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Research Project T2695, Task 36
Congestion Measurement

MEASUREMENT OF RECURRING VERSUS NON-RECURRING CONGESTION

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16. ABSTRACT

A research effort was initiated to develop and test a methodology to estimate the extent to which urban congestion is produced by the routine presence of large numbers of vehicles on a facility (so-called recurring congestion) versus unexpected disruptions or other events (non-recurring congestion), particularly lane blocking incidents. An analysis was performed using a preliminary methodology to estimate the magnitude, extent, and relative causes of congestion on urban freeways in the central Puget Sound region of Washington State. This information is designed to assist transportation agencies in 1) selecting the most appropriate strategies to improve freeway operations, and 2) allocating available resources to achieve those improvements. This paper documents the preliminary methodology and results from this ongoing research project.

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MEASUREMENT OF RECURRING VERSUS NON-RECURRING CONGESTION

This project examined the size, extent, and relative causes of congestion on urban freeways in the Puget Sound region. It made a substantial (but initial) step toward understanding the relative importance of different causes of congestion in the metropolitan area. The intent was to provide the Washington State Department of Transportation (WSDOT) with the knowledge it needs to make decisions about how to improve freeway operations and how to allocate the resources available for making those improvements.

Key to this study was an analysis of how much congestion is caused simply because too many vehicles routinely attempt to use the facility, and how much is caused by frequent, "unexpected" disruptions or events.

RECURRING VERSUS NON-RECURRING CONGESTION

For this project, congestion was subdivided into "recurring" and "non-recurring" congestion. "Non-recurring" congestion was further subdivided into delay caused by lane blocking incidents and other causes of "unusual congestion."

Recurring congestion was defined by this study as congestion caused by routine traffic volumes operating in a typical environment. In layman's terms it might be thought of as "the congestion present on a normal day if nothing bad has happened on the roadway." In essence, this definition is grounded in the concept of "expected congestion" if no "unusual circumstances" occur.

While this definition makes sense, it does create some analytical difficulties. Most important is the fact that "expected congestion" is dependent on time and location.

On most urban freeways, more congestion is expected on weekdays in the commute periods than during the middle of the day. Similarly, more congestion is expected in the middle of the day than at night. Friday mornings tend to have light congestion, while Friday afternoon tends to be worse. Weekends tend to have lower "expected" levels of congestion than weekdays, although most people expect very heavy congestion during specific holiday weekends (e.g., the Sunday afternoon on Memorial Day weekend).

Similarly, expected conditions change with location. Most urban freeways have known bottlenecks, locations where traffic backs up routinely, especially during peak commute periods. Other roadway sections experience little routine congestion.

"Non-recurring congestion" was defined for this study as "unexpected or unusual congestion caused by an event that was unexpected and transient relative to other similar days." Non-recurring congestion can be caused by a variety of factors, including, but not limited to,

- lane blocking accidents and disabled vehicles
- other lane blocking events (e.g., debris in the roadway)
- construction lane closures
- significant roadside distractions that alter driver behavior (e.g., roadside construction, electronic signs, a fire beside the freeway)
- inclement weather
- heavier than normal vehicle merging movements
- significant increases in traffic volume in comparison to "normal" traffic volumes.

Under low traffic volume conditions (relative to capacity), none of these events may result in congestion. But as volume grows relative to capacity, congestion can easily result from these events.

Reducing the impacts of these unexpected events during moderate to high volume conditions is one of the major goals of traffic management systems. Many of these same traffic management efforts can also be used to control and limit recurring congestion. The question for highway agencies is how much congestion is caused by simply having too many vehicles routinely using the roadways (recurring congestion), and how much is caused by short-term, unexpected events (non-recurring congestion)?

Understanding and tracking this distribution may allow the agency to

- select cost-effective approaches for lowering the mount of congestion experienced by travelers
- track the effectiveness of the congestion relief efforts the agency undertakes
- determine the limits of likely operational improvements, and thus identify congestion that can be alleviated only by capacity expansion through either mode shift or an increased number of roadway lanes.

Within the category of non-recurring congestion, it is also important for highway agencies to understand how much congestion is caused by particular types of events, as the causes of these "temporary" problems may change how an agency would approach limiting their effects. This study examined only the simple split of lane blocking versus "other" non-recurring events. This split was intended to address the need for incident response programs aimed at quickly arriving at, and clearing, lane blockages. However, these programs are likely to have a limited effect in the face of many other causes of non-recurring congestion. Thus, additional study will be needed to identify these other causes and their relative importance to improving traffic flow.

RESEARCH APPROACH

To simplify this project while dealing with the issues of temporal and spatial variability in traffic flow, the research team restricted this initial analysis of recurring and non-recurring congestion to weekdays, and specifically, Tuesday through Thursday. In addition, the analysis was broken into four specific time periods: AM peak (6:00 to 9:00 AM), midday (9:00 AM to 3:00 PM), PM peak (3:00 to 7:00 PM), and night.

Geographically, the study included the mainlines of the entire central Puget Sound metropolitan freeway system under surveillance. That includes five separate, connected freeways and roughly 100 center-line miles of roadway.[1] Data for two months were used, covering September and October of 2002.

Although the times and locations were limited, the approach we have developed is applicable to any time period and geographic scope. Only the conclusions produced in this report are limited to these facilities and time periods.

The key to the analysis was the mathematical definition of "recurring" and "non-recurring" congestion. We chose to define "non-recurring congestion" and to then associate any congestion not associated with those non-recurring conditions as being "recurring." For this study, we used the following definitions:

"**Non-recurring Congestion**" is all congestion that occurs when conditions are significantly worse than expected, that is, worse than routine operating conditions.

Recurring Congestion is all other congestion.

[1] 35 miles on I-5, 28 miles on I-405, 13 miles on I-90, 12 miles on SR 520, and 11 miles on SR 167.

Routine Operating Conditions are the median operating condition for that time and location on the road network.

Mathematically, we used percentage of lane occupancy, aggregated at 5-minute intervals across all (directional) lanes of a freeway at each data collection location, as our measure of facility operating condition, along with vehicle volume and speed. We defined "non-recurring congestion" mathematically as occurring when lane occupancy is 5 or more percentage points higher than the median operating condition (expressed in percentage of lane occupancy) for that time and location for all days being studied that do not contain a lane blocking incident during the period of interest. Thus, if between 6:00 and 6:05, at milepost 100, the roadway routinely operates with a median lane occupancy of 10 percent, non-recurring congestion only exists when measured lane occupancy exceeds 14.9 percent. A more detailed discussion of how this definition was chosen is presented in the Technical Report for this project.[2]

The estimation of the amount of actual congestion at any point in time and space is based on the volume and speed of vehicles present at each loop measurement location, every 5 minutes. The speed of vehicles is compared to a reference speed, and vehicle-hours of delay is computed on the basis of the difference between average speed and that reference speed. Two different reference speeds are used, one of 60 miles per hour, the speed limit for most of the freeway system being studied, and one of 50 mph, the approximate speed at which the Highway Capacity Manual indicates maximum facility flow can be maintained. The 60 mph reference can be thought of as a measure of "delay" from the perspective of the motorist, who wishes to travel at the speed limit. The 50 mph

[2] John Ishimaru, "Measurement of Recurring and Non-recurring Congestion: Technical Report," October 2003.

reference speed can be thought of as "delay" from the perspective of a highway agency trying to maximize the use of existing roadway capacity.

The following list describes the steps in the delay computation procedure. All procedures are performed by facility, by direction.

- Determine traffic performance (vehicle volume, speed, and lane occupancy) by time and location.
- Identify which days were affected by lane blocking incidents. (This is performed by time of day, where the time of day is defined as AM peak period, midday, and PM peak period.)
- For all days when lane blocking incidents did not occur during the period of analysis, compute the median condition (by time of day and location).[3] This median condition serves as the "expected, recurring, condition."
- For each day, compute the times and locations where congestion was "significantly worse"[4] than the "expected recurring condition." These locations were defined for this study as being sites of "non-recurring congestion."
- For all days when major lane blocking incidents took place, determine the time, location, and duration of each incident recorded.

[3] Note that if a lane blocking incident occurred in the AM peak period and the effect of that incident lasted into the midday period, that midday was also treated as an "incident day."
[4] "Significantly worse" is defined as a change in lane occupancy of greater than 5 percent.

- For all days when major lane blocking incidents took place, determine the geographic and temporal extent of "significantly worse than expected" congestion[5] that was associated with each lane blocking incident.[6]
- Using the 60 mph baseline standard, compute the delay associated with each of the "significantly worse than expected" geographic and temporal areas associated with lane blocking incidents. (This is performed twice, once with a "liberal" definition and once with a "conservative" definition.) These are the estimates of non-recurring delay caused by lane blocking incidents.
- Using the 60 mph baseline speed, compute the delay associated with all areas where and times when conditions are defined as "significantly worse than expected" for all days. This includes the delay associated with incidents, as well as all other non-recurring delay. This is the estimate of total non-recurring delay.
- For all days compute the total amount of delay, assuming delay is any travel slower than free flow conditions (60 mph).

[5] Because of the interaction of the many factors that affect traffic congestion, this task is extremely difficult. The project team chose two alternative approaches to this task. One provided a conservative estimate of "incident related congestion," meaning that much of the congestion occurring in the vicinity of the incident after it had been cleared was attributed to background traffic volumes and was not associated with the incident. The second approach assigned the majority of congestion contiguous to the location of the incident and after its occurrence to that incident. See the Technical Report cited previously for a more detailed discussion of how congestion was assigned to a lane blocking incident under these two different approaches.

[6] Note that one limitation of this analysis methodology is that the project team did not attempt to track the effects of incident congestion across facilities. That is, we did not attempt to determine the extent to which delay on I-5 was caused by a lane blocking incident that occurred on SR 520. Thus, our estimates of lane blocking-related, non-recurring delay slightly underestimated the actual values.

- Subtract from the estimate of total delay the non-recurring delay computed above. The result is the estimate of total recurring delay based on a 60 mph standard.
- Repeat the preceding four steps, except with a 50 mph baseline speed. This produces the required estimates of recurring, non-recurring, and total delay based on the 50 mph standard.
- Aggregate and summarize these levels of delay across corridors and for different time of day/volume conditions within corridors.

SUMMARY PROJECT FINDINGS

Our review of the performance and incident data for these two months in 2002 provided the following insights. (Some additional notes on these conclusions follow these bullets.)

- Corridor performance, including total delay, the percentage of delay that is related to non-recurring sources, and the percentage of delay associated with lane blocking incidents, is highly variable.
  The primary sources of variation are vehicle volumes, especially as they vary as they approach roadway capacity, the length of time at which volumes routinely approach capacity, the number of incidents that occur along the corridor, and the frequency with which those incidents block freeway lanes.
- For the urban freeway corridors examined, lane blocking incidents are responsible for between 2 and 20 percent of total daily delay. Facilities

that have few lane blocking incidents, primarily I-90 and I-405 northbound from Bellevue to Mill Creek, are on the lower range of these figures, whereas facilities with larger numbers of lane blocking incidents (SR 520, I-5) are on the upper end.

- Non-recurring delay generally ranges between 30 to 50 percent of all peak period, peak direction delay, but it is between 30 and 70 percent of total daily delay. Outliers occur where the frequency or severity of incidents is particularly high, or where traffic volumes are very low relative to roadway capacity.
- Lane blocking incidents generally account for between 10 and 35 percent of all non-recurring delay.
- Thus, for most corridors, only between 1 and 10 percent of peak period delay is caused by lane blocking incidents. In part this is due to the high level of "recurring congestion" on the area's freeways and the relative infrequency of lane blocking incidents during the peak period. These numbers can be exceeded when a large number of lane blocking incidents occur, or when little other congestion takes place.
- For all roadways, the more that recurring congestion occurs, the lower the <u>percentage</u> of "non-recurring" congestion from all sources. For example, on a frequently congested facility such as I-405 northbound from Tukwila to Bellevue, only a modest percentage of congestion is caused by non-recurring events (including lane blocking events). The opposite is also true. Late at night, when almost no recurring congestion exists, essentially

all delay is caused by lane blocking events. This is because without significant reductions in available roadway capacity, there is no congestion.

- Expressing the significance of non-recurring congestion only as a percentage of total congestion does not fully describe the magnitude of non-recurring congestion such as lane blocking events. For example, even though the percentage of congestion that is non-recurring decreases as volume on a facility increases, the absolute number of vehicle hours of delay due to non-recurring events can increase significantly. (This dichotomy occurs simply because of mathematical relationships of ratios.)
- In peak periods, on any facility, a lane blocking incident of even a short duration tends to result in substantial delay. For example, a 3-minute, lane blocking incident on eastbound I-90 that occurred at 9:00 AM (after the peak of the rush hour) resulted in 35 vehicle-hours of delay on that freeway (roughly 700 minutes of vehicle-delay for each minute of incident duration).

The combination of these facts leads to the following conclusions.

- While incident response is as important as it has been made out to be, the Department still has a long way to go in reducing the effects of “unusual” occurrences. Many large delays still occur for which incidents are not responsible, and for which no “cause” is present in the WITS[7] database.

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[7] The Washington Incident Tracking System database (WITS) tracks the activities of the WSDOT freeway service patrol.

(This means that there was no on-site WSDOT response to whatever caused the “unusual” delay.)

These “extra” delays could be caused by any of a large number of factors, including

* unusual volume surges at ramps (e.g., on I-90 westbound at West Lake Sammamish) that are not being handled effectively by the ramp metering program (This could in turn be caused by a lack of ramp storage space or other control issues.)
* weather, although the period selected for study (September/October of 2002) does not have the worst weather of the year
* visual distractions (police vehicle by the side of the road) or something occurring outside of the right-of-way.

Additional effort needs to be spent to understand the causes of these non-recurring congestion events.

- Even in places where congestion occurs routinely, the scope and intensity of that congestion varies considerably from day to day.
- This implies that there is still considerable room for improvement in increasing the reliability of the freeway system through better freeway management.

DETAILED ANALYTICAL RESULTS

The six tables at the end of this report summarize the basic results of this analysis. Table 1 describes the level of daily delay experienced on each of the study corridors if a 50 mph baseline standard (optimal flow) is used as the basis for delay calculations. Table 2 describes corridor delay using the 60 mph baseline standard (free flow conditions). Table 3 provides some basic statistics on each of the corridors, including its length, the width of the "average" directional section for each corridor (this changes from segment to segment within a corridor), the number of lane blocking incidents recorded by WSDOT during the two-month study, and the resulting delay per lane-mile calculated for each facility.

Tables 4, 5, and 6 show how delay varies across the three primary time periods during which delay occurs (AM, midday, and PM). Table 4 shows delay related to lane blocking incidents using the "conservative" method for associating specific delay to a given incident. Table 5 shows how these values change if the more liberal association of congestion is used. Table 6 shows the distribution of <u>all</u> "non-recurring" congestion.

ADDITIONAL INFORMATION AND LIMITATIONS OF THE DATABASES

All facility performance data used in this study were extracted from the 5-minute freeway flow archive maintained by WSDOT. Data on the time, location, and duration of all lane blocking incidents used in the study area were obtained by comparing two major data sources, the Washington Incident Tracking System database (WITS), which tracks the activities of WSDOT's freeway service patrols, and the Traffic Systems Management Center (TSMC) incident log. Comment fields in both databases were manually reviewed to more precisely determine the presence, location, and duration of lane blocking incidents. While this was time consuming, it was necessary to resolve discrepancies found in both incident databases. Removing these discrepancies was necessary to ensure the integrity of the project conclusions.

The existing CD Analyst software and analytical process were then revised to perform the analytical steps described earlier in this paper.

By using only Tuesday through Thursday flow data during September and October, the analysis was able to remove some known variation in traffic volumes. This carefully selected timeframe allowed a more precise definition of "routine, non-incident, traffic conditions," and thus the computation of "non-recurring" congestion. However, it also skewed the results toward Tuesday-Thursday travel conditions, and thus results in a slightly biased conclusion. Inclusion of Monday, Friday, and weekend traffic performance data would result in slightly different results. However, the inclusion of these days would also complicate the analysis by making it more difficult to define routine, non-incident conditions. The reason is that because motorists expect weekend conditions to be different, different baseline conditions would be needed to perform this analysis from the perspective of the traveler. It is not clear without additional research which of these four days should be treated independently from the "average weekday" condition.

Before extending the analysis to these additional days, the project team wanted to present this approach to the roadway performance research community to obtain input and comments. The project team has particular interest in the research community's review of this study's use of alternative baseline speeds for the calculation of delay, the use of the median condition for determining “routine” conditions, and the use of “routine conditions” along with a modest performance band to define “non-recurring” congestion.

Table 1: Daily Delay Computations Using a 50 mph Baseline Condition

	SB I-5 Everett - Seattle	SB I-5 Seattle CBD – Des Moines	NB I-5 Des Moines – Seattle CBD	NB I-5 Seattle CBD - Everett	WB SR 520 Redmond - Seattle	EB SR 520 Seattle - Redmond	WB I-90 Issaquah - Seattle	EB I-90 Seattle – Issaquah	NB I-405 Tukwila - Bellevue	NB I-405 Bellevue – Swamp Creek	SB I-405 Swamp Creek - Bellevue	SB I-405 Bellevue - Tukwila	SB SR 167 Renton - Auburn	NB SR 167 Auburn - Renton
Total Delay (Tues-Thurs, for Sept/Oct) (veh.-hrs.)	161,000	23,000	98,000	103,000	29,000	35,000	29,000	19,000	72,000	65,000	85,000	75,000	40,000	16,000
Percentage of Delay Caused by Lane Blocking Incidents (Conservative Estimate)	8.1%	18.6%	8.8%	6.9%	10.1%	6.1%	1.8%	2.5%	3.9%	0.4%	4.1%	3.2%	4.9%	6.5%
Percentage of Delay Caused by Lane Blocking Incidents (Liberal Estimate)	15.1%	19.3%	16.6%	16.8%	23.3%	9.4%	2.%	5.6%	4.6%	1.6%	8.1%	4.2%	12%	7.9%
Percentage of All Delay That Is Non-Recurring	52.2%	70.5%	43.%	49.6%	60.4%	35.6%	68.2%	53.3%	37.4%	19.5%	40.3%	41.4%	65.2%	77.5%

Table 2: Daily Delay Computations Using a 60 mph Baseline Condition

	SB I-5 Everett - Seattle	SB I-5 Seattle CBD – Des Moines	NB I-5 Des Moines – Seattle CBD	NB I-5 Seattle CBD - Everett	WB SR 520 Redmond - Seattle	EB SR 520 Seattle – Redmond	WB I-90 Issaquah - Seattle	EB I-90 Seattle – Issaquah	NB I-405 Tukwila - Bellevue	NB I-405 Bellevue – Swamp Creek	SB I-405 Swamp Creek - Bellevue	SB I-405 Bellevue - Tukwila	SB SR 167 Renton - Auburn	NB SR 167 Auburn - Renton
Total Delay (Tues-Thurs, for Sept/Oct) (veh.-hrs.)	208,000	48,000	127,000	145,000	56,000	48,000	40,000	29,000	103,000	91,000	113,000	100,000	55,000	34,000
Percentage of Delay Caused by Lane Blocking Incidents (Conservative Estimate)	6.8%	9.8%	7.5%	5.4%	6.%	4.9%	1.5%	1.9%	3.%	0.3%	3.4%	2.7%	3.9%	3.4%
Percentage of Delay Caused by Lane Blocking Incidents (Liberal Estimate)	12.8%	10.2%	14.3%	13.1%	13.6%	7.6%	1.7%	4.1%	3.6%	1.3%	6.7%	4.%	13.3%	4.1%
Percentage of All Delay That Is Non-Recurring	44.9%	38.1%	37.3%	39.9%	36.3%	29.1%	57.2%	42.1%	29.8%	15.9%	33.7%	25.1%	51.6%	40.1%

Table 3: Daily Delay Computations Descriptive Corridor Statistics

	SB I-5 Everett - Seattle	SB I-5 Seattle CBD – Des Moines	NB I-5 Des Moines – Seattle CBD	NB I-5 Seattle CBD - Everett	WB SR 520 Redmond - Seattle	EB SR 520 Seattle - Redmond	WB I-90 Issaquah - Seattle	EB I-90 Seattle – Issaquah	NB I-405 Tukwila - Bellevue	NB I-405 Bellevue – Swamp Creek	SB I-405 Swamp Creek - Bellevue	SB I-405 Bellevue - Tukwila	SB SR 167 Renton - Auburn	NB SR 167 Auburn - Renton
Total Delay (Tues-Thurs, for Sept/Oct) (veh.-hrs.)	161,000	23,000	98,000	103,000	29,000	35,000	29,000	19,000	72,000	65,000	85,000	75,000	40,000	16,000
Length of Corridor (miles)	22.5	12.5	13	22	11.5	11	13.5	12.5	13	15	15.5	12.5	9	9
Width of Average Roadway Section (Number of lanes)	3	4	4	3	2	2	3	3	2	3	3	2	2	2
Number of Lane Blocking Incidents Recorded (Sept – Oct 2002)	45	18	37	27	28	24	8	8	28	7	26	19	11	8
Delay Per Lane-Mile (veh.-hrs.)	7,200	1,900	7,500	4,700	2,600	3,200	2,100	1,500	5,500	4,300	5,500	6,000	4,400	1,700

Table 4: Congestion Caused By Lane Blocking Incidents (Conservative Estimate, 50 mph Baseline) By Time Period

	SB I-5 Everett - Seattle	SB I-5 Seattle CBD – Des Moines	NB I-5 Des Moines – Seattle CBD	NB I-5 Seattle CBD - Everett	WB SR 520 Redmond - Seattle	EB SR 520 Seattle – Redmond	WB I-90 Issaquah - Seattle	EB I-90 Seattle – Issaquah	NB I-405 Tukwila - Bellevue	NB I-405 Bellevue – Swamp Creek	SB I-405 Swamp Creek - Bellevue	SB I-405 Bellevue – Tukwila	SB SR 167 Renton - Auburn	NB SR 167 Auburn – Renton
AM Peak Period Tues-Thurs Veh.-hrs of Delay)	2,100	50	2,100	600	200	300	100	100	1,100	0	1,900	700	100	700
Percentage of Total AM Peak Period Delay	2%	4%	5%	10%	2%	3%	1%	1%	3%	0%	3%	6%	17%	8%
Number of Days With Lane Blocking Incidents	10	1	10	5	6	4	4	2	10	0	10	3	1	4
Midday Tues-Thurs Veh.-hrs of Delay)	5,100	1,700	3,600	2,200	1,100	500	100	100	1,100	0	800	300	500	200
Percentage of Total Midday Delay	17%	29%	14%	28%	25%	9%	7%	5%	5%	0%	6%	2%	10%	5%
Number of Days With Lane Blocking Incidents	16	9	16	7	8	8	3	3	9	0	9	4	4	4
PM Peak Period Tues-Thurs Veh.-hrs of Delay)	5,800	2,600	2,900	4,300	1,600	1,300	300	200	600	200	800	1,400	1,400	50
Percentage of Total PM Peak Period Delay	14%	16%	11%	5%	6%	7%	3%	3%	5%	0%	10%	3%	4%	3%
Number of Days With Lane Blocking Incidents	19	8	11	15	12	12	3	3	8	7	7	13	6	3

Table 5: Congestion Caused By Lane Blocking Incidents (Liberal Estimate, 50 mph baseline) By Time Period

	SB I-5 Everett - Seattle	SB I-5 Seattle CBD – Des Moines	NB I-5 Des Moines – Seattle CBD	NB I-5 Seattle CBD - Everett	WB SR 520 Redmond - Seattle	EB SR 520 Seattle - Redmond	WB I-90 Issaquah – Seattle	EB I-90 Seattle – Issaquah	NB I-405 Tukwila - Bellevue	NB I-405 Bellevue – Swamp Creek	SB I-405 Swamp Creek - Bellevue	SB I-405 Bellevue - Tukwila	SB SR 167 Renton - Auburn	NB SR 167 Auburn - Renton
AM Peak Period Tues-Thurs Veh.-hrs of Delay)	3,300	50	2,400	600	500	300	100	100	1,300	0	2,900	800	100	1,000
Percentage of Total AM Peak Period Delay	4%	4%	5%	10%	5%	3%	1%	1%	3%	0%	5%	6%	17%	7%
Number of Days With Lane Blocking Incidents	10	1	10	5	6	4	4	2	10	0	10	3	1	4
Midday Tues-Thurs Veh.-hrs of Delay)	8,500	1,700	6,500	3,700	2,100	1,000	200	200	1,100	0	1,900	300	500	200
Percentage of Total Midday Delay	29%	29%	25%	46%	46%	18%	10%	6%	6%	0%	15%	2%	11%	5%
Number of Days With Lane Blocking Incidents	16	9	16	7	8	8	3	3	9	0	9	4	4	4
PM Peak Period Tues-Thurs Veh.-hrs of Delay)	12,500	2,700	7,400	13,000	4,200	2,000	300	800	900	1,000	2,100	2,200	4,200	50
Percentage of Total PM Peak Period Delay	29%	17%	27%	15%	15%	10%	3%	8%	7%	2%	25%	4%	12%	3%
Number of Days With Lane Blocking Incidents	19	8	11	15	12	12	3	3	8	7	7	13	6	3

Table 6: Total Non-Recurring Congestion (50 mph baseline) By Time Period

	SB I-5 Everett - Seattle	SB I-5 Seattle CBD – Des Moines	NB I-5 Des Moines – Seattle CBD	NB I-5 Seattle CBD – Everett	WB SR 520 Redmond - Seattle	EB SR 520 Seattle – Redmond	WB I-90 Issaquah - Seattle	EB I-90 Seattle – Issaquah	NB I-405 Tukwila - Bellevue	NB I-405 Bellevue – Swamp Creek	SB I-405 Swamp Creek - Bellevue	SB I-405 Bellevue - Tukwila	SB SR 167 Renton - Auburn	NB SR 167 Auburn - Renton
AM Peak Period Tues-Thurs Veh.-hrs of Delay)	33,100	800	11,500	3,500	2,700	1,800	9,900	2,800	12,000	100	19,600	6,600	500	7,300
Percentage of Total AM Peak Period Delay	37%	68%	26%	60%	35%	17%	58%	44%	30%	29%	31%	51%	92%	56%
Midday Tues-Thurs Veh.-hrs of Delay)	21,000	3,300	17,500	6,900	4,000	2,800	1,400	2,000	9,500	900	8,500	7,700	2,800	3,300
Percentage of Total Midday Delay	71%	57%	68%	88%	87%	52%	86%	69%	48%	33%	64%	48%	56%	75%
PM Peak Period Tues-Thurs Veh.-hrs of Delay)	30,000	12,300	13,000	40,500	11,000	7,900	8,400	5,300	5,400	11,600	6,100	16,700	22,700	1,500
Percentage of Total PM Peak Period Delay	70%	76%	48%	46%	39%	41%	82%	54%	47%	19%	74%	37%	66%	83%