REF: TRAFFIC ENGINEERING REPORT
8th ST E.
JAN 8th, 2001.
TRANS SYSTEMS CORPORATION CONSULTANTS.

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Technical Appendix

BACKGROUND – PURPOSE OF STUDY

TranSystems is currently performing design services for Pierce County for 8th Street East between SR167 and the access to the proposed Greenwater Corporate Park (about 145th Avenue East). The design project will provide a widened street section with appropriate auxiliary lanes at major intersections. A map showing the project location is included as Figure 1.

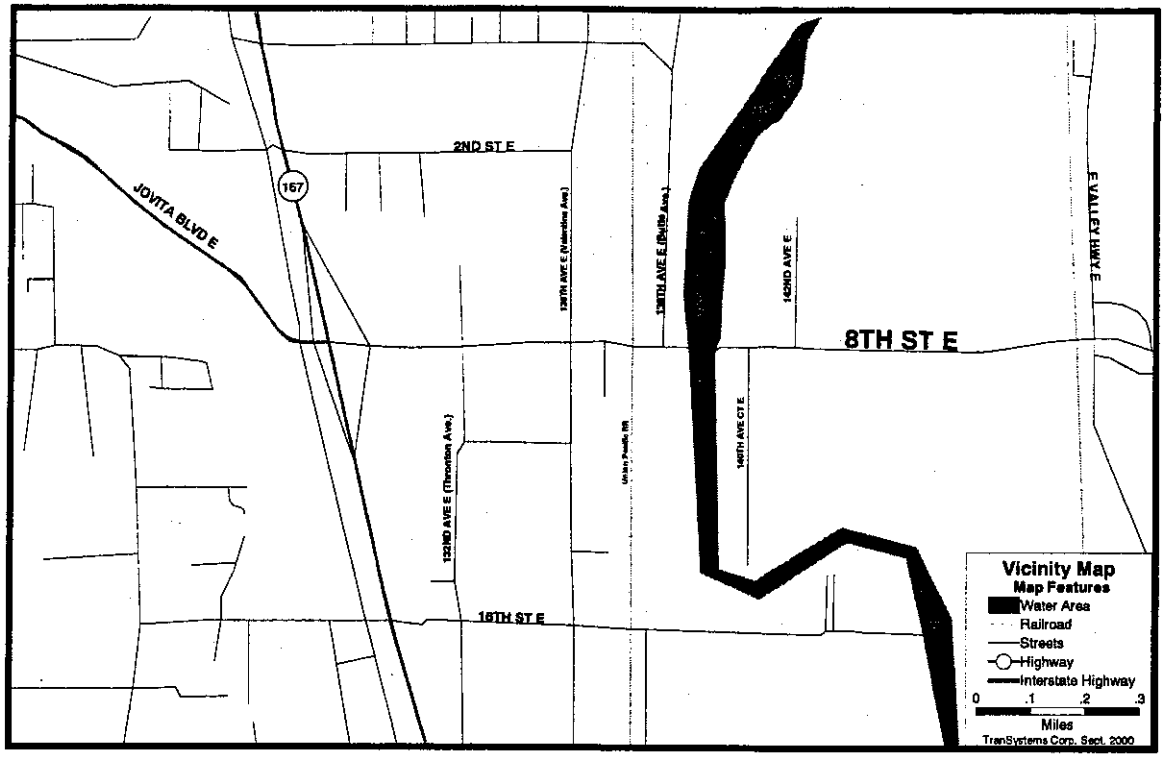
8th Street East within the study segment currently exists as a two-lane paved roadway. Posted with a speed limit off 35mph, the roadway crosses the Union Pacific (UP) Railroad tracks at-grade. A two-lane bridge carries 8th Street over the Stuck River. With the exception of SR167, all street intersections along the study segment are at-grade intersections. SR167 has a diamond interchange with 8th Street with an overpass structure carrying SR167 over 8th Street East. All intersections within the study segment currently operate under stop-sign control for side street traffic. A traffic signal does exist at the 8th Street East/West Valley Highway intersection, just west of the SR167 interchange.

Increased traffic and proposed development along this corridor, in addition to proposed improvements further east have created the need to widen this facility for increased capacity. In conjunction with the increased capacity, the potential exists for future traffic signal control at the 8th Street East intersections with the SR167 ramps, Thornton Avenue (132nd Ave. E.), Valentine Avenue (136th Ave. E.), Butte Avenue (138th Ave. E.), 140th Avenue Ct. East and at the proposed access to the Greenwater Corporate Park (approximately at 144th Ave. E.). Traffic signal warrant studies are being conducted separately from this study.

With the potential for traffic signals noted above, especially the SR167 ramp intersections with 8th Street East, the Washington Department of Transportation has requested an operational analysis of this corridor to ensure signal progression can be maintained at an acceptable level. Specifically, their request is to perform an assessment of the corridor east of the northbound SR167 ramps, considering the potential for signals at all of the intersections noted above.

In addition to the signal assessment, this Traffic Study will also examine the geometric needs of the study corridor and documents development of future year traffic projections. Although a grade separation is proposed for the UP Railroad crossing, this study will also assess queuing potential for future traffic should this railroad crossing remain at-grade.

Figure 1 – Project Location Map



EXISTING TRAFFIC VOLUME

Traffic counts were taken for 8th Street and some intersecting streets in January and April of this year. Traffic counts were 24-hour counts separated by direction and vehicle classification. Three different vehicle types were identified with traffic counts; passenger vehicles (cars), buses and large trucks.

Data collected shows that 8th Street East just west of Thronton Avenue (132nd Ave. E.) carries approximately 14,500 vehicles per day (vpd). Traffic volume is nearly equal in east and westbound travel directions. Approximately 11% of the total traffic volume is made up of heavy trucks. Buses make up only about 1% of the total volume. The morning peak hour shows the most directionality, with about 54% of traffic moving in an eastbound direction. During the morning peak hour, truck traffic is lighter than the daily average, constituting about 8% of total traffic. Total morning peak hour traffic represents about 7% of the daily traffic total. During the evening peak hour directionality is reversed with about 52% of traffic moving in the westbound direction. Trucks make up about 7% of the evening peak hour traffic stream. The evening peak hour traffic is higher than the morning peak, carrying almost 12% of the daily total. Heaviest truck traffic volumes are experienced during the early afternoon period, sometimes making up as much as 15% of total traffic.

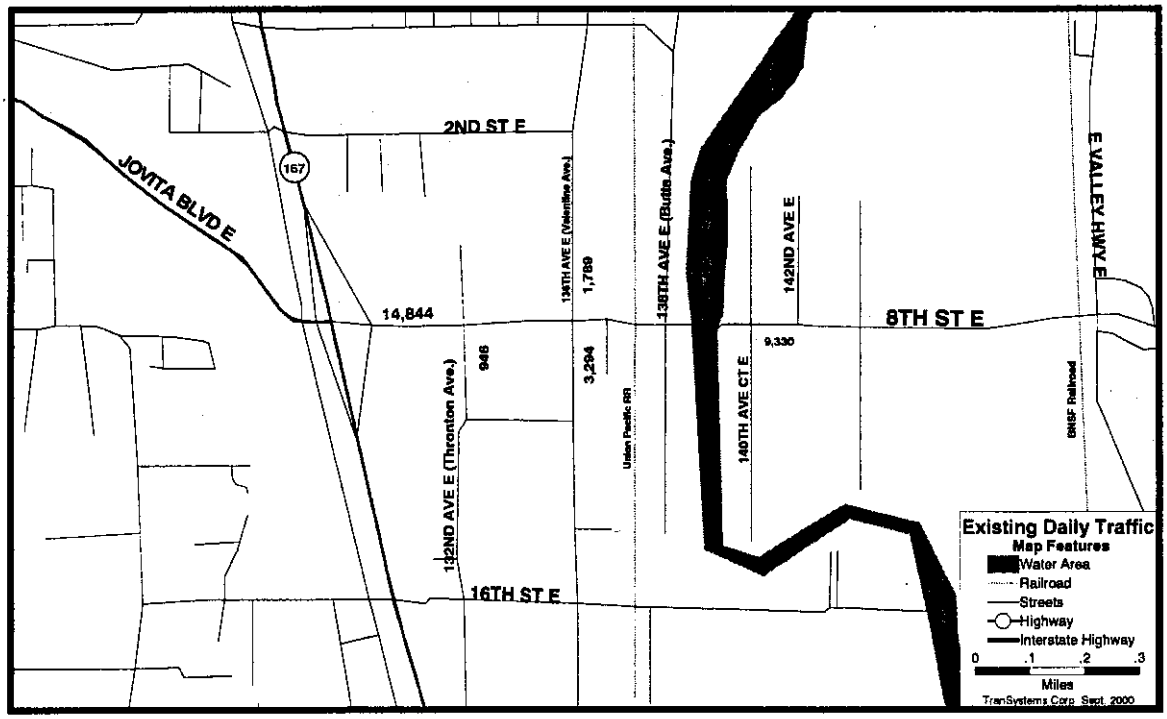
Data for 8th Street further to the east carries significantly lighter traffic volume. 8th Street just east of Butte Avenue (138th Ave. E.) carries a total 24-hour volume of approximately 9,300 vpd. Truck traffic constitutes about 5% of the total volume and buses make up less than 1% of the traffic stream. Morning peak hour traffic is approximately 7% of the 24-hour volume with a heavy directionality. About 60% of the morning peak hour traffic is moving in a westbound direction. During the morning peak hour, truck traffic is about 5% of the traffic stream with almost half of trucks moving in a westbound direction. The evening peak hour traffic is again

heaviest, carrying about 8.5% of the 24-hour volume. Directionality is reversed from the morning period, with 62% of the evening peak hour traffic moving in an eastbound direction. Truck traffic is only about 3% of the evening peak hour total traffic. The heaviest truck traffic noted for this section of 8th Street East is also during the afternoon period with some hourly truck volumes noted as high as 8% of the hourly total traffic.

Side street traffic was also counted on the south leg of Thronton Avenue (132nd Ave. E.) and on both the north and south legs of Valentine Avenue (136th Ave. E.). Thornton Avenue south of 8th Street East carries about 950 vpd with about 8% trucks. Traffic is predominately southbound during the morning peak and northbound during the evening peak. Valentine Avenue north of 8th Street East carries about 1,800 vpd while Valentine Avenue south of 8th Street East carries much higher traffic of almost 3,300 vpd. While Valentine Avenue north of 8th Street East exhibits distinct directionality during morning and evening peak periods, less directionality is noted for Valentine Avenue south of 8th Street. Valentine Avenue north of 8th Street carries truck volumes typical of other area roads at about 6-7% of daily traffic volume. Valentine Avenue south of 8th Street carries significantly heavier truck traffic, with truck volume counted at about 19% of daily traffic.

Existing daily traffic is summarized in Figure 2. Detailed traffic count data is contained in the Appendix to this memorandum.

Figure 2 – Existing Daily Traffic Volume



FORECAST TRAFFIC VOLUME

Peak Hour traffic volume forecasts for this corridor were provided by Pierce County. Peak hour turning volume projections were provided for the 8th Street East intersections with West Valley Highway, SR167 ramps, Thornton Avenue (132nd Ave. E.), and Valentine Avenue (136th Ave. E.). Near-term (year 2005) peak hour traffic projections for these locations were provided for two development scenarios; with and without the proposed 24th Street East interchange with SR167. Peak hour projections were also provided for the long-range future design year 2025 (24th Street Interchange assumed by 2025).

Peak hour traffic for remaining study area intersections were developed as part of this traffic study. Information obtained from the Traffic Impact Study completed for the Greenwater Corporate Park was used for projections at that development access point. Peak hour corridor traffic predicted by the Greenwater Corporate Park traffic analysis was significantly higher than that projected by Pierce County. Since the traffic projections provided by Pierce County were based on a metropolitan-wide travel demand model, Pierce County projections were utilized as a starting point for corridor volumes. Greenwater Corporate Park driveway volumes were then placed on the system by increasing through volumes throughout the corridor to accommodate driveway traffic predicted for the Greenwater Corporate Park.

Aerial photography was utilized to estimate current and potential land uses and magnitudes for areas accessed by Butte Avenue (138th Ave. E.) and 140th Avenue Ct. East assuming development along these roadways will be similar in nature to that along Thornton Avenue and Valentine Avenue. Potential land uses considered were lumberyards, general light industrial, warehousing and truck terminals. The ITE Trip Generation Report was consulted to estimate peak hour turning traffic volumes at these intersections. As with the Greenwater Corporate Park, 70% of side street traffic was assumed to be oriented towards SR167.

Proportion of heavy vehicle traffic for future conditions assessments was maintained at observed levels for current conditions. Where observations were not available, 10% of traffic was assumed to be heavy vehicle traffic.

Future daily traffic projections were derived utilizing the derived relationships between the existing daily traffic and existing peak hour traffic, future average daily traffic was derived for year 2005 (with and without the 24th Street Interchange) and year 2025. Estimated future daily traffic volumes are shown in Figures 3 through 5. The methodology for deriving traffic volumes is included in the Appendix.

Peak hour traffic projections utilized for the assessment of corridor traffic operations, including projections for the SR167 southbound ramp and West Valley Highway intersections, are illustrated in Figures 6 through 11. Based on the methodology and assumptions utilized, intersection turning traffic volumes utilized for this assessment are most likely conservative (high). Details of the process utilized to develop future design hour traffic volumes are contained in the Appendix to this memorandum.

Figure 3 – Year 2005 Daily Traffic without 24th Street Interchange

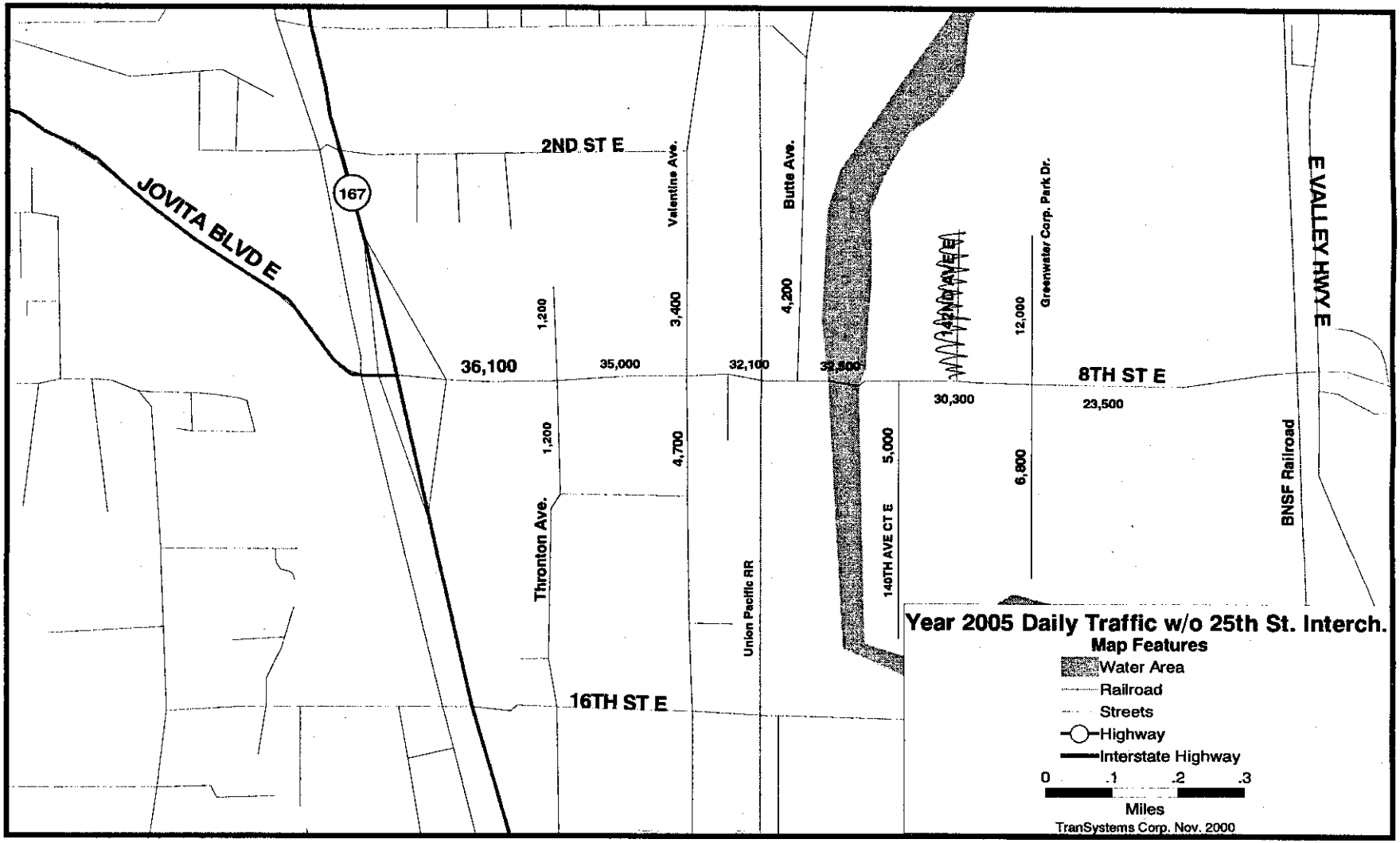


Figure 4 – Year 2005 Daily Traffic with 24th Street Interchange

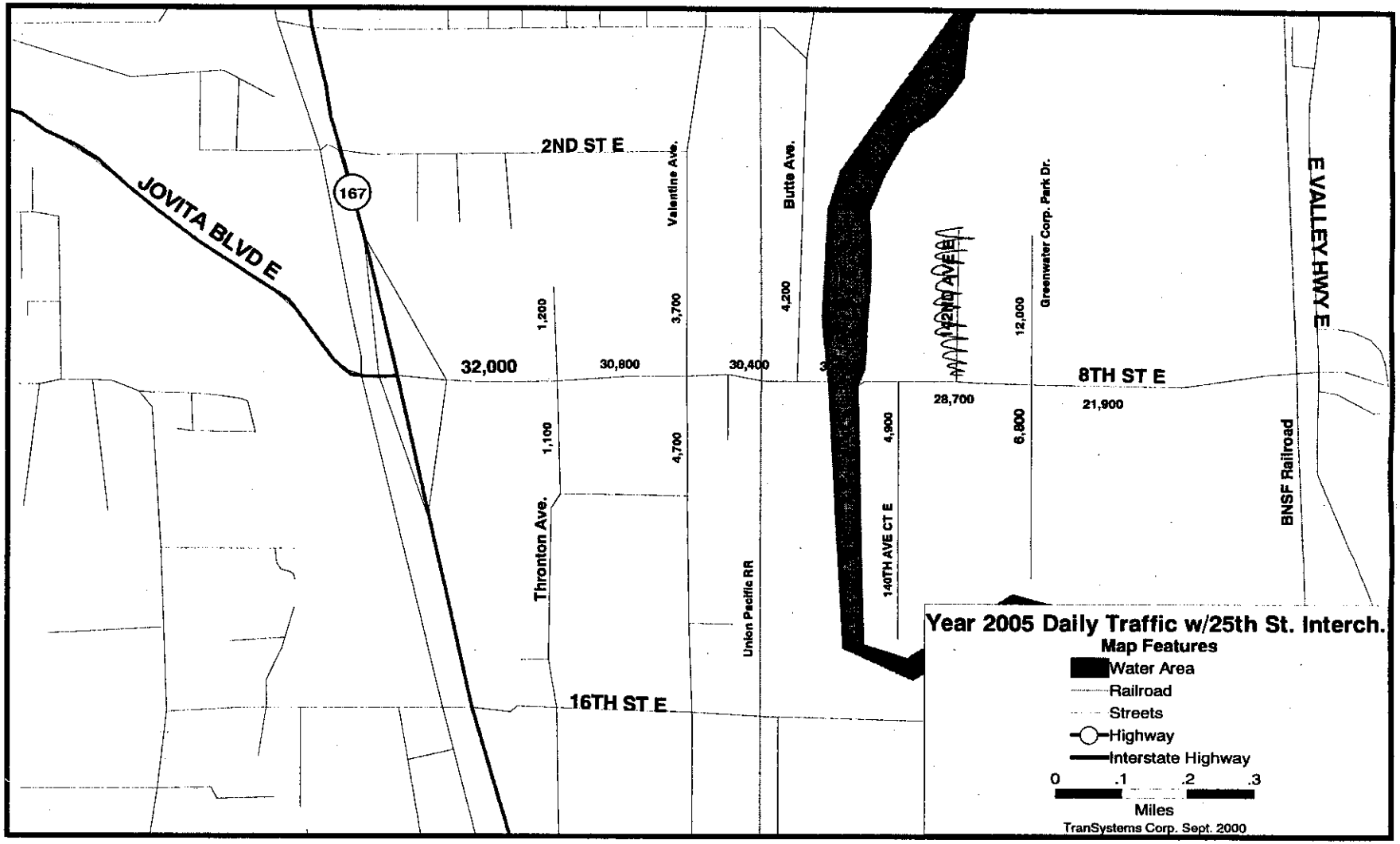
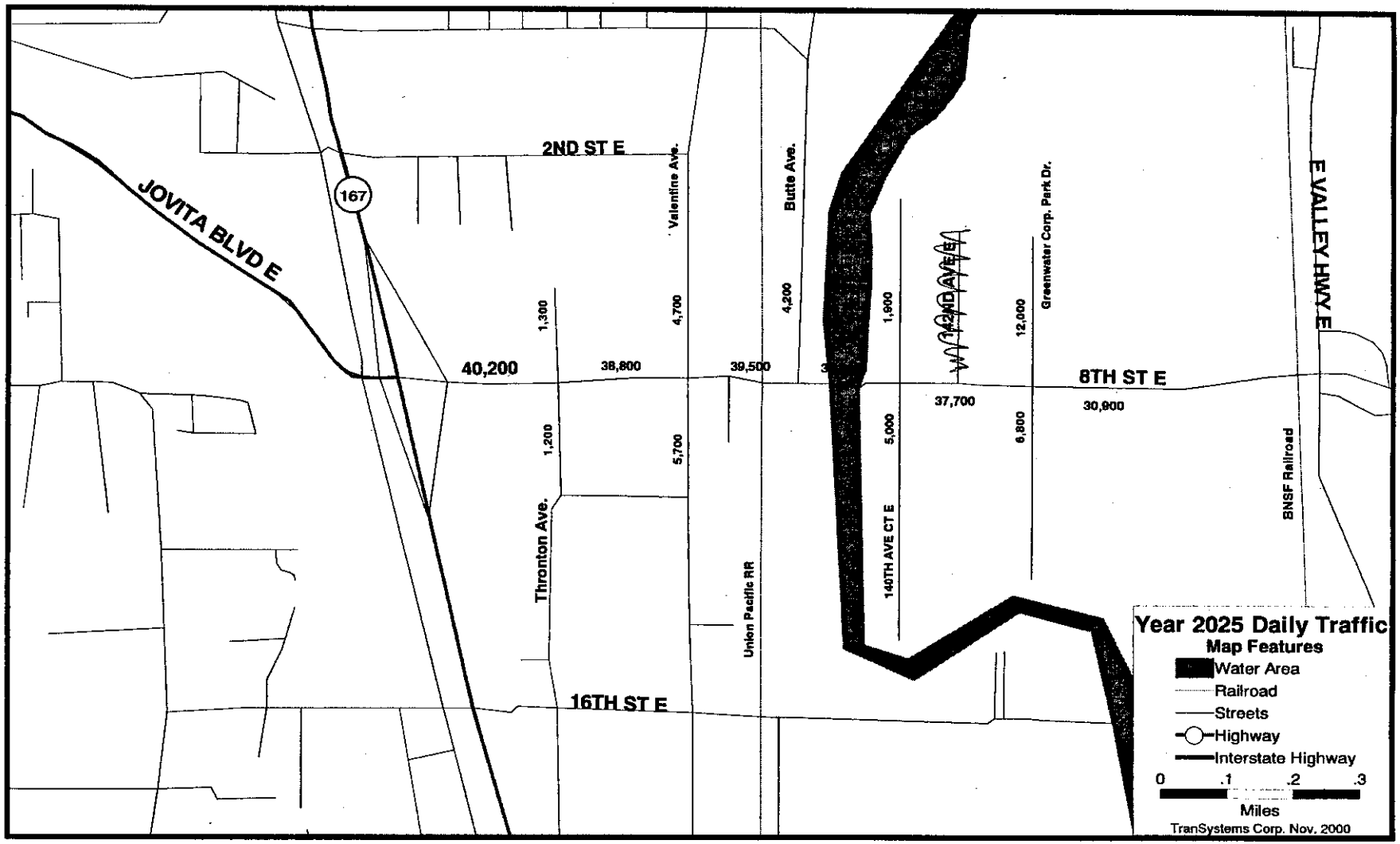


Figure 5 – Year 2025 Daily Traffic (with 24th Street Interchange)



TRAFFIC SIGNAL WARRANT ASSESSMENT

The 8th Street East project will improve a segment of 8th Street by widening, intersection improvements and a grade separation at the Union Pacific Railroad crossing. This section addresses the basis and warrants fo installation of traffic signals at six key access points and intersections within the project limits.

The Manual of Uniform Traffic Control Devices (MUTCD) establishes eleven warrants for installation of traffic signals. The warrants set forth in the MUTCD are:

1. Minimum Vehicular Volume
2. Interruption of Continuous Traffic
3. Minimum Pedestrian Volume
4. School Crossing
5. Progressive Movement
6. Accident Experience
7. Systems Warrant
8. Combination of Warrants
9. Four Hour Volumes
10. Peak Hour Delay
11. Peak Hour Volume

The MUTCD states that while satisfaction of one or more warrants does not *require* installation of a traffic signal, traffic signals should not be installed unless one or more warrants are met. Traffic signals may be installed for a variety of reasons, including high volume intersecting traffic, side-street delay, accident mitigation and pedestrian safety.

Based on peak hour traffic volumes developed for study area intersections, this analysis makes an assessment of warrants number 1, 2, and 11. For purposes of this assessment, it is assumed that 60% of the peak hour traffic represents the 8th highest hour approach volume (as agreed by Pierce County). Truck traffic volume (significant in this corridor) is converted to passenger car equivalents (PCE's) at a ration of 2:1 for use with warrant evaluations.

Six different intersections with 8th Street are evaluated as part of this assessment as follows:

- Thornton Avenue (132nd Avenue E)
- Valentine Avenue (136th Avenue E)
- Butte Avenue (138th Avenue E)
- 140st Avenue Ct. E
- New 8th Street intersection at Sta 69+/-
- New intersection for Greenwater Corporate Park at Sta 58+/-

Warrant assessments are made for both near and long-range future conditions. Year 2005 traffic (without proposed 24th Street interchange on SR167) are used as representative "opening day" conditions, while year 2025 traffic projections are utilized for the long-range future condition. The results of the warrant analysis at each study area intersection are discussed in the following sections. Details of the analysis are included in the Appendix.

Thornton Avenue (132nd Avenue E)
Year 2005 PM peak hour conditions are expected to generate up to 100 vehicles per hour (vph) on the south approach to this intersection, with up to 113 vph on the north approach under year 2025 PM peak hour conditions. Truck volumes are expected to represent about 10% of the Thornton Avenue approach volume (based on current counts).

As a single lane approach, this intersection would need to experience at least 150 vph for eight hours of an average day to meet the conditions of warrant #1, and at least 75 vph for eight hours to meet conditions of warrant #2. With 60% of the peak hour traffic assumed to be the 8th highest hour, this intersection can be expected to generate at least 66 vph (PCE's) or more for eight hours of an average day. Expected eight-hour traffic volume at this location is not sufficient to meet the conditions of warrant #1 or #2.

Conclusion: This location experiences 110 vph as PCE's under year 2005 PM peak hour conditions. This volume is sufficient to meet conditions of warrant #11 with the proposed single approach lane.

Valentine Avenue (136th Avenue E)
Year 2005 PM peak hour conditions are expected to generate up to 260 vehicles per hour (vph) on the south approach and up to 228 vph on the north approach at this intersection. Truck volumes are expected to represent about 21% of the south approach volume and 6% of the north approach volume of Valentine Avenue (based on current counts).

As a two-lane approach, this intersection would need to experience at least 200 vph for eight hours of an average day to meet the conditions of warrant #1, and at least 100 vph for eight hours to meet conditions of warrant #2. With 60% of the peak hour traffic assumed to be the 8th highest hour, this intersection can be expected to generate at least 189 vph (PCE's) or more for eight hours of an average day on the north approach. Expected eight hour traffic volume at this location is not sufficient to meet the conditions of warrant #1, but is sufficient to meet warrant #2 requirements.

Conclusion: This location experiences 316 vph as PCE's under year 2005 PM peak hour conditions (south approach). This volume is sufficient to meet conditions of warrant #11 with the proposed single approach lane.

Butte Avenue (138th Avenue E)
Year 2005 PM peak hour conditions are expected to generate up to 160 vehicles per hour (vph) on the north approach at this intersection. Truck volumes are expected to represent about 10% of the approach volume of Butte Avenue.

As a two-lane approach, this intersection would need to experience at least 200 vph for eight hours of an average day to meet the conditions of warrant #1, and at least 100 vph for eight hours to meet conditions of warrant #2. With 60% of the peak hour traffic assumed to be the 8th highest hour, this intersection can be expected to generate about 106 vph (PCE's) or more for eight hours of an average day on the north approach. Expected eight-hour traffic volume at this location is not sufficient to meet the conditions of warrant #1, but is sufficient to meet warrant #2 requirements.

Conclusion: This location experiences 176 vph as PCE's under year 2005 PM peak hour conditions. This volume is sufficient to meet conditions of warrant #11 with the proposed two-lane approach.

140th Avenue Ct. E

Year 2005 and 2025 PM peak hour conditions are expected to generate up to 280 vph on the south approach at this intersection. Truck volumes are expected to represent about 5-6% of the approach volume of this side street.

As a two-lane approach (south leg), this intersection would need to experience at least 200 vph for eight hours of an average day to meet the conditions of warrant #1, and at least 100 vph for eight hours to meet conditions of warrant #2. With 60% of the peak hour traffic assumed to be the 8th highest hour, this intersection can be expected to generate about 184 vph (PCE's) or more for eight hours of an average day on the north approach. Expected eight-hour traffic volume at this location is not sufficient to meet the conditions of warrant #1, but is sufficient to meet warrant #2 requirements.

Conclusion: This location experiences 308 vph as PCE's under year 2005 PM peak hour conditions. This volume is sufficient to meet conditions of warrant #11 with the proposed two-lane approach.

New 8th Street East Intersection at Sta 69 +/-

Traffic volumes were not generated for this intersection as part of the corridor geometric assessment. For purposes of this traffic signal warrant analysis, traffic volume was estimated based on information gathered from the Summer Meadows Golf Links. At that location, peak hour traffic varies from 40-80 vph, averaging about 65 vph during the week and about 68 vph on weekends. This peak usually occurs in the late morning or early afternoon. Data indicates that peak directional traffic is usually split 60/40 with the inbound peak occurring in the late morning and the outbound peak happening in the early afternoon. Peak approach traffic to 8th Street East is estimated to reach 35-40 vph. This volume is insufficient to meet the requirements of warrants 1, 2 or 11.

Greenwater Corporate Park Access

The proposed access to the Greenwater Corporate Park development was the subject of a Transportation Impact Analysis (TIA) prepared by SCA Engineering in December 1999. Traffic volumes projected for this access point were based on development intensity and proposed land use. The TIA states that a "signal will be required" for this intersection under year 2002 conditions. Based on trip generation estimates, this location meets conditions to satisfy warrants 1, 2 and 11.

Conclusions & Recommendations

This assessment examined projected traffic conditions to assess requirements of traffic signal warrants number 1, 2 and 11 as listed in the MUTCD. While not all locations are expected to meet the requirements of warrants #1 and #2, all locations except the 8th Street intersection at Sta 69+/- were estimated to meet the requirements of warrant #11. Table 1 contains a summary of the assessment conducted for study area intersections relative to warrants 1, 2 and 11.

Table 1 – Signal Warrant Summary

INTERSECTION	Year	Warrant #1	Warrant #2	Warrant #11	Signal Warranted?
Thornton Avenue	2005	No	No	Yes	Yes
	2025	No	No	Yes	Yes
Valentine Avenue	2005	No	Yes	Yes	Yes
	2025	No	Yes	Yes	Yes
Butte Avenue	2005	No	Yes	Yes	Yes
	2025	No	Yes	Yes	Yes
140 Ave. Ct. E	2005	No	Yes	Yes	Yes
	2025	No	Yes	Yes	Yes
New 8th Street Intersection at Sta 69+/-	2005	No	No	No	No
	2025	No	No	No	No
Greenwater Corp. Park Access	2005	Yes	Yes	Yes	Yes
	2025	Yes	Yes	Yes	Yes

Although an engineering study will be eventually required to fully assess the warrants under actual operating conditions, our opinion is that warrant #10 (peak hour delay) would be met at most locations studied, and that warrant #8 (combination of warrants) may also be met at many of the locations. Warrant #10, peak hour delay would likely be met at most locations under actual operating conditions, but would need to be assessed under actual observations. Further assessment of accident data would also enable more aggressive assessment of warrant #6 (accident experience).

Based on this assessment of corridor traffic and analysis of traffic signal needs, it is recommend that traffic signals be installed with the reconstruction project at Valentine Avenue, Butte Avenue, 140th Avenue Ct. East and at the proposed Greenwater Corporate Center access intersections.

CORRIDOR OPERATIONS ASSESSMENT

Corridor operations were assessed for future conditions assuming traffic signal control at all major intersections (SR167 ramps, Thornton Avenue, Valentine Avenue, Butte Avenue, 140th Avenue Ct. E. and the Greenwater Corporate Park access). Traffic signal operations for the corridor were assessed utilizing the Syncro V4.0 software platform. Intersection operating conditions are reported as level of service (LOS) in accordance with the methods and procedures specified in the Highway Capacity Manual. Intersection LOS is based on average vehicle delay expected and is reported using letter grades from A to F. Much like school grades, LOS A represents excellent operating conditions of free flow traffic with little delay or congestion, while LOS F represents congested conditions characterized by long traffic queues and excessive delays.

The corridor assessment was undertaken to determine how the corridor, as well as the individual intersections, would function under expected future traffic loads and signal control. The assessment was also used to determine required intersection geometry to maintain adequate level of service conditions. For purposes of this assessment, minimum "acceptable" operating conditions were defined as overall LOS D conditions with no single movement or lane group operating below LOS D.

Since 8th Street East is being constructed as a 5-lane facility (two traffic lanes in each direction with continuous left turn lane), this geometry was utilized as a starting point for the corridor assessment. (A three-lane section was tested for 8th Street East for year 2005 conditions (without 24th Street Interchange) and found unacceptable. With only three through lanes, intersections or individual lane groups fell below the acceptable LOS standard of LOS D overall, and at some locations, individual lane groups fell to LOS F. Details of the three-lane assessment, including a summary LOS table, are provided in the Appendix.) Initial operational assessments were performed without benefit of any auxiliary lanes (turn lanes). Without separate turn-bays for left turns, the corridor was found to operate at conditions below acceptable minimums since waiting left-turn vehicles reduced through lane capacity.

Next, left-turn lanes were added at intersections and allowed to function as permitted movements everywhere except at the Greenwater Corporate Park access. Since a double left-turn lane is anticipated at this location, this movement was programmed for protected-only left-turn phasing. As permitted movements, left turn traffic does not have a protected signal phase and must yield to opposing through traffic. The addition of left turn bays and protected-only phasing at the Greenwater Corporate Park access improved intersection operations to acceptable levels throughout the study area. The cross-product of eastbound and westbound conflicting flows suggests, however, that protected left-turn phasing may be desirable at 136th, 138th and 140th Avenues. The need for protected left-turn phasing at these locations should be re-examined periodically and compared against local policy for implementation at these locations.

This assessment was conducted for six (6) different corridor scenarios:

1. 2005 AM Traffic without the proposed 24th Street interchange with SR167
2. 2005 PM Traffic without the proposed 24th Street interchange with SR167
3. 2005 AM Traffic with the proposed 24th Street interchange with SR167
4. 2005 PM Traffic with the proposed 24th Street interchange with SR167
5. 2025 AM Traffic (24th Street interchange assumed)
6. 2025 PM Traffic (24th Street interchange assumed)

The assessments were conducted in the order listed above to examine the need for additional auxiliary lanes or different traffic control schemes as the model scenario changed. Conducting the assessment in this manner allowed a determination of when particular improvements may be required to serve projected traffic demands. The assessment indicated that left-turn bays will be required by the year 2005 for the southbound approach at Butte Avenue (138th Ave. E.) and for the northbound approach at 140th Avenue Ct. East. Intersection lane requirements to provide adequate level of service are shown for 2005 conditions in Figure 12. Figure 13 shows lane requirements for year 2025 traffic conditions.

In addition to modeling and optimizing individual intersections, the Syncro platform also performs signal timing optimization for optimum corridor progression. With good progression, vehicles are able to move through the entire corridor with minimal stops or delays. A progression assessment will ascertain if potential signal locations can fit within a good progression scheme, or if a proposed location will degrade overall corridor progression.

Corridor progression can be measured with several "yardsticks". Generally, corridor bandwidths as well as the number of total stops incurred are the measures utilized to compare progression potential. Bandwidth is the theoretical 'window' of time that exists where a vehicle can travel through the entire corridor without encountering a red light and is calculated independently of traffic volumes. Total stops are a measure of vehicle stops predicted for traffic traveling the corridor during the peak hour and takes vehicle queuing into consideration. Generally more weight is given to minimizing the number of stops since doing so will usually reduce the travel time through the corridor and reduce the potential for rear-end type accidents.

The progression assessment indicated that good signal progression is feasible for all potential signalized locations between the SR167 northbound ramp intersection to the Greenwater Corporate Park intersection. Although the number of total stops is small, large bandwidths are limited by the use of protected left-turn phasing at the Greenwater Corporate Park entrance. With the exception of this location, link bandwidths are typically 40 seconds or greater for all scenarios modeled. Intersection levels of service and progression parameters for various build scenarios are summarized in Table 2 and Table 3. Complete details of corridor and intersection analysis are contained in the Appendix.

Table 2 – Intersection Level of Service

SCENARIO	INTERSECTION LEVEL OF SERVICE					
	SR167 NB Ramps	Thornton Avenue	Valentine Avenue	Butte Avenue	140th Ave.Ct.E	Greenwater Corp. Pk.
2005 AM without 24th St. Interchange	B	A	A	A	A	B
2005 PM without 24th St. Interchange	A	A	A	A	A	B
2005 AM with 24th St. Interchange	A	A	A	A	A	B
2005 PM with 24th St. Interchange	A	A	B	A	A	B
2025 AM (with 24th St. Interchange)	B	A	A	A	A	C
2025 PM (with 24th St. Interchange)	B	A	A	A	A	B

Table 3 – Corridor Performance Summary

SCENARIO	PERFORMANCE MEASURE			
	EASTBOUND BANDWIDTH	WESTBOUND BANDWIDTH	STOPS / VEH	TOTAL STOPS
2005 AM without 24th Street Interchange	35	21	0.33	5,307
2005 PM without 24th Street Interchange	39	32	0.39	6,389
2005 AM with 24th Street Interchange	55	34	0.34	4,842
2005 PM with 24th Street Interchange	50	30	0.38	6,995
2025 AM (with 24th Street Interchange)	28	32	0.32	5,934
2025 PM (with 24th Street Interchange)	14	19	0.42	7,792

A discussion of corridor progression is not complete without a discussion of the impacts of the SR167 interchange ramps. The southbound SR167 ramp intersection and the West Valley Highway intersection were both included in corridor modeling. In addition, the traffic demand expected within the corridor indicates improvements west of the northbound SR167 ramp intersection would be required to maintain acceptable levels of service at the SR167 northbound ramp intersection. Through volumes expected at this intersection indicate the need for a four-lane facility to the west as well. The following section discusses how the interchange could impact corridor operations.

SR167 INTERCHANGE OPERATIONS

The SR167 ramp intersections with 8th Street East are in close proximity to each other, and the southbound ramp intersection is located extremely close to the 8th Street intersection with the West Valley Highway. Such close spacing leaves little room for storage of queued vehicles. Heavy traffic demand, coupled with the close spacing of these intersections makes it very difficult to maintain acceptable levels of service at the intersections, or to maintain adequate progression through the intersections. The Washington Department of Transportation recognizes the limitation of the current physical configuration and will be evaluating near-term and long-range plans to improve conditions at this interchange. One possible solution includes re-routing the southbound SR167 off-ramp to the West Valley Highway north of 8th Street East. This reconfiguration would alter traffic demands for 8th Street East intersections west of the northbound ramp intersection. Since the focus of this investigation is 8th Street East to the *east* of the northbound SR167 ramp intersection, an assessment of the reconfigured interchange was not performed. Instead, the current interchange configuration was included in the Syncro model, although was not allowed to have an influence in the progression optimization procedure. Designating a 'zone number' for intersections east of, and including the SR167 northbound ramps accomplished this. Progression assessment and intersection operations were optimized only for intersections with the appropriate zone designation (only for study area intersections).

Even though the interchange ramps and West Valley Highway intersections were not allowed to dictate parameters that could influence, or degrade progression for the remainder of the corridor, operational conditions were reported for these locations by the Syncro model. The model indicates that the interchange will reach capacity by the year 2005 if development along the 8th Street corridor progresses as anticipated. Near the 2005 horizon, the West Valley Highway and

SR167 southbound ramp intersections with 8th Street East will operate at overall LOS D or worse. Some traffic movements or lane groups will suffer unacceptably low levels of service (LOS E and LOS F). The model also indicates that queuing requirements frequently exceed the spacing of the intersections and spill back through adjacent intersections, suggesting the need for double left-turn lanes or additional through lanes. Physical improvements of this magnitude would require significant interchange reconstruction, including replacing the overpass with a structure of longer span.

To adequately assess operations of the study area segment of the 8th Street East corridor, interchange operations were not allowed to degrade performance of the corridor. Some capacity improvements were assumed to be in-place (i.e. the ability of 8th Street to carry two through lanes westbound beyond the northbound SR167 ramp intersection). These assumptions were necessary to complete analysis of the 8th Street East corridor within the study limits. Assumed improvements are evident on Figure 10 which shows lane requirements for acceptable operating level of service.

CORRIDOR GEOMETRY RECOMMENDATIONS

The analysis conducted was used to determine the auxiliary lanes needed to provide acceptable operating level of service. Based on the analysis performed, the required geometry for corridor auxiliary lanes can now be estimated. This section discusses the length of auxiliary lanes necessary to accommodate expected vehicle queues.

Since the year 2025 forecast represents the heaviest traffic volume, and since roadway improvements should be constructed for long-range future projected conditions, the queuing requirements for year 2025 operations will be utilized for geometric recommendations. Both the morning and evening peak hour conditions were examined to determine the worst-case requirements for intersection geometry. When considering lengths of left and right turn lanes, the length of the through movement queues is also considered so that access to the auxiliary lane is not blocked. For purposes of this assessment, queuing requirements utilized will represent 95th percentile queuing... that is the queue length that is not expected to be exceeded for 95% of signal cycles during the peak period.

Auxiliary turn lanes serve two distinct functions within the corridor; they provide storage for turning vehicles so through lanes remain unimpeded, and they provide space for turning vehicles to decelerate clear of through traffic to retain capacity in the through lanes. Auxiliary lanes have three components; entering taper, deceleration length and storage length. Ideally all three should be provided. In urban locations, however, it is common to forgo most of the deceleration length typically allocated and provide only storage and taper, accepting that some of the deceleration will take place in the through lane. This practice has evolved due to the expense of providing longer auxiliary lanes and the frequency of intersections typical of urban environments.

It is the recommendation of this study that auxiliary left-turn lanes provide full storage requirements and taper length. Due to the large percentage of truck traffic within this corridor, it is recommended that auxiliary turn lanes provide a minimum of 100 ft. for storage lengths. Based on a 35mph travel speed, auxiliary lane entering tapers of 8:1 to 12:1 are appropriate. (It should be noted that taper ratios recommended are for auxiliary lane entering tapers only. Transition sections where roadway cross section changes from two to four lanes or vice-versa should be provided with much longer tapers on the order of 20:1.)

Each major intersection within the study area of 8th Street East was examined for queuing requirements. Table 4 lists the 95th percentile queues expected for left turn and through lane approaches to all intersections within the study area. Table 5 lists recommended storage

requirements for study area auxiliary lanes. Details of queuing analysis are contained in the appendix to this memorandum.

Table 4 - Year 2025 95th Percentile Queue Length

INTERSECTION	95TH Percentile Queue Length (ft.)							
	EBL	EBTh	WBL	WBTh	NBL	NBTh	SBL	SBTh
NB SR167 Ramps								
AM Peak Hour	109	213	N/A	194	N/A	138	N/A	N/A
PM Peak Hour	141	179	N/A	425	N/A	91	N/A	N/A
Thornton Ave (132nd)								
AM Peak Hour	4	24	5	323	N/A	42	N/A	27
PM Peak Hour	7	124	3	87	N/A	61	N/A	80
Valentine Ave (136th)								
AM Peak Hour	112	0	40	143	118	77	132	23
PM Peak Hour	78	81	5	0	133	29	44	74
Butte Ave (138th)								
AM Peak Hour	119	64	N/A	13	N/A	N/A	133	N/A
PM Peak Hour	74	196	N/A	76	N/A	N/A	70	N/A
140th Avenue Ct. E.								
AM Peak Hour	43	179	2	12	57	16	N/A	18
PM Peak Hour	12	37	22	224	129	53	N/A	51
Greenwater Corp. Pk.								
AM Peak Hour	206	115	131	381	103	26	146	26
PM Peak Hour	60	56	66	187	129	20	207	16

Table 5 - Recommended Intersection Geometry

INTERSECTION	Recommended Minimum Auxiliary Lane Length (ft. – excluding taper*)							
	EBL	EBR	WBL	WBR	NBL	NBR	SBL	SBR
NB SR167 Ramps	250**	N/A	N/A	N/A	N/A	350	N/A	N/A
Thornton Ave (132nd)	150	N/A	325	N/A	N/A	N/A	N/A	N/A
Valentine Ave (136th)	125	N/A	150	N/A	150	N/A	150	N/A
Butte Ave (138th)	200	N/A	100	N/A	N/A	N/A	150	N/A
140th Avenue Ct. E.	200	N/A	225	N/A	150	N/A	N/A	N/A
Greenwater Corp. Pk.	250***	N/A	400	N/A	150	50	225	175

*Auxiliary lane entering tapers of 8:1 (96 ft. for 12 ft. lane widths) are recommended in addition to lane length specified.
**Approximately ½ of distance between ramps, less 96 ft. for shared lane taper.
***Double left-turn lane

UP RAILROAD CROSSING

The UP Railroad crosses 8th Street at-grade just west of Butte Avenue (138th Ave. E.). Preliminary design efforts have examined alternatives to provide a grade separation at this location by taking 8th Street underneath the UP tracks. It is also proposed to raise the elevation of the railroad tracks to ease the geometry of going under the tracks and over the Stuck River. Due to the proximity of the UP grade crossing to the Butte Avenue intersection, it is also necessary to examine the potential vehicle queues which may result should the railroad crossing remain at-grade with 8th Street.

To examine the potential vehicle queue, information about train speed and length was obtained from discussions with the UP. Train frequency information was also obtained. Based on information provided by the UP, two to three trains are expected to use this crossing during

morning and evening peak traffic periods in the future. Trains are expected to be traveling about 45mph and will be approximately 6,000 ft. long.

Due to the traffic volumes expected on 8th Street East and the expected speed of approaching trains, it will be assumed in this study that the "active" traffic control devices already in place will continue to be utilized at the grade crossing. (Active controls are devices that are activated by approaching trains. Active controls may consist of flashing lights, bells, gates, or all three. Active controls may also include preemption of vehicle traffic signals located near the grade crossing.)

The Manual of Uniform Traffic Control Devices (MUTCD) recommends preemption of traffic signal devices when an at-grade railroad crossing is located within 200 feet of a traffic signal. The latest rewrite of the MUTCD will likely mandate preemption at this distance. In this case, the at-grade crossing is located about 260 feet from the Butte Avenue (138th Ave. E.) intersection, indicating that signal preemption should be strongly considered to ensure traffic queues from the signal are allowed to clear the railroad tracks in advance of an approaching train.

Even with signal preemption, 8th Street East will be blocked for some time with the passage of a train. Using 6,000 ft. long trains traveling at 45mph, and assuming advance warning of 20 seconds, each train crossing will effectively close the roadway to traffic for approximately 115 seconds (almost 2 minutes). Closing 8th Street East to traffic will cause a queue of vehicles to form. Even when the roadway is re-opened, the queue will continue to form until the last vehicle in the original queue begins to move.

Using queuing formulas obtained from the Northwestern Traffic Institute's Highway-Railroad Grade Crossing Workshop, year 2025 peak hour traffic could queue to lengths of 800 ft. in the westbound direction and up to 700 ft. in the eastbound direction during each closure. Queuing of this magnitude will block adjacent intersections and will take several signal cycles to clear. With trains expected to cross 8th Street two to three times during the peak hour, and with as few as 40 signal cycles per hour, train traffic could cause severe congestion for well over one-third of the peak hour signal cycles.

In addition, with over 25,000 vehicles per day forecast for 8th Street, the potential exposure and safety aspects of this grade crossing suggest that a grade separation should be strongly considered.

CONCLUSIONS & RECOMMENDATIONS

Development within and near the 8th Street East corridor will increase year 2025 traffic to levels over twice existing daily volume. Planned widening of 8th Street East to a five-lane facility will provide adequate capacity to meet expected 20-year forecasted demand. Expected traffic signal installations within the corridor will provide good level of service for major intersections and can be implemented without any significant detrimental impacts to corridor level of service or traffic progression. To adequately and safely handle expected future traffic demands within the corridor, left-turn auxiliary lanes are recommended for 8th Street at signalized intersections. As a minimum, these left-turn lanes should provide 100 feet of deceleration/storage length with a minimum 8:1 (96 ft.) entering taper. A double left-turn lane is necessary for the eastbound approach to the Greenwater Corporate Park access, as recommended in the traffic study for that development. Left turn auxiliary lanes should also be provided for side street approaches at Valentine Avenue (136th Ave. E.), Butte Avenue (138th Ave. E.) and 140th Avenue Ct. East. Side street approaches for the Greenwater Corporate Park access should provide separate lanes for left, through and right-turn approach traffic (as recommended in the traffic study for the Greenwater Corporate Park).

To eliminate exposure and reduce delays in the corridor, the crossing of the UP Railroad tracks should be grade-separated.