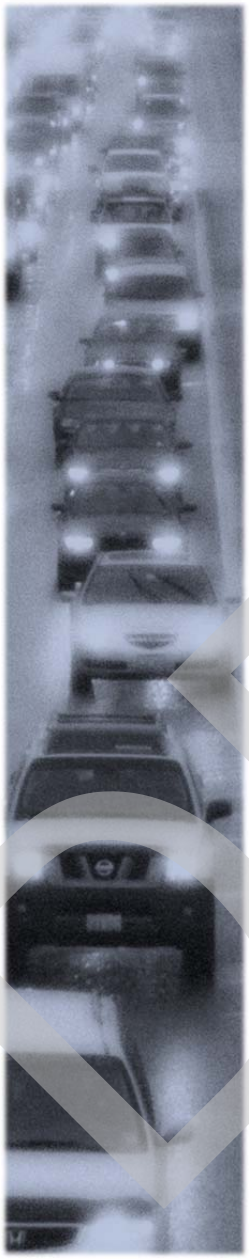
Chapter 2: System Monitoring



This section contains a discussion and display of the system performance measures contained in the Congestion Management Process.

System monitoring is described in two sections. The first, **System Performance Measures**, consists of data compiled for measuring system performance at the corridor level. It is comprised of data that supports the Congestion Management System. The second, **Areas of Concern**, uses shorter segment transportation data, with detail provided in Appendix A, to identify specific segments with congestion concerns related to volume-to-capacity ratio and speed.

There are many sources of congestion including bottlenecks, traffic incidents, bad weather, construction, poor signal timing, and other events. The source of congestion can vary from one corridor to another, such that the strategies to improve capacity must be tailored to each corridor.

This report attempts to measure and quantify average weekday AM and PM peak period "congestion" consistently across the congestion management corridors, through the use of performance measures.

System Performance Measures

Volumes: Vehicle Volumes

AM and PM peak hour vehicle volumes were compiled from the regional traffic count database. Volumes represent traffic counts within each corridor and provide a good comparison of the relative difference in travel demand among the congestion management corridors.

Peak hour traffic volumes for the congestion management corridors are delineated by four volume range categories. These categories are intended to provide a regional picture of travel flows for the Clark County region.

PM peak hour trends are similar to AM peak hour; although, most congestion management corridors carry higher volumes during the PM Peak.

Map 4, Page 20: During the PM peak, I-5 and I-205 and portions of SR-14 and SR-500 display volumes greater than 3,000 vehicles per hour. Within the region, facilities carrying more than 1,500 vehicles in the PM peak hour include segments of

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SR-14, SR-500, SR-503, Mill Plain, Fourth Plain, Andresen Road, 164th Avenue, 192nd Avenue, Padden Parkway, and 134th Street.

The corridors with the highest peak hour volume difference (at least 500 additional vehicles) between the AM and PM peak include: portions of I-5, Mill Plain Boulevard, Fourth Plain Boulevard and Main Street. Main Street is an AM higher peak where the Main Street corridor is used as an alternative to the congested I-5 corridor.

Volumes: Highest Volume Intersections

Table 3 displays the highest volume intersections in 2012 based on the total number of vehicles entering an intersection on an average weekday. At-grade intersections along SR-500, Mill Plain, SR-503, and Padden Parkway dominate the list.

Table 3: Highest Volume Intersections

Rank	East/West	North/South	Volume
1	Mill Plain	Chkalov Drive	74,000
2	Fourth Plain	SR-500	72,000
3	SR-500	54th Avenue	62,000
4	Mill Plain	136th Avenue	62,000
5	SR-500	42nd Avenue	58,000
6	Padden Parkway	SR-503	57,000
7	78th Street	Highway 99	54,000
8	Fourth Plain	Andresen Road	53,000
9	Padden Parkway	Andresen Road	53,000
10	Mill Plain	120th Avenue	51,000
11	134th Street	20th Avenue/Highway 99	50,000
12	Mill Plain	164th Avenue	48,000
13	Mill Plain	123rd /124th Avenue	48,000
14	SR-502	SR-503	47,000

Volumes: Columbia River Bridge Volumes

A good indicator of change to bi-state travel is the amount of vehicle travel across the Columbia River bridges (I-5 and I-205). Table 4 shows the historical growth in Columbia River bridge crossings since 1980.

Daily bridge traffic volumes have been maintained at Columbia River bridges since 1961. The Interstate Bridge carried approximately 33,500 vehicles a day in 1961. Volumes had increased to over 108,000 vehicles a day by 1980. With the opening of the Glenn Jackson Bridge in late-1982, total Columbia River crossings had increased to 144,000 vehicles a day by 1985. By 1995, total river crossings had reached

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222,700; more than double the 1980 crossings. In 2005, Columbia River crossings peaked at 278,500.

The Interstate Bridge had reached capacity during peak hours in the early 1990's. Glenn Jackson Bridge traffic volumes began to exceed the Interstate Bridge traffic volumes on a daily basis in 1999. Interstate Bridge traffic volumes began to decrease, beginning in 2006, as the corridor became saturated through much of the day. Total bridge crossings have declined twice since 1961, in 1974 and 2006-2008. The Glenn Jackson Bridge had its first decline ever in vehicle volumes in 2008.

Table 4: Average Weekday Traffic across the Columbia River

Year	I-5	I-205	Total
1980	108,600	N/A	108,600
1985	91,400	52,600	144,000
1990	95,400	87,100	182,500
1995	116,600	106,100	222,700
2000	126,900	132,100	259,000
2005	132,600	145,900	278,500
2010	126,700	145,500	272,200
2012	128,373	145,440	273,813

Capacity: Corridor Capacity Ratio

The corridor capacity ratio is an aggregation of the volume/capacity ratios for the individual general-purpose segments that make up a facility within a corridor. The corridor capacity ratio is calculated for both the AM and PM peak hours and for the peak directions of travel within a corridor. For each segment in a corridor, the volume/capacity ratio, vehicle miles traveled, and vehicle miles traveled weighted by volume/capacity ratio (the product of the volume/capacity ratio and vehicle miles traveled) for the peak hour are calculated. The corridor capacity ratio is the sum of the weighted link ratios.

The five highest volume-to-capacity ratio corridors include:

1. 18th Street, 112th to 162nd Avenue
2. SR-14, I-205 to 164th Avenue
3. I-205, Airport Way to SR-500
4. Fourth Plain, SR-503 to 162nd Avenue
5. I-5, Jantzen Beach to Main Street

Map 5, Page 21: Both the AM and PM periods show congestion along major facilities such as I-5 South, I-205, SR-14 Central, and SR-500 West. Much of the AM period congestion can be attributed to the demand for crossing the two Interstate

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bridges into Oregon. Generally, the PM period displays higher corridor congestion than that experienced in the AM period.

Map 6, Page 22: In the PM period, additional congestion is shown along SR-503 South, Mill Plain East, Fourth Plain East, and 18th Street.

Map 7, Page 23: In addition to existing corridor capacity ratio, the 2035 PM corridor capacity ratio was calculated using the regional travel forecasting model (2011 MTP forecast model version). The model shows where future corridor congestion will occur even with planned transportation improvements. Generally, the 2035 MTP shows a worsening of congestion. With PM congestion in the I-5, I-205, SR-502, SR-503, Main Street/Highway 99, 112th Avenue, Andresen, 162nd/164th Avenue, Mill Plain East, Fourth Plain East, 18th Street, Burton Road, 134th Street, and La Center Road Corridors. The 2035 model shows that planned transportation improvements positively impact future corridor capacity.

Speed: Auto Travel Speed

Travel time data is collected annually. The data is collected using global position units (GPS) and by driving corridors as many times as possible during peak periods (6:30-8:30 a.m. and 4:00-6:00 p.m.). Travel speed is computed from the travel time data. It consists of utilizing the travel time and distance to calculate the average travel speed in the peak period for through movements.

In general, facilities with multiple at-grade controlled intersections operate at speed below the posted speed limit. While grade-separated facilities show speed near the posted speed limit. Usually, the PM period displays lower corridor speed than that experienced in the AM period.

Map 8 & 9, Pages 24-25: Corridor travel speed continues to be a problem. As development occurs, corridor travel speed continues to decline. One concern is regional facilities that have a travel speed below 25 mph, which may encourage trips to divert to alternate routes. During the AM period, Main Street, Andresen South, SR-503 South, and 136th/137th /138th Avenues display average speeds below 25 mph.

In the PM period, corridors with travel speed below 25 mph include Main Street, Highway 99, Saint Johns, Andresen, 112th Avenue, 136th /137th /138th Avenues, Mill Plain, Fourth Plain, 78th /76th Street, and Burton Road.

Speed: Speed as Percent of Speed Limit

Travel speed was converted to a percent of posted speed limit for each of the congestion management corridors. This was intended to provide another measure of the delay along the corridor.

As development occurs along the corridors, travel speed often decreases because of congestion, multiple driveways, and additional traffic signals. One of the difficulties

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is in balancing access to land uses and maintaining the throughput travel speed on arterials.

The speed percentages for the freeway facilities are generally close to 100% of the posted speed limit. While facilities with multiple signalized intersections and driveways are generally between 65% and 80% of the posted speed limit.

The five lowest speed corridors compared to posted speed limit include:

1. 112th Avenue, Mill Plain to SR-500
2. Andresen Road, Mill Plain to SR-500
3. Fourth Plain, SR-503 to 162nd Avenue
4. Mill Plain, I-205 to 164th Avenue
5. Highway 99, I-5 to 134th Street

Map 10, Page 26: In the AM period, I-5 South, SR-503 South, and 136th/137th/138th Avenues operate at less than 65% of the posted speed.

Map 11, Page 27: In the PM period, SR-14 Central, Highway 99, Main Street, 112th Avenue, Saint Johns/Fort Vancouver, Andresen, 136th/137th/138th Avenue, Fourth Plain, Mill Plain East, SR-500, 78th/76th Street all operate at less than 65% of the posted speed.

Speed: Intersection Delay

The delay at an intersection, for the through movement, was recorded as part of the PM travel time. Delay time represents the period of time travel speed is below 5 mph due to the intersection control. The delay time at an intersection was averaged for the multiple travel time runs. Intersections with an average delay time of greater than 45, 60, and 90 seconds were identified as a location of delay along a corridor. This delay is only calculated for through movement on the congestion management corridor and does not include delay associated with left turns or cross street traffic.

Map 12, Page 28: Generally, intersections that displayed a 45 second or greater delay, for the average through movement on a CMP corridor, were located where two major arterials intersect. Map 12 displays the location of the 42 intersections that demonstrated this characteristic. Of these intersections, 19 had an average delay between 60-89 seconds and 6 had an average delay greater than 90 seconds. Delay at these intersections adds to the overall travel time and increases congestion at these locations. The longest delays are at the following locations:

1. Fourth Plain/SR-500/SR-503 northbound
2. Fourth Plain/Andresen northbound
3. 65th Street/SR-503 northbound
4. Fourth Plain/Fort Vancouver northbound
5. Padden Parkway/Andresen northbound

With the implementation of a number of signal timing improvements, beginning in year 2010 the region began to see an overall decrease in the number of intersections with 45 seconds or longer delay.

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In addition to intersection delay, delay can also occur at freeway off ramps, where high volumes of traffic are loaded onto the arterial system. This can create a significant problem when traffic backs onto the freeway. Locations known to experience this characteristic in the PM peak include northbound I-205 off ramp to SR-14, Mill Plain, SR-500, and eastbound SR-14 off ramp to 164th Avenue. In the AM peak, backups can occur on SR-500 and SR-14 ramps to I-5 South, and Padden Parkway, SR-500, and SR-14 ramps to I-205 South.

Occupancy: Vehicle Occupancy

Average automobile occupancy is calculated by observing passenger cars at a given location and the number of people in each vehicle. The number of people divided by the number of passenger cars is the average automobile occupancy for that location. Trucks, buses, and other commercial vehicles are excluded from average automobile occupancy. Data is collected for the AM and PM time periods.

Table 5: Average Automobile Occupancy by Time of Day

Facility Type	AM	PM
Freeway *	1.12	1.19
Arterial	1.12	1.25

** Freeway includes I-5, I-205, SR-14, and SR-500*

The AM time period displays a lower average automobile occupancy, with the AM average automobile occupancy at 1.12 persons per vehicle. The PM average automobile occupancy rate is approximately 1.22 persons per vehicle.

It may be that the AM peak period is more of a traditional commute time, while the PM peak period likely has a greater percentage of discretionary trips such as shopping where drive-alone trips are less prominent.

Occupancy: Carpool and Vanpool

Carpools and vanpools are modes that mitigate congestion and increase vehicle occupancy in the peak periods. Carpools and vanpools form when a group of people commute together. Carpools are generally informal, including 2 or more people, while vanpool arrangements are generally more formal and include 5 or more people. C-TRAN owns, maintains, manages, insures, and licenses a fleet of vans which are available to commuter groups. In 2012, C-TRAN had twenty-six vanpools in service.

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Safety: Safety

Safety for all modes of travel is an important component of the metropolitan transportation planning process. As such, the region completed a *2011 Safety Management Assessment for Clark County*[1].

Map 13, Page 29: Illustrates the 30 signalized intersections that had 20 or more collisions between years 2007 and 2009. The CMP supports the goals and objectives of the *Safety Assessment*.

Trucks: Truck Percentage

Traffic counts are collected at several locations where vehicles are classified according to the number of axles. This provides a measure of trucks as a percentage of all vehicles traveling on the roadway. Trucks are defined as vehicles with more than two axles, such as typical tractor/trailer rigs, traveling on the roadway during the peak period. It is important to note that trucks often travel outside of peak periods to avoid congestion.

Map 14, Page 30: Overall, I-5, I-205, SR-14 East, SR-501 (Pioneer), SR-502, SR-503, and Fourth Plain/Mill Plain west of I-5 display the highest percentage of truck volumes during the PM peak period with truck percentages greater than 4 percent. I-5 North has a truck percentage above 12%.

In the AM period, the percentage of trucks is generally higher. I-5 North, I-205 Central, and Fourth Plain/Mill Plain west of I-5 all have percentages above 8%.

Transit: Transit System Ridership

Table 6 provides 2012 annual C-TRAN patronage by type of service. Between 2010 and 2012 minor transit service revisions were made and minor fare increases were implemented. With changes, total ridership increased by 5.1%.

Approximately 84% of C-TRAN system ridership was made up of urban fixed route patrons, followed by commuter service that carried 11% of the total riders and C-VAN that carried 3% of the total riders. Vanpool usage has increase to almost 1% of the total ridership.

Table 6: 2012 C-TRAN Ridership by Type of Service

Service Type	Annual Riders	Percent
Urban/Local	5,816,170	84.4%
Commuter	757,276	11.0%
C-VAN	217,468	3.2%
Events/Other	24,122	0.4%

[1] *http://www.rtc.wa.gov/reports/misc/SafetyMgmt2011.pdf*

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Service Type	Annual Riders	Percent
Connector	17,155	0.2%
Vanpool	56,758	0.8%
Total	**6,888,949**	**100.0%**

Table 7 compares growth in Clark County population with changes to C-TRAN system ridership during the same period. The average annual growth rate in Clark County population since 1985 has ranged from 2.3% to 4.4% per year depending on the time period. Over the same time period, C-TRAN ridership's growth rate has generally been higher than the population growth rate.

Table 7: Historical Population and Patronage Growth

Year	Population	Annual Growth Rate	System Passenger Trips	Annual Growth Rate
1985	206,744	---	1,765,423	---
1990	238,053	3.0%	2,840,724	12.2%
1995	291,000	4.4%	4,327,291	10.5%
2000	345,238	3.7%	5,437,084	5.1%
2005	391,500	2.7%	5,812,417	1.4%
2010	425,363	1.7%	6,552,570	2.5%
2012	431,250	0.7%	6,888,949	2.6%

In 2000, the passage of initiative 695 had a significant impact on transit revenue, and C-TRAN had to reduce transit service. In 2005, C-TRAN restructured transit fares to increase the proportion that fare revenue contributes to service costs. These changes resulted in a decrease in ridership. In September 2005, voters overwhelmingly supported a sales tax increase to support preservation of C-TRAN service levels and restore service that had been cut following passage of Initiative 695 in 2000.

As a result of the 2007 Service Redesign Study, C-TRAN implemented a number of service improvements in 2007, and opened the 99th Street Transit Center. These service changes, along with high fuel costs, have resulted in passenger increases.

Transit: Transit Seat Capacity Used

Transit seat capacity used includes transit riders divided by the transit capacity at a defined location. Transit seat capacity represents the percentage of seats that are occupied during the two-hour peak period. C-TRAN uses an automated ridership collection system on their vehicles. RTC compiled this data at a specific location in

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each corridor to calculate bus capacity based on the vehicle type and frequency of service. This process has allowed for the estimation of transit patronage and capacity for congestion management corridors.

Map 15, Page 31: Generally, in the PM Peak period, the number of available seats is higher to accommodate the greater transit demand. In the PM period, 14 corridors utilize more than 50% of the available seat capacity. Of those corridors, ten use more than 75% of the transit seat capacity, while four corridors utilize 100% or more of the transit seat capacity. Corridors at 100% or greater are experiencing standing riders.

Transit: Park and Ride Capacity

Park and Ride capacity and daily average usage include lots owned or leased by C-TRAN. In addition to the capacity shown in Table 7, there are WSDOT maintained or informal park and ride and park and pool facilities located throughout the County.

On September 25, 2011, the re-located Salmon Creek Park and Ride lot opened. The Camas/Washougal Park and Ride lot is being moved as part of a current road project and will not be available until 2013. Clark County park and ride capacity and usage is shown in Table 8.

Table 8: Clark County Park and Ride Capacity and Usage in 2011

Facility	Lot Capacity	Lot Usage
99th Street	610	371
Evergreen	279	32
Salmon Creek	467	264
BPA Ross	200	63
Andresen/KMART	60	51
Fisher's Landing	560	498
Camas/Washougal	0	0
Total	**2,176**	

Transit: Transit On-Time Performance

Traffic congestion, station dwell time, wheel chair boardings, and other factors can impact transit vehicles' ability to maintain a schedule.

To improve on-time performance, C-TRAN will begin testing a pilot project in 2013 to implement Transit Signal Priority along 22 signals in the Mill Plain corridor. The demo Transit Signal Priority project will allow buses to communicate with traffic

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signals and allow additional green time. C-TRAN will evaluate its performance in 2013 and decide whether to use similar technology in additional corridors.

C-TRAN's 2012 On-Time Performance Report showed five routes with the lowest on-time performance: Route 4 (Fourth Plain), Route 37 (Highway 99/Mill Plain), Route 25 (Fruit Valley & Saint Johns), Route 44 (Fourth Plain Limited), Route 30 (Burton), and Route 72 (Orchards). These routes are experiencing a number of issues which create problems for meeting on-time reliability.

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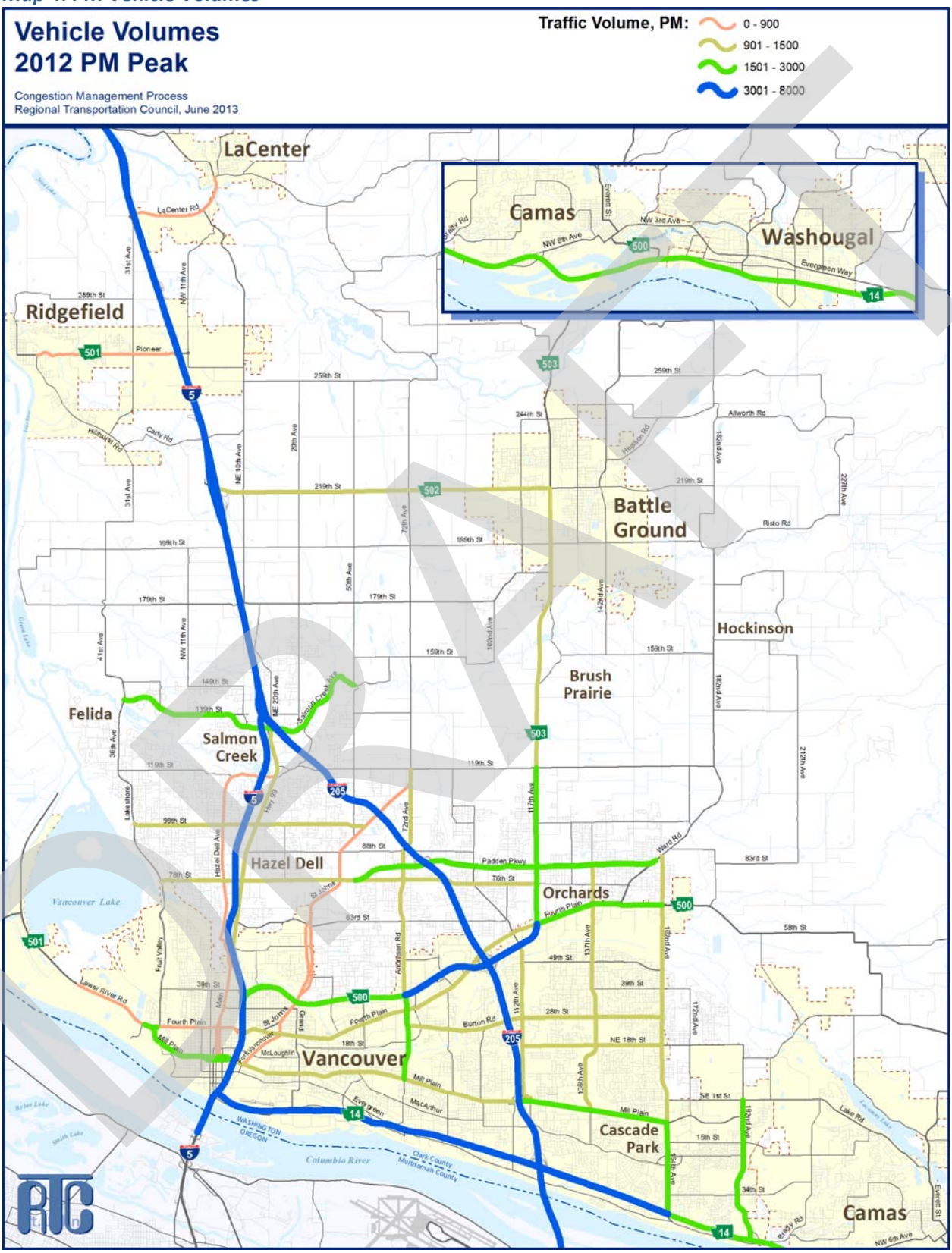
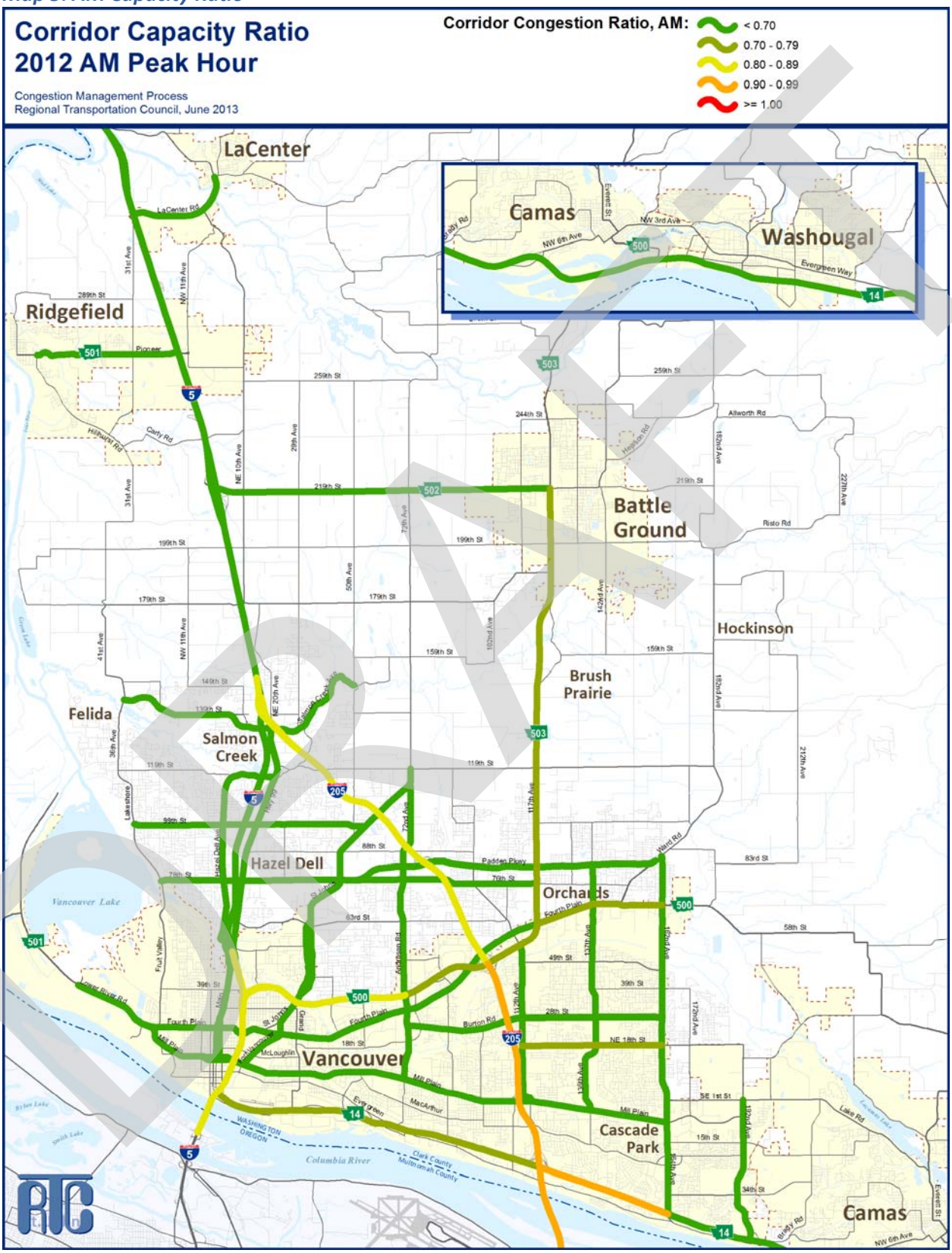
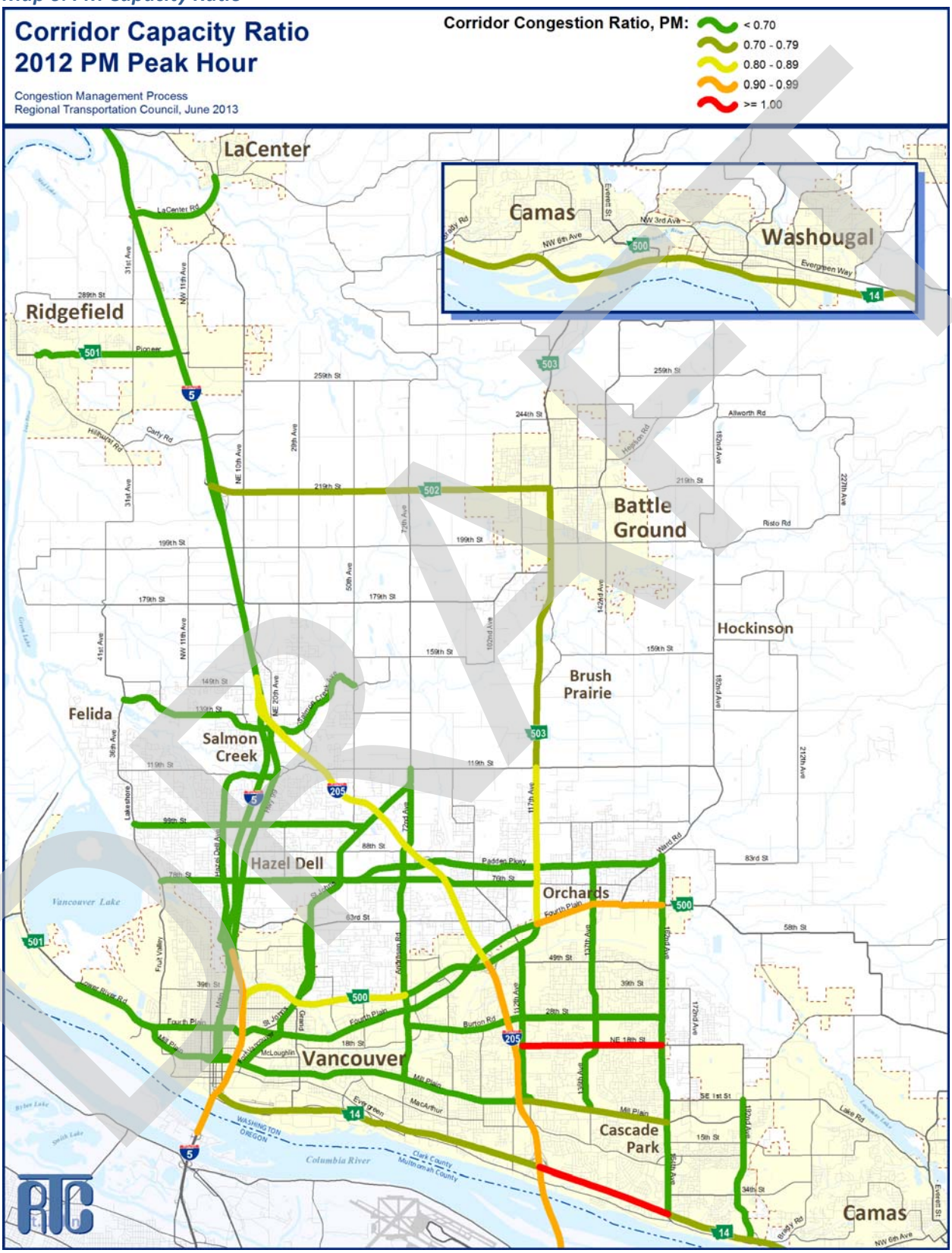
Map 4: PM Vehicle Volumes



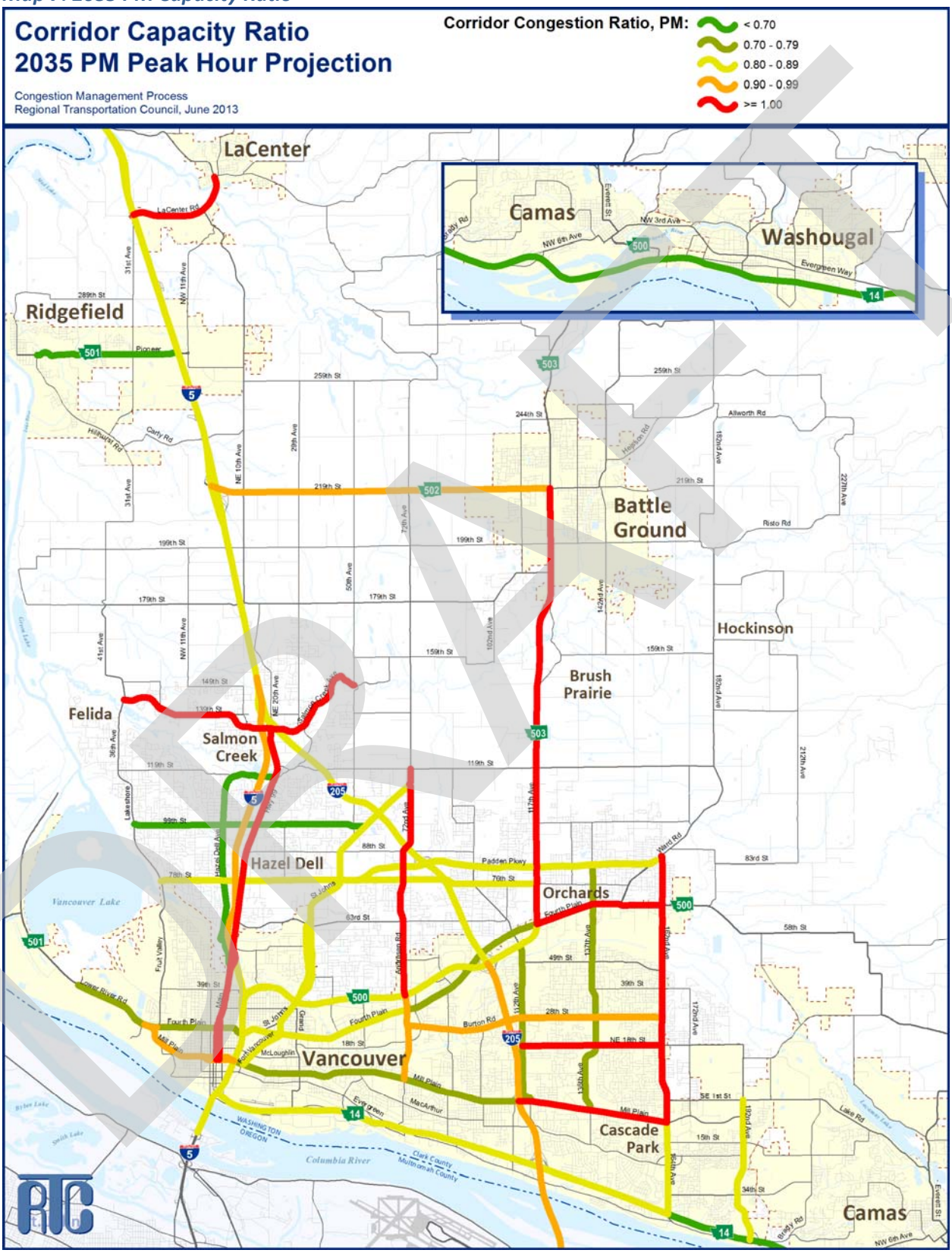
Map 5: AM Capacity Ratio



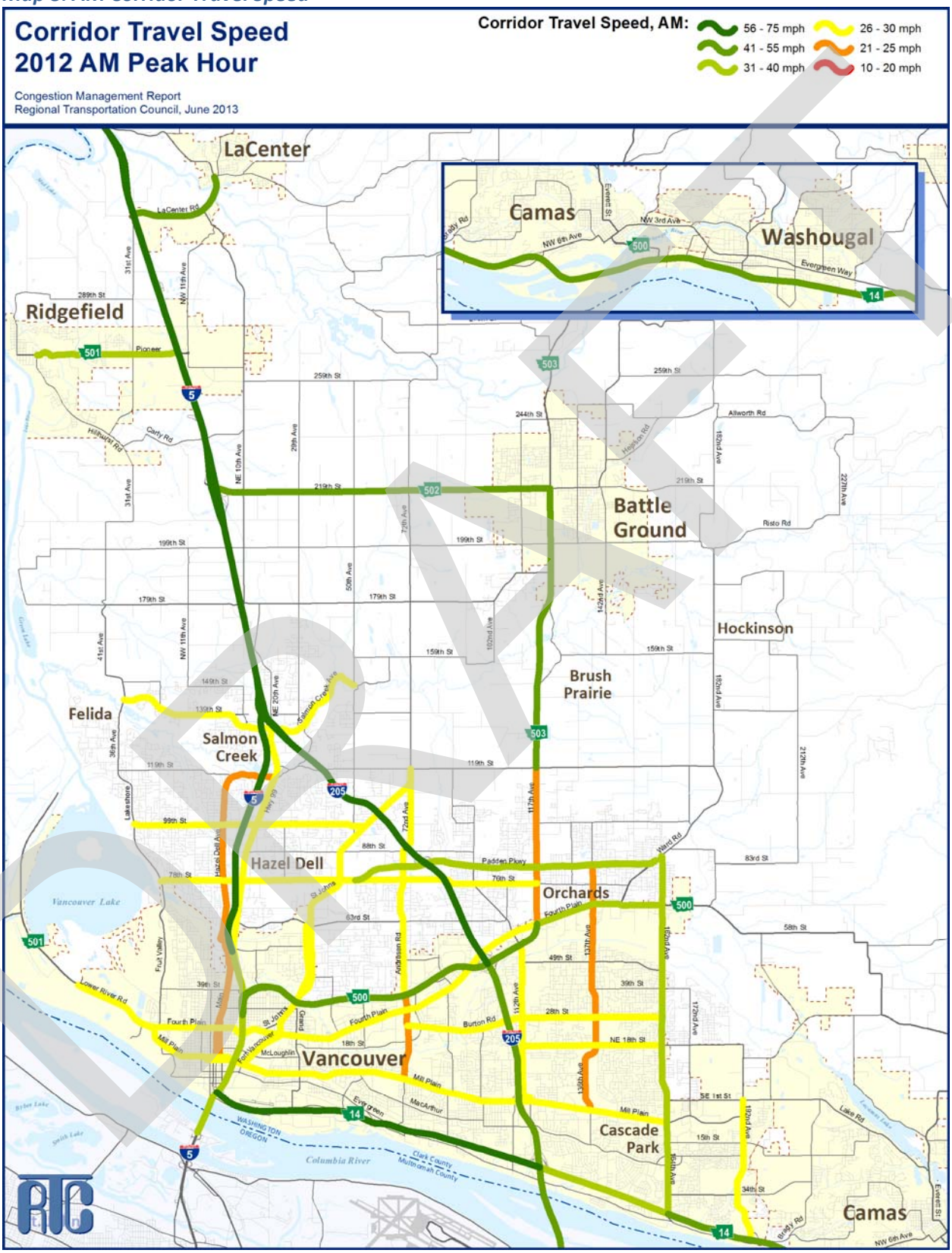
Map 6: PM Capacity Ratio



Map 7: 2035 PM Capacity Ratio



Map 8: AM Corridor Travel Speed



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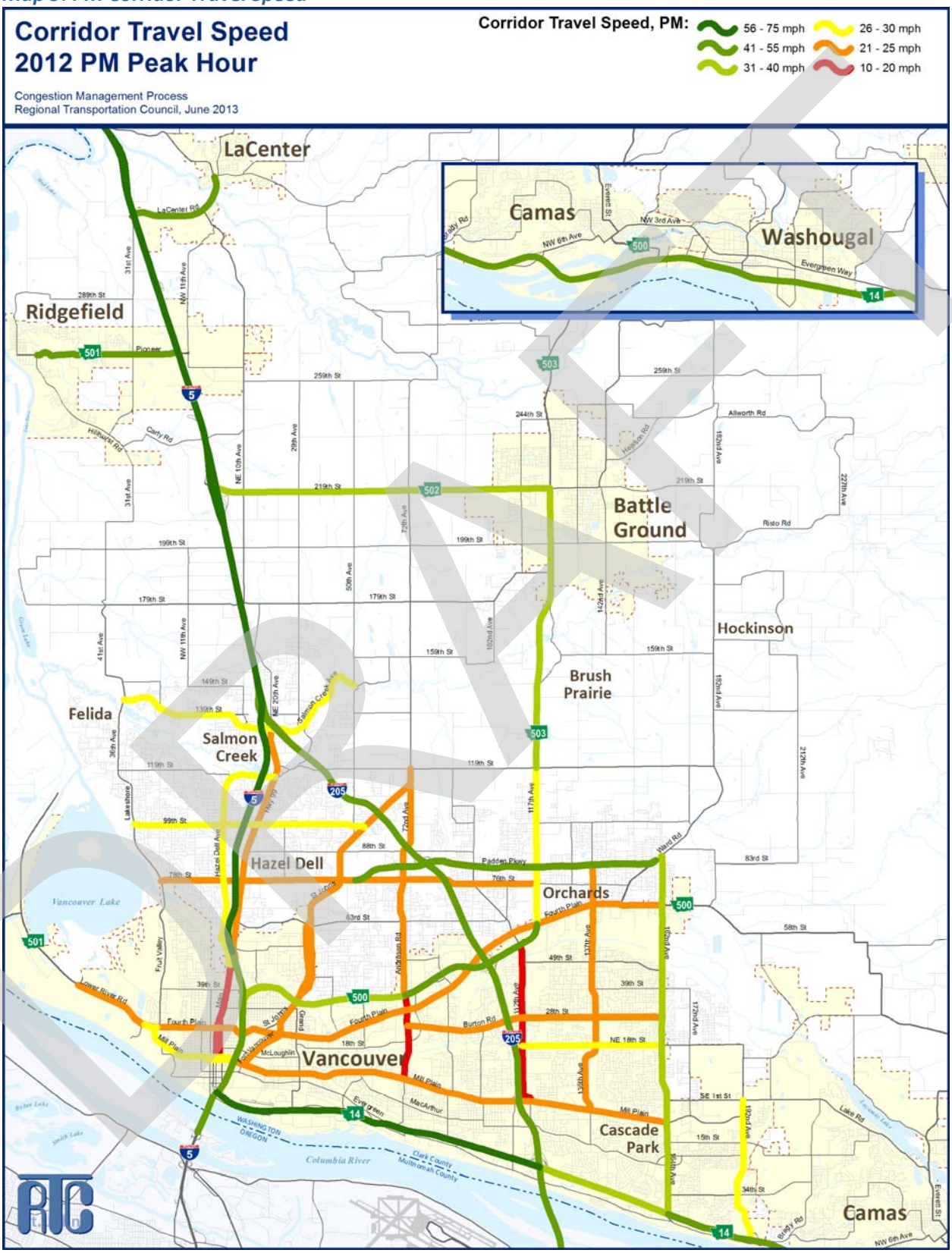
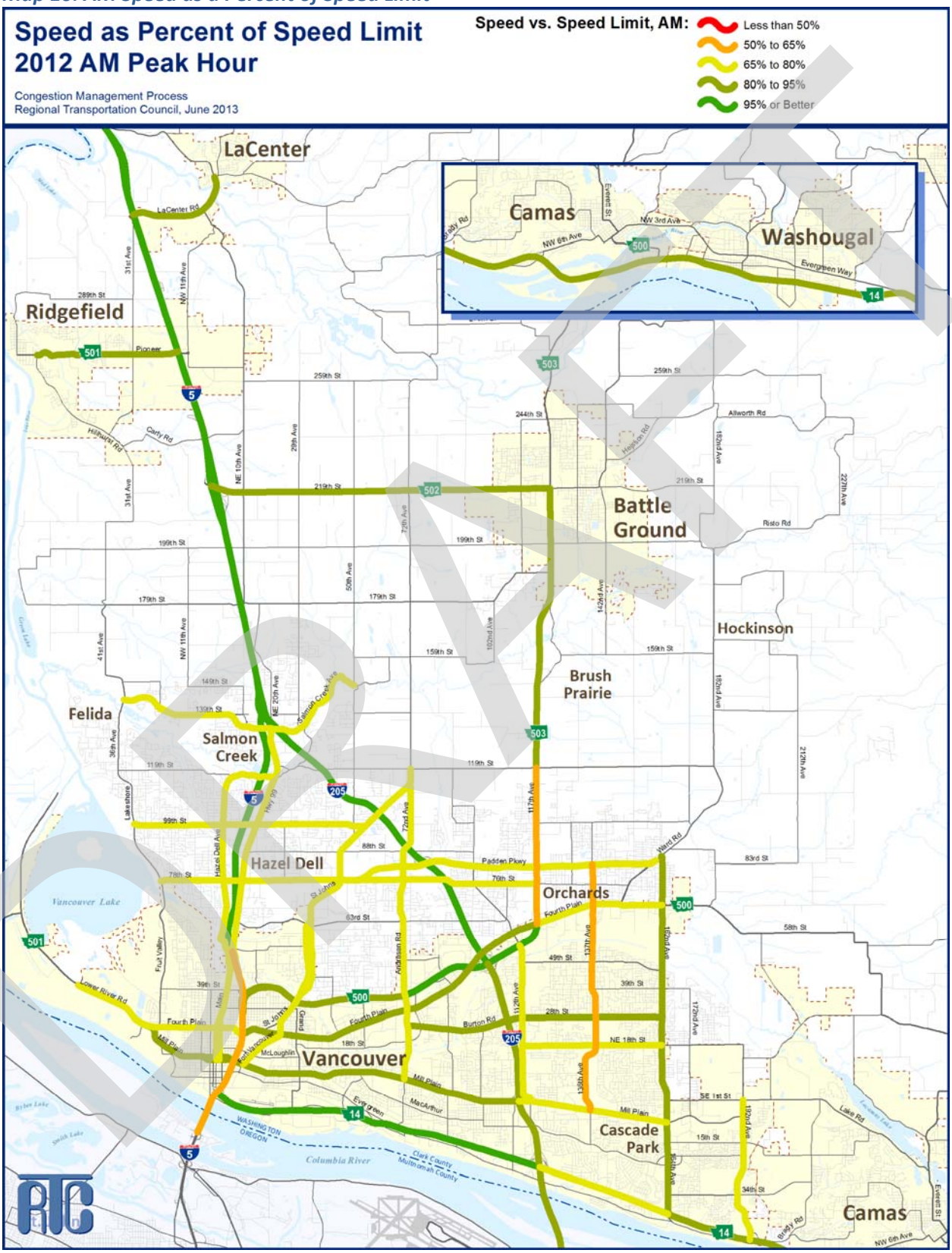
Map 9: PM Corridor Travel Speed



Map 10: AM Speed as a Percent of Speed Limit



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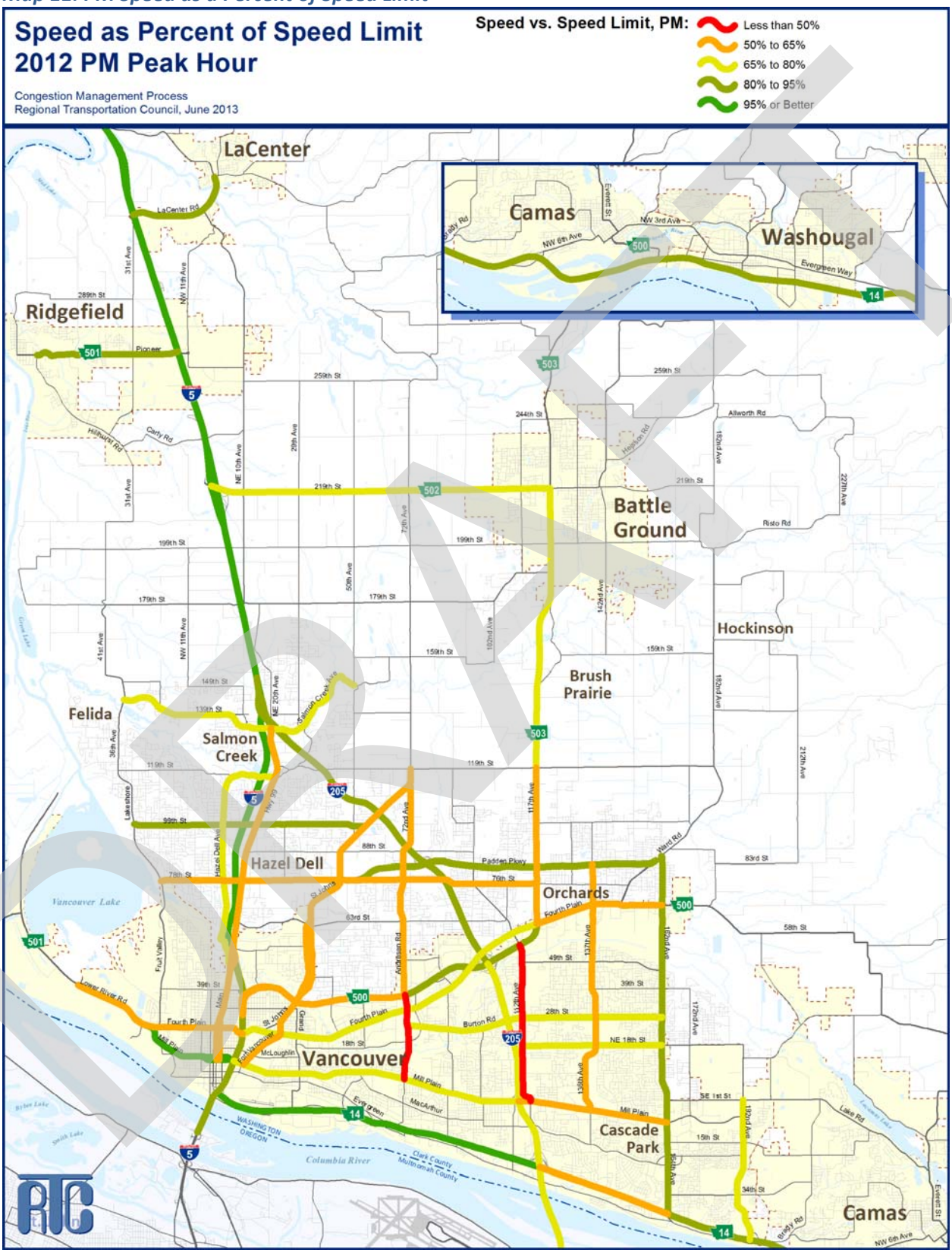
Map 11: PM Speed as a Percent of Speed Limit



Map 12: PM Intersection Delay

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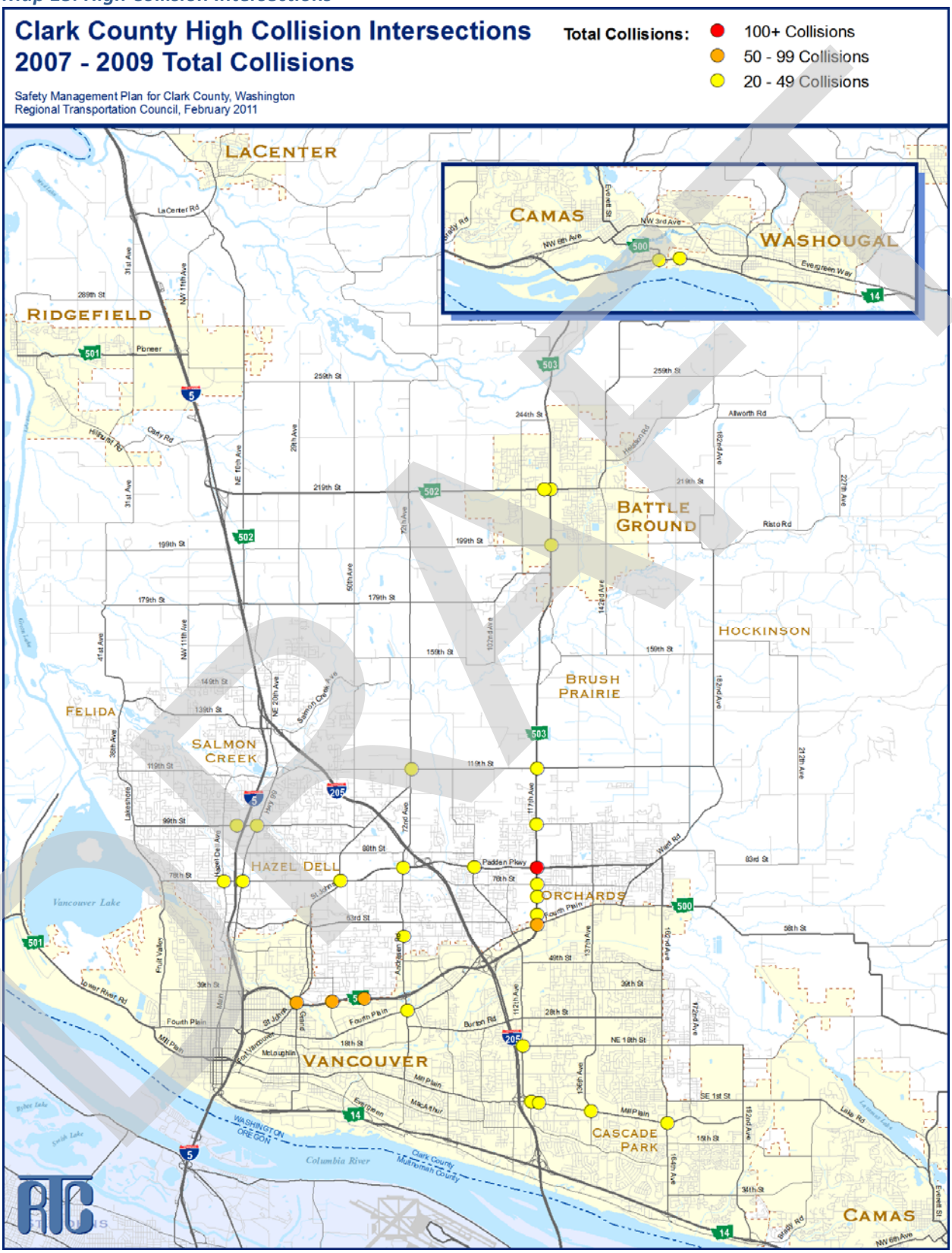
Map 13: High Collision Intersections



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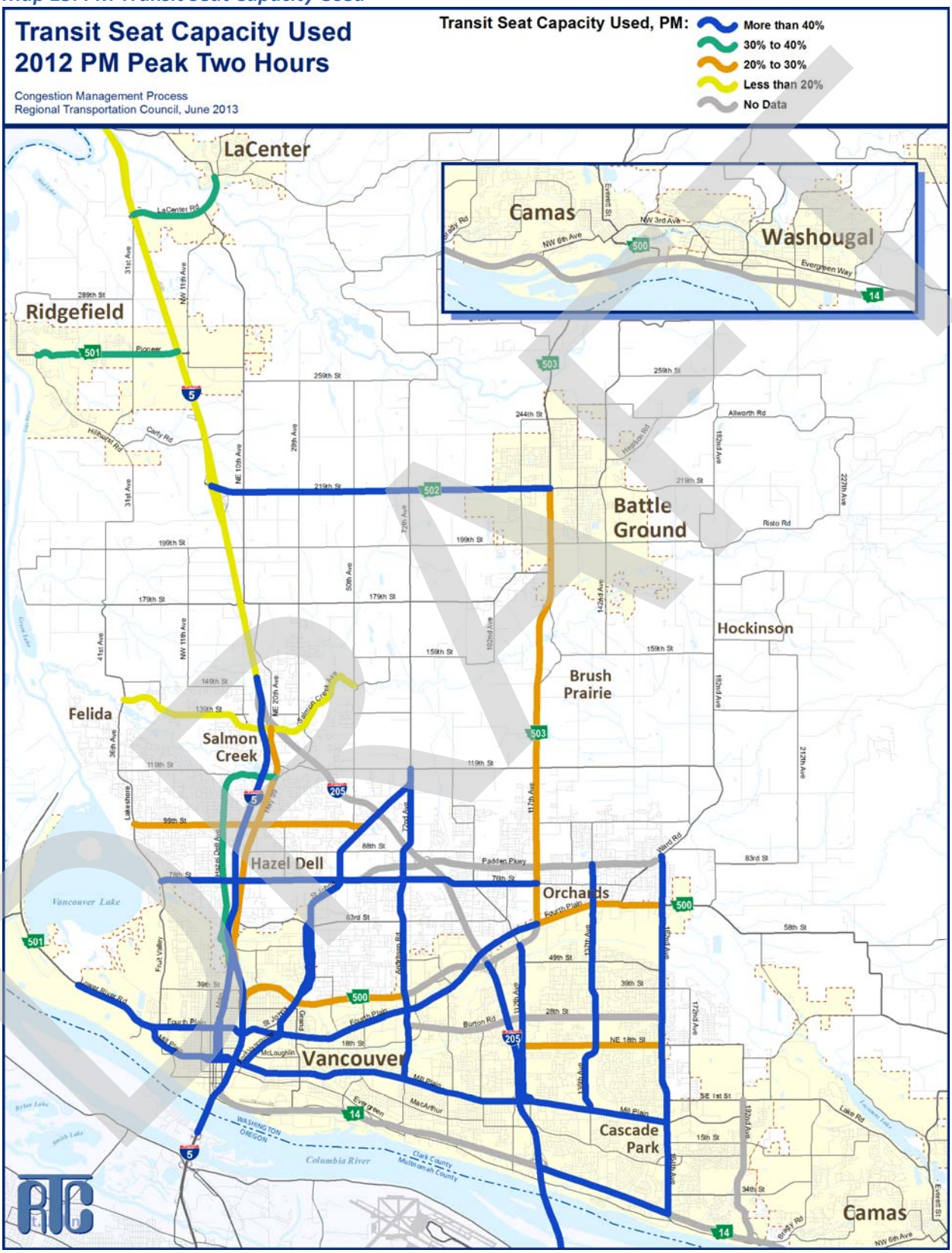
Map 14: PM Truck Percentage

Map 15: PM Transit Seat Capacity Used



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Areas of Concern

Using the individual CMS corridor segment data, areas of concerns were identified. Areas of concern are defined as segments within an individual corridor with a volume-to-capacity (V/C) ratio greater that 0.9 or a travel speed 60% or less of the posted speed limit.

Volume-to-capacity Ratio

The volume-to-capacity ratio identifies road segments where current volumes are approaching road capacity. This limitation on road capacity leads to congestion.

Map 16, Page 34: Prominent volume-to-capacity ratio areas of concern in the AM peak period are the bottlenecks at the two interstate bridges. The AM period shows a high volume-to-capacity ratio with related poor system performance on portions of I-5, I-205, SR-14, SR-500, and Saint Johns/Fort Vancouver Way.

Map 17, Page 35: In the PM period, additional volume-to-capacity ratio areas of concern showed up. The PM period shows congestion on portions of I-5, I-205, SR-14, SR-500, SR-502, SR-503, Fourth Plain, 18th Street, and 28th Street.

Speed

A travel speed lower than 60% of the posted speed limit is an indicator of delay, which can result in congestion.

Often these speed areas of concern occur at locations with multiple traffic signals in close proximity or with intersections experiencing delay of greater than 45 seconds.

Map 18, Page 36: In the AM period, speed areas of concern occur along portions of I-5, Main Street, Highway 99, Andresen, SR-503, 137th Avenue, Mill Plain, Fourth Plain, 78th Street, Padden Parkway, and 134th Street.

Map 19, Page 37: In the PM period, speed areas of concern occur along portions of most of the congestion management corridors in the Vancouver Urban Area, with the exception of grade-separated facilities (I-5, I-205, and SR-14).

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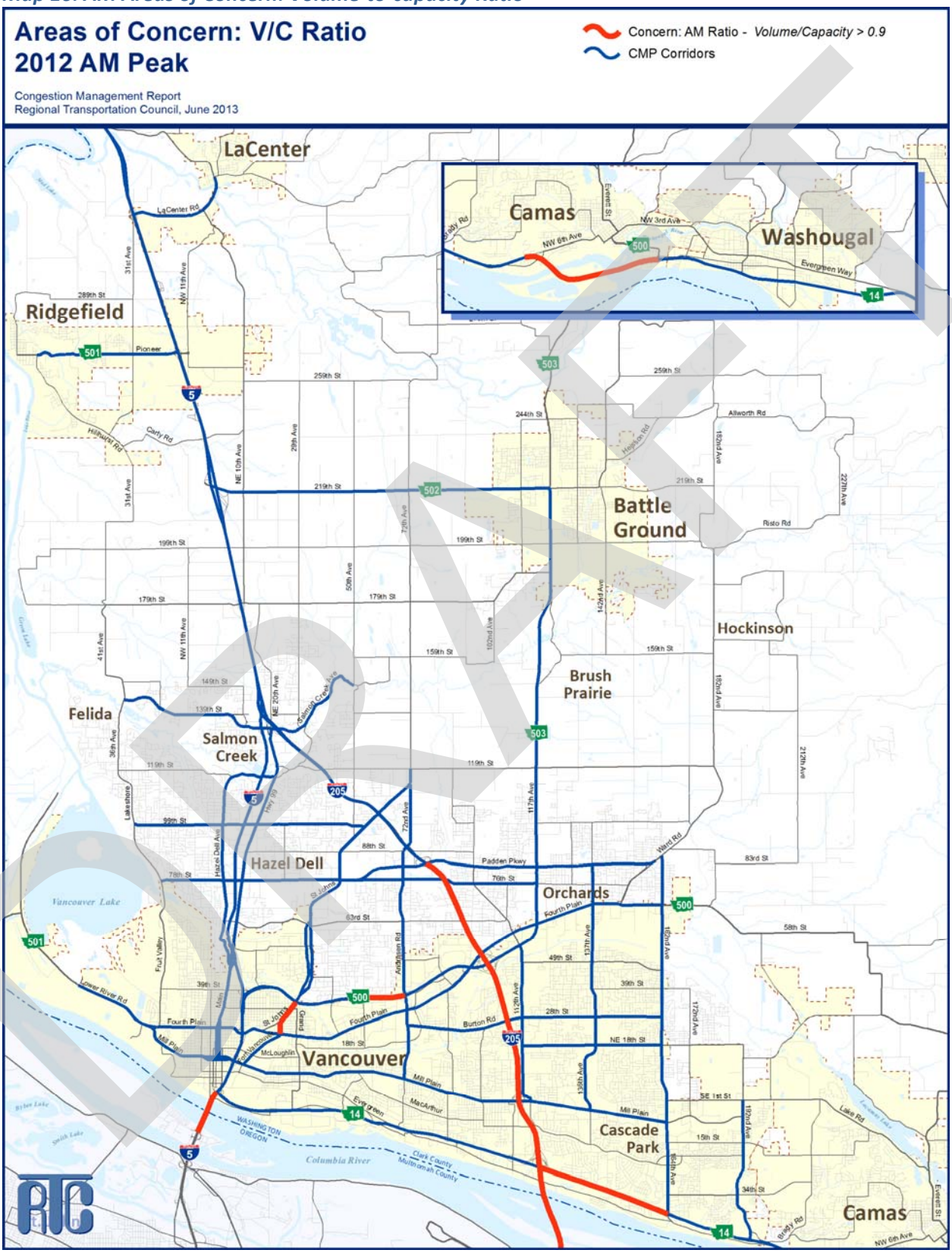
Map 16: AM Areas of Concern: Volume-to-capacity Ratio



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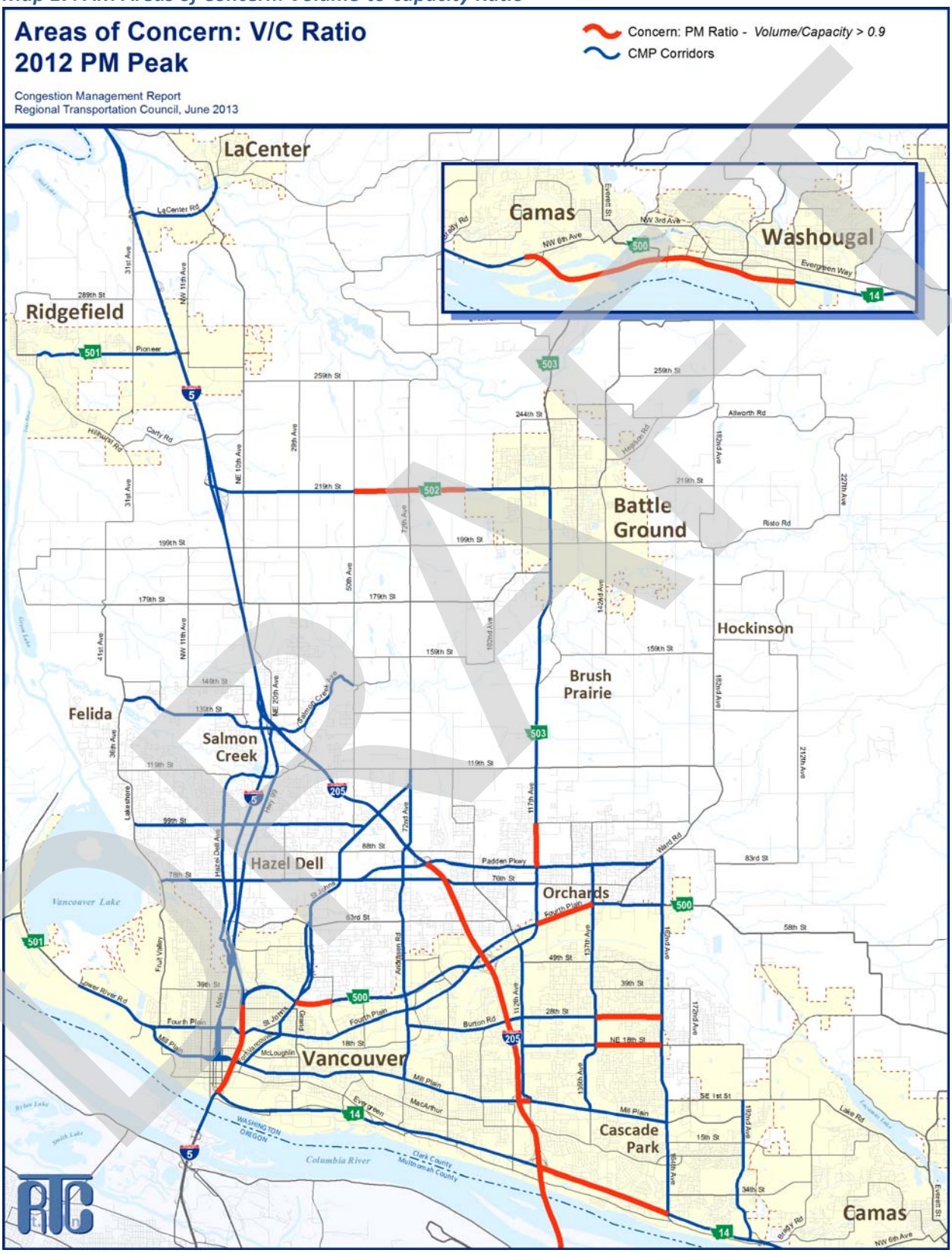
Map 17: AM Areas of Concern: Volume-to-capacity Ratio



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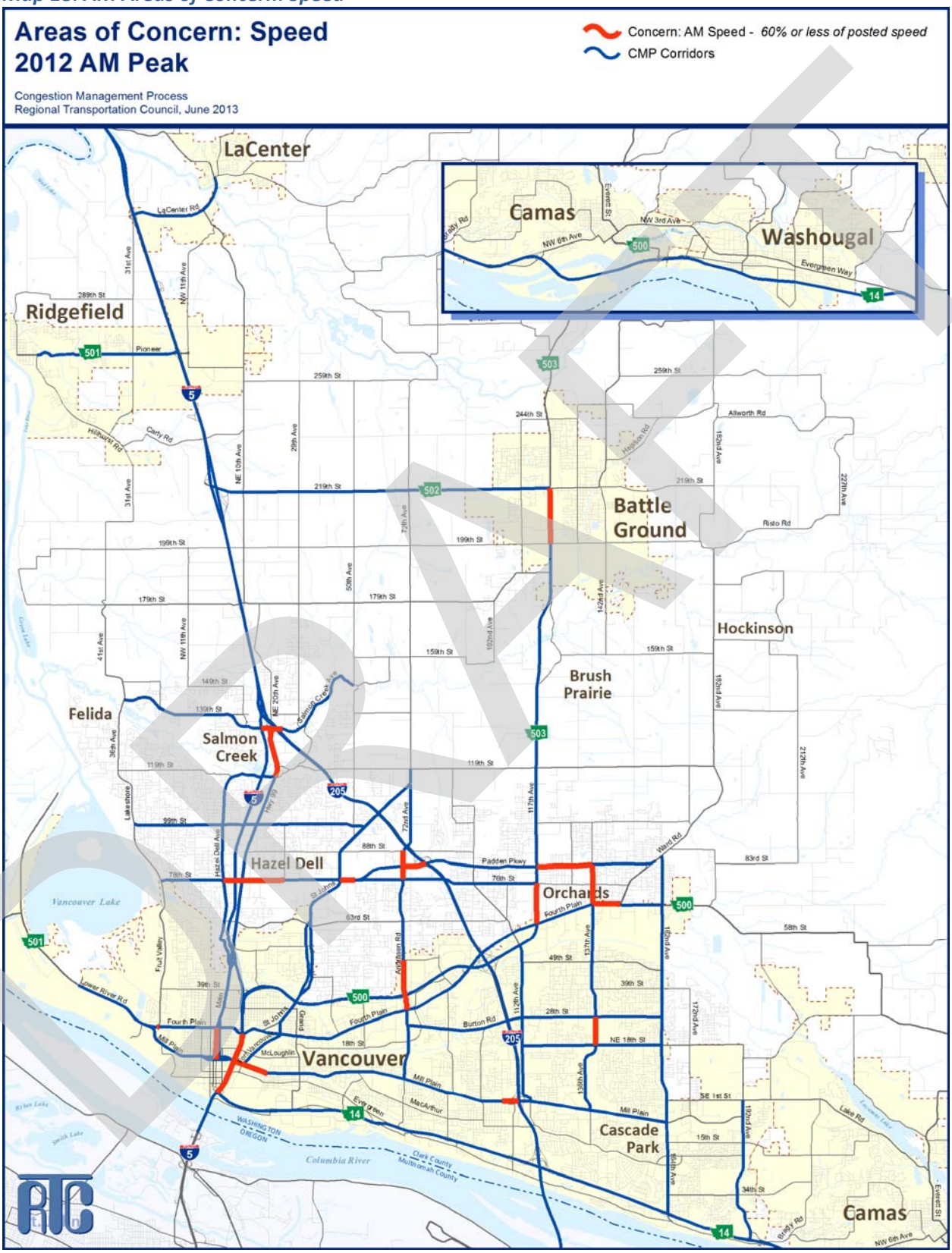
Map 18: AM Areas of Concern: Speed



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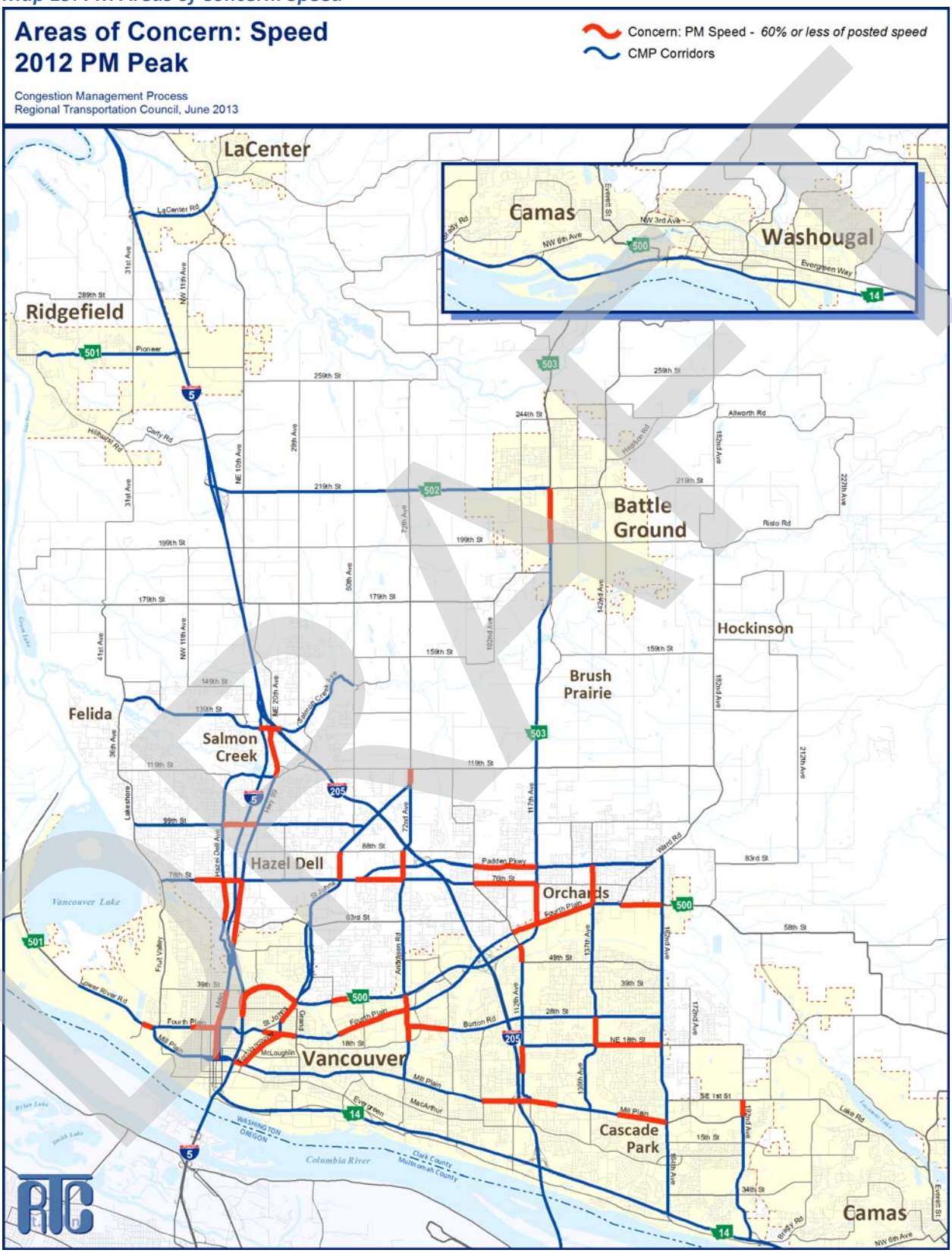
Map 19: PM Areas of Concern: Speed