

DRAFT

TERMINAL 91 2011 TRAFFIC MONITORING STUDY

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1. INTRODUCTION

This report presents the results of the traffic monitoring study conducted at the Port of Seattle's Terminal 91 in September 2011. This study was conducted in accordance with the Terminal 91 Short Fill Redevelopment Agreement¹ (SFRA) between the Port of Seattle (Port) and the neighborhood community councils of Magnolia and Queen Anne (Communities). For this analysis, new traffic counts were collected at all Terminal 91 access points and compared to thresholds identified in the SFRA. The current traffic volumes were also compared to historical data collected for previous Terminal 91 monitoring studies.

2. MONITORING PROCESS AND THRESHOLDS

The SFRA was a "comprehensive resolution of all disputes regarding the Port's 'short fill' redevelopment of Terminal 91." Additionally the SFRA provided procedures for resolving future issues. The establishment of a traffic monitoring program was one of the elements of the SFRA, and detailed procedures for monitoring traffic are outlined in Section F of the agreement. It states that, "the purpose of the monitoring program is to determine whether future traffic volumes and levels of service stay within estimated ranges. The Port and the Communities have established "trigger" levels for traffic volumes which, if exceeded, will result in more intensive review by the Port and action if required."

Key steps within the monitoring program stated in the SFRA are as follows:

Gates: *The Port will obtain daily (24 hour), A.M. and P.M. peak period gate counts of trucks and autos entering or leaving all Terminal 91 gates for one (1) week each quarter. Gate counts will be reported as trip ends. A trip end is an arrival or a departure. Thus, a single vehicle which enters and then leaves the terminal will generate two trip ends.*

Intersections: *Congestion and delay at intersections are measured in terms of Level of Service (LOS) under a system described in Interim Materials on Highway Capacity (Transportation Research Board, 1980). Levels of service range from A through F, with LOS A representing congestion free service and LOS F representing jammed conditions. The Port will obtain LOS determinations for the peak hours at the following intersections once a year: Elliott and Galer; Elliott/15th Avenue and Garfield; 15th and Dravus (until Galer access is completed), West Mercer Place and Elliott; and 20th and Dravus.*

According to industry standard, the methodology to determine level of service has been updated many times since this agreement was originally drafted. Computers now allow more complex calculations to occur, which have resulted in more accurate analyses of intersection operations. The newest methodologies from the *Highway Capacity Manual*² were used to evaluate intersection operations. Details related to the methodology are provided in Section 5.3.

1 Short Fill Redevelopment Agreement, As amended 1985 including 1998 Second Amendment; Port of Seattle, Magnolia Community Club, and Queen Anne Community Council; January 2000.

2 HCM 2000, Transportation Research Board, 2000.

Another change that has occurred since the SFRA was created is construction of the Galer Flyover. Therefore, the Galer Flyover/Elliott Avenue W intersection was evaluated instead of the Galer Street /Elliott Avenue intersection (which still exists, but is a more minor intersection). Finally, the North Gate to Terminal 91 is not currently active; therefore, no analysis was performed for intersections along W Dravus Street for this regular monitoring study.

The SFRA outlined thresholds for both auto and truck traffic volumes over three specific time periods. The time periods and volume thresholds are summarized in Table 1. It is noted that the AM and PM peak periods differ from traditional traffic analysis time periods. The SFRA defines a 75-minute period for the AM peak and a 105-minute period for the PM peak; a typical traffic analysis would evaluate a 60-minute peak period.

Table 1. SFRA Traffic Volume Threshold Criteria

	Time Period	Automobiles ¹	Trucks ¹
AM Peak	7:15 – 8:30 A.M.	395	25
PM Peak	3:45 – 5:30 P.M.	612	48
Daily	24 hours	3,500	325

Source: SFRA (as amended 1985, 1988)

1. Thresholds are for total trip ends.

3. GATE COUNTS

3.1. Count Locations

There are currently three locations where vehicular traffic can enter and exit Terminal 91; these are shown on Figure 1.

1. **East Gate** – This gate is located off Alaskan Way W, and is accessed via the Galer Flyover.
2. **Center Gate** – This gate is accessed via the center ramps of the Magnolia Bridge just west of 15th Avenue W.
3. **West Access** – On days with cruise activity, a retractable gate at the west end of the Magnolia Bridge is open. Vehicles can enter this gate and park, or traverse the yard beneath the Magnolia Bridge to access Pier 91 south of the bridge. Vehicles also exit the parking lot via this gate. When cruise vessels are at sea, the gate is closed to secure the parking lot.

Figure 1. Terminal 91 Access Points



Vehicle classification counts were performed at all three Terminal 91 access locations in September 2011. The machine traffic counts track the types of vehicles entering and exiting the terminals for each hour of the day. These data were collected over a nine-day period from Saturday, September 9, 2011 through Sunday, September 18, 2011. Cruise vessels called at Terminal 91 on six of the days surveyed. Table 2 identifies the cruise vessels and the numbers of passengers that embarked or disembarked each vessel while it was at Terminal 91.

Table 2. Cruise Passengers at Terminal 91 During 2011 Monitoring Survey

Date	Vessel	Capacity	Number of Passengers		
			Disembark	Embark	Total per Day
Sat, 9/10/11	Golden Princess	2,600	2,675	2,655	9,386
	Westerdam	1,916	2,021	2,035	
Sun, 9/11/11	Sapphire Princess	2,670	2,684	2,703	9,391
	Oosterdam	1,848	1,986	2,018	
Mon, 9/12/11	None	0			0
Tues, 9/13/11	Carnival Spirit	2,124	2,238	2,218	4,456
Wed, 9/14/11	None	0			0
Thurs, 9/15/11	None	0			0
Fri, 9/16/11	Amsterdam	1,380	1,328	1,432	2,760
Sat, 9/17/11	Golden Princess	2,600	2,630	2,649	9,285
	Westerdam	1,916	2,023	1,983	
Sun, 9/18/11	Sapphire Princess	2,670	2,664	2,774	9,445
	Oosterdam	1,848	2,008	1,999	

Source: Port of Seattle and Cruise Terminals of America, September 2011.

3.2. Automobile Traffic

Automobile traffic that entered or exited Terminal 91 was summed for all three access locations. The total reflects the “trip ends” defined by the SFRA. Table 3 summarizes the automobile trip ends and compares them to the thresholds established in the SFRA. Figure 2 through Figure 4 show these data graphically for the three respective time periods. As shown, the AM peak period and daily automobile thresholds were exceeded only on days when there was high cruise passenger activity at Terminal 91. None of the days exceeded the threshold for the PM peak period.

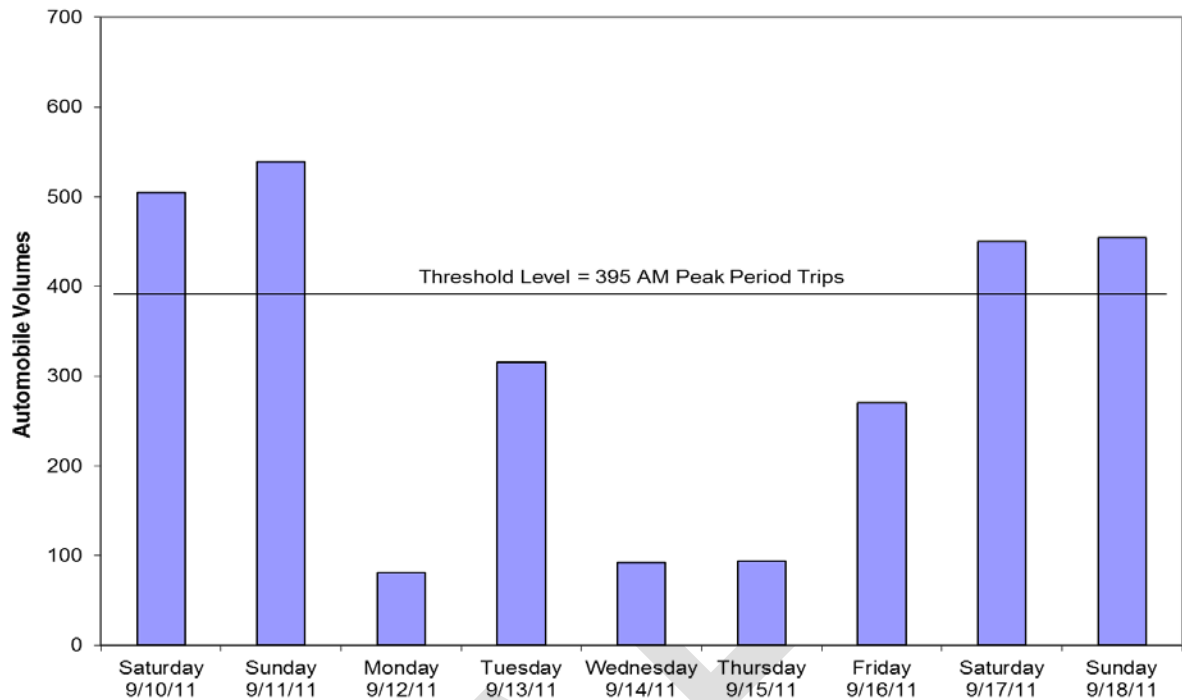
Table 3. Automobile Traffic to and from Terminal 91

	AM Peak (7:15 – 8:30 AM) Threshold = 395	PM Peak (3:45 – 5:30 PM) Threshold = 612	Daily Threshold = 3,500
Saturday 9/10/2011	505	362	4,570
Sunday 9/11/2011	539	122	4,957
Monday 9/12/2011	81	300	2,059
Tuesday 9/13/2011	315	375	4,063
Wednesday 9/14/2011	92	331	2,016
Thursday 9/15/2011	94	294	2,113
Friday 9/16/2011	270	301	3,781
Saturday 9/17/2011	450	163	4,697
Sunday 9/18/11	454	155	4,647

Source: Nine-day machine count by All Traffic Data, September 10, through September 18, 2011. Combined volumes at three site access locations to Terminal 91.

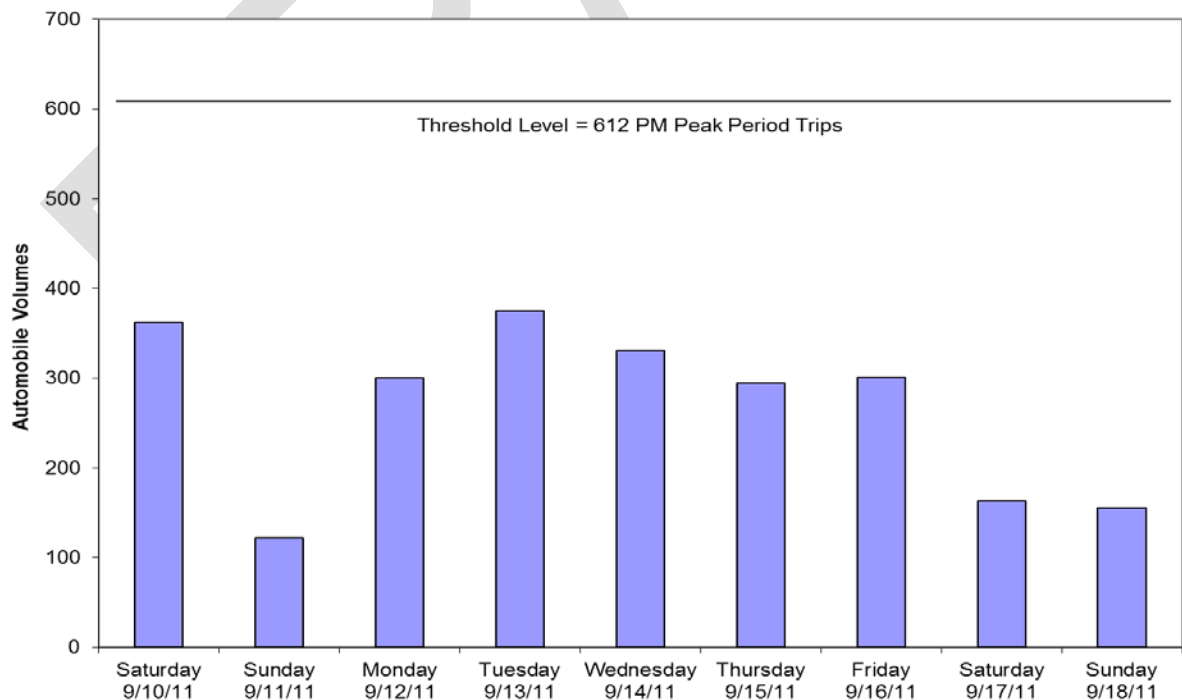
Volumes in **bold** identify time periods where the Short-Fill Redevelopment Agreement threshold limit is met or exceeded.

Figure 2. Automobile Traffic – AM Peak Period



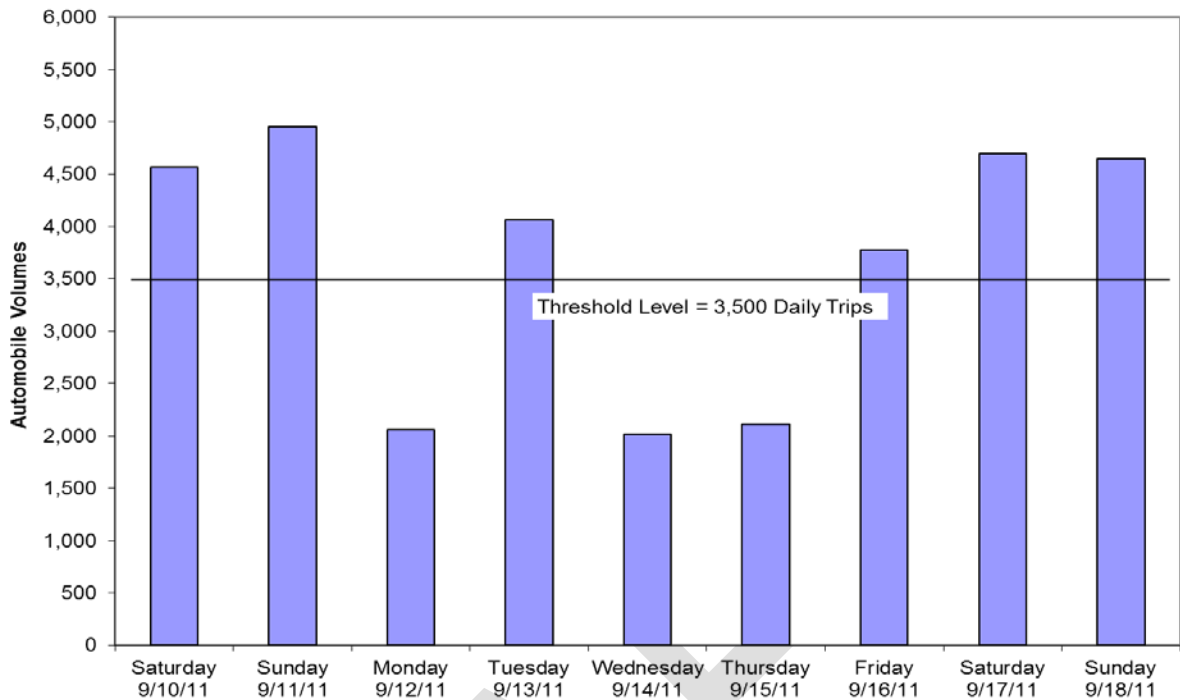
Source: Nine-day machine count by All Traffic Data, September 10, through September 18, 2011. Combined volumes at three site access locations to Terminal 91.

Figure 3. Automobile Traffic – PM Peak Period



Source: Nine-day machine count by All Traffic Data, September 10, through September 18, 2011. Combined volumes at three site access locations to Terminal 91.

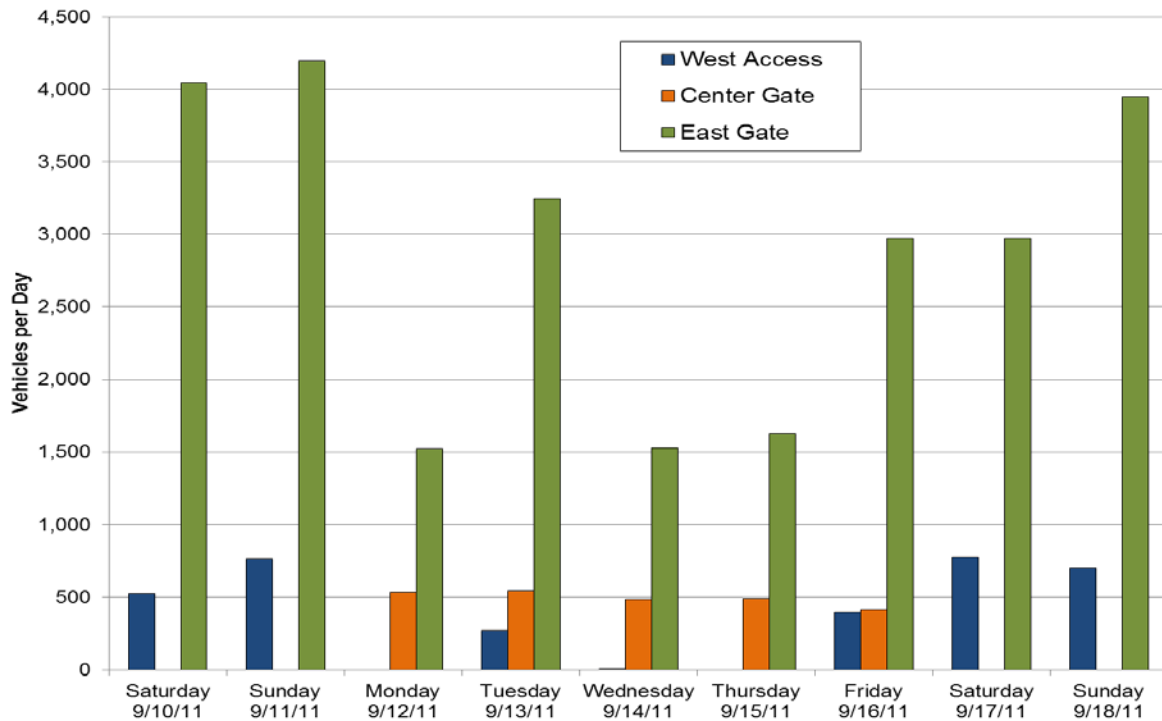
Figure 4. Automobile Traffic – 24-Hour Period



Source: Nine-day machine count by All Traffic Data, September 10, through September 18, 2011. Combined volumes at three site access locations to Terminal 91.

The locations where traffic enters the terminal vary depending on cruise operations. The volume by access is shown on Figure 5. On days without a cruise ship call, the parking lot at the West Access is gated and traffic does not enter or exit the terminal via that route. On weekdays, the number of automobiles using the Center Gate does not vary substantially between a cruise day and a non-cruise day. The Center Gate is closed on weekends. The largest fluctuations in volume occur at the East Gate on days when there is cruise activity. Figure 5 shows the daily automobile volumes by access location.

Figure 5. Daily Automobile Trips by Access Location



Source: Nine-day machine count by All Traffic Data, September 10, through September 18, 2011.

3.3. Truck Traffic (and other Large Vehicles)

As with prior Terminal 91 Monitoring efforts, the “truck traffic” thresholds were measured for all large vehicles generated by Terminal 91 including buses, school buses, and shuttles. Almost all large vehicles access the terminal through the East Gate; vertical clearance issues prevent large trucks from using the other two access points, although some smaller trucks and shuttles may use those gates. The volume of trucks, buses, and shuttles were derived from the vehicle classification counts. The total number of trip ends for all three access locations is summarized in Table 4. As shown, the volume of trucks and buses exceeded the AM peak and daily thresholds on all days of the week, and the PM peak threshold on all days but the weekend.

Table 4. Trucks and Buses to and from Terminal 91

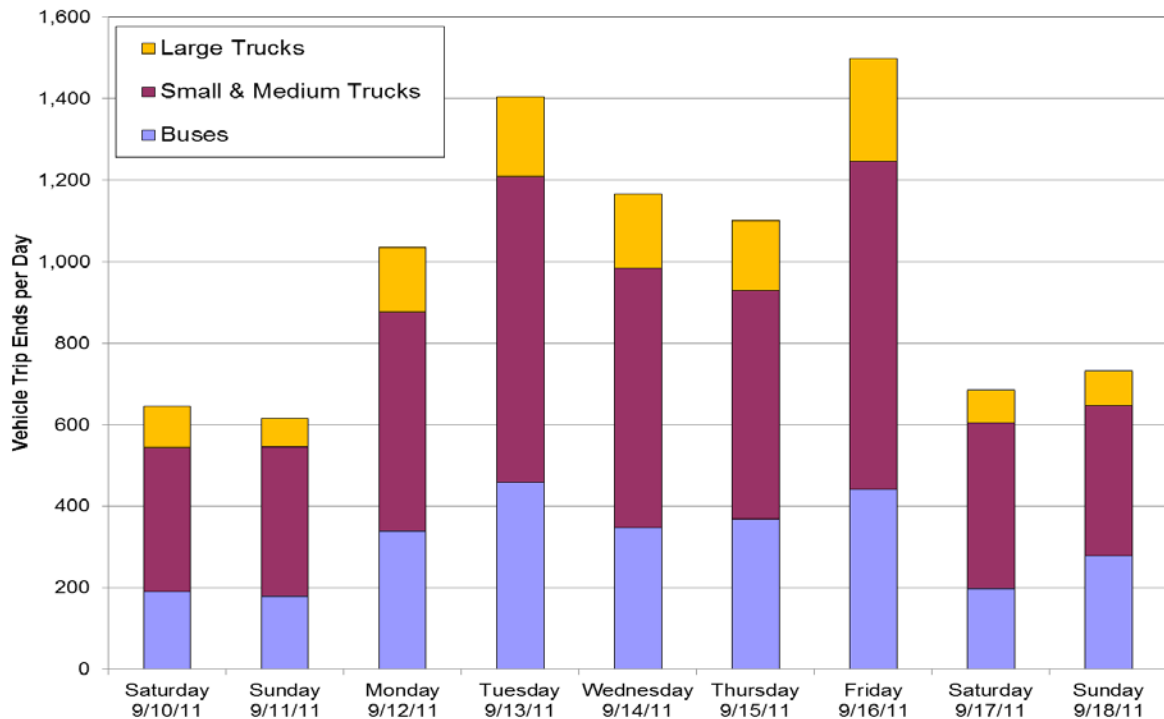
	AM Peak Threshold = 25	PM Peak Threshold = 48	Daily Threshold = 325
Saturday 9/10/11	81	10	645
Sunday 9/11/11	81	7	615
Monday 9/12/11	92	178	1,035
Tuesday 9/13/11	134	190	1,404
Wednesday 9/14/11	94	185	1,166
Thursday 9/15/11	82	188	1,101
Friday 9/16/11	133	191	1,497
Saturday 9/17/11	92	18	685
Sunday 9/18/11	106	11	732

Source: Nine-day machine count by All Traffic Data, September 10, through September 18, 2011. Combined volumes at three site access locations to Terminal 91.

Volumes in **bold** identify time periods where the acceptable threshold limit is met or exceeded

The types of vehicles were compiled for each day to show the proportion of each type of large vehicle: buses, small and medium trucks (2 to 4 axles), and large trucks (more than 5 axles). These are shown on Figure 6.

Figure 6. Large Vehicles by Day of Week



Source: Nine-day machine count by All Traffic Data, September 10, through September 18, 2011. Combined volumes at three site access locations to Terminal 91.

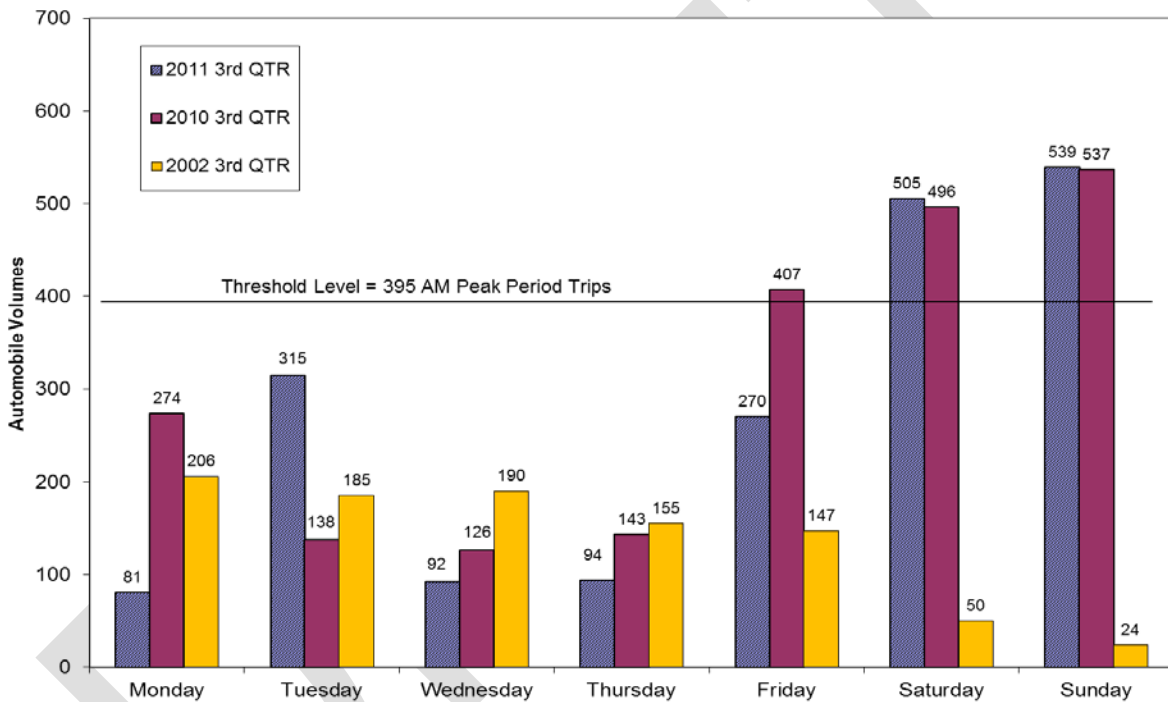
4. HISTORIC TRENDS

This section compares the two most recent traffic monitoring results—from September 2010 and 2011—to conditions that existed prior to cruise operations being moved to T-91. For the purpose of this comparison, the results from the same quarter in 2002 were used.³

4.1. Automobile Traffic Trends

Figures 7, 8, and 9 compare historic automobile traffic monitoring results for the AM peak, PM peak and 24-hour periods, respectively. As shown, the number of automobiles has increased substantially on days with cruise activity (Tuesday, Friday, Saturday and Sunday) compared to conditions in 2002.

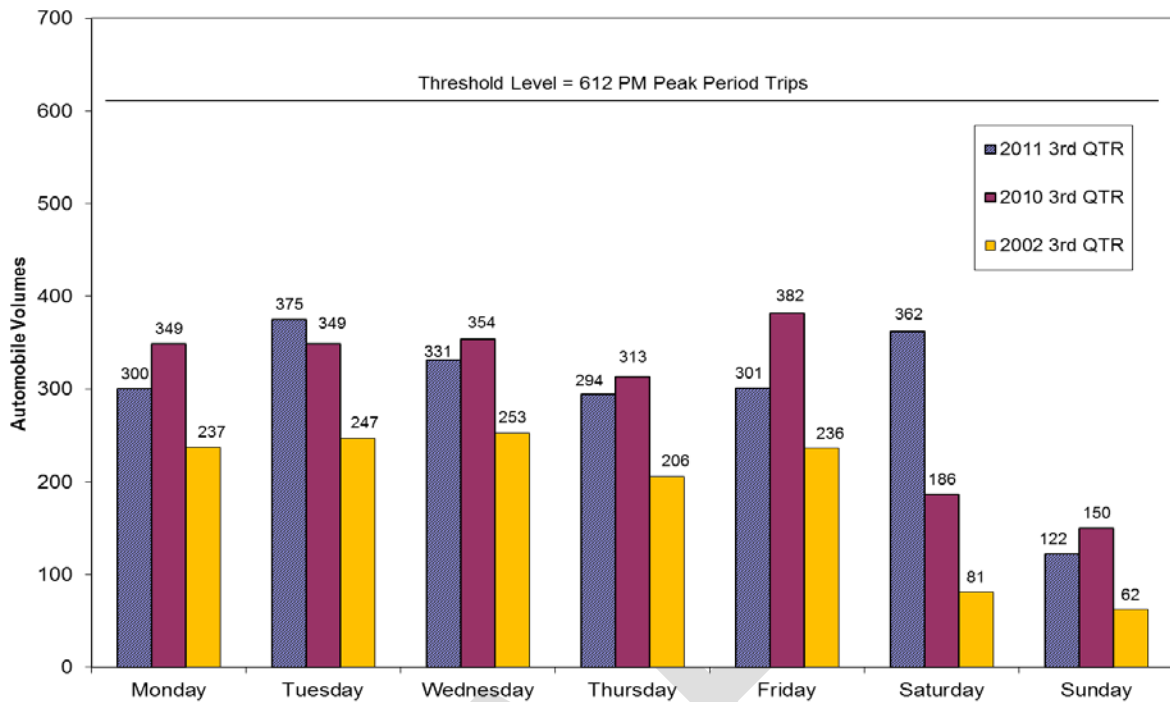
Figure 7. Automobile Trends – AM Peak Period



Source: Results from 2010 and 2011 were compiled by Heffron Transportation, Inc.; results for 3rd Quarter 2002 were compiled by The Transpo Group.

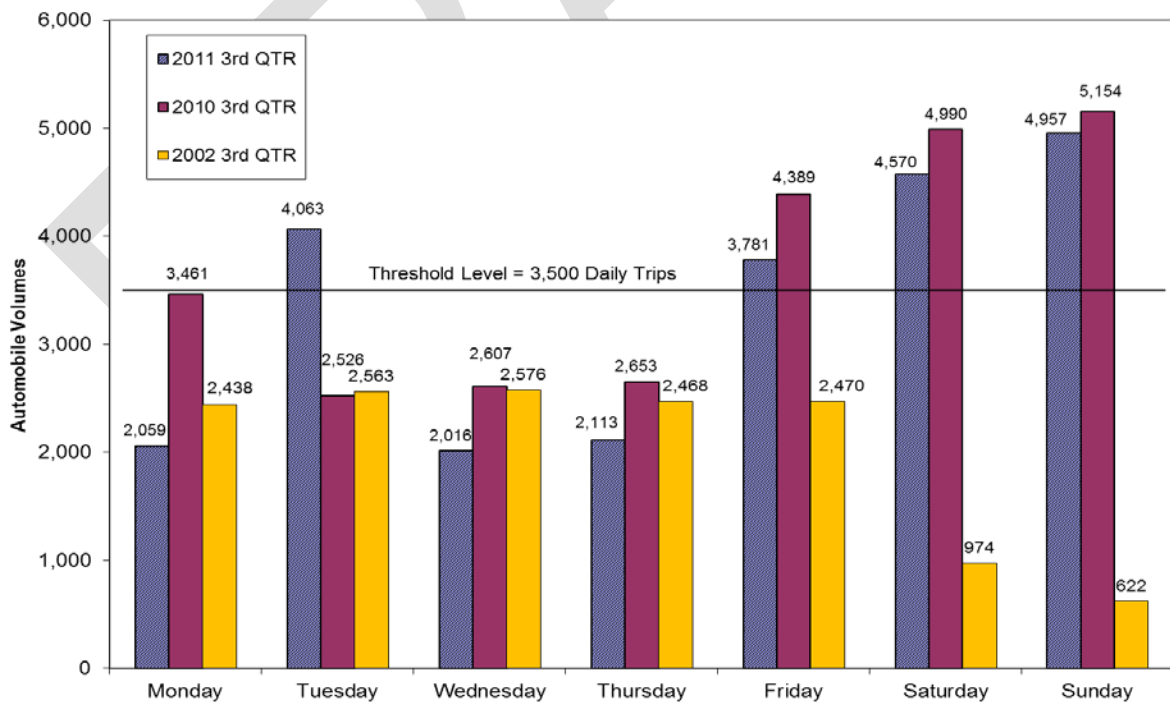
³ Results for 3rd Quarter 2002 were summarized in *Terminal 91 Traffic Monitoring Survey – 2004 1st Quarterly Report*, The Transpo Group, May 2004.

Figure 8. Automobile Trends – PM Peak Period



Source: Results from 2010 and 2011 were compiled by Heffron Transportation, Inc.; results for 3rd Quarter 2002 were compiled by The Transpo Group.

Figure 9. Automobile Traffic – 24-Hour Period

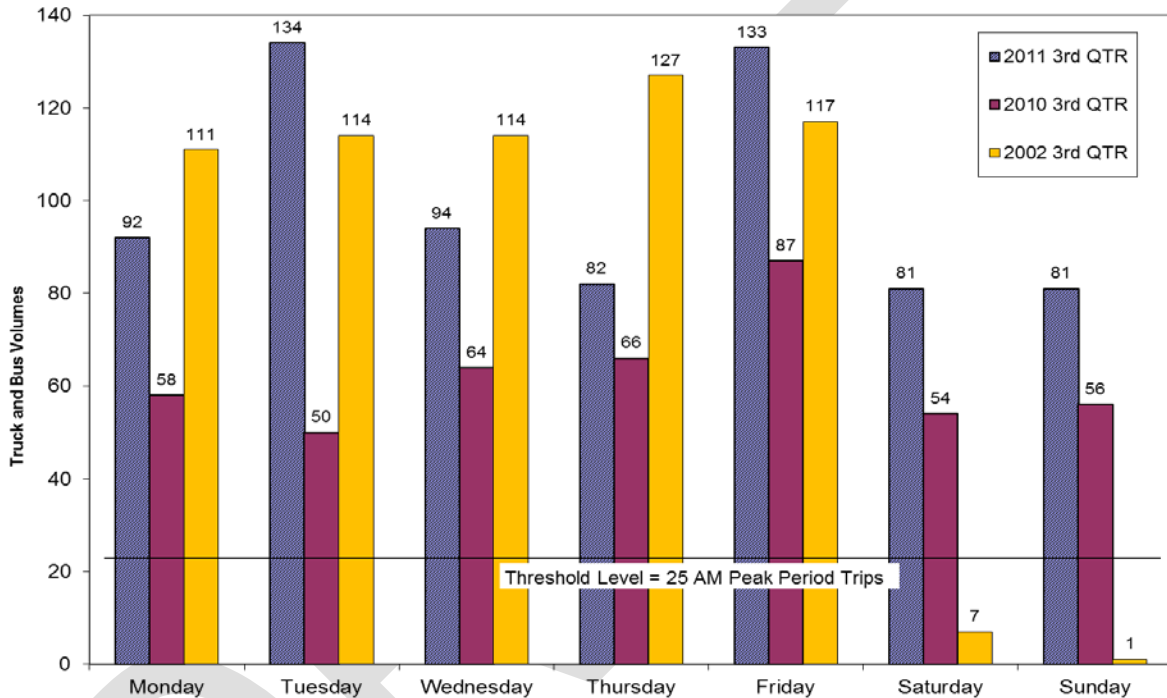


Source: Results from 2010 and 2011 were compiled by Heffron Transportation, Inc.; results for 3rd Quarter 2002 were compiled by The Transpo Group.

4.2. Truck (and Bus) Traffic Trends

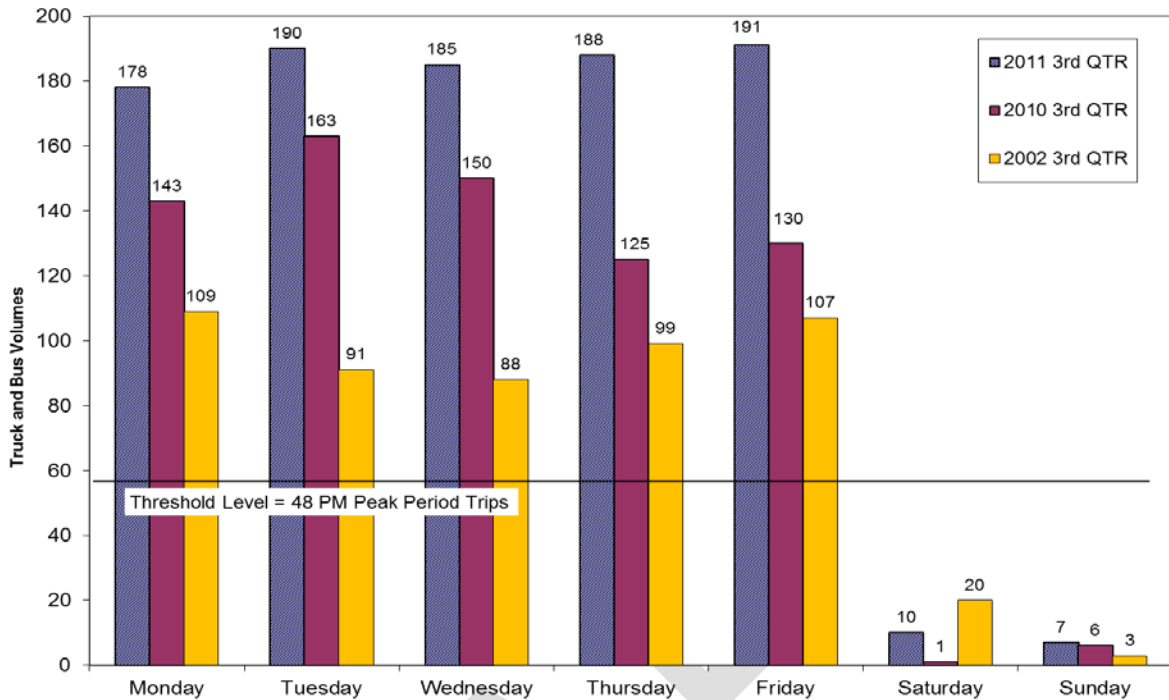
Figures 10, 11, and 12 compare truck volumes to prior monitoring results for the AM peak, PM peak, and 24-hour periods, respectively. These volumes include buses and trucks. These results show that the number of large vehicles during the AM peak period is slightly higher than 2002 levels on days with cruise operations (Tuesday and Friday) and lower than 2002 levels on days without cruise activity. During the PM peak hour and for the 24-hour period, the number of large vehicles is higher on all days of the week. This indicates an increase in industrial activity (and school bus traffic) at T-91 that is not related to cruise operations.

Figure 10. Truck (and Bus) Trends – AM Peak Period



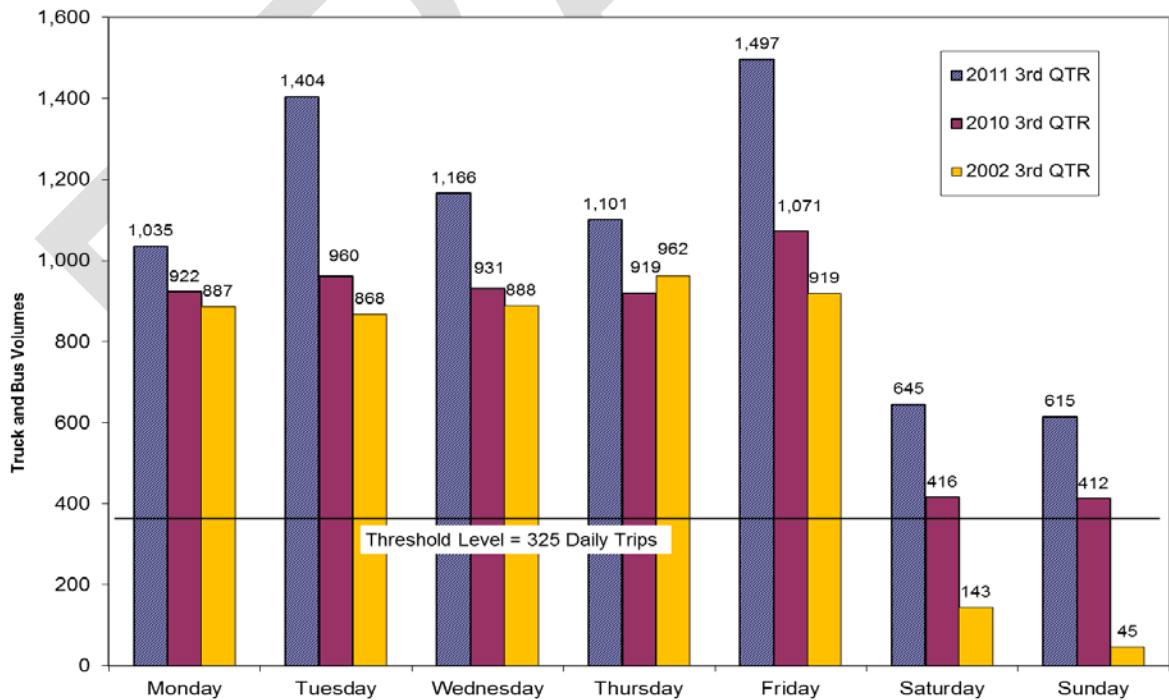
Source: Results from 2010 and 2011 were compiled by Heffron Transportation, Inc.; results for 3rd Quarter 2002 were compiled by The Transpo Group.

Figure 11. Truck (and Bus) Trends – PM Peak Period



Source: Results from 2010 and 2011 were compiled by Heffron Transportation, Inc.; results for 3rd Quarter 2002 were compiled by The Transpo Group.

Figure 12. Truck (and Bus) Trends – 24-Hour Period



Source: Results from 2010 and 2011 were compiled by Heffron Transportation, Inc.; results for 3rd Quarter 2002 were compiled by The Transpo Group.

5. INTERSECTION LEVEL OF SERVICE

5.1. Trigger Levels

The SFRA established level of service trigger levels for three off-site intersections. Level of service is a qualitative measure used to characterize traffic operating conditions. Six letter designations, “A” through “F,” are used to define level of service. LOS A is the best and represents good traffic operations with little or no delay to motorists. LOS F is the worst and indicates poor traffic operations with long delays. The trigger levels are summarized in Table 5. It is noted that the SFRA included the W Galer Street intersection on Elliott Avenue W, which was the primary access to Terminal 91 when the SFRA was created. That access has been replaced with the Galer Street Flyover. Therefore, the trigger level previously established for Galer Street was applied to the Elliott Avenue W/Galer Flyover intersection

Table 5. Level of Service Trigger Levels from SFRA

Intersection	Trigger Level
Elliott Avenue W/Galer Flyover ^a	LOS E
Elliott Avenue W/W Garfield Street	LOS C
Elliott Avenue W/W Mercer Place	LOS E

Source: Short-Fill Redevelopment Agreement, January 2000.

a. SFRA included the Elliott Avenue W/ W Galer Street intersection, which was the primary access to Terminal 91. That access has been replaced with the Galer Street Flyover.

As previously discussed, the level of service methodology prescribed by the SFRA (Critical Lane Analysis) is outdated. Computers now allow more complex calculations to occur, which have resulted in more accurate analyses of intersection operations. For this study, intersection levels of service were determined using the methodologies in the two latest editions of the *Highway Capacity Manual* (Transportation Research Board, 2000 and 2010), which serves as the industry standard. The year 2000 methodology was used to provide a comparison to last year’s monitoring results; the year 2010 methodology to provide a basis of comparison for future monitoring studies, which should be performed based on the latest version of the *Highway Capacity Manual* to ensure that the analysis is compatible with other, related studies that may be conducted by others in the vicinity of Terminal 91. Levels of service for study area intersections were calculated using Trafficware’s *Synchro 7.0* and *Synchro 8.0* traffic operations analysis software, which relate to the 2000 and 2010 methodologies, respectively. These methodologies reflect standard traffic engineering practice and are compatible with analyses performed for other projects.

Levels of service models developed by Seattle Department of Transportation (SDOT) for the Elliott/15th Avenue corridor were used for all analyses; these models reflect the current configuration (with the BAT lanes) and existing signal timings. The model was updated to reflect the extended southbound left turn lane on Elliott Avenue W at W Mercer Place.

5.2. Year 2011 Traffic Volumes

New intersection counts were performed at all three study intersection on October 5, 2011. These volumes were performed when no cruise activity was occurring at the Port.

The gate counts described in the prior sections were used to determine the net change in AM and PM peak hour traffic between a cruise and a non-cruise day. This information is summarized in Table 6. As shown, a single cruise ship generated 243 more trips to and from Terminal 91 during the AM peak hour (8:00 to 9:00 A.M.) than a non-cruise day. During the PM peak hour, traffic generated by Terminal 91 is

nearly identical on cruise and non-cruise days confirming prior assumptions that the cruise terminal generates little to no traffic during this period. The volumes in the table reflect a condition with just one cruise ship at Terminal 91 for which a total of 4,362 passengers embarked and disembarked. Although it did not happen in 2011, in prior years, there were times when two cruise ships would berth simultaneously at T-91. During last year’s monitoring, two ships on a Friday had a total of 6,942 passengers embark and disembark. Therefore, in order to evaluate a condition with two cruise ships at the terminal on a weekday, traffic associated with the cruise terminal was increased to reflect a total of 6,942 total passenger embark and disembark per day.

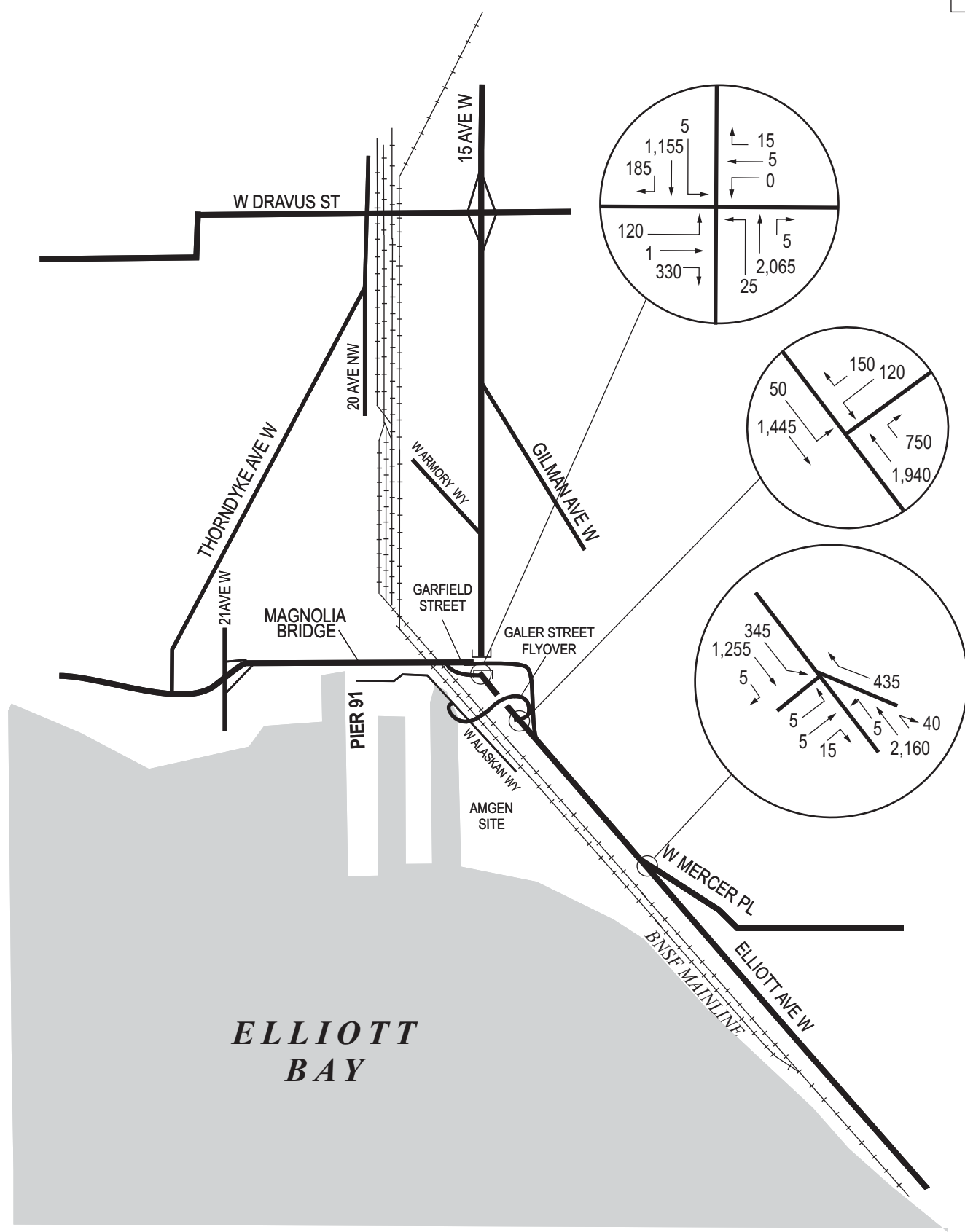
Table 6. Peak Hour Traffic: Cruise Day vs. Non-Cruise Day

	East Gate		Center Gate		West Access		Total Terminal 91		
	Enter	Exit	Enter	Exit	Enter	Exit	Enter	Exit	Total
AM Peak Hour (8:00 to 9:00 A.M.)									
Cruise Day (Tues, 9/13/11) ^a	171	151	22	5	20	27	213	183	396
Non-Cruise Day (Wed,9/14/11)	<u>75</u>	<u>44</u>	<u>27</u>	<u>7</u>	<u>0</u>	<u>0</u>	<u>102</u>	<u>51</u>	<u>153</u>
Net Change with One Cruise Ship	96	107	-5	-2	20	27	111	132	243
<i>Net Change with Two Cruise Ships ^b</i>	<i>153</i>	<i>170</i>	<i>-5</i>	<i>-2</i>	<i>32</i>	<i>43</i>	<i>177</i>	<i>210</i>	<i>387</i>
PM Peak Hour (5:00 to 6:00 P.M.)									
Cruise Day (Tues, 9/13/11) ^a	55	136	0	16	0	0	55	152	207
Non-Cruise Day (Wed,9/14/11)	59	133	1	18	0	0	60	151	211
Net Change	-4	3	-1	-2	0	0	-5	1	-4

Source: Compiled by Heffron Transportation, Inc. from nine-day machine counts performed by All Traffic Data in September 2011.

- a. The Cruise Day (Tuesday, September 13, 2011) reflects a condition with one cruise ship at Terminal 91 with a total of 4,362 passengers that embarked and disembarked at the terminal.
- b. Net change with two cruise ships estimated for a total of 6,942 passengers that embark and disembark at the terminal on a weekday. This is the number that embarked or disembarked on a day with two, simultaneously-berthed cruise ships in 2010.

Traffic generated by two cruise ships was distributed to the roadway network and assigned to the study-area intersections according to travel patterns defined by traffic counts performed for the 2010 Monitoring study. The cruise traffic was then added to study-area traffic counts from October 2011 to reflect conditions with the cruise ship activity. Figures 13 and 14 show the AM peak hour volumes at the three monitoring intersections without and with a double-cruise operation at Terminal 91, respectively. Figure 15 shows the PM peak hour volumes, which are the same without or with a cruise.



TERMINAL 91
TRAFFIC MONITORING

Figure 15
EXISTING (2011) PM PEAK HOUR TRAFFIC VOLUMES
WITHOUT or WITH CRUISE AT TERMINAL 91

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5.3. Level of Service Analysis

Peak hour traffic volumes shown on Figures 13 through 15 were used to determine the levels of service for study-area intersections. This analysis reflects existing conditions on a normal day (without cruise operations at Terminal 91) and on a cruise day (with traffic from two cruise ships added to the roadways). As previously discussed, the methodology to determine level of service has been updated many times since this agreement was originally drafted. To provide a direct comparison between year 2010 and 2011 results, the same methodology, using Synchro 7.0 software, was used to calculate level of service. These results are summarized in Table 7. However, a new *Highway Capacity Manual* was released at the end of 2010 and the Synchro analyses software was updated in 2011. Therefore, results were also evaluated using the new methodology (with the Synchro 8.0 software) in order to provide a comparison basis for future monitoring efforts. These results are summarized in Table 8.

Using either level of service methodology, all three intersections would be below the SFRA trigger levels with cruise operations.

Table 7. Existing (2011) Traffic Operations With and Without Cruise Traffic from Two Ships ^a
 Using Synchro 7.0 Methodology

Condition/Intersection	SFRA Trigger Level	Level of Service			
		Without Cruise		With Cruise ^a	
		LOS	Delay	LOS	Delay
AM Peak Hour					
15th Ave/Garfield Street	LOS C	A	2.6	A	2.8
Elliott Ave/Galer Street Flyover	LOS E	B	10.0	C	24.2
Elliott Ave/W Mercer Place	LOS E	D	42.9	D	56.6
PM Peak Hour					
15th Ave/Garfield Street	LOS C	B	10.6	Same as without cruise	
Elliott Ave/Galer Street Flyover	LOS E	B	14.2	Same as without cruise	
Elliott Ave/W Mercer Place	LOS E	C	25.7	Same as without cruise	

Source: Heffron Transportation, Inc. Levels of service were calculated using traffic operations models developed by SDOT for the Elliott Avenue corridor. They reflect existing signal timing and lane geometry. All analysis was performed using the Synchro 7.0 model and methodology.

a. Reflects a condition with two cruise ships at Terminal 91.

Table 8. Existing (2011) Traffic Operations With and Without Cruise Traffic from Two Ships^a
 Using Synchro 8.0 Methodology

Condition/Intersection	SFRA Trigger Level	Level of Service			
		Without Cruise		With Cruise ^a	
		LOS	Delay	LOS	Delay
AM Peak Hour					
15th Ave/Garfield Street	LOS C	A	2.5	A	2.8
Elliott Ave/Galer Street Flyover	LOS E	A	8.4	C	21.8
Elliott Ave/W Mercer Place	LOS E	C	27.7	D	36.6
PM Peak Hour					
15th Ave/Garfield Street	LOS C	A	7.9	Same as without cruise	
Elliott Ave/Galer Street Flyover	LOS E	B	12.1	Same as without cruise	
Elliott Ave/W Mercer Place	LOS E	C	20.5	Same as without cruise	

Source: Heffron Transportation, Inc. Levels of service were calculated using traffic operations models developed by SDOT for the Elliott Avenue corridor. They reflect existing signal timing and lane geometry. All analysis was performed using the Synchro 8.0 model and methodology.

a. Reflects a condition with two cruise ships at Terminal 91.

6. CONCLUSIONS

This Terminal 91 Monitoring Study shows that truck trips continue to exceed the volume thresholds for AM, PM and daily periods, and have exceeded those thresholds for many years. Automobile trips exceed the thresholds during the AM and daily periods on days with cruise operations. However, despite the fact that the traffic volume thresholds are exceeded, traffic operations along the Elliott Avenue/15th Avenue W corridor still operate below the trigger levels. This year's results are very similar to last year's.