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MEMORANDUM

Date:	April 19, 2010	**TG:**	10046.00
To:	Desiree Winkler, PE, City of Lakewood		
From:	Jon Pascal, PE, PTOE, Transpo Group Jesse Birchman, PE, Transpo Group		
Subject:	Union Avenue SW Traffic Simulation Modeling – Summary of Results		

The purpose of this memorandum is to summarize the traffic simulation modeling that was conducted to evaluate alternative improvement scenarios along the Union Avenue SW corridor in the Tillicum neighborhood of Lakewood. The simulation modeling was performed to better highlight traffic operational issues and solutions in regards to the numerous business driveways along the corridor. The City is considering improvements to the corridor to address property access, operations, and safety. The improvement alternatives that were evaluated include:

1. **No-Build** – No modifications to the existing roadway.

2. **Three Lane** – Construct a three-lane roadway section between Berkeley Street to Maple Street. The new lane would be a two-way left-turn lane to serve left-turning vehicles.

3. **Median with U-Turns** – Construct a three-lane roadway section between Berkeley Street to Thorne Lane, and install a median barrier to prohibit left-turns to and from Union Avenue from Thorne Lane to Maple Street. Widen the intersections with Thorne Lane and Maple Street to allow for U-turns (could include roundabouts).

The analysis of these improvement alternatives included the collection of existing data along the Union Avenue SW corridor, forecasting future volume conditions, and modeling anticipated traffic operations using a traffic simulation software program. Traffic simulation is a tool to evaluate corridor performance measures such as travel times, average speeds, delays, and vehicle queuing. In addition, traffic simulation accounts for inter-connected operations, such as vehicle queues extending from one intersection into and through another adjacent intersection, and provides detailed results for system/corridor-wide traffic operations.

This following summarizes the comparitive traffic simulation results for the three alternative roadway configurations along Union Avenue SW for the mid-day peak hour. A further description of existing traffic volumes and the methodology used to forecast future traffic is provided, along with an overview of the simulation methodology and the results for each improvement alternative.

Existing Traffic Volumes

Existing mid-day peak hour traffic volumes were collected along Union Avenue in March 2010 at each roadway intersection and driveway or parking lot location between Berkeley Street and Maple Avenue, including the intersections at Thorne Lane and Orchard Street. The study focused on the mid-day PM peak hour due to the large number of soldiers and civilian employees from Joint Base Lewis-McChord (JBLM) that travel outside the installation during lunch. The fast-food restaurants and retail shops in Tillicum are a major attraction during this time period. This was the most logical time period to evaluate due to the numerous turning movements along the corridor.

Several adjustments were made to the existing traffic volumes collected in March due to construction activities in the Tillicum neighborhood related to the Sewer Extension Project. The adjustments accounted for shifts in traffic due to construction on Union Avenue north of the Maple

Street intersection. In addition, further adjustments accounted for the large number of JBLM personnel (approximately 17,000 soldiers) that are currently deployed overseas. The specific adjustments to the existing mid-day traffic volumes included:

- Some right-turns from Maple Street onto Union Avenue and left-turns onto Maple Street were reassigned to Union Avenue through movements at the Maple Street intersection.

- Traffic volumes to and from JBLM were increased throughout the study area to account for the eventual return of currently deployed personnel. They were increased by approximately 30-percent.

Existing (2010) adjusted traffic volumes for the mid-day peak hour are shown in Attachment A.

Future Traffic Volumes

The existing 2010 adjusted traffic volumes were used as a basis for developing forecast 2030 traffic volumes for the study area. By 2011, it is assumed the Main Gate to Camp Murray will be relocated from Union Avenue SW to Portland Avenue SW. The new Main Gate will replace the existing Main Gate and will result in changes in travel patterns within the Tillicum neighborhood and along Union Avenue SW. Based on this, traffic to and from the existing Camp Murray Main Gate was reassigned throughout the Tillicum neighborhood to account for the relocation of the gate to Portland Avenue SW, consistent with Camp Murray's traffic study.

Once the Camp Murray traffic reassignments were made, the resulting traffic volumes were grown at an average annual rate of 1-percent per year. The growth rate was derived from the City of Lakewood travel demand model which accounts for expected growth at JBLM and within the Tillicum neighborhood. The growth was assumed to be spread out through the area consistent with the Tillicum Neighborhood Plan. No significant changes in land use were assumed for Union Avenue SW, other than some additional commercial businesses similar to those that exist today. The one percent annual growth rate results in an increase in traffic volumes at study area intersections and driveways of approximately 23-percent over existing 2010 adjusted conditions. The resulting forecast 2030 traffic volumes are shown in Attachment B.

Model Development

Operations for each Union Avenue SW alternative were analyzed using a microsimulation model, where individual vehicles and driver behavior are simulated. Compared to other traffic operations software such as Synchro, vehicle-based traffic simulation models are more effective tools for design and performance evaluation on a network or corridor-wide level, where as Synchro analyzes the operations of individual intersections regardless of the surrounding network. The results from Synchro are based on empirical equations designed to evaluate the performance of each intersection, but their calculations typically lack a robust ability to incorporate impacts of surrounding intersections and driveways. Traffic simulation models provide a better understanding of system-wide impacts and performance characteristics when evaluating design options.

The VISSIM microsimulation computer software program was used to build a roadway network model. This model was then visually calibrated to approximate expected conditions under the no-build alternative. The network was constructed such that southeast-bound traffic on Berkeley Street would stop at the southbound I-5 ramps intersection, as occurs under existing conditions.

Simulation Findings

To provide a basis for comparison of the improvement alternatives, several performance measures were identified. The performance measures focused on network-wide metrics and were used to compare and contrast each of the improvement alternatives. They included:

- **Total Travel Time** - The total time that all simulated vehicles traveled on the simulated network.
- **Average Stopped Delay** – The average time that all vehicles were stopped.
- **Average Total Delay** – The average time that vehicles were delayed, including effects from congestion, slow moving vehicles, and time spent stopped.
- **Total Distance Traveled** – The distance travelled by all vehicles.

In addition to these network-wide measures, the average travel speed for vehicles that travel along Union Avenue between Berkeley Street and Maple Street was also analyzed. Operational results of the three alternatives are shown in Table 1. Results are an average of five replicate simulation runs.

Table 1. Union Avenue Modeling – Comparison of Alternatives (2030)[1]

	Alternatives			Percentage Difference from No-Build	
Performance Measure	**No-Build**	**Three-Lane**	**Median w/U-turns**	**Three-Lane**	**Median w/U-turns**
Time					
Total Travel Time [hours]	95.5	95.8	101.3	0.3%	6.1%
Avg. Stopped Delay per Vehicle [seconds]	89.8	90.6	78.4	0.8%	-12.7%
Avg. Delay Time per Vehicle [seconds] **Network-wide*	110.2	110.5	104.3	0.3%	-5.3%
*Berkeley to Thorne *Segment*	*67.7*	*72.3*	*62.6*	*6.8%*	*-7.6%*
*Thorne & East *Segment*	*27.0*	*25.5*	*33.7*	*-5.4%*	*24.7%*
Speed					
Average Northbound Travel Speed [mph]	22.3	20.5	21.6	-7.9%	-3.3%
Average Southbound Travel Speed [mph]	4.7	5.0	10.9	6.4%	131.0%
Distance					
Total Distance Traveled [miles]	661.5	665.5	865.8	0.6%	30.9%

1. Results shown are an average of 5 replicate simulation runs.

As shown in Table 1, results for the no-build and three-lane alternatives are similar while the U-turn alternative has larger differences from the no-build.

- Compared to the no-build, total travel time, average stopped delay, and average total delay increase by less than 1-percent under the three-lane alternative. In contrast, total travel time increases under the U-turn alternative, but overall network delays decrease by 5-percent and the average time stopped decreases by almost 13-percent. This shows that little is gained from a network perspective when constructing a three-lane roadway section, and that vehicles will spend more time driving but are delayed less under the U-turn alternative.

- Delays for the segment of Union Avenue SW between Berkeley Street SW and W Thorne Lane increase by 7-percent under the three-lane alternative from no-build conditions, and decrease by 8-percent under the U-turn alternative. This variation is primarily the result of congested conditions along this segment and does not necessarily indicate significantly improved or worsened conditions. Similarly, delay beyond W Thorne Lane only improves by 5-percent under the three-lane alternative and is similar in magnitude to the variation observed between Berkeley Street SW and W Thorne Lane. However, under the U-turn alternative, delays east of W Thorne Lane increase by 25-percent and are a result of concentrating all left-turning vehicles along this segment at the U-turn locations at W Thorne Lane and Maple Street SW.

- Average travel speeds in the northbound direction would decrease approximately 3 and 8-percent from no-build conditions under the three-lane and U-turn alternatives, respectively. Southbound travel speeds would increase by 6-percent under the three-lane alternative, but under the U-turn alternative would increase by 131-percent, more than doubling the speed under no-build conditions. This increased speed is the result of concentrating southbound left-turning vehicles at Thorne Lane which results in a concentration of the vehicles that would otherwise begin to slow before turning left across northbound traffic under either the no-build or three-lane alternatives. In addition, adequate storage for the southbound Union Avenue SW U-turn to prevent U-turn vehicles from blocking the southbound through lane. Preventing this blockage decreases the likelihood of the southbound Union Avenue SW queues (due to the I-5 interchange) from extending past W Thorne Lane. Preventing this blockage and concentrating the slowing for southbound Union Avenue SW left-turns and U-turns into one location results in higher southbound travel speeds.

- The total distance travelled by vehicles under the three-lane alternative is less than 1-percent different from no-build conditions. In constrast, the distance travelled under the U-turn alternative is approximately 31-percent greater than no-build conditions and is a direct result of left-turn restrictions along Union Avenue SW. Storage lengths at the U-turn lanes would need to accommodate a 95th-percentile queue of 226 feet at Thorne Lane and 208 feet at Maple Street.

- Each alternative still results in severe congestion along Union Avenue SW and Berkeley Street SW caused by the I-5 interchange at Berkeley Street SW. Because of the layout of this interchange, not enough signal green time is provided to the eastbound Berkeley Street SW movement which serves both the eastbound Berkeley Street SW and southbound Union Avenue SW movements traveling towards the I-5 interchange. As a result, vehicle queues extend from the interchange through the Union Avenue SW/Berkeley Street SW intersection on both Union Avenue SW and Berkeley Street SW.

Conclusions

Unfortunately the traffic simulation results, including observation of the video clips, indicate that operating conditions do not significantly improve over no-build conditions for both the three-lane and U-turn improvement alternatives. However, this traffic analysis assumed existing land use patterns remain similar to those today. The businesses along Union Avenue SW are small and dispersed enough where a two-way left-turn lane is not necessary to serve the required trip demand. If the types of businesses or the intensity of land use significantly changes from those observed today, the resulting traffic demand may warrant consideration of a dedicated left-turn lane. As consistent with City guidelines, it is recommended that the City review each development and land use change to determine its specific trip generation and whether any improvements are needed to address safety or operational issues – such as a left-turn lane into the proposed development.

Even though the analysis was inconclusive in regards to improvements along the entire corridor, there are several other specific improvements to consider based on a closer look at the traffic simulation evaluation. They include the following:

- Left-turns could be restricted by using C-curb along the Union Avenue SW centerline between Berkeley Street SW and W Thorne Lane. This would prevent left-turning vehicles from blocking northbound Union Avenue SW and creating a northbound queue that would extend through the Union Avenue SW/Berkeley Street SW intersection and possibly across the railroad tracks.

- The east and west legs of the Union Avenue SW/Berkeley Street SW intersection could be widened to accommodate a second eastbound lane. This additional through lane could function as a drop lane for traffic traveling from Berkeley Street SW or Union Avenue SW to southbound I-5 to bypass queued vehicles waiting to cross I-5 at the interchange.

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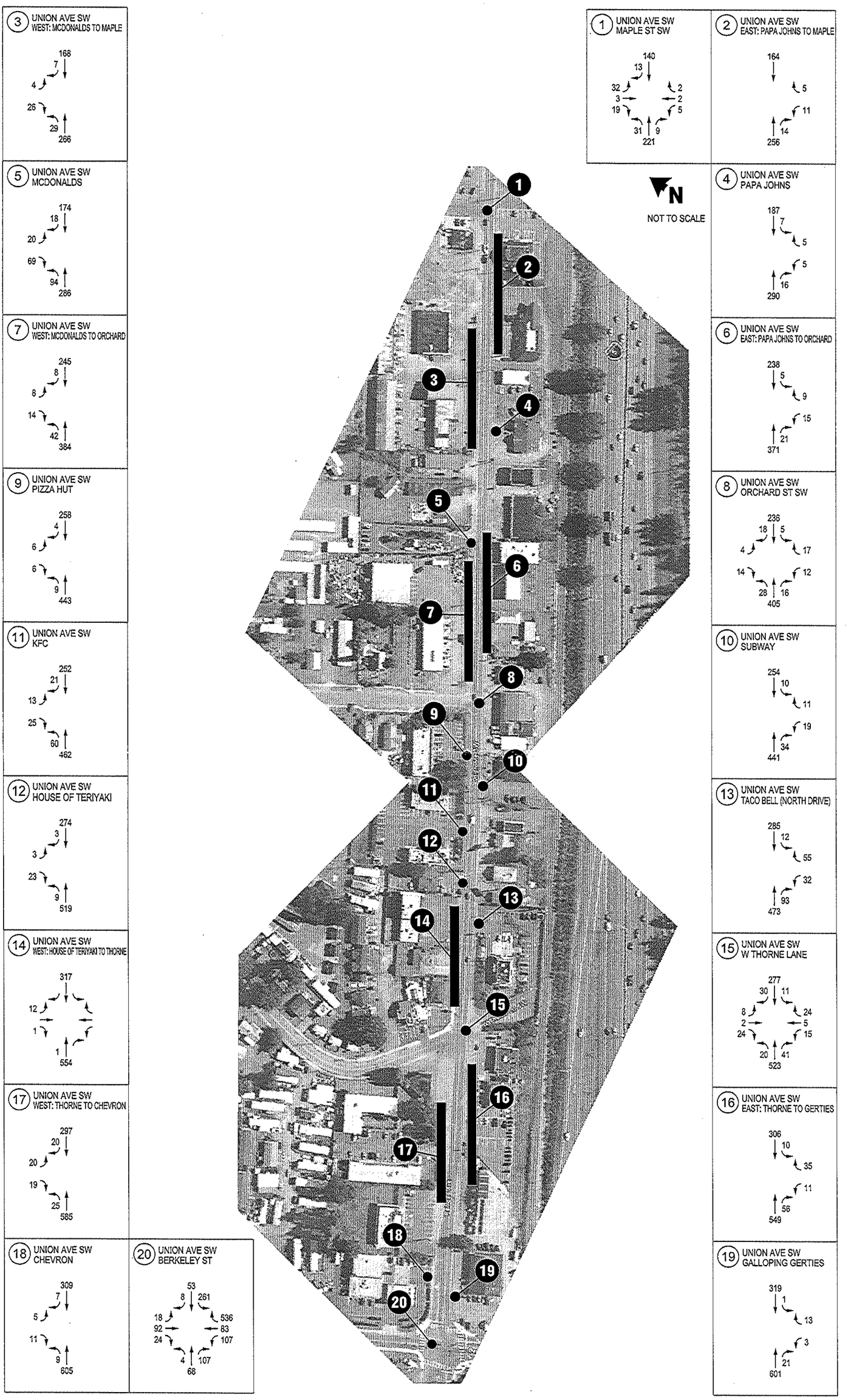

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2010 Adjusted Existing Mid-Day Volumes

Union Avenue Modeling

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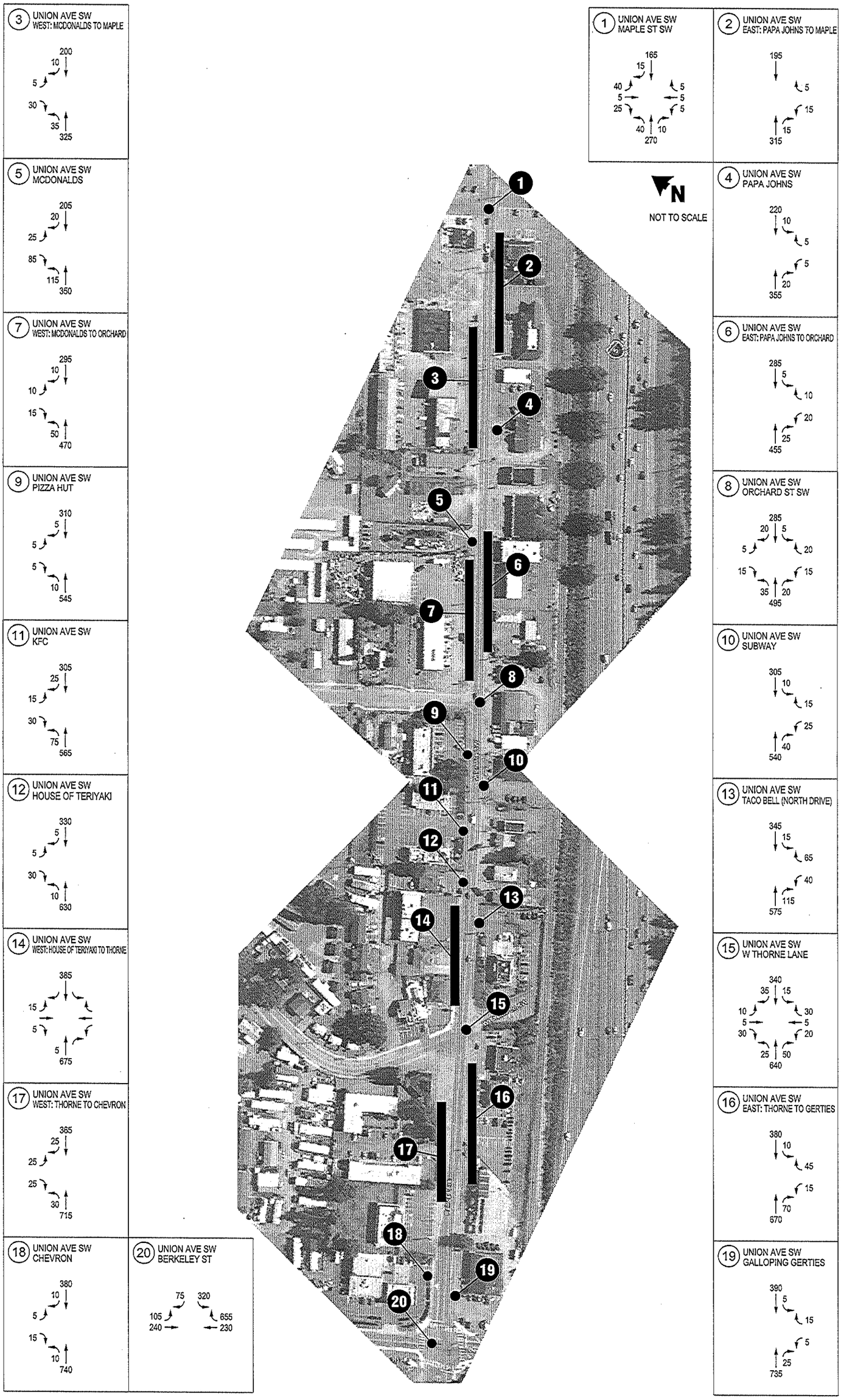
ATTACHMENT 1



2030 Forecast Mid-Day Volumes

Union Avenue Modeling

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ATTACHMENT 2

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