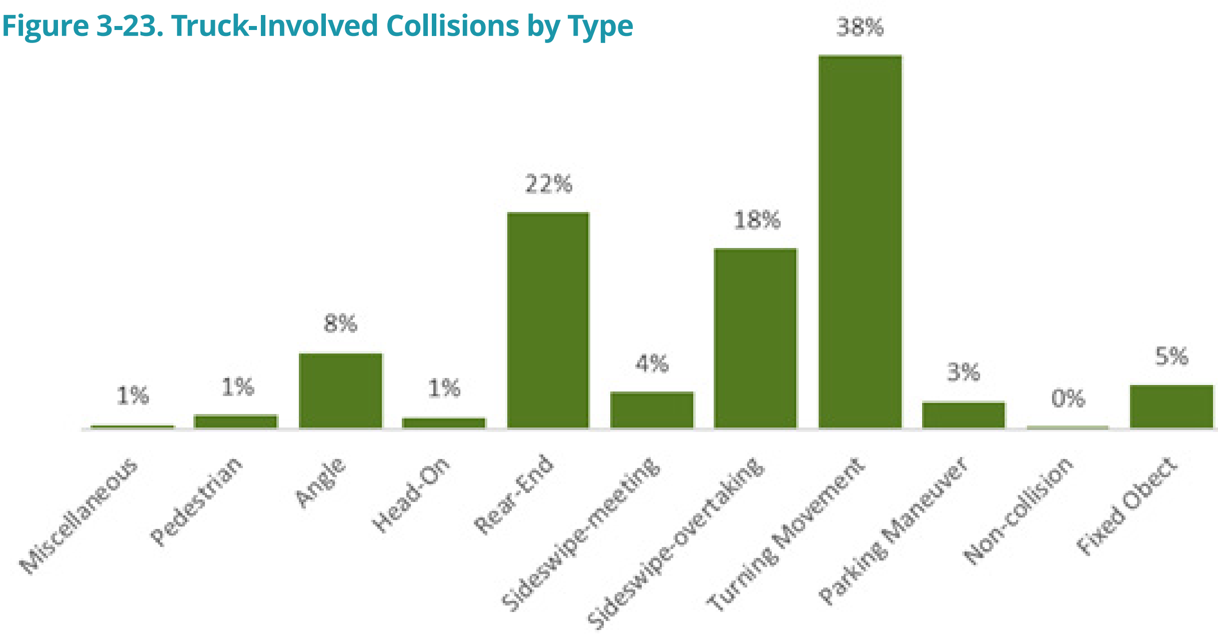
The recent changes in consumer behavior may result in permanent behavioral changes, have no long-term effects, or simply expedite inevitable evolutions. It is unclear whether the growth in on-line retail sales will continue at its current pace or whether customers will return to brick-and-mortar stores in droves.

3.11 Safety

To analyze the current state of truck safety in Portland, five years of collision data were analyzed. Looking at the collision records provides an understanding of the parties involved in the collision, the location where the collision occurred, and important details about the circumstances in which the collision occurred. The details of the truck-involved collisions in the City were examined for patterns that could help explain whether there are issues around roadway characteristics such as geometry and signage, conflicts between trucks and other road users such as pedestrians and bicyclists, or circumstances that could call for programmatic changes to help reduce fatalities and injuries in Portland.

From 2014 to 2018, 56,942 collisions were reported in Portland and of these, 1,361 were fatal or serious injury collisions (referred to as "KSI collisions"). There

Figure 3-23. Truck-Involved Collisions by Type



Source: Oregon Department of Transportation. Crash Data System. (2014-2018) https://tvc.odot.state.or.us/tvc/

Table 8. Collision Summary at Non-Freeway Locations

	ALL COLLISIONS	TRUCK-INVOLVED COLLISIONS
Total	44,280	1,165
Percent KSI	2.6%	3.9%
Percent involving a Bicyclist or Pedestrian	6.2%	3.5%
Turning Movement related	26%	38%
Rear-end related	34%	22%
Sideswipe-overtaking related	9%	18%
Intersection related	67%	62%
Failed to yield ROW	29%	20%
Located on a Principal or Minor Arterial	51%	63%

Source: Oregon Department of Transportation. Crash Data System. (2014-2018) https://tvc.odot.state.or.us/tvc/

were 2,267 truck involved collisions (4% of total collisions) and 3.3% of those were KSI collisions. On City of Portland streets there were 1,165 truck collisions. During this period the City's daily VMT/capita has decreased by 1% from 18.84 to 18.55, while the population has increased by about 5% from 620,647 to 653,115[22]. The population multiplied by the VMT/capita provides the total daily VMT in the City for each year from 2014-2018. Using this information, between 2014-2018 the average annual KSI collision on City streets per 100 million VMT is 5.23 and the average truck involved KSI collision on City streets is 0.21[23]. The average annual total collisions per 100 million VMT on City streets is 202.3 and average annual total truck collisions per 100 million VMT on City streets is 5.3.

As shown in **Figure 3-23**, most truck collisions were a result of drivers who did not yield right-of-way (20% of collisions), followed by improper turns (17% of collisions). The most common collision type for truck collisions in the City of Portland is turning movement (38%), followed by rear-end (22%) and sideswipe-overtaking (18%)[24].

Intersection collisions accounted for 62% of freight collisions. Of those, 59% were at a four-legged 'cross' type intersection, and 33% occurred at a three-legged intersection.

Table 8 compares some key characteristics of all collisions on non-freeways to the truck-involved collisions on non-freeways. As shown, truck-involved collisions are more likely to be KSI, turning movement related and involved sideswipe-overtaking and be located on a principal or minor arterial compared to all collisions. On the other hand, truck-involved collisions are less likely to involve a bicyclist or pedestrian, be rear-end related, take place at intersections or fail to yield ROW than all collisions combined.

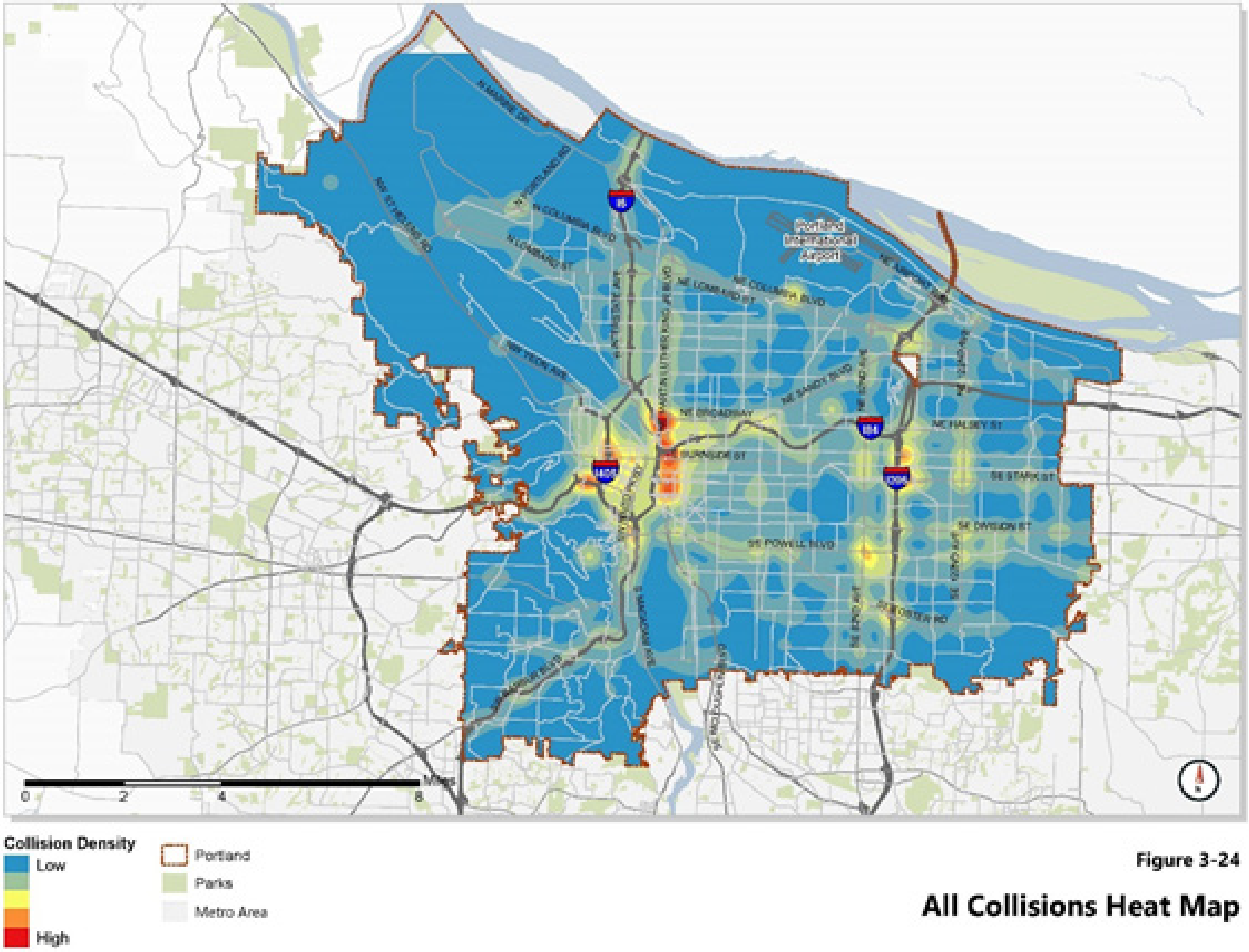
As much as 60% of truck collisions occurred on designated truck streets in the City of Portland (**Figure 3-2**6), and 48% of truck collisions occurred on Portland's designated High Crash Network (**Figure 3-27**).

22 https://www.oregonmetro.gov/transportation-system-monitoring-daily-vehicle-miles-travel

23 These statistics are roughly calculated based on available VMT information.

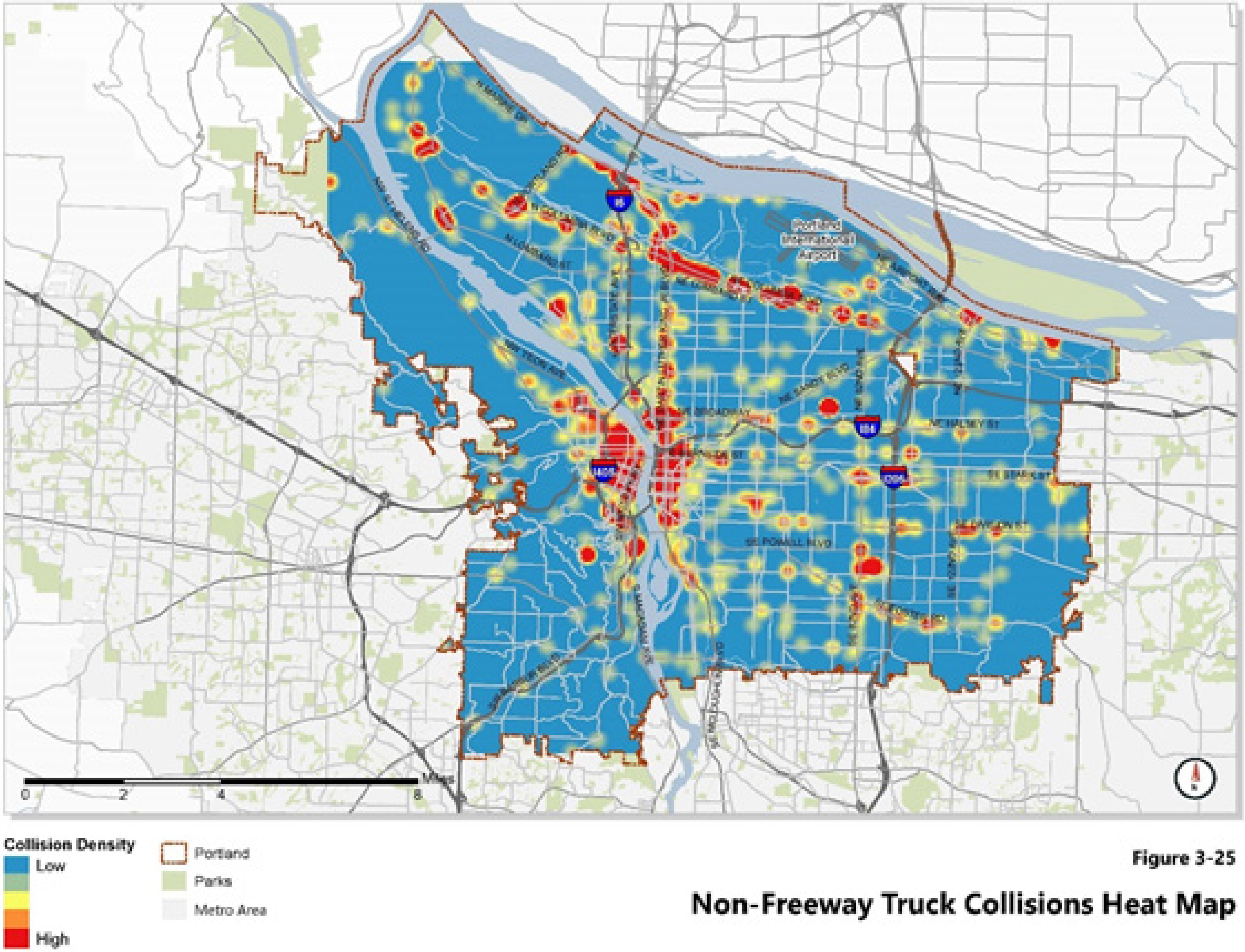
24 Sideswipe overtaking collision results when vehicles traveling in the same direction on parallel paths collide. The side of at least one of the vehicles must be involved.

Figure 3-24. All Collisions Heat Map



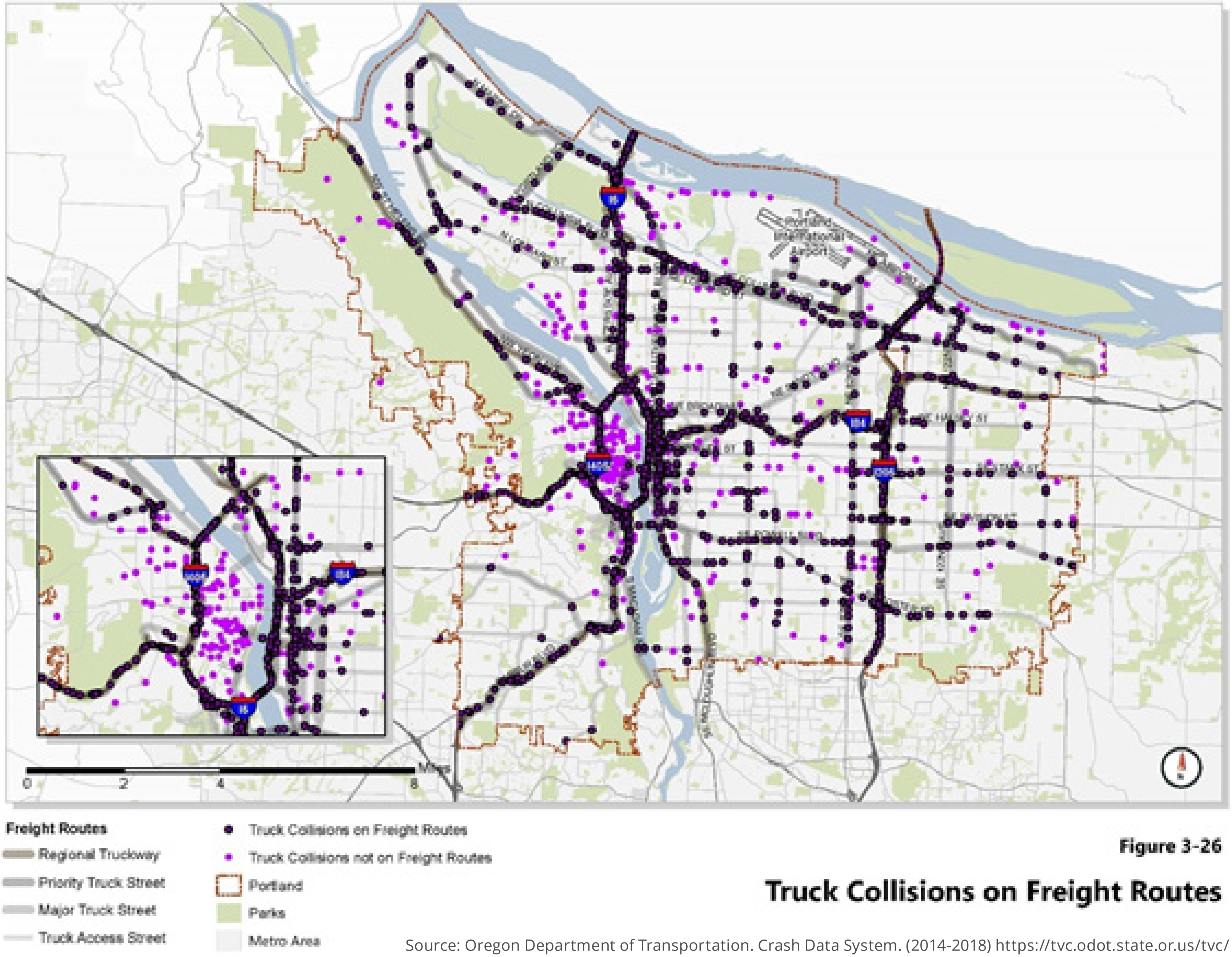
Source: Oregon Department of Transportation. Crash Data System. (2014-2018) https://tvc.odot.state.or.us/tvc/

Figure 3-25. Non-Freeway Collisions Heat Map



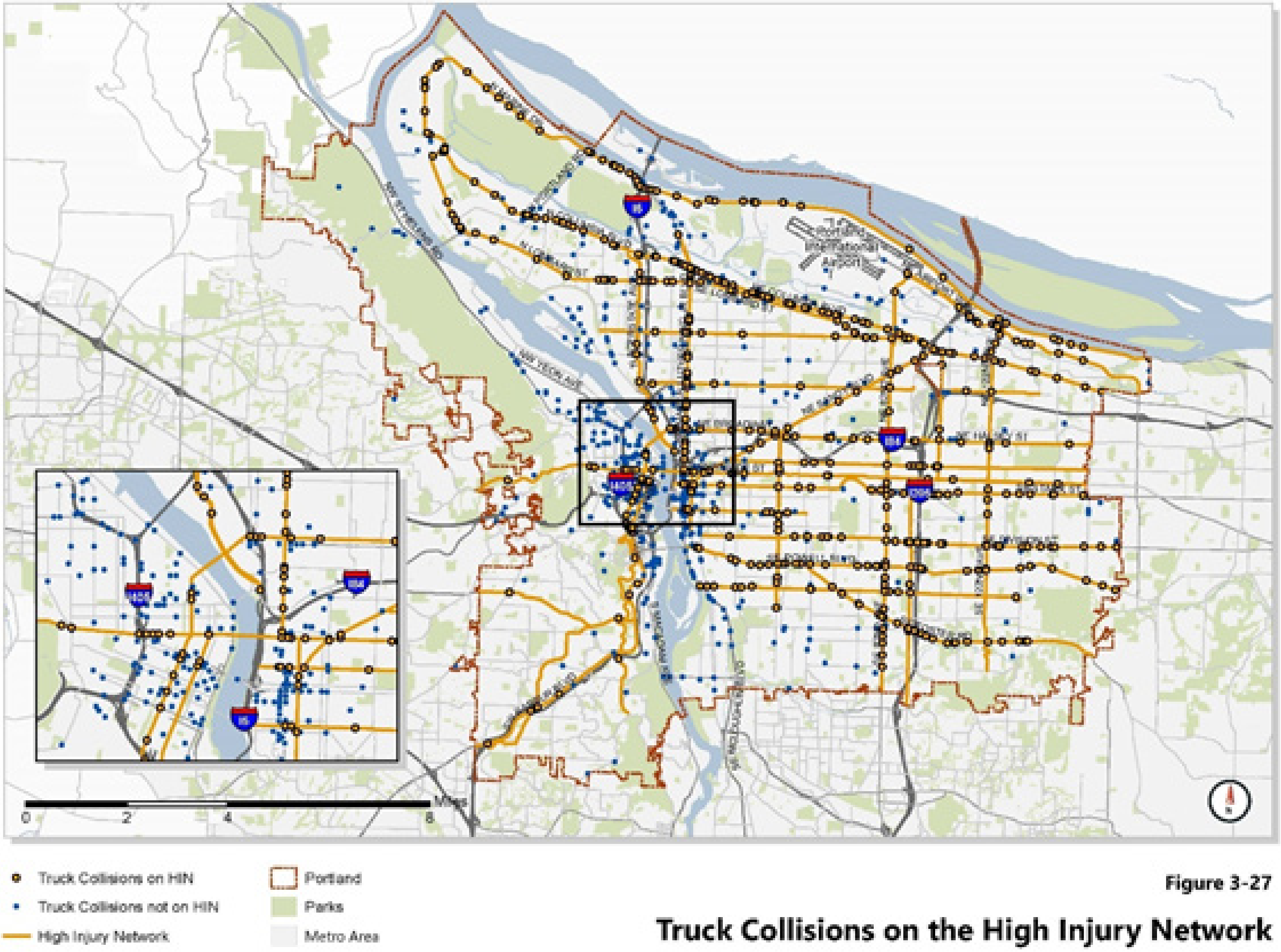
Source: Oregon Department of Transportation. Crash Data System. (2014-2018) https://tvc.odot.state.or.us/tvc/

Figure 3-26. Truck Collisions on Freight Routes



Source: Oregon Department of Transportation. Crash Data System. (2014-2018) https://tvc.odot.state.or.us/tvc/

Figure 3-27. Truck Collisions on the High Crash Network



Source: Oregon Department of Transportation. Crash Data System. (2014-2018) https://tvc.odot.state.or.us/tvc/

3.11.1 Truck Safety Hot Spots

A density map of all the truck collisions on City streets reveals the areas with the highest concentration of truck collisions. From this map, three corridors and six areas were identified for a detailed analysis:

- Downtown core
- Central Eastside Industrial District
- NE Broadway near the I-5 on/off ramps
- Martin Luther King Jr Boulevard
- Columbia Boulevard
- 82nd Avenue

3.11.1.1 Downtown Core

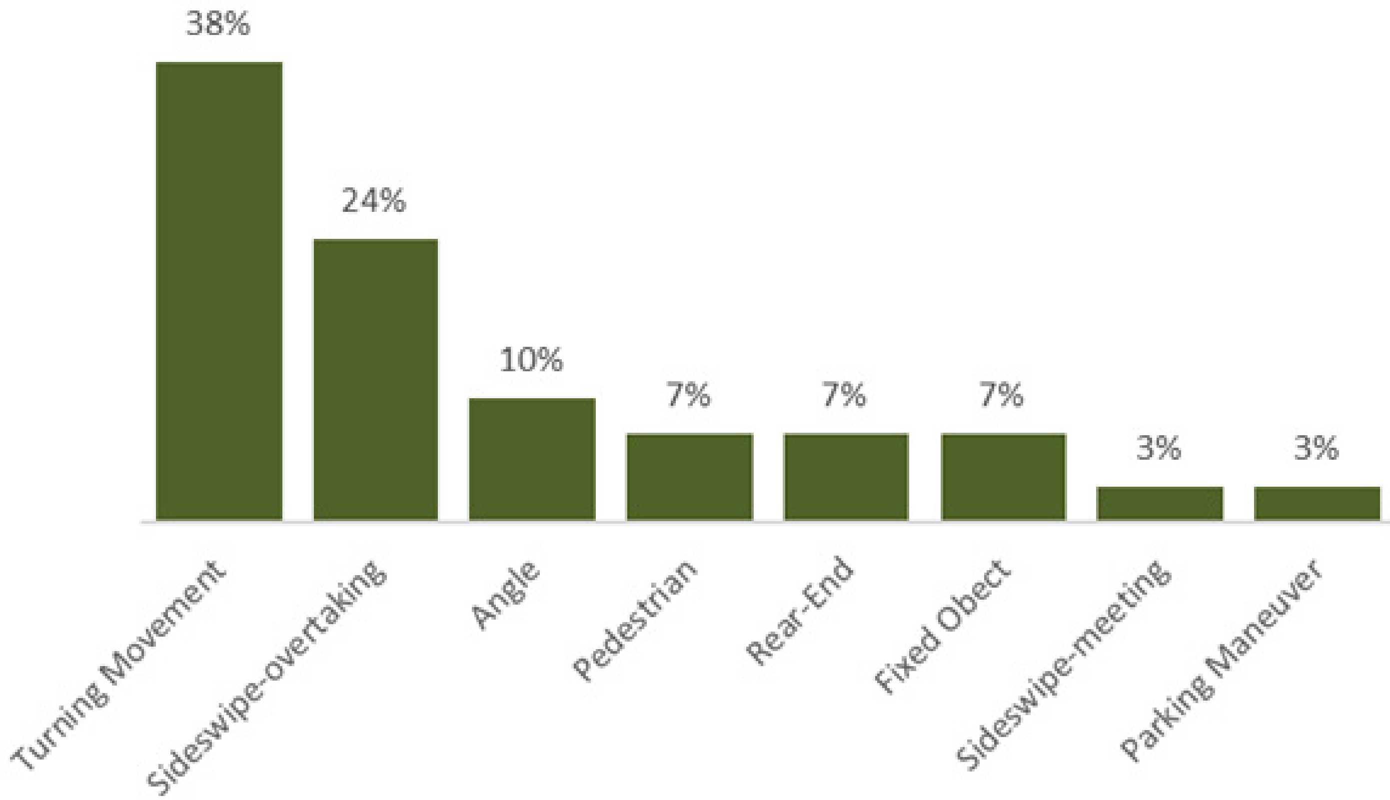
Downtown Portland on the west side of the Willamette River is the commercial core of the city. Characterized by narrow streets, a one-way street grid, and high transit activity (LRT, buses, shuttles, etc.), the Downtown Core does not have any designated freight corridors.

85% of collisions Downtown are intersection related, with most at 4-legged intersections. The most frequent truck collision types in Downtown are turning movement (38%) or sideswipe-overtaking related (24%). 8% of the freight collisions Downtown involved a pedestrian or a person on a bicycle, one of which was a KSI (**Figure 3-28**).

Freight related collisions in Downtown are mostly concentrated along SW Washington Street, SW Alder Street, Burnside Street, and SW Salmon Street because these streets provide key connections to Willamette River Bridges and carry higher truck traffic (**Figure 3-29**). Just north of Downtown, there are a high number of collisions along NW Broadway adjacent to the United States Postal Service facility, and NW Glisan Street proximate to I-405 Freeway ramps.

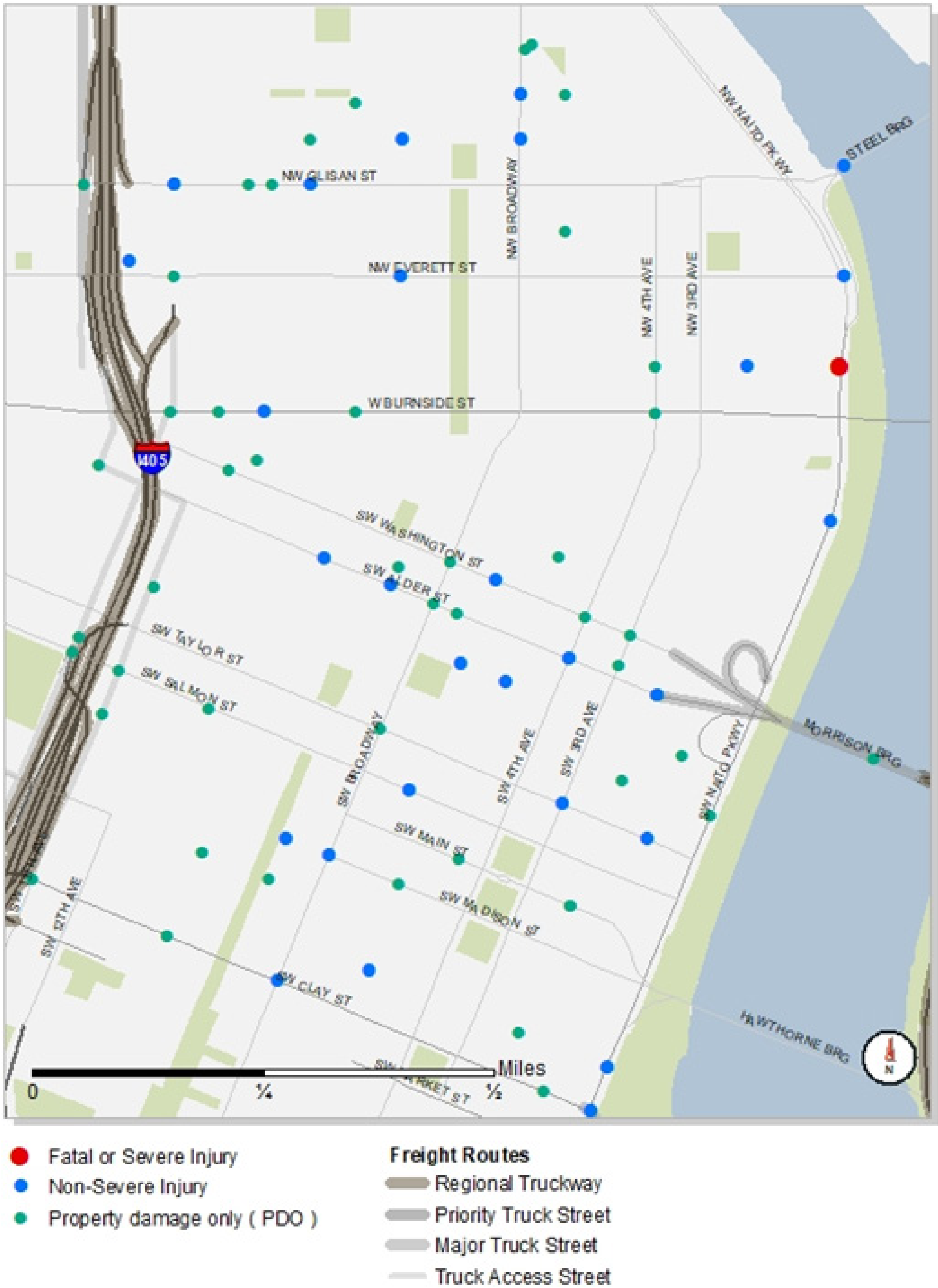
Picture 8.1: *White and red cars driving on a busy freeway bridge. Buildings in the downtown Portland, Oregon area are visbile in the background. [Source: ODOT]*

Figure 3-28. Truck-Involved Collision Type - Downtown Collisions



Source:Oregon Department of Transportation. Crash Data System. (2014-2018) https://tvc.odot.state.or.us/tvc/

Figure 3-29. Truck Collisions at Downtown Core



Source:Oregon Department of Transportation. Crash Data System. (2014-2018) https://tvc.odot.state.or.us/tvc/

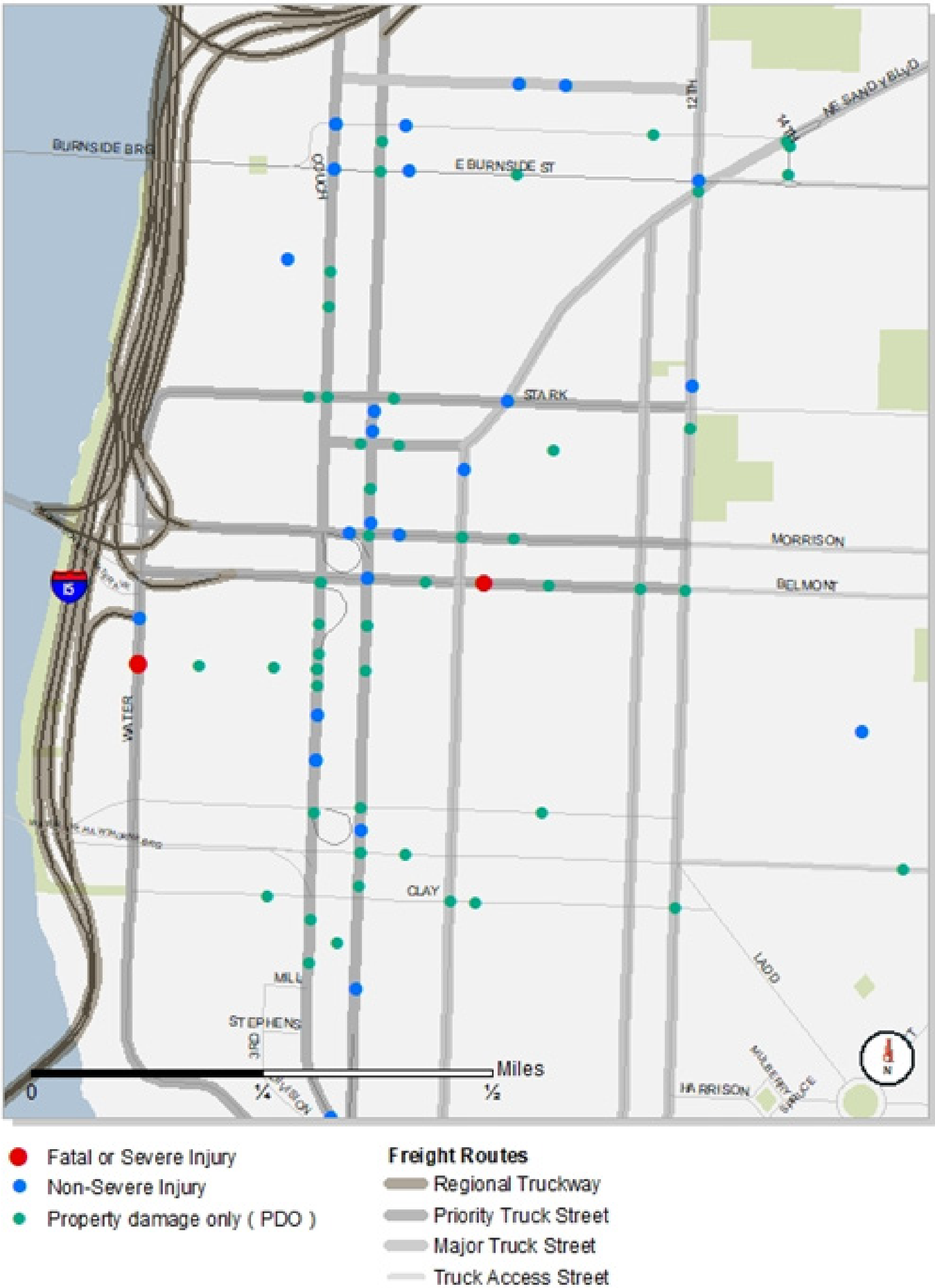
Picture 9.1: *White freight trailers sitting at a loading dock, where goods are unloaded and loaded for transport. [Source: Chris Yunker]*

3.11.1.2 Central Eastside Industrial District

The central eastside industrial district is a mix of industrial and commercial zoning located between the Burnside and Ross Island bridges, from the Willamette River to SE 12th Street. It is predominantly made up of truck routes and has a high volume of truck traffic.

This area of the City has the highest density of collisions involving trucks, though most are not KSI collisions. The one-way, narrow street grid coupled with tight turn-radii, sight-distance issues and high volume of passenger vehicle/bicycle/pedestrian activity already present circulation and safety challenges. These characteristics combined with a high volume of truck activity serving a very active industrial area, likely contribute to multiple collisions along SE Martin Luther King Jr. Boulevard, SE Grand Avenue, SE Belmont Street, and SE Morrison Street.

Figure 3-30. Truck Collisions in Central Eastside Industrial District



Source:Oregon Department of Transportation. Crash Data System. (2014-2018) https://tvc.odot.state.or.us/tvc/

3.11.1.3 NE Broadway near the I-5 on/off ramps

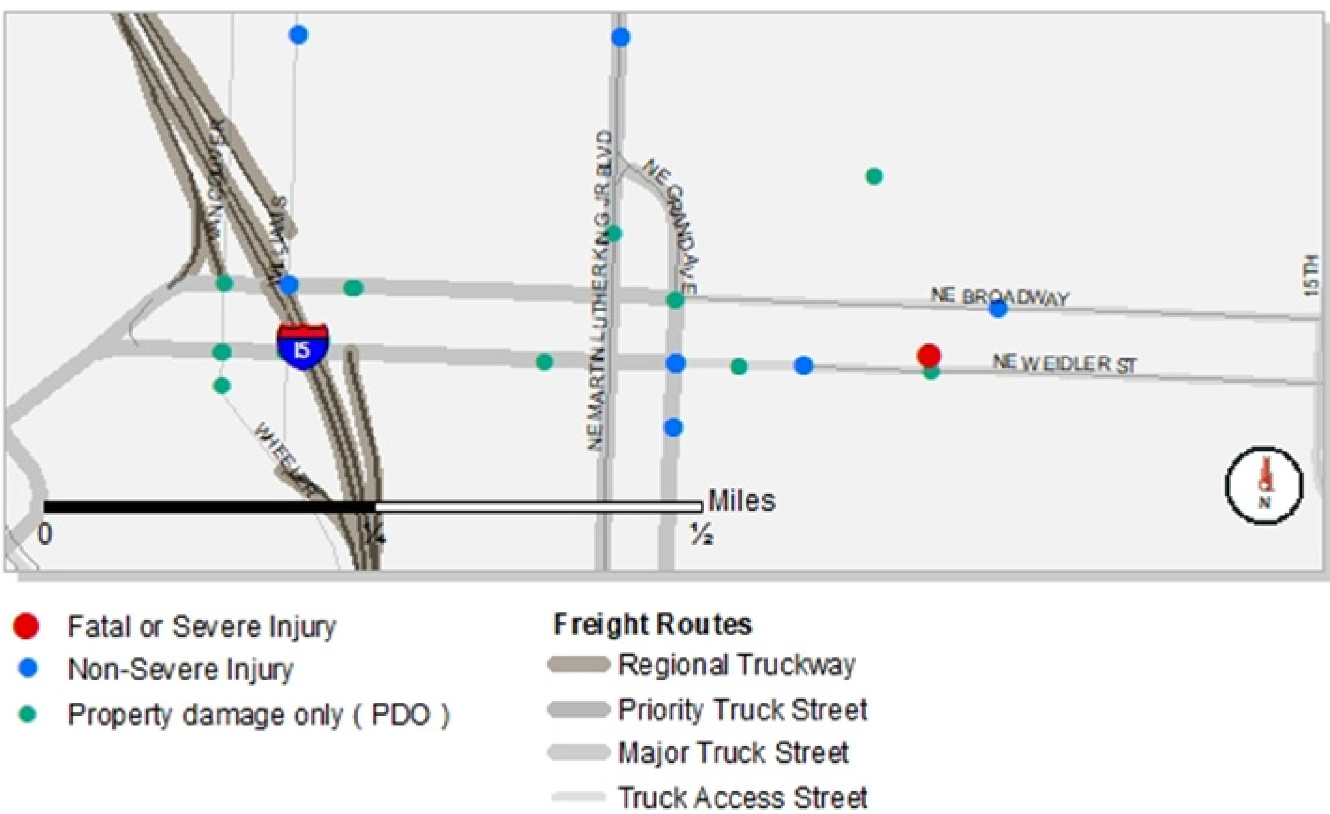
The north Lloyd District, especially the couplet of NE Broadway and NE Weidler Street, have a high concentration of collisions involving trucks (**Figure 3-31**). In addition to their connection with I-5, NE Broadway and NE Weidler Street are highly traversed routes for traffic travelling east and west between Downtown and dense mixed-use Lloyd District. The Moda Center, Oregon Convention Center, and Veteran's Memorial Coliseum are located just to the southwest of the I-5 interchange and this area has a high number of truck trips.

The intersection of N Weidler Street and N Vancouver Avenue had eight truck involved collisions from 2014 to 2017, and NE Weidler and N Williams Avenue had five truck involved collisions from 2014 to 2018. There was one severe injury collision on NE 9th Avenue north of NE Weidler Street that involved a bicyclist.

Truck collision types in this area are overwhelmingly turning movement related (67%), and all but one are intersection related. Most collisions here happened during the off-peak hours between 9:00 AM and 12:00 PM.

The most frequent truck collision types at the east end of Morrison Bridge are turning movement (32%) or sideswipe-overtaking related (32%). Making an improper turn (32%) and improper change of traffic lane (27%) are the most common causes of freight collisions.

Figure 3-31. Truck-Involved Collisions at NE Broadway near I-5 on/offramps



Source:Oregon Department of Transportation. Crash Data System. (2014-2018) https://tvc.odot.state.or.us/tvc/

3.11.1.4 Martin Luther King Jr Boulevard

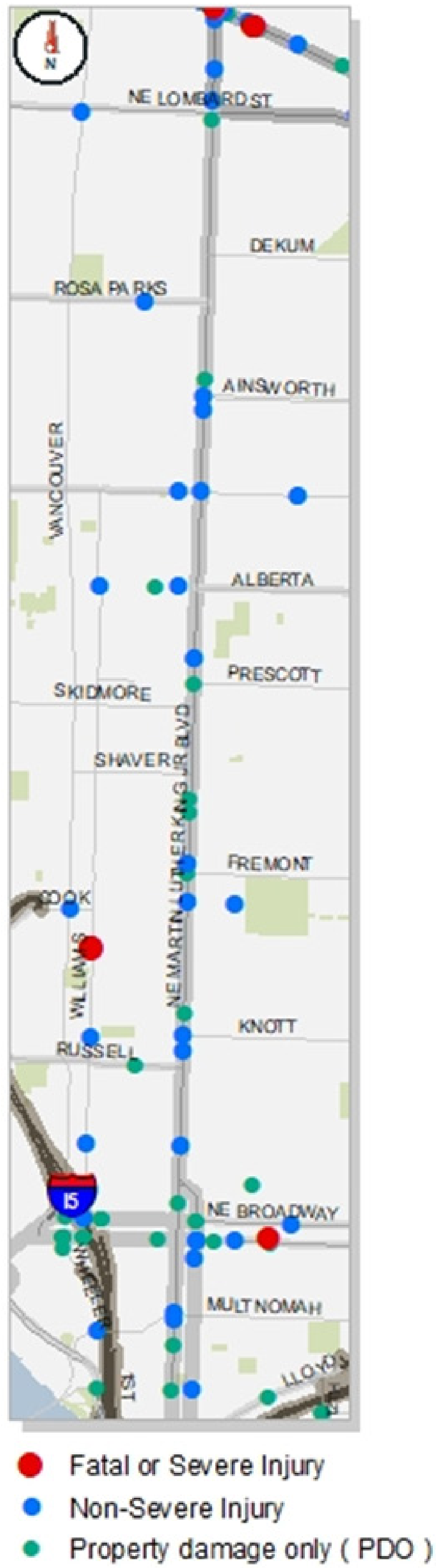
North of the Lloyd Center and Central Eastside districts, Martin Luther King Jr Boulevard is a major north/south corridor which runs parallel to I-5 and is a mixed-use corridor with a variety of commercial land uses backed by neighborhoods.

Making an improper change of traffic lane (44%) and making an improper turn (18%) are the most common causes of collisions involving trucks (**Figure 3-32**). The most frequent collision types involving trucks along Martin Luther King Jr Boulevard are sideswipe-overtaking (47%) and turning movement related (29%). These collisions are most common in the morning peak and the afternoon peak when traffic is at its highest levels.

The majority of the collisions involving trucks along NE Martin Luther King Jr Boulevard (OR 99E) are observed at or proximate to the intersections with NE Weidler Street and NE Broadway (**Figure 3-33**). This is primarily due to both NE Broadway and NE Weidler Street being routes that connect the truck traffic on OR 99E to/from the I-5 Freeway. Tight turn-radii, dense and narrow street grid with high volume of vehicles and other modes such as transit, bicyclists, and pedestrians mixing with trucks activity are potential contributing factors to higher number of collisions along this route. Further north, NE Martin Luther King Jr Boulevard converts to a two-way roadway with multiple side streets intersecting at stop-controlled intersections.

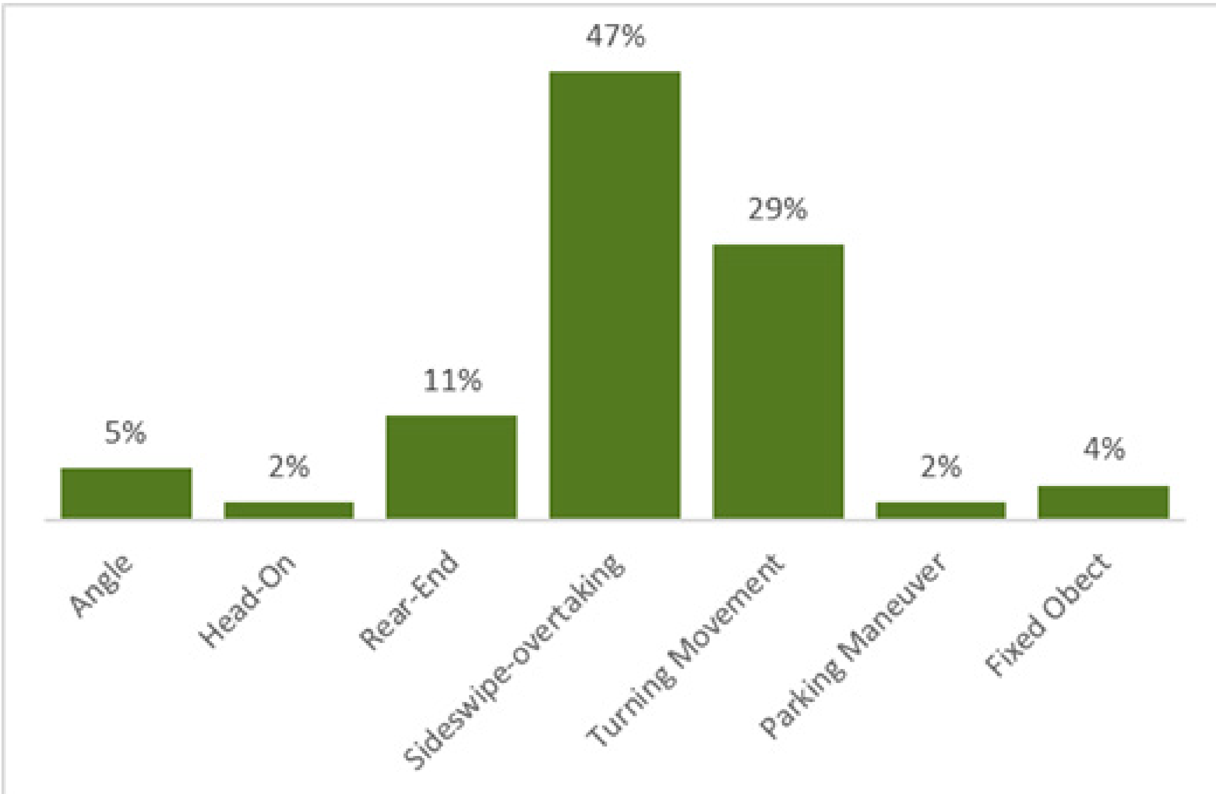
Many of these streets form offset intersections and require two turns to get across the boulevard. These factors are potentially contributing to higher number of truck collisions along this corridor.

Figure 3-33. Truck-Involved Collisions along MLK Jr Boulevard



Source:Oregon Department of Transportation. Crash Data System. (2014-2018) https://tvc.odot.state.or.us/tvc/

Figure 3-32. Truck Collision Type MLK Jr Boulevard Collisions



Source:Oregon Department of Transportation. Crash Data System. (2014-2018) https://tvc.odot.state.or.us/tvc/

3.11.1.5 Columbia Boulevard

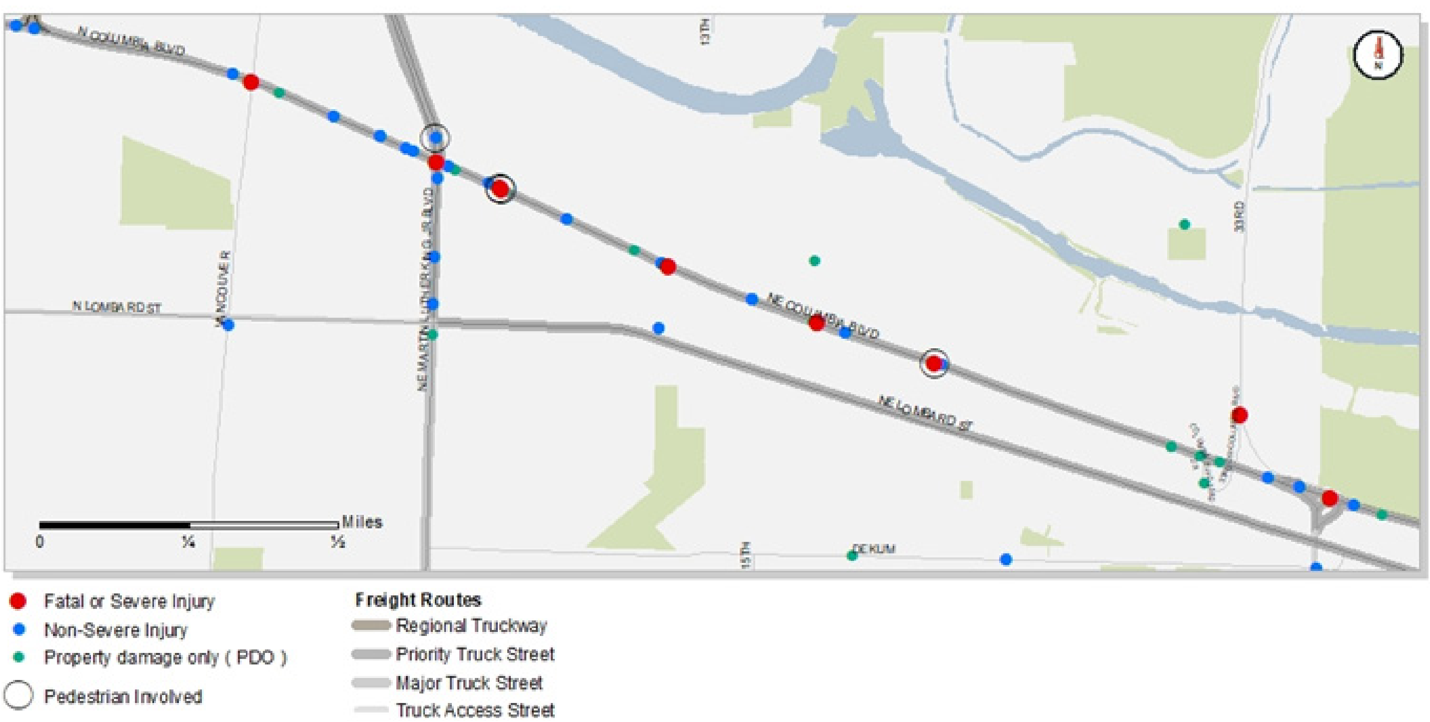
Columbia Boulevard is a heavily used truck corridor traversing through the marine industrial areas, Portland International Airport, and connecting directly with I-5 and I-205. It contains four and five lane cross sections with speed limits of 40mph and 45 mph, the land uses on both sides of the corridor is mainly industrial.

The most frequent collision type involving trucks along Columbia Boulevard are turning movement related (49%), rear-ends (22%) and sideswipe overtaking related (17%). As much as 66% of collisions here are intersection related, with 56% of those occurring at a four-way intersection and 44% at a three-way intersection. Most collisions involving trucks occurred during the midday off-peak.

Of the eight truck-related KSI collisions on this corridor during the time period under study, two of them involved a total of four pedestrians (**Figure 3-34**). The Columbia Lombard Mobility Corridor Plan identified numerous bicycle and sidewalks gaps and barriers along the corridor, and recommendations for Columbia Boulevard include speed management, driveway access management, and improved walking and biking connections.

There are sidewalks along Columbia Boulevard but there are few crossings for pedestrians to use. There are also many driveways to the various businesses along the corridor and with high speeds and volumes, it is difficult for trucks to turn across traffic. For instance, the distance to a marked and signalized pedestrian crossing at NE Martin Luther King Jr. Boulevard and the next one at NE 21st Avenue along NE Columbia Boulevard is approximately 4600 feet (over ¾ mile). In addition to the trucks and other vehicles making turns from multiple driveways along both sides of the boulevard, pedestrians do not have a safe option to go across Columbia Boulevard contributing to the safety issues along the corridor.

Figure 3-34. Truck-Involved Collisions along Columbia Boulevard



Source:Oregon Department of Transportation. Crash Data System. (2014-2018) https://tvc.odot.state.or.us/tvc/

3.11.1.6 82nd Avenue

NE/SE 82nd Avenue is a major north/south corridor running parallel to I-205. There is a mix of commercial, mixed use, and residential land uses along the corridor.

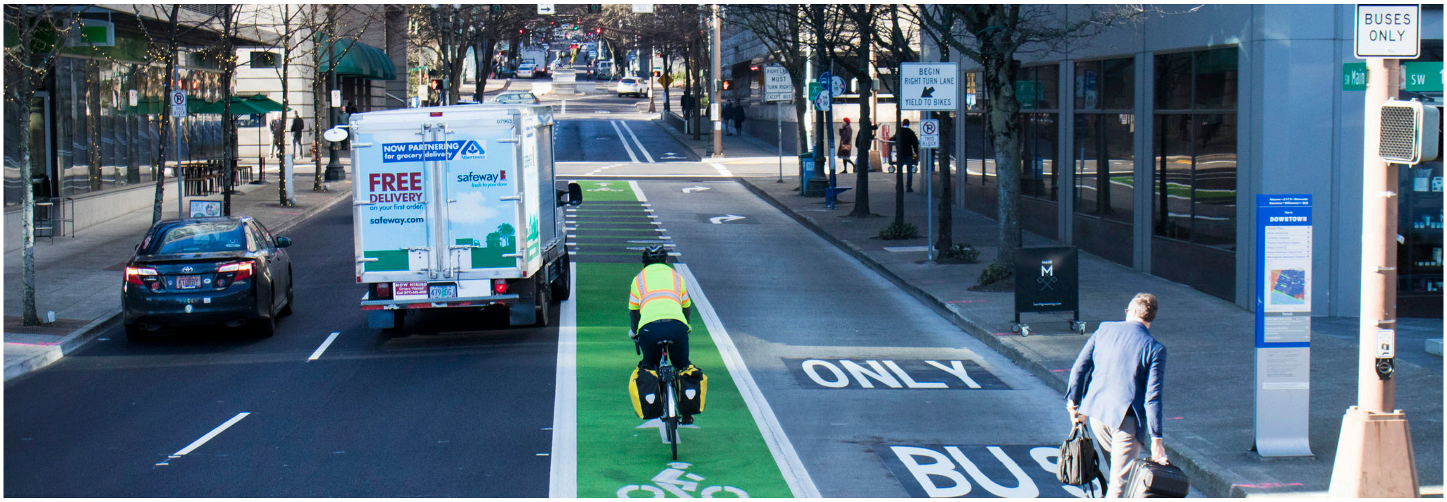
The majority (71%) of these collisions along the corridor were intersection related. The most frequent collision types involving trucks along 82nd Avenue are turning movement related (36%), rear-end (29%) and sideswipe-overtaking related (25%).

Along SE 82nd Avenue, there are three specific locations that experienced a higher number of truck related collisions. These include:

- Intersections of SE 82nd Avenue with the SE Stark Street and SE Washington Street couplet. Both SE Stark and SE Washington Street provide direct access to I-205 from SE 82nd Avenue, but also intersect with many residential local streets and segments with major commercial uses. These local streets are mostly stop-controlled at intersections with SE Stark and SE Washington streets and only a couple of locations have marked crosswalks between SE 82nd Avenue and the I-205 interchange.
- Intersections of SE 82nd Avenue at SE Powell Boulevard (US 26) and SE Holgate Boulevard. Multiple collisions involving trucks have also been reported along SE Holgate Boulevard between SE 82nd Avenue and SE 92nd Avenue where a high volume of vehicular traffic (including trucks) turn into and out of the Walmart Supercenter shopping center and Grant High School / Marshall campus conflicts with cars, bicyclists and pedestrians on SE Holgate Boulevard.
- Intersections of SE 82nd Avenue at SE Foster Road and SE Woodstock Boulevard. Truck related collisions are also reported where the SE Foster Road and SE Woodstock Boulevard become one-way couplets just west of the I-205 interchange. In addition, SE Foster Road intersections with SE 82nd Avenue at an oblique angle making some turns tight for trucks and may result in poor sight-distance. This geometrical issue could be a potential contributing factor for collisions at this location.

Figure 3-35. Truck-Involved Collisions along 82nd Avenue

Source:Oregon Department of Transportation. Crash Data System. (2014-2018) https://tvc.odot.state.or.us/tvc/



Picture 10.1: Image of a busy street in downtown Portland, Oregon. A black car, white freight truck, and a person on a bicycle each occupy a lane on the street. A person holding luggage is seen crossing the street. [Source: PBOT]

4. SUMMARY OF FINDINGS AND NEXT STEPS

Through the existing conditions analysis, travel demands, congestion and safety hot spots related to truck movements in the City of Portland were identified. The next step is finding projects that meet the City's goals of economic prosperity, human health, environmental health, equity, resilience, safety, moving people and goods, and asset management.

4.1 Truck Activity and Delay

As set forth in the previous chapters, the following locations have high truck activity, congestion, and delay:

- N Portsmouth Avenue between N Lombard Street and N Columbia Boulevard
- SE Milwaukie Avenue between SE Powell Boulevard and SE Holgate Boulevard
- N Marine Drive east of NE Martin Luther King Jr Boulevard
- W Burnside Road from the west City boundary to I-405
- SW 30th Avenue from Beaverton Hillsdale Highway to SW Vermont Street
- N Willamette Boulevard
- N Greeley Avenue
- N Peninsular Avenue
- NE Prescott Street between NE 102nd Avenue and NE 122nd Avenue
- NE Shaver Street from NE 122nd Avenue to Sandy Boulevard
- Sellwood Bridge and SE Tacoma Street
- SW Terwilliger Boulevard near OHSU
- SE Powell Boulevard near SE McLoughlin Boulevard

While these locations were identified based on a combination of model and count data, model data is estimated and should be verified by observed data when identifying solutions at these locations. Additionally, the change between the existing and future model conditions will be evaluated in a separate technical report and may provide more insight into the truck conditions and growth on specific facilities.

Further review of truck movements, routing and speed profile based on recent observed data is needed to provide recommendations on location specific improvements to the designated truck routes and routes where trucks may be prohibited except for local delivery and last mile access. In several cases, modifications may be needed to better accommodate the trucks, such as roadway geometric and traffic control changes.

Through this analysis, a few gaps in the data currently available were noted. There is little quantitative data available for e-commerce/last mile delivery in Portland, which makes it difficult to draw conclusions about delivery movements and curbspace constraints. Smaller class 3 vehicles are increasingly being used for deliveries but these vehicles are not modeled as a separate class in the Metro travel demand model available for this analysis and aren't always identified in the collision data. These gaps make it hard to understand how these vehicle movements may differ from larger trucks. Metro has recently developed an updated freight model that breaks out smaller trucks. Future studies may look to collect this specific data to fill in the gaps in the current data.

4.2 Safety

Many of the truck-involved collisions in the City of Portland were classified as turning movement, rear-end or sideswipe-overtaking collisions occurring on high volume corridors throughout the City. Improving visibility, especially at intersections to allow vehicles to safely pass freight vehicles turning to access businesses throughout Portland could help reduce these types of collisions.

The project team also recommends focusing on improving safety for those vulnerable road users, who are especially exposed in collisions with trucks due to the large nature of the vehicles involved. Safety countermeasures for pedestrians include ensuring there are sidewalks and safe crosswalks on high collision corridors. Safety improvements for cyclists could include providing separated facilities, clear signage and/or providing for alternate parallel routes.

Safety countermeasure recommendations vary based on the location and classification of roadway where the collisions involving trucks are occurring. In Downtown, the high-volume multimodal traffic and narrow streets means that curb space management, clear signage and inventory of truck loading zones and designating truck routes through Downtown could lower the risk of truck collisions. At busy locations on the east side of the Willamette River such as the east end of Morrison Bridge and Broadway Bridge, the high concentration of truck traffic results in the highest density of truck collisions in the City of Portland. Implementing truck signage and physical measures to restrict last minute lane changes could improve safety in these areas.

Key truck corridors such as Martin Luther King Jr Boulevard, Columbia Boulevard and 82nd Avenue typically see morning, mid-day and afternoon peak collisions involving trucks related to side-swipe overtaking, turning and rear-ends. The mixed-use commercial and residential land uses along the high traffic corridors could result in access issues and impatient drivers overtaking truck vehicles. Improved signage and access control may be warranted in certain locations.

Picture 11.1: *A person walking in front of a blue Amazon delivery vehicle exiting a parking garage. [Source: Tony Webster]*