SR 167 Corridor Plan
Technical Memorandum 7

Appendix B:

Port Truck trips in the SR 167 Corridor,
Heffron Transportation, Inc.

TECHNICAL MEMORANDUM

Project: SR 167 Corridor Study

Subject: Truck Mobility Design Concepts

Date: February 1, 2007

Author: Marni C. Heffron, P.E., P.T.O.E.
Claudia S. Hirschey, P.E.

In urban areas across the country there's growing concern about the impacts of increasing congestion on the ability of trucks to deliver goods in a predictable, and cost effective manner to meet the needs of the just-in-time economy.

With the steady growth of freight and congestion, urban areas are looking for ways improve truck movements, including truck climbing lanes, truck only ramps and Truck Only Toll Lanes or (TOTs). TOT Lanes are lanes dedicated to trucks that are charged a toll to cover the expense of construction and operations.

To help frame the discussion of whether or not a TOT lane is a feasible option for urban areas, the engineering consultant firm, Parson Brinckerhoff developed the "Handbook for Planning Truck Facilities on Urban Highways" (2004). The author concluded that there is a threshold where TOT lanes may become a viable option for some highways. The thresholds include:

- Four lanes in each direction on the highway
- Daily volume of 3+ axle trucks that exceed 20,000 for at least 10 miles
- Total daily traffic exceeds 120,000

1. Overview of Truck Mobility on SR 167

The Green River Valley is Puget Sound's largest freight distribution center and supports the vital economic function of warehouse and distribution centers in the valley, and the State of Washington's international trade network. Given the growing congestion and forecasted increase in freight movement by trucks, there's interest in finding ways to improve speed, reliability and safety for freight trucks using SR 167.

Currently, SR 167 has 2-3 lanes in each direction with an ADT of 80,000 to 124,400.

The total daily truck volume on SR 167 just north of South 212th Street is approximately 12,110 trucks, or 9.7% of all traffic. The majority of trucks travel during daytime hours to meet the operating schedules of the suppliers and receivers. At the same time, trucks on SR 167 are shifting to travel after the morning peak period and before the evening peak period. Approximately 44% of all truck movements occur between 9:00 A.M. and 3:00 P.M.

The peak truck flow northbound is 470 trucks and occurs from 10:00 to 11:00 A.M. During this hour, medium and heavy trucks are 46% of the truck volume, and 14 % of all traffic. The southbound peak flow of 485 trucks occurs from 1:00 to 2:00 P.M. During this hour, medium and heavy trucks are 40% of the truck volume and 13 % of all traffic.

2. Freight in Truck Only Toll Lanes

2.1. Description

TOT Lanes are lanes designated for truck use where vehicles pay a fee to use the lanes. The tolls could be used to either pay for the facility or managed to maintain a reliable speed using variable tolls depending on congestion in the lanes.

2.2. Operating Conditions

TOT lanes would provide a travel time benefit for long distance truck trips of 10 miles or more. For short trips, the time delay associated with weave maneuvers, to enter and exit the truck-only lane, is a large portion of the total travel time. Warehouse and distribution centers are located throughout the length of the SR 167 corridor, and are accessed largely from the arterials. This land use pattern and arterial network would necessitate frequent access to SR 167 for trucks. In addition, there is limited net travel time benefit for TOT lanes during the off peak.

Truck-only facilities on a limited access facility are generally recommended to be physically separated from general-purpose traffic to reduce or eliminate the effect of trucks weaving into and out of this lane. Because of this separation, direct-access ramps to the truck-only lane would be required, and would likely have limited locations. The footprint of a direct access interchange is substantial, and the physical separation of the truck only lane would add to the width of SR 167. The cost and environmental impacts of added infrastructure within this corridor would be considerable. The land use patterns through the Green River Valley are such that trucks use nearly all of the interchanges to access SR 167. However, if direct access ramps were constructed they would likely be limited to a few select locations. Therefore, truck-only lanes would only benefit those businesses or trucks with origins or destination served by the few direct ramps.

There is limited research with regard to criteria for truck-only lanes. The criteria from two sources are included herein as examples. These sources state that truck-only lanes should be considered when:

1) Truck volume exceeds 30% of the normal traffic mix[1].
2) Daily two-way truck volume of heavy (3+axle) trucks exceeds 20,000 for a distance of 10 miles.[2].

[1] *Feasibility of Exclusive Facilities for Cars and Trucks, Final Report, Contract No. DTFH61-89-Y-00018,* Center for Transportation Analysis, Oak Ridge National Laboratory, Oak Ridge, TN, B. N. Janson and A. Rathi, April 1990.

[2] *Handbook for Planning Truck Facilities on Urban Highways, James G. Douglas, AICP, August 2004*

Trucks are 10% of daily traffic on SR 167 just north of South 212th Street, estimated to reach 15% by 2030. The total daily truck volume on SR 167 just north of South 212th Street is approximately 12,110 trucks and estimated to reach 24,000 by 2030. Of the existing 12,110 trucks 52% are tractor-trailer trucks with 3+axles. The volume of 3+ axle trucks on SR 167 would not reach the levels recommended for implementation of a truck-only lane. Ultimately, a decision to implement a truck-only lane would require a benefit-cost analysis including analysis based on truck volumes that would use the lane, potential disadvantage for trucks that could not use the lane, travel time savings, cost savings to truck transport and cost of the facility.

3. Freight By-pass Lanes

3.1. Description

By-pass lanes can accommodate a high volume of through trips around a system interchange (freeway to freeway) or around a major arterial interchange. A freight by-pass lane could also be applied to ramps, and be used to avoid starting from a stop at ramp meters. Examples are shown in Attachment A.

3.2. Operating Conditions

Freight by-pass lanes divert truck traffic past an interchange, thus minimizing potential for delay due to local congestion. In addition to benefiting trucks, it removes trucks from the freeway mainline and improves the ability for general-purpose traffic to weave onto the mainline.

Truck by-pass lanes on a ramp can be used to allow trucks to by-pass a ramp meter. This is particularly useful on uphill ramps where a truck would not be able to reach highway speeds if they have to accelerate from a ramp meter located partway up the ramp. Such a bypass lane not only reduces the delay for truck, but can increase capacity of the mainline by increasing the speed at which truck traffic merges into the mainline. This benefit would be most noticeable during off-peak conditions when the highway speeds are highest. It can also extend the periods of uncongested flow by limiting the slow-down effect of trucks.

4. Freight Direct Access Ramps

4.1. Description

The concept of a freight direct access ramp provides access from an independent freeway lane such as a truck-only lane . However, a truck access ramp could be provided where there is such a high volume of trucks from an industrial area that a truck-only ramp would be warranted. Such a ramp may or may not be for the exclusive use of trucks, but warranted due to the truck volume.

4.2. Operating Conditions

Separation of trucks and passenger cars could reduce conflict created by their different operating characteristics. Removing trucks from high volume ramps would preserve capacity for general-purpose traffic.

Most of the interchanges in the Green River Valley have high volumes of truck trips given the existing land use patterns. There are no locations where the concentration of truck trips would be so great as to warrant a separate ramp. However, there are missing ramps that force trucks to use local streets. The most significant is the lack of a direct ramp from eastbound SR 18 to southbound SR 167.

Providing this ramp would improve travel times for trucks using this route, and would free up capacity on the local arterial street.

5. Enhanced Design for Truck Mobility

5.1. Description

Enhanced design for truck mobility addresses the difference in operating characteristics between trucks and general-purpose traffic. Trucks are longer and heavier; require longer distances for acceleration and deceleration; are affected more significantly by steep grades; and are more limited in mobility around tight curves and on super elevated curves. When truck speeds and mobility differ from that of general-purpose traffic, they have the effect of reducing the capacity along a mainline segment and on a ramp. Improvements that increase the speed of a merging truck can increase the overall capacity of a freeway facility. Improvements could include:

- Increasing the length of the ramp.
- Providing an acceleration lane parallel to the mainline.
- Increasing the radius and decreasing the super elevation of loop ramps.
- Reducing the grade of on-ramps

5.2. Operating Conditions

Table 1 presents select speed-distance relationships for trucks accelerating on an uphill grade from a stop condition. Trucks must accelerate from a stop conditions at ramp terminals and ramp meters. For a typical ramp design with a 3% uphill grade and 1,000 feet of ramp length, heavy trucks are entering the freeway at 29 mph.

Table 1. Speed-Distance for Acceleration of a Typical Heavy Truck

3% Grade		5 % Grade	
Distance (feet)[1]	Speed (mph)	Distance	Speed
500	27	500	22
1,000	29	1,000	24
1,500	31	1,500	25

[a] Source: AASHTO, A Policy on Geometric Design of Highways and Streets, 2004, Exhibit 3-56

1. Distance from a stop condition

The affect of reduced truck speed is to increase the passenger car equivalent (E_T) of a truck, which impacts the amount of freeway capacity consumed by the truck. A medium or heavy truck traveling at speed on a flat freeway has an E_T of 1.5. In other words, trucks consume the same space and capacity as one-and-a-half passenger cars. Where grade has the affect of decreasing truck speed the E_T increases. Note that as the percentage of trucks increases the E_T decreases. When the proportion of trucks is higher, trucks begin to travel in platoons. Trucks traveling in a platoon have less of a capacity impact, per truck, than traveling alone. The net effect is to reduce the passenger car equivalent of a truck at higher truck percentages.

Table 2. Passenger Car Equivalents for Trucks for Grade Lengths of ¼ to ½ mile

Upgrade	Percentage of Trucks						
	2%	4%	5%	6%	8%	10%	15%
<2%	1.5	1.5	1.5	1.5	1.5	1.5	1.5
≥2-3%	1.5	1.5	1.5	1.5	1.5	1.5	1.5
>3-4%	2.0	2.0	2.0	2.0	2.0	2.0	1.5
>4-5%	3.0	2.5	2.5	2.5	2.0	2.0	2.0

Source: Highway Capacity Manual 2000. Transportation Research Board, Exhibit 23-9

6. Inteligent Transportation Systems (ITS) Applications

6.1. Description

Intelligent Transportation System (ITS) applications improve freeway operations and can be developed to provide truck-specific information. Examples include: advance information about major construction changes, real-time information about incidents and emergencies, and changeable message signs in advance of route choice. The incident information is particularly useful for freight movements. If provided via e-mail alerts or fax bulletins, it allows businesses to hold trucks at the site rather than have them get stuck in a traffic jam from which a large truck cannot escape (unlike cars, trucks cannot easily U-turn or use streets with steep topography).

6.2. Operating Conditions

Under today's conditions, SR 167 is congested for six hours per day[3]. Studies show that over one half of urban congestion is due to incidents. When freeway lanes are blocked, congestion levels increase dramatically and take a long time to dissipate. The Texas Transportation Institute estimates that incidents cause 52 percent of the delay, or about 1.9 billion hours of delay[4], based on a study of 85 urban areas in 2003. The extent that ITS applications smooth traffic flow would result in less congestion and an expected reduction in congestion-related crashes.

The crash history on SR 167 indicates that 35% of crashes occur during the PM peak period and 18% occur during the AM peak period, for a total of 53% of crashes occurring during the peak period.[5]. These crashes and incidents can cause severe congestion. Secondary crashes such as rear-end crashes due to congestion also occur during the congestion caused by blocked freeway lanes. A combined program of ITS applications during severe congestion, combined with a well-developed incident management program can reduce congestion and crashes for general purpose traffic and truck traffic.

A well-developed incident management program to quickly clear blockages is a cost-effective method to reduce congestion. Incidents are events that disrupt the normal flow of traffic, usually by physical impedance in the travel lanes. Events such as vehicular crashes, breakdowns, and debris in travel lanes are the most common form of incidents.

[3] *(Source: Existing Conditions Technical Memorandum, Appendix A, Traffic Data, Preliminary Draft, December 2005,Perteet)*
[4] *Source: U.S. Federal Highway Administration, Focus on Congestion:, http://www.fhwa.dot.gov/congestion/factoids.htm*
[5] *Source: Perteet, Inc. based on SR 167 crash data from August 2002 to July 2005.*

7. Summary

Truck-only facilities benefits are associated with locations with very high volumes of trucks and trucks traveling to or from a single location (through truck trips, direct access, etc.). Other truck-friendly design concepts throughout the corridor could accrue benefit to all major truck movements within and through the SR 167 corridor, whether or not the location warrants a truck-only facility. Examples of major improvements that could provide improved mobility for trucks are:

- Geometric design enhancements to minimize the speed differential of trucks and general-purpose traffic.
- Geometric improvements to increase capacity and reduce the crash rate – grades, ramp curves and superelevation, merge and weave distances, and clear zones to fixed objects.
- Truck by-pass of ramp meters. (Allows trucks to accelerate for the entire length of the ramp rather than starting from a stop at the ramp meter, which is near the merge point.)
- Interchange bypass lanes
- Intelligent Transportation System (ITS) applications to improve freeway operations and to provide truck-specific information including advance information about major construction changes, real-time information about incidents and emergencies, and changeable message signs in advance of route choice.
- Incident management to quickly clear blockages.

Attachment A: Example Truck Only Facilities
B: Freight Distribution Map
\ C: Truck Definition Graphic